



# Influence of habitats on fish assemblages in tropical marine coastal areas of the Southwestern Atlantic

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In the Southwestern Atlantic, estuarine and marine habitats connect to form biodiverse coastal landscapes. However, the structuring relationships of the assemblages in these landscapes are not yet fully understood. In this context, we sought to investigate the composition of fish assemblages from estuarine and marine habitats: mangroves, artificial structures, sandstone and coral reefs. We also sought to understand the relationship between the assemblages of these habitats by means of similarity. The research was carried out in the RESEX de Jequiá (RXJ) - AL and in Porto Seguro (PTS) - BA, using single Baited Underwater Video (BRUV). At total, 80 samples were taken (40 per location). The coral reef samples stood out significantly, with the greatest richness and abundance at both locations. RXJ had 18% similarity between its habitats, while PTS had 31%, indicating a relationship and the sharing of species in the composition of their assemblages. Sandstone reefs proved to be structural links between mangroves and coral reefs. Additionally, habitat characteristics and depth significantly influence the composition of the assemblages. Here we highlight relevant information for tropical areas little investigated by science in the Southwestern Atlantic, especially with regard to the importance of coastal sandstone reefs.

**Keywords:** BRUV, Conservation, Ecology, Ichthyofauna, Reef.

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No Atlântico Sul ocidental, habitats estuarinos e marinhos se conectam para formar paisagens biodiversas. Contudo, as relações estruturantes das assembleias dessas paisagens ainda não são totalmente conhecidas. Nesse contexto, buscamos investigar a composição das assembleias de peixes de habitats estuarinos e marinhos: mangues, estruturas artificiais, recifes costeiros de arenito e recifes de coral. Também buscamos conhecer a relação entre as assembleias desses habitats por meio da similaridade. A pesquisa foi desenvolvida na RESEX de Jequiá (RXJ) – AL e em Porto Seguro (PTS) – BA, com a utilização de vídeos subaquáticos remotos simples com isca. No total foram coletadas 80 amostras (40 por localidade). As amostras de recifes de coral destacaram-se significativamente, com maior riqueza e abundância em ambas as localidades. A RXJ obteve a similaridade de 18% entre os seus habitats, enquanto PTS dispôs de 31%, indicando relação e compartilhamento de espécies na composição de suas assembleias. Recifes de arenito demonstraram serem elos estruturantes entre mangues e recifes de coral. Assim como, possivelmente, as características dos habitats e a profundidade são fatores que influenciaram a composição das assembleias. Destacamos aqui informações relevantes para áreas tropicais pouco investigadas pela ciência no Atlântico Sudoeste, especialmente no que diz respeito à importância dos recifes costeiros de arenito.

**Palavras-chave:** BRUV, Conservação, Ecologia, Ictiofauna, Recifes.

## INTRODUCTION

In the tropical zones of the Southwestern Atlantic, mosaics of estuarine and marine habitats interconnect to form highly productive and biodiverse landscapes (Nagelkerken *et al.*, 2015; Bradley *et al.*, 2017). These habitats are isolated from each other and each have unique abiotic characteristics, but their fish assemblages can have levels of overlap. This leads to the formation of complex and integrated functional networks, which are interdependently connected and create intrinsic ecological niches (Berkström *et al.*, 2013; Bradley *et al.*, 2017; Reis-Filho *et al.*, 2019). The habitat characteristics also provide important mechanisms for selecting and structuring fish assemblages, as well as conditioning possible connectivity patterns, between estuarine and marine environments (Bradley *et al.*, 2017; Reis-Filho *et al.*, 2019; Araujo *et al.*, 2020).

Inserted in this tropical mosaic, estuaries have fish assemblages composed of juvenile marine species, resident species, and occasional visitors (Sampaio *et al.*, 2015). In the estuary, the mangrove functions as a critical nursery for larvae and fry brought in by the currents and tides, and serves as the destination or migration route for reproductive purposes for many species (Aschenbrenner *et al.*, 2016; Roocker *et al.*, 2018). Close to estuaries and parallel to the coastline, sandstone reefs — common in the tropical Southwest Atlantic — are the result of the consolidation of old beaches or sandbanks through the sedimentation of calcium carbonate or iron oxide (Correia, 2011). These habitats can also double as nurseries for exclusively marine species or immature fish that migrate from mangroves (Moura *et al.*, 2011; Aschenbrenner *et al.*, 2016; Sampaio

*et al.*, 2015). They represent transitional habitats, the junction between mangrove and coral reef ichthyofauna (Moura *et al.*, 2011; Aschenbrenner *et al.*, 2016). Together, these environments provide important ecological services and house ecosystems with great biodiversity, being among the marine habitats with the highest concentration of biomass (Nunes *et al.*, 2022).

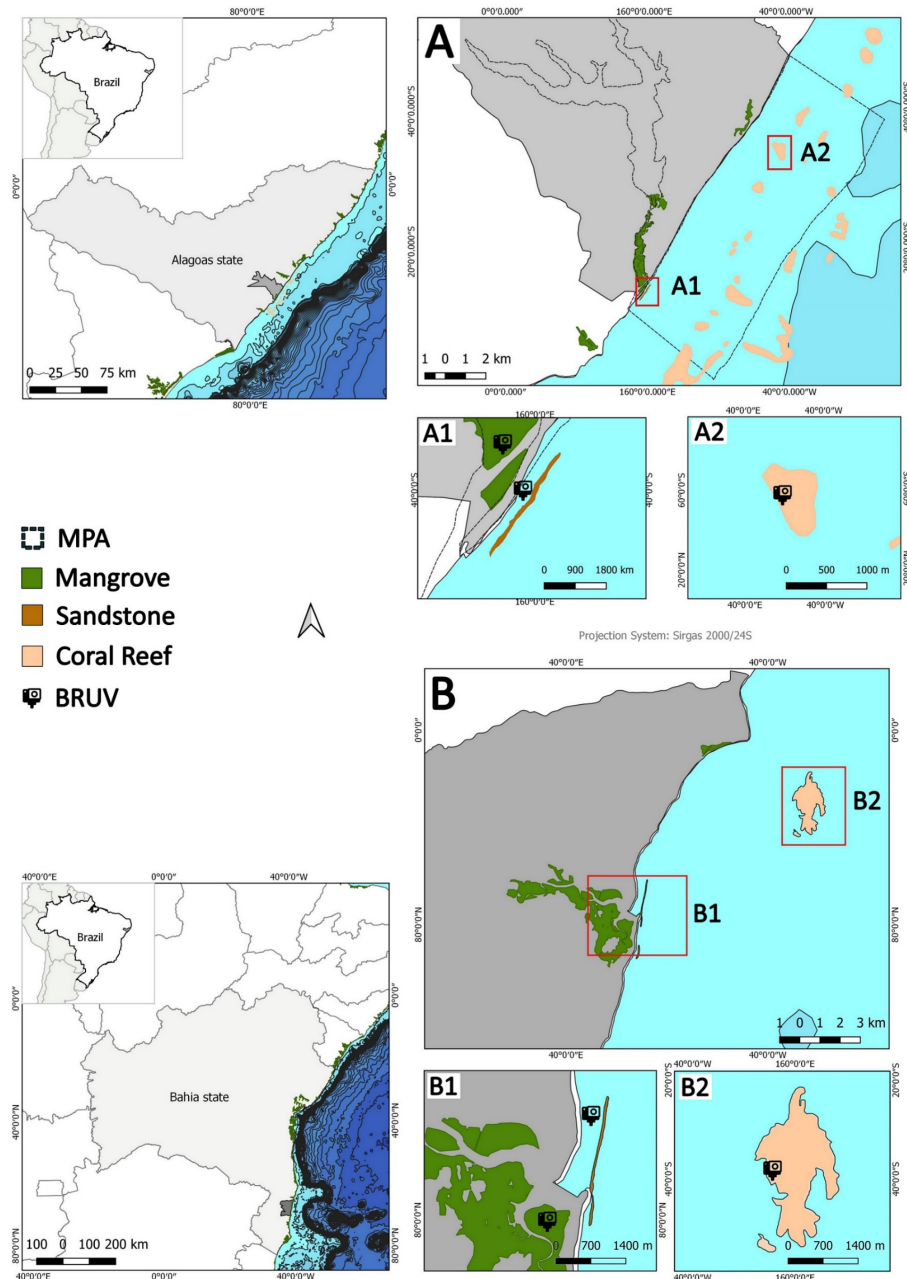
Despite the implementation of extensive research initiatives into these estuarine and marine environments, a considerable number of them remain unknown in the Southwest Atlantic (Miloslavich *et al.*, 2011; Gagnolati *et al.*, 2024). There are still gaps in knowledge about the composition and ecology of fish assemblages, as well as the similarities between habitats. It is therefore essential to address these gaps to facilitate the development of more efficient conservation strategies (Olds *et al.*, 2012; Goetze *et al.*, 2021).

