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OCCURRENCE OF WATERFOWL AND SHOREBIRDS IN RICE CULTIVATIONS IN THE NORTHWESTERN REGION OF PARANÁ STATE, BRAZIL[1]

OCORRÊNCIA DE AVES AQUÁTICAS E LIMÍCOLAS EM CULTIVOS DE ARROZ NO NOROESTE DO ESTADO DO PARANÁ, BRASIL[1]

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ABSTRACT - A significant portion of the world's natural wetlands has been lost or altered, primarily due to agricultural expansion. Among these activities, rice cultivation stands out, particularly in the southern Brazilian states. Rice, a grass adapted to aquatic environments, is typically grown in flood-prone areas, creating conditions similar to natural wetlands and providing habitat and food resources for many waterbird species. In the state of Paraná, natural environments suitable for sustaining large concentrations of waterbirds are scarce. The first records of large waterbird flocks in the region were made along the left bank of the Paraná River, in artificial lagoons formed for rice cultivation. Given the ecological and economic relevance of this issue, a systematic study was conducted to assess the species richness and abundance of birds benefiting from these conditions. The research was carried out in floodplain rice fields along the right bank of the Ivaí River, a tributary of the Paraná River, within the municipalities of Planaltina do Paraná, Querência do Norte and Santa Mônica. The study began in 2013 and extended through 2019. Additional censuses were conducted in 2021 and 2024, totaling 20 field phases. Across the three study sites, 14 families and 49 species of water-associated birds were recorded. The findings provide valuable insights for developing agricultural land management strategies that maintain the functionality of these areas as supplementary habitats while balancing agricultural productivity with waterbird conservation.

Keywords: Wetlands; Rice; Cultivations; Conservation.

RESUMO - Grande parte das áreas úmidas naturais do planeta têm sido perdidas ou modificadas, principalmente pelo avanço das atividades agrícolas. Entre estas, destaca-se a rizicultura, com ampla expansão principalmente nos estados do Sul do Brasil. O arroz é uma gramínea adaptada ao ambiente aquático e seu cultivo, geralmente em áreas inundáveis, oferece condições semelhantes a zonas úmidas naturais, proporcionando habitat e recursos alimentares para muitas espécies de aves aquáticas. No estado do Paraná são escassos ambientes naturais adequados à manutenção de concentrações de aves aquáticas e os primeiros registros de bandos ocorreram na margem esquerda do rio Paraná, em lagoas artificiais formadas para cultivo de arroz. Devido à relevância do assunto que envolve a economia agrícola e a conservação da natureza, foi realizada uma pesquisa sistemática com o objetivo de conhecer a riqueza e a abundância das espécies de aves favorecidas por essas condições. Esse estudo foi efetuado nos cultivos de arroz em regiões de várzea ao longo da margem direita do rio Ivaí, afluente do rio Paraná, nos municípios de Planaltina do Paraná, de Querência do Norte e de Santa Monica. O trabalho ocorreu de 2013 a 2019, com duas fases adicionais em 2021 e 2024, totalizando 20 fases de campo. Considerando as três áreas pesquisadas, foram registradas 14 famílias e 49 espécies de aves de hábitos aquáticos. Os resultados são importantes para sugerir pautas de manejo de áreas agrícolas, tornando possível a manutenção de sua funcionalidade como hábitat suplementar, compatibilizando produtividade com a conservação dessas aves.

Palavras-chave: Aves; Áreas úmidas; Arroz; Cultivo; Conservação.

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1 INTRODUCTION

In the state of Paraná, southern Brazil, approximately 50 species of waterfowl can be found, including marine species, belonging to the families Diomedeidae, Procellariidae, Hydrobatidae, Sulidae, Stercorariidae, Laridae, Sternidae, Phalacrocoracidae, Anhingidae, Sphenicidae, Fregatidae, and Podicipedidae. Shorebirds are associated with beaches and wetlands and include an additional 96 species from the families Anhimidae, Anatidae, Phoenicopteridae, Aramidae, Rallidae, Heliornithidae, Charadriidae, Haematopodidae, Recurvirostriidae, Scolopacidae, Jacanidae, Rostratulidae, Ciconiidae, Anhingidae, Ardeidae, and Threskiornithidae (Sick 1997, Scherer-Neto et al. 2011, Pacheco et al. 2021).

