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Diversity and abundance patterns of fish fauna in cascade reservoirs in the Brazilian semiarid tropical region

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We investigated the spatial patterns of distribution and abundance of native (migratory and sedentary) and non-native fish species in a cascade reservoir system located in the semiarid region of Brazil. Our hypothesis was that sedentary and non-native species would dominate the reservoirs in terms of abundance. Additionally, we expected to observe an increase in species abundance along the cascade, accompanied by changes in community composition. Sampling was conducted using gillnets in four reservoirs distributed along the longitudinal axis of the Apodi-Mossoró River. Data were analyzed using non-metric multidimensional scaling (MDS) and Generalized Additive Models for Location, Scale, and Shape (GAMLSS). A total of 13,787 individuals belonging to 22 species were captured. Mean species abundance (CPUEn) increased toward the mid-course reservoir, followed by a sharp decline in the downstream reservoir. The study hypothesis was confirmed, as sedentary species were the most abundant throughout the cascade system, while the abundance of non-native species surpassed that of migratory fishes. The spatial variation observed in fish assemblages along the Apodi-Mossoró River appears to be associated with multiple factors, particularly reservoir size and position within the cascade.

Keywords: Conservation, Hydrographic basin, Intermittent river, Migration, Non-native species.

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Investigamos os padrões espaciais de distribuição e abundância de peixes nativos (migradores e sedentários) e não nativos em um sistema de reservatórios em cascata localizado no semiárido brasileiro. Nossa hipótese era de que espécies sedentárias e não nativas dominariam os reservatórios do sistema em termos de abundância. Além disso, esperávamos observar um aumento na abundância de espécies, acompanhado por mudanças na composição das assembleias ao longo da cascata. A amostragem foi realizada com redes de espera em quatro reservatórios distribuídos ao longo do eixo longitudinal do rio Apodi-Mossoró. Os dados foram analisados por meio de ordenação não métrica (MDS) e Modelos Aditivos Generalizados para Localização, Escala e Forma (GAMLSS). No total, foram capturados 13.787 espécimes pertencentes a 22 espécies. A abundância média das espécies (CPUEn) apresentou um aumento em direção ao reservatório localizado no médio curso do rio, seguido de uma redução acentuada no reservatório do baixo curso. A hipótese do estudo foi confirmada uma vez que as espécies sedentárias apresentaram maior abundância ao longo do sistema em cascata, enquanto a abundância de espécies não nativas superou os migratórios. A variação espacial observada nas assembleias de peixes do rio Apodi-Mossoró parece estar relacionada a múltiplos fatores, especialmente ao tamanho dos reservatórios e à sua posição na cascata.

Palavras-chave: Bacia hidrográfica, Conservação, Espécies não nativas, Migração, Rio intermitente.

INTRODUCTION

The hydrographic basins of the semiarid region of Brazil exhibit distinctive features, with intermittent river regimes prevailing (Nascimento, 2014; Felix, Paz, 2016). The phenomenon of intermittent rivers arises from the short duration of the rainy season, low annual rainfall indices, irregular precipitation patterns, and high evaporation rates (Marques *et al*., 2020). Given these issues, reservoirs have been constructed along river courses to store water to meet diverse human needs (Novais *et al*., 2022), including water supply, irrigation, agriculture, and industrial activities. However, these constructions are not without impacts on the functioning of local ecosystems and biodiversity.

Dams act as barriers, obstructing the natural movement of fish and exerting direct influence on their distribution and abundance (Zacardi *et al*., 2021). This disruption in movement patterns can precipitate declines in population sizes, particularly impacting migratory species (Santos *et al*., 2018). Paradoxically, while these barriers pose challenges to native migratory species, they create favorable conditions for native sedentary species and non-native species, often leading to their proliferation (Jo *et al*., 2019). The presence of dams within river systems can significantly alter the composition and dynamics of fish communities, particularly in cascade reservoirs. This is because fluvial connectivity is essential for the dynamics of aquatic systems, encompassing interactions across multiple scales and dimensions, including longitudinal, lateral, vertical, and temporal (Fullerton *et al*., 2010).

Although the impacts of dams on large river systems such as altered hydrological dynamics and reduced migratory fish populations are well documented (Foubert *et al*., 2018), there is a gap in understanding these effects in smaller river basins, particularly in the semiarid region of Brazil. The fragmentation of aquatic ecosystems due to dam construction is a growing global concern, causing significant alterations in rivers and fish assemblages (Terêncio *et al*., 2021). However, the specific impact of this fragmentation on reservoir cascade systems along small rivers in the semiarid region of Brazil remains largely unexplored (Oliveira *et al*., 2021).