In this context, we sought to evaluate the composition, richness, abundance, and similarity of fish assemblages in different coastal habitats, such as mangroves, artificial structures, sandstone reefs and coral reefs. We did this in two little-known tropical locations in Brazil located at different latitudes, evaluating the composition of the fish assemblages and their association with natural (coral and sandstone reefs) and artificial habitats, as well as estuarine habitats (mangroves). Our hypothesis is that coastal sandstone reefs serve as bridges for reef species, linking mangrove habitats to coral reefs in these regions of the Southwestern Atlantic, contributing to the structuring patterns of the assemblages.

## MATERIAL AND METHODS

**Sampling sites.** The study was carried out in two locations in the Northeast of Brazil (Fig. 1) with similar characteristics, such as the presence of the same ecosystems, habitats, depth gradient, tropical climate (coastal) and the presence of Marine Protected Areas (MPAs). This guaranteed minimum conservation for reef fishes. We selected the municipality of Jequiá da Praia (Alagoas – AL) which includes the estuary of the Jequiá River, coastal sandstone reefs, and coral reefs of the Reserva Extrativista Marinha Lagoa do Jequiá (RESEX de Jequiá). We also chose the municipality of Porto Seguro (Bahia – BA), located approximately 780 km away from Jequiá da Praia, with the Buranhém River, sandstone reefs, and the Recife de Fora Municipal Natural Park (Chaves *et al.*, 2010).

The municipality of Jequiá da Praia (AL) is home to the RESEX de Jequiá (RXJ), a multiple-use marine protected area (MPA) covering approximately 10,203.79 hectares. This encompasses a mosaic of coastal habitats, including both estuarine and reef ecosystems. These environments play a fundamental role in the productivity and maintenance of fishing resources, thereby supporting artisanal fishing and tourism as local economic activities (Correia, Sovierzoski, 2008; Correia, 2011; Sampaio *et al.*, 2015). This MPA is situated on the southern coast of Alagoas and is subject to the influence of the São Francisco River and lagoon complexes, with mangroves occupying a considerable portion of the coastline (Correia, Sovierzoski, 2008; Sampaio, Pinto, 2019). Important areas of coral and sandstone reef formations are present along the coastline, as are numerous submerged artificial structures that remain largely unstudied from a scientific perspective.



**FIGURE 1** | Representation of the areas of the RESEX Marinha Lagoa do Jequiá – AL (A) and Porto Seguro – BA (B). Mangroves, sandstone (A1) and coral reefs (A2) accessed at the RESEX de Jequiá. Mangroves, sandstone (B1) and coral reefs (B2) accessed at the Porto Seguro. Marine protected area (MPA). The artificial habitats were not represented on the map as they are part of the mangrove area. The reefs were mapped by Santos *et al.* (2019).

The Buranhém River, also known as the Porto Seguro River, traverses the Brazilian states of Minas Gerais and Bahia, traveling a total length of 128 km in the latter state before emptying into the Atlantic Ocean. In its lower course, the river forms a 12 km long estuary with mangroves and a variety of estuarine species. Near this estuary is the Recife de Fora Municipal Natural Park. This is a no-take MPA located at the bay of

Porto Seguro, about 3.4 km from the coast with an area of 19.68 km<sup>2</sup>, which includes a main reef and many nearby submerged formations (Chaves *et al.*, 2010). This area is on the Royal Charlotte Reef Bank and has a history of tourist and fishing activities. It was transformed into a Municipal Natural Park in 1997 with the aim of conserving the great local biodiversity. It is worth noting that, unlike the RXJ, the mangroves and sandstone reefs of Porto Seguro (PTS) are not part of an MPA.

**Data collection.** Data collections were carried out between November 2021 and March 2023; however, field efforts were intensified in the summer months (December–March) due to the better oceanographic conditions, including the greater water transparency. The single Baited Underwater Video (BRUV), a method with high replicability and low invasiveness, was used to obtain the data (Reis-Filho *et al.*, 2019; Langlois *et al.*, 2020; Meeuwig, 2021). Footage obtained using BRUV can provide data on species richness, abundance, which is important for assessing the structure of fish assemblages and understanding ecological parameters related to habitat similarity (Reis-Filho *et al.*, 2019; Rolim *et al.*, 2019).

High-definition digital cameras (GoPro Hero 7 Black, 4k – 12.1 Mp) with wide-angle lenses and fixed focal lengths were used to take the samples. The bait bags were filled with approximately 800 g of crushed sardines (*Sardinella* spp.) for each sample (Schmid *et al.*, 2017; Reis-Filho *et al.*, 2019). The BRUVs were set out during the day between 7 am and 3 pm and remained submerged for 40 min each. They were distributed among 12 sites per location (3 sites per habitat). In all, there were three samples per site, with one site having four samples, totaling 10 samples per habitat for each location. Three random BRUV replicas were placed at each site, arranged at a minimum distance of 250 m, thus maintaining independence between them and avoiding overlapping olfactory trails (Rolim *et al.*, 2019). The BRUVs were situated near the habitats, at a distance of between one and two meters, with the camera consistently oriented towards the structure.

The habitats were classified as: mangroves, artificial estuarine structures (piers, bridges and rockfills), sandstone reefs, and coral reefs. Spatially, the mangroves and artificial habitats are in the estuary, while the sandstone reefs are in the marine environment and are directly influenced by the estuary. Coral reefs are further from the coast and the influences of the estuary. The sandstone reefs are approximately 2.5 km from the mangrove areas sampled for both locations, and the coral reefs are between 9 and 10 km from the sandstone reefs.

A total of 80 valid BRUV samples were taken, 40 per location, distributed between mangrove habitats (n = 10), artificial estuarine habitats (n = 10), sandstone reefs (n = 10), and coral reefs (n = 10). The sites in each habitat were randomly selected and characteristics data, such as distance from the estuary, was observed by georeferencing the points. The depth data was collected utilizing marine navigation probes or metric markings on the cables of the BRUV buoys. The depth data was collected using the BRUV cable as soon as the equipment was launched, with the cable taut and in contact with the seabed. This technique was also employed to estimate vertical visibility. The mean depth observed at the RESEX de Jequiá (RXJ) was 3m (SD = 2.3), with a minimum of 1m and a maximum of 10 m (Tab. 1). For Porto Seguro (PTS) the mean was 3.6 m (SD = 2.9), with a minimum of 1 m and a maximum of 13 m. The amplitude of the tide was also recorded during the collections.