The state of Paraná lacks natural habitats suitable for maintaining large concentrations of waterfowl, except for floodplains along the Paraná, Ivaí, and Piquiri rivers, as well as the upper stretch of the Iguaçu River and wetland areas in the first and second plateaus (Scherer-Neto et al. 2009). Along the state's coastal zone, the large inlets that form the Paranaguá and Guaratuba bays and the beaches, harbor some populations of these species. In the marine zone, the Currais Islands Marine National Park serves as crucial breeding site for seagulls (*Larus dominicanus*), boobies (*Sula leucogaster*), and frigatebirds (*Fregata magnificens*). Migratory species have been the focus of significant research and the application of capture and marking techniques for individuals of various species has provided valuable insights into ecological aspects, migration routes, population dynamics, and other data provided by Centro Nacional de Pesquisa e Conservação de Aves Silvestres – CEMAVE.

A significant portion of the world's natural wetlands has been lost or modified, mainly due to agricultural expansion (Dugan and Diegues 1993), with rice farming being a major factor, as these areas have often been converted into grain fields (Gibbs 2000), especially in the states of Rio Grande do Sul and Santa Catarina. Rice crops (*Oryza sativa* L.), an annual grass adapted to aquatic environments (Embrapa 2007), are cultivated in flood-prone areas, where it creates conditions resembling those of natural wetland habitats (Abreu et al. 2011). Consequently, the most common bird species in rice cultivation areas are those associated with such environments, including waterfowl that rely on these areas for foraging, breeding, resting, or residence. Furthermore, although these areas have been altered, they continue to play a crucial role in conservation by supporting migratory and threatened species (Guadagnin et al. 2005).

The interaction between waterfowl and rice farming systems can lead to contrasting outcomes. On one hand, it may improve system performance, as birds trampling while foraging help decompose rice straw and increase nitrogen in the soil. In addition, they may reduce weed seed populations through foraging, which benefits farmers. On the other hand, some waterfowl species that thrive in rice agroecosystems can become overly abundant and harmful, potentially reducing crop yields (Justo 2019).

Rice crops are predominantly carried out in southern and southeastern Brazil, especially in Rio Grande do Sul, Santa Catarina, and São Paulo. These regions face significant challenges associations with granivorous, aquatic, and shorebird species that exploit different stages of rice production cycle, from planting to grain harvest. To keep these birds away, farmers use various methods, such as raptors, fireworks, scarecrows, domestic dogs, and even pesticides with mixed results. This issue has led research aimed at reducing the negative effects on farming while protecting local biodiversity, contributing to more sustainable ways of managing the environment. (Embrapa 1997, Embrapa 2007, Justo 2019).

Historically, no records of large flocks of waterfowl and shorebirds were documented in Paraná. This scenario began to change in the northwestern region of the state, particularly along the upper stretch of the Ivaí River, where floodplain areas on the right bank were converted into rice fields. This agricultural practice involves land clearing, field preparation, and irrigation, which together create favorable conditions for these bird species. Furthermore, the various stages of rice cultivation, from seedling establishment to crop maturation, play a key role in attracting these birds to the region.

The first recorded observation of waterfowl flocks occurred incidentally in May 2008 during research on Macaws (*Ara chloropterus*, *Ara*

ararauna) conducted within the Biodiversity Corridor Caiuá - Ilha Grande. The observation took place while traveling along roads connecting multiple municipalities on the left bank of the Paraná River. These flocks were noted in artificial ponds created for rice cultivation, where they took advantage of land preparation activities and followed active agricultural machinery. It is estimated that over 6,000 individuals of *Dendrocygna autumnalis* (Black-bellied Whistling-Duck) and *Dendrocygna viduata* (White-faced Whistling-Duck) were present in the shallow waters of these artificial reservoirs, alongside other species such as *Sarkidiornis sylvicola* (Comb Duck), *Jabiru mycteria* (Jabiru), and *Mycteria americana* (Wood Stork) (Scherer-Neto et al. 2009).

Given the relevance of this issue, which intersects agricultural economics and nature conservation, a long-term systematic research project was launched. The initiative aims to evaluate the species richness and abundance of bird species that are relatively advantaged by rice agroecosystems.

2 MATERIAL AND METHODS

2.1 Study area

The study was carried out in rice fields located within floodplain regions along the right bank of the Ivaí River, a tributary of the Paraná River. The research encompassed areas in the municipalities of Planaltina do Paraná (Gauchinha locality, 19 samples), Querência do Norte (Canassa e Porto Jundiá localities, 17 samples), and Santa Monica (Aparecidinha locality, 18 samples).

