Universidade Federal do Maranhão

Programa de Pós-Graduação em Biodiversidade e Conservação

INVENTÁRIO DA ICTIOFAUNA DA BACIA DO RIO TIBIRI, SÃO LUÍS, AMAZÔNIA MARANHENSE

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SÃO LUÍS/MA

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Dissertação apresentada ao Programa de Pós-graduação em Biodiversidade e Conservação da Universidade Federal do Maranhão, como requisito parcial para obtenção do título de Mestre em Biodiversidade e Conservação.

Orientador: Prof. Dr. Marcelo Ândrade

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Aprovado em / /

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“O sucesso é a soma de pequenos esforços repetidos dia após dia”.

(Robert Collier)

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Summary

LISTA DE ABREVIAÇÕES

ICMBIO – Instituto Chico Mendes de Conservação da Biodiversidade

VU - Vulnerável

NT – Quase Ameaçada

IMESC – Instituto Maranhense de Estudos Socioeconômicos e Cartográficos

TMS – Metanossulfonato de Tricaína

LABIPI – Laboratório de Ictiofauna e Piscicultura Integrada

UEMA – Universidade Estadual do Maranhão

CIUEMA – Coleção Ictiológica da Universidade Estadual do Maranhão

CICCAA – Coleção Ictiológica do Centro de Ciências Agrárias e Ambientais

GPS – Sistema de Posicionamento Global

GIS – Sistema de Informação Geográfica

DEM – Modelo Digital de Elevação

SRTM – Missão de Topografia do Radar Shuttle

DD – Dados Insuficientes

LC – Menos preocupante

CLOFFBR-MA – Checklist dos peixes de água doce do Maranhão

UFMA – Universidade Federal do Maranhão

LISTA DE TABELAS

LISTA DE FIGURAS

RESUMO

A rica biodiversidade aquática brasileira tem sido alvo de diversos estudos com a descrição e novos registros de espécies de peixes, embora os ecossitemas aquáticos neotropicais tenham sido alvo da intensificação de ações antrópicas com potencial aumento da perda de habitat. O objetivo do presente trabalho foi inventariar as espécies de peixe que ocorrem na bacia do rio Tibiri, no município de São Luís, Amazônia maranhense. O estudo foi realizado a partir de coletas científicas ao longo da bacia do Rio Tibiri na Ilha de São Luís, também conhecida como Ilha Grande, Ilha do Upaon-Açu e Ilha do Maranhão, no período de agosto de 2021 a julho de 2024. Foram utilizadas armadilhas para peixes, redes de arrasto, redes de cerco, peneiras e redes de pesca de várias malhagens com artes de pesca. Os peixes coletados foram eutanasiados com uma solução de água e metanossulfonato de tricaína (TMS), fixados em formol a 10% e, posteriormente, transferidos ao Laboratório de Ictiofauna e Piscicultura Integrada da Universidade Estadual do Maranhão (LABIPI-UEMA) para preservação em álcool diluído a 70% e identificação ao nível taxonômico mais baixo possível com base na literatura específica. Classificação taxonômica, táxons, nomes, Neste estudo, 7.465 espécimes de peixes foram coletados na bacia do rio Tibiri, representando 65 espécies incluídas em 17 ordens e 37 famílias. A ordem Acanthuriformes apresentou a maior riqueza de espécies, seguida por Carangiformes, Clupeiformes e Gobiiformes. Das 65 espécies registradas, três são não nativas da região: *Megaleporinus macrocephalus*, *Butis koilomatododon* e *Poecilia reticulata*, documentando uma das ações humanas mais preocupantes para os ecossistemas naturais: a introdução de espécies exóticas. A espécie mais abundante foi *Rhinosardinia amazonica*, enquanto espécies como *Megalops atlanticus*, *Scomberomorus cavalla* e *Bagre bagre* foram raramente coletadas, além de serem categorizadas pelo ICMBio como Vunerável (VU) e Quase ameaçada (NT), respectivamente. Além disso, uma espécie potencialmente não descrita, *Hemigrammus* sp., foi registrada. O estudo enfatiza que a bacia do rio Tibiri abriga uma alta riqueza de espécies de peixes, no entanto, é prejudicada por atividades antrópicas graves, enfrentando problemas para a conservação de suas espécies e manutenção das características naturais de sua paisagem. Nossos resultados sugerem a necessidade de estudos adicionais que integrem abordagens taxonômicas, moleculares e ecológicas para melhorar a conservação da bacia do rio Tibiri, bem como para mitigar as pressões humanas que influenciam esse ecossistema.

Palavras-chaves: Fauna; Peixes Neotropicais; Levantamento; Vulnerabilidade

ABSTRACT

Brazil's rich aquatic biodiversity has been the target of several studies with the description and new records of fish species, although Neotropical aquatic ecosystems have been the target of intensified anthropic actions with a potential increase in habitat loss. The objective of this work was to inventory the fish species that occur in the Tibiri river basin, in the municipality of São Luís, Maranhão Amazon. The study was carried out based on scientific collections along the Tibiri River basin on São Luís Island, also known as Ilha Grande, Ilha do Upaon-Açu and Ilha do Maranhão, from August 2021 to July 2024. fish traps, trawl nets, seine nets, sieves and fishing nets of various mesh sizes are used with fishing gear. The collected fish were euthanized with a solution of water and tricaine methanesulfonate (TMS), fixed in 10% formaldehyde and subsequently transferred to the Ichthyofauna and Integrated Pisciculture Laboratory of the State University of Maranhão (LABIPI-UEMA) for preservation in alcohol. diluted to 70% and identification to the lowest possible taxonomic level based on specific literature. Taxonomic classification, taxa, names, In this study, 7,465 fish specimens were collected in the Tibiri River basin, representing 65 species included in 17 orders and 37 families. The order Acanthuriformes presented the greatest species richness, followed by Carangiformes, Clupeiformes and Gobiiformes. Of the 65 species recorded, three are non-native to the region: Megaleporinus macrocephalus, *Butis koilomatodon* and Poecilia reticulata, documenting one of the most worrying human actions for natural ecosystems: the introduction of exotic species. The most abundant species was Rhinosardinia amazonica, while species such as Megalops atlanticus, Scomberomorus cavalla and *Bagre bagre* were rarely collected, in addition to being categorized by ICMBio as Vulnerable (VU) and Near Threatened (NT), respectively. Additionally, a potentially undescribed species, Hemigrammus sp., was recorded. The study emphasizes that the Tibiri River basin is home to a high richness of fish species, however, it is harmed by serious human activities, facing problems in conserving its species and maintaining the natural characteristics of its landscape. Our results suggest the need for additional studies that integrate taxonomic, molecular and ecological approaches to improve the conservation of the Tibiri River basin, as well as to mitigate human pressures that influence this ecosystem.

Keywords: Fauna; Neotropical fish; Lifting; Vulnerability

CAPÍTULO 1

Inventário da ictiofauna da bacia do rio Tibiri: Referencial teórico

Capítulo introdutório à dissertação e não será submetido à publicação

1. Fundamentação Teórica

1.1.Ictiofauna de Água doce

O Brasil se destaca com a maior diversidade de peixes de água doce, com mais de 2.500 espécies descritas válidas (BUCKUP et al., 2007; FRICKE et al., 2022). Esse valor representa aproximadamente 50 % de todas as espécies de peixes de água doce da região Neotropical (BUCKUP et al., 2007; REIS et al., 2016). Essa grande diversidade pode ser justificada, principalmente, pelo país possuir em seus 10 territórios grandes redes hidrográficas e áreas de endemismo (AGOSTINHO et al., 2005; BUCKUP et al., 2007; REIS et al., 2016). A maior parte dessa biodiversidade é constituída por peixes de pequeno e médio porte, que estão distribuídos em vários ecossistemas aquáticos, como rios, riachos, córregos e lagos (VAZZOLER, 1996; CASTRO, 1999; LOWE-MCCONNEL, 1999; CASTRO; POLAZ 2020; CÔRREA; CASTRO, 2021). Além disso, o país possui várias espécies de peixes que tem o hábito migratório em seu ciclo de vida (CAROLSFELD et al., 2004).

No momento atual os ecossistemas aquáticos neotropicais são os mais ameaçados do mundo e uma alta de extinção e projetada para os próximos anos (DUDGEON et al., 2006). Levêque et al (2008) apontam que dentre as principais ameaças estão a destruição dos habitats, sobre-exploração, modificações dos cursos d´água, introdução de espécies exóticas, poluição, eutrofização e assoreamento, que podem resultar em mudanças na estrutura das comunidades, extinções local e total de espécies.

Atualmente o número de descrições e novos registros a cada ano vêm amentando exponencialmente (REIS et al.,2003; REIS et al., 2016; LONDOÑO-BURBANO et al., 2021). O crescente número de descrições de novas espécies nos últimos anos em território brasileiros como Roxo et al. (2017) descrevendo *Hypostomus velhochico*, um novo *Hypostomus* da bacia do São Francisco, Guimarães et al (2018a) descrevendo uma nova espécies de Characiformes no Nordeste do Brasil, o *Hyphessobrycon caru* entre outros peixes que foram descritos (GUIMARÃES et al.,2018b; 2019;2020;LEÃO et al., 2019; BRITO et al., 2019; COSTA et al., 2020; KATZ et al., 2020; SARAIVA et al., 2021; DIAS; ZAWADZKI, 2021; COSTA et al.,2022; NEUHAUS et al., 2022; AGUIAR et al., 2022; LIMA et al., 2022; STAECK et al., 2022) revela que ainda são necessários mais estudos para se compreender a rica e complexa ictiofauna brasileira (VARI; MALABARA, 1998).

