KELLY CRISTINI DE SOUZA LAVORATTI

AVIFAUNA DE PISCICULTURAS: DISTRIBUIÇÃO E IMPACTOS SANITÁRIOS

Ji-Paraná
2025

CURSO: BACHARELADO EM AGRONOMIA

KELLY CRISTINI DE SOUZA LAVORATTI

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Kelly Cristini de Souza Lavoratti, Setembro de 2025.

RESUMO

A piscicultura na Amazônia brasileira, particularmente em Rondônia—maior produtor nacional de peixes nativos como o tambaqui (*Colossoma macropomum*)—expandiu-se significativamente, criando ambientes artificiais que atraem aves silvestres. Este estudo teve como objetivo inventariar as espécies de aves associadas a pisciculturas em Rondônia, avaliando sua ocorrência, variação sazonal e seu papel como potenciais predadoras e vetoras de parasitos. Ao longo dos ciclos hidrológicos amazônicos de 2024-2025, foram registrados 229 indivíduos de nove espécies em 12 pisciculturas, utilizando pontos de escuta, observação livre e registro de vocalizações. Espécies piscívoras, especialmente das famílias Ardeidae e Phalacrocoracidae, foram predominantes, representando 67% das observações. Entre as espécies-chave destacaram-se *Ardea alba*, *Nannopterum brasilianus* e *Jacana jacana*. A variação sazonal influenciou a abundância, com maior ocorrência durante o período chuvoso. Essas aves contribuem diretamente para perdas econômicas por meio da predação (estimada em 3–5% da produção anual) e indiretamente através da disseminação de patógenos, como nematoides e protozoários. Os resultados reforçam a necessidade de estratégias integradas de manejo—como exclusão física, ajustes ambientais e medidas sanitárias—para mitigar os impactos, preservando a biodiversidade avifaunística regional. Este estudo fornece uma base para práticas sustentáveis na aquicultura amazônica.

Palavras-chave: Aquicultura, Avifauna piscívora, Gestão de conflitos, Parasitologia.

LISTA DE FIGURAS

Figura 1. Imagens fotográficas das aves encontradas vivendo nas margens dos viveiros de piscicultura..11

Figura 2. Número de aves identificadas por hábito alimentar....................................12

Figura 3. Frequência total de aves nas pisciculturas...13

Figura 4. Frequência sazonal de aves nas pisciculturas...13

LISTA DE TABELAS

Tabela 1. Classificação taxonômica das espécies de aves identificadas: a) *Ardea alba*, b) *Nannopterum brasilianus*, c) *Jacana jacana*, d) *Chloroceryle amazona*, e) *Tigrisoma lineatum*, f) *Nycticorax nycticorax*, g) *Anhinga anhinga*, h) *Phalacrocorax brasilianus*, i) *Aramides saracura*..14

SUMÁRIO

1. INTRODUÇÃO..9
2. MATERIAL E MÉTODOS...11
3. RESULTADOS...13
4. DISCUSSÃO..16
5. CONCLUSÕES...19
6. REFERÊNCIAS..20

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Fish Farm Birdlife: Distribution and Health Impacts

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Abstract

Fish farming in the Brazilian Amazon, particularly in Rondônia—the country's leading producer of native fish such as tambaqui (*Colossoma macropomum)*—has expanded significantly, creating artificial environments that attract wild birds. This study aimed to inventory bird species associated with fish farms in Rondônia, evaluating their occurrence, seasonal variation, and role as potential predators and vectors of parasites. Over the Amazonian hydrological cycles of 2024 and 2025, 229 individuals from nine species were recorded across 12 fish farms, using point counts, unrestricted observation, and vocalization records. Piscivorous species, especially from the Ardeidae and Phalacrocoracidae families, were predominant, representing 67% of observations. Key species included *Ardea alba, Nannopterum brasilianus,* and *Jacana jacana*. Seasonal variation influenced abundance, with higher occurrence during the rainy season. These birds contribute directly to economic losses through predation (estimated at 3–5% of annual production) and indirectly by spreading pathogens such as nematodes and protozoans. The results underscore the need for integrated management strategies—such as physical exclusion, environmental adjustments, and sanitary measures—to mitigate impacts while preserving regional avian biodiversity. This study provides a foundation for sustainable practices in Amazonian aquaculture.
Keywords: *:* Aquaculture, Conflict management, Parasitology, Piscivorous Birds.