In Brazil, dam construction has played a crucial role in modulating the distribution and abundance of fish in reservoir cascade systems. For example, in the Paranapanema River, one of the main tributaries of the upper Paraná River basin, studies have revealed a prevalence of sedentary fish species, a low abundance of migratory species, and a high number of non-native species (Pelicice *et al*., 2018). Similarly, at the international scale, dams in the Columbia River basin in the United States have had negative impacts on migratory fish populations (Leonard *et al*., 2015), and reservoirs associated with hydropower plants in Serbia have influenced the distribution of fish, particularly sedentary species (Simonović *et al*., 2021).

The central question guiding our research was as follows: what is the distribution and abundance of fish in a cascade reservoir system of a small river in the semiarid region of Brazil? We hypothesize that sedentary and non-native fish species will dominate the reservoirs of the cascade system in terms of abundance. Additionally, we expect to observe an increase in species abundance, accompanied by changes in species composition throughout the cascade. In this study, data on the distribution and abundance of fish in the reservoir cascade system along the Apodi-Mossoró River, which is situated in the semiarid region of Brazil, were collected. Our primary objective was to analyze the fish communities present in these reservoirs and explore the spatial.

MATERIAL AND METHODS

Study region. The study was conducted in the Atlantic Northeast Oriental Hydrographic Region (Lima *et al*., 2022), which is located in the Brazilian semiarid region and is characterized by medium-sized to small river basins. This hydrographic area is classified as medium-sized, with a perennial reach (Miranda, Meirelles Filho, 2016), covering 14,276 km². Its extent is impacted by the presence of approximately 618 reservoirs (IGARN, 2019). The Apodi-Mossoró River is one of the main watercourses of the Rio Grande do Norte State, exhibiting a predominantly intermittent regime typical of the Brazilian semiarid region. Its flow is directly dependent on rainfall, leading to periods of high discharge during the rainy season interspersed with prolonged droughts, during which many sections experience reduced flow or dry up completely. The climate is semiarid, with annual precipitation ranging between 400 and 800 mm (Costa *et al*., 2021) that is concentrated between February and May. The vegetation consists of arboreal and shrubby Caatinga biome, characterized by thorny plants and cacti. Currently, this watershed supports the regional economy, which is driven by oil extraction, agriculture and irrigated fruit farming, extensive livestock farming, and limestone mining (Carvalho *et al*., 2011).

Sampling. Sampling was conducted quarterly in February, May, August, and November. Collections were carried out in 2011 and 2012 in Pau dos Ferros Reservoir (PF), as funding was available specifically for that period, and in Major Sales (MS), Flechas (FL), and Santa Cruz (SC) Reservoirs in 2015 and 2016 (Fig. 1; Tab. 1).

Standardized procedures were implemented at each sampling site within the reservoirs (Tab. 1), utilizing a set of eleven mesh gillnets with sizes ranging from 12 to 70 mm (measured between adjacent knots). Each gillnet measured 15 m in length and had a height varying between 1.8 and 2.0 m.

The gillnets were positioned parallel to the reservoir shores, prioritizing areas with greater depth. The gillnets were exposed for 12 hours, spanning from 5:00 p.m. to 5:00 a.m. the following day, with two fish removal operations per sampling site at 10:00 p.m. and 5:00 a.m. The captured specimens were carefully placed in plastic bags, preserved on ice, and transported to the Fish Ecology and Continental Fisheries Laboratory at UFERSA. Species identification was subsequently confirmed by taxonomists from the Universidade Federal da Paraíba (UFPB), where specimens were deposited in the ichthyology collection (voucher numbers UFPB 8934–8986 in Tab. **S1**).