1.2.Ictiofauna de Áreas estuarinas

A associação dos estuários com os manguezais resulta em um ecossistema de enorme complexidade, podendo ser comparados a outras áreas de grande produtividade do planeta, tais como os ambientes recifais e as florestas tropicais (RICKLEFS, 2003). Tal complexidade está relacionada à variedade e quantidade de nutrientes resultantes da mistura das águas que, por sua vez, exercem a ação fertilizadora local influenciando ambientes adjacentes (LEGOVIC, 1991; KEMP, 1992).

Os estuários em condições naturais são biologicamente mais produtivos que os rios e oceanos adjacentes, devido concentrarem elevada quantidade de nutrientes que estimulam a produção primária (MIRANDA et al., 2002). Esses ambientes podem ser colonizados pelos mangues, que associado a fatores físicos, químicos, geológicos e biológicos culminam em condições propícias para reprodução, alimentação e desenvolvimento de diversas espécies(SCHAEFFER-NOVELLI, 1989). Dentre as espécies inclui-se o grupo de peixes que usam este ecossistema como berçários, rotas de migração e áreas de refúgios (CATTRUSE e HAMPEL, 2006).

Nos sistemas estuarinos distribuídos em torno da ilha de São Luís – MA, Martins-Juras et al.(1987) registrou a presença de 132 espécies de peixes como predominância de *Genyatremus luteus* (Bloch 1790), *Mugil curema* Valenciennes 1836, *Sciades herzbergii* (Bloch 1794). Estes táxons, com inclusão do *Sphoeroides psittacus* (Bloch & Schneider 1801), caracterizam-se pela ocorrência durante todo o ano.

Carvalho-Neta e Castro (2008) avaliando a diversidade da assembleia de peixes nos sistemas estuarinos da ilha dos Caranguejos, Golfão Maranhense, efetuou a amostragem de 32 espécies, sendo *Anableps anableps* (Linnaeus 1758), *Sciades herzbergii* (Bloch 1794), *Bagre bagre* (Linnaeus 1766), *Cathrorops spixxi* (Agassiz 1829), *Genyatremus luteus* (Bloch 1790) e *Sphoeroides psittacus* (Bloch & Schneider 1801) caracterizando como as mais abundantes.

Júnior et al.(2005) avaliando a estrutura da comunidade de peixes do estuário do Rio Anil, Ilha de São Luís, Maranhão foram capturados 22.640 indivíduos, pertencentes a 43 espécies, sendo que as ordens Siluriformes e Mugiliformes ocorreram com maior frequência. Júnior et al (2013) analisando a caracterização da ictiofauna em três canais de maré do Rio

Paciência, São Luís, Estado do Maranhão caracterizou 12.219 indivíduos, pertencentes a 55 espécies, identificadas em 11 ordens e 27 famílias, sendo que as famílias que tiveram maior riqueza de espécies foram Sciaenidae com 10, seguidos de Arridae com 6, Carangidae com 5 e Engraulidae e Mugilidae com 4 espécies. Castro (2001) observou a presença de 75 espécies no Rio Paciência, e estudos de prospecção no estuário do Rio Cururuca registraram 50 espécies (SUDAM, 1983).

Os estuários desempenham importante papel econômico e ecológico, mas, ainda assim, sofrem pressão antrópica de origem diversa, como destruição dos manguezais, assoreamento e descarga de efluentes urbanos (JESUS et al., 2004)

1.3.Atividades Antrópica

A expansão das atividades humanas tem provocado diversas alterações nos ecossistemas aquáticos e uma das preocupações da comunidade científica tem sido verificar como essas atividades afetam a biota desses ambientes (WANG et al, 2012; ROSENVALD; JÃRVEKULG; LÔHMUS, 2014). Uma das formas de se verificar as consequências dessas alterações é através do conhecimento sobre a estrutura e a diversidade ictiofaunística.

Dentre as principais causas da degradação de hábitats e perda de biodiversidade referem-se à poluição, eutrofização, assoreamento, construção de barragens, pesca e introdução de espécies exóticas (AGOSTINHO; THOMAZ; GOMES, 2005). Desta forma a variação na diversidade de espécies pode ser alterada em função da mudança nas características do ambiente ou devido à modificação de determinado recurso explorado por uma ou várias espécies (BRUSCHI JR; MAÇABARBA; SILVA 2000).

A realização de um inventário completo da ictiofauna na bacia do rio Tibiri, combinado com análises detalhadas de variáveis ambientais nos permitirá entender não apenas a diversidade e distribuição das espécies de peixes, mas também os processos ecológicos subjacentes que moldam suas comunidades. Espera-se que este estudo revele padrões de hábitat e uso da terra que influenciam a saúde dos ecossistemas aquáticos, bem como potenciais ameaças antropogênicas, como poluição e degradação do habitat. Ao integrar abordagens multidisciplinares, esta pesquisa fornecerá conhecimentos valiosos para a conservação e gestão sustentável dos recursos pesqueiros na Amazônia Maranhense, contribuindo para a preservação da biodiversidade e o bem-estar das comunidades locais dependentes desses ecossistemas.

1.4. Espécies não nativas

A introdução de espécies não nativas (espécies que ocorrem fora de sua distribuição natural) vem aumentando em todo o mundo LATINI et al., 2016). Embora o Brasil possua uma grande diversidade de peixes nativos, as espécies de peixes não nativos vêm se proliferado nos sistemas hidrográficos brasileiros. Essas introduções são oriundas de diferentes ações antrópicas, tais como: aquicultura, introduções, solturas intencionais, aquariofilismo, intervenções biológicas para controle de mosquitos, transposição de água entre bacias hidrográficas isoladas, pesca esportiva, entre outras atividades (FIGUEREDO; GIANI, 2005; AZEVEDO-SANTOS et al., 2011; VITULE et al., 2015; LATINI et al., 2015., PADIAL et al., 2017; BRAGANÇA et al., 2020; DORIA et al., 2021; OTTONI et al., 2021; FRANCO et al., 2022). Espécies não nativas podem causar mudanças na composição das assembleias locais e na abundância das populações de espécies nativas, causando grandes impactos ambientais (GIACOMINI et al.,2011;Latini et al., 2016, PADIAL et al., 2017; DORIA et al., 2021; OTTONI et al., 2021).

2. OBJETIVOS

2.1. Geral

- Inventariar as espécies de peixe que ocorrem na bacia do rio Tibiri, no município de São Luís, Amazônia maranhense.

2.2. Específicos

- Catalogar a biodiversidade de peixes da bacia do rio Tibiri;
- Descrever espécies de peixes no âmbito do projeto;
- Ampliar distribuições e registrar novas ocorrências para espécies de peixes de água doce ou marinho-estuarino no âmbito do projeto;
- Ampliar o acervo das Coleções Ictiológicas presentes no estado do Maranhão, e de instituições parceiras.

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CAPÍTULO II

Fishes of the Tibiri River basin: an urban insular hydrographic system located in the capital of the state of Maranhão, Northeastern Brazil.

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Fishes of the Tibiri River basin: an urban insular hydrographic system located São Luís , Northeastern Brazil

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Background

The Tibiri River basin is a hydrographic system of in the city of São Luís, the capital of the state of Maranhão located in the Upaon-Açu Island. It is an important watercourse in the region but has been increasingly impacted by urbanization, as well as other anthropic activities. The estuaries and mangroves of this river basin serve as nurseries for several fish species, providing shelter, food, and protection. Despite its ecological and biodiversity significance, the Tibiri River basin remains understudied, particularly concerning its ichthyofauna. Understanding its fish diversity is crucial, since this provides basic information that will serve as baseline for appropriate actions, and conservation policies and measures, aiming to mitigate the effects caused by anthropic actions in this river system.

New Information

In this study, 7,465 fish specimens were collected in the Tibiri River basin, representing 65 species included in 17 orders and 37 families. The order Acanthuriformes had the highest species richness, followed by Carangiformes, Clupeiformes, and Gobiiformes. Of the 65 recorded species, three are non-native to the region: *Megaleporinus macrocephalus*, *Butis koilomatodon*, and *Poecilia reticulata*, documenting one of the most worrying human actions to natural ecosystems: the introduction of exotic species. The most abundant species was *Rhinosardinia amazonica*, while species such as *Megalops atlanticus*, *Scomberomorus cavalla* and *Bagre bagre* were rarely collected, besides being categorized by ICMBio as Vunerable (VU) and Near Threatened (NT), respectively. Additionally, a potentially undescribed species, *Hemigrammus* sp., was recorded. The study emphasizes that the Tibiri River basin hosts a high fish species richness, however, it is impaired by serious anthropic activities, facing problems for its species conservation and maintenance of the natural characteristics of its landscape. Accurate species identification and an understanding of historical colonization processes are essential for preserving the local fauna. Our results suggest the need for additional studies that integrate taxonomic, molecular, and ecological approaches to improve the conservation of the Tibiri River basin, as well as to mitigate the human pressures over this ecosystem.