**TABLE 1** | Depth observed using BRUVs at Porto Seguro (BA) and RESEX de Jequiá (AL) minimum depth (Min. Depth); maximum depth (Max. Depth); average depth of sampling (Average Depth) and Standard Deviation (SD).

HABITATS	Porto Seguro			RESEX de Jequiá		
	Min. Depth	Max. Depth	Average (SD)	Min. Depth	Max. Depth	Average (SD)
Mangrove	1.3	1.8	1.5 (0.18)	1	2	1.3 (0.42)
Artificial	1.5	2	1.8 (0.2)	1	5	2.3 (1.3)
Sandstone Reef	1.9	6	3.8 (1.3)	1	5	2.2 (1.0)
Coral Reef	1.6	13	7 (3.5)	5	10	6.2 (1.9)

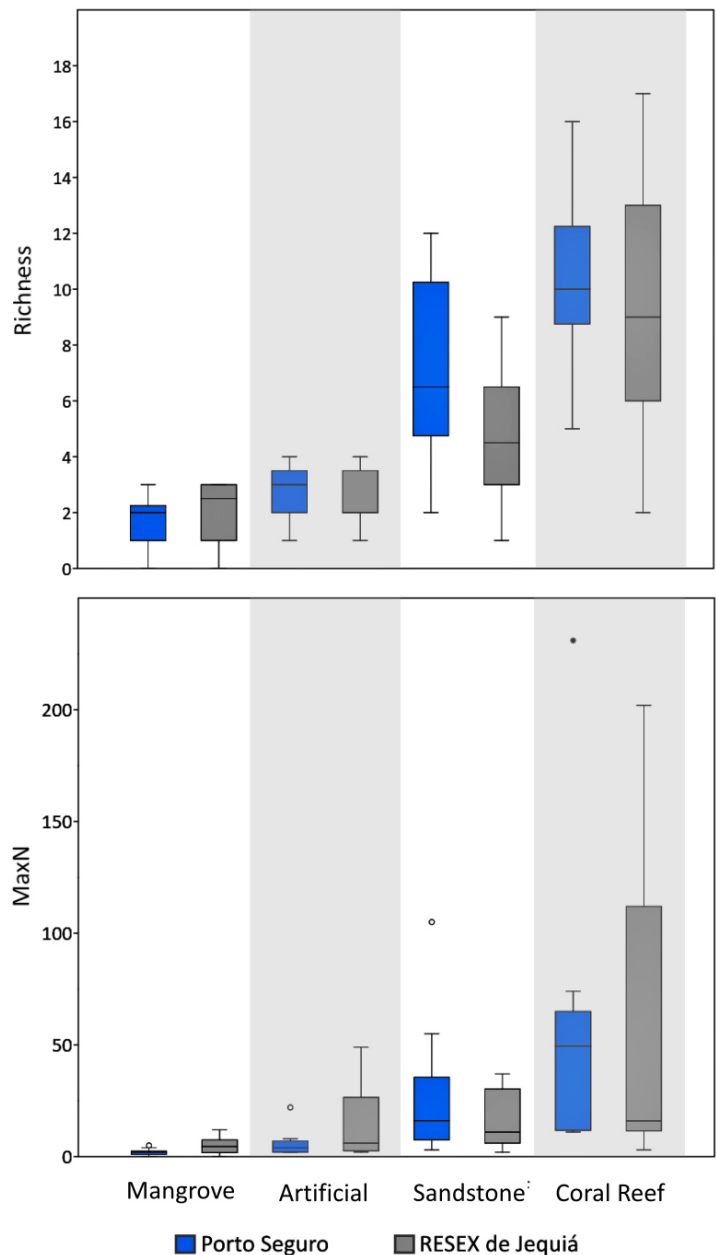
All videos were analyzed by one person to reduce sampling error. However experts were consulted to resolve any doubts about taxonomic classification. To analyze the structure of the fish assemblages, we tried to identify the lowest possible taxonomic level (Floeter *et al.*, 2023; Carvalho-Filho, 2024). The software used to analyze videos was VCL media player Version 3.0.21. The maximum number (MaxN) of individuals (abundance proxy) of a given species was obtained by counting the number of fish of that species in the same frame of the video (paused image) (Harvey *et al.*, 2013; Reis-Filho *et al.*, 2019; Laglois *et al.*, 2020). We did not estimate the total length of the fish, but for species that have different patterns depending on their life stage, we differentiated between juveniles and adults by means of coloration (Floeter *et al.*, 2023; Carvalho-Filho, 2024). The fish were also classified into six trophic groups: carnivores (CAR), herbivores (HERB), planktivores (PLAN), omnivores (OMNI), sessile invertebrate feeders (SINV), and mobile invertebrate feeders (MINV) according to the literature (Pinheiro *et al.*, 2018; Floeter *et al.*, 2023). For the species' threat status, the latest update of the Brazilian Red List (MMA, 2022) was considered.

**Statistical analyses.** Pearson's correlation was employed to examine the relationship between abundance (MaxN) and depth. The potential for differences in richness (number of species per sample) and univariate abundance (total MaxN/sample) were evaluated using PERMANOVA with Euclidean distance and two factors (site, fixed factor, and habitat, random factor, nested with location). The composition of the ichthyofauna (multivariate abundance matrix) was evaluated using PERMANOVA with a Bray-Curtis similarity matrix and the same design (site, fixed factor and habitat, random factor, nested with location).

The same similarity matrix (Bray-Curtis) was employed in the non-metric multidimensional scaling (NMDS) analysis, comparing the composition between locations and habitats. Similarity percentage analyses (SIMPER) were conducted to ascertain the contribution of each species to the formation of assemblages between habitats and localities. Additionally, Chao 2 was employed to ascertain the total richness for each habitat. This indicator is based on the incidence of species, using the presence or absence of data and accounting for the distribution of species between samples. The calculations and statistical analysis were conducted using the R programming language, v. 4.4.0, with the following packages: devtools, ggplot2, vegan, nlme, and dplyr. All tests were conducted with a 95% confidence level.

## RESULTS

**Richness and abundance (MaxN).** We found 21 Families, 40 species and 1,180 individuals were recorded for RXJ and 23 families, 50 species and 938 individuals for PTS. The richest families were Labridae (n = 6), Haemulidae (n = 5), and Lutjanidae (n = 5) for both locations. No differences were observed in abundance (MaxN) and richness between RXJ and PTS; however, a similarity of 11% was noted. The coral reefs stood out significantly, with higher richness and abundance in both locations (Fig. 2). The multivariate analysis revealed significant differences in richness and abundance between the habitats, both locally and between RXJ and PTS (Tab. 2). The expected richness (Chao 2 estimator) exceeded that observed in most of the habitats included in the Fig. S1.



**FIGURE 2 |** The localities of Porto Seguro (BA) and RESEX de Jequiá (AL) are separated by color. The boxplots of richness and MaxN by habitat show the maximum and minimum limits (upper and lower extremities). In the interquartile range are the third and first quartiles at the boundaries of the boxes and the most centralized horizontal line represents the mean. Points outside the boxplots represent “outliers”, data found outside the observed pattern. The grey stripes only serve to separate the habitats.



**TABLE 2** | Richness observed using BRUVs in Porto Seguro (BA) and RESEX de Jequiá (AL). Total number of species recorded (S total); average richness of samples (S mean) and Standard Deviation (SD).