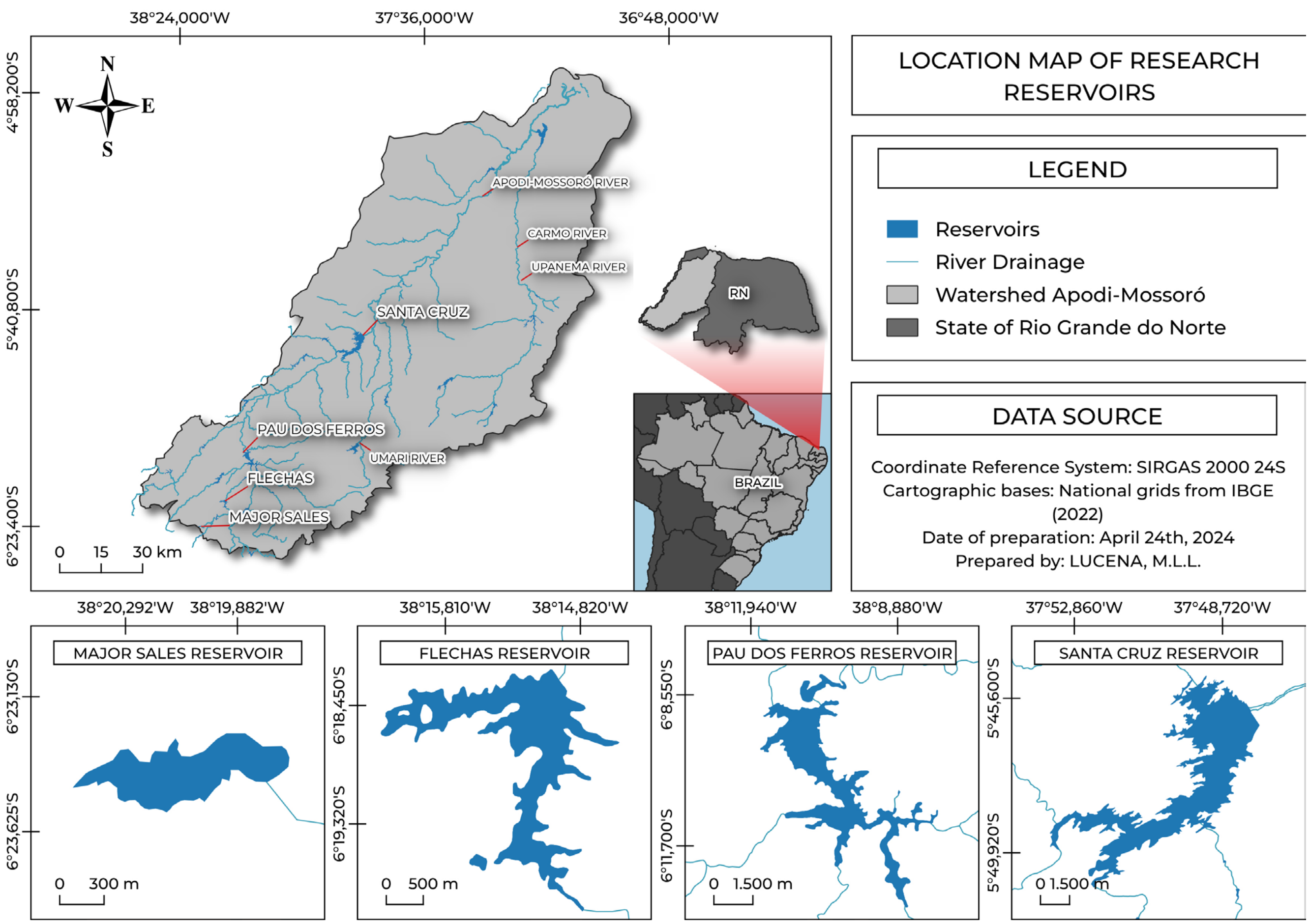

FIGURE 1 | Reservoir cascade system along the Apodi-Mossoró River in the semiarid region of Rio Grande do Norte State, Brazil.

TABLE 1 | Reservoirs forming the cascade system along the main channel of the Apodi-Mossoró River, Rio Grande do Norte State, Brazil. Information about the reservoirs: river course region, coordinates, conclusion year, area (km²), volume (m³), sampling period, number of sampling sites and Sampled areas.

General information	Major Sales	Flechas	Pau dos Ferros	Santa Cruz
Position in the watershed	Upper	Upper	Medium	Lower
Coordinates	06°23'24"S 38°19'44"W	06°18'18"S 38°15'01"W	06°08'48"S 38°11'34"W	05°45'45"S 37°48'00"W
Started of operation	1985	1983	1967	2002
Area (km²)	0.06	2.59	11.65	34.13
Maximum volume (m³)	2,641,850	8,949,675	50,846,000	599,712,000
Sampling period	2015–2016	2015–2016	2011–2012	2015–2016
Number of samplings sites	2	2	4	8
Sampled areas	Near the dam, transition areas between reservoir and river	Near the dam, transition areas between reservoir and river	Near the dam, transition areas between reservoir and river	Near the dam, transition areas between reservoir and river

Data analysis. To evaluate the relative abundance of fish species in behavioral groups and reservoirs and the interactions between these factors, we computed the catch per unit effort in numbers (CPUEn = C/f), where 'C' represents the catch in numbers and 'f' is the effort, which is defined as a^2/t, wher 'a' is the net area (301.8 m^2) and 't' is the exposure time of the fishing nets (12 h) (Orsi *et al*., 2014). CPUEn data were standardized to capture number per 1,000 m^2 over 24 h. A rarefaction curve by reservoir was generated using the iNext package (Hsieh *et al*., 2022) to assess sampling sufficiency.

The assemblages of the reservoirs were compared using a permutational multivariate analysis of variance (PERMANOVA) followed by visualization using nonmetric multidimensional scaling (NMDS). Prior to these analyses, the biotic data matrix was standardized using the Hellinger method. The PERMANOVA procedure was conducted with 9,999 permutations, and the p values were adjusted using the Bonferroni correction. Data standardization was performed using the "decostand" function of the "vegan" package (Oksanen *et al*., 2022), a step recommended as a preliminary treatment for linear tests (Legendre, Legendre, 2012).