Keywords: Coastal river basins, estuarine region, Ichthyology, Maranhão Island, Neotropical region, *Upaon-Açu* Island.

Introduction

Freshwater ecosystems, such as river and lake systems, represent a tiny fraction of both the volume and the area of Earth (Miller, 2021; Val et al., 2022), however, they includes an astonishing biodiversity (Dudgeon et al. 2006; Dudgeon, 2019; Albert et al. 2020; Tickner et al., 2020; Miller, 2021; Val et al. 2022). One of the most diverse groups of these ecosystems are fish (Miller, 2021; Val et al. 2022). Despite the enormous importance in terms of biodiversity and ecology, anthropic activities has been posing severe negative impacts to these ecosystems and to the species inhabiting them, causing extinction of population and species at alarming rates, as well as modification and destruction of natural landscapes (Dudgeon et al. 2006; Darwall et al. 2018; Harrison et al. 2018; Dudgeon, 2019; Reid et al. 2019; Tickner et al., 2020; Ottoni et al. 2023), a global phenomenon known as "The freshwater biodiversity crisis" (Harrison et al., 2018). It is also important to highlight that freshwaters provide important ecosystem services for both nature and human population, however, paradoxically, these ecosystems have been extremely threatened and impacted by human activities (Dudgeon et al. 2006; Dudgeon, 2019; Pelicice et al., 2022; Ottoni et al., 2023). To illustrate this, in the last decades, changes in soil use associated with rapid urbanization and deforestation significantly altered a large proportion of ecosystems of tropical regions (Drigo, 2009). These impacts affect not only river flow, but also other water cycle compartments, such as groundwater, which may decrease during the dry season as a consequence of reducing infiltration volume (Costa et al. 2003). Therefore, studying hydrographic systems and conducting ichthyological surveys is extremely relevant in the current context of global conservation. These studies provide founding information that will serve as baseline for appropriate actions, and conservation policies and measures, aiming to mitigate the effects caused by anthropic actions in these ecosystems (Ferrazi et al., 2024).

Ichthyological surveys are conducted to assess the biodiversity of a stream, river, or lake (Guimarães et al. 2020, Ferrazi et al., 2024). Consequently, these studies may lead to new discoveries (e.g., new and first records, record of undescribed species, range extensions, and exotic species introductions), representing a main source of information for the assessment of species conservation status (e.g., Nascimento et al. 2016; Brito et al. 2019; Dagosta and Pinna 2019; Lima et al. 2019; Guimarães et al. 2020; Oliveira et al. 2020; Vieira et al.2023; Lopez et al.2024; Acácio et al.2024; Barbosa et al.2024).

The Tibiri River basin is a small coastal basin located in the capital of the State of Maranhão, São Luís. Maranhão is the westernmost state in the northeast region of Brazil. Spanning approximately 140 km², this watershed has historically been impacted by various anthropogenic disturbances, such as heavy metal contamination (Campos et al., 2009), leachate from accumulated waste within its boundaries (IMESC, 2011), removal of riparian vegetation (Martins, 2008), infestations of invasive plants (Pinheiro and Linhares 2019), improper disposal of domestic sewage, and the construction of black pits—holes dug in the ground used as disposal sites for local bathroom waste—near water sources (Coelho et al. 2017). In addition to these impacts, the expansion of São Luís' urban area compromises the quality of the environments within this watershed.

The city of São Luís, is included in a metropolitan island, called as *Upaon-Açu* Island. The Tibiri River watershed faces numerous threats due to unplanned urban development and is heavily impacted by human activities. Despite this, there are no studies in the literature focusing on a comprehensive survey of its ichthyofauna. To understand the fish fauna of this small basin, we provide a fish survey of the Tibiri River basin, from its source to its mouth, covering various microhabitats. Additionally, we discuss the consequences of urban growth for the conservation of the species present in this river basin, emphasizing the eed for studies to understand the colonization by freshwater species in this river system.

Material and methods

Study Area

The study was conducted on São Luís Island, also known as Ilha Grande, *Upaon-Açu* Island, and Maranhão Island. This island includes four municipalities: São Luís, São José de Ribamar, Paço do Lumiar, and Raposa, covering a area of approximately 831.7 km² (Bandeira, 2018). The São Luís Island includes the Anil, Bacanga, Tibiri, Paciência, Maracanã, Calhau, Pimenta, Coqueiro, and Cachorros river systems, as well as the Bacanga Reservoir. These river systems are small, and they flow in several directions, covering areas of dunes and beaches.

The Tibiri River basin covers an area of approximately 140 km² and is located in the City of São Luís. It is bordered to the east by the Tijupá River basin and the Geniparana River basin; to the west by the São Luís Industrial District; to the north by the Marechal Cunha Machado Airport and the Agricultural Exhibition Park; and to the south by the São José de Ribamar bay, into which it flows (Figure 1).

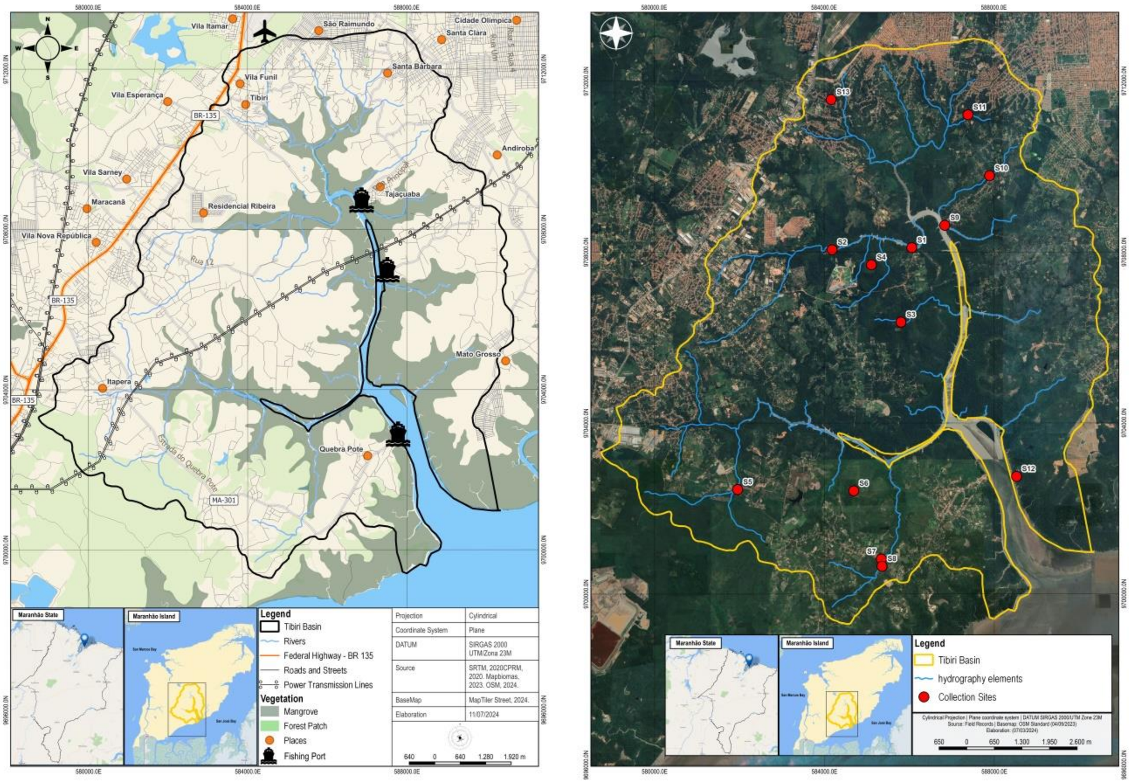

Figura 1. Mapa da área de estudo. A Bacia do Rio Tibiri é delineada, destacando os rios, a Rodovia Federal BR-135 em laranja, outras estradas e ruas da Ilha Upaon-Açu, além de linhas de transmissão, ferrovias e linhas de energia representadas por traços e pontos. Os pontos vermelhos no segundo mapa (S1-S13) indicam locais de amostragem dentro da Bacia do Rio Tibiri.

The Tibiri River basin is an integral part of the Maranhão Gulf drainage system and encompasses a complex drainage area with a network of tributary and sub-tributary channels that converge to form the main river course. This system is responsible for the transport of sediments and dissolved materials. The basin originates in the central region of *Upaon-Açu* Island, with a maximum elevation of about 70 meters, and flows southeast into São José Ribamar Bay, within the municipality of São Luís. The main waterways in this river basin include the Santa Bárbara and Tibiri igarapés, with the latter receiving the Meio and Saúde igarapés (small rivers or streams, with etymology in Portuguese from Brazil). These igarapés feed into the main channel, which is further supplemented by other tributaries such as the Sabino and Maracujá igarapés on the right bank, and the Tajaçuaba, Andiroba, and two unnamed igarapés on the left bank. The basin's boundaries are defined by small elevations along the coastal plain, which separate the Tibiri River basin from neighboring basins on this island (Silva, 2001).