HABITATS	Porto Seguro		RESEX de Jequiá	
	S total	S Average (SD)	S total	S Average (SD)
Mangrove	4	1.7 (0.9)	10	2.1 (1)
Artificial	10	2.6 (0.9)	9	2.4 (0.94)
Sandstone Reef	31	7.2 (3.1)	19	4.7 (2.3)
Coral Reef	38	10.4 (2.8)	26	9.3 (4.4)

The depths of the coral reefs in the two locations differed significantly from those observed in the other habitats (Tab. S2). Furthermore, a significant correlation was identified between depth and the MaxN abundances ( $r = 0.39$ ;  $p < 0.01$ ). With regard to tidal range, the mean value for RXJ was 1.8 m (SD = 0.3), while that for PTS was 1.2 m (SD = 0.4).

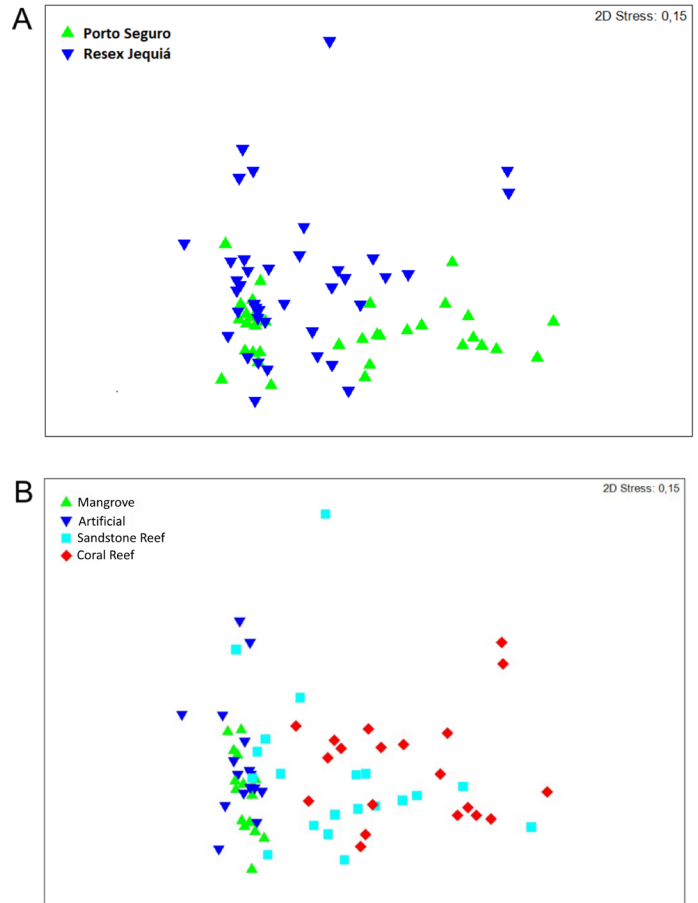
**Composition of assemblages.** The localities shared 29 species and 14 families with no differences in their assemblages (Fig. 3). The most abundant species for the study, occurring at both locations, were *Haemulon aurolineatum* Cuvier, 1830 ( $n = 529$ ; mean = 6.6), *Anchoa* sp. ( $n = 399$ ; mean = 4.99), *Acanthurus coeruleus* Bloch & Schneider, 1801 ( $n = 371$ ; mean = 4.63), *Stegastes fuscus* (Cuvier, 1830) ( $n = 63$ ; mean = 1.05), *Lutjanus jocu* (Bloch & Schneider, 1801) ( $n = 76$ ; mean = 0.95), and *Caranx latus* Agassiz, 1831 ( $n = 76$ ; mean = 0.95). Only two species were recorded in all habitats, *Gymnothorax funebris* Ranzani, 1839 and *L. jocu*, with the latter showing the highest frequency (47% of samples) for RXJ and PTS.

The RXJ habitats exhibited 18% similarity, while the PTS habitats demonstrated 31% similarity (Tab. S3). The species that contributed most to the similarity between the RXJ habitats were *L. jocu* (36%), *Cephalopholis fulva* (Linnaeus, 1758) (19%), and *Caranx latus* (7%) (Fig. 4). With regard to PTS, the species that made the greatest contributions to similarities between habitats were *Sphoeroides testudineus* (Linnaeus, 1758) (46%), *Lutjanus jocu* (15%) and *Haemulon aurolineatum* (13%).

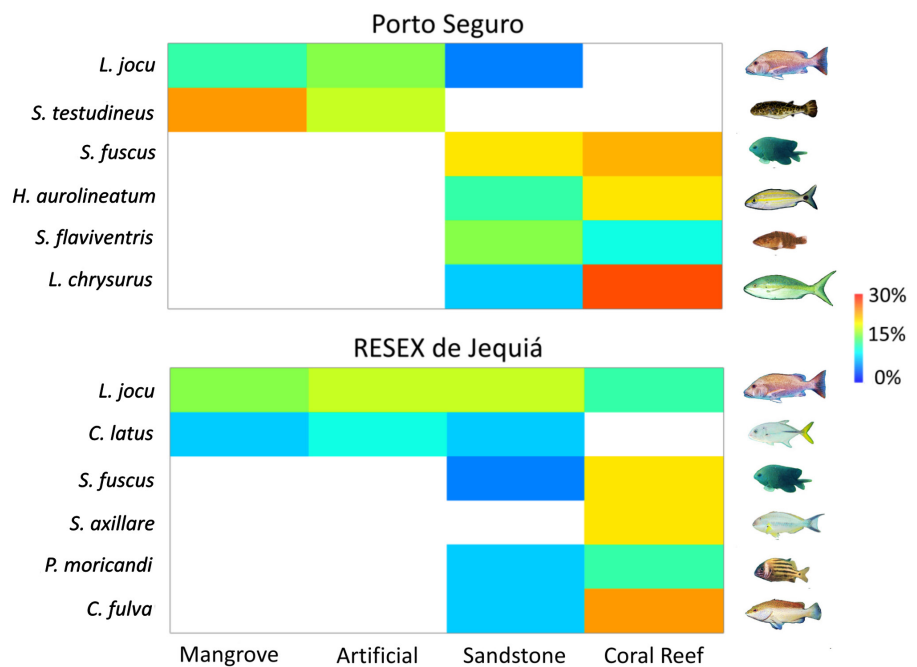
Sandstone and coral reefs shared 12 species in RXJ and 22 in PTS. A total of 28 species were observed exclusively in reef environments (coral and sandstone) in RXJ, while 39 species in PTS. Among the families that exhibited exclusive occurrence in these habitats were Acanthuridae, Haemulidae, and Labridae.

In RXJ, the species that were shared between the estuarine and reef habitats were *L. jocu*, *C. latus*, *G. funebris*, *Anchoa* sp. and *Mugil* sp. In PTS, there were five species, *L. jocu*, *Sphoeroides greeleyi* Gilbert, 1900, *G. funebris*, *Mugil* sp. and *Eugerres brasiliensis* (Cuvier, 1830). In the RXJ estuary, *Centropomus* spp. was recorded only in the mangroves, while the remaining species showed generalist behavior in their selection of estuarine habitats. In PTS, only *C. latus*, *L. jocu* and *S. testudineus* were distributed between the mangroves and artificial estuarine habitats, with *Sciades* sp. occurring exclusively in the mangroves and the other six species observed only in artificial environments.





**FIGURE 3** | Non-metric multidimensional scaling (NMDS) analysis comparing locations A and habitats B using the Bray-Curtis similarity index.