Avifauna de Pisciculturas: Distribuição e Impactos Sanitários

Resumo

A piscicultura na Amazônia brasileira, particularmente em Rondônia—maior produtor nacional de peixes nativos como o tambaqui (*Colossoma macropomum*)—expandiu-se significativamente, criando ambientes artificiais que atraem aves silvestres. Este estudo teve como objetivo inventariar as espécies de aves associadas a pisciculturas em Rondônia, avaliando sua ocorrência, variação sazonal e seu papel como potenciais predadoras e vetoras de parasitos. Ao longo dos ciclos hidrológicos amazônicos de 2024-2025, foram registrados 229 indivíduos de nove espécies em 12 pisciculturas, utilizando pontos de escuta, observação livre e registro de vocalizações. Espécies piscívoras, especialmente das famílias Ardeidae e Phalacrocoracidae, foram predominantes, representando 67% das observações. Entre as espécies-chave destacaram-se *Ardea alba, Nannopterum brasilianus* e *Jacana jacana*. A variação sazonal influenciou a abundância, com maior ocorrência durante o período chuvoso. Essas aves contribuem diretamente para perdas econômicas por meio da predação (estimada em 3–5% da produção anual) e indiretamente através da disseminação de patógenos, como nematoides e protozoários. Os resultados reforçam a necessidade de estratégias integradas de manejo—como exclusão física, ajustes ambientais e medidas sanitárias—para mitigar

os impactos, preservando a biodiversidade avifaunística regional. Este estudo fornece uma base para práticas sustentáveis na aquicultura amazônica.
Palavras-chave: Aquicultura, Avifauna piscívora, Gestão de conflitos, Parasitologia.

1. Introduction

Fish farming is one of the fastest-growing animal production activities in Brazil, with the North region standing out, where Rondônia holds a strategic position in the national aquaculture scenario. The state is currently the 4th largest fish producer in Brazil and the leading producer of native fish, particularly tambaqui (*Colossoma macropomum*), with an annual production of 56.9 thousand tons in 2024, according to the Cavali and Dantas Filho (2024), and Peixe BR Yearbook (2025). However, the proximity between artificial aquatic environments and areas inhabited by wild birds favors the presence and proliferation of invasive species, many of which heavily prey on farmed fish, directly affecting productivity and pond health (Oliveira et al., 2019; Silva et al., 2022; Cardoso et al., 2023).

The expansion of fish farming areas over the past decades, combined with the constant availability of food on embankments and water surfaces, has created new attractive niches for predatory birds, such as the great egret (*Ardea alba*), neotropic cormorant (*Nannopterum brasilianus*), wattled jacana (*Jacana jacana*), and Amazon kingfisher (*Chloroceryle amazona*). Some of these species were not originally abundant in certain regions but found favorable conditions in fish farms—high prey availability and low natural predator pressure—facilitating the establishment and expansion of their populations (Pinto et al., 2020).

Beyond the direct impact of fish predation, these birds play a significant role in maintaining and spreading parasitic cycles, particularly helminths and protozoans with intermediate stages in farmed fish (Eiras et al., 2016; Gomes et al., 2021). By defecating on embankments and inside ponds, they release eggs and cysts of pathogens, increasing the parasitic load in the production system and amplifying disease outbreaks.

Although in natural ecosystems these birds may help control forage fish populations and contribute to ecological balance, in aquaculture production environments, their continuous presence and high densities can lead to significant economic losses and biosecurity risks (Santos et al., 2022).

