Acta Scientiarum. Biological Sciences
ISSN: 1679-9283
ISSN: 1807-863X
actabiol@uem.br
Universidade Estadual de Maringá
Brasil

Acta Scientiarum

http://periodicos.uem.br/ojs
ISSN on-line: 1807-863X
Doi: 10.4025/actascibiolsci.v44i1.61005

ECOLOGY

Evaluation of ichthyofauna in lotic and lentic environments in the Araguaia River basin, Cerrado Biome, Brazil

Bernardo Ramos Simões Corrêa[1*], Murilo Luiz e Castro Santana[1], Lilian de Castro Moraes Pinto[1], Fernanda Nunes de Araújo Fonseca[1], Carlos Alberto da Cruz Junior[2] and Rodrigo Diana Navarro[3]

[1]Faculdade de Planaltina, Universidade de Brasília, Campus Planaltina, Vila Nossa Senhora de Fátima, 73345-010, Planaltina, Distrito Federal, Brazil. [2]Faculdade de Medicina Veterinária, Centro Universitário de Brasília, Brasília, Distrito Federal, Brazil. [3]Faculdade de Agronomia e Medicina Veterinária, Universidade de Brasília, Campus Darcy Ribeiro, Brasília, Distrito Federal, Brazil. *Author for correspondence. E-mail: bernersc@hotmail.com

ABSTRACT. The Araguaia River is an important watercourse located in Central Brazil and well known for its diversity of fish fauna. Differences between landscape and resources in the distinct environments existing in a floodplain can determine the success of a species. This study presents a list of ichthyofauna species found in lentic and lotic environments in the floodplain of the Araguaia River basin, bordering Mato Grosso and Goiás States. We carried out sampling in July 2019, during the dry season, using diverse fish collection strategies, such as waiting nets, trawl, cast net and fishing rods. Were distributed 12 sampling points between lentic and lotic environments and we captured a total of 168 individuals of 42 species, 19 families and six orders. The predominant orders were Characiformes, Siluriformes and Cichliformes, while the families were Serrasalmidae, Characidae, Triportheidae, Curimatidae and Anostomidae. The genera *Triportheus*, *Psectrogaster* and *Moenkhausia* were the most abundant, while *Pimelodus* was the most dispersed. Results showed greater abundance and diversity in the lentic environment than in the lotic one, with top-of-the-chain species in both. The variance between environments and the presence of species that are endemic, recently described, of undefined taxonomic status, and bioindicators, highlight the importance of conserving and further studying the ichthyofauna in the Araguaia River basin.

Keywords: Fish fauna; diversity; endemic; conservation; Characiformes; Cichliformes.

Received on September 25, 2021.
Accepted on February 7, 2022.

Introduction

The Tocantins-Araguaia basin is the second largest hydrographic basin in Brazil (Prysthon, Cunha, & Dias, 2019) and it is formed by the intense fluvial dynamics of the channel and several overflow deposits of the channel, which create different morphological environments (Alves & Carvalho, 2007) and a wide variety of micro habitats.

Located entirely within Brazil, this basin drains a vast area of the Cerrado savanna and rainforest ecosystems (Pelicice et al., 2021). Two main rivers form the basin: the Tocantins, characterized by a unique ichthyofauna with many exclusive species, and the Araguaia, with one of the largest and most biodiverse floodplains in the world (Latrubesse et al., 2019). The Araguaia River is extremely important for Neotropical biodiversity, however, about 78% of the basin is in the Cerrado biome, which has been constantly threatened (Jarduli, Claro-Garcia, & Shibata, 2014), mainly due to deforestation caused by changes in land use and occupation (Bitencourt, Reis, & Loureiro, 2020). The Middle Araguaia River floodplain emerges in Central Brazil, in a transition area between the Cerrado and Amazonian Biomes, with a wide diversity of natural landscapes.

This flood causes the junction of rivers and streams in the region (Lowe-McConnell, 1999; Santos & Ferreira, 1999), as well as the confluence between the main channel and the lakes, which may or may not be permanently connected to the main channel. This phenomenon tends to increase the productivity of the system (Thoms, 2003) through the complexification of habitats, providing a greater number of shelters for fish species, availability and access to food resources and, finally, areas that support greater quantities of species (Agostinho & Zalewski, 1996; Junk, Soares, & Saint-Paul, 1997).

The fluvial system of the Araguaia River maintains a complex mosaic of lentic and lotic aquatic environments, with a high richness and diversity of fish species (Mérona, 1987; Tejerina-Garro, Fortin, & Rodríguez, 1998; Lowe-McConnell, 1999). Lentic (lagoons, lakes, dams) and lotic (rivers, streams, creeks) ecosystems differ fundamentally in local habitat conditions, such as presence or absence of flow and length of stay, and in physical connectivity (Rosset, Ruhi, Bogan, & Datry, 2017). Lentic ecosystems are discrete aquatic habitats in a terrestrial matrix (De Meester, Gomez, Okamura, & Schwenk, 2002), while lotic ecosystems are continuous habitats, linked by unidirectional flow within dendritic river networks (Fagan, 2002). The geometry of the habitat, as well as its fragmentation and connectivity, can influence the structure of the community (Tejerina-Garro, Fortin, & Rodríguez, 2002; France & Duffy, 2006; Starzomski and Srivastava, 2007), whereas the hydrological connectivity can greatly facilitate dispersion of aquatic taxa and their coexistence in various locations (Bilton, Freeland, & Okamura, 2001).

Tejerina-Garro et al. (2002) noted that in the ichthyofauna of the Middle Araguaia River, formed mainly by Amazonian species, there are species that are endemic, migratory, threatened with extinction and of commercial interest. Ferreira, Zuanon, Santos, and Amadio (2011), in an ichthyological inventory of an Araguaia River Conservation Unit, found a high diversity of species and well-preserved assemblies. Identifying the species of ichthyofauna and their ecology helps understand the ecosystem processes that constitute the trophic chain in a water body and their contributions to the systemic balance of this aquatic environment (Saviato, Mariano, Saviato, & Sassi, 2017).

Among the river basins originating within the Cerrado, the Araguaia River basin harbors more considerable fish diversity (Dagosta, Pinna, Peres, & Tagliacollo, 2021), despite undergoing a rapid transformation (Lima, Oliveira, Borges, Corrêa, & Lima-Junior, 2021). Environmental impacts resulting from amateur fishing, carried out mostly by tourists during periods of drought, should be more observed (Araújo, Carvalho, & Tejerina-Garro, 2016), and establishing conservation units could assist with its preservation (Anacleto, Ferreira, Diniz Filho, & Ferreira, 2005). Fish are a common and familiar component of aquatic ecosystems, acting as excellent indicators of environmental conditions, as they can reflect disturbances at different scales, due to their mobility characteristics, lifestyle and their position close to the top of the food chain (Freitas & Souza, 2009).

Thus, this study aimed to evaluate, through a brief sampling, the abundance and richness of ichthyofauna species present in a lotic and in a lentic environment in the floodplain of the Middle Araguaia River: the Araguaia riverbed and Dumbá Lake.

