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Spatio-Temporal Dynamics of Fish Assemblages in Guiana Shield Tributaries of the Lower Amazon River, Brazilian Amazon

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Abstract

The Amazon Basin harbors the greatest diversity of freshwater fishes on the planet, yet many remote regions remain poorly studied, particularly regarding spatial and temporal variation in fish assemblages. This study evaluated fish assemblage variation between river and stream habitats and between two hydrological periods in the Curuá and Maicuru drainages, located in the Northern Pará Drainage System, Brazilian Amazon. Fish were sampled during low- and high-water periods, and species richness was estimated using the first-order Jackknife estimator. Assemblage variation was assessed using non-metric multidimensional scaling (NMDS) and permutational multivariate analysis of variance (PERMANOVA) based on Bray–Curtis and Jaccard dissimilarities. A total of 262 taxa belonging to 46 families and 11 orders were recorded, with Characiformes and Siluriformes predominating. Rivers harbored 201 taxa and streams 134 taxa, including 73 taxa shared between habitats. Estimated richness was higher in rivers (229 taxa) than in streams (167 taxa). PERMANOVA revealed significant differences between river and stream assemblages during both sampling campaigns, based on Bray–Curtis and Jaccard dissimilarities (Holm-adjusted $p \leq 0.0004$). Significant differences between low- and high-water sampling campaigns were also detected in rivers and streams using both indices (Holm-adjusted $p \leq 0.0049$). For Bray–Curtis dissimilarity, sampling campaign explained 10.09% of assemblage variation in rivers and 5.73% in streams. In contrast, comparisons between the Curuá and Maicuru drainages, as well as temporal comparisons within individual drainage–habitat combinations, were not statistically significant after correction for multiple comparisons. These findings indicate that river and stream assemblages differed consistently across sampling campaigns, while temporal variation was detectable when samples from both drainages were pooled. However, differences in sampling gear between habitats and the limited temporal replication require cautious interpretation. The results highlight the complementary contributions of river and stream habitats to regional fish diversity and reinforce the importance of conserving interconnected freshwater ecosystems in the Guiana Shield.

Keywords: Amazon basin; biodiversity; conservation; freshwater fishes; Guiana Shield

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1. Introduction

The Amazon basin, covering approximately 7 million km^2, constitutes the largest river system on the planet, concentrating about 16–22% of all continental water that flows into the

oceans [1,2]. This extensive drainage network supports the world's greatest freshwater fish diversity, with estimates ranging from 2406 [3] to 2716 valid species [4]. Furthermore, the number of species described continues to increase, with new species being described each year [5], showing a high degree of endemism and broad taxonomic diversity, representing approximately 15% of the planet's freshwater fish [4,6]. This remarkable diversity is also associated with strong environmental heterogeneity across the Amazon Basin, where variation in water chemistry and geomorphological habitat characteristics plays an important role in structuring fish assemblages and their temporal dynamics [7,8]. The resulting mosaic of lower-order streams, lakes, and large river systems draining distinct geological formations, provides a broad range of aquatic habitats and ecological niches, enabling the coexistence of numerous species adapted to diverse environmental conditions [7,9,10].

The dynamics of large Amazonian rivers, particularly floodplain systems, are well documented and are known to be strongly influenced by the seasonal hydrological regime, characterized by the alternation between high-water and low-water periods [11]. This process regulates connectivity among aquatic habitats and acts as an important structuring mechanism for fish assemblages, especially in areas subject to the flood pulse [9,10]. During the high-water period, the lateral expansion of aquatic environments increases the availability of habitats and food resources, favoring displacement, feeding, and reproduction of various species [12]. In contrast, during the low-water period, there is a reduction in habitat availability, increased environmental isolation, and changes in the composition and structure of fish assemblages, processes also associated with climatic variability and regional precipitation patterns [11,13,14].

Although the influence of seasonal hydrological dynamics has been extensively documented in Amazonian floodplain rivers, the spatio-temporal dynamics of aquatic ecosystems in rivers draining the Guiana Shield remain poorly understood. In contrast to Amazonian floodplain rivers, rivers draining the Guiana Shield encompass distinct environmental and geomorphological conditions that contribute to variation in fish assemblage composition [15]. These geomorphological characteristics strongly influence local hydrology, restricting the development of extensive floodplains and reducing hydrological connectivity among aquatic habitats [16]. In the northern region of Pará State (Calha Norte), these geomorphological characteristics play a key role in shaping aquatic ecosystems. Nevertheless, the spatio-temporal dynamics of fish assemblages remain largely unknown, particularly with respect to how variation between sampling periods may relate to changes in species composition and distribution, e.g., [8].

Furthermore, insufficient sampling effort across large portions of the region has resulted in significant knowledge gaps regarding Amazonian aquatic biodiversity [17,18]. This limitation is particularly evident in the state of Pará, where the remarkable diversity of river systems contrasts with the scarcity of comprehensive ichthyofaunal surveys, leaving many basins and sub-basins inadequately documented, e.g., [3,4,15,19]. The Curuá and Maicuru rivers are among the principal clear-water tributaries draining the southern Guiana Shield into the lower Amazon River and are recognized for supporting a highly diverse fish fauna associated with heterogeneous habitats. Recent inventories have expanded the knowledge of their ichthyofauna, while the description of new species from the Curuá River basin demonstrates that these drainages still harbor poorly known biodiversity and remain important areas for ecological, biogeographic, and conservation studies [15,20]. Therefore, the limited knowledge of fish assemblage dynamics in these rivers restricts advances in ecological and biogeographic understanding and hampers the development of effective conservation and management strategies for regional aquatic biodiversity [21]. A companion study by Silva et al. [22] investigated the influence of hydrological period, drainage, and local environmental conditions on fish assemblages in upland streams of

the eastern Amazon. The present study expands this scope by simultaneously sampling river and stream habitats across two adjacent drainages, Curuá and Maicuru, providing an integrated assessment of fish assemblage variation across habitats, drainages, and two sampling campaigns in the Northern Pará Drainage System.

In this context, the present study evaluated variation in fish assemblages in rivers and streams of the Curuá and Maicuru river drainages between two sampling campaigns conducted in December 2020 and July 2021. Specifically, we tested three hypotheses: (i) fish assemblages differ between river and stream habitats, reflecting contrasts in channel morphology, substrate, and habitat heterogeneity; (ii) assemblages differ between the two sampled campaigns, with stronger temporal turnover expected in river than in stream habitats; and (iii) fish assemblages differ between the Curuá and Maicuru drainages, potentially reflecting their distinct spatial and biogeographic contexts. We assessed these hypotheses using taxon richness, abundance, diversity, evenness, dominance, and multivariate analyses based on abundance (Bray–Curtis) and occurrence (Jaccard) data. Because each hydrological period was represented by only one sampling campaign, the temporal comparisons were interpreted as differences between the two campaigns rather than as an independently replicated test of seasonality.

2. Materials and Methods

2.1. Study Area

The study was conducted in the municipalities of Alenquer and Monte Alegre, located in the western region of the state of Pará, Brazil. The investigated areas correspond to the drainages of the Curuá and Maicuru rivers, located on the left bank of the Amazon River and integrate an important river system of the Northern Calha Paraense.

The Curuá River is approximately 814.6 km long and flows into the territory of the municipality of Alenquer. Its watershed exhibits intense erosion and a dense drainage network, reflecting typical geological and geomorphological processes of the region. The Maicuru River, with approximately 697.5 km in length and an estimated drainage area of 13,000 km^2, is a direct tributary of the Amazon River, standing out for the presence of reliefs covered by dense ombrophilous forest [23,24].

Although both are classified as clearwater rivers, the Curuá and Maicuru rivers present marked variations along their course. The lower portion is dominated by flat relief and greater sediment deposition, with direct influence from the Amazon River. The basin encompasses distinct environmental settings. The middle reaches are characterized by a mosaic of aquatic habitats and high ecological complexity, whereas the upper reaches occur in rugged landscapes with relatively low levels of anthropogenic disturbance [25,26]. The upper Maicuru reaches were not included in the quantitative sampling because their remote, rugged setting, lack of road access and settlements, and limited logistical support prevented access during the field campaigns.

The regional hydrological regime in the northern Pará drainage system is characterized by a well-defined dry season from September to December, with minimum river levels typically recorded in November–December, and a flood season from March to July, with maximum levels in May–June [14,23,24]. This pattern is driven by the seasonal migration of the Intertropical Convergence Zone and modulated by the Amazon River flood pulse. The two sampling campaigns (1–7 December 2020 and 6–10 July 2021) were therefore timed to coincide with these contrasting hydrological extremes.

2.2. Sampling

Collection permits were issued by ICMBio/SISBIO under permit number 10227. Voucher specimens were deposited in the Ichthyological Collection of the Federal University of Western Pará (UFOPA).

Ichthyofaunistic sampling was conducted during two field campaigns designed to assess the differences between sampling campaigns on fish assemblages. The first campaign was carried out between 1 December and 7, 2020, during the low-water period, whereas the second campaign took place between 6 July and 10, 2021, during the high-water period [24,25]. The sampling design initially comprised 25 planned stations distributed between river (12 stations) and stream (13 stations) environments within the Curuá and Maicuru drainages (Figure 1; Table 1). Sampling stations were georeferenced using a global positioning system (GPS). The dataset used for quantitative analyses comprised 45 station-by-campaign sampling units: 23 sampled during the December 2020 campaign and 22 during the July 2021 campaign. Of these, 22 stations were sampled during both campaigns. River station P12 was sampled only in December 2020 and was therefore retained in analyses of that campaign but excluded from paired comparisons between campaigns. All quantitative analyses were based exclusively on data obtained during these two sampling campaigns. Sampling encompassed both rivers and streams distributed across the Curuá and Maicuru river basins. Sampling sites in the Curuá drainage were distributed along the surveyed section of the basin, whereas in the Maicuru drainage the quantitative analyses included only sampling sites located in the middle and lower reaches.