The relative abundance of the fish species (CPUEn) was calculated in relation to spatial variables (reservoirs), behavioral groups, and their interaction using Generalized Additive Models for Location, Scale, and Shape (GAMLSS). In preparation for statistical analysis, the abundance data were transformed by squaring the values. We subsequently utilized the "fitDist" function from the "gamlss" package (Rigby, Stasinopoulos, 2005) to determine the distribution of the response variable ($CPUE^2$), which was modeled as a reverse Gumbel distribution. Model selection was carried out using the "stepGAICAll.A" function from the "gamlss" package, with selection based on the generalized Akaike information criterion (GAIC), choosing the final model with the lowest value (Rigby, Stasinopoulos, 2005). We conducted pairwise post hoc analysis of each factor using the "emmeans" function (Lenth, 2022). The resulting statistical model underwent visual validation through worm plots and inspection of the residual distribution. All analyses were performed using R software (R Development Core Team, 2021).

The data analysis was performed using GAMLSS, a semiparametric univariate regression suitable for a wide range of potential distributions of the response variable (Stasinopoulos *et al*., 2018). We used the GAMLSS model, which includes multiple distribution parameters, such as the mean, variance, skewness, and kurtosis, providing a better fit for complex data (Rigby, Stasinopoulos, 2005). The use of multiple coefficients reflects the ability of GAMLSS to separately capture the effects of individual variables on various aspects of the distribution (Rigby *et al*., 2019). This flexibility enables the fitting of models that are better suited to complex data, where the assumption of homoscedasticity or symmetric distribution may not be realistic.

RESULTS

During the study, a total of 13,787 individuals fish representing 22 species, were collected from four reservoirs in the semiarid region of northeastern Brazil. The rarefaction curve of the reservoir tended to stabilize, demonstrating sufficiency sampling of the fish assemblage at each site (Fig. 2).

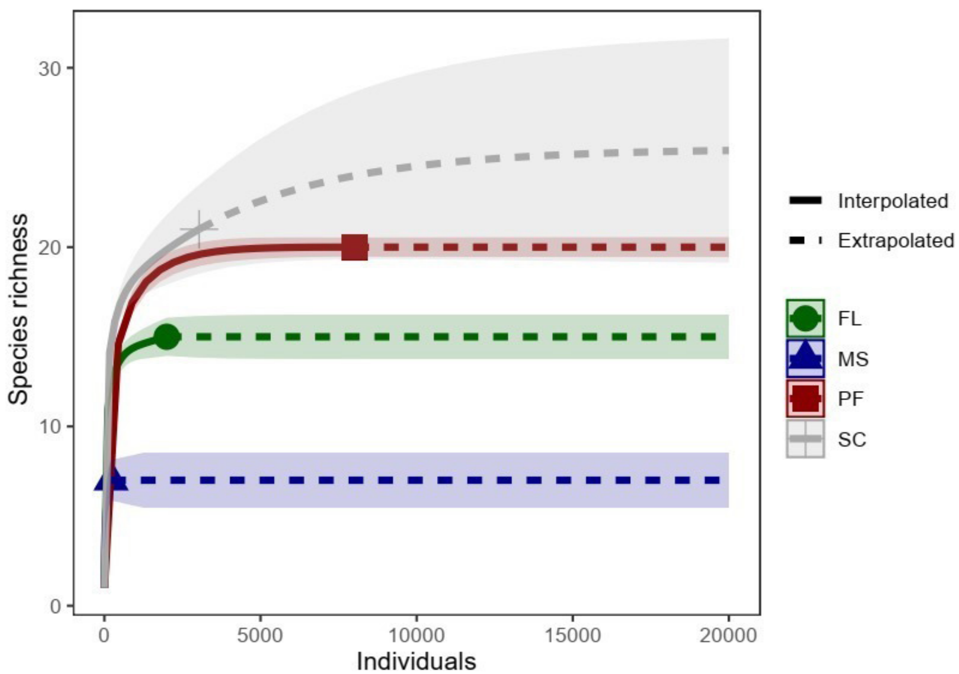

FIGURE 2 | Species accumulation curve based on sampling effort in the cascade reservoir system along the Apodi-Mossoró River, semiarid region, Rio Grande do Norte State. Major Sales (MS), Flechas (FL), Pau dos Ferros (PF), and Santa Cruz (SC).