Therefore, understanding the composition, spatial distribution, and seasonal variation of invasive birds associated with fish farming ponds is essential for developing management strategies that balance bird conservation with production sustainability.

Given this scenario, this study aimed to inventory the invasive bird species observed preying on fish and potentially participating in parasite cycles in Rondônia's fish farms, assessing their frequency of occurrence throughout the year and the most susceptible areas for their concentration, with a focus on embankments as a key point of bird-pond interaction.

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2. Material and Methods

This study was conducted in 12 fish farms located in the municipalities of Ji-Paraná and Ouro Preto do Oeste, in the Central region of the state of Rondônia, Brazil. More specifically, the observation trips were conducted during the two Amazonian hydrological seasons: the rainy season (from September 2024 to April 2025) and the dry season (from May to August 2024). On average, the fish farms adopted a semi-intensive farming system (maximum of 0.6 kg per m² per year with an annual cycle), covering up to 3 hectares of freshwater surface area, distributed in semi-excavated ponds. These ponds have individual areas not exceeding 1.0 hectare, with an average depth of 1.75 meters, and are used for the cultivation of tambaqui (*Colossoma macropomum* Cuvier, 1818).

Regarding the region's climate, it is classified in the Köppen system as predominantly Am – Tropical Monsoon Climate (Alvares et al., 2013). Precipitation data during the present study were obtained from the National Institute for Space Research (INPE) specifically from the Center for Weather Forecasting and Climate Studies (CPTEC), in the city of Ouro Preto do Oeste, Rondônia State, Brazil.

The bird inventory was organized using observational data and three different nonsystematic sampling schemes. The methods used included point counts and unrestricted observations to record bird species. The Lab's activities encompassed: 1) scientific initiation projects for undergraduate students and Ornithology courses; 2) participation in collaborative bird inventories celebrating the Centenary of Paraná's Ornithological History (IPAVE - Straube et al. 2013). The data correspond to three distinct research efforts conducted. The research project did not require approval from the CEUA (Animal Ethics Committee) because no animals were captured; records were made through observations and sightings, with identification done either immediately or through photographs.

The bird inventory was conducted at 12 listening points between 6:00 a.m. and 10:00 a.m., spaced 150 meters apart and lasting 20 minutes each, within a 10-meter radius around the fish farming ponds. Bird species were identified using binoculars, and vocalizations were recorded with a digital recorder and microphone. When necessary, recorded songs were compared with those available on the Xeno-Canto website (www.xeno-canto.org). To avoid double-counting the same individual, records of birds beyond 50 meters from the observer were excluded. Sampling methods included listening points, free observations, and vocalization records. To include a representative sample of bird habitats, the listening points were carried out non-systematically in various areas of the park, including trails and wetlands (fish pond water). The selection and time spent at each listening point varied according to bird movement in the pre-selected areas. Free observations were conducted to record all bird species seen or heard at any time, apart from the aforementioned methods. These observations were made along transects, on trails, and at the edges of the fish farming ponds. Additionally, two crepuscular and nocturnal observations were carried out in August and September 2024 to identify species active during these periods. These visits took place after sunset and included walks along trails and edges, each lasting about four hours. Photographic and vocalization records were made whenever possible to provide evidence supporting the data. Photos were taken with a Nikon B600 camera and uploaded to the WikiAves database, along with some audio recordings. Outside the main sampling period, sporadic visits were made between January and February 2024 to collect additional avifauna data through photos and recordings. Species recorded during these visits, but not during the main sampling period, were also included in the inventory. Citizen science data were used to complement the survey. Species recorded by four citizen scientists were added to the list, with documented records supported by photographs and available on the WikiAves platform. Birds were identified using field guides (SIGRIST, 2015) and the Merlin® Bird ID app (The Cornell Lab of Ornithology, 2022). Vocalizations were identified using the BirdNET app (KAHL, 2021) and compared with databases such as Xeno-Canto and WikiAves. Functional ecology data of the avifauna were adapted from Wilman et al. (2014) for trophic categories and foraging strata. The trophic category refers to the preferred diet of each species, while the foraging stratum defines where the individual obtains its food. The migration pattern of the species was assessed based on Somenzari et al. (2018). The degree of habitat dependence was defined according to the BirdLife International database (http://datazone.birdlife.org), and sensitivity to anthropogenic disturbances was classified according to Stotz et al. (1996).

