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Biology-Ecology

Bird richness and composition post-fire in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia

Riqueza e composição de aves pós fogo na Reserva Vegetal do Clube Caça e Pesca Itororó de Uberlândia

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ABSTRACT

Fire in the *Cerrado* is characterized as a structuring factor in ecosystems, influencing species richness and composition. The study of birds is important in analyses of post-fire changes in the *Cerrado*, as fire can alter the richness and composition of bird species. In September 2021, the Vegetation Reserve of *Clube Caça e Pesca Itororó* was exposed to a fire, resulting in the loss of vegetation from several phytophysiognomies of the *Cerrado*. This study aimed to observe changes in the composition and richness of the avifauna, searching if, after one year, the community had reached stabilization compared to a previous study. To monitor this process, a fortnightly survey of the birdlife was carried out, using points and transects, in the *Cerrado* and *Vereda* phytophysiognomies. A total of 137 species, 18 orders and 41 families were registered. The bird community did not reach stabilization one year after the fire. The richness of the *Cerrado* consisted of 116 species while the *Vereda* had 118, with a similarity of 70% in their composition. Regarding the previous study, of the 179 that had already been cataloged for the *Cerrado* and *Vereda*, 48 species were not registered, such as *Saltatricula atricollis*, *Melanopareia torquata*, *Cypsnagra hirundinacea*, *Neothraupis fasciata*, which are typical of the biome and were previous residents of the research areas. More severe fires can affect bird communities, which take more than a year to be reestablished.

Keywords: Avifauna; *Cerrado*; Fire; *Vereda*

RESUMO

O fogo no Cerrado é caracterizado como um fator estruturador de ecossistemas, influenciando na riqueza e composição de espécies. O estudo das aves é importante em análises de alterações pós fogo no Cerrado, pois o fogo pode alterar a riqueza e a composição de espécies de aves. Em setembro de 2021, a Reserva Vegetal do Clube Caça e Pesca Itororó foi exposta a um incêndio, houve perda de vegetação

de várias fitofisionomias de Cerrado. Este estudo objetivou verificar as alterações na composição e a riqueza da avifauna, identificando se depois de um ano, a comunidade atingiu a estabilização em comparação com um estudo anterior. Para acompanhar este processo, foi feito um levantamento quinzenal da avifauna, por meio de pontos e transectos, nas fitofisionomias cerrado e vereda. Foram registradas 137 espécies, 18 ordens e 41 famílias. A comunidade de aves não se estabilizou, um ano após a queimada. A riqueza do cerrado foi de 116 espécies, e da vereda foi de 118, com similaridade de 70% em sua composição. Em relação ao estudo anterior, das 179 que já haviam sido catalogadas para o cerrado e vereda, não foram registradas 48 espécies, como por exemplo *Saltatricula atricollis*, *Melanopareia torquata*, *Cypsnagra hirundinacea*, *Neothraupis fasciata*, que são típicas do bioma e antes eram residentes nas áreas de pesquisa. Queimadas mais severas podem afetar as comunidades de aves, de forma que estas demorem mais do que um ano para se reestabelecerem.

Palavras-chave: Avifauna; Cerrado; Fogo; Vereda

1 INTRODUCTION

Fire is considered an environmental disturbance, as it influences the structure of environments and the composition of certain ecosystems (Coutinho, 1990; Miranda, 2010). In environments where fire is characteristic, such as in savannas, it acts to maintain habitats and biodiversity, modifying the flora and fauna, the herbaceous and shrub stratum, and the relationships between animals and plants (Mcgranahan & Wonkka, 2021). Furthermore, this maintenance relies on the level of disturbance and the frequency of fire passage. As a result, diversity can increase, remain the same, or even decrease if the disturbance is sporadic or devastating (Sousa, 2009; Meacham & McNamee, 2023).

Fire, in *Cerrado* environments, besides acting as an ecosystem structurer, positively and negatively influences species composition (Frizzo et al., 2011). Positively, fire can lead to an increase in environmental heterogeneity, making the habitat more diverse and, consequently, allowing new species to colonize it (Tubelis & Cavalcanti, 2000). However, it can also act negatively, generating loss of species and individuals, due to the reduction in the availability of resources, causing the displacement of animals, for example, to other areas, as well as a possible competition for space and food (Townsend, Begon & Harper, 2008).

Among the animals that are affected by fire, birds respond to this disturbance in different ways, varying with the behavior of the species, its habitat, the season of the year, and also the fire regime (Sendoda, 2009). Some species' populations benefit from the passage of fire, increasing their abundance (Braz, 2008). Nevertheless, other species can migrate to other areas to find more resources (Tubelis & Cavalcanti, 2000). The study of birds is important in analyses of post-fire changes in the *Cerrado*, since their high mobility allows understanding how community dynamics work in the face of a disturbance, especially if it is caused by human action, allowing the promotion of preservation and conservation practices in essential areas for birds.

Therefore, to understand how bird composition can change over time after the sporadic passage of fire, a survey was carried out in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia (CCPIU). This area of *Cerrado* was exposed to a large-scale arson fire in September 2021 (Barbosa, 2021). Thus, this work aimed to analyze the current richness and composition of post-fire avifauna, in the *Cerrado* and *Vereda* areas of the CCPIU Vegetation Reserve, and compare them with the study by Malacco and contributors (2013). Furthermore, the present study aimed to answer the following questions: did fire alter the composition, richness, and return of birdlife? Did the bird community fully recover one year after the fire? Therefore, it is expected that the richness and composition of species within the two sampling environments will be similar to that registered in the previous study.