The most abundant species was *Astyanax* aff. *bimaculatus* (Linnaeus, 1758), a native sedentary species found in all sampled reservoirs. Additionally, five other species were present in all reservoirs: *Psalidodon fasciatus* (Cuvier, 1819), *Saxatilia brasiliensis* (Bloch, 1792), *Hoplias* aff. *malabaricus* (Bloch, 1794), *Hypostomus pusarum* (Starks, 1913), and *Leporinus piau* Fowler, 1941. The highest fish abundance was recorded in the upper (FL) and middle (PF) reservoirs, where sedentary species predominated. Migratory species were also more abundant in these reservoirs, whereas nonnative species were more prevalent in the lower reservoir (SC). Therefore, the composition of the fish assemblage differed among reservoirs (PERMANOVA; $F = 21.992$; $R^2 = 71.73\%$; $p < 0.0001$; Fig. 3; Tab. 2).

The average fish abundance (CPUEn) increased in the reservoirs from the upper to the middle course of the river (PF), followed by a sharp decline in the lower course reservoir (SC). The PF reservoir exhibited the highest total fish abundances, with mean CPUE value of 3.64. In contrast, the FL and SC reservoirs recorded significantly intermediate abundances, with values of 1.74 and 0.85, respectively. The MS reservoir presented the lowest CPUEn, with values of 0.13 (GAMLSS; $p < 0.05$; Tab. 3; Fig. 4A).

Sedentary species (SED) presented the highest average abundance (CPUE = 4.48), followed by migratory species (MIG) and non-native fish (NNA), which presented an average CPUEn of 0.19 and 0.13, respectively (GAMLSS; $p < 0.05$; Tab. 3; Fig. 4B). Analysis of the abundance of the three fish groups in each individual reservoir revealed a higher abundance of sedentary fish (SED). However, in the MS and SC reservoirs, the CPUE of non-native fish (NNA) surpassed that of migratory fish (MIG) (GAMLSS; $p < 0.05$; Tab. 3; Fig. 4C).

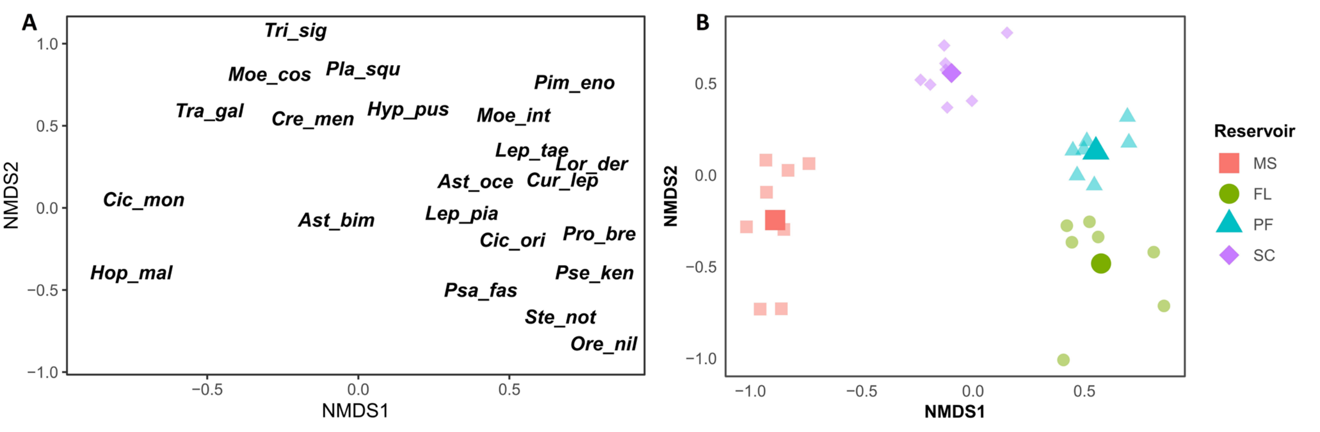

FIGURE 3 | Representation of the NMDS ordination showing the variation in fish species along the Apodi-Mossoró River reservoir cascade system, Rio Grande do Norte State. Reservoir positions: upper section, Major Sales (MS) and Flechas (FL); middle section, Pau dos Ferros (PF); and lower section, Santa Cruz (SC). **A.** Distribution of species along the first two NMDS axes. **B.** Clustering of samples according to the analyzed reservoirs.

TABLE 2 | Taxonomic classification and CPUE (standardized for catch numbers per 1000 m² and 24 hours) for sedentary, non-native, and migratory species in the reservoir cascade system along the Apodi-Mossoró River, semiarid region, Rio Grande do Norte State, Brazil. The bold numbers indicate the most abundant species in the Apodi-Mossoró River reservoir cascade system.