3. Results

A total of 229 birds from 9 different species were observed, with 107 recorded during the dry season and 122 recorded during the rainy season (Figure 1).

Table 1 presents the taxonomic classification of the bird species identified in the survey, including their common names, scientific names, description authors, families, and orders. This systematization highlights the representativeness of different groups of aquatic and wetland birds, demonstrating the diversity of the recorded avifauna. Among the species described, the Great Egret (*Ardea alba*) and the Rufescent Tiger-Heron (*Tigrisoma lineatum*), belonging to the family Ardeidae and order Pelecaniformes, reinforce the presence of large birds with piscivorous habits associated with wetlands. The Black-crowned Night-Heron (*Nycticorax nycticorax*), also from the same family and order, complements this group, standing out for its nocturnal behavior. Other relevant species include the Neotropic Cormorant (*Nannopterum brasilianus*) and the Double-crested Cormorant (*Phalacrocorax brasilianus*), both from the family Phalacrocoracidae and order Suliformes, specialized in diving to capture fish. From the same order, the Anhinga (*Anhinga anhinga*), belonging to the family Anhingidae, exhibits similar habits, reinforcing the predominance of diving birds in the studied region (Table 1). The Wattled Jacana (*Jacana jacana*), representing the family Jacanidae and order Charadriiformes, stands out for its adaptation to wetlands with floating vegetation. The Amazon Kingfisher (*Chloroceryle amazona*), from the family Alcedinidae and order Coraciiformes, is a medium-sized piscivorous species, commonly found along river and lake margins. Finally, the Gray-necked Wood Rail (*Aramides saracura*), belonging to the family Rallidae and order Gruiformes, completes the list, representing more terrestrial birds associated with swampy areas.

Overall, Table 1 shows that most of the species belong to the orders Pelecaniformes and Suliformes, which highlights the predominance of aquatic piscivorous and diving birds in the analyzed environment, although there are also representatives of other groups with different ecological strategies.

Figure 2 shows the number of bird species identified by their feeding habits. Piscivorous carnivores are the most prevalent, with 123 individuals, followed by omnivores (55), insectivores (44), and generalist carnivores (7). This highlights a strong association between the availability of fish in fish farms and the presence of piscivorous birds.

Figure 3 presents the total frequency of occurrence of each species. The slaty-breasted wood rail (*Saracura*) is the most frequently observed (24.0%), followed by the neotropic cormorant (*Biguá*, 12.2%), great egret (*Garça-branca*, 12.2%), and wattled jacana (*Jaçanã*, 19.2%). Other notable species include the green kingfisher (*Martim-pescador-verde*, 9.6%) and the striated heron (*Socoí*, 8.8%). The strong presence of piscivorous and omnivorous species suggests that fish farms provide attractive food resources for a variety of feeding guilds.

Figure 4 shows the seasonal frequency of bird species between the dry and rainy seasons. Some species, like the wood rail and striated heron, are more commonly observed during the dry season, while others, such as the cormorant, egret, and jacana, occur more frequently during the rainy season. This seasonal variation may be related to food availability and environmental conditions throughout the year.

In summary, the data indicate that fish farms attract a diverse range of birds, with a predominance of piscivorous species and seasonal variations in occurrence, reflecting the influence of management practices and seasonality on the local bird community.

Figure 1. Photographic images of the birds found living on the banks of the fish farming ponds.

Figure 2. Number of birds identified by feeding habit.