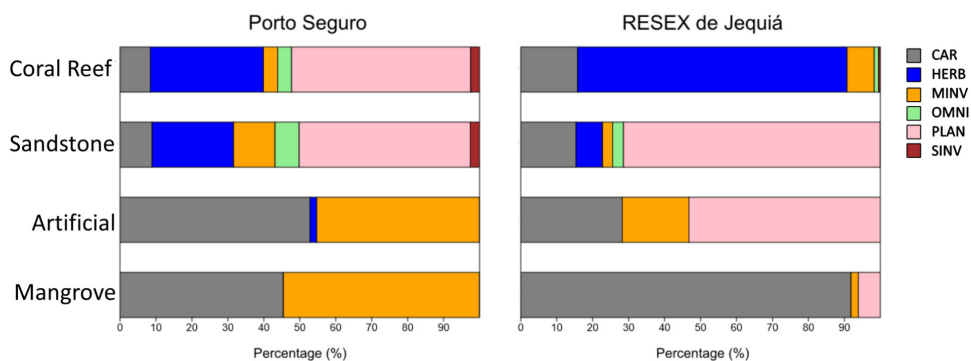
**FIGURE 4** | Distribution of the most frequent species by habitat for Porto Seguro (BA) and RESEX de Jequiá (AL). Warmer colors (close to red) represent higher frequencies of species among the samples.

**Trophic composition.** On the coral reefs of RXJ, HERB accounted for 74.9% of the records, with the CAR group representing the second most abundant group at 15.9%. PLAN stood out on sandstone reefs (71.4%) and in artificial estuarine habitats (53.2%). In the mangroves, CAR highlights with 91.8% of the observations. In the PTS coral reefs, HERB fish (31.5%) and PLAN (45.3%) were the most abundant trophic groups (Fig. 5), but in the sandstone reefs the proportion of HERB was lower, giving way to SINV. In the estuaries, the groups that predominated were CAR and SINV for PTS (Fig. 5).

The planktivorous fish *Anchoa* sp. was the most abundant ( $n = 399$ ; mean = 10.23) in RXJ, absent only from the coral reefs, as was the carnivore *C. latus* ( $n = 56$ ; mean = 1.4). Herbivores such as *Acanthurus coeruleus* ( $n = 340$ ; mean = 8.5), *A. bahianus* Castelnau, 1855 ( $n = 69$ ; mean = 1.7), and *Sparisoma axillare* (Steindachner, 1878) ( $n = 26$ ; mean = 0.65) stood out on the coral reefs. The carnivore species *C. fulva* exhibited the highest frequency ( $n = 52$ ; mean = 1.3) in this habitat, occurring in all samples. *Lutjanus jocu* was present in all habitats, but exhibited a higher abundance in estuarine environments, particularly mangrove ecosystems ( $n = 22$ ; mean = 2.2).

*H. aurolineatum* was the most abundant fish in both sandstones and coral reefs of PTS ( $n = 528$ ; mean = 13.2), and many individuals were observed in the planktivorous stage. *Stegastes fuscus* ( $n = 56$ ; mean = 1.4) and *A. coeruleus* ( $n = 31$ ; mean = 0.78) were the most abundant herbivores on the sandstone and coral reefs, as was the omnivore *Abudefduf saxatilis* (Linnaeus, 1758) ( $n = 44$ ; mean = 1.1). The invertivore *Sphoeroides testudineus* ( $n = 34$ ; mean = 0.85) thrives in estuarine habitats, as *L. jocu* ( $n = 22$ ; mean = 0.55). *Lutjanus synagris* (Linnaeus, 1758) ( $n = 17$ ; mean = 0.45) was the most abundant carnivore on the PTS coral reefs.

**Commercial and endangered species.** Of the species recorded, 36% ( $n = 18$ ) for PTS and 48% ( $n = 19$ ) for RXJ represent commercial or subsistence fishing resources. Families with broad economic importance for the tropics stand out, such as Carangidae, Centropomidae, Engraulidae, Epinephelidae, Gerreidae, Labridae, Lutjanidae, and Mugilidae. Additionally, endangered species were also recorded for the reef habitats, such as *Epinephelus morio* (Valenciennes, 1828) and *Mycteroperca bonaci* (Poey, 1860) in PTS and *Microspathodon chrysurus* (Cuvier, 1830), *Sparisoma axillare*, and *S. frondosum*



**FIGURE 5 |** Proportion in percentage of trophic groups by habitat for Porto Seguro (BA) and RESEX de Jequiá. Fish trophic categories: carnivore (CAR); herbivore (HERB); mobile invertebrate feeders (MINV); omnivore (OMNI); planktivore (PLAN); sessile invertebrate feeders (SINV).

(Agassiz, 1831) for RXJ and PTS. For estuarine habitats, only *Lutjanus cyanopterus* (Cuvier, 1828) was recorded in RXJ. All these species are classified as Vulnerable (VU) according to the Brazilian Red List (MMA, 2022).

## DISCUSSION

**Richness, abundance, and composition.** The localities exhibited approximate parameters, such as richness and abundance. However, biogeographical characteristics (Pinheiro *et al.*, 2018) may have influenced the low similarity and the composition of each locality and between habitats. Habitat characteristics, with the degree of influence of the estuary and depth, may have contributed to the composition patterns (Berkström *et al.*, 2012; Cordeiro *et al.*, 2016; Gragnolati *et al.*, 2024). Estuarine zones and coastal areas, such as mangroves and sandstone reefs, receive a greater discharge of sediment, nutrients, and freshwater, limiting them to only species adapted to these factors, such as estuarine, migratory, or marine species with osmoregulatory capacity (Eggertsen *et al.*, 2017; Roocker *et al.*, 2018). The depths observed in coral reefs were different when compared to other habitats, showing positive relationships when correlated with abundance (Reis-Filho *et al.*, 2019; Goetze *et al.*, 2021). In the end, both the depth and the spatialization of the habitats are structuring factors and influence the composition, richness, and abundance of the assemblages, which is reflected in our results and consistent with findings in other studies (Rolim *et al.*, 2022; Gragnolati *et al.*, 2024).

Coral reefs showed the highest richness values when compared to the other habitats, confirming the literature (Olds *et al.*, 2012; Goetze *et al.*, 2021). This higher richness was expected, as these habitats are part of the most biodiverse aquatic ecosystems in the world (Floeter *et al.*, 2023; Carvalho-Filho, 2024). In contrast, sandstone reefs may represent transitional habitats and an important link between estuarine and marine connectivity. They share similarities in the composition of the ichthyofauna of coral reefs and mangroves, as observed (Moura *et al.*, 2011; Aschenbrenner *et al.*, 2016). They can facilitate ontogenetic migrations by being close to mangroves, requiring less energy for fish and constituting a lower risk of exposure to predators, until they migrate to coral reefs. Their fish assemblages, which represent a set of estuarine and reef species, are conditioned to the characteristics of this habitat: the constant variation of coastal abiotic factors, such as turbidity, salinity variation, sediment discharge and suspension, nutrients and shallow waters (Bradley *et al.*, 2017).

The sandstone reefs can also have great complexity, due to the growth of macroalgae, sponges and corals on these reefs, which contribute to expansion and increasing structural complexity and generate shelter for fauna (Correia, Sovierzoski, 2008; Correia, 2011). They therefore share many families and species with coral reefs. However, the composition of their respective assemblages differs. This may be related to the influence of the estuary and depth, which affect habitat selection by species adapted to these conditions (Araújo *et al.*, 2020).