Material and methods

The study area is located in the Cerrado biome, far east of Mato Grosso State, bordering Goiás State, near the city of Cocalinho, MT (Figure 1). The Araguaia River is the main affluent of the Tocantins River, which constitutes the Tocantins-Araguaia basin, a tributary of the great Amazon Basin. It is divided into three segments: high, middle and low Araguaia (Tejerina-Garro et al., 1998; Aquino, Stevaux, & Latrubesse, 2005). The middle Araguaia extends for 1100 km, reaching a drainage area of over 300,000 km^2 in a flat area formed by Pleistocene sediments (Bananal plain), characterized by a well-developed Holocene alluvial plain (Latrubesse, Amsler, Morais, & Aquino, 2009; Gomes & Fernandes, 2017).

Situated in the tropical climate zone, it presents a predominant Aw climate (tropical with dry winter), with a rainy season between October and April and a dry season from May to September, with an average annual temperature of 22-26°C (Muniz, Santana, & Oliveira-Filho, 2020). Annual rainfall varies from 1300 to 2000 mm across the basin, with 95% of annual rainfall in the wet season (Irion et al., 2016; Lininger & Latrubesse, 2016). Located in the Cerrado biome, it has a great diversity of vegetation associated with aquatic ecosystems in good preservation conditions (Borges, Silveira, & Vendramin, 2014). In the dry period, the main channel becomes narrow and well delimited, while in the rain period it fills up and lateral flooding occurs (Junk et al., 1997).

We took samples through waiting nets of different mesh sizes (6, 7 and 8 cm), 20 meters in length and 1.5 meters in height, a 10-meter long trawl net, a cast net with a lead line of 3 meters, and fishing rods, totaling twelve points, six points in the Araguaia River channel and six in Dumbá Lake (Table 1). This lake is parallel and connected to the river in the way out, morphologically known as lagoon or meander lake (Figure 2). All collection methods were performed at all sampling points, with limitations for some methods depending on the local physiology.

We installed the nets near the backwaters in the river, as well as in the lake, tied to branches that penetrated the water layer, while in areas with stones the fishing rods and casting nets were preferred. The hauls were carried out in beach areas, where there could be an extensive capture. Sampling took place in the morning and afternoon.

The study has been approved by institutional ethics committee of the University of Brasília (CEUA/UnB protocol code 115/2019 of August 20th, 2020) for studies involving animals, and the Brazilian Institute for the Environment and Renewable Resources (IBAMA) SISBIO authorized fish capture (license # 64640-1).

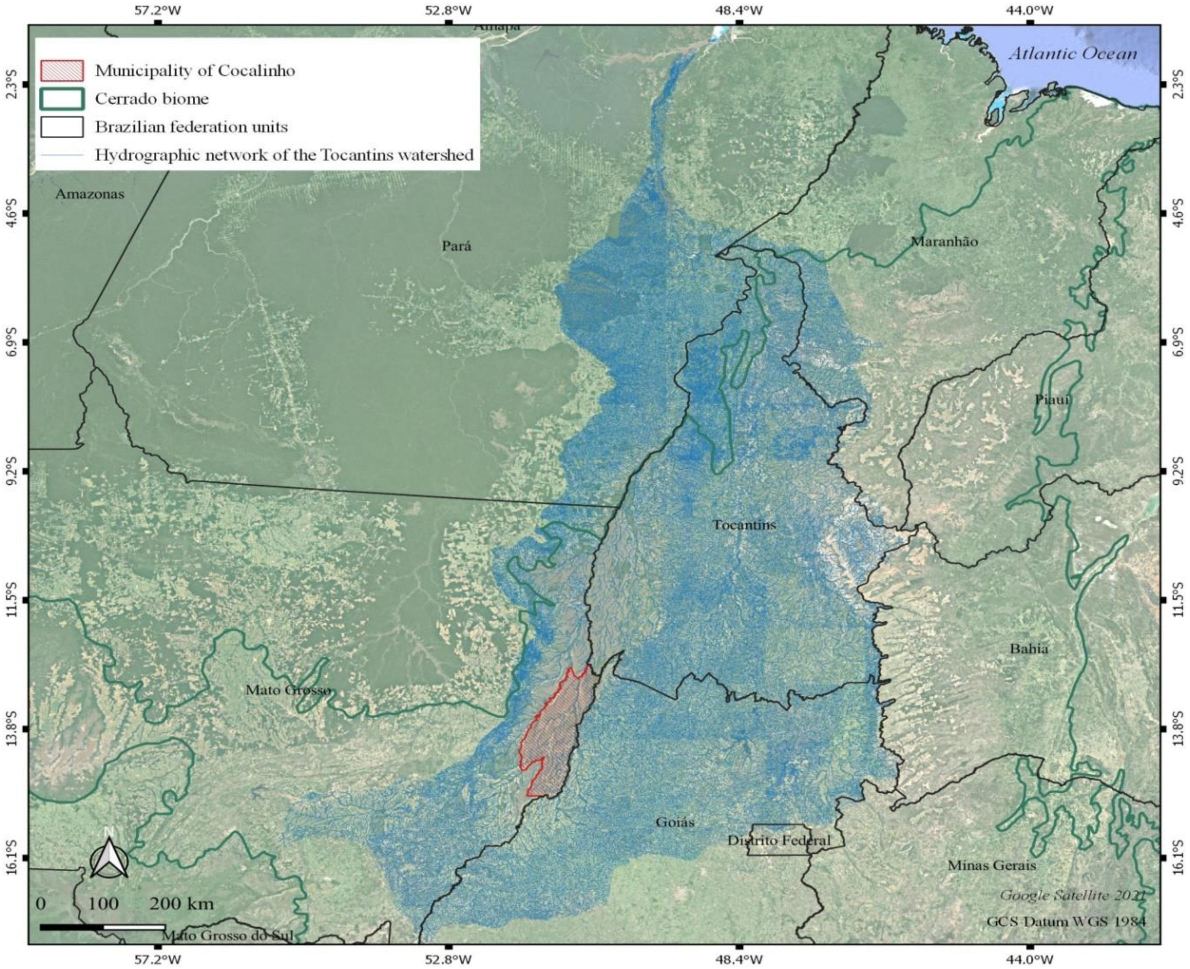

Figure 1. Map indicating the Tocantins-Araguaia basin and the municipality of Cocalinho, MT. Source: The authors.

We performed this study in the dry season, between July 7th and 11th, 2019. We left the waiting nets for 2 hours at each sampling site, using the three different meshes, while for the trawl, we used a 100m^2 transect (10 meters from the margin into the water body and 10 meters from the net). We threw the cast net and line and hook in adjacent areas. For the methods of trawling, cast net and fishing rod, three collection efforts were made at each point. We used methods according to the morphology of the environment and the possibility of their use, giving priority to using as many techniques as possible at each sampling site.

Table 1. Geographical coordinates and altitude of sampling sites in the Araguaia River basin, Mato Grosso and Goiás States, Brazil (LEN – Lentic; LOT – Lotic).