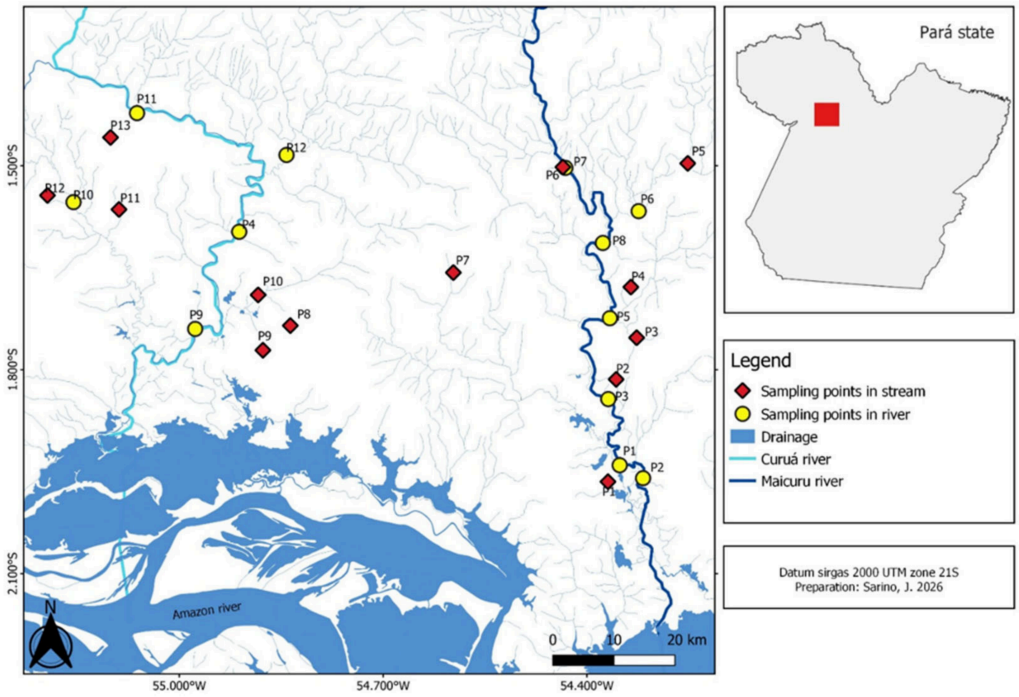


Figure 1. Location of sampling stations in the drainages of the Curuá and Maicuru rivers, Northern Pará Drainage System, Brazilian Amazon [27].

Because only one campaign was conducted per hydrological period, hydrological period was fully confounded with campaign date and year, and within-period replication was not possible. Therefore, temporal comparisons should be interpreted as comparisons between two specific sampling campaigns (December 2020 and July 2021), rather than as a fully replicated test of seasonal effects. This limitation is considered when interpreting temporal patterns.

Table 1. Relationship and coordinates of sampling stations of the Curuá and Maicuru river basins, Northern Pará Drainage System, Brazilian Amazon.

Station	Drainage	Habitat	Latitude	Longitude
1	Maicuru River	River	01°56′25.6″ S	054°21′6.5″ W
2	Maicuru River	River	01°57′34.2″ S	054°19′2.8″ W
3	Maicuru River	River	01°50′35.4″ S	054°22′07.05″ W
4	Curuá River	River	01°35′49.3″ S	054°54′42.7″ W
5	Maicuru River	River	01°43′27.0″ S	054°21′58.7″ W
6	Maicuru River (Ipixuna)	River	01°34′00.2″ S	054°19′26.1″ W
7	Maicuru River	River	01°30′10.9″ S	054°25′54.5″ W
8	Maicuru River	River	01°36′48.6″ S	054°22′35.9″ W
9	Curuá River	River	01°44′24″ S	054°58′35.8″ W
10	Curuá River (Mamiá)	River	01°33′12.4″ S	055°9′20.4″ W
11	Curuá River (Cuminã)	River	01°25′20.8″ S	055°03′43.9″ W
12	Curuá River (Paraíso)	River	01°29′2.5″ S	054°50′31.9″ W
1	Maicuru River (Murumurú)	Stream	01°57′53.08″S	054°22′8.65″ W
2	Maicuru River (Mendes)	Stream	01°48′50.90″ S	054°21′25.40″ W
3	Maicuru River (Fartura)	Stream	01°45′10.50″ S	054°19′36.70″ W
4	Maicuru River (Índio)	Stream	01°40′42.40″ S	054°20′7.40″ W
5	Maicuru River (Setor)	Stream	01°29′47.2″ S	054°15′5.8″ W
6	Maicuru River (Mussum)	Stream	01°30′6.81″ S	054°26′7.48″ W
7	Maicuru River (Tamanduá)	Stream	01°39′25.50″ S	054°35′48.00″ W
8	Curuá River (Cachimbo)	Stream	01°44′6.30″ S	054°50′11.60″ W
9	Curuá River (Estreito)	Stream	01°46′16.70″ S	054°52′36.90″ W
10	Curuá River (Carapanã)	Stream	01°41′23.80″ S	054°53′2.20″ W
11	Curuá River (Palha branca)	Stream	01°33′51.17″ S	055°5′19.38″ W
12	Curuá River (Visão II)	Stream	01°32′36.73″ S	055°11′38.49″ W
13	Curuá River (Paiol do velho)	Stream	01°27′29.70″ S	055°6′4.30″ W

2.3. Species Collection

Species collection was carried out using passive and active methods, standardized according to the characteristics of the sampled environments, allowing qualitative and quantitative comparisons among sampling sites.

In river environments, gill nets and seine nets were used. In each sampling unit, seven simple-mesh gill nets were employed, measuring 1.5 m in height and 10 m in length, totaling 70 linear meters of net. The gill nets had mesh sizes of 1.5, 2, 3, 4, 6, 8, and 10 cm between non-adjacent knots, allowing the capture of species with different body sizes. In river environments, gillnets were deployed from 4:00 PM to 10:00 PM and inspected every two hours. The selection of this time interval was based on observations made during fieldwork, which indicated increased fish activity in the upper portion of the water column during twilight and early evening, favoring their capture by gillnets. Therefore, this period was selected to take advantage of a time window of increased fish activity and catchability. Nevertheless, sampling during this interval does not fully cover the diurnal and nocturnal periods, and species with different activity patterns may therefore be underrepresented.

In stream environments, the sampling stretches were previously delimited into 50 m long segments using a measuring tape, and then georeferenced. To prevent fish escape, the stretches were blocked upstream and downstream with fine-mesh nets (0.5 mm between non-adjacent knots). Collections were carried out by a team of four researchers, using hand-operated seine nets and sieves (0.5 mm between non-adjacent knots), lasting approximately two hours per sampling unit. The objective of the employed methodology was to encompass the diversity of microhabitats available in each stretch of the aquatic environment, with adaptations based on the methodological proposal of Mendonça et al. [28], also considering the influence of environmental heterogeneity on the structuring of Amazonian fish assemblages, as discussed by Benone et al. [29].

Sampling procedures were applied consistently within each habitat type across both campaigns. However, because river channels and forest streams differ in depth, width, flow velocity, and substrate, sampling gear was selected according to habitat characteristics: gill nets and seines were used in rivers, whereas seines and sieves were used in streams. Conse-

quently, habitat comparisons are partially confounded with gear selectivity because gill nets were used only in rivers. This limitation should be considered when interpreting differences between habitats. The use of both abundance-based (Bray–Curtis) and occurrence-based (Jaccard) dissimilarities provides complementary assessments of assemblage variation but does not eliminate potential gear-related effects.

2.4. Fixation and Identification of Species

Specimens were euthanized following accepted ichthyological protocols, according to Inoue & Moraes [30]. They were subsequently fixed in 10% formalin for approximately 48 h and transferred to 70% ethanol for long-term preservation. Taxonomic identification was performed to the lowest possible taxonomic level based on specialized literature [31–33], following the taxonomic classification adopted by the Catalog of Fishes [5] and the International Code of Zoological Nomenclature (ICZN). Voucher specimens were deposited in the Ichthyological Collection of the Federal University of Western Pará.

Throughout this study, we used "taxon" (plural "taxa") as the operational unit. This category includes formally described species, morphospecies, and taxa identified under open nomenclature (e.g., aff., cf., gr., and sp.). These units were treated as independent operational taxonomic units (OTUs) when consistent diagnostic morphological differences were recognized.

2.5. Data Analysis

The characterization of fish assemblages was conducted using ecological descriptors widely employed in aquatic community studies, including taxon richness and abundance, Shannon diversity index, Pielou's evenness, and dominance measures. Total potential richness was estimated separately for river and stream environments based on the Jackknife 1 estimator, proposed by Heltshe & Forrester [34], processed in the EstimateS 9.1 program, which allowed inferring the occurrence of species not detected in the samplings.

Fish assemblage composition was analyzed using Bray–Curtis and Jaccard dissimilarities. Abundance data were square-root transformed before calculating Bray–Curtis dissimilarities to reduce the influence of highly abundant taxa. Jaccard dissimilarities were calculated from presence–absence data. Differences in assemblage composition were evaluated using permutational multivariate analysis of variance (PERMANOVA). Four planned comparisons were performed for each dissimilarity index to assess differences between sampling campaigns within rivers and streams and between habitat types within each campaign. Six additional comparisons per index were conducted to examine differences between campaigns within each drainage–habitat combination and between the Curuá and Maicuru drainages within each habitat type.

The permutation design accounted for repeated observations from the same sampling stations. Temporal comparisons included only stations sampled during both campaigns, with campaign labels exchanged within stations. Between-drainage comparisons preserved the repeated observations belonging to each station by permuting entire station blocks. Exact permutation tests were used when the number of admissible permutations was limited. For comparisons between rivers and streams within individual campaigns, 9999 random permutations were performed. The Holm correction was applied separately to the four main comparisons and six additional comparisons for each dissimilarity index. Statistical significance was assessed at an adjusted p-value of 0.05.

Differences in multivariate dispersion were assessed using PERMDISP, implemented in Python 3.15.2 using NumPy 2.5.0 and SciPy 1.18.1. Distances to group centroids were calculated in principal coordinates space, retaining positive eigenvalue axes. The significance of dispersion differences was evaluated using permutation procedures corresponding

to the respective comparisons. Non-significant PERMDISP results were interpreted as an absence of statistical evidence for heterogeneous dispersion, rather than as proof of equal dispersions.