Collection and identification of specimens

The fishing gear used included fish traps, drag nets, seine nets, sieves, and scoop nets of various mesh sizes. The collected fish were euthanized using a solution of water and tricaine methanesulfonate (TMS), which is used for anesthesia, sedation, or euthanasia of fish, and were subsequently preserved in 10% formalin. For specimens 15 cm or longer, formalin was injected into the abdominal cavity and the dorsal and lateral muscles.

In the Fish Ecology and Integrated Aquaculture Laboratory at the State University of Maranhão (LABIPI-UEMA), the collected fish were sorted, identified, and preserved in 70% diluted alcohol. Species identification was carried out to the lowest possible taxonomic level based on specific literature (particularly original descriptions and/or taxonomic revisions), and primarily through the analysis of the most relevant morphological features (e.g., meristic, morphometric, general morphology, color pattern) for each group. Taxonomic classification, taxa, names, species validity, authors and year of publication, habitat of occurrence, and geographic distribution were based on the compilations proposed in Eschmeyer´s Catalog of Fishes (Fricke et al. 2024a; Fricke et al. 2024b), where the authors gather the most recent classifications for each fish group. Species conservation status was accessed based on Instituto Chico Mendes de Conservação da Biodiversidade - ICMBio (2024), a Brazilian government agency responsible for monitoring, inspecting, gathering information, and preserving the country's biodiversity and ecosystems. All collected material was deposited in the Ichthyological Collection of the State University of Maranhão (CIUEMA) and Ictiological Collection of the Center for Agricultural and Environmental (CICCAA) (see Examined Material).

Sampling Design

For the fish sampling, nine collection expeditions were conducted between August 2021 and July 2024. A total of 13 collecting sites were sampled (Table 2, Fig. 1, Fig. 2, Fig. 3) ranging from marginal pools and small tributaries to the main channel of the Tibiri River. The collection efforts were spread across different sections of the rivers (headwaters, midstream, lower reaches, and estuary) to ensure a comprehensive representation of the fish species. All sampling points were georeferenced using GPS.

Table 1: Locations sampled in the Tibiri river basin, state of Maranhão, Brazil.

Site	Coordinates	Remarks

S01	-2.640631, -44.225786	Left bank tributary of the Tibiri River, São Luis, Maranhão.
S02	-2.641069, -44.242653	Left bank tributary of the Tibiri River, São Luis, Maranhão.
S03	-2.656383, -44.228075	Left bank tributary of the Tibiri River, São Luis, Maranhão.
S04	-2.644247, -44.234342	Left bank tributary of the Tibiri River, São Luis, Maranhão.
S05	-2.691833, -44.262667	Left bank tributary of the Tibiri River, São Luis, Maranhão.
S06	-2.692100, -44.238075	Left bank tributary of the Tibiri River, São Luis, Maranhão.
S07	-2.706531, -44.232239	Left bank tributary of the Tibiri River, São Luis, Maranhão.
S08	-2.708067, -44.232089	Left bank tributary of the Tibiri River, São Luis, Maranhão.
S09	-2.635839, -44.218806	Tibiri River, São Luis, Maranhão.
S10	-2.625292, -44.209306	Right bank tributary of the Tibiri River, São Luis, Maranhão.
S11	-2.612500, -44.213889	Right bank tributary of the Tibiri River, São Luis, Maranhão.
S12	-2.688889, -44.203333	Tibiri River, São Luis, Maranhão.
S13	-2.609275, -44.242864	Right bank tributary of the Tibiri River, São Luis, Maranhão.

Figure 2: Samples sites: S1-10 according to Table 2.

Figure 3: Sampls sites: S11-S13 acording to Table 2

Cartographic procedures

All mapping procedures and georeferenced data analyses for this study were conducted using the GIS (Geographic Information System) software Quantum GIS version 3.10. The delineation of the Tibiri Basin was based on the Digital Elevation Model (DEM) from the *Shuttle Radar Topography Mission* (SRTM) of 2002, with a spatial resolution of one arc-second (thirty meters), obtained from the *Earth Explorer* virtual catalog of the United States Geological Survey.

Analysis

A total of 7,465 specimens were sampled, representing 17 orders, 37 families, and 65 fish species (Table 1). The order with the highest species richness was Acanthuriformes, represented by 10 species, followed by Carangiformes, Clupeiformes, and Gobiiformes, each represented by eight species (Figure 4A and table 1). Engraulidae was the family comprising the highest species richness, represented by six species, followed by Sciaenidae with five species, and Oxudercidae with four species (Table 4b and Table 1). From these 65 fish species only 13 are considered as strictly freshwaters, and seven as strictly marine The remaining species occur in brackish waters, and/or transit between fresh, brackish and marine waters.

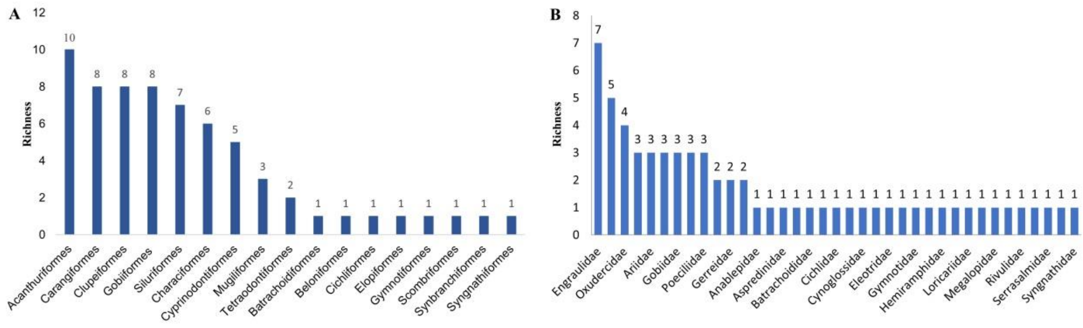

Figure 4: Ranking of richness by orders and family observed in the studied area. The numbers in the left column correspond to the number of species.

Rhinosardinia amazonica (Steindachner 1879) was the most abundant species, with approximately 1,416 specimens sampled. *Megalops atlanticus* Valenciennes 1847, *Amphiarius rugispinis* (Valenciennes, 1840), *Scomberomorus cavalla* (Cuvier 1829), *Selene vomer* (Linnaeus 1758), *Pomacanthus paru* (Bloch 1787), *Macrodon ancylodon* (Bloch & Schneider 1801), and *Serrasalmus* sp. were rarely collected, each one represented by only one collected specimen (see examined material). The highest species richness was found at Sample Site 1, with 44 species, followed by Site 2 with 34 species, Site 9 with 31 species, Site 5 with 10 species, Sites 4 and 10 with seven species each, Site 12 with four species, and Sites 3, 11, and 13 with three species each. Sites 6, 7, and 8 had only one species each (Table 2). Of the 65 recorded species, three are non-native for the studied region: *Megaleporinus macrocephalus* (Garavello & Britski, 1988), an Anostomidae native to the Paraguay River basin, *Butis koilomatodon* (Bleeker 1849), an Eleotridae native to the Indo-West Pacific region, and *Poecilia reticulata* Peters 1859, a Poeciliidae native to the coastal basins of Venezuela and Trinidad (Fricke et al., 2024b). Additionally, *Hemigrammus* sp. possibly represents a new species that requires further study for formal description.

Regarding the threat status of species, *Megalops atlanticus* is categorized as Vulnerable (VU), and *Bagre bagre* (Linnaeus 1766), *Lutjanus jocu* (Bloch & Schneider 1801) and *Scomberomorus cavalla* (Cuvier 1829) as Near Threatened (NT). The remaining species were categorized as Data Deficient (DD), Least Concern (LC) or have not yet been evaluated (ICMBio, 2024).

Discussion

Taxonomic composition

Here, we carried out the first long-term fish inventory using different collection methodologies, covering almost the entire Tibiri River basin (Figuras 1 e 2, Tabela 1). In general, coastal river environments including estuaries and mangroves guarantee great importance for juvenile fish in their processes, as in these environments they find a large supply of food, shelter and a lower risk of predation (Blaber and Blaber, 2006; Ottoni et al., 2021b; Whitfield et al., 2023). These characteristics provide ideal environments to be used as nursery areas by a large number of species, as observed at sampling sites 1, 2, 9 and 12, as also described for coastal ecosystems, such as mangroves (Nagelkerken et al. 2000; Nagelkerken et al. 2002; Paterson and Whitfield 2000; Laegdsgaard and Johnson 2001; Blaber and Blaber, 2006; Short et al. 2007; Lasiak, 2015; Ottoni et al., 2021b).

From the 65 species recorded here, 35 (almost the half) are typically found in brackish water environments (see table 2). These species, when present in freshwater environments, tend to be concentrated in estuaries or in the lower sections of rivers (observed at the points 1, 2, 9 e 12). In additon, only 13 species are considered as strictly freshwaters (table 2). This demonstrates that the Tibiri River basin, as well as its fish species composition, are greatly influenced by the marine environments, being composed by several diadromous fish species. The low representation of exclusively freshwater species can be explained by the physiological difficulties and restrictions imposed by the presence of salinity, in addition to the difficulties in adapting to changes in salinity that freshwater fish face.