SITE	WATERCOURSES	LATITUDE	LONGITUDE	ALT (M)
LEN 1	Dumbá Lake	-14,45625	-50,99414	243
LEN 2	Dumbá Lake	-14,45594	-50,99400	242
LEN 3	Dumbá Lake	-14,50031	-50,98367	241
LEN 4	Dumbá Lake	-14,47289	-50,98975	239
LEN 5	Dumbá Lake	-14,47286	-50,98975	236
LEN 6	Dumbá Lake	-14,47236	-50,99011	239
LOT 1	Araguaia River	-14,51769	-50,95522	243
LOT 2	Araguaia River	-14,48906	-50,98036	239
LOT 3	Araguaia River	-14,46542	-50,98036	239
LOT 4	Araguaia River	-14,46028	-50,98525	235
LOT 5	Araguaia River	-14,37853	-50,98536	233
LOT 6	Araguaia River	-14,36081	-50,98561	237

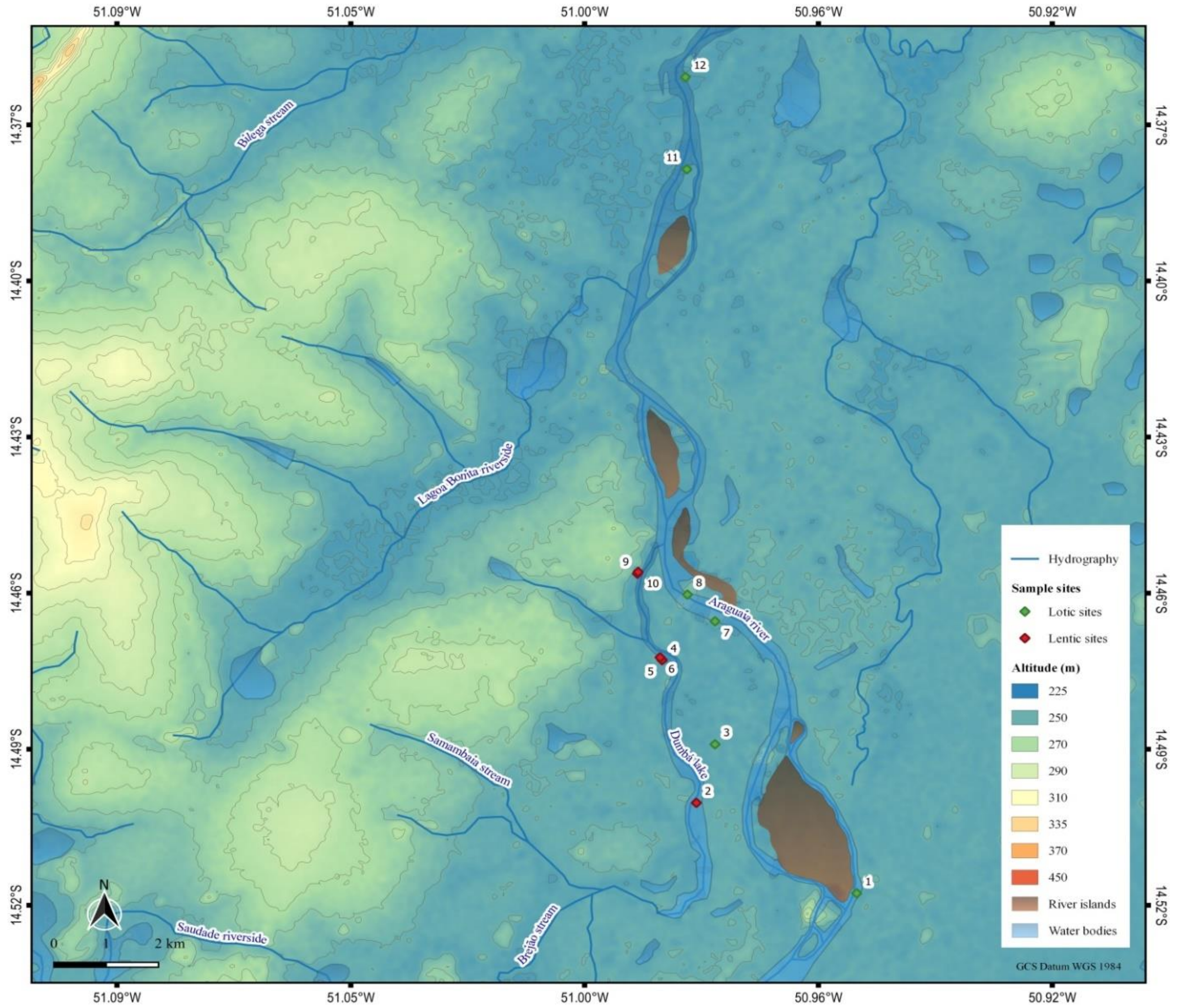

Figure 2. Map indicating the hydrography and the sampled sites on the lentic and lotic environments. Source: The authors.

The captured individuals were identified up to the most basal taxonomic level possible using taxonomic classification following Reis, Kullander, and Ferreira Jr. (2003) and Van Der Laan, Eschmeyer, and Fricke (2014) by the team of the Aquaculture Research Group, AcquaUnB, with complementary confirmations with specialists, when necessary. These fishes were later used for parasitological and mercury bioaccumulation studies.

For data analyses, we estimated the total and relative abundances of each species, and thus, the representativeness of each species in the total, as well as richness, Shannon's diversity index, homogeneity and species accumulation curve. We used Statistica version 10 (Statsoft®) and BioEstat® 5.3 (Ayres, Ayres Júnior, Ayres, & Santos, 2007).

Results and discussion

We captured 168 individuals in the two environments, belonging to 06 orders, 19 families, and 42 species (Table 2). Characiformes, 28spp., Siluriformes, 6spp. and Cichliformes, 5spp., were the orders that reached the highest species richness, 66.66, 14.28 and 11.90%, respectively. The greatest abundance of individuals was observed at the point LEN 3, 52 specimens, followed by LEN 2, 37 specimens and LEN 1, 22 specimens, representing 66.07% of the total individuals caught, with an average of 14 fish per sampled point. The largest number of species collected occurred at point LEN 1, 15spp., followed by LEN 3, 10spp., LEN 2, 9spp., and LOT 2, 9spp., while points LEN 4, LEN 5, LOT 1 and LOT 6 had the lowest number of species, 1spp., presenting an average of 3.5 different species per sampling point. We did not catch any non-native species.

Table 2. Fish species presence/absence, abundance and richness per sample site in the environments of Rio Araguaia basin, Mato Grosso and Goiás States, Brazil.