The landscape matrix was similar between Gauchinha (Planaltina do Paraná) and Aparecidinha (Santa Monica), characterized by extensive floodplain areas along the Ivaí River, currently allocated to rice cultivation. In contrast, the landscape in Querência do Norte exhibited a variety of phytophysiognomic characteristics derived from several rural properties converted for rice farming. These properties varied in size from 7.22 ha to 1569.57 ha, encompassing a total of 1963 hectares under cultivation. This heterogeneity provided a mix of planting sizes and cultivation stages, integrating rice fields with human settlement areas and necessitating extensive survey routes (Figures 1a, b, c, d).

2.2 Primary data

To assess the species richness of waterfowl and shorebirds inhabiting rice fields and lacustrine formations in the northwestern region of Paraná, a species identification and census method was adapted from Bibby et al. (1993). Surveys were conducted along roads adjacent to rice fields using a vehicle traveling at low speed. When birds were spotted, either in groups or alone, four trained observers identified and counted them using binoculars (8 x 42 Nikon), cameras, and guidebooks. The surveys utilized roads separating the rice fields, with support from a vehicle provided by the Instituto Água e Terra - IAT – Paranavaí Regional Office, stopping to observe target species. Data on species and numbers were written in notebooks and later added to a spreadsheet for analysis.

Field censuses started in 2013 and continued until 2019, when the research was interrupted due to the COVID-19 pandemic. Additional censuses were conducted in 2021 and 2024, resulting in a total of 20 field phases each one lasting three days. The time spent at each site varied based on climatic conditions, the stage of rice cultivation, and the presence or absence of the target bird groups.