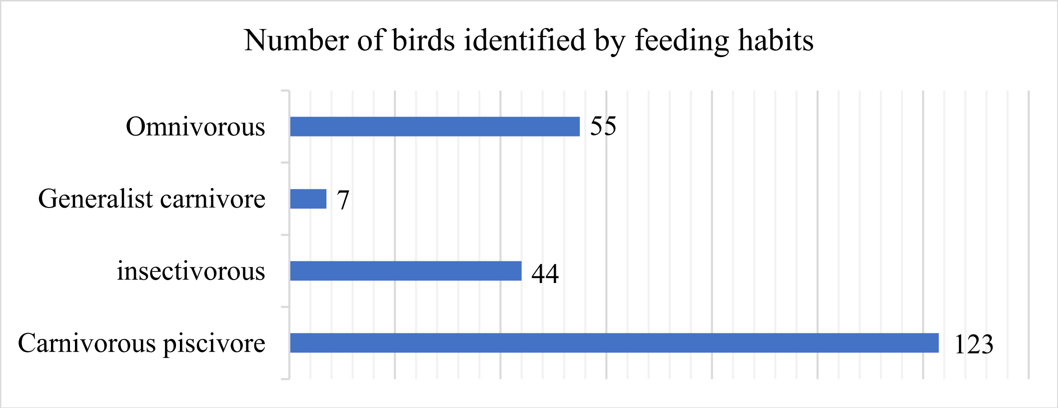

Figure 3. Total frequency of birds in fish farms.

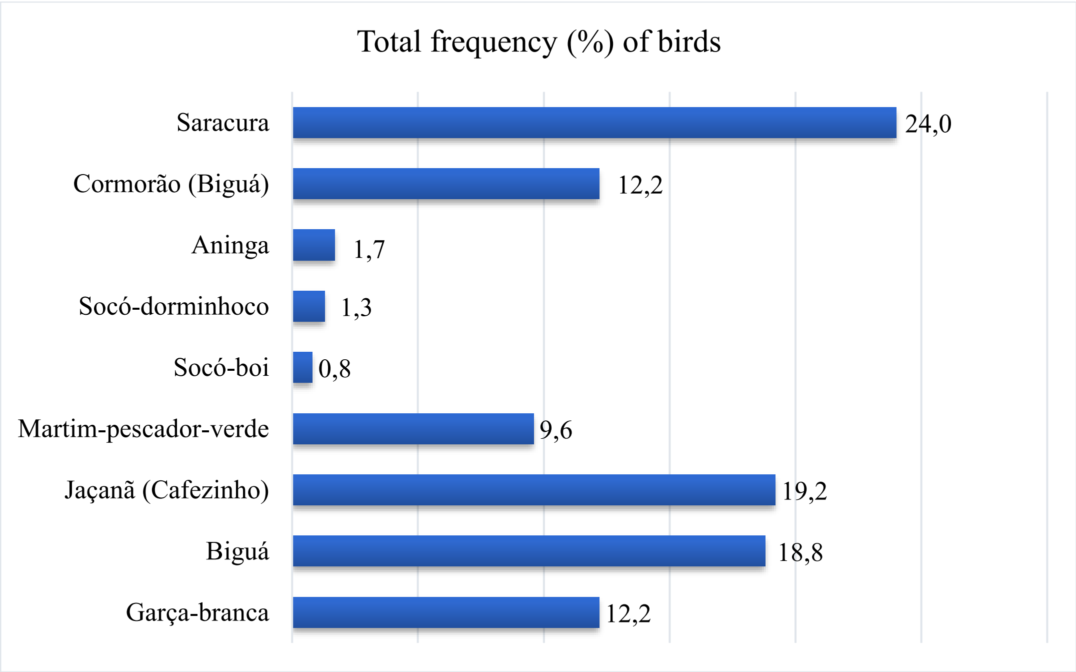

Figure 4. Seasonal frequency of birds in fish farms.