Non-metric multidimensional scaling (NMDS) was performed using the same dissimilarity definitions employed in PERMANOVA. Two- and three-dimensional solutions were compared based on stress values. Ordination quality was further examined using Spearman correlations between original dissimilarities and ordination distances, together with Shepard diagnostics. The three-dimensional solutions were selected for visualization because they provided lower stress values.

3. Results

A total of 262 taxa were recorded in the Curuá and Maicuru river drainages, distributed across 46 families and 11 orders, totaling 17,288 individuals (Table A1). Of these, 198 taxa were recorded in the Maicuru drainage and 173 in the Curuá drainage. A total of 109 taxa were shared between the two drainages, whereas 89 taxa were exclusive to the Maicuru drainage and 64 were exclusive to the Curuá drainage (Figure 2).

Habitat-specific richness also differed within each drainage (Figure 3). In the Maicuru drainage, river habitats harbored 156 taxa (113 exclusive and 43 shared with streams), whereas stream habitats contained 85 taxa (42 exclusive and 43 shared). In the Curuá drainage, river habitats comprised 116 taxa (73 exclusive and 43 shared), while streams comprised 100 taxa (57 exclusive and 43 shared).

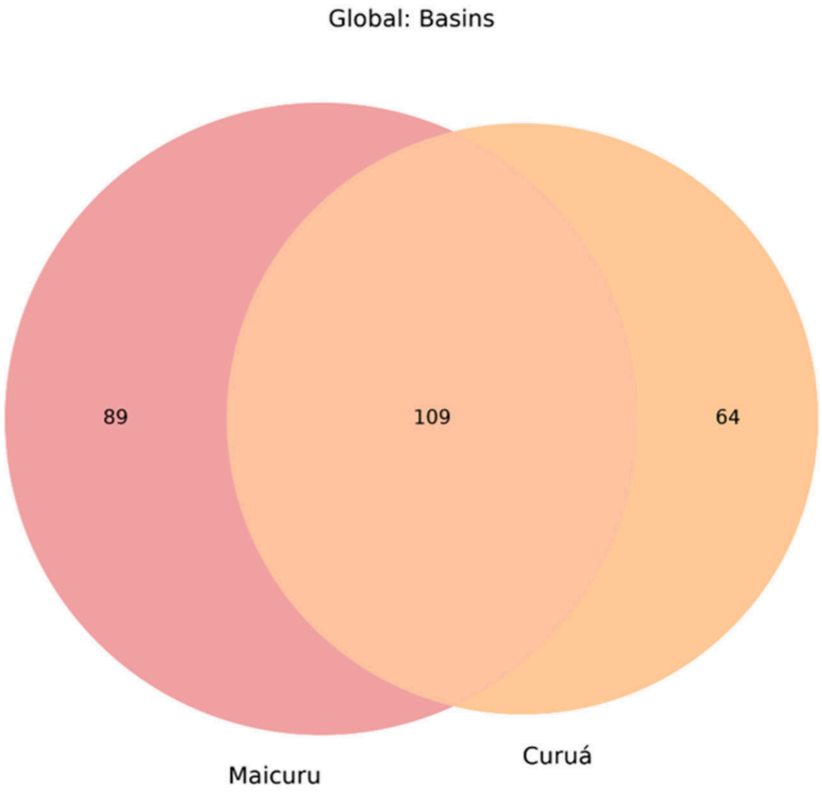


Figure 2. Venn diagram showing the richness of fish taxa shared between the Curuá and Maicuru river drainages and the number of taxa exclusive to each drainage, Northern Pará Drainage System, Brazilian Amazon.

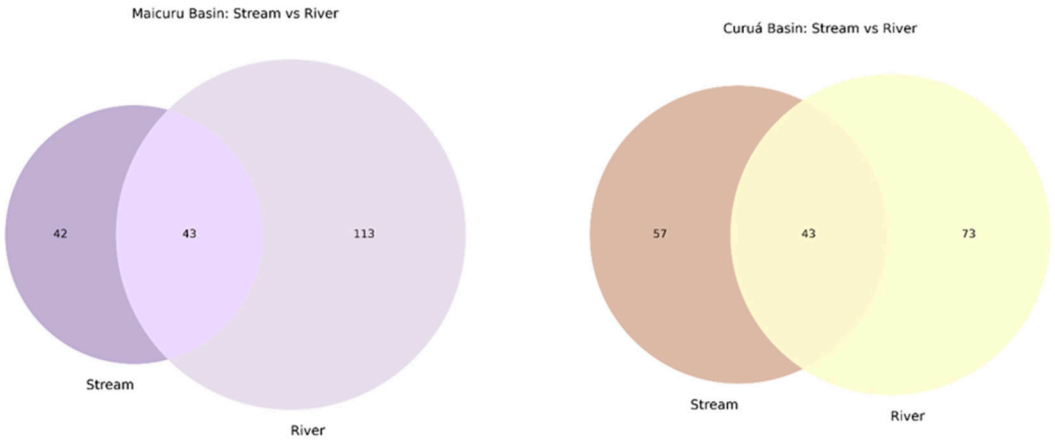


Figure 3. Venn diagrams showing the richness of fish taxa shared between river and stream environments within the Curuá and Maicuru river drainages, Northern Pará Drainage System, Brazilian Amazon.

Considering both drainages together, 201 taxa were recorded in river environments and 134 in stream environments. Of these, 128 taxa were exclusive to rivers, 61 were exclusive to streams, and 73 taxa were shared between both habitat types (Figure 4; Table A1).

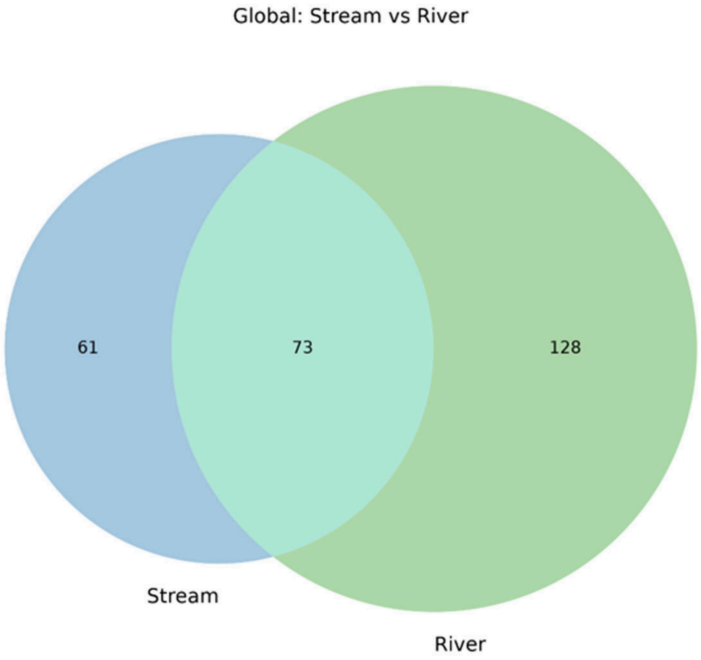


Figure 4. Distribution of fish taxa shared between river and stream environments and the number of taxa exclusive to each habitat type in the Curuá and Maicuru drainages, Northern Pará Drainage System, Brazilian Amazon.

Fish assemblages were strongly dominated by Characiformes, which accounted for more than half of the recorded taxa (57.6%) and 90.0% of total abundance. Siluriformes was the second most representative order, with 25.2% of richness and 3.9% of total abundance, while all remaining orders individually contributed less than 10% to family richness, taxa richness, or abundance (Table 2). Characiformes dominated the fish assemblages in terms of both taxa richness and abundance, accounting for 151 taxa and 15,564 individuals. Siluriformes was the second most representative order, with 66 taxa and 675 individuals, followed by Cichliformes (17 taxa; 628 individuals) and Gymnotiformes (12 taxa; 74 individuals).

The remaining orders contributed relatively little to the assemblage, with each accounting for fewer than 2% of total abundance (Table 2).

Table 2. General composition of fish orders, in river and stream environments in the drainages of the Curuá and Maicuru rivers, Northern Pará Drainage System, Brazilian Amazon.

Orders	Families		Taxa Richness		Abundance	
	n	%	*n*	%	*n*	%
Characiformes	21	45.7%	151	57.6%	15,564	90.0%
Siluriformes	10	21.7%	66	25.2%	675	3.9%
Cichliformes	2	4.3%	17	6.5%	628	3.6%
Cyprinodontiformes	2	4.3%	3	1.1%	204	1.2%
Clupeiformes	2	4.3%	5	1.9%	91	0.5%
Gymnotiformes	4	8.7%	12	4.6%	74	0.4%
Tetraodontiformes	1	2.2%	1	0.4%	18	0.1%
Gobiiformes	1	2.2%	1	0.4%	13	0.1%
Synbranchiformes	1	2.2%	3	1.1%	12	0.1%
Beloniformes	1	2.2%	2	0.8%	8	0.0%
Osteoglossiformes	1	2.2%	1	0.4%	1	0.0%
Total	46		262		17,288	

The ecological descriptors indicated higher taxa richness and Shannon diversity during the low-water campaign, as well as higher Pielou's evenness, indicating a more even distribution of individuals among taxa. In contrast, total abundance was higher during the high-water campaign (Table 3).

Table 3. Ecological descriptors of fish assemblages in the low-water and high-water periods.

Season	Species Richness	Sampling Units	Shannon	Pielou	Dominance	Abundance
Low-water	213	23	3.9041	0.7282	0.03688	7024
High-water	159	22	3.3135	0.6537	0.07558	10,264
Total	262	45				17,288

The richness estimate demonstrated that the ichthyofaunistic diversity of the studied drainages may still be underestimated. In stream environments, 134 species were recorded, while the estimated richness was 167 species. In river environments, 201 species were observed, with an estimated richness of 229 species, evidencing the potential occurrence of additional taxa not detected during the samplings.

PERMANOVA analyses based on Bray–Curtis dissimilarity, calculated from square-root-transformed abundance data, revealed significant differences in fish assemblage structure between rivers and streams during both low-water (Pseudo-F = 3.7879, R^2 = 0.1528, *p*-Holm = 0.0004) and high-water periods (Pseudo-F = 3.1462, R^2 = 0.1359, *p*-Holm = 0.0004). Significant differences were also detected between the two sampling campaigns in rivers (Pseudo-F = 2.2455, R^2 = 0.1009, *p*-Holm = 0.0020) and streams (Pseudo-F = 1.2164, R^2 = 0.0573, *p*-Holm = 0.0049). These results indicate that fish assemblage abundance structure differed between habitat types and sampling campaigns, although the proportion of variation explained by these comparisons was relatively low.