2 MATERIALS AND METHODS

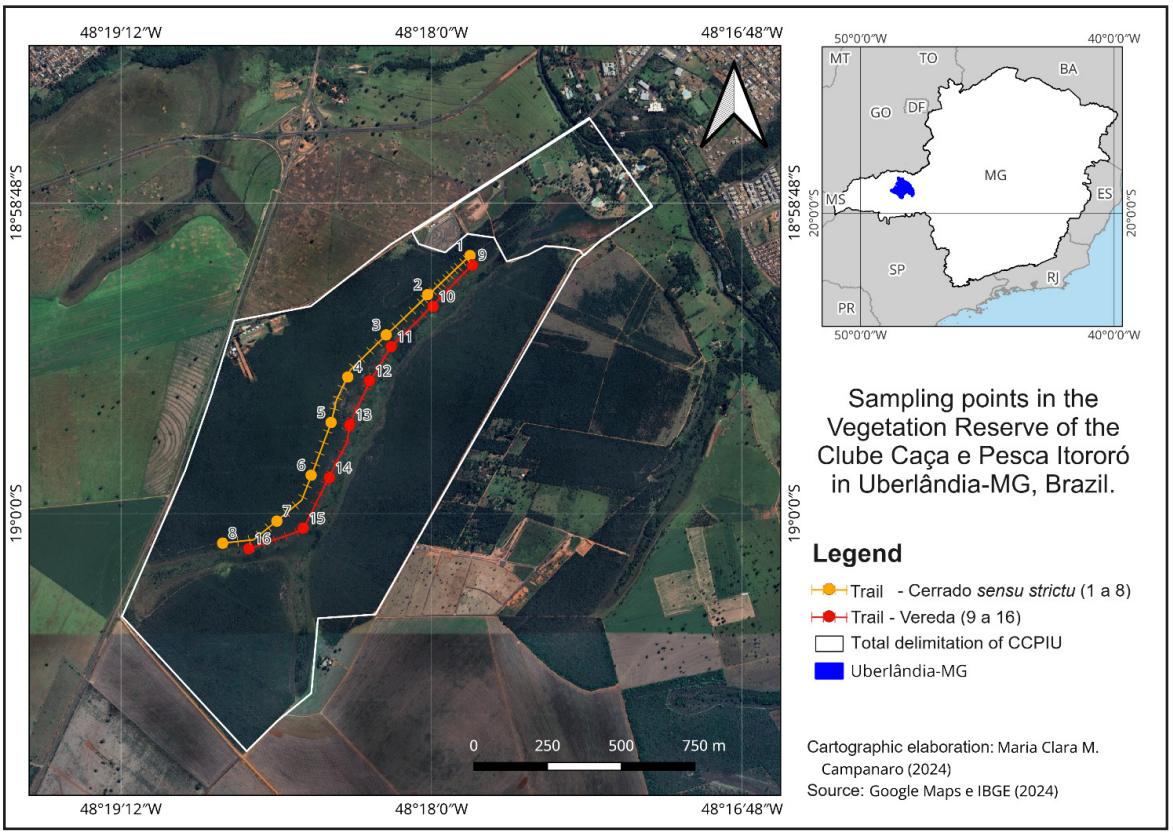
2.1 Birdlife study and sampling area

The study was carried out in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia (CCPIU) (18°58'56.65"S and 48°17'45.62"W), located in the southern part of the municipality of Uberlândia, in the state of Minas Gerais. The club has a total area of 640 hectares, of which 127 hectares are considered a Vegetation Reserve (VR)

(Bacci et al., 2016). Vegetation in the VR covers phytophysiognomies of the *Cerrado* domain, such as *Cerrado sensu stricto* (ss), *campo sujo*, *campo limpo*, *Veredas*, and small areas of forest (Appolinario & Schiavini, 2002). The region is characterized by a humid subtropical climate, with a hot rainy period, from October to March, and a dry and cold period, from April to September (Alvares et al., 2013).

Bird sampling was conducted from October 2021 (one month after the fire) to September 2022. For bird observation, two transects were established, one in the phytophysiognomy of *Cerrado sensu stricto,* where there is a main trail, and the other in the phytophysiognomy of *Vereda* which are on average 100 meters apart (Figure 1). In each sampling area, eight observation points were delimited, equidistant at 400 meters, the first being 200 meters from the road to avoid interference. At each point, observations were made for five minutes.

Figure 1 – Sampling points in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia, referring to the 23 collections, from October 2021 to September 2022



Source: Organized by authors (2024)

In the *Cerrado*, birds were recorded within a radius of up to 150 meters from the observer, in addition to those flying overhead. In the *Vereda*, the route was carried out in the *campo sujo*, from which observations were directed towards the *Vereda*, to register species that used the *campo sujo*, the edge of the *Vereda*, the *Vereda*, the *buritizais* and the edge of the forest, since on the route there were some overlaps of *Vereda*, forest, and swamp (Bacci et al., 2016). Sampling was carried out directionally towards the Vereda, and not within it, as the area in question was waterlogged and difficult to access. Therefore, no species were registered in the area of the *Vereda*, which were behind the observer, since it was phytophysiognomy of the *Cerrado sensu stricto*.

A total of 23 collections were made on the *Cerrado* trail and 23 on the *Vereda* trail. Sampling in each environment was carried out in the first and second fortnight of each month, respecting a minimum interval of seven days, maximum of 21 days between one sampling and another. Sampling was carried out only in the morning, starting at 6 a.m., lasting an average of 3 hours in each research area per day, totaling 142 hours in the field.