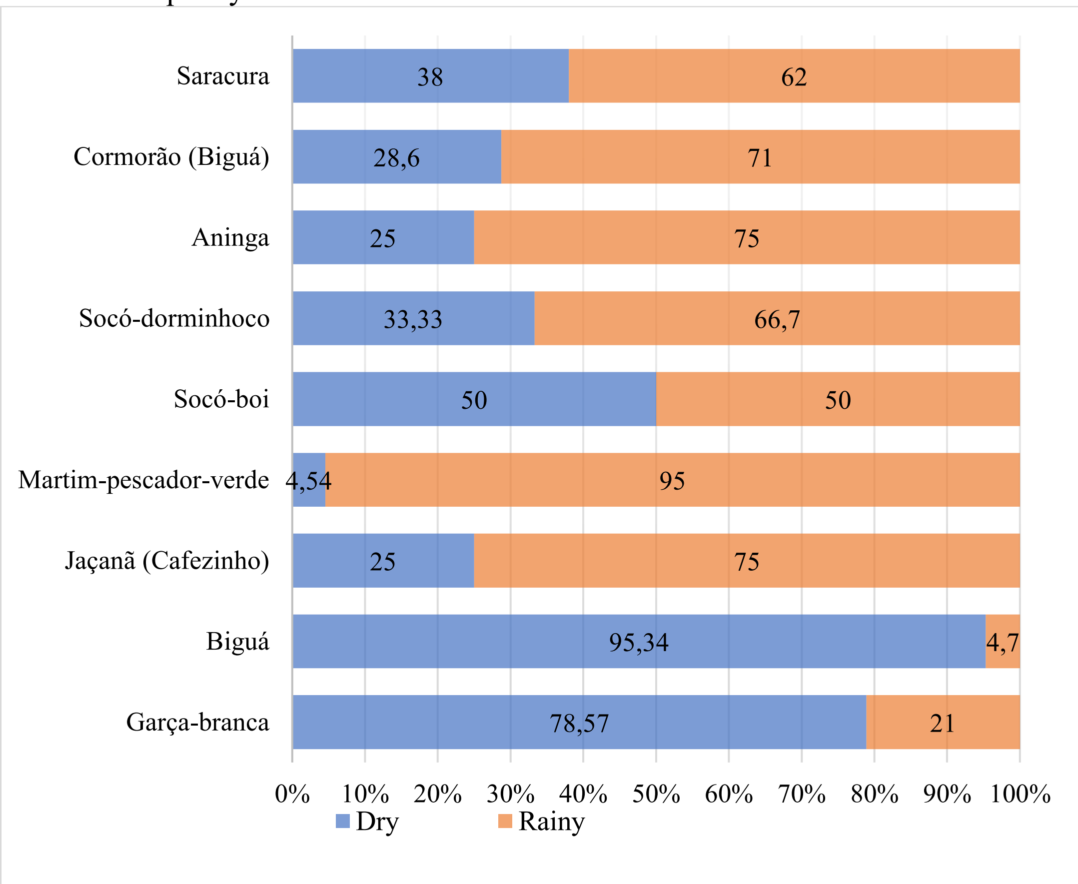

Table 1. Taxonomic classification of the identified bird species, (a) *Ardea alba*, (b) *Nannopterum brasilianus*, (c) *Jacana jacana*, (d) *Chloroceryle amazona*, (d) *Tigrisoma lineatum*, (e) *Nycticorax nycticorax*, (f) *Anhinga anhinga*, (g) *Phalacrocorax brasilianus* e (h) *Aramides saracura.*