Analyses based on Jaccard dissimilarity also revealed significant differences in taxon composition between rivers and streams during the low-water (Pseudo-F = 3.1479, R^2 = 0.1304, *p*-Holm = 0.0004) and high-water campaigns (Pseudo-F = 2.3262, R^2 = 0.1042, *p*-Holm = 0.0004). Differences between sampling campaigns were also significant in streams (Pseudo-F = 1.3936, R^2 = 0.0651, *p*-Holm = 0.0020) and rivers (Pseudo-F = 1.6123,

$R^2 = 0.0746$, p-Holm = 0.0020). Thus, both abundance-based and occurrence-based analyses indicated differences in fish assemblage composition between habitat types and sampling campaigns (Table 4).

Table 4. Results of PERMANOVA comparisons of fish assemblage composition among habitat types and hydrological periods based on Bray–Curtis (calculated from square-root-transformed abundance data) and Jaccard (presence–absence data) dissimilarities.

Comparison	Dissimilarity	Pseudo-F	R^2	p-Value	p-Holm
Streams: low vs. high water	Bray–Curtis	1.2164	0.0573	0.0049	0.0049
Rivers: low vs. high water	Bray–Curtis	2.2455	0.1009	0.0010	0.0020
Streams vs. rivers: low water	Bray–Curtis	3.7879	0.1528	0.0001	0.0004
Streams vs. rivers: high water	Bray–Curtis	3.1462	0.1359	0.0001	0.0004
Streams: low vs. high water	Jaccard	1.3936	0.0651	0.0020	0.0020
Rivers: low vs. high water	Jaccard	1.6123	0.0746	0.0010	0.0020
Streams vs. rivers: low water	Jaccard	3.1479	0.1304	0.0001	0.0004
Streams vs. rivers: high water	Jaccard	2.3262	0.1042	0.0001	0.0004

The multivariate dispersion analysis (PERMDISP) did not detect significant differences in within-group dispersion for any of the main comparisons between habitat types or sampling campaigns (all $p > 0.05$). For Bray–Curtis dissimilarities, p-values ranged from 0.3828 to 0.7716, whereas for Jaccard dissimilarities, they ranged from 0.2649 to 0.9492. Likewise, none of the additional comparisons involving drainages showed significant differences in dispersion. These results provided no statistical evidence of heterogeneous multivariate dispersion among the groups compared.

PERMANOVA comparisons between the Curuá and Maicuru drainages revealed no statistically significant differences in fish assemblage composition after Holm correction for multiple comparisons (Table 5). In streams, nominally significant differences were detected using both Bray–Curtis (Pseudo-F = 2.1809, $R^2 = 0.0983$, $p = 0.0411$) and Jaccard dissimilarities (Pseudo-F = 1.8903, $R^2 = 0.0864$, $p = 0.0152$), but neither remained significant after adjustment (p-Holm = 0.1645 and 0.0909, respectively). In rivers, no significant differences between drainages were detected using either dissimilarity metric, even before correction.

Comparisons between low-water and high-water sampling campaigns within each drainage–habitat combination likewise revealed no statistically significant differences after Holm correction. However, nominally significant differences were detected in Maicuru streams using Bray–Curtis ($p = 0.0312$, p-Holm = 0.1562) and Jaccard dissimilarities ($p = 0.0312$, p-Holm = 0.1250), as well as in Maicuru rivers using Bray–Curtis ($p = 0.0156$, p-Holm = 0.0938) and Jaccard dissimilarities ($p = 0.0156$, p-Holm = 0.0909). No nominally significant differences between campaigns were detected in Curuá streams or rivers. Overall, none of the comparisons remained statistically significant after correction for multiple testing (Table 5).

Three-dimensional non-metric multidimensional scaling (NMDS) provided a better representation of fish assemblage dissimilarities than two-dimensional solutions. Stress values decreased from 0.2439 to 0.1760 for Bray–Curtis dissimilarity and from 0.2584 to 0.1817 for Jaccard dissimilarity. Spearman correlations between the original dissimilarities and ordination distances were 0.8626 and 0.8557, respectively.

The three-dimensional ordinations were used to visualize differences in fish assemblage composition among sampling units (Figures 5 and 6). Although the lower stress values improved the representation of the multivariate data, some distortion remained, and

spatial relationships among samples were therefore interpreted cautiously. Compositional differences between habitat types and sampling campaigns were evaluated statistically using PERMANOVA (Table 4), rather than inferred solely from the ordination patterns.

Table 5. Results of PERMANOVA comparisons of fish assemblage composition between the Curuá and Maicuru river drainages and between hydrological periods (low-water and high-water) within each drainage based on Bray–Curtis (calculated from square-root-transformed abundance data) and Jaccard (presence–absence data) dissimilarities.

Comparison	Dissimilarity	Pseudo-F	R^2	*p*-Value	*p*-Holm
Maicuru streams: low vs. high water	Bray–Curtis	1.0060	0.0914	0.0312	0.1562
Curuá streams: low vs. high water	Bray–Curtis	1.1938	0.1298	0.1875	0.3750
Maicuru rivers: low vs. high water	Bray–Curtis	1.9044	0.1370	0.0156	0.0938
Curuá rivers: low vs. high water	Bray–Curtis	1.2623	0.1738	0.1250	0.3750
Streams: Maicuru vs. Curuá	Bray–Curtis	2.1809	0.0983	0.0411	0.1645
Rivers: Maicuru vs. Curuá	Bray–Curtis	1.5095	0.0671	0.1414	0.3750
Maicuru streams: low vs. high water	Jaccard	1.2452	0.1107	0.0312	0.1250
Curuá streams: low vs. high water	Jaccard	1.2662	0.1366	0.1250	0.3750
Maicuru rivers: low vs. high water	Jaccard	1.4237	0.1061	0.0156	0.0909
Curuá rivers: low vs. high water	Jaccard	1.1832	0.1647	0.1250	0.3750
Streams: Maicuru vs. Curuá	Jaccard	1.8903	0.0864	0.0152	0.0909
Rivers: Maicuru vs. Curuá	Jaccard	1.2689	0.0570	0.2222	0.3750

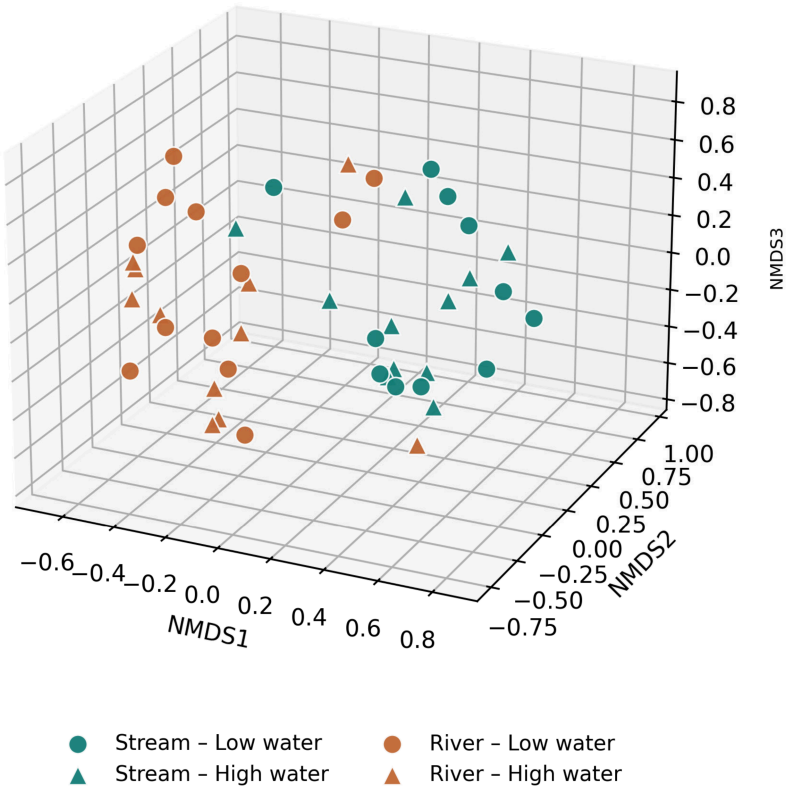


Figure 5. Three-dimensional non-metric multidimensional scaling (NMDS) ordination based on Bray–Curtis dissimilarity showing patterns of fish assemblage composition among rivers and streams during low-water and high-water periods in the Curuá and Maicuru river basins, Northern Pará Drainage System, Brazilian Amazon. Points represent sampling units classified by habitat type (river or stream) and sampling campaign (low-water or high-water). Stress = 0.1760.

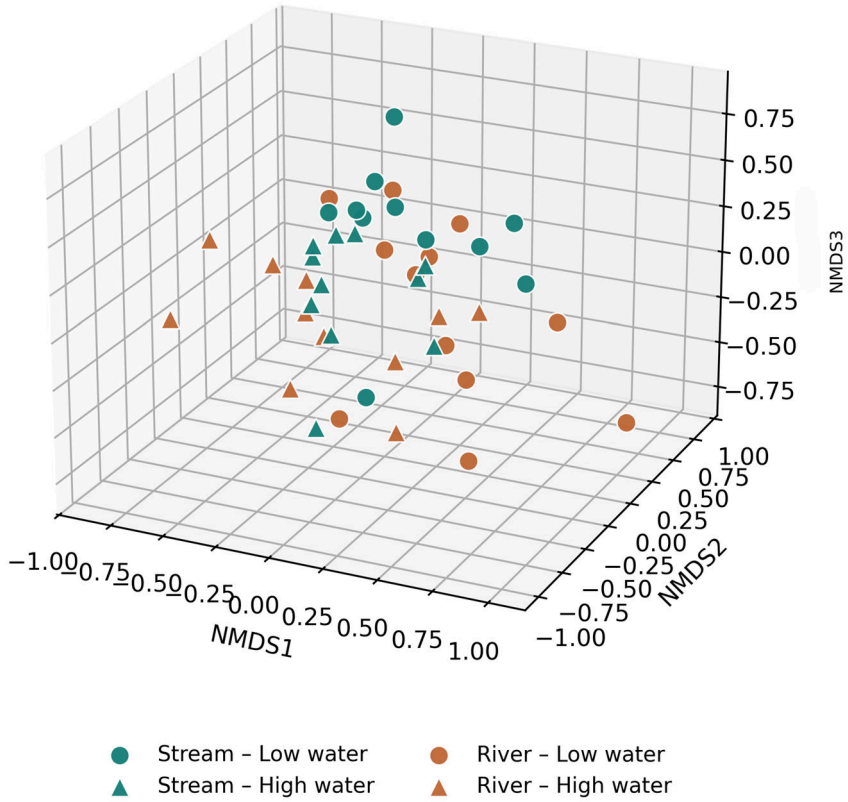


Figure 6. Three-dimensional non-metric multidimensional scaling (NMDS) ordination of fish assemblages based on Jaccard dissimilarity showing variation in fish taxa composition among rivers and streams during low-water and high-water periods in the Curuá and Maicuru river basins, Northern Pará Drainage System, Brazilian Amazon. Points represent sampling units classified by habitat type and sampling campaign. Stress = 0.1817.