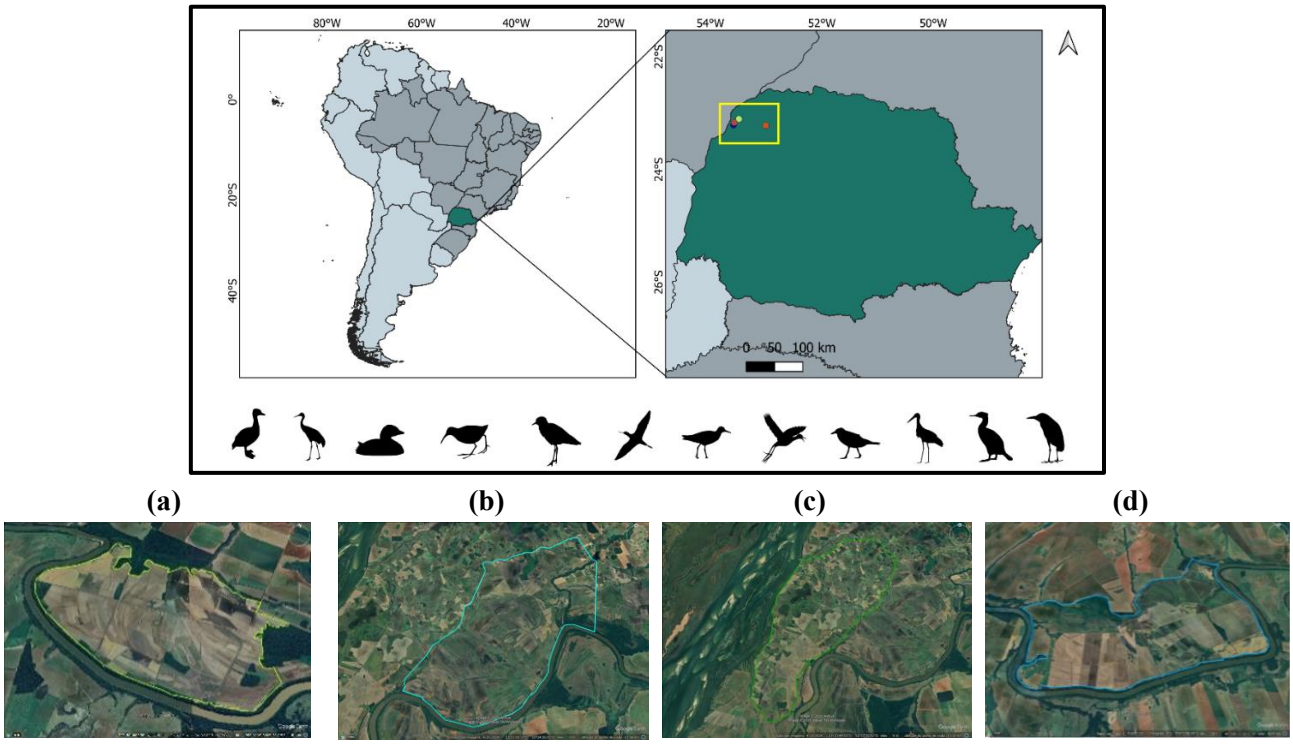

Figure 1. Map of South America with emphasis on Brazil and the state of Paraná and the study areas in following locations: (a) Gauchinha – Planaltina do Paraná; (b) Canassa – Querência do Norte; (c) Porto Jundiá - Querência do Norte; (d) Aparecidinha – Santa Mônica. The silhouettes illustrate below represent of the recorded main families.

Figura 1. Mapa da América do Sul com ênfase no Brasil e no estado do Paraná e a localização das áreas de estudo: (a) Gauchinha – Planaltina do Paraná; Canassa – Querência do Norte; (c) Porto Jundiá – Querência do Norte; (d) Aparecidinha – Santa Mônica. As silhuetas ilustradas abaixo representam as principais famílias registradas

3 RESULTS AND DISCUSSION

Across the study areas, 14 bird families were identified. The most frequent and abundant families were Anatidae, Aramidae, Recurvirostridae, Scolopacidae, Ciconiidae, Ardeidae, and Threskiornithidae (Figure 2). The corresponding number of records and species within each family is detailed in Table 1.

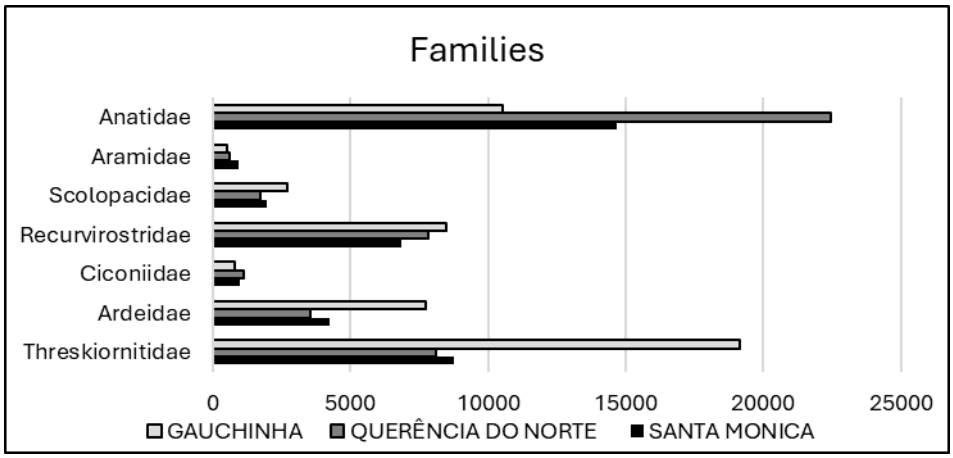

Figure 2. Number of individuals of the largest families recorded at different locations in the study area.

Figura 2. Número de registros de indivíduos das famílias mais frequentes e numerosas em cada localidade na área de estudo.

Table 1. Number of records and of species of the largest families at each location.

Tabela 1. Número de registros e de espécies pertencentes às famílias mais frequentes e abundantes em cada localidade.

Families	Gauchinha		Querência do Norte		Santa Monica	
	Records	Species	Records	Species	Records	Species
Anatidae	10525	07	22474	09	14688	08
Aramidae	497	01	605	01	913	01
Scolopacidae	2686	07	1706	06	1938	06
Recurvirostridae	8486	01	7840	01	6851	01
Ciconiidae	768	03	1094	03	959	03
Ardeidae	7748	09	3553	09	4221	10
Threskiornitidae	19142	04	8105	04	8770	04

A total of 49 species of waterfowl were identified, with 38 species in Gauchinha (49,852 records), 45 in Querência do Norte (45,377 records), and 43 in Santa Monica (38,340 records), belonging to 14 families (Table 2).

Table 2. Total number of records and frequency of occurrence of the species.