TAXA	SAMPLING SITES											
	LEN 1	LEN 2	LEN 3	LEN 4	LEN 5	LEN 6	LOT 1	LOT 2	LOT 3	LOT 4	LOT 5	LOT 6
Order Myliobatiformes												
Potamotrigonidae												
Potamotrygon motoro (Müller & Henle, 1841)						2						
Order Characiformes												
Hemiodontidae												
Hemiodus unimaculatus (Bloch, 1794)	1		4			1					1	
Hemiodus microlepis Kner, 1858	2											
Curimatidae												
Psectrogaster amazonica Eigenmann & Eigenmann, 1889	2		13							1		
Prochilodontidae												
Prochilodus nigricans Spix & Agassiz, 1829	2		2		1							
Anostomidae												
Leporinus affinis Günter, 1864		1										
Leporinus friderici (Bloch, 1794)		5										
Leporinus geminis Garavelo & Santos, 2009		2	2					1				
Megaleporinus obtusidens (Valenciennes, 1837)		1										
Schizodon vittatus (Valenciennes, 1850)		1										
Erythrinidae												
Hoplias malabaricus Bloch, 1794	1											
Ctenolucidae												
Boulengerella cuvieri (Agassiz, 1829)									1			
Ancestrorhynchidae												
Ancestrorynchus microlepis (Shomburgk, 1841)						1						
Cynodontidae												
Rhaphiodon vulpinus Agassiz, 1829	1									2		
Serralsamidae												
Pygonocentrus nattereri Kner, 1858	3						3	3				
Serrasalmus maculates Kner, 1858								3				
Serrasalmus rhombeus (Linnaeus, 1766)									4			
Serrasalmus brandtii Lütken, 1875								1	1	1		
Serrasalmus eigenmanni Norman, 1929									2			
Myleus setiger Müller & Troschel, 1844								1				
Metynnis hypsauchen (Müller & Troschel, 1844)			6									
Characidae												
Characinae												
Charax leticiae Lucena, 1987								1				
Exodon paradoxus Müller & Troschel, 1844	1		1									
Tretagonopterinae												
Tetragonopterus argenteus Cuvier, 1816		7										
Pristellinae												
Moenkhausia dichroura (Kner, 1858)			15									
*Moenkhausia megalops (*Eigenmann, 1907)								1				
Bryconidae												
Bryconinae												
Brycon falcatus Müller & Troschel, 1844		4										
Triportheidae												
Triportheinae												
Triportheus auritus Cuvier & Valencinnes, 1850								1			1	
Triportheus trifurcates (Castelnau, 1855)		15	4									
Order Siluriformes												
Loricariidae												
Hypostominae												
Hypostomus carinatus Steindachner, 1877	1								2	1	6	
Heptapteridae												
Pimelodella aff. *cristata* (Müller & Troschel, 1849)										1		
Pimelodidae												
Pimelodus aff. *ornatus* Kner, 1858	1					1						
Pseudoplatystoma fasciatum (Linnaeus, 1766)	1											
Propimelodus araguayae Rocha, de Oliveira, Rapp & Py-Daniel, 2007									1	1		
Pirinampus pirinampu (Spix & Agassiz, 1829)	1		1			1		1	1	1		
Order Cyprinodontiformes												

Sciaenidae												
Pachypops fourcroi (Lacepède, 1802)						1						
Order Cichliformes												
Cichlidae												
Cichlinae												
Cichla kelberi Kullander & Ferreira, 2006				1								
Biotodoma cupido (Heckel, 1840)	1					1						
Geophagus altifrons Heckel, 1840	1											
Satanoperca jurupari (Heckel, 1840)	3		4									
Cichlasomatinae												
Heros aff. *notatus* (Jardine, 1843)		1										
Order Pleuronectiformes												
Achiridae												
Hypoclinemus mentalis (Günther, 1862)						1				1		1
ABUNDANCE	22	37	52	1	1	9	3	13	12	9	8	1
RICHNESS	15	9	10	1	1	8	1	9	7	8	3	1

The families that presented the greatest richness of species, analyzing both environments, were Serrasalmidae, 16.66%, Characidae, 15.47%, Triportheidae, 12.5%, Curimatidae, 9.52% and Anostomidae, 7.73%, representing more than 61% of total individuals. The most abundant species were *Triportheus trifurcates* (11.30%), *Psectrogaster amazonica* (9.52%), *Moenkhausia dichroura* (8.92%), *Hypostomus carinatus* (5.95%) and *Pygocentrus nattereri* (5.35%), totaling 41.04% of individuals captured.

In the lentic environment, we captured 31 species from six orders, while in the lotic environment, we caught 19 species from three orders, and the two environments had 8 species in common (Figure 3). Considering the abundance of individuals per environment, the most abundant orders were Characiformes, 81.14% and Cichliformes, 9.83%, in the lentic environment, and Characiformes, 63.04% and Siluriformes, 32.60% in the lotic environment.

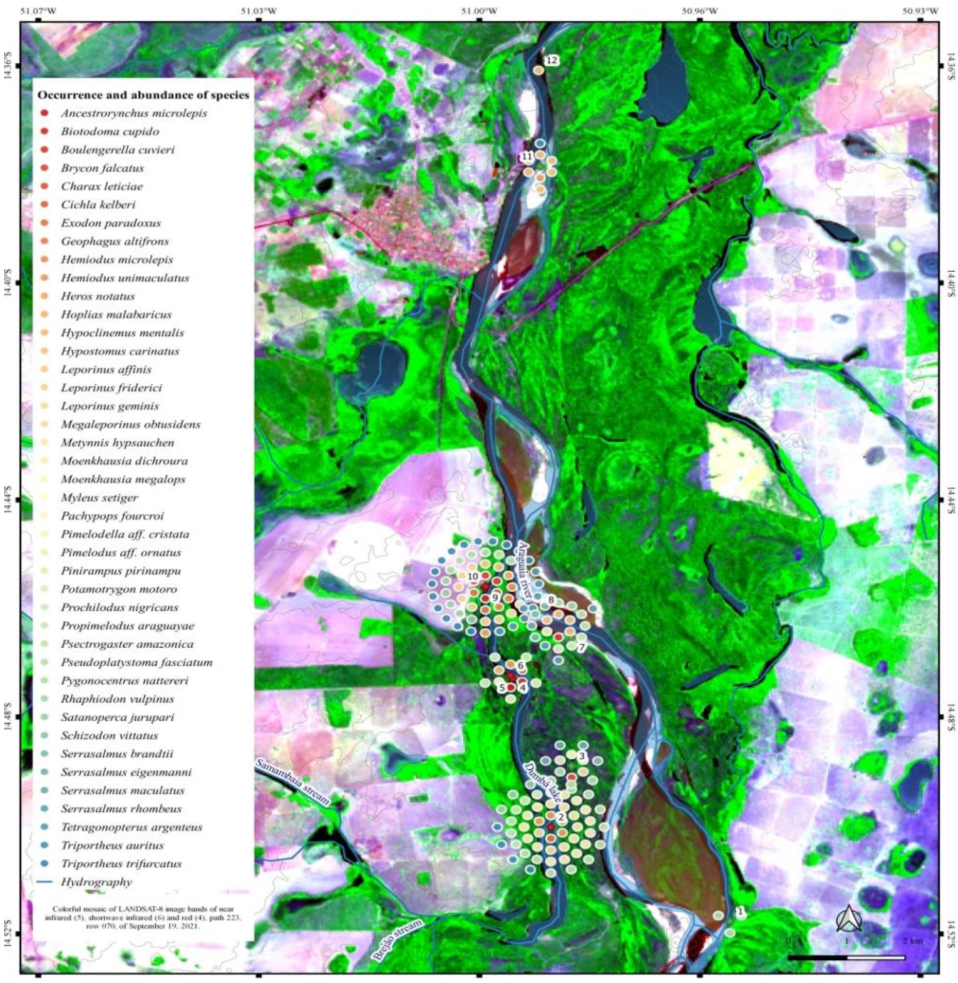

Figure 3. Fish species distribution in the sampled environments of the Upper Middle Araguaia floodplain. Source: The authors.