4. Discussion

4.1. Spatial Dynamics

The drainages of the Curuá and Maicuru rivers harbor a remarkably diverse fish fauna, with 262 recorded taxa distributed among 46 families and 11 orders. This richness highlights the importance of the Northern Pará Drainage System for freshwater biodiversity in the eastern Amazon, particularly considering the relatively restricted geographic extent of the sampled area. Previous studies have emphasized that the Calha Norte region remains comparatively poorly explored despite its considerable biological diversity [3,4]. Although the first-order Jackknife estimator indicated that the sampling captured a substantial proportion of the estimated richness, additional taxa may remain undetected, particularly those occurring at low frequencies or exhibiting limited detectability. Thus, the recorded richness represents an important baseline for regional biodiversity assessments rather than a complete inventory of the fish fauna.

River environments exhibited greater observed taxon richness than streams, a pattern potentially associated with differences in habitat dimensions, environmental heterogeneity, connectivity, and resource availability. Larger tropical rivers may encompass a broader range of habitats and ecological opportunities, facilitating the coexistence of taxa with different environmental requirements and life-history strategies [9,10,35]. However, the higher richness observed in rivers should not be attributed exclusively to ecological differences, as sampling methods were not identical between habitat types. Although seine nets were employed in both rivers and streams, gill nets were used exclusively in rivers, whereas sieves were used exclusively in streams. These differences in sampling gear may have

influenced the detection of taxa with different body sizes, behaviors, and habitat preferences. Consequently, the relative contributions of environmental characteristics and gear selectivity to the observed differences in taxon richness cannot be disentangled in the present study.

Despite their lower richness, stream environments supported a substantial number of exclusive taxa, highlighting the distinct contribution of stream habitats to regional fish diversity. This pattern indicates differentiation in taxonomic composition between rivers and streams and reveals a substantial faunal complementarity between habitat types. It also emphasizes the importance of preserving both environments to maintain regional biodiversity. Small forest streams frequently harbor specialized taxa adapted to shallow waters, structurally complex habitats, low conductivity, and high allochthonous input from riparian vegetation [28]. Such environmental conditions may contribute to the occurrence of fish assemblages that differ from those found in larger river channels [29].

The NMDS ordinations and PERMANOVA analyses revealed significant differences in fish assemblage composition between river and stream samples (Table 4). These results suggest that habitat differentiation involves differences in both abundance structure and taxon occurrence. Similar patterns have been documented throughout the Amazon Basin and have been associated with differences in substrate composition, channel morphology, water chemistry, and habitat complexity among lotic environments of different sizes [8,10,22,29]. Although these environmental attributes were not directly measured in the present study, they provide plausible ecological mechanisms that may contribute to the observed differences between habitat types.

In contrast, comparisons between the Curuá and Maicuru drainages did not reveal statistically significant differences in fish assemblage composition after Holm correction for multiple comparisons (Table 5). Although nominally significant differences were detected between stream assemblages using both Bray–Curtis and Jaccard dissimilarities, neither remained significant after adjustment. These findings indicate insufficient statistical evidence to establish compositional differences between the sampled drainages under the adopted significance criterion, rather than demonstrating ecological equivalence between them.

The spatial organization of freshwater fish assemblages may be influenced by historical drainage configurations, geomorphological characteristics, and hydrological connectivity [8,36–39]. In the Guiana Shield, features such as rapids, waterfalls, and the limited development of extensive floodplains may constrain dispersal and contribute to faunal differentiation among aquatic habitats [4,8]. However, because neither historical processes nor physical barriers to dispersal were directly investigated, their potential influence on the assemblages sampled in the Curuá and Maicuru drainages remains hypothetical. Moreover, the absence of statistically significant differences between drainages after Holm correction does not provide sufficient evidence to attribute their assemblage organization to these processes.

Although spatial autocorrelation and longitudinal position within the drainage network may also influence fish assemblage organization, these factors were beyond the scope of the present study. Future investigations explicitly incorporating hydrological distances, environmental variables, and spatially explicit analytical approaches may provide additional insights into the relative contributions of spatial and environmental processes shaping fish assemblages in northern Amazonian drainages.

4.2. Temporal Dynamics

The comparisons between sampling campaigns revealed differences in fish assemblage composition, although the magnitude and interpretation of these differences depended on habitat type, dissimilarity measure, and spatial scale. Because each hydrological period

was represented by a single sampling campaign, the results describe variation between December 2020 and July 2021 but cannot independently establish a general seasonal effect.

The Bray–Curtis analyses detected significant differences between the two sampling campaigns in both river and stream assemblages when the drainages were pooled, with a larger proportion of variation explained in rivers ($R^2 = 0.1009$) than in streams ($R^2 = 0.0573$). Similarly, Jaccard analyses revealed significant differences between campaigns in both habitat types, with slightly higher explained variation in rivers ($R^2 = 0.0746$) than in streams ($R^2 = 0.0651$) (Table 4). These results are descriptively consistent with our second hypothesis, which predicted greater temporal variation in river assemblages than in stream assemblages. However, because the difference in the magnitude of temporal variation between habitat types was not directly tested, this prediction cannot be considered statistically confirmed.

Abundance-based and occurrence-based dissimilarity metrics capture complementary dimensions of community change. Bray–Curtis is sensitive to differences in abundance structure, whereas Jaccard emphasizes differences in taxon occurrence independently of abundance [40,41]. The significant results obtained with both indices indicate that differences between campaigns were detectable in both abundance-based and occurrence-based assemblage composition when the drainages were pooled.

When comparisons between campaigns were performed separately for each drainage and habitat type, none remained statistically significant after Holm correction (Table 5). Some comparisons involving Maicuru streams and rivers produced unadjusted *p*-values below 0.05, but these results did not remain significant after adjustment. This distinction emphasizes the importance of considering the analytical scale and correction for multiple comparisons when interpreting assemblage variation. However, the lack of statistical significance within individual drainage–habitat combinations should not be interpreted as evidence of temporal stability or as demonstrating that the two drainages responded differently. Smaller sample sizes within the stratified comparisons may have limited the ability to detect compositional differences.

Changes in water level may influence fish assemblage composition by modifying habitat availability and hydrological connectivity, potentially affecting the local occurrence and relative abundance of taxa [9,10,42]. The structural heterogeneity of stream and river habitats may also mediate assemblage responses to hydrological variation [8,22,29]. These mechanisms provide plausible ecological explanations for the differences detected between the two sampling campaigns when the drainages were pooled. However, because water-level dynamics, habitat availability, and fish movements were not directly quantified, their contributions to the observed patterns cannot be established. Furthermore, the absence of statistically significant differences in drainage-specific comparisons after Holm correction precludes attributing distinct temporal responses to either drainage.

The high richness recorded, together with the differences observed between river and stream habitats, underscores the conservation importance of the Northern Pará Drainage System. The Calha Norte region encompasses one of the largest continuous blocks of preserved tropical forest in South America and remains relatively unaffected by many of the anthropogenic pressures impacting other portions of the Amazon Basin. At the same time, studies have highlighted its potential to harbor undescribed taxa and previously unrecorded taxa, emphasizing the need for continued biological inventories and ecological monitoring [15,20].

Given the expansion of mining activities, infrastructure projects, deforestation, and climate-related pressures across the Amazon, maintaining the ecological integrity of both river and stream environments is essential for preserving regional biodiversity. Conservation strategies should therefore recognize the complementary role played by different

aquatic habitats and prioritize the protection of entire drainage networks rather than isolated ecosystems.

Overall, the results indicate that habitat type was an important factor associated with fish assemblage structure in the Northern Pará Drainage System. Differences between rivers and streams were statistically significant during both sampling campaigns, whereas differences between the two campaigns were detected in the pooled analyses for both habitat types. However, the drainage-specific comparisons did not remain significant after correction for multiple comparisons. The results therefore support the importance of habitat differentiation and demonstrate variation between the two sampling campaigns, while providing insufficient statistical evidence to establish differences between the Curuá and Maicuru drainages after adjustment for multiple testing.

5. Conclusions

The Curuá and Maicuru drainages exhibited high fish diversity, with 262 recorded taxa distributed among 46 families and 11 orders, predominantly Characiformes and Siluriformes. These findings highlight the importance of the Northern Pará Drainage System for Amazonian freshwater biodiversity and provide a valuable baseline for future ecological and conservation studies.

Fish assemblage composition differed significantly between river and stream samples during both sampling campaigns, based on Bray–Curtis and Jaccard dissimilarities. These results underscore the complementary contributions of river and stream environments to regional fish diversity, although differences in sampling gear should be considered when interpreting the observed patterns. Significant compositional differences were also detected between the December 2020 and July 2021 campaigns when the drainages were pooled. However, these findings cannot establish recurring seasonal patterns, and neither comparisons between drainages nor temporal comparisons within individual drainage–habitat combinations remained significant after correction for multiple testing.