Most of the cataloged species were small and medium in size, however, some of them were large-sized species, especially marine and estuarine ones, such as: *Megalops atlanticus* Valenciennes, 1847, *Lutjanus jocu(*Bloch & Schneider, 1801), *Sciades herzbergii(*Bloch, 1794), *Bagre bagre(*Linnaeus,1766), *Genyatremus luteus*(Bloch, 1790), *Macrodon ancylodon*(Bloch & Schneider, 1801), *Mugil incilis Hancock, 1830*, *Mugil brevirostris(*Ribeiro,1915), *Mugil curema Valenciennes 1836*, *Oligoplites saliens(*Bloch, 1793) and *Oligoplites palometa(*Cuvier, 1832), recorded at the collecting sites S1, S2, S9, and S12. Furthermore, the presence of marine species in the lower regions highlight the importance of this river basin as a nursery area for marine and estuarine fish species. Some works estuaries (e.g. Parsons et al., 2014; Whitfield et al., 2023) advocated that many marine fish juveniles are associated with estuaries, which evidence the relevance of this river basin for the conservation and ecology of these species.

At collecting sites S3, S4, S5, S6, S7, S8, S10, S11, and S13, which are exclusively freshwaters, a predominance of species of the Order Characiformes was observed, corroborating the pattern commonly found in the Neotropical Region (Langeani et al. 2007, Vari et al. 2009, Brito et al. 2019, Dagosta & de Pinna 2019; Guimarães et al. 2021, Vieira et al. 2023). Comparing our findings (65 species for the Tibiri River basin) with the data compilation published by the "Checklist of the freshwater fishes of Maranhão, Brazil" (CLOFFBR-MA) (Koerber et al., 2022, Koerber eta al. 2023), which reported only nine fish species occurring in freshwaters, we can conclude that the hydrographic systems of the *Upaon-Açu* Island is undersampled, and consequently its fish diversity is underestimated. Although, it is important to highlight that the works published by (Korber et al. 2022; Koerber et al.2023) focused mainly on freshwater fish species. This is not a characteristic only of this island, but also of several other hydrographic systems of the State of Maranhão, as already pointed out by (Guimarães et al. 2020; Vieira et al. 2023) Therefore, our findings contributed significantly to increase the knowledge on the composition of ichthyofuna from the river systems of the *Upaon-Açu* Island.

Challenges in identifying freshwater species in the Tibiri basin

The Tibiri River basin, with its mouth at the Arraial Bay, near the São José de Ribamar Bay (Figures 1 and 2), hosts species found in the upper reaches of the basin (S3, S4, S5, S6, S7, S8, S10, S11, and S13) that are exclusively freshwater and may have colonized this region thousands of years ago. The São José Bay receives the mouth of the Itapecuru River, close to Arraial Bay (Barros et al. 2011), a location that also receives the mouth of the Munim River (Vieira et al. 2023). Historically, this region's formation was heavily influenced by sea-level fluctuations and, consequently, by marine transgressions and regressions that shaped the current drainage systems (Lovejoy et al., 2006; Albert and Reis, 2011; Thomaz and Knowles, 2018; Abreu et al., 2020). In the state of Maranhão, these drainage systems were affected by sea-level variations during different periods: during the Miocene, the sea level was about 75 meters above the current level; in the Lower Miocene-Pliocene, the sea level was 35 meters above the current level; in the Middle and Upper Pleistocene, the sea level was 6 meters above the current level; and in the Holocene, the sea level was 2 meters above the current level (Abreu et al., 2020). These paleogeographic changes indicate that tectonic and climatic events acted as significant driving factors in shaping the fish fauna of Maranhão by altering the connectivity of river basins and impacting the rates of dispersal, speciation, and extinction of riverine species (Abreu et al., 2020). Therefore, the colonization of freshwater species in the upper part of the Tibiri River basin likely occurred through historical hydrological connections and dispersal routes, shaped by these tectonic and climatic processes over time. However, these processes are still not fully understood. So far, there are no taxonomic, molecular, or ecological explanations that clarify the extent of the geographical distribution of freshwater species in the Tibiri basin and other basins on *Upaon-Açu* Island.

Our results demonstrate that the accurate identification of freshwater species remains a challenge (Table 2). For instance, it was not possible to identify morphotypes such as *Hemigrammus* sp. and *Serrasalmus* sp. to the species level. *Hemigrammus* sp., for example, belongs to a group of species that is still poorly understood in the region, presenting multiple morphotypes, such as *Hemigrammus* sp. 1 and sp. 2 *sensu* Oliveira et al. (2020), *H.* cf. *rodwayi* has been recorded in the Munim River basin (Oliveira et al., 2020; Vieira et al. 2023) and in the Mearim River basin [*Hemigrammus* aff. *ocellifer* and *Hemigrammus* cf. *rodwayi*] (Guimarães et al., 2020). Since these basins drain near *Upaon-Açu* Island, they may influence the species composition of the island's basins. Therefore, *Hemigrammus* sp. from the Tibiri River basin could represent one of the cited morphotypes, possibly with variations related to local environmental characteristics, or it might even be a new species. Another possibility is that it is an introduced species in the basin, given the recurring history of fish species introductions on São Luís Island (Bragança et al., 2019; Bragança et al., 2020; Ottoni et al., 2021a; Trevisan et al., 2022a). Thus, additional studies, including approaches such as integrative taxonomy, biogeography, paleogeography, and microsatellite analysis, are necessary to better understand the colonization processes and accurately identify the species present in the Tibiri basin. Furthermore, it is important to expand these studies to other basins on *Upaon-Açu* Island, including estuarine and saltwater areas around the island, where the survival of freshwater species is more limited

Ecosystem and fish fauna conservation

Although the urbanization process of the Maranhão population is recent, being accelerated from 1997, anthropogenic changes such as the construction of dams, deforestation, urbanization without proper planning, dumping of ichthyotoxins in the habitat to eradicate harmful species, and changes in the rivers course have already been recorded in the Tibiri River basin (Santos et al. 2021). In addition, the introduction of non-native species in river systems is also very common on *Upaon-Açu* Island (e.g. Nogueira and Luvizotto-Santos, 2018, Bragança et al. 2019,Bragança et al. 2020, Ottoni, et al., 2021a).

In our survey, we reported three non-native fish species to this region. The first is *Butis koilomatodon*, popularly known as "mudsleeper" or "amoré", a fish of the family Eleotridae, native to the Indo-Western Pacific region, including Thailand, Indonesia, Vietnam, southern China, Papua New Guinea, and northern Australia (Fricke et al., 2024b). Bomfim et al. (2017) argued that, In Brazil, the introduction of this species is probably related to the ship traffic around oil platform. In the *Upaon-Açu* Island the introduction of this fish species is probably related to the ship traffic between ports near the mouth of the Amazon River. However, the expansion of this species along the coast of America, through larval dispersal, following the currents towards the north, cannot be disregarded (Aguiar et al., 2021). It is worth mentioning that *Butis koilomatodon* was recorded for the first time for Maranhão, in a tide pool by Guimarães et al. (2017).

The second species is *Poecilia reticulata*, popularly know as "barrigudinho" or "Guppy", which is one of the most widely introduced freshwater fish species around the world, with established populations in tropical and subtropical regions of all continents (Deacon et al., 2011). This species does not naturally occur in Brazil, neither in the Amazon River basin, and its southernmost geographic limit is likely to be in one of the Guyanan coastal river drainages, between the Essequibo River and Orinoco River delta (Bragança et al., 2020). Its introduction is probably related to releases by aquarium hobbyists, from fish farms and/or introductions to mosquito larvae control (Dias et al., 2020). On the *Upaon-Açu* Island, this species was recorded in the brackish waters of the Anil River estuary (Bragança et al., 2020) and in polluted streams near the municipality of São Luís (Nogueira and Luvizotto-Santos, 2018).

The third species *Megaleporinus macrocephalus*, popularly know as "piau-açu", occurs naturally in the Paraguay River basin, but currently it is widely introduced (Fricke et al., 2024b). This fish species is usually introduced due to accidental escapes from fish farming (LANGEANI et al., 2007; BERTACO et al., 2016; Almeida et al., 2022). In the State of

Maranhão, this species has already been recorded for the Mearim River basin (Guimarães et al., 2020; Almeida et al. 2022) and Itapecuru basin (Almeida et al. 2022).

The presence of non-native species, such as the three mentioned above, raises concern that these species become dominant in this river basin. Once a invasive species become dominat, this dominance can lead to serious consequences, such as habitat modification and the subsequent loss of native species (Didham et al. 2005). Furthermore, the introduction non-native species is considered one of the main causes of loss of local biodiversity and threats to natural ecosystems (Vitule and Pozenato 2012; Ricciardi et al.2021; Rocha et al., 2023), being a issue that deserves a special attention in the current panorama of biodiversity crisis.