Group	Species	Major Sales	Flechas	Pau dos Ferros	Santa Cruz
Sedentary (SEDNA)	**CHARACIFORMES**				
	Acestrorhamphidae				
	Astyanax aff. *bimaculatus* (Linnaeus, 1758)	**42.13**	**16.17**	**35.33**	**14.67**
	Psalidodon fasciatus (Cuvier, 1819)	0.46	**9.03**	3.06	0.16
	Moenkhausia costae (Steindachner, 1907)			0.12	**20.46**
	Moenkhausia cf. *intermedia* Eigenmann, 1908		0.34	**14.54**	**6.95**
	Ctenobrycon kennedyi (Eigenmann, 1903)		1.21	0.29	0.03
	Anostomidae				
	Leporinus piau Fowler, 1941	1.39	3.86	**6.94**	0.84
	Curimatidae				
	Curimatella lepidura (Eigenmann & Eigenmann, 1889)		**14.38**	**26.51**	**7.49**
	Steindachnerina notonota (Miranda-Ribeiro, 1937)		**43.48**	0.24	
	Erythrinidae				
	Hoplias aff. *malabaricus* (Bloch, 1794)	**44.44**	2.99	1.52	**4.79**
	Triportheidae				**8.43**
	Triportheus signatus (Garman, 1890)				
	SILURIFORMES				**8.43**
	Auchenipteridae				
	Trachelyopterus galeatus (Linnaeus, 1766)	2.31		0.07	**8.33**
	Heptapteridae				
	Pimelodella enochi Fowler, 1941			0.04	0.03
	Loricariidae				
	Hypostomus pusarum (Starks, 1913)	1.39	0.24	0.32	**6.92**
	Loricariichthys derbyi Fowler, 1915			**5.25**	0.06
	CICHLIFORMES				
	Cichlidae				
	Cichlasoma orientale Kullander, 1983		1.69	0.40	0.39
	Saxatilia brasiliensis (Bloch, 1792)	0.93	0.29	0.09	2.96
Migratory (MIG)	**CHARACIFORMES**				
	Anostomidae				
	Leporinus taeniatus Lütken, 1875		0.72	2.34	0.29
	Prochilodontidae				
	Prochilodus brevis Steindachner, 1875		4.01	2.50	0.77
Non-native (NNSSED)	**CICHLIFORMES**				
	Cichlidae				
	Astronotus ocellatus (Agassiz, 1831)		0.05		0.03
	Oreochromis niloticus (Linnaeus, 1758)		1.54	0.07	0.26
	Cichla kelberi Kullander & Ferreira, 2006	6.94		0.12	0.93
	ACANTHURIFORMES				
	Sciaenidae				
	Plagioscion squamosissimus (Heckel, 1840)			0.24	**15.21**
Total number of species per reservoir		**8**	**15**	**20**	**21**

TABLE 3 | Generalized Additive Models for Location, Shape, and Scale (GAMLSS) results with the best-fit model for comparing fish abundance in three groups (Sedentary, Migratory, and Nonnative) across four reservoirs (Major Sales, Flechas, Pau dos Ferros, and Santa Cruz) within the main channel of the Apodi-Mossoró River in northeastern Brazil. Legend: R^2 - coefficient of determination; AIC - Akaike information criterion; Pr (>|t|) - significance level; df - degree of freedom; MIG - migratory; NNA - nonnative; FL - Flechas; PF - Pau dos Ferros; SC - Santa Cruz. Bold values indicate statistical significance of the variable ($\alpha < 0.05$).

Model: CPUEn ~ Group + Reservoir + Group: Reservoir, sigma.formula =~ Group + Reservoir, Family = Normal, AIC = 23.251, R^2 = 99.55%				
Mu coef.	***Estimate***	***Std. Error***	***t value***	***Pr(>|t|)***
Intercept	0.5144	0.0673	7.641	**4.65e-11**
Group (MIG)	-0.5144	0.0673	-7.634	**4.79e-11**
Group (NNA)	-0.4771	0.0677	-7.039	**6.65e-10**
Reservoir (FL)	4.3190	1.5786	2.736	**0.0077**
Reservoir (PF)	9.8726	1.1440	8.630	**5.65e-13**
Reservoir (SC)	1.7033	0.3985	4.274	**5.37e-05**
Group (MIG): Reservoir (FL)	-4.0258	1.5801	-2.548	**0.0128**
Group (NNA): Reservoir (FL)	-4.2345	1.5896	-2.664	**0.0093**
Group (MIG): Reservoir (PF)	-9.3928	1.1450	-8.203	**3.81e-12**
Group (NNA): Reservoir (PF)	-9.8411	1.1519	-8.543	**8.32e-13**
Group (MIG): Reservoir (SC)	-1.6791	0.3988	-4.210	**6.78e-05**
Group (NNA): Reservoir (SC)	-1.4189	0.4012	-3.536	**0.0006**
Sigma coef.				
Intercept	-1.6586	0.2170	-7.642	**4.63e-11**
Group (MIG)	-3.1540	0.1971	-16.003	**<2e-16**
Group (NNA)	-2.1379	0.2164	-9.878	**2.16e-15**
Reservoir (FL)	3.1540	0.2696	11.701	**<2e-16**
Reservoir (PF)	2.8311	0.2548	11.111	**<2e-16**
Reservoir (SC)	1.7638	0.2118	8.328	**2.18e-12**