The findings reinforce the importance of conserving both river and stream environments in the Northern Pará Drainage System. Future studies incorporating environmental variables, hydrological distances, and repeated sampling across multiple years will be essential to clarify the relative contributions of habitat characteristics, spatial processes, and hydrological variation to fish assemblage organization. These efforts will help strengthen the scientific basis for freshwater biodiversity conservation and management in this still poorly studied region of the eastern Amazon.

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Data Availability Statement: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Conflicts of Interest: The authors declare that they have no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

CAPES	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico
GPS	Global Positioning System
ICMBio	Instituto Chico Mendes de Conservação da Biodiversidade
ICTA	Instituto de Ciências e Tecnologia das Águas
ICZN	International Code of Zoological Nomenclature
IFPA	Instituto Federal de Educação, Ciência e Tecnologia do Pará
Imazon	Instituto do Homem e Meio Ambiente da Amazônia
NMDS	Non-metric Multidimensional Scaling
OTUs	Operational Taxonomic Units
PERMANOVA	Permutational Multivariate Analysis of Variance
SISBIO	Sistema de Autorização e Informação em Biodiversidade
UFOPA	Universidade Federal do Oeste do Pará

Appendix A

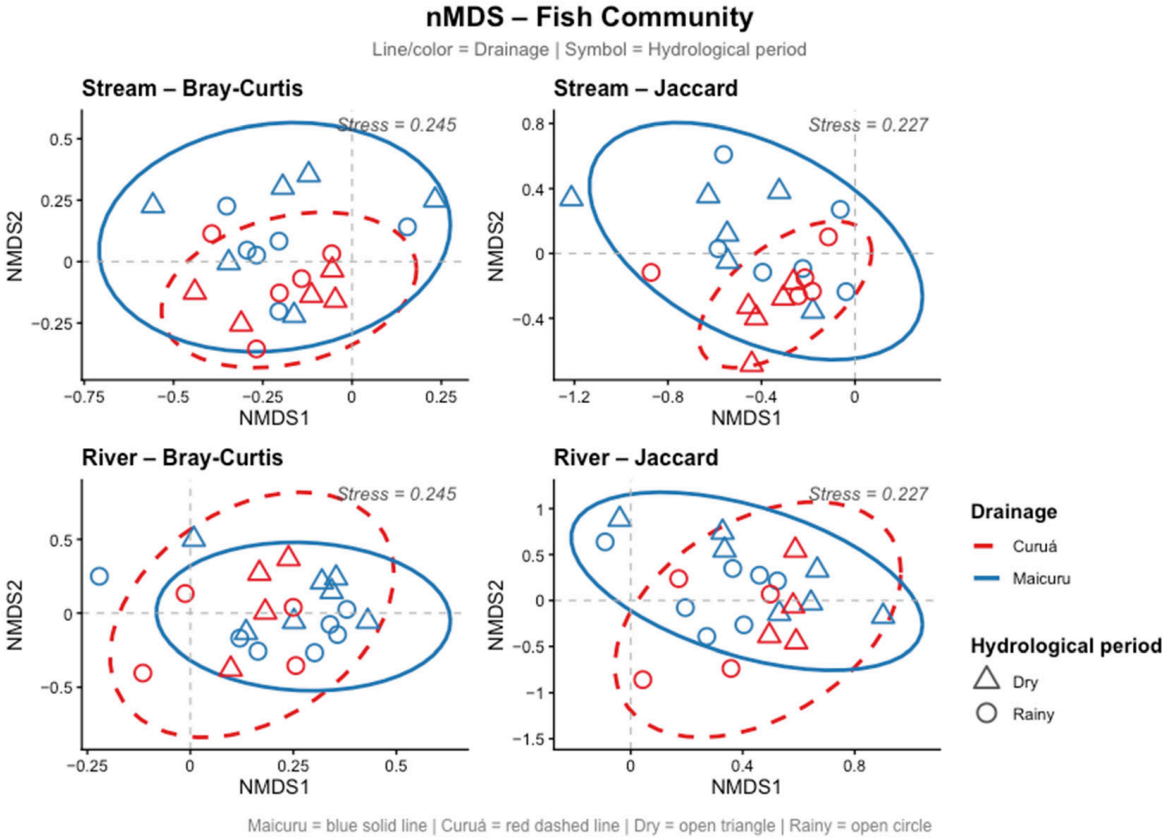


Figure A1. NMDS ordinations comparing fish assemblages between the Curuá and Maicuru drainages.

Appendix B

Table A1. Taxonomic composition of the ichthyofauna recorded in the drainages of the Curuá and Maicuru rivers, Northern Pará Drainage System, Brazilian Amazon.

Orders, Families, and Species	SAMPLING STATIONS																						
	Maicuru River														Curuá River								
	STREAM						RIVER								STREAM				RIVER				
	1	2	3	4	6	7	1	2	3	5	6	7	8	8	10	11	12	13	4	9	10	11	12
Synbranchiformes																							
Synbranchidae																							
Synbranchus madeirae (Rosen & Rumney, 1972)	1	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0
Synbranchus marmoratus (Bloch, 1795)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Synbranchus sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Clupeiformes																							
Engraulidae																							
Amazonsprattus scintilla (Roberts, 1984)	0	0	0	0	0	0	8	1	0	0	0	0	0	0	0	0	0	0	51	2	0	9	0
Anchovia surinamensis (Bleeker, 1865)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0
Anchoviella guianensis (Eigenmann, 1912)	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Lycengraulis batesii (Günther, 1868)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Pristigasteridae																							
Ilisha amazonica (Miranda Ribeiro, 1920)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Osteoglossiformes																							
Osteoglossidae																							
Osteoglossum bicirrhosum (Cuvier, 1829)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Characiformes																							
Erythrinidae																							
Hoplerythrinus unitaeniatus (Spix & Agassiz, 1829)	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
Hoplias malabaricus (Bloch, 1794)	2	7	1	4	0	1	3	2	0	0	0	0	1	1	2	0	2	9	0	2	0	0	0
Hoplias curupira (Oyakawa & Mattox, 2009)	0	1	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Lebiasinidae																							
Nannostomus beckfordi (Günther, 1872)	2	354	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Nannostomus eques (Steindachner, 1876)	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	13	0	0	0	0	0
Nannostomus unifasciatus (Steindachner, 1876)	0	1	0	0	0	0	5	3	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Nannostomus digrammus (Fowler, 1913)	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nannostomus marginatus (Eigenmann, 1909)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	5	9	2	0	0	0	0
Pyrrhulina cf. *australis* (Eigenmann & Kennedy, 1903)	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyrrhulina cf. *semifasciata* (Steindachner, 1876)	0	0	0	0	0	17	0	0	0	0	0	0	0	0	12	13	3	11	0	0	0	0	0
Pyrrhulina cf. zigzag (Zarske & Géry, 1997)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	15	0	0	1	0	0	0	0
Pyrrhulina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Pyrrhulina vittata (Regan, 1912)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serrasalmidae																							
Mylesinus paraschomburgkii (Jégu, Santos & Ferreira, 1989)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Myloplus arnoldi (Ahl, 1936)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Myloplus lobatus (Valenciennes, 1850)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Mylossoma albiscopum (Cope, 1872)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mylossoma aureum (Spix & Agassiz, 1829)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mylossoma sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serrasalmus cf. *eigenmanni* (Norman, 1929)	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0
Serrasalmus rhombeus (Linnaeus, 1766)	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0

Table A1. *Cont.*

Orders, Families, and Species	SAMPLING STATIONS																						
	Maicuru River													Curuá River									
	STREAM						RIVER							STREAM					RIVER				
	1	2	3	4	6	7	1	2	3	5	6	7	8	8	10	11	12	13	4	9	10	11	12
Serrasalmus scapularis (Günther, 1864)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemiodontidae																							
Hemiodus microlepis longo (Kner, 1858)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Hemiodus microlepis (Kner, 1858)	0	0	0	0	0	0	3	3	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemiodus quadrimaculatus (Pellegrin, 1909)	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0
Hemiodus unimaculatus (Bloch, 1794)	0	0	0	0	0	0	2	2	6	6	6	0	17	0	0	0	0	0	10	0	0	0	3
Hemiodus vorderwinkleri (Géry, 1964)	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Hemiodus argenteus (Pellegrin, 1909)	0	0	0	0	0	0	4	1	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
Anostomidae																							
Laemolyta proxima (Garman, 1890)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Leporinus agassizii (Steindachner, 1876)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leporinus cf. *cylindriformis* (Borodin, 1929)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0
Leporinus cf. *desmotes* (Fowler, 1914)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypomasticus torrenticola (Birindelli, Teixeira & Britski, 2016)	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Leporinus altipinnis (Borodin, 1929)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leporinus maculatus (Muller & Troschel, 1864)	0	0	8	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Leporinus friderici (Bloch, 1794)	0	0	2	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	1	0
Megaleporinus trifasciatus (Steindachner, 1876)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudanos trimaculatus (Kner, 1858)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Rhytiodus argenteofuscus (Kner, 1858)	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0
Schizodon fasciatus (Spix & Agassiz, 1829)	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	4	0	0	0
Chilodidae																							
Caenotropus labyrinthicus (Kner, 1858)	0	0	0	0	0	0	3	4	0	0	0	0	2	0	0	0	0	0	6	7	0	0	0
Chilodus punctatus (Müller & Troschel, 1844)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	2	0	0	0
Curimatidae																							
Curimata inornata (Vari, 1989)	0	0	0	0	0	0	13	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Curimata knerii (Steindachner, 1876)	0	0	0	0	0	0	1	0	0	0	0	9	0	0	0	0	0	0	0	0	0	1	0
Curimatella alburnus (Müller & Troschel, 1844)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Curimatella immaculata (Fernández-Yépez, 1948)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Curimatella meyeri (Steindachner, 1882)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0	0	0
Cyphocharax notatus (Steindachner, 1908)	0	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyphocharax sp.	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyphocharax spiluropsis (Eigenmann & Eigenmann, 1889)	1	5	0	0	0	1	0	0	0	0	1	7	0	4	0	23	7	0	2	0	0	1	0
Cyphocharax spilurus (Günther, 1864)	0	20	0	0	0	0	0	1	0	0	1	20	0	0	0	0	0	0	0	8	0	3	0
Potamorhina latior (Spix & Agassiz, 1829)	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steindachnerina brevipinna (Eigenmann & Eigenmann, 1889)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0
Ctenoluciidae																							
Boulengerella maculata (Valenciennes, 1850)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	0	0
Boulengerella cuvieri (Spix & Agassiz, 1829)	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Crenuchidae																							