The invasion of exotic species in aquatic ecosystems is one of the major threats to biodiversity, causing serious impacts on native species, such as competition for resources and habitat, which can lead to the local extinction of these species (Bella et al .2016). Coastal basins, due to their isolated nature and the presence of various endemic species, are particularly vulnerable to these invasions. The introduction of non-native species, coupled with vegetation loss and siltation, further exacerbates the loss of biodiversity in rivers and lakes (Leão et al. 2011). In the Tibiri River basin, located on an island, this situation is particularly concerning. Of the 65 species cataloged, four are classified as threatened by ICMBio. Megalops atlanticus is categorized as Vulnerable (VU), while Bagre bagre, Lutjanus jocu, and Scomberomorus cavalla are classified as Near Threatened (NT) (ICMBio, 2024). The presence of these species in an environment already impacted by environmental changes and biological invasions highlights the need to develop and implement effective conservation strategies in the Tibiri basin.

6. Conclusions and Future Perspectives

In addition to the fish species inventory presented for the Rio Tibiri, there are currently no studies focused on the biology of this fauna available in the literature. Research on other regional faunas is also limited. This nascent understanding of biodiversity makes the Rio Tibiri a critical site for taxonomic, molecular, and ecological studies. It is imperative to understand both historical processes and the current dynamics of fish species dispersion, especially those unique to freshwater, to preserve local biodiversity. This understanding will clarify how species have established themselves and how they may be affected by environmental changes. Regarding conservation, the main challenge faced in the Rio Tibiri is the effective implementation of public policies aimed at protecting this basin.

7. Supplementary Material

The following online material is available for this article: Appendix 1 - Examined material

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Apendice

Examined material

List of examined specimens with their collection site (S1-S13 according to Table 1) and voucher numbers, presented in alphabetical order.

Achirus achirus

CIUEMA1342, 8 specimens; CIUEMA1346, 5 specimens; CIUEMA1604, 1 specimens; CIUEMA1605, 5 specimens.

Achirus declivis

CIUEMA 1398, 5 specimens; CIUEMA 1620, 2 specimens; CIUEMA 1629, 4 specimens.

Amphiarus rugispinis

CIUEMA1437, 1 specimen.

Anableps anableps

CIUEMA1309, 3 specimens; CIUEMA1319, 3 specimen; CIUEMA1415, 10 specimens; CIUEMA1458, 3 specimens; CIUEMA1619, 1 specimen.

Anablepsoides urophthalmus

CIUEMA1303, 105 specimens; CIUEMA1305, 15 specimens; CIUEMA1400, 26 specimens; CIUEMA1402, specimens; CIUEMA1432, 4 specimens, CIUEMA1444, 28 specimens; CIUEMA1445, 53 specimens; CIUEMA 1452, 1 specimens; CIUEMA1473, 7 specimens; CIUEMA1513, 4 specimens; CIUEMA1514, 4 specimens; CIUEMA1515, 4 specimens, CIUEMA1516, 16 specimens; CIUEMA1530, 6 specimens; CIUEMA1534, 35 specimens; CIUEMA1561, 62 specimens; CIUEMA1564, 6 specimens.

Anchoa spinifer

CIUEMA1315, 14 specimens; CIUEMA1343, 4 specimens.

Anchovia clupeoides

CIUEMA1334, 23 specimens; CIUEMA1347, 130 specimens; CIUEMA1348, 77 specimens; CIUEMA1412, 3 specimens; CIUEMA1463, 13 specimens; CIUEMA1593, 1 specimen; CIUEMA1594, 108 specimens.

Anchoviella guianensis

CIUEMA1344, 48 specimens; CIUEMA1360, 4 specimens;

Aspedro aspredo

CIUEMA1420, 2 specimens; CIUEMA1540, 1 specimen; CIUEMA1551, 27 specimens; CIUEMA1568, 9 specimens; CIUEMA1577, 38 specimens;

Astyanax bimaculatus

CIUEMA1443, 2 specimens; CIUEMA1447, 1 specimen; CIUEMA1450, 3 specimens; CIUEMA1469, 29 specimens; CIUEMA1471, 10 specimens; CIUEMA1529, 5 specimen; CIUEMA1536, 1 specimen

Bagre bagre

CIUEMA1436, 4 specimens

Bathygobius soporator

CIUEMA1349, 3 specimens

Batrachoides surinamensis

CIUEMA1310, 5 specimens; CIUEMA1316, 2 specimen; CIUEMA1361, 1 specimen; CIUEMA1414, 3 specimens; CIUEMA1503, 1 specimen; CIUEMA1542, 1 specimen; CIUEMA1550, 1 specimen; CIUEMA1566, 1 specimen; CIUEMA 1588, 1 specimen; CIUEMA1617, 1 specimen

Butis koilomatodon

CIUEMA1313, 12specimens; CIUEMA1324, 4 specimens;CIUEMA1351, 1 specimen; CIUEMA1352, 3 specimens; CIUEMA1410, 3 specimens, CIUEMA1457, 1 specimen CIUEMA1500, 3 specimens.

Callichthys callichthys

CIUEMA1403, 3 specimens; CIUEMA1448 2 specimens; CIUEMA1532, 1 specimen; CIUEMA1559, 3 specimens.

Cetengraulis edentulus

CIUEMA1339, 9 specimen;CIUEMA1353, 15 specimens; CIUEMA1354, 4 specimens; CIUEMA1595, 1 specimen.

Cichlasoma zarskei

CIUEMA1301, 7 specimens; CIUEMA1428, 5 specimens; CIUEMA1439, 7 specimens; CIUEMA1455, 9 specimens, CIUEMA1476, 1 specimen; CIUEMA1479, 1 specimens; CIUEMA1533, 9 specimens, CIUEMA1560, 15 specimens, CIUEMA1562, 7 specimens.

Citharichthys spilopterus

CIUEMA1306, 1 specimen; CIUEMA1327, 6 specimens; CIUEMA1355, 5 specimens; CIUEMA1356, 7 specimens; CIUEMA1427, 18 specimens; CIUEMA1487, 5 specimens;

CIUEMA1508, 9 specimens; CIUEMA1607, 11 specimens; CIUEMA1608, 3 specimens; CIUEMA1618, 1 specimens; CIUEMA1627, 2 specimens.

Ctenogobius boleosoma

CIUEMA1325, 2 specimens.

Ctenosciaena gracilicirrhus

CIUEMA1341, 11 specimens; CIUEMA1345, 1 specimen, CIUEMA1350, 3 specimens; CIUEMA1408, 39 specimens; CIUEMA1495, 1 specimen; CIUEMA1545, 18 specimen, CIUEMA1555, 44 specimens; CIUEMA1575, 11 specimens; CIUEMA1586, 39 specimens; CIUEMA1633, 5 specimens.

Diapterus auratus

CIUEMA1362, 54 specimens; CIUEMA1363, 39 specimens; CIUEMA1417, 33 specimens; CIUEMA1460, 3 specimens; CIUEMA1497, 1 specimen; CIUEMA1523, 36 specimens; CIUEMA1525, 36 specimens; CIUEMA1587, 6 specimens.

Euciostomus harengulus

CIUEMA1335, 3 specimens; CIUEMA1364, 19 specimens; CIUEMA1365, 36 specimens; CIUEMA1491, 3 specimens; CIUEMA1510, 6 specimens; CIUEMA1602, 5 specimens

Genyatremus luteus

CIUEMA1321, 2 specimens; CIUEMA1366, 9 specimens; CIUEMA1367, 23 specimens, CIUEMA1418, 2 specimens; CIUEMA1489, 2 specimens; CIUEMA1509, 5 specimens.

Gobioides broussonnetti

CIUEMA1600, 3 specimens.

Gobionellus oceanicus

CIUEMA1368, 2 specimens; CIUEMA1369, 2 specimens; CIUEMA1404, 3 specimens; CIUEMA1597, 1 specimen.

Gobionellus stomatus

CIUEMA1419, 1 specimen; CIUEMA1496, 1 specimen; CIUEMA1505, 3 specimens; CIUEMA1522, 1 specimen.

Gymnotus carapo

CIUEMA 1475, 2 specimens; CIUEMA1481, 1 specimen.

Hemigrammus sp.

CIUEMA1429, 5 specimens; CIUEMA1477, 85 specimens.

Hoplias malabaricus

CIUEMA 1300, 7 specimens; CIUEMA1431, 1 specimen; CIUEMA1441, 4 specimens; CIUEMA1451, 2 specimens; CIUEMA1472, 6 specimens; CIUEMA1484, 2 specimens; CIUEMA1537, 2 specimens; CIUEMA1563, 3 specimens.

Hyporhamphus roberti

CIUEMA1323, 9 specimens; CIUEMA1370, 5 specimen; CIUEMA1371, 2 specimens; CIUEMA1423, 3 specimens; CIUEMA1459, 1 specimen; CIUEMA1488, 4 specimens; CIUEMA1589, 48 specimens.

Hypostomus sp.

CIUEMA1331, 1 specimen; CIUEMA1435, 3 specimens; CIUEMA1483, 2 specimens.

Lutjanus jocu

CIUEMA1372, 8 specimens; CIUEMA1626, 2 specimens.