Tabela 2. Número total de registros e frequência de ocorrência das espécies.

Species	Gauchinha		Querência do Norte		Santa Monica	
	Records	f %	Records	f %	Records	f %
ANSERIFORMES						
Anatidae						
Dendrocygna bicolor (Vieillot, 1886)	598	47,3	57	11,7	389	44,4
Dendrocygna viduata (Linnaeus, 1766)	7272	84,2	5486	64,7	9154	83,3
Dendrocygna autumnalis (Linnaeus, 1758)	1330	68,4	15331	88,2	3303	66,6
Cairina moschata (Linnaeus, 1758)	69	21	549	35,2	-	-
Sarkidiornis sylvicola Ihering&Ihering, 1907)	86	31,5	37	11,7	28	22,2
Amazonetta brasiliensis (Gmelin, 1789)	604	78,9	329	58,8	1533	94,4
Anas bahamensis Linnaeus, 1758	566	21	675	47	165	22,2
Spatula versicolor (Vieillot, 18816)	-	-	2	5,8	42	33,3
Calonetta leucophrys (Vieillot, 1816)	-	-	8	11,7	74	11,1
PODICEPIDIFORMES						
Podicepididae						
Podilymbus podiceps (Linnaeus, 1758)	-	-	30	17,6	10	16,6
Tachybaptus dominicus (Linnaeus, 1766)	-	-	51	11,7	-	-
GRUIFORMES						
Aramidae						
Aramus guarauna (Linnaeus, 1766)	497	84,2	605	88,2	913	94,4
Rallidae						
Porphyrio martinica (Linnaeus, 1766)	39	21	21	29,4	49	38,8
Pardyrralus sanguinolentus (Swainson, 1838)	-	-	-	-	1	5,5
Galinulla galeata (Lichtenstein, 1818)	-	-	120	17,6	21	27,7
CHARADRIIFORMES						
Charadriidae						
Charadrius collaris Viellot, 1818	24	5,2	13	5,8	-	-
Pluvialis dominincana (Statius Muller, 1776)	-	-	2	11,7	-	-

to be continued
continua

continuation – table 2
continuação – tabela 2

Species	Gauchinha		Querência do Norte		Santa Monica	
	Records	f %	Records	f %	Records	f %
Recurvirostridae						
Himantopus melanurus **Vieillot, 1817**	8486	89,4	7840	88,2	6851	88,8
Scolopacidae						
Calidris sp.	54	5,2	18	5,8	-	-
Calidris fuscicollis (Vieillot, 1819)	23	5,2	-	-	70	11,1
Phalaropus tricolor (Vieillot, 1819)	65	5,2	-	-	11	5,5
Gallinago paraguaiae (Vieillot, 1816)	95	5,2	3	5,8	17	27,7
Tringa solitaria Wilson, 1813	02	5,2	6	7,6	14	5,5
Tringa flavipes (Gmelin, 1789)	2159	36,8	1607	47	1273	50
Tringa melanoleuca (Gmelin, 1789)	288	31,5	70	35,2	553	38,8
Actitis macularius (Linnaeus, 1766)	-	-	2	11,7	-	
Jacanidae						
Jacana jacana (Linnaeus, 1766)	90	57,8	463	64,7	373	72,2
Laridae						
Phaetusa simplex (Gmelin, 1789)	-	-	12	17,6	9	16,6
CICONIIFORMES						
Ciconiidae						
Ciconia maguari (Gmelin, 1789)	445	94,7	351	100	621	94,4
Jabiru mycteria	153	57,8	108	82,3	92	50
Mycteria americana Linnaeus, 1758	170	73,6	635	88,2	246	66,6
SULIFORMES						
Phalacrocoracidae						
Nannopterum brasilianum (Gmelin, 1789)	40	26,3	128	47	136	66,6
PELECANIFORMES						
Ardeidae						
Nycticorax nycticorax (Linnaeus, 1758)	100	33,3	20	17,6	34	16,6
Tigrisoma lineatum (Bodaert, 1783)	07	26,3	40	64,7	16	22,2
Butorides striata (Linnaeus, 1758)	54	52,6	205	52,9	45	50
Bubulcus ibis (Linnaeus, 1758)	4360	73,6	1093	76,4	1507	66,6
Ardea cocoi Linnaeus, 1766	35	73,6	82	88,2	34	61,1
Ardea alba Linnaeus, 1758	1585	94,7	1031	94,1	1132	83,3
Egretta caerulea (Linnaeus, 1758)	-		-	-	3	11,1
Egretta thula (Molina, 1782)	1520	89,4	1033	88,2	1344	88,8
Syrigma sibilatrix (Temminck, 1824)	82	42,1	42	5,8	86	66,6
Botaurus pinnatus (Wagler, 1829)	05	15,7	7	23,5	20	27,7
Threskiornitidae						
Plegadis chihi (Vieillot, 1827)	15142	73,6	6090	70,5	6135	61,1
Phimosus infuscatus (Lichtenstein, 1823)	3656	78,9	1731	88,2	2362	72,2
Theristicus caudatus (Bodaert, 1783)	07	10,5	19	23,5	18	27,7
Platalea ajaja Linnaeus, 1758)	337	84,2	265	88,2	255	66,6
CORACIIFORMES						
Alcedinidae						
Megaceryle torquata (Linnaeus, 1766)	2	5,2	19	41,1	5	27,7
Chloroceryle amazona (Lathan, 1790)	-	-	2	5,8	1	5,5
Chloroceryle americana (Gmelin, 1788)	1	5,2	1	5,8	1	5,5