Of all individuals captured, orders Characiformes, Siluriformes and Cichliformes represented 92.85% of the species. The dominance of these orders is similar to that proposed by Roberts (1972) and, generally, observed for most rivers in Neotropical regions (Casatti, Langeani, & Castro, 2001; Böjsen & Barriga, 2002; Cetra & Petrete Jr., 2006; Jarduli, et al., 2014), which is first Characiformes, followed by Siluriformes and Perciformes. It is noteworthy that with the new classification proposed by Betancur et al. (2013), the Cichlidae family, with numerous species, is no longer part of the order of Perciformes, with the creation of a single order for these fish, Cichliformes, which can change the dominance of orders previously found in Neotropical rivers.

It is observed that of the five species that presented above 10% relative abundance, *Hypostomus carinatus* (20%), *Moenkhausia dichroura* (12%), *Psectrogaster amazonica* (14%), *Pygocentrus nattereri* (15%) and *Triportheus trifurcatus* (15%), three were found in both environments, while the other two were found only in the lentic environment (Figure 4). We highlight that most species found, 31 out of 42 (73.80%), were captured in the lentic environment.

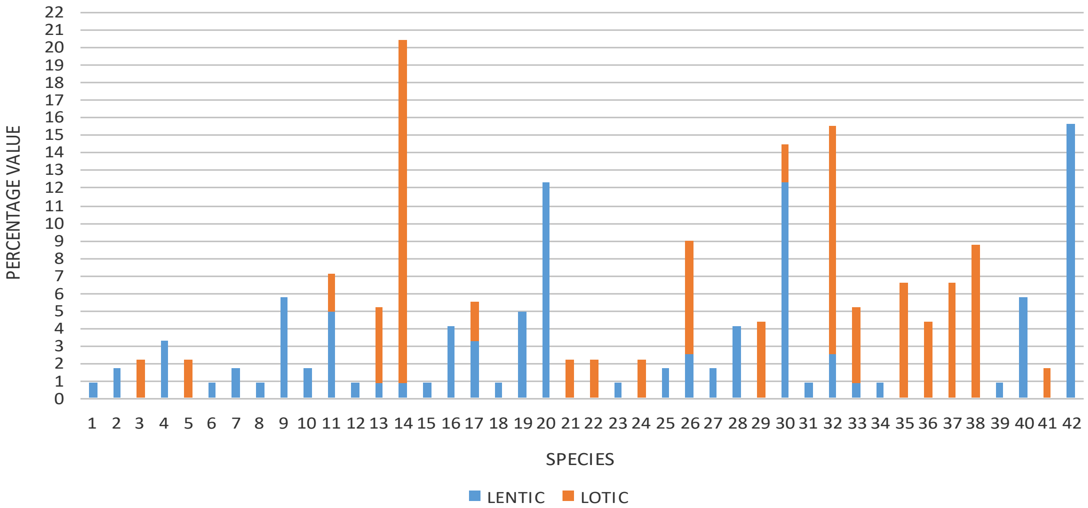

Figure 4. Graph showing the ranking of relative abundance in the two sampled environments in the Araguaia River basin. 1-*Ancestrorynchus microlepis*; 2-*Biotodoma cupido*; 3-*Boulengerella cuvieri*; 4-*Brycon falcatus*; 5-*Charax leticiae*; 6-*Cichla kelberi*; 7-*Exodon paradoxus*; 8-*Geophagus altifrons*; 9- *Satanoperca jurupari*; 10-*Hemiodus microlepis;* 11-*Hemiodus unimaculatus*; 12-*Hoplias malabaricus*; 13-*Hypoclinemus mentalis*; 14-*Hypostomus carinatus*; 15-*Leporinus affinis*; 16-*Leporinus friderici*; 17-*Leporinus geminis*; 18- *Megaleporinus obtusidens*; 19-*Metynnis hypsauchen*; 20-*Moenkhausia dichoura*; 21-*Moenkhausia megalops*; 22-*Myleus torquatus*; 23-*Pachypops fourcroi*; 24- *Pimelodella* aff. *cristata*; 25-*Pimelodus* aff. *ornatus*; 26- *Pinirampus pirinampu*; 27-*Potamotrygon motoro*; 28-*Prochilodus nigricans*; 29-*Propimelodus araguayae*; 30-*Psectrogaster amazonica;* 31-*Pseudoplatystoma fasciatum*; 32-*Pygocentrus nattereri*; 33-*Rhaphiodon vulpinus*; 34-*Schizodon vittatus*; 35-*Serrasalmus brandtii*; 36-*Serrasalmus eigenmanni*; 37-*Serrasalmus maculatus*; 38-*Serrasalmus rhombeus*; 39- *Heros notatus*; 40-*Tetragonopterus argenteus*; 41-*Triportheus auritus*; 42-*Triportheus trifurcatus*.

The Shannon diversity indices found were 1.27 for the lentic and 1.16 for the lotic environment. These low values may be explained by the index' sensitivity to rare species, being inversely proportional to high percentages of rare species. The homogeneity of the samples by environment was 0.78 for the lentic and 0.71 for the lotic. The vast majority of the species in this study are distributed throughout the Amazon Basin, as suggested by Tejerina-Garro et al. (2002), but some are characterized as being migratory species, either for reproduction or due to feeding habits, as is the case of genera *Prochilodus* and *Brycon*.

As one of the most biodiverse rivers in the world, regarding fish fauna, the species accumulation curve (Figure 5) demonstrated that the number of observed species would be higher with more sampled spots at the stretch of the Araguaia River basin, considering both lotic and lentic environments.

The Cichlidae family comprises a vast number of species, approximately 1600, and recent studies seek to uncover errors in the classification of this huge group of vertebrates. In addition, species from this family are under significant fishing pressure due to their economic importance (Chao, 2001; Leiva, Pereira-Bonilla, Senior-Mojica, & Telles-Murcia, 2007). Of the five species from this family found in the study, *Cichla kelberi*, *Biotodoma cupido*, *Geophagus altifrons*, *Satanoperca jupari* and *Heros notatus*, the last three have taxonomic uncertainties and several phylogeny and morphology studies seek to genetically distinguish the different species from the genera and broaden the understanding about the distribution of the species from this family.

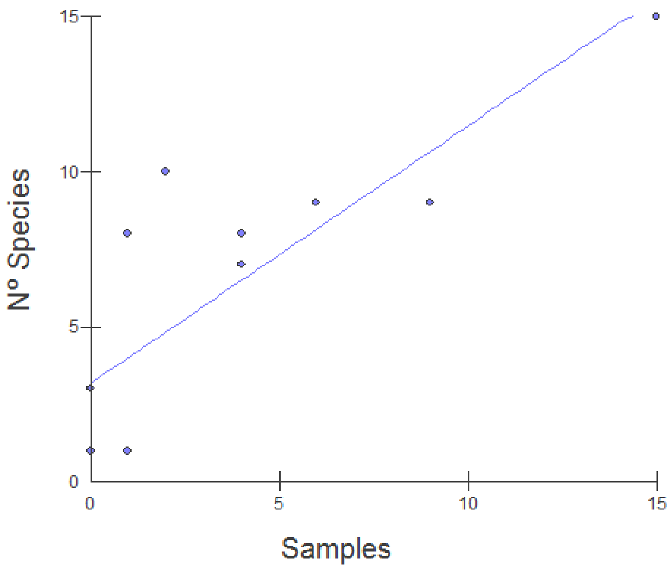

Figure 5. Species accumulation curve, a geometric regression between the number of observed species and the sampling effort.