Lycengraulis batessi

CIUEMA1332, 11 specimens; CIUEMA1373, 42 specimens; CIUEMA1374, 71 specimens; CIUEMA1375, 48 specimens; CIUEMA1376, 14 specimens; CIUEMA1406, 14 specimens; CIUEMA1492, 1 specimen; CIUEMA1499, 121 specimens; CIUEMA1506, 17 specimens; CIUEMA1521, 6 specimens; CIUEMA1527, 3 specimens; CIUEMA1546, 77 specimens; CIUEMA1558, 92 specimens; CIUEMA1576, 105 specimens; CIUEMA1582, 20 specimens; CIUEMA1623, 52 specimens; CIUEMA1628, 3 specimens.

Lycengraulis grossidens

CIUEMA1425, 37 specimens.

Macrodon ancyldon

CIUEMA1603, 1 specimen.

Megaleporinus macroecephalus

CIUEMA1438, 1 specimen.

Megalops atlanticus

CIUEMA1616, 1 specimen.

Microgobius meeki

CIUEMA1377, 4 specimens.

Mugil brevirostris

CIUEMA1466, 8 specimens.

Mugil Curema

CIUEMA1308, 1 specimens; CIUEMA1378, 6 specimens; CIUEMA1379, 3 specimens; CIUEMA1541, 2 specimens; CIUEMA1580, 1 specimens; CIUEMA1598, 2 specimens; CIUEMA1599, 1 specimens.

Mugil incilis

CIUEMA1307, 8 specimens

Nannostomus beckfordfi

CIUEMA1401, 51 specimens; CIUEMA1442, 155 specimens; CIUEMA1454, 23 specimens; CIUEMA1468, 4 specimens; CIUEMA1474, 135 specimens; CIUEMA1482, 25 specimens.

Oligoplites palometa

CIUEMA1314, 17 specimens; CIUEMA1326, 22 specimens; CIUEMA1380, 9 specimens; CIUEMA1422, 19 specimens; CIUEMA1511, 3 specimens.

Oligoplites saliens

CIUEMA1322, 1 specimens; CIUEMA1381, 13 specimens; CIUEMA1382, 2 specimens; CIUEMA1407, 18 specimens; CIUEMA1409, 3 specimens; CIUEMA1465, 3 specimens; CIUEMA1544, 7 specimens; CIUEMA1556, 13 specimens; CIUEMA1570, 12 specimens, CIUEMA1581, 3 specimens; CIUEMA1601, 2 specimens; CIUEMA1624, 37 specimens.

Poecilia sarrafae

CIUEMA1302, 55 specimens; CIUEMA1430, 106 specimens; CIUEMA1433, 3 specimens; CIUEMA1440, 70 specimens; CIUEMA1446, 3 specimens; CIUEMA1453, 23 specimens; CIUEMA1467, 3 specimens; CIUEMA1470, 500 specimens; 1480, 4 specimens; CIUEMA1517, 3 specimens; CIUEMA1518, 250 specimens; CIUEMA1538, 8 specimens; CIUEMA1565, 11 specimens.

Poecilia vivípara

CIUEMA1416, 2 specimens; CIUEMA1502, 1 specimen.

Poecilia reticulata

CIUEMA1531, 11 specimens.

Pomacanthus paru

CIUEMA1383, 1 specimen.

Priolepis dawsoni

CIUEMA1384, 3 specimens.

Pseudauchenipterus nodosus

CIUEMA1543, 18 specimens; CIUEMA1552, 24 specimens; CIUEMA1567, 31 specimens; CIUEMA1579, 9 specimens; CIUEMA1621, 1 specimens.

Pseudophallus brasiliensis

CIUEMA1385, 1 specimen.; CIUEMA1490, 1 specimen; CIUEMA1572, 1 specimen.

Pterengraulis atherinoides

CIUEMA1338, 46 specimens

Rhinosardinia amazonica

CIUEMA1333, 34 specimens; CIUEMA1340, 18 specimens; CIUEMA1386, 28 specimens; CIUEMA1387, 85 specimens; CIUEMA1405, 37 specimens; CIUEMA1426, 100 specimens; CIUEMA1434, 55 specimens; CIUEMA1464, 2 specimens; CIUEMA1498, 369 specimens; CIUEMA1507, 35 specimens; CIUEMA1524, 44 specimens; CIUEMA1526, 41 specimens; CIUEMA1548, 41 specimens; CIUEMA1557, 32 specimens; CIUEMA1571, 40 specimens; CIUEMA1578, 5 specimens; CIUEMA1591, 335 specimens; CIUEMA1592, 96 specimens; CIUEMA1622, 17 specimens; CIUEMA1631, 2 specimens.

Sciades herzbergii

CIUEMA1318, 2 specimens; CIUEMA1388, 4 specimens; CIUEMA1411, 2 specimens; CIUEMA1609, 1 specimens; CIUEMA1610, 4 specimens; CIUEMA1611, 1 specimen.

Scomberomorus cavalla

CIUEMA1328, 1 specimen

Selene vomer

CIUEMA1320, 1 specimen

Serrasalmus sp.

CIUEMA 1632, 1 specimen

Sphoeroides psittacus

CIUEMA1312, 8 specimens; CIUEMA1317, 10 specimens; CIUEMA1357, 21 specimens; CIUEMA1358, 252 specimens; CIUEMA1359, 1 specimens; CIUEMA1421, 31 specimens; CIUEMA1424, 6 specimens; CIUEMA1456, 7 specimens, CIUEMA1485, 11 specimens; CIUEMA1501,11 specimens; CIUEMA1520, 2 specimens, CIUEMA1528, 3 specimens; CIUEMA1539, 27 specimens; CIUEMA1549, 140 specimens, CIUEMA1569, 119 specimens; CIUEMA1583, 142 specimens; CIUEMA1612, 5 specimens; CIUEMA1613, 61 specimens; CIUEMA1614, 7 specimens; CIUEMA1615, 117 specimens; CIUEMA1625, 10 specimens.

Sphoeroides testudineus

CIUEMA 1330, 2 specimens; CIUEMA1389, 12 specimens; CIUEMA1390, 36 specimens; CIUEMA1486, 2 specimens; CIUEMA1504, 3 specimens; CIUEMA1519, 1 specimens.

Stellifer naso

CIUEMA1311 7 specimens; CIUEMA1336, 3 specimens; CIUEMA1391, 5 specimens; CIUEMA1392, 80 specimens; CIUEMA1393, 70 specimens; CIUEMA1394, 54 specimens; CIUEMA1512, 1 specimen; CIUEMA1596, 2 specimens.

Stellifer rastrifer

CIUEMA1462, 9 specimens; CIUEMA1554, 15 specimens; CIUEMA1574, 4 specimens; CIUEMA1585, 19 specimens.

Stellifer stellifer

CIUEMA1337, 2 specimens; CIUEMA1395, 3 specimens; CIUEMA1461, 14 specimens; CIUEMA1547, 9 specimens; CIUEMA1553, 19 specimens; CIUEMA1573, 4 specimens; CIUEMA1584, 49 specimens; CIUEMA1630, 9 specimens.

Symphurus tessellatus

CIUEMA1396, 7 specimens; CIUEMA1397, 1 specimens; CIUEMA1493, 1 specimens; CIUEMA1590, 3 specimens.

Synbranchus marmoratus

CIUEMA1304, 1 specimen; CIUEMA1449, 3 specimens; CIUEMA1478, 2 specimens.

Trinectes maculatus

CIUEMA1329, 4 specimens; CIUEMA1399, 2 specimens; CIUEMA1413, 7 specimens; CIUEMA1494, 1 specimens; CIUEMA1606, 9 specimens.

Table 2. List of species recorded he Tibiri River basin, State of Maranhão, Northeastern Brazil.

CLASS/ ORDER/ FAMILY/SPECIES	Abundance	ICMBio conservation satus	Status	Habitat of occurrence	Local name (in Portuguese)
REINO ANIMALIA					
FILO CHORDATA					
CLASSE ACTINOPTERYGII					
Ordem Elopiformes					
Família Megalopidae					
Megalops atlanticus Valenciennes 1847	1	VU	native	freshwater, brackish, marine	pirapema, camurupim
Ordem Clupeiformes					
Família Dorosomatidae					
Rhinosardinia amazonica (Steindachner 1879)	1416	LC	native	Freshwater, brackish	sardinha de água doce
Família Engraulidae					
Anchoa spinifer (Valenciennes 1848)	18	LC	native	Freshwater, brackish, marine	sardinha amarela
Anchovia clupeoides (Swainson 1839)	355	LC	native	Marine	Sardinha
Anchoviella guianensis (Eigenmann 1912)	52	LC	native	Freshwater, brackish	sardinha do rio
Cetengraulis edentulus (Cuvier 1829)	68	LC	native	Marine	sardinha do rabo amarelo
Lycengraulis batesii (Günther 1868)	697	LC	native	Freshwater, brackish	sardinha amarela
Lycengraulis grossidens (Spix & Agassiz, 1829)	37	LC	native	Freshwater, brackish, marine	Manjubão