Table A1. *Cont.*

Orders, Families, and Species	SAMPLING STATIONS																						
	Maicuru River														Curuá River								
	STREAM						RIVER								STREAM					RIVER			
	1	2	3	4	6	7	1	2	3	5	6	7	8	8	10	11	12	13	4	9	10	11	12
Characidium cf. *zebra* (Eigenmann, 1909)	2	0	1	0	0	4	2	0	0	0	1	0	0	4	17	33	32	12	0	1	0	0	0
Crenuchus spilurus (Günther, 1863)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	5	0	0	0	0	0	0	0
Prochilodontidae																							
Prochilodus nigricans (Spix & Agassiz, 1829)	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0
Parodontidae																							
Parodon aff. *guyanensis* (Géry, 1960)	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Parodon sp.	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Gasteropelecidae																							
Carnegiella marthae (Myers, 1927)	0	27	0	0	0	0	59	6	0	0	0	0	0	0	39	0	12	0	0	0	3	0	0
Carnegiella strigata (Günther, 1864)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	153	31	22	0	0	0	0	0
Iguanodectidae																							
Bryconops aff. *colanegra* (Chernoff & Machado-Allison, 1999)	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	1	0	1	0	0
Bryconops alburnoides (Kner, 1858)	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Bryconops chernoffi (Silva-Oliveira, Lima & Bogotá-Gregory, 2018)	0	0	0	0	0	0	0	0	0	0	46	26	0	0	0	3	0	0	0	0	0	0	78
Bryconops gracilis (Eigenmann, 1908)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Bryconops sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4
Bryconops aff. *melanurus* (Bloch, 1794)	0	0	0	0	0	0	0	0	0	0	7	9	0	7	0	0	5	0	2	0	0	2	0
Iguanodectes spilurus (Günther, 1864)	0	44	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0
Acestrorhynchidae																							
Acestrorhynchus falcirostris (Cuvier, 1819)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0
Acestrorhynchus minimus Menezes, 1969	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acestrorhynchus falcatus (Bloch, 1794)	0	3	0	0	0	0	0	1	0	0	0	2	0	0	0	0	1	2	0	0	0	0	0
Characidae																							
Aphyocharax sp.	0	13	4	0	0	0	10	0	13	25	233	0	34	0	0	0	0	0	0	0	0	0	0
Charax gibbosus (Linnaeus, 1758)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
Charax sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Charax niger (Lucena, 1989)	0	0	0	0	0	0	2	2	0	2	0	0	0	0	0	0	3	0	0	0	0	2	0
Cyanogaster geisleri (Zarske & Géry, 2007)	0	0	0	0	1	1	328	699	65	37	311	0	158	0	0	0	0	0	2	21	1	0	0
Microschemobrycon casiquiare (Böhlke, 1953)	0	0	0	0	0	0	4	39	6	33	24	0	0	0	0	0	0	0	18	386	0	1	0
Microschemobrycon cf. *guaporensis* (Eigenmann, 1915)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Microschemobrycon geisleri (Géry, 1973)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Phenacogaster cf. *pectinata* (Cope, 1870)	0	0	0	0	0	0	0	1	0	0	0	0	0	7	0	159	45	14	0	0	0	11	0
Phenacogaster megalosticta (Eigenmann, 1909)	0	0	0	0	0	0	43	7	1	0	0	0	0	19	20	36	0	0	5	273	2	0	0
Phenacogaster retropinnus (Lucena & Malabarba, 2010)	0	0	0	0	0	0	3	3	4	10	51	0	1	0	0	0	0	0	11	0	0	24	0
Phenacogaster sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Roeboides affinis (Günther, 1868)	0	9	0	0	0	0	4	23	1	6	0	0	0	0	0	0	0	0	4	46	2	0	0
Roeboides oligistos (Lucena, 2000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Roeboides sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roeboides myersii (Gill, 1870)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serrapinnus cf. *microdon* (Eigenmann, 1915)	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0
Serrapinnus sp.	29	476	0	39	0	14	42	4	12	0	1	0	0	46	0	9	12	3	6	129	0	0	0
Serrapinnus cf. *gracilis* (Géry, 1960)	2	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tetragonopterus argenteus (Cuvier, 1816)	0	0	7	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	4	0	1	0	0
Tetragonopterus chalceus (Spix & Agassiz, 1829)	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0
Triportheidae																							
Triportheus angulatus (Spix & Agassiz, 1829)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	1	1	0	0

Table A1. *Cont.*

Orders, Families, and Species	SAMPLING STATIONS																						
	Maicuru River													Curuá River									
	STREAM						RIVER							STREAM						RIVER			
	1	2	3	4	6	7	1	2	3	5	6	7	8	8	10	11	12	13	4	9	10	11	12
Triportheus albus (Cope, 1872)	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chalceidae																							
Chalceus epakros Zanata & Toledo-Piza, 2004	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Chalceus guaporensis Zanata & Toledo-Piza, 2004	0	0	0	0	0	0	0	0	5	9	0	0	0	0	0	0	0	0	0	0	0	0	0
Cynodontidae																							
Cynodon gibbus (Spix & Agassiz, 1829)	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Bryconidae																							
Brycon melanopterus (Cope, 1872)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Acestrorhamphidae																							
Astyanax gr. *bimaculatus* (Linnaeus, 1758)	11	0	2	0	0	14	0	0	0	0	4	6	2	6	0	1	9	2	0	0	0	0	0
Bario oligolepis (Günther, 1864)	10	43	3	13	152	33	4	0	0	0	0	57	0	14	30	15	42	14	0	0	0	4	0
Brachychalcinus copei (Steindachner, 1882)	0	13	1	2	0	19	0	0	0	0	0	0	0	13	0	0	9	5	0	2	0	0	0
Ctenobrycon spilurus (Valenciennes, 1850)	5	20	4	0	0	1	3	3	0	5	1	0	0	21	0	0	2	0	0	4	2	0	0
Gymnocorymbus thayeri (Eigenmann, 1908)	186	19	6	1	0	0	0	3	1	0	0	0	0	1	0	0	5	0	1	0	0	0	0
Hemigrammus aff. *levis*	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	0	0	0
Hemigrammus analis (Durbin, 1909)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0
Hemigrammus bellottii (Steindachner, 1882)	0	23	0	0	0	102	0	0	1	0	0	0	0	0	611	1810	76	116	20	6	1	0	0
Hemigrammus cf. *bellottii* (Steindachner, 1882)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0
Hemigrammus collettii (Steindachner, 1882)	3	100	5	0	0	0	44	0	4	0	0	0	0	18	38	211	55	20	2	0	9	5	0
Hemigrammus durbinae (Ota, Lima & Pavanelli, 2015)	0	0	0	0	3	0	13	2	0	0	0	0	0	0	0	0	6	0	1	9	1	0	0
Hemigrammus levis (Durbin, 1908)	0	118	0	0	0	0	3	2	8	0	0	1	0	1	0	0	0	0	1	0	0	0	0
Hemigrammus lunatus (Durbin, 1918)	37	66	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Hemigrammus melogrammus (Eigenmann, 1908)	1	0	6	0	0	0	0	24	28	34	0	0	5	33	0	232	130	17	33	0	14	0	0
Holopristis ocellifera (Steindachner, 1882)	1	605	1	0	0	0	25	1	9	0	0	2	1	4	90	167	2	58	2	47	0	0	0
Jupiaba acanthogaster (Eigenmann, 1911)	0	8	0	0	0	0	0	0	0	0	0	0	0	12	0	2	0	0	0	0	0	0	0
Jupiaba meunieri (Géry, Planquette & Le Bail, 1996)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Jupiaba polylepis (Günther, 1864)	0	0	30	7	0	0	1	0	0	12	135	2	41	2	0	0	0	0	10	0	0	5	0
Jupiaba atypindi (Zanata, 1997)	0	0	3	0	0	0	0	0	0	21	6	6	19	0	0	0	0	0	0	0	0	0	0
Makunaima guaporensis (Eigenmann, 1911)	0	0	0	0	0	0	0	20	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Makunaima multidens (Eigenmann, 1908)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76	49	0	0	0
Makunaima guianensis (Eigenmann, 1909)	0	0	0	0	0	0	5	56	20	1	4	0	0	0	0	0	53	0	0	0	0	0	0
Megalamphodus copelandi (Durbin, 1908)	3	304	0	0	0	0	10	4	1	0	1	0	0	3	2	90	124	168	2	14	3	19	0
Moenkhausia ceros (Eigenmann, 1908)	0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Moenkhausia copei (Steindachner, 1882)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0
Moenkhausia cotinho (Eigenmann, 1908)	3	77	208	1	0	0	11	11	22	15	146	0	54	0	0	18	9	1	9	3	29	0	0
Moenkhausia dichroura (Kner, 1858)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moenkhausia grandisquamis (Müller & Troschel, 1845)	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Moenkhausia jamesi Eigenmann, 1908	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moenkhausia lepidura (Kner, 1858)	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0
Moenkhausia megalops (Eigenmann, 1907)	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	59	57	0	0	0	0	0
Moenkhausia mikia Marinho & Langeani, 2010	0	0	21	0	0	0	0	0	21	13	37	0	18	0	0	0	11	0	31	0	0	86	0
Moenkhausia pirahan (Mathubara & Toledo-Piza, 2020)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Moenkhausia sp.	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1. *Cont.*