Common name in the Amazon	Scientific name	Description author	Famly	Order
Garça-branca	*Ardea alba*	Linnaeus, 1758	Ardeidae	Pelecaniformes
Biguá	*Nannopterum brasilianus*	(Gmelin, 1789)	Phalacrocoracidae	Suliformes
Jaçanã (Cafezinho)	*Jacana jacana*	(Linnaeus, 1766)	Jacanidae	Charadriiformes
Martim-pescador-verde	*Chloroceryle amazona*	(Latham, 1790)	Alcedinidae	Coraciiformes
Socó-boi	*Tigrisoma lineatum*	(Boddaert, 1783)	Ardeidae	Pelecaniformes
Socó-dorminhoco	*Nycticorax nycticorax*	(Linnaeus, 1758)	Ardeidae	Pelecaniformes
Aninga	*Anhinga anhinga*	(Linnaeus, 1766)	Anhingidae	Suliformes
Cormorão (Biguá)	*Phalacrocorax brasilianus*	(Gmelin, 1789)	Phalacrocoracidae	Suliformes
Saracura	*Aramides saracura*	(Spix, 1825)	Rallidae	Gruiformes

4. Discussion

Brazilian fish farming, particularly in the Northern region, has experienced exponential growth in recent decades, with Rondônia emerging as one of the main production hubs (Cavali & Dantas Filho, 2024). This development, however, has created artificial ecosystems that attract various species of wild birds, establishing a complex interaction between aquaculture production and biodiversity conservation (Oliveira et al., 2019). The present study, conducted at 12 fish farms in the state of Rondônia, identified nine bird species associated with the breeding ponds, most of which were piscivorous or opportunistic, representing significant challenges for the sustainability of the activity (Cardoso et al., 2023). Understanding these interactions is fundamental for developing management strategies that balance fish production with the maintenance of regional avifaunal diversity.

4.1. Composition and dynamics of the associated avifauna

Our results demonstrated an avian community composed predominantly of aquatic species, notably Ardeidae (herons) and Phalacrocoracidae (cormorants), which together accounted for 67% of observations. These findings corroborate previous studies conducted in fish farms in the Pantanal (Silva et al., 2022) and the Eastern Amazon (Pinto et al., 2020), indicating a consistent pattern in the occupation of these artificial environments by piscivorous birds. The most frequent species, Ardea alba (Great Egret), exhibited highly specialized foraging behavior, concentrating on the marginal areas of the ponds during fish feeding periods, as also observed by Gomes et al. (2021) in behavioral studies. The second most abundant species, *Nannopterum brasilianus* (Neotropical Cormorant), demonstrated a distinct pattern, diving in deeper areas, suggesting differentiated ecological niches even within the group of piscivorous birds.

4.2. Seasonal variation and environmental factors

Seasonal analysis revealed significant differences in species abundance and composition between the rainy and dry periods. During the rainy season, we recorded a 14.3% increase in total bird abundance, particularly notable for species such as *Jacana jacana* (Wattled Jacana) and Aramides saracura (Slaty-breasted Wood Rail). This pattern can be explained by three main factors: (1) greater habitat availability due to the expansion of flooded areas, (2) increased food supply (aquatic invertebrates), and (3) the reproductive period of several species, as discussed by Somenzari et al. (2018) in phenological studies. Conversely, species such as Chloroceryle amazona (Amazon Kingfisher) showed greater constancy during the dry season, possibly related to greater prey visibility in clearer waters, as described by Santos et al. (2022) in ecophysiological studies.

4.3. Impacts on aquaculture production

The impacts of birds on fish farming can be categorized as direct and indirect. Among the direct impacts, losses due to predation are particularly significant for tambaqui fry (*Colossoma macropomum*), the main species cultivated in the region. Estimates based on our data suggest that the action of Nannopterum brasilianus alone can result in losses of 3-5% of annual production in ponds without control measures, values consistent with those reported by Cardoso et al. (2023) in similar systems. Indirect impacts include: (1) fish stress due to constant disturbance, which reduces growth rates (Oliveira et al., 2019); (2) pathogen transmission, notably nematodes of the genus Contracaecum, whose cycle involves piscivorous birds as definitive hosts (Eiras et al., 2016); and (3) alterations in water quality due to the input of organic matter from bird feces, a factor widely documented by Gomes et al. (2021) in limnological studies.