Mangroves, being in the estuary, do not have great fish richness when compared to reef habitats. However, a greater abundance was expected for these environments, which may be related to the positive relationship in depth found at the sites (Reis-Filho *et al.*, 2019). Despite these results, the role of mangroves in structuring the reef fauna

is indispensable and vital for countless species (Aschenbrenner *et al.*, 2016; Roocker *et al.*, 2018), representing key habitats and considered nurseries for some reef fish. This is especially true for endangered and economically important species, such as the *Lutjanus cyanopterus*, recorded in this study. The juvenile of this largest species of snapper in the Atlantic (Carvalho-Filho, 2024) uses mangrove roots for development due to the high availability of shelter and food such as small crustaceans (Moura *et al.*, 2011; Roocker *et al.*, 2018).

Mangroves and artificial structures showed few differences between their compositions. In RXJ the species richness was more equally distributed between the two habitats. In PTS most of the species recorded in the estuary (75%) were observed in artificial environments, especially predators of mobile invertebrates such as *Spherooides testudineus*, as observed by Pereira *et al.* (2017). Artificial habitats, as natural ones, can be attractive to species due to their complexity (Pereira *et al.*, 2017; Miranda *et al.*, 2020). Interspecific associations between predators and prey may also be closely related to the use and selection of these habitats (Stankwich, Blumstein, 2005; Nunes *et al.*, 2015), as juvenile fish opt for complex structures in search of refuge which may be offered by artificial environments (Roocker *et al.*, 2018). Artificial habitats were represented by piers, bridges, and rockfills—structures where fish are usually landed and where fishing waste and leftovers are discarded. Although attractive, these habitats do not offer the quality of refuge, microhabitats, and availability of food resources offered by mangroves (Aschenbrenner *et al.*, 2016; Goetze *et al.*, 2021).

**Trophic composition.** In the coral reefs of RXJ, herbivores contributed the most to abundance, especially the species *Acanthurus coeruleus*, *A. bahianus*, and *Sparisoma axillare*. This result is in line with the literature for these reef environments (Araújo *et al.*, 2020) with herbivorous fish being important agents in the maintenance of coral reefs (Ferreira *et al.*, 2004; Ferreira, Gonçalves, 2006; Cordeiro *et al.*, 2016; Pereira *et al.*, 2021). In PTS, the fish assemblage composition of the coral reefs was different from that found in RXJ: herbivores (*A. coeruleus*, *S. fuscus*) shared space with planktivores (represented by juvenile *H. aurolineatum*) on the sandstone and the coral reefs. The genus *Haemulon* spp. is abundant in the PTS region (Ferreira *et al.*, 2004; Chaves *et al.*, 2010), represented by predators of mobile invertebrates, which were also abundant on the sandstone.

**Reefs.** In PTS, carnivores represented less than 10% of the fish abundance for coral reefs, with *Lutjanus synagris* and *L. chrysurus* being the main representatives, as in other studies for this latitude (Chaves *et al.*, 2010; Rolim *et al.*, 2022). Although the organization of the trophic structure of the coral reefs of RXJ and PTS follows the pattern of their sub-provinces (Ferreira *et al.*, 2004; Pinheiro *et al.*, 2018; Floeter *et al.*, 2023), the absence of many large carnivores and herbivores was noted in the samplings. This phenomenon is not commonly observed in conserved environments (Rolin *et al.*, 2022), which may indicate that although coral reefs are located within MPA, the level of protection allocated to this trophic group is inadequate. Such measures do not guarantee the maintenance of abundances and biomasses, nor do they ensure the overflow of fish populations into adjacent areas.

In mangrove, artificial, and sandstone reef habitats, planktivores and carnivores alternated in abundance for RXJ. In these environments, the carnivores fish Family Carangidae and Lutjanidae and the planktivores Engraulidae were the most abundant, highlighting the similarity and possible connectivity between the habitats (Roocker *et al.*, 2018). The Engraulidae was represented by *Anchoa* sp., which plays an important role in the trophic chain of these environments, serving as food for carnivores. In the mangroves, the Lutjanidae, which are of great importance to artisanal fishers in the tropics (Bastos *et al.*, 2022) and represented in our study by *L. cyanopterus*, *L. jocu*, *L. alexandrei* Moura & Lindeman, 2007, and *L. synagris*.

The Lutjanidae were the most abundant carnivores found in this habitat during the juvenile stage. The species of this family observed in the present study select mangroves in their early life stages (Moura *et al.*, 2011) and subsequently undergo ontogenetic transitions, later migrating towards shallow and deep reefs (Moura *et al.*, 2011; Roocker *et al.*, 2018; Reis-Filho *et al.*, 2019). In these ontogenetic movements, species tend to occupy and distribute themselves in different habitats and ecosystems, which may have variations in abiotic parameters (Nagelkerken *et al.*, 2015; Aschenbrenner *et al.*, 2016).

These species are structural links between habitats and have important ecological functions in estuarine and reef assemblages (Reis-Filho *et al.*, 2019). These characteristics are not restricted to the Lutjanidae; other species of Epinephelidae, Carangidae, and Centropomidae, for example, can also possess these attributes and contribute to the connectivity between habitats (Ferreira *et al.*, 2004). However, families such as Acanthuridae, Haemulidae, Labridae and Pomacanthidae typically exhibit a strong attachment to their habitat (Nunes *et al.*, 2013; Araújo *et al.*, 2020; Pereira *et al.*, 2021), with a tendency to be confined to reef environments (Reis-Filho *et al.*, 2019; Rolim *et al.*, 2022).

**Conservation and management.** The reef biodiversity of RXJ has long been neglected and unexplored, either due to a lack of interest from researchers and managers or the logistical difficulty of operations in the region (Sampaio, Pinto, 2019). In addition, the low visibility in the reefs, due to the contribution of the large lagoons, makes it difficult to carry out data collection; it is only possible during some summer months. We highlight an unpublished survey of reef ichthyofauna in this MPA and in the region, revealing its composition and inferring the importance of its conservation.

As observed in our study, the fish assemblages of mangroves, sandstone and coral reefs are related despite the differences found between RXJ and PTS. The compositions of the assemblages reveal similarities in the structure and contribution of sandstone reefs as a link between mangroves and coral reefs, forming a rich and abundant reef ichthyofauna between RXJ and PTS. This knowledge is of paramount importance for the management of MPAs and appropriate conservation measures (Reis-Filho *et al.*, 2019), designing spatial protection efforts that recognize the link between fish composition in these essential habitats (Eggertsen *et al.*, 2017, 2020).

The capacity of organisms to traverse diverse environments is a primary determinant of inter-habitat connectivity, exerting influence over ecological processes and the configuration of assemblage structures (Goodwin, 2003; Aschenbrenner *et al.*, 2016). Although we did not infer connectivity in our study, we identified certain species as the primary representatives in the relationship between habitats. These species were

also highlighted for their similarity, which corroborates the link between estuarine and marine environments (Roocker *et al.*, 2018). We also emphasize that knowledge about connectivity and the structure of fish assemblages needs to be expanded and used for efficient management and effective conservation (Rolim *et al.*, 2019, 2024), due to its importance for significant economic activities, such as fishing and local tourism (Pereira *et al.*, 2021).

The natural habitats observed are equally relevant for conservation, but management measures do not usually take the same direction. For example, in PTS, only the coral reefs sampled in our study are in MPA. It is important to consider that habitats are interconnected and that the conservation of species, such as *L. jocu*, depends on the preservation of multiple habitats. In RXJ, the multi-habitat approach was used when the MPA was created, with the aim of covering lagoon, estuarine, and marine ecosystems (ICMBio, 2023). This MPA has a design that aims to maintain connectivity between habitats, however, actions aimed at understanding the ichthyofauna of these environments are recent and were initiated through this study.