The Anostomidae family, composed of about 110 species, restricted to South America and with representatives in all hydrographic basins of Brazil, especially in the Amazon basin, has high commercial importance and small species have great acceptance in aquariums (Melo, Machado, & Silva, 2014). All the species we collected from this family (*Leporinus affinis*, *Leporinus friderici*, *Schizodon vittatus*, *Leporinus geminis* and *Megaleporinus obtusidens*) are recurrently found in the region, but the last two showed different color patterns suggesting that future phylogenetic studies can attest to a concrete classification of these specimens.

As with the Cichlidae family, studies that unravel the gaps in the classification and distribution of species in the Anostomidae family deserve attention. Ferreira, Oliveira, Venere, Galetti Jr., and Martins (2007), Olivatti et al. (2011) and Garavello et al. (2021) investigated genetic characters of genera from this family. Garavello and Santos (2009) found a species identified as *Leporinus unitaeniatus* and stated that there is a shortage of taxonomic information about the specimens of the genus *Leporinus* for the Tocantins/Araguaia basin. Britski and Birindelli (2008) described a new species of this genus in the basin, distinct from the other two *(Leporinus parae* and *Leporinus lacustris*) in dental pattern and habitat preference.

The comparison of species dominance by environment shows that the conversion from lotic to lentic environment changes the pattern (Lowe-McConnell, 1999). We collected a higher number of top-of-the-chain species, either carnivorous or omnivorous in the river channel, but we also found specimens with the same feeding habits in the lake. We observed dominance of carnivorous species (76.4%), such as *Ancestrorynchus microlepis*, *Boulengerella cuvieri*, *Propimelodus araguayae*, *Pinirampus pirinampu*, *Rhaphiodon vulpinus* and the species of the family Serrasalmidae, *Pygocentrus nattereri*, *Serrasalmus brandtii*, *Serrasalmus eigenmanni*, *Serrasalmus maculatus* and *Serrasalmus rhombeus,* in the lotic environment. However, the two individuals of the species *Pimelodus* aff. *ornatus* and the only individual of the species *Pseudoplatystoma fasciatum* were found in the lentic environment, just like the insectivorous species *Pimelodella* aff. *cristata*.

The species described in the literature as frugivores collected in the study, such as *Brycon falcatus*, *Myleus torquatus*, *Metynnis hypsauchen*, *Prochilodus nigricans*, *Psectrogaster amazonica*, *Schizodon vittatus* and those of the genus *Triportheus*, *Triportheus auritus* and *Triportheus trifurcatus*, were primarily found in the lentic environment, more precisely 97.2%. Dense vegetation was observed in the margins of the lentic environment, while the margins in most of the sampled lotic environments were composed of sandbanks that formed beaches. Most individuals of the genus *Hemiodus*, *Hemiodus microlepis* and *Hemiodus unimaculatus*, as well as the only specimen of *Hoplias malabaricus,* were also captured in the lentic environment.

Amongst the species found, three were described after the year 2000, *Leporinus geminis* (2009), *Cichla kelberi* (2006) and *Propimelodus araguayae* (2007), the latter being endemic to the Araguaia River basin. Another endemic species captured was *Triportheus trifurcatus*. According to Queiroz, Mateus, Garutti, and Venere (2008), the species of the genus *Triportheus* are among the least known so far and they are broadly consumed by the local people. In the present study we captured 28 individuals of two species from this genus, and the endemic species showed a high relative abundance.

It is also noteworthy that several of the species found are classified as commercial, of interest for aquaculture, aquarium and/or sport fishing. The specimens of evidenced coloring and/or small sizes, as the case of *Charax leticiae*, *Monkhausia megalops*, *Moenkhausia dichroura, Exodon paradoxus*, *Leporinus affinis*, *Metynnis hypsauchen*, *Geophagus altifrons*, *Heros notatus, Tetragonopterus argenteus* and *Pachypops fourcroi*, or of different habits and morphology, case of *Hypostomus carinatus, Potamotrygon motoro* and *Hypoclinemus mentalis*, are some of the species with aquarism potential, and are commonly found for sale in aquarium stores.

The richness of species found in this study demonstrates the environmental health of the studied area; however, the conservation of the analyzed environments must be stimulated in order to preserve these species locally. Species with uncertain taxonomic status suggest a certain lack of information and description of taxa of the floodplain in the upper-middle Araguaia ichthyofauna, as well as the possibility of being species not yet described. Also, according to Freitas and Souza (2009), who presented a proposal of 'ideal' biological indicator fish species (eight species in total) based on the criteria proposed by Johnson, Wiederholm, and Rosemberg (1993), we captured three of these species, and the genus *Triportheus,* which in this study was the most abundant, is one of the genera cited.

At first, we determined collection points in stretches close to the sampled environments and that were spatially parallel, understanding that the lake is located parallel to the river, but we opted for two more distant sites in an attempt to sample heterogenic landscapes in the lotic environment. At each sampling spot, we used all collection techniques, but there were method limitations at certain points. The waiting net, as well as trawling, were more efficient in the lentic environment, while hook casting was as efficient as the waiting net in the lotic environment. Therefore, for future studies we suggest that more sample spots and more distance between them would result in more individuals and a higher diversity. In addition, a bigger effort in sampling, considering length of time and period of the day, would better assess local diversity.

Conclusion

A brief ichthyological sampling in the Araguaia basin allowed for the observation of numerous species in both lentic and lotic environments. Top-of-the-chain species were found in both environments, though the lentic was more diverse and abundant, likely due to sampling methods working better in this environment. In the lotic environment there was a predominance of carnivorous and benthonic species. The most abundant genus was *Triportheus*, and other genera that are bioindicators in Amazonian watercourses were found. The sampled stretch demonstrated the environmental health of the water body, in addition to being able to help future studies of the Araguaia River.

Acknowledgements

We would like to thank professors Antônio Felipe Couto Júnior (*In memoriam*) and Ludgero Cardoso Galli Vieira, the academic group AcquaUnB, and the Postgraduate Program in Environmental Sciences at the University of Brasília (UnB) for their support, logistics and endorsement. We also thank the Coordenação para Aprimoramento de Pessoal de Ensino Superior (CAPES) for the funding.

References

Agostinho, A. A., & Zalewski, M. (1996). *A planície alagável do Alto Rio Paraná: importância e preservação*. Maringá, PR: Eduem.

Alves, T. M., & Carvalho, T. M. (2007). Técnicas de sensoriamento remoto para classificação e quantificação do sistema lacustre do Rio Araguaia entre Barra do Garças e Foz do Rio Cristalino. *Revista de Geografia Acadêmica, 1*(1), 79-94.