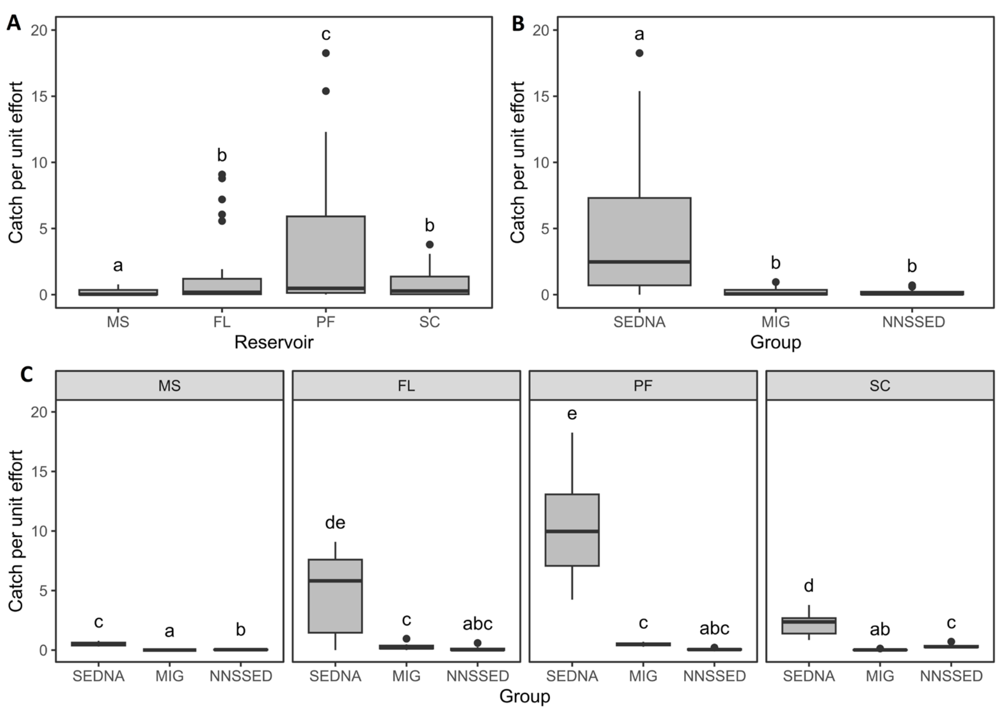

FIGURE 4 | Comparisons of fish abundance (capture per unit of effort²) according to reservoirs (**A**), behavioral groups (**B**), and the interaction of these factors (**C**) collected in the main channel of the Apodi-Mossoró River, Northeast Brazil. Legend: MS - Major Sales; FL - Flechas; PF - Pau dos Ferros; SC - Santa Cruz; SED - sedentary; MIG - migratory; NNS - nonnative (NNSSED). *Different letters indicate statistical significance ($\alpha < 0.05$).

DISCUSSION

The spatial variation observed in the average abundance of fish species, particularly in sedentary and migratory species, with an increase downstream in the cascade reservoir system of the Apodi-Mossoró River, was expected. This is because the reservoirs in the middle (PF) and lower (SC) courses of the river are the two largest reservoirs in the cascade system. According to Agostinho *et al*. (2007), there is a positive correlation between species abundance and flooded area in Neotropical reservoirs due to a greater variety of habitats and resources. However, we recognize that the sharp reduction in species abundance in the lower course reservoir (SC) may reflect the sampling design, as this reservoir is both the largest and the newest in the Apodi-Mossoró cascade system.

The high abundance of species in the impoundment of the middle region of the river (PF) was surprising, given that this reservoir began operating in 1967. In Neotropical reservoirs, there is a tendency for species abundance to decline in older reservoirs, with higher values observed in newer reservoirs (Agostinho *et al*., 2007). The high trophic status of the middle impoundment (Moura, Henry-Silva, 2018), compared with that of the other impoundments, may have influenced species abundance, as the high productivity of a lacustrine environment favors the establishment and abundance of small Acestrorhamphidae species (Agostinho *et al*., 1999; Monaghan *et al*., 2020).

The predominance of sedentary fish species in the reservoir cascade system of the Apodi-Mossoró River likely stems from the role of reservoirs in reshaping aquatic habitats and fish population dynamics (Agostinho *et al*., 2016). According to reservoir theory (Bem *et al*., 2021), dam construction and reservoir formation create new aquatic environments that may differ from natural river habitats, affecting the distribution and abundance of fish species, especially those with sedentary habits. In some cases, the construction of reservoirs can positively affect certain sedentary fish species by flooding previously dry areas, creating new aquatic habitats, and providing opportunities for colonization by species that previously could not inhabit these regions (Agostinho *et al*., 2007; Vitule *et al*., 2012). In the cascade system analyzed, all non-native fish species are classified as sedentary. It is also noteworthy that the system supports both sedentary and migratory native species.