It is also important to note that more than 1/3 of the species recorded in PTS and RXJ represent fishery resources. Endangered and endemic species, which are fundamental for structuring assemblages and maintaining habitats, were also recorded. Although the entire study area of RXJ and the reef environments of PTS represent MPAs, these fish groups, which are targeted by artisanal and sport fisheries, are not protected under any no management or recovery strategy. In this context, there is a need to direct efforts towards maintaining the populations of these species through the protection of their habitats and connectivity. Therefore, the implementation of studies and long-term monitoring that seek to know the reef ichthyofauna are important to inform decision-makers and support management strategies (Olds *et al.*, 2012; Reis-Filho *et al.*, 2019; Goetze *et al.*, 2021).

Finally, we understand that the disposition of sandstone reefs, as well as abiotic factors characteristic of each habitat, especially depth, represent structuring agents for estuarine and reef fish assemblages in our study. The similarity between the different habitats varied between 18–31%, indicating the relationship and sharing of species in the composition of the ichthyofauna and highlighting the importance of sandstone reefs dynamics between these environments, being ecologically vital for the maintenance of reef fish populations. Artificial estuarine habitats indicate that mangrove fauna is being shared, which is a worrying factor in the declining quality and area of the environment. However, further investigations are needed.

Knowledge about the structure of fish assemblages at the two locations is especially important to promote efficient management initiatives. MPAs should save the habitat diversity of these areas. Considering the vulnerability of estuarine and reef habitats in tropical regions and their importance for reef fish, artisanal and sport fishing, and tourism, we acknowledge that the management of habitats comprising the coastal mosaic is strategic for the conservation the economic activities, fish species and ecosystems. It is recommended that measures be implemented with the objective of conserving fish species that are threatened with extinction and that are economically important, as well as ensuring the connectivity between coastal habitats.



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## REFERENCES

- **Araújo ME, Mattos FMG, Melo FPL, Chaves LCT, Feitosa CV, Lippi DL *et al.*** Diversity patterns of reef fish along the Brazilian tropical coast. *Mar Environ Res.* 2020; 160:105038. <https://doi.org/10.1016/j.marenvres.2020.105038>
- **Aschenbrenner A, Hackradt CW, Ferreira BP.** Spatial variation in density and size structure indicate habitat selection throughout life stages of two Southwestern Atlantic snappers. *Mar Environ Res.* 2016; 113:49–55. <https://doi.org/10.1016/j.marenvres.2015.10.013>
- **Bastos RF, Lippi DL, Gaspar ALB, Yogui GT, Frédou T, Garcia AM *et al.*** Ontogeny drives allochthonous trophic support of snappers: seascape connectivity along the mangrove-seagrass-coral reef continuum of a tropical marine protected area. *Estuar Coast Shelf Sci.* 2022; 264:107591. <https://doi.org/10.1016/j.ecss.2021.107591>
- **Berkström C, Gullström M, Lindborg R, Mwandya AW, Yahya SAS, Kautsky N *et al.*** Exploring “knowns” and “unknowns” in tropical seascape connectivity with insights from East African coral reefs. *Estuar Coast Shelf Sci.* 2012; 107:1–21. <https://doi.org/10.1016/j.ecss.2012.03.020>
- **Berkström C, Lindborg R, Thyresson M, Gullström M.** Assessing connectivity in a tropical embayment: fish migrations and seascape ecology. *Biol Conserv.* 2013; 166:43–53. <https://doi.org/10.1016/j.biocon.2013.06.013>
- **Bradley M, Baker R, Sheaves M.** Hidden components in tropical seascapes: deep-estuary habitats support unique fish assemblages. *Estuaries Coast.* 2017; 40(4):1195–206. <https://doi.org/10.1007/s12237-016-0192-z>
- **Carvalho-Filho A.** Peixes: costa Brasileira. São Paulo: Editora Literare Books International; 2024.
- **Chaves LCT, Nunes JACC, Sampaio CLS.** Shallow reef fish communities of South Bahia coast, Brazil. *Braz J Oceanogr.* 2010; 58:33–46.
- **Cordeiro CAMM, Mendes TC, Harborne AR, Ferreira CEL.** Spatial distribution of nominally herbivorous fishes across environmental gradients on Brazilian rocky reefs. *J Fish Biol.* 2016; 89(1):939–58. <https://doi.org/10.1111/jfb.12849>
- **Correia DM, Sovierzoski HH.** Management and sustainable development in Alagoas state’s coastal zone, Brazil. *RGCI.* 2008; 8(2):25–45. Available from: [https://www.aprh.pt/rgci/pdf/rgci-146\\_Correia.pdf](https://www.aprh.pt/rgci/pdf/rgci-146_Correia.pdf)
- **Correia MD.** Scleractinian corals (Cnidaria: Anthozoa) from reef ecosystems on the Alagoas coast, Brazil. *J Mar Biol Assoc U K.* 2011; 91(3):659–68. <https://doi.org/10.1017/S0025315410000858>
- **Eggertsen L, Ferreira CEL, Fontoura L, Kautsky N, Gullström M, Berkström C.** Seaweed beds support more juvenile reef fish than seagrass beds in a south-western Atlantic tropical seascape. *Estuar Coast Shelf Sci.* 2017; 196:97–108. <https://doi.org/10.1016/j.ecss.2017.06.041>
- **Eggertsen L, Goodell W, Cordeiro CAMM, Mendes TC, Longo GO, Ferreira CEL *et al.*** Seascape configuration leads to spatially uneven delivery of parrotfish herbivory across a western Indian ocean seascape. *Diversity (Basel).* 2020; 12(11):1–24. <https://doi.org/10.3390/d12110434>