Anacleto, T. C. S., Ferreira, A. A., Diniz Filho, J. A. F., & Ferreira, L. G. (2005). Seleção de áreas de interesse ecológico através de sensoriamento remoto e de otimização matemática: um estudo de caso no município de Cocalinho, MT. *Acta Amazônica, 35*(4), 437-444. DOI: http://doi.org/10.1590/S0044-59672005000400008

Aquino, S., Stevaux, J. C., & Latrubesse, E. M. (2005). Regime hidrológico e aspectos do comportamento morfohidráulico do rio Araguaia. *Revista Brasileira de Geomorfologia, 6*(2), 29-41. DOI: http://doi.org/10.20502/rbg.v6i2.49

Araújo, N. B., Carvalho, R. A., & Tejerina-Garro, F. L. (2016). Pesca amadora e turismo no Médio Rio Araguaia, Brasil Central. *Fronteiras: Journal of Social, Technological and Environmental Science, 5*(3), 136-150. DOI: http://doi.org/10.21664/2238-8869.2016v5i3.p136-150

Ayres, M., Ayres Júnior, M., Ayres, D. L., & Santos, A. A. (2007). *BIOESTAT: aplicações estatísticas nas áreas das ciências bio-médicas*. Belém, PA: Sociedade Civil Mamirauá.

Betancur, R. R., Broughton, R. E., Wiley, E. O., Carpenter, K., López, J. A., Li, C., ... Ortí, G. (2013). The tree of life and a new classification of bony fishes. *PLoS currents, 5*. DOI: http://doi.org/10.1371/currents.tol.53ba26640df0ccaee75bb165c8c26288

Bilton, D. T., Freeland, J. R., & Okamura, B. (2001). Dispersal in freshwater invertebrates. *Annual Review of Ecology and Systematics, 32*, 159–181. DOI: http://doi.org/10.1146/annurev.ecolsys.32.081501.114016

Bitencourt, E. B., Reis, L. M., & Loureiro, G. E. (2020). Análise temporal do desmatamento na Bacia Hidrográfica do Rio Sororó – Região de Integração de Carajás, PA. *Revista Geoaraguaia, 10* (1), 89-106.

Böjsen, B. H., & Barriga, R. (2002). Effects of deforestation on fish community structure in Ecuadorian Amazon streams. *Freshwater Biology, 47*(11), 2246-2260. DOI: http://doi.org/10.1046/j.13652427.2002.00956.x

Borges, H. B. N., Silveira, E. A., & Vendramin, L. N. (2014). *Flora arbórea de Mato Grosso: tipologias vegetais e suas espécies*. Cuiabá, MT: Entrelinhas.

Britski, H. A., & Birindelli, J. L. O. (2008). Description of a new species of the genus *Leporinus* Spix (Characiformes: Anostomidae) from the rio Araguaia, Brazil, with comments on the taxonomy and distribution of *L. parae* and *L. lacustris*. *Neotropical Ichthyology, 6*(1), 45-51. DOI: http://doi.org/10.1590/S1679-62252008000100005

Casatti, L., Langeani, F., & Castro, R. M. C. (2001). Peixes de riacho do Parque Estadual Morro do Diabo, bacia do Alto rio Paraná, SP. *Biota Neotropica, 1*(1-2), 1-15. DOI: http://doi.org/10.1590/S1676-06032001000100005

Cetra, M., & Petrete Jr., M. (2006). Fish assemblage structure of the Corumbataí river basin, São Paulo State, Brazil: characterization and anthropogenic disturbances. *Brazilian Journal of Biology, 66*(2), 431-439. DOI: http://doi.org/10.1590/S1519-69842006000300007

Chao, N. L. (2001). The fishery, diversity, and conservation of ornamental fishes in the Rio Negro Basin, Brazil - a review of Project Piaba (1989-99). In N. L. Chao, P. Petry, G. Prang, L. Sonneschien & M. Tlusty (Eds.), *Conservation and Management of Ornamental Fish Resources of the Rio Negro Basin, Amazonia, Brazil* (p. 161-204). Manaus, AM: Universidade do Amazonas.

Dagosta, F. C. P., Pinna, M., Peres, C. A., & Tagliacollo, V. A. (2020 2021). Existing protected areas provide a poor safety-net for threatened Amazonian fish species. *Aquatic Conservation Marine and Freshwater Ecosystems, 31*(5), 1167-1189. DOI: http://doi.org/10.1002/aqc.3461

De Meester, L., Gomez, A., Okamura, B., & Schwenk, K. (2002). The monopolization hypothesis and the dispersal-gene flow paradox in aquatic organisms. *Acta Oecologica - International Journal of Ecology, 23*(3), 121-135. DOI: http://doi.org/10.1016/S1146-609X(02)01145-1

Fagan, W. F. (2002). Connectivity, fragmentation, and extinction risk in dendritic metapopulations. *Ecology 83*(12), 3243-3249. DOI: http://doi.org/10.1890/0012-9658(2002)083[3243:CFAERI]2.0.CO;2

Ferreira, E., Zuanon, J., Santos, G., & Amadio, S. (2011). A ictiofauna do Parque Estadual do Cantão, Estado do Tocantins, Brasil. *Biota Neotropica, 11*(2). DOI: http://doi.org/10.1590/S1676-06032011000200028

Ferreira, I. A., Oliveira, C., Venere, P. C., Galetti Jr., P. M., & Martins, C. (2007). 5S rDNA variation and its phylogenetic inference in the *genus Leporinus* (Characiformes: Anostomidae). *Genetica, 129*, 253-257. DOI: http://doi.org/10.1007/s10709-006-0005-6

France, K. E., & Duffy, J. E. (2006). Diversity and dispersal interactively affect predictability of ecosystem function. *Nature, 441*(7097), 1139-1143. DOI: http://doi.org/10.1038/nature04729

Freitas, C. E. C., & Souza, F. K. S. (2009). O uso de peixes como bioindicador ambiental em áreas de várzea da bacia amazônica. *Revista Agrogeoambiental, 1*(2), 39-45. DOI: http://doi.org/10.18406/2316-1817v1n2200975

Garavello, J. C., & Santos, G. M. (2009). Two new species of *Leporinus* Agassiz, 1829 from Araguaia-Tocantins system, Amazon basin, Brazil (Ostariophysi, Anostomidae). *Brazilian Journal of Biology, 69*(1), 109-116. DOI: http://doi.org/10.1590/S1519-69842009000100013

Garavello, J. C., Ramirez, J. L., Oliveira, A. K., Britski, H. A., Birindelli, J. L. O., & Galetti Jr., P. M. (2021). Integrative taxonomy reveals a new species of Neotropical headstanding fish in genus *Schizodon* (Characiformes: Anostomidae). *Neotropical Ichthyology, 19*(4), 1-32. DOI: http://doi.org/10.1590/1982-0224-2021-0016

Gomes, R. R. K. A. & Fernandes, L. L. (2017). Hydrological characterization of the Araguaia River through reference flows. *Applied Water Science, 7*(8), 4605-4614. DOI: http://doi.org/10.1007/s13201-017-0622-5

Irion, G., Nunes, G. M., Cunha, C. N., Arruda, E. C., Tambelini, M. S., Dias, A. P., ... Junk, W. J. (2016). Araguaia River floodplain: size, age, and mineral composition of a large tropical savanna wetland. *Wetlands, 36*(5), 945-956. DOI: http://doi.org/10.1007/s13157-016-0807-y

Jarduli, L. R., Claro-Garcia, A., & Shibata, O. A. (2014). Ichthyofauna of the rio Araguaia basin, states of Mato Grosso and Goiás, Brazil. *Check List: The Journal of Biodiversity Data, 10*(3), 483-515. DOI: http://doi.org/10.15560/10.3.483

Johnson, R. D., Wiederholm, T., & Rosemberg, D. M. (1993). Freshwater biomonitoring using individual organisms, populations, and species assemblages of benthic macroinvertebrates, p.40-158. In D. M. Rosemberg & V. H. Resh (Eds.), *Freshwater Biomonitoring and Benthic Macroinvertebrates* (p. 40-158). New York, NY: Chapman & Hall.