For each point, the species found, the phytophysiognomy in which they were observed, the type of registration - visual, overflight or sound (Vielliard et al., 2010), and the registration method - visual, recording or photographic - were noted. To assist in observation, binoculars (ELEPAWL® 10x42 (98–1000m), a camera (Nikon Coolpix® P520 – SuperZoom 42X (24–1000 mm)) and a cell phone as a voice recorder were used.

Bird identification was carried out with the help of: field guides, specialized bibliographies (Malacco et al., 2013; Fieker et al., 2014; Sigrist, 2015), identification platform such as WikiAves (www.wikiaves.com.br) and eBird (www.ebird.org). To identify the species, experts in ornithology were consulted and the citizen science application BirdNET (www.birdnet.cornell.edu) was used for identifying vocalizations. Species nomenclature followed the list by Pacheco and contributors (2021).

The registered birds were classified according to their feeding guilds, as per Wilman (2014) and Motta-Júnior (1990), as carnivores, granivores, insectivores, nectarivores, frugivores and omnivores.

2.2 Comparison of species lists

For twelve years, Malacco and contributors (2013) carried out bird surveys at the CCPIU, using several methodologies, such as mist netting captures, visual observation, and sound recordings by transect, using the same areas as the current research. To complement the research, the authors also compiled data from other works carried out in the area.

This allowed a comparative analysis of the list of species already published for the research areas and the species registered in the current survey, checking whether there was a change in the composition and richness of species over time due to the passage of the fire. However, as the list by Malacco and contributors (2013) is the result of several surveys and methodologies that were carried out throughout the Club's area, not only in the Vegetation Reserve, only those species that were recorded in the *Cerrado sensu stricto* and/or on the reserve *Vereda* were selected for analysis. In addition, species reported by Malacco et al. (2013) in areas of the CCPIU not surveyed in the present study (e.g., anthropized areas), but which were also recorded by us within the surveyed phytophysiognomies (Cerrado and/or Vereda), were retained in their list in order to enable a more precise comparison between the previous and current surveys.

Playback was used to check whether species that had not been registered, after eight months of sampling, were present in the areas where they had been registered in the previous study. Only the vocalizations of birds of the order Passeriformes were emitted, corresponding to the habitat in which they were previously registered (*Cerrado* or *Vereda*). To emit the sounds, a portable speaker was used. The corresponding vocalizations were selected from the sound database of the WikiAves and eBird

applications, preferably the chirps that had less external interference, and that were recorded as close as possible to the sampling location. The ethical parameters of bird watchers were followed (ICMBIO, 2021).

2.3 Data analysis

In an attempt to maximize the registering potential, biweekly samplings were grouped into monthly samplings, thus data analyses were carried out with monthly data.

To check the sampling effort and whether the bird community had stabilized, species accumulation and rarefaction curves (95% confidence interval) were generated using the Chao 2 richness estimator (Rodrigues, 2019) for both the general richness of species, as well as richness in each sampled environment. These curves were generated from a presence and absence matrix using the '*vegan*' package in the R software (Oksanen et al., 2022; R Core Development Team, 2023).

To compare the similarity in species composition between sampling environments, the Jaccard Similarity Index (Sj) was calculated, which uses the presence and absence of species to compose the calculation. The index corresponds to:

$$Sj = \frac{a}{(a + b + c)} \quad (1)$$

where:
a = is the number of species in common in both areas;
b and c = total number of species exclusive to each area

To find out if there was a difference in the monthly species richness in the *Cerrado* and *Vereda* and between the dry and rainy seasons, a t-test was carried out. The increase in richness between the first month of collections (October/2021) and the last month of sampling (September/2022) in each environment was presented as a percentage.

To identify whether there was overlap in species composition before and after the fire, the Jaccard index was calculated between these periods. For this purpose, presence/absence data obtained from filtering the list by Malacco et al. (2013) and the list of species obtained in the current survey were used.

To graphically illustrate the overlap of species between the pre- and post-fire periods, a Venn diagram was created. The diagram shows the number of species exclusive to each period and those shared between both, based on the presence/absence matrix. This visual representation was used to aid in the interpretation of compositional similarity, complementing the value of the Jaccard index obtained.

Statistical analyses were carried out in R, version 4.2.2 (R CORE DEVELOPMENT TEAM, 2023). To verify the homogeneity of variance and normality of data, the Levene test and the Shapiro-Wilk test were used, respectively. For the graphs built in R, the '*sciplot*' (Morales et al., 2020), and '*ggplot2*' (Wickham, 2016) packages were used. Microsoft Excel 356 (version 2304) was also used to create other graphs and tables.

3 RESULTS

3.1 Species richness and composition

A total of 137 species (Table 1), distributed in 18 orders and 41 families, were registered. The most diverse order was Passeriformes with 76 species, followed by Apodiformes with 11 species, corresponding to 55.4 and 8% of all records, respectively.

Table 1 – List of species registered in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia, from October 2021 to September 2022, according to the taxonomic classification of Pacheco et al. (2021)

(To be continued...)

Species	Feeding guilds	Registration location
Tinamiformes (2)		
Tinamidae (2)		
Crypturellus parvirostris	Granivore	Cer, Ver

Table 1 – List of species registered in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia, from October 2021 to September 2022, according to the taxonomic classification of Pacheco et al. (2021)

(To be continued...)