Orders, Families, and Species	SAMPLING STATIONS																						
	Maicuru River													Curuá River									
	STREAM						RIVER							STREAM						RIVER			
	1	2	3	4	6	7	1	2	3	5	6	7	8	8	10	11	12	13	4	9	10	11	12
Moenkhausia surinamensis (Géry, 1965)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Moenkhausia celibela (Marinho&Langeani, 2010)	0	0	0	0	0	0	0	0	0	0	0	2	38	0	0	0	0	0	0	9	0	0	0
Moenkhausia cf. *lata* (Eigenmann, 1908)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moenkhausia gracilima (Eigenmann, 1908)	0	0	7	0	0	0	14	1	0	240	84	0	5	0	0	0	0	0	4	0	0	16	0
Moenkhausia justae (Eigenmann, 1908)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Poptella compressa (Günther, 1864)	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poptella sp.	0	0	0	0	0	0	7	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stethaprion erythrops (Cope, 1870)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Stevardiidae																							
Chrysobrycon ximango (Silva-Oliveira, Vanegas-Ríos, Canto & Ribeiro, 2025)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	20	0	0	0	0	0
Creagrutus sp.	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0
Knodus cf. *heteresthes* (Eigenmann, 1908)	0	0	0	0	0	0	0	0	0	0	0	95	0	0	0	0	0	0	0	0	0	2	0
Knodus sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Knodus sp.2	0	0	0	0	2	0	0	0	0	1	30	64	0	0	0	0	0	4	2	0	42	21	0
Knodus sp.3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	11	33	32	0	0	0	0	0
Knodus sp.4	0	0	0	0	0	0	0	0	0	0	17	3	6	0	0	0	21	26	0	0	18	0	0
Knodus sp.5	0	0	0	0	0	0	0	0	0	0	10	2	0	0	0	0	0	7	0	0	0	0	0
Rhinopetitia sp.	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0
Xenurobrycon sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0
Gymnotiformes																							
Sternopygidae																							
Eigenmannia gr. *trilineata* (López & Castello, 1966)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Eigenmannia muirapinima (Peixoto, Dutra & Wosiacki, 2015)	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0
Eigenmannia macrops (Boulenger, 1897)	2	1	0	0	0	0	14	10	0	0	0	0	0	0	0	1	0	2	0	0	3	0	0
Sternopygus macrurus (Bloch & Schneider, 1801)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hypopomidae																							
Brachyhypopomus beebei (Schultz, 1944)	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Brachyhypopomus regani (Crampton, de Santana, Waddell & Lovejoy, 2017)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0
Brachyhypopomus sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Brachyhypopomus sp.2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachyhypopomus brevirostris (Steindachner, 1868)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0
Gymnotidae																							
Gymnotus cf. *javari* (Albert, Crampton & Hagedorn, 2003)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Rhamphichthyidae																							
Hypopygus lepturus (Hoedeman, 1962)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0
Gymnorhamphichthys rondoni (Miranda Ribeiro, 1920)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siluriformes																							
Trichomycteridae																							
Ituglanis amazonicus (Steindachner, 1882)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Ochmacanthus cf. *reinhardtii* (Steindachner, 1882)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paravandellia sp.	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schultzichthys sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Auchenipteridae																							
Ageneiosus sp.nov.	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ageneiosus ucayalensis (Castelnau, 1855)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1. *Cont.*

Orders, Families, and Species	SAMPLING STATIONS																						
	Maicuru River													Curuá River									
	STREAM						RIVER							STREAM							RIVER		
	1	2	3	4	6	7	1	2	3	5	6	7	8	8	10	11	12	13	4	9	10	11	12
Auchenipterichthys coracoideus (Eigenmann & Allen, 1942)	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Auchenipterichthys longimanus (Günther, 1864)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Centromochlus aff. *melanoleucus* (Vari & Calegari, 2014)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Centromochlus sp. nov.	0	0	0	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	0	0	0	0	0
Tatia sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Tatia intermedia (Steindachner, 1877)	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	2	0	2	0	0
Trachelyopterus galeatus (Linnaeus, 1766)	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trachelyopterus porosus (Eigenmann & Eigenmann, 1888)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aspredinidae																							
Bunocephalus coracoideus (Cope, 1874)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudobunocephalus bifidus (Eigenmann, 1942)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	9	1	0	0	0	0	0
Callichthyidae																							
Brochis ornata (Nijssen & Isbrücker, 1976)	0	41	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callichthys callichthys (Linnaeus, 1758)	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corydoras acutus (Cope, 1872)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Corydoras sarareensis (Dinkelmeyer, 1995)	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corydoras sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5	0	0	0	0	0	0
Hoplisoma melanistium (Regan, 1912)	0	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hoplisoma trilineatum (Cope, 1872)	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	47	5	0	0	0	0	0	0
Hoplosternum littorale (Hancock, 1828)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megalechis picta (Müller & Troschel, 1849)	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	9	0	0	0	0	0
Osteogaster aenea (Gill, 1858)	0	1	2	0	0	8	0	0	0	0	0	0	0	4	0	0	3	0	0	0	0	0	0
Doradidae																							
Trachydoras brevis (Kner, 1853)	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	9	12	0	0
Heptapteridae																							
Imparfinis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	14	0	0	0	0	0
Pimelodella cf. *cristata* (Müller & Troschel, 1849)	0	1	0	1	0	2	1	11	10	2	0	1	1	0	0	0	0	2	10	1	0	0	0
Rhamdia cf. *foina* (Müller & Troschel, 1849)	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhamdia quelen (Quoy & Gaimard, 1824)	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Pimelodidae																							
Pimelodus blochii (Valenciennes, 1840)	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Pimelodus tetramerus (Ribeiro & Lucena, 2006)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Pimelodus ornatus (Kner, 1858)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Propimelodus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Pseudopimelodidae																							
Batrochoglanis raninus (Valenciennes, 1840)	0	0	1	0	0	4	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Loricariidae																							
Ancistrus cf. *dubius* (Eigenmann & Eigenmann, 1889)	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0
Ancistrus sp.1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
Ancistrus sp.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0
Aphanotorulus emarginatus (Valenciennes, 1840)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Aphanotorulus unicolor (Steindachner, 1908)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Dekeyseria amazonica (Rapp Py-Daniel, 1985)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Farlowella amazonum (Günther, 1864)	0	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0

Table A1. *Cont.*

Orders, Families, and Species	SAMPLING STATIONS																						
	Maicuru River													Curuá River									
	STREAM						RIVER							STREAM						RIVER			
	1	2	3	4	6	7	1	2	3	5	6	7	8	8	10	11	12	13	4	9	10	11	12
Harttia guianensis (Rapp Py-Daniel & Oliveira, 2001)	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harttia trombetensis (Rapp Py-Daniel & Oliveira, 2001)	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Hemiodontichthys acipenserinus (Kner, 1853)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hypoptopoma incognitum (Aquino & Schaefer, 2010)	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hypostomus cf. *gymnorhynchus* (Norman, 1926)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hypostomus cochliodon (Kner, 1854)	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypostomus gr. *plecostomus* 1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Hypostomus simios (Hollanda Carvalho & Weber, 2005)	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Limatulichthys griseus (Eigenmann, 1909)	0	0	0	0	0	0	3	1	1	0	0	0	1	0	0	0	0	0	3	3	0	0	0
Loricaria cataphracta (Linnaeus, 1758)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Loricariichthys nudirostris (Kner, 1853)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Panaque sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peckoltia sabaji (Armbruster, 2003)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudancistrus sp.	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0
Pterygoplichthys pardalis (Castelnau, 1855)	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygoplichthys weberi (Armbruster & Page, 2006)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
Rineloricaria formosa (Isbrücker & Nijssen, 1979)	0	63	0	0	0	4	0	4	0	0	0	0	0	2	0	4	10	3	0	2	0	0	0
Rineloricaria lanceolata (Günther, 1868)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	17	21	0	0	0	0	0
Rineloricaria phoxocephala (Eigenmann & Eigenmann, 1889)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Rineloricaria sp.	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0
Rineloricaria castroi (Isbrücker & Nijssen, 1984)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0
Sturisoma lyra (Regan, 1904)	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cetopsidae																							
Cetopsidium morenoi (Fernández-Yépez, 1972)	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
Gobiiformes																							
Eleotridae																							
Microphilypnus ternetzi (Myers, 1927)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0
Cichliformes																							
Cichlidae																							
Aequidens sp. Jovem	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Aequidens tetramerus (Heckel, 1840)	7	11	1	10	0	3	0	0	0	1	0	0	0	0	2	0	0	1	0	0	1	0	0
Acarichthys heckelii (Müller & Troschel, 1849)	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	25	0	0	0
Apistogramma linkei (Koslowski, 1985)	6	62	0	94	0	35	0	0	0	0	0	7	0	0	9	56	46	59	0	0	0	0	0
Apistogramma sp.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Apistogramma sp.2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Bujurquina peregrinabunda (Kullander, 1986)	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	4	70	0	0	0	0	0
Caquetaia spectabilis (Steindachner, 1875)	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0
Cichlasoma amazonarum (Kullander, 1983)	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0
Geophagus altifrons (Heckel, 1840)	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geophagus proximus (Castelnau, 1855)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Geophagus sp.	0	0	0	0	0	0	5	0	0	0	5	1	0	0	0	0	0	0	12	0	0	1	0
Satanoperca jurupari (Heckel, 1840)	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Satanoperca sp.	0	6	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Geophagus sp. Jovem	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	25	0	0	0
Saxatilia semicincta (Steindachner, 1892)	0	3	0	2	0	0	0	0	0	0	0	0	0	1	0	0	2	5	0	0	0	0	0
Sciaenidae																							
Plagioscion squamosissimus (Heckel, 1840)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Table A1. *Cont.*

Orders, Families, and Species	SAMPLING STATIONS																						
	Maicuru River													Curuá River									
	STREAM						RIVER							STREAM					RIVER				
	1	2	3	4	6	7	1	2	3	5	6	7	8	8	10	11	12	13	4	9	10	11	12
Cyprinodontiformes																							
Poeciliidae																							
Poecilia scalpridens (Garman, 1895)	0	85	0	0	0	0	3	0	12	0	0	0	0	0	0	0	0	0	1	43	0	0	0
Rivulidae																							
Anablepsoides sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anablepsoides urophthalmus (Günther, 1866)	0	0	1	1	0	8	0	0	0	0	0	0	0	1	37	11	0	0	0	0	0	0	0
Beloniformes																							
Belonidae																							
Belonion apodion (Collette, 1966)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Potamorrhaphis guianensis (Jardine, 1843)	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0
Tetraodontiformes																							
Tetraodontidae																							
Sphoeroides asellus (Müller & Troschel, 1849)	0	0	0	0	0	0	4	0	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0

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