Junk, W. J., Soares, M. G. M., & Saint-Paul, U. (1997). *The central amazon floodplain: ecology of a pulsing system*. Berlim, AL: Springer Verlag.

Latrubesse, E. M., Amsler, M. L., Morais, R. P., & Aquino, S. (2009). The Geomorphologic response of a large pristine alluvial river to tremendous deforestation in the South American tropics: the case of the Araguaia River. *Geomorphology, 113*(3-4), 239-252. DOI: http://doi.org/10.1016/j.geomorph.2009.03.014

Latrubesse, E. M., Arima, E., Ferreira, M. E., Nogueira, S. H., Wittmann, F., Dias, M. S., ... Bayer, M. (2019). Fostering water resource governance and conservation in the Brazilian Cerrado biome. *Conservation Science and Practice, 1*(9), e77. DOI: http://doi.org/10.1111/csp2.77

Leiva, A. F. A., Pereira-Bonilla, D. J., Senior-Mojica, A., & Telles-Murcia, C. (2007). *Pesca y acuicultura Colombia 2007: informe técnico regional Cuencas del Orinoco y Amazonas*. Bogota, CO: CCI.

Lima, L. B., Oliveira, F. J. M., Borges, F. V., Corrêa, F., & Lima-Junior, D. P. (2021). Streams fish from Upper Araguaia and Middle Rio da Mortes basin, Brazil: generating subsidies for preservation and conservation of this critical natural resource. *Biota Neotropica, 21*(4), e20211205. DOI: http://doi.org/10.1590/1676-0611-BN-2021-1205

Lininger, K. B., & Latrubresse, E. M. (2016). Flooding hydrology and peak discharge attenuation along the middle Araguaia River in central Brazil. *Catena, 143*, 90-101. DOI: http://doi.org/10.1016/j.catena.2016.03.043

Lowe-McConnell, R. H. (1999). *Estudos ecológicos de comunidades de peixes tropicais* (A. E. A. M. Vazzoler, A. A. Agostinho & P. T. M. Cunnhingham, Trad.). São Paulo, SP: Edusp.

Melo, C. E., Machado, F. A., & Silva, V. P. (2014). Feeding habits of fish from stream in the savanna of Central Brazil, Araguaia Basin. *Neotropical Ichthyology, 2*(1). DOI: http://doi.org/10.1590/S1679-62252004000100006

Mérona, B. (1987). Aspectos ecológicos da ictiofauna no baixo Tocantins. *Acta Amazônica, 17*, 109-124. DOI: http://doi.org/10.1590/1809-43921987171124

Muniz, D. H. F., Santana, M. L. C., & Oliveira-Filho, E. C. (2020). Avaliação da qualidade da água e condições de balneabilidade no Médio Rio Araguaia. *Fronteiras: Journal of Social, Technological and Environmental Science, 9*(2), 308-327. DOI: http://doi.org/10.21664/2238-8869.2020v9i2.p308-327

Olivatti, A. M., Boni, T. A., Silva-Júnior, N. J., Resende, L. V., Gouveia, F. O., & Telles, M. P. C. (2011). Heterologous amplification and characterization of microsatellite markers in the Neotropical fish *Leporinus friderici*. *GMR - Genetics and Molecular Research, 10*(3), 1403-1408. DOI: http://doi.org/10.4238/vol10-3gmr1020

Pelicice, F. M., Agostinho, A. A., Akama, A., Andrade Filho, J. D., Santos, V. M. A., Barbosa, M. V. M., ... Zuanon, J. (2021). Large-scale degradation of the Tocantins-Araguaia river basin. *Environmental Management, 68*, 445-452. DOI: http://doi.org/10.1007/s00267-021-01513-7

Prysthon, A., Cunha, C. V., & Dias, C. R. G. (2019). The fishing productivity assessment upstream and downstream of Tucuruí Hydroeletric Dam, Tocantins-Araguaia basin, Brazil. *International Journal of Advanced Engineering Research and Science, 6*(4), 85-92, Apr. DOI: http://doi.org/10.22161/ijaers.6.4.10

Queiroz, M. F. M., Mateus, L. A. F., Garutti, V., & Venere, P. C. (2008). Reproductive biology of *Triportheus trifurcatus* (Castelnau, 1855) (Characiformes: Characidae) in the middle rio Araguaia, MT, Brazil. *Neotropical Ichthyology, 6*(2), 231-236. DOI: http://doi.org/10.1590/S1679-62252008000200010

Reis, R. E., Kullander, S. O., & Ferraris Jr., C. J. (2003). *Checklist of the freshwater fishes of South and Central America*. Porto Alegre, SC: Edipucrs.

Roberts, T. R. (1972). Ecology of fishes in the Amazon and Congo basins. *Bulletin of the Museum of Comparative Zoology at Harvard College, 143*(2), 117-147.

Rosset, V., Ruhi, A., Bogan, M. T., & Datry, T. (2017). Do lentic and lotic communities respond similarly to drying? *Ecosphere, 8*(7), e01809. DOI: http://doi.org/10.1002/ecs2.1809

Santos, G. M., & Ferreira, E. J. G. (1999). Peixes da Bacia Amazônica. In R. H. Lowe-McConnel (Ed.), *Estudos Ecológicos de Comunidades de Peixes Tropicais* (p. 345-373). São Paulo, SP: USP.

Saviato, M. J., Mariano, W. S., Saviato, P. L. C., & Sassi, V. B. (2017). Ictiofauna do Riberão Jacubinha, Bacia do Rio Lontra na cidade de Araguaína – TO. *Enciclopédia Biosfera - Centro Científico Conhecer,14*, (25), 1362-1374. DOI: http://doi.org/10.18677/EnciBio_2017A113

Starzomski, B. & Srivastava, D. (2007). Landscape geometry determines community response to disturbance. *Oikos*, *116*, 690-699. DOI: https://doi.org/10.1111/j.0030-1299.2007.15547.x

Tejerina–Garro, F. L., Fortin, R., & Rodríguez, M. A. (1998). Fish community structure in relation to environmental variation in floodplain lakes of the Araguaia River, Amazon Basin. *Environmental Biology of Fishes, 51*, 399–410. DOI: http://doi.org/10.1023/A:1007401714671

Tejerina-Garro, F. L., Fortin, R., & Rodríguez, M. A. (2002). Caracterização da ictiofauna e das interações peixe-ambiente no médio Araguaia, Bacia Amazônica. *Estudos Goiânia, 29*, 87-101.

Thoms, M. C. (2003). Floodplain–river ecosystems: lateral connections and the implications of human interference. *Geomorphology, 56*(3-4), 335–349. DOI: http://doi.org/10.1016/S0169-555X(03)00160-0

Van Der Laan, R., Eschmeyer, W. N., & Fricke, R., (2014). Family-group names of Recent fishes. *Zootaxa, 3882*(1), 1–230. DOI: http://doi.org/10.11646/zootaxa.3882.1.1