Species	Feeding guilds	Registration location
Rhynchotus rufescens	Omnivore	Ver
Anseriformes (2)		
Anatidae (2)		
Cairina moschata	Omnivore	Cer, Ver
Amazonetta brasiliensis	Omnivore	Cer
Galliformes (1)		
Cracidae (1)		
Penelope superciliaris	Frugivore	Cer, Ver
Columbiformes (6)		
Columbidae (6)		
Patagioenas cayennensis	Frugivore	Cer, Ver
Patagioenas picazuro	Granivore	Cer, Ver
Leptotila verreauxi	Granivore	Ver
Zenaida auriculata	Granivore	Cer, Ver
Columbina squammata	Granivore	Cer, Ver
Columbina talpacoti	Granivore	Cer, Ver
Cuculiformes (3)		
Cuculidae (3)		
Guira guira	Carnivore	Cer
Crotophaga ani	Omnivore	Cer, Ver
Tapera naevia	Insectivore	Cer, Ver
Caprimulgiformes (3)		
Caprimulgidae (3)		
Nyctidromus albicollis	Insectivore	Cer, Ver
Hydropsalis maculicaudus	Insectivore	Ver
Hydropsalis torquata	Insectivore	Cer
Apodiformes (11)		
Apodidae (2)		
*Streptoprocne zonaris**	Insectivore	Ver
*Tachornis squamata**	Insectivore	Cer, Ver
Trochilidae (9)		
Phaethornis pretrei	Nectarivore	Ver
Colibri serrirostris	Nectarivore	Cer, Ver
Heliomaster squamosus	Nectarivore	Cer, Ver
Heliomaster furcifer	Nectarivore	Ver
Calliphlox amethystina	Nectarivore	Ver
Chlorostilbon lucidus	Nectarivore	Cer, Ver
Eupetomena macroura	Nectarivore	Cer, Ver

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(To be continued...)

Species	Feeding guilds	Registration location
Chrysuronia versicolor	Nectarivore	Cer
Chionomesa fimbriata	Nectarivore	Cer, Ver
Gruiformes (2)		
Rallidae (2)		
Mustelirallus albicolis	Insectivore	Cer, Ver
Pardirallus nigricans	Insectivore	Ver
Charadriiformes (1)		
Charadriidae (1)		
Vanellus chilensis	Insectivore	Cer, Ver
Pelecaniformes (4)		
Ardeidae (2)		
*Ardea alba**	Carnivore	Ver
Syrigma sibilatrix	Insectivore	Cer
Threskiornithidae (2)		
Mesembrinibis cayennensis	Insectivore	Cer, Ver
Theristicus caudatus	Insectivore	Cer, Ver
Cathartiformes (1)		
Cathartidae (1)		
Coragyps atratus	Carnivore	Cer, Ver
Accipitriformes (3)		
Accipitridae (3)		
Heterospizias meridionalis	Carnivore	Cer, Ver
Rupornis magnirostris	Carnivore	Cer, Ver
*Geranoaetus albicaudatus**	Carnivore	Ver
Galbuliformes (2)		
Galbulidae (1)		
Galbula ruficauda	Insectivore	Ver
Bucconidae (1)		
Nystalus maculatus	Insectivore	Cer, Ver
Piciformes (7)		
Ramphastidae (1)		
Ramphastos toco	Frugivore	Cer, Ver
Picidae (6)		
Picumnus albosquamatus	Insectivore	Cer, Ver
Melanerpes candidus	Frugivore	Cer, Ver
Veniliornis passerinus	Insectivore	Cer, Ver
Campephilus melanoleucos	Insectivore	Cer, Ver
Dryocopus lineatus	Insectivore	Cer

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(To be continued...)

Species	Feeding guilds	Registration location
Colaptes melanochloros	Insectivore	Cer, Ver
Cariamiformes (1)		
Cariamidae (1)		
Cariama cristata	Insectivore	Cer, Ver
Falconiformes (4)		
Falconidae (4)		
Herpetotheres cachinnans	Carnivore	Cer, Ver
Caracara plancus	Carnivore	Cer, Ver
Falco sparverius	Insectivore	Ver
Falco femoralis	Omnivore	Cer, Ver
Psittaciformes (8)		
Psittacidae (8)		
*Brotogeris chiriri**	Frugivore	Cer, Ver
Alipiopsitta xanthops	Omnivore	Cer, Ver
Amazona aestiva	Omnivore	Cer, Ver
Eupsittula aurea	Frugivore	Cer, Ver
*Orthopsittaca manilatus**	Frugivore	Cer, Ver
*Ara ararauna**	Frugivore	Cer, Ver
Diopsittaca nobilis	Frugivore	Cer, Ver
*Psittacara leucophthalmus**	Frugivore	Cer, Ver
Passeriformes (76)		
Thamnophilidae (4)		
Formicivora rufa	Insectivore	Cer, Ver
Herpsilochmus longirostris	Insectivore	Ver
Thamnophilus doliatus	Insectivore	Cer, Ver
Thamnophilus torquatus	Insectivore	Cer, Ver
Dendrocolaptidae (1)		
Lepidocolaptes angustirostris	Insectivore	Cer, Ver
Furnariidae (4)		
Furnarius rufus	Insectivore	Cer
Phacellodomus ruber	Insectivore	Cer, Ver
Synallaxis albescens	Insectivore	Cer
Synallaxis frontalis	Insectivore	Cer, Ver
Tityridae (1)		
Pachyramphus polychopterus	Omnivore	Cer
Rhynchocyclidae (2)		
Todirostrum cinereum	Insectivore	Cer, Ver
Hemitriccus margaritaceiventer	Insectivore	Cer, Ver

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(To be continued...)