CLASS/ ORDER/ FAMILY/SPECIES	Abundance	ICMBio conservation satus	Status	Habitat of occurrence	Local name (in Portuguese)
Pterengraulis atherinoides (Linnaeus 1766)	46	LC	native	Freshwater, brackish	sardinha de asa
Ordem Characiformes					
Família Anostomidae					
Megaleporinus macrocephalus (Garavello & Britski, 1988)	2	-	Non-native species	Freshwater	piau
Família Characidae					
Astyanax bimaculatus (Linnaeus, 1758)	51	LC	native	Freshwater	Lambari
Hemigrammus sp.	85		native	Freshwater	Piaba
Família Erythrinidae					
Hoplias malabaricus (Bloch 1794)	27	LC	native	Freshwater	traíra
Família Lebiasinidae					
Nannostomus beckfordi Günther 1872	393	LC	native	Freshwater	peixe lápis

CLASS/ ORDER/ FAMILY/SPECIES	Abundance	ICMBio conservation satus	Status	Habitat of occurrence	Local name (in Portuguese)
Família Serrasalmidae					
Serrasalmus sp.	1	-	native	Freshwater	piranha
Ordem Gymnotiformes					
Família Gymnotidae					
Gymnotus carapo Linnaeeus,1758	3	LC	native	Freshwater	sarapó
Ordem Siluriformes					
Família Ariidae					
Amphiarius rugispinis (Valenciennes, 1840)	1	LC	native	Freshwater, brackish, marine	Jurupiranga
Bagre bagre (Linnaeus,1766)	4	NT	native	Brackish, marine	Bandeirado
Sciades herzbergii (Bloch 1794)	14	LC	native	Brackish, marine	bagre
Família Aspredinidae					

CLASS/ ORDER/ FAMILY/SPECIES	Abundance	ICMBio conservation satus	Status	Habitat of occurrence	Local name (in Portuguese)
Aspredo aspredo (Linnaeus 1758)	77	LC	native	Freshwater, brackish, marine	banjo, rebeca
Família Callichthyidae					
Callichthys callichthys (Linnaeus 1758)	9	LC	native	Freshwater	tamuatá
Família Loricariidae					
Hypostomus watwata Hancock, 1828	6	LC	native	Freshwater	cascudo
Família Auchenipteridae					
Pseudauchenipterus nodosus (Bloch 1794)	83	LC	native	Freshwater, brackish	papista
Ordem Batrachoidiformes					
Família Batrachoididae					
Batrachoides surinamensis (Bloch & Schneider 1801)	17	LC	Native	Brackish, marine	*p*acamão
Ordem Syngnathiformes					
Família Syngnathidae					

CLASS/ ORDER/ FAMILY/SPECIES	Abundance	ICMBio conservation satus	Status	Habitat of occurrence	Local name (in Portuguese)
Pseudophallus brasiliensis Dawson 1974	3	LC	Native	Freshwater, brackish	cachimbo de rio
Ordem Scombriformes					
Família Scombridae					
Scomberomorus cavalla (Cuvier 1829)	1	NT	Native	Marine	cavala
Ordem Gobiiformes					
Família Eleotridae					
Butis koilomatodon (Bleeker 1849)	27		Non-native species	Freshwater, brackish, marine	Amoré, mudsleeper
Família Gobiidae					
Bathygobius soporator (Valenciennes 1837)	3	LC	native	Freshwater, brackish, marine	Amuré
Microgobius meeki Evermann & Marsh 1899	4	LC	native	Marine	amuré bocão
Priolepis dawsoni Greenfield 1989	3	LC	native	Marine	amuré de pijama
Família Oxudercidae					

CLASS/ ORDER/ FAMILY/SPECIES	Abundance	ICMBio conservation satus	Status	Habitat of occurrence	Local name (in Portuguese)
Ctenogobius boleosoma (Jordan & Gilbert 1882)	2	LC	native	Freshwater, brackish, marine	amuré de garça
Gobionellus oceanicus (Pallas 1770)	8	LC	native	Freshwater, brackish, marine	muré banana
Gobionellus stomatus Starks, 1913	6	LC	native	Brackish	amoré
Gobioides broussonnetii Lacepède 180	3	DD	native	Freshwater, brackish, marine.	*muçurango*
Ordem Synbranchiformes					
Família Synbranchidae					
Synbranchus marmoratus Bloch 1795	6	LC	native	Freshwater.	mussum
Ordem Carangiformes					
Família Achiridae					
Achirus achirus (Linnaeus 1758)	19	LC	native	Freshwater, brackish, marine.	solha
Achirus declivis Chabanaud 1940	11	LC	native	Freshwater, brackish, marine	Solha

CLASS/ ORDER/ FAMILY/SPECIES	Abundance	ICMBio conservation satus	Status	Habitat of occurrence	Local name (in Portuguese)
Trinectes maculatus (Bloch & Schneider 1801)	23		native	Freshwater, brackish, marine.	Solha
Família Carangidae					
Oligoplites palometa (Cuvier 1832)	70	LC	native	Freshwater, brackish, marine.	Timbira
Oligoplites saliens (Bloch 1793)	114	LC	native	Brackish, marine.	Timbiro
Selene vomer (Linnaeus 1758)	1	LC	native	Brackish, marine.	peixe galo do alto
Família Cyclopsettidae					
Citharichthys spilopterus Günther 1862	68	LC	native	Freshwater, brackish, marine.	língua de areia
Família Cynoglossidae					
Symphurus tessellatus (Quoy & Gaimard 1824)	12	LC	native	Brackish, marine	lingua de mulata
Ordem Cichliformes					
Família Cichlidae					

CLASS/ ORDER/ FAMILY/SPECIES	**Abundance**	**ICMBio conservation satus**	**Status**	**Habitat of occurrence**	**Local name (in Portuguese)**
Cichlasoma zarskei Ottoni, 2011	61	LC	native	Freshwater	cará preto
Ordem Cyprinodontiformes					
Família Anablepidae					
Anableps anableps (Linnaeus 1758)	20	LC	native	Freshwater, brackish	*tralhoto*
Família Poeciliidae					
Poecilia sarrafae Bragança & Costa, 2011	1042	LC	native	Freshwater	barrigudinho, guppy
Poecilia vivipara Bloch & Schneider 1801	3	LC	native	Freshwater, brackish	barrigudinho, guppy
Poecilia reticulata Peters 1859	11		Non-native species	Freshwater, brackish	barrigudinho, Guppy
Família Rivulidae					
Anablepsoides urophthalmus (Günther, 1866)	446	LC	native	Freshwater	*peixe das nuvens*
Ordem Beloniformes					

CLASS/ ORDER/ FAMILY/SPECIES	Abundance	ICMBio conservation satus	Status	Habitat of occurrence	Local name (in Portuguese)
Família Hemiramphidae					
Hyporhamphus roberti (Valenciennes 1847)	72	LC	native	Brackish, marine	peixe agulha
Ordem Mugiliformes					
Família Mugilidae					
Mugil brevirostris (Ribeiro,1915)	8	DD	native	Freshwater, brackish, marine	caíca, tainha
Mugil curema Valenciennes, 1836	16	DD	native	Brackish, marine	caíca, tainha branca
Mugil incilis Hancock, 1830	8	DD	native	Brackish, marine	caíca, tainha-de-olho amarelo
Ordem Acanthuriformes					
Família Gerreidae					
Diapterus auratus Ranzani 1842	208	LC	native	Freshwater, brackish, marine	carapeba
Eucinostomus harengulus (Goode & Bean 1879)	72	LC	native	Marine	bico doce
Família Haemulidae					

CLASS/ ORDER/ FAMILY/SPECIES	**Abundance**	**ICMBio conservation satus**	**Status**	**Habitat of occurrence**	**Local name (in Portuguese)**
Genyatremus luteus (Bloch, 1790)	43	LC	native	Brackish, marine	peixe pedra
Família Lutjanidae					
Lutjanus jocu (Bloch & Schneider 1801)	10	NT	native	Freshwater, brackish, marine	carapitanga, dentão
Família Pomacanthidae					
Pomacanthus paru (Bloch 1787)	1	DD	native	Marine	paru preto
Família Sciaenidae					
Ctenosciaena gracilicirrhus (Metzelaar 1919)	172	LC	native	Marine	carioquinha
Macrodon ancylodon (Bloch & Schneider 1801)	1	LC	native	Brackish, marine	pescada gó
Stellifer naso (Jordan 1889)	222	LC	native	Brackish, marine	curuca, cabeçudo-preto
Stellifer rastrifer (Jordan,1889)	47		native	Brackish, marine	Curuca

CLASS/ ORDER/ FAMILY/SPECIES	Abundance	ICMBio conservation satus	Status	Habitat of occurrence	Local name (in Portuguese)
Stellifer stellifer (Bloch, 1970)	109	LC	native	Brackish, marine	curuca, cabeçudo-vermelho
Ordem Tetraodontiformes					
Família Tetraodontidae					
Sphoeroides psittacus (Bloch & Schneider 1801)	991	LC	native	Freshwater, brackish, marine.	baiacu açu
Sphoeroides testudineus (Linnaeus 1758)	56	LC	native	Freshwater, brackish, marine.	baiacu pintado