- **Ferreira CEL, Floeter SR, Gasparini JL, Ferreira BP, Joyeux JC.** Trophic structure patterns of Brazilian reef fishes: a latitudinal comparison. *J Biogeogr.* 2004; 31(7):1093–106. <https://doi.org/10.1111/j.1365-2699.2004.01044.x>
- **Ferreira CEL, Gonçalves JEA.** Community structure and diet of roving herbivorous reef fishes in the Abrolhos Archipelago, south-western Atlantic. *J Fish Biol.* 2006; 69(5):1533–51. <https://doi.org/10.1111/j.1095-8649.2006.01220.x>
- **Floeter SR, Pinheiro HT, Rocha LA.** Biogeography and evolution of Brazilian reef fishes. In: Floeter SR, Krajewski JP, Fiuza TMJ, Rocha LA, Carvalho-Filho A, editors. *Brazilian Reef Fishes*. Curitiba: Editora CRV; 2023. p.15–20.
- **Gragnotati M, Rolim FA, Pereira-Filho GH, Athayde ACS, Ciotti AM, Motta FS.** Vertical structure of reef fish assemblages and light penetration reveal new boundaries of mesophotic ecosystems in the subtropical Southwestern Atlantic. *Mar Environ Res.* 2024; 198:106527. <https://doi.org/10.1016/j.marenvres.2024.106527>
- **Goetze JS, Wilson S, Radford B, Fisher R, Langlois TJ, Monk J et al.** Increased connectivity and depth improve the effectiveness of marine reserves. *Glob Chang Biol.* 2021; 27(15):3432–47. <https://doi.org/10.1111/gcb.15635>
- **Harvey ES, Cappel M, Kendrick GA, McLean DL.** Coastal fish assemblages reflect geological and oceanographic gradients within an Australian zootone. *PLoS ONE.* 2013; 8(11):e80955. <https://doi.org/10.1371/journal.pone.0080955>
- **Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio).** Plano de manejo da Reserva Extrativista Marinha da Lagoa do Jequiá. Brasília, DF; 2023. Available from: <https://acesso.one/hSjd4>
- **Langlois T, Goetze J, Bond T, Monk J, Abesamis RA, Asher J et al.** A field and video annotation guide for baited remote underwater stereo-video surveys of demersal fish assemblages. *Methods Ecol Evol.* 2020; 11(11):1401–09. <https://doi.org/10.1111/2041-210X.13470>
- **Meeuwig J.** Counting and measuring fishes: the use of baited remote underwater video systems (BRUVs). In: Froese R, Pauly D, editors. 2021. Fishbase. World Wide Web Electronic Publication. 2021.
- **Miloslavich P, Klein E, Díaz JM, Hernández CE, Bigatti G, Campos L et al.** Marine biodiversity in the Atlantic and Pacific coasts of South America: knowledge and gaps. *PLoS ONE.* 2011; 6(1):e14631. <https://doi.org/10.1371/journal.pone.0014631>
- **Ministério do Meio Ambiente (MMA).** Portaria MMA N° 148, de 7 de junho de 2022. Lista nacional de espécies ameaçadas de extinção. Brasília, DF; 2022. Available from: <https://l1nk.dev/ROJAK>
- **Miranda RJ, Malhado ACM, Fabrè NN, Batista VS, Santos R, Campos-Silva JV et al.** Integrating long term ecological research (Lter) and marine protected area management: challenges and solutions. *Oecol Aust.* 2020; 24(2):279–300. <https://doi.org/10.4257/oeco.2020.2402.05>
- **Moura RL, Francini-Filho RB, Chaves EM, Minte-Vera CV, Lindeman KC.** Use of riverine through reef habitat systems by dog snapper (*Lutjanus jocu*) in eastern Brazil. *Estuar Coast Shelf Sci.* 2011; 95(1):274–78. <https://doi.org/10.1016/j.ecss.2011.08.010>
- **Nagelkerken I, Sheaves M, Baker R, Connolly RM.** The seascape nursery: a novel spatial approach to identify and manage nurseries for coastal marine fauna. *Fish Fish.* 2015; 16(2):362–71. <https://doi.org/10.1111/faf.12057>
- **Nunes JACC, Sampaio CLS, Barros F.** How wave exposure, group size and habitat complexity influence foraging and population densities in fishes of the genus *Halichoeres* (Perciformes: Labridae) on tropical rocky shores. *Mar Biol.* 2013; 160(9):2383–94. <https://doi.org/10.1007/s00227-013-2233-5>
- **Nunes JACC, Sampaio CLS, Barros F.** The influence of structural complexity and reef habitat types on flight initiation distance and escape behaviors in labrid fishes. *Mar Biol.* 2015; 162(3):493–99. <https://doi.org/10.1007/s00227-014-2578-4>
- **Nunes VFC, Ferreira MTO, Ferreira-Júnior FS, Amorim MBB, Sampaio CLS, Pinto TK.** Do marine protected areas protect shallow coral reef systems? A resilience-based management approach in Tropical Southwestern Atlantic reefs. *J Coast Conserv.* 2022; 26:79. <https://doi.org/10.1007/s11852-022-00930-y>

- **Olds AD, Connolly RM, Pitt KA, Maxwell PS.** Habitat connectivity improves reserve performance. *Conserv Lett.* 2012; 5(1):56–63. <https://doi.org/10.1111/j.1755-263X.2011.00204.x>
- **Pereira PHC, Côrtes LGF, Lima GV, Gomes E, Pontes AVF, Mattos F et al.** Reef fishes biodiversity and conservation at the largest Brazilian coastal Marine Protected Area (MPA Costa dos Corais). *Neotrop Ichthyol.* 2021; 19(4):e210071. <https://doi.org/10.1590/1982-0224-2021-0071>
- **Pereira PHC, Santos MVB, Lippi DL, Silva PHP, Barros B.** Difference in the trophic structure of fish communities between artificial and natural habitats in a tropical estuary. *Mar Freshw Res.* 2017; 68(3):473–83. <https://doi.org/10.1071/MF15326>
- **Pinheiro HT, Rocha LA, Macieira RM, Carvalho-Filho A, Anderson AB, Bender MG et al.** South-western Atlantic reef fishes: zoogeographical patterns and ecological drivers reveal a secondary biodiversity centre in the Atlantic Ocean. *Divers Distrib.* 2018; 24(7):951–65. <https://doi.org/10.1111/ddi.12729>
- **Reis-Filho JA, Schmid K, Harvey ES, Giarrizzo T.** Coastal fish assemblages reflect marine habitat connectivity and ontogenetic shifts in an estuary-bay-continental shelf gradient. *Mar Environ Res.* 2019; 148:57–66. <https://doi.org/10.1016/j.marenvres.2019.05.004>
- **Rolim FA, Gibran FZ, Neves LM, Roos NC, Pereira-Filho GH, Souza GR et al.** Is a recent large expansion of a no-take reserve sufficient to change the reef fish assemblage? A before-after assessment in Alcatrazes Wildlife Refuge, Southwestern Atlantic. *Ocean Coast Manag.* 2024; 250:107043. <https://doi.org/10.1016/j.ocecoaman.2024.107043>
- **Rolim FA, Langlois T, Motta FS, Castro GM, Lester E, Abieri ML et al.** Habitat and marine reserve status drive reef fish biomass and functional diversity in the largest South Atlantic coral reef system (Abrolhos, Brazil). *Front Mar Sci.* 2022; 9:701244. <https://doi.org/10.3389/fmars.2022.701244>
- **Rolim FA, Langlois T, Rodrigues PFC, Bond T, Motta FS, Neves LM et al.** Network of small no-take marine reserves reveals greater abundance and body size of fisheries target species. *PLoS ONE.* 2019; 14(1):e0204970. <https://doi.org/10.1371/journal.pone.0204970>
- **Roocher JR, Dance MA, Wells RJD, Quigg A, Hill RL, Appeldoorn RS et al.** Seascape connectivity and the influence of predation risk on the movement of fishes inhabiting a back-reef ecosystem. *Ecosphere.* 2018; 9(4):e02200. <https://doi.org/10.1002/ecs2.2200>
- **Sampaio CLS, Paiva ACG, Silva ECS.** Peixes, pesca e pescadores do Baixo São Francisco, Nordeste do Brasil. In: Eliane M, Nogueira MF, Sá P, editors. *A pesca artesanal no Baixo São Francisco: atores, recursos, conflitos.* Petrolina: Sabeq; 2015. p.105–48.
- **Sampaio CLS, Pinto TK.** Recifes e ambientes coralíneos sob a influência do Rio São Francisco (SE/AL). In: Laborel DF, Castro CB, Nunes FLD, Pires DO, editors. *Recifes Brasileiros: o legado de Laborel.* Rio de Janeiro: Editora do Museu Nacional; 2019. p.174–75.
- **Santos JR, Santos LA, Fontes LCS.** Geomorphological and sedimentary mapping of paleolines of coast in the continental platform south of Alagoas. *Rev GeoNordeste.* 2019; 30(1):60–79. <https://doi.org/10.33360/RGN.2318-2695.2019.i1p60-79>
- **Schmid K, Reis-Filho JA, Harvey E, Giarrizzo T.** Baited remote underwater video as a promising nondestructive tool to assess fish assemblages in clearwater Amazonian rivers: testing the effect of bait and habitat type. *Hydrobiologia.* 2017; 784(1):93–109. <https://doi.org/10.1007/s10750-016-2860-1>

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**Márcio J. C. A. Lima Júnior:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing–original draft, Writing–review and editing.

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**Cláudio L. S. Sampaio:** Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Validation, Writing–review and editing.

**Neotropical Ichthyology**

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**ETHICAL STATEMENT**

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**COMPETING INTERESTS**

The author declares no competing interests.

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