Species	Feeding guilds	Registration location
Tyrannidae (24)		
Camptostoma obsoletum	Insectivore	Cer, Ver
Elaenia flavogaster	Omnivore	Cer, Ver
Elaenia cristata	Omnivore	Cer, Ver
Elaenia chiriquensis	Omnivore	Cer
Elaenia obscura	Omnivore	Cer, Ver
Suiriri suiriri	Insectivore	Cer
Phaeomyias murina	Insectivore	Cer, Ver
Serpophaga subcristata	Insectivore	Cer, Ver
Myiarchus swainsoni	Insectivore	Cer, Ver
Myiarchus ferox	Omnivore	Cer, Ver
Myiarchus tyrannulus	Insectivore	Cer, Ver
Pitangus sulphuratus	Omnivore	Cer, Ver
Machetornis rixosa	Insectivore	Cer
Megarynchus pitangua	Insectivore	Cer
Tyrannus albogularis	Insectivore	Cer, Ver
Tyrannus melancholicus	Insectivore	Cer, Ver
Tyrannus savana	Insectivore	Cer, Ver
Griseotyrannus aurantioatrocristatus	Insectivore	Cer
Empidonomus varius	Insectivore	Cer
Pyrocephalus rubinus	Insectivore	Ver
Gubernetes yetapa	Insectivore	Cer, Ver
Myiophobus fasciatus	Insectivore	Cer, Ver
Xolmis velatus	Insectivore	Cer, Ver
Nengetus cinereus	Insectivore	Cer, Ver
Vireonidae (1)		
Cyclarhis gujanensis	Insectivore	Cer, Ver
Corvidae (1)		
Cyanocorax cristatellus	Omnivore	Cer, Ver
Hirundinidae (4)		
*Pygochelidon cyanoleuca**	Insectivore	Cer
Stelgidopteryx ruficollis	Insectivore	Cer, Ver
Progne chalybea	Insectivore	Cer
*Hirundo rustica**	Insectivore	Cer, Ver
Troglodytidae (2)		
Troglodytes musculus	Insectivore	Cer, Ver
Cantorchilus leucotis	Insectivore	Cer, Ver
Polioptilidae (1)		

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(To be continued...)

Species	Feeding guilds	Registration location
Polioptila dumicola	Insectivore	Cer, Ver
Turdidae (3)		
Turdus leucomelas	Insectivore	Cer, Ver
Turdus rufiventris	Omnivore	Cer, Ver
Turdus amaurochalinus	Frugivore	Cer, Ver
Mimidae (1)		
Mimus saturninus	Insectivore	Cer, Ver
Fringillidae (1)		
Euphonia chlorotica	Frugivore	Cer, Ver
Passerellidae (2)		
Ammodramus humeralis	Granivore	Cer, Ver
Zonotrichia capensis	Granivore	Cer, Ver
Icteridae (3)		
Icterus pyrrhopterus	Insectivore	Cer, Ver
Gnorimopsar chopi	Omnivore	Cer, Ver
Pseudoleistes guirahuro	Omnivore	Ver
Parulidae (3)		
Geothlypis aequinoctialis	Insectivore	Ver
Myiothlypis leucophrys	Insectivore	Cer, Ver
Myiothlypis flaveola	Insectivore	Cer, Ver
Cardinalidae (1)		
Cyanoloxia brissonii	Frugivore	Ver
Thraupidae (17)		
Nemosia pileata	Insectivore	Cer
Emberizoides herbicola	Omnivore	Ver
Dacnis cayana	Omnivore	Cer, Ver
Saltator maximus	Insectivore	Cer, Ver
Saltator similis	Omnivore	Cer, Ver
Coereba flaveola	Nectarivore	Cer
Volatinia jacarina	Omnivore	Cer, Ver
Coryphospingus cucullatus	Omnivore	Cer, Ver
Sporophila plúmbea	Granivore	Ver
Sporophila nigricollis	Granivore	Cer, Ver
Sporophila caerulescens	Granivore	Ver
Sporophila leucoptera	Granivore	Ver
Sicalis flaveola	Granivore	Cer, Ver
Schistochlamys ruficapillus	Omnivore	Cer, Ver
Thraupis sayaca	Omnivore	Cer, Ver

Table 1 – List of species registered in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia, from October 2021 to September 2022, according to the taxonomic classification of Pacheco et al. (2021)

(Conclusion)

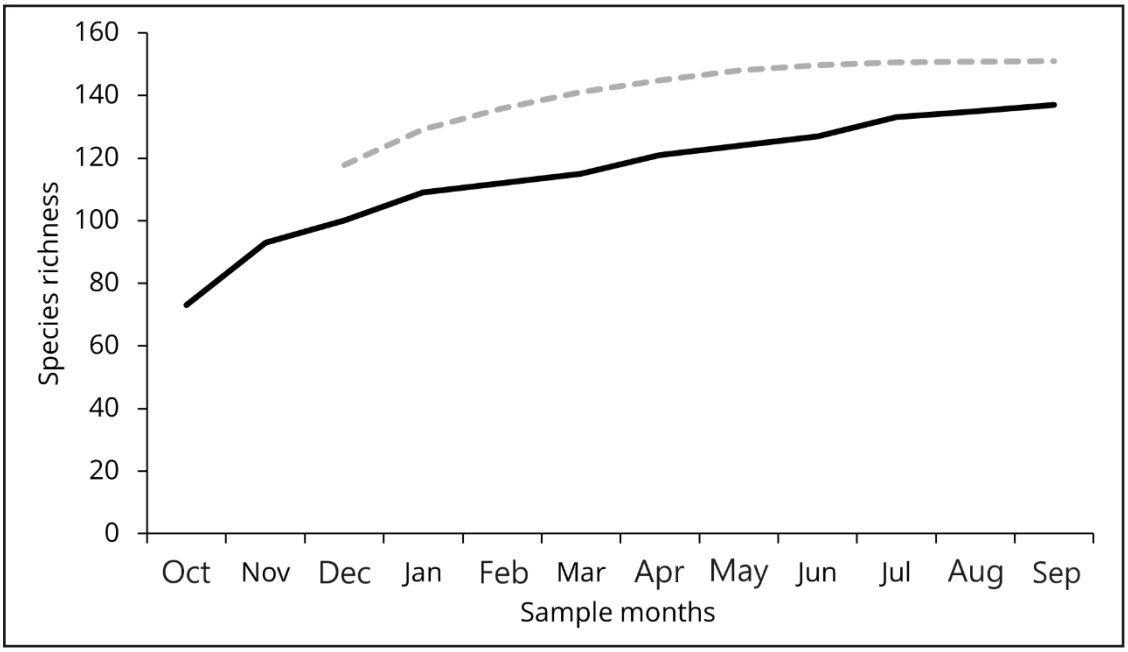
Species	Feeding guilds	Registration location
Thraupis palmarum	Frugivore	Cer, Ver
Stilpnia cayana	Frugivore	Cer, Ver