As observed in other regions (Guadagnin et al. 2000, Guadagnin et al. 2005, Guadagnin and Maltchik 2007, Justo 2019), food availability and field size during various rice growth stages influence the presence of large flocks of *Dendrocygna* species, which are primarily responsible for considerable damage to rice crops. These invasions typically occur from dusk until dawn, as these birds forage using their sensitive bills, which enable them to locate food without relying on visual cues (Sick 1997). In recent years, to mitigate the negative impacts of nocturnal whistling-duck invasions, rice farmers have begun planting rice in fields without water, making these areas less attractive to this bird group.

Other species found during this study, with more diverse feeding habits that do not rely exclusively on rice, did not cause significant damage to the rice crop.

The different rice cultivation scenarios observed during this study were as follows:

. During soil tilling by agricultural machinery: species taking advantage of this stage included Storks, White Herons, and Cattle Egrets.

. Shortly after planting, with a thin water layer in the field: species such as Whimbrels, Comb Ducks, White-faced Whistling-ducks, and White Herons were observed.

. During various rice growth stages: this long period, from plant development to grain ripening, saw the presence of species such as Wattled Jacanas, Sandpipers, all types of Whistling-ducks, and later, White Herons, Jabirus, Spoonbills, and Wattled Jacanas.

. During harvest: almost all species were present following harvest machines, except for Sandpipers and White-backed Stilt.

. After harvest: many species continued to benefit, with larger species like Cattle Egrets, White Herons, and Storks feeding on invertebrates and small vertebrates (reptiles, amphibians, and fish).

As highlighted by Guadagnin et al. (2005) and Guadagnin and Maltchik (2007), rice fields do not replace the original natural habitats for the conservation of regional waterfowl and shorebirds. However, effective water management before, during, and after harvest plays a critical role in determining the capacity of rice fields to support these bird species. Fields that are maintained with water, even during fallow periods, can host a greater diversity of species continuously compared to drained rice fields (Elphick et al. 2003, Stafford et al. 2006). In addition to rice fields, irrigation canals are also important for these waterfowls when inactive and holding only a small amount of water.

The results suggest the adoption of conservation-oriented management practices for agricultural areas that can maintain their role as supplementary habitats and potentially serve as connectivity elements between natural remnants, as proposed by Guadagnin and Maltchik (2007). The presence of numerous flocks of waterfowl and shorebirds in the northwestern municipalities of Paraná, along the Ivaí and Paraná rivers, indicates that positive impacts may be associated with rice cultivation practices. This highlights the importance of preserving wetland areas without temporarily suppressing these habitats, even if they are artificially created. Therefore, ongoing monitoring and collaboration with rice farmers are critical for ensuring the long-term conservation of these bird species.

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5 AUTHORS' CONTRIBUTION

Pedro Scherer Neto: conceptualization, methodology, fieldwork, writing – original draft. Valdi Paula Gonçalves: **f**ieldwork, Adriano Travassos: fieldwork, Luiz Fernando Franco de Macedo: fieldwork, Antenor Silva Júnior: fieldwork.

6 CONFLICTS OF INTEREST

The authors declares that they have no conflict of interest related to the publication of this manuscript.

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