As expected, migratory species exhibited low abundance in the cascade reservoir system of the Apodi-Mossoró River, with the main factor being the presence of dams, which interrupt the longitudinal connectivity of rivers and hinder fish movement (Pelicice, Agostinho, 2008; Petesse, Petrere Jr., 2012; Santos *et al*., 2017). The main factor responsible for the low abundance of migratory fish species in these systems is the presence of dams, which interrupt the longitudinal connectivity of rivers and hinder fish movement (Pelicice, Agostinho, 2008; Petesse, Petrere Jr., 2012; Santos *et al*., 2017). Additionally, the intermittency of fluvial systems a common feature in arid and semi-arid regions may also influence this dynamic, particularly in river stretches where some seasonal variation in the hydrological regime still occurs. In these environments, due to the short rainy season and prolonged dry periods, river segments remain disconnected for most of the year (Sarmento-Soares *et al*., 2017). As a result, migratory species generally have the opportunity to migrate only during the rainy season, typically initiating their movements at the beginning of this period to exploit newly flooded habitats as breeding grounds. It is noteworthy that, in some cases, reservoirs may mask this seasonal variation, rendering certain river stretches perennial, which can further alter the natural migration patterns.

The higher abundance of migratory species (MIG) recorded in the mid-river reservoirs aligns with diversity patterns commonly observed in reservoir cascade systems, especially when considering the effects of physical barriers, longitudinal position along the river, and hydrological connectivity factors that, collectively, are widely discussed in the scientific literature (Agostinho *et al*., 2007; Pompeu *et al*., 2012; Lima *et al*., 2016). Reservoirs located in these intermediate positions tend to maintain a certain degree of connectivity with upstream and downstream sections and receive direct influence from adjacent tributaries, which favors the occurrence and persistence of species with different ecological strategies.

The absence of migratory fish in the Major Sales Reservoir can be attributed to three main factors: (i) the geographic location of the reservoir in the upper course of the river, which presents low connectivity with downstream reaches (Maltchik, Medeiros, 2006). This limitation is associated with the presence of physical barriers, such as dams, which restrict the longitudinal connectivity of the system and hinder the arrival of migratory species inhabiting the middle and lower stretches, thus compromising their natural distribution; (ii) the typical environmental conditions of headwater areas in semiarid regions (Lima *et al*., 2016), characterized by lower water volume, increased hydrological seasonality, and low diversity of aquatic habitats; (iii) the cumulative effect of barriers imposed by the cascade reservoir system (Agostinho *et al*., 2007; Pompeu *et al*., 2012), which progressively reduces longitudinal connectivity along the river, impairing the reproductive migration of migratory species. Therefore, these factors emphasize the necessity of considering longitudinal connectivity and the preservation of functional habitats as fundamental elements for the conservation of migratory species in rivers of the Brazilian semiarid region.

In summary, the study's hypothesis was confirmed: sedentary species were more abundant throughout the cascade reservoir system, while the abundance of non-native species exceeded that of migratory ones. The spatial variation observed in fish assemblages appears to be related to multiple factors, including reservoir size, position within the cascade, and local environmental characteristics. These results highlight the role of fragmentation in reservoir systems in the semiarid region in shaping ichthyofauna distribution, reinforcing the importance of connectivity between water bodies for maintaining community dynamics and biodiversity. These findings are consistent with those reported by de Oliveira *et al*. (2024), who analyzed the ichthyofauna in three reservoirs of the Apodi-Mossoró River prior to the São Francisco River transposition. Together, both studies complement each other by revealing similar patterns in fish community structure and emphasizing the combined influence of local variables and the spatial organization of reservoirs on the composition and abundance of regional ichthyofauna.

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AUTHORS’ CONTRIBUTION

Jean Carlos Dantas de Oliveira: Conceptualization, Data curation, Investigation, Writing-original draft, Writing-review and editing.

Jônnata Fernandes de Oliveira: Investigation.

Alexandre de Oliveira Marques: Data curation, Formal analysis.

Danielle Peretti: Investigation.

Rodrigo S. da Costa Goldbaum: Project administration.

José Luís Costa Novaes: Conceptualization, Investigation, Methodology.

ETHICAL STATEMENT

Fish collection was conducted under the appropriate license issued by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio, process number 27046).

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article.

AI STATEMENT

Artificial Intelligence (ChatGPT – GPT-5) was used for text adjustments and translation purposes.

SUPPLEMENTARY MATERIAL

Supplementary material **S1**

COMPETING INTERESTS

The authors declare no competing interests.

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