Source: Organized by the authors (2023)Legend: Feeding guilds = Wilman et al. (2014) and Motta-Júnior (1990); Registration location: Cer = *Cerrado*; Ver = *Vereda*; * = flight registration

Among the registered families, the one with the greatest richness was Tyrannidae with 24 species, which corresponds to 17.5% of the total records in this study, followed by Thraupidae (17) with 12.4%, Trochilidae (9) with 6, 5%, Psittacidae (8) with 5.8%.

The species accumulation curve (Figure 2) depicts richness over the months. The observed richness represented 91.33% (150 species) of the expected number of species, according to the estimator Chao 2 (Figure 2).

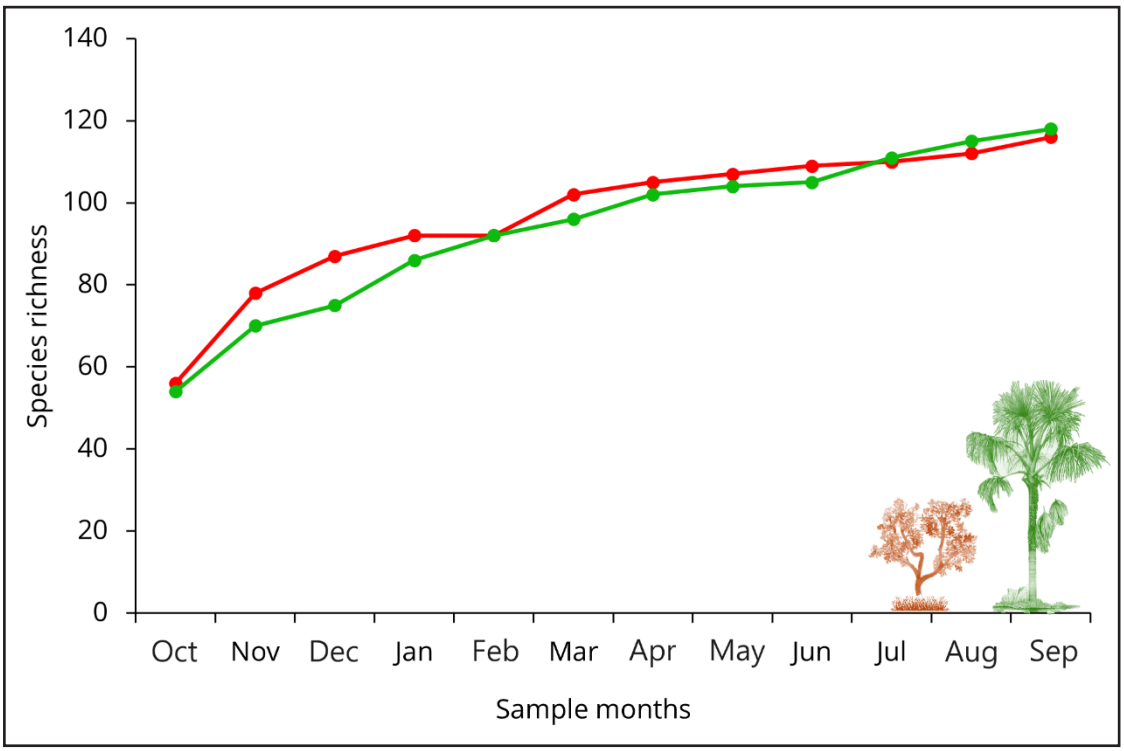
Figure 2 – Monthly accumulation curve of species registered in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia, from October 2021 to September 2022



Source: Authors (2023). Legend: Solid black line refers to the observed richness and the dashed gray line refers to the expected richness by the Chao2 index

Among the 137 species sampled in this study, 27 species were registered in all sampling months and 20 were registered only once. When analyzing each area (*Vereda* and *Cerrado sensu stricto*) separately, the species accumulation curve maintained a similar pattern of species discovery (Figure 3). In the *Cerrado*, 116 species were registered, 19 of which were observed only in the *Cerrado;* in the *Vereda,* 118 species, of which 21 were seen only in the *Vereda* (Table 1).

Figure 3 – Accumulation curve of species, according to the environment *Cerrado* (red line) and *Vereda* (green line), of birds registered in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia, from October 2021 to September 2022



Source: Authors (2023)

On average, the *Cerrado* and the *Vereda* had similar monthly richness, 58.8 ± 8.0 and 57.4 ± 8.9, respectively, with no significant difference between the months (t_{21} = 0.407, p = 0.68) (Table 2). The similarity index (Sj) between the *Cerrado* and the *Vereda* was 70%. However, there is the possibility of registering more species in the *Vereda* than in the *Cerrado*, since the estimator Chao 2 showed the probability of finding 123 species in the *Cerrado* and 147 in the *Vereda*, if more samplings were carried out.