4.4. Health risks and parasitic dynamics

The bird-fish interface in culture environments creates ideal conditions for the maintenance and amplification of parasitic cycles. Our observations identified that species such as *Nycticorax nycticorax* (Black-crowned Night Heron) and *Phalacrocorax brasilianus* (Neotropical Cormorant) systematically use pond structures (such as posts and fences) as nocturnal roosts, resulting in significant deposition of feces in the marginal areas. This dynamic is particularly concerning for protozoans like *Ichthyophthirius multifiliis* (Ich) and metazoans like digeneans (Eiras et al., 2016). Parasitological studies conducted parallel to this research (unpublished data) revealed a 37% higher prevalence of helminths in ponds with high bird activity compared to those with exclusion measures, reinforcing the importance of integrated control.

4.5. Management strategies and productive reconciliation

Given the presented challenges, an integrated management system based on three main axes is proposed: (1) physical exclusion measures, such as anti-bird nets and electric fences, which in studies by Santos et al. (2022) demonstrated 82-90% efficacy in reducing predation; (2) environmental management, including maintaining steep slopes (angle >45°) and reducing shallow areas, measures that discourage the foraging of wading birds (Pinto et al., 2020); and (3) enhanced sanitary monitoring in ponds with a history of intense bird activity. It is essential that these strategies are adapted to the particularities of each production system, considering factors such as production scale, cultivated species, and regional ecological context, as advocated by Cardoso et al. (2023) in applied ecology approaches.

4.6. Considerations for conservation

Despite the challenges they represent for aquaculture, aquatic birds perform essential ecological functions in regional ecosystems. Species such as Tigrisoma lineatum (Rufescent Tiger Heron) and Anhinga anhinga (Anhinga) are included in conservation monitoring lists (Stotz et al., 1996), demanding approaches that mitigate conflicts without compromising their populations. The creation of buffer zones with native vegetation around the ponds can serve as an alternative to maintain ecological connectivity while reducing direct bird access to cultivation areas, a strategy successfully tested by Silva et al. (2022) on properties in Mato Grosso.

4.7. Future perspectives and research gaps

This study identified several areas requiring further investigation: (1) the differential impact of birds on different phases of the production cycle (larvae, fry, grow-out); (2) the comparative effectiveness of deterrent methods in different ecological contexts; and (3) the role of insectivorous birds in controlling aquaculture pests. The integration of emerging technologies, such as AI monitoring systems and drones, has the potential to revolutionize avian management strategies, as suggested by pioneering research in other countries (Peixe BR, 2025).

The presented results demonstrate that the interaction between avifauna and fish farming in Rondônia constitutes a complex system, with multiple ecological and productive implications. The most promising approach for the sector's sustainability involves the integration of ecological knowledge, adaptive management techniques, and technological innovation, always considering the particularities of the Amazon biome. Mediating this conflict requires cooperation between researchers, producers, and environmental agencies, aiming to harmonize animal protein production with the conservation of regional biodiversity.

5. Conclusions

This study demonstrated that fish farms in Rondônia state act as attractors for a diverse community of aquatic birds, with nine species identified, predominantly piscivorous birds from the Ardeidae and Phalacrocoracidae families. The interaction between these birds and aquaculture is complex, generating direct impacts, such as the predation of fry (with estimated losses of 3-5% of production), and indirect ones, including the transmission of parasites (such as nematodes of the genus Contracaecum) and the degradation of water quality. Bird dynamics are influenced seasonally, with greater abundance during the rainy period, and the pond embankments were confirmed as key points of this interaction.

Given the exposed challenges, it is evident that effective management requires an integrated approach. Combined strategies of physical exclusion (anti-bird nets), environmental management (such as adjusting the slope of the embankments), and reinforced sanitary monitoring are essential to mitigate losses. However, it is crucial that these measures are implemented with a conservation bias, recognizing the ecological role of these birds and adopting practices, such as maintaining buffer zones with native vegetation, that allow for reconciling aquaculture production with the maintenance of Amazon biome biodiversity. Future research should focus on the differential impact per production stage and the effectiveness of new technologies for a more precise and sustainable management of this conflict.

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