Table 2 – Monthly species richness in each environment, *Cerrado* and *Vereda* and in each season, rainy and dry

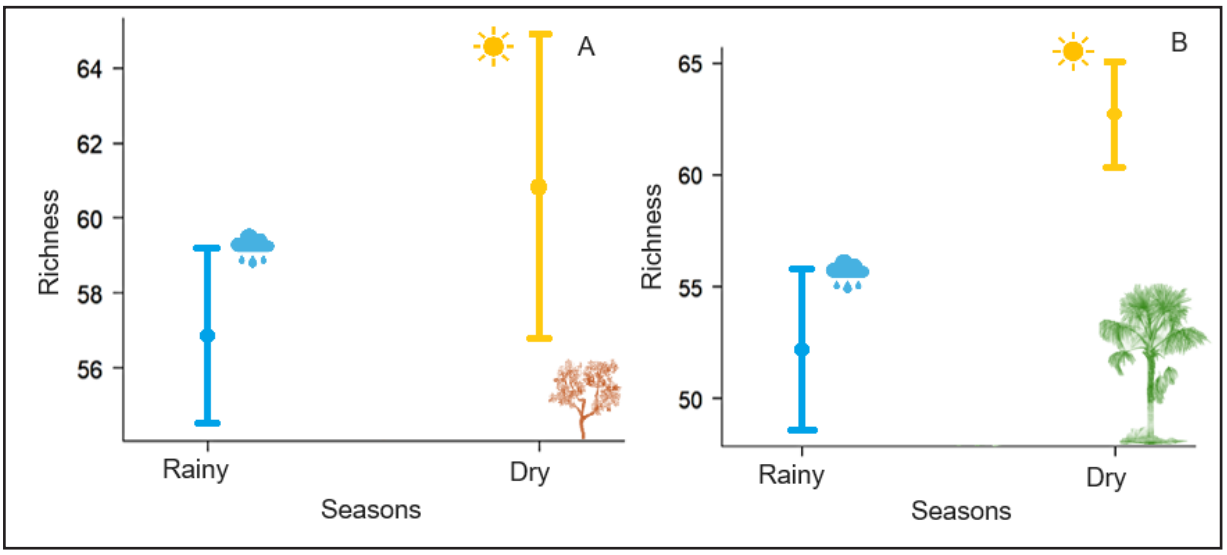
Sample months	Season	*Cerrado*	*Vereda*
October/2021	Rainy	56	54
November/2021	Rainy	64	59
December/2021	Rainy	62	36
January/2022	Rainy	54	60
February/2022	Rainy	48	49
March/2022	Rainy	57	55
April/2022	Dry	54	65
May/2022	Dry	64	61
June/2022	Dry	54	54
July/2022	Dry	53	59
August/2022	Dry	61	68
September/2022	Dry	79	69

Source: Organized by the authors (2023)

The monthly richness in the *Cerrado* immediately after the fire (October/2021=56) represented 70.9% of that found after one year of sampling (September/2022=79) (Table 2). For the *Vereda*, this value was 78%. The species composition between October/2021 and September/2022 in the *Cerrado* showed a similarity of 52%, while in the *Vereda* the similarity was 54%.

The total species richness in the rainy season was 115 and in the dry season 120. The similarity in species composition between the two seasons was 72%. The total richness in each season in the *Cerrado* was equal (n=102), however the similarity was 75% between the seasons. There was also no difference in the monthly richness of species in the *Cerrado* between the seasons (t_8 = -0.853; p = 0.41; Figure 4A). In the *Vereda*, during the rainy season, a total of 95 species was registered, and in the dry season there were 106, with a similarity in species composition of 69%. Furthermore, there was a difference in the monthly species richness in the *Vereda* between the rainy and dry seasons (t_8 = -2.438; p = 0.03; Figure 4B).

Figure 4 – Differences in average monthly richness between the rainy (blue line) and dry (yellow line) seasons, in the two collection areas, *Cerrado* (A) and *Vereda* (B), of birds sampled in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia, October 2021 to September 2022. The dots represent the means and the bars correspond to the standard deviation



Source: Authors (2023)

In the current survey, 6 new species were registered in relation to the study by Malacco and contributors (2013). Of these, two were registered both in the *Cerrado* and in the *Vereda*, *Serpophaga subcristata* and *Myiothlypis flaveola;* one only in the *Cerrado*, *Chrysuronia versicolor;* and three only on the *Vereda*, *Hydropsalis maculicaudus*, *Heliomaster furcifer,* and *Cyanoloxia brissonii*.

Of the six categories of feeding guilds, the one with the greatest richness was the Insectivores, with 66 species, followed by the Omnivores with 25 species, Frugivores with 15, Granivores with 13 species, Nectarivores with 10 species, and Carnivores with 8 species.

3.2 Lists comparative analysis

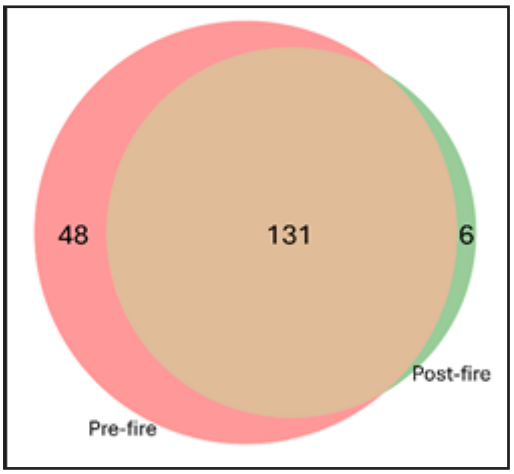
In the survey conducted by Malacco et al. (2013) at CCPIU, a total of 202 bird species were recorded, of which 170 occurred in the Cerrado (n = 141) and/or in the

Vereda (n = 127). In the present study, nine species were recorded that had previously been reported by Malacco et al. (2013) in other areas of the CCPIU (e.g., anthropized habitats), but not specifically in the Cerrado or Vereda. Since these species were found within these two phytophysiognomies in our survey, they were included in the comparative list, resulting in 179 species considered for comparison (170 + 9). Of these, 131 were also recorded in the present study. In addition, we report six species that are new records for the CCPIU as a whole, thereby expanding the total number of species known for the area.

Of the species sampled by Malacco and contributors (2013) in the study areas, 48 species were not registered (Figure 5), which corresponds to 26.8% of the records, of which 12 had been registered in both environments, 23 in the *Cerrado,* and 13 in the *Vereda*. Of the unregistered species, eight are from the *Thraupidae* family, six from the *Tyrannidae* family, and five from the *Accipitridae* family.

The Jaccard index between the pre and post-fire periods was 70%, indicating high overlap in species composition based on species presence/absence.

Figure 5 – Overlap of species composition before and after the fire in the Vegetation Reserve of the *Clube Caça e Pesca Itororó* in Uberlândia, using a Venn diagram



Source: Authors (2025). Legend: Pink: number of species recorded just before the burn; Light brown: number of species recorded from the current survey; Green: new species for the areas

4 DISCUSSION

In studies describing how fire influences the richness and composition of communities, two areas with similar vegetation structure are generally compared simultaneously, of which one was affected by fire and the other was not (Cavalcanti & Alves, 1997; Cintra & Sanaiotti, 2005; Braz, 2008; Sendoda, 2009; Woinarski & Legge, 2013). However, due to the severity and unpredictability of the fire that occurred in the Vegetation Reserve of the *Clube Caça e Pesca*, it was not possible to carry out this simultaneous comparison between the burned and unburned area, as the VR had several of its phytophysiognomies completely burned, with the exception of gallery forest areas. For this reason, data published by Malacco et al. (2013) were used for comparison. As the previous research was only carried out at times when the fire had not passed through the area, it was assumed that the data from this research demonstrate a stabilized community, despite this being work based on various collection methodologies.

Based on the current survey, we investigated how the fire affected the composition and richness of bird species in the Vegetation Reserve. After a year of sampling, it was found that the bird community had not yet stabilized, because, although the richness estimators showed a small percentage of the possibility of new records, when compared to the richness recorded in the previously sampled areas, more species were expected to be found.

In a study carried out by Braz (2008), in open areas of *Cerrado*, it was observed that the return of birds to recently burned areas showed a brief decrease in richness immediately after the fire, but after the first rains, the birdlife returned, stabilizing until the end of 20 months of sampling. Therefore, as in the aforementioned study, it is possible that the community sampled in the current survey takes longer to stabilize. Furthermore, the severity of the fire may have contributed to the non-stabilization of bird richness over the months of sampling.

The richness sampled in each collection environment was similar, showing high similarity. This also occurred in the research of Bagno and Marinho-Filho (2001). The authors found a similarity of 71% between the *Cerrado* and the *Vereda*. They explained that these areas allow the presence of forest, grassland, and aquatic birds, in the case of *Veredas*, as it is a transitional zone between forests and fields.

This work also showed that more species could be registered, mainly in the *Vereda*, due to the connection with areas of gallery forests, marshes, and streams, which would allow for a greater richness of species (Bagno & Marinho-Filho, 2001). However, the richness in the *Vereda* was lower in the rainy season, probably due to the fire occurring shortly before the start of this season. According to Woinarski and Legge (2013), the passage of fire at the beginning of the rainy season could reduce species richness, as most *Cerrado* birds concentrate their reproduction during this period (Sick, 1997). October may also have had its richness reduced by the fire to the point of resembling the last month of drought, which is September. The similarity of 52% between these months in the *Cerrado* and 54% in the *Vereda* highlights the change in species composition over the months of sampling.

Changes in composition over the months were observed through the movement of species between areas and the high number of species not registered after the fire compared to the study by Mallaco and contributors (2013). Humid areas, of *Veredas* and forests, for example, possibly became a refuge for birds of open areas, from where they moved to these areas in search for resources, after the fire (Cavalcanti, 1992; Bagno & Marinho-Filho, 2001; Robinson et al., 2013). Therefore, the hypothesis of this work was not corroborated, as the richness was not reestablished one year after the fire, and the composition showed differences due to non-registration of some species and the registration of new species, in relation to the previous study.

This displacement was observed based on registries of vocalizations of the tinamidae *Crypturellus parvirostris* and *Rhynchotus rufescens* and rallidae *Mustelirallus albicollis* and *Pardirallus nigricans*, in forest edge and interior areas, as in the previous

survey they had been registered in open areas of *Cerrado* and *Vereda*. Furthermore, Reis (2015) reported that the abundance of the species *R. rufescens* in the *Cerrado* increased over ten months after the fire, but in the current survey, the species was recorded only once in the *Vereda*, ten months after the fire.

As the sampling area is close to the river Uberabinha and a lake that is inside the Club, during the fire, water birds, such as *Ardea alba* and *Cairina moschata* may have moved and taken refuge in these adjacent areas, not being directly affected by the fire, since they were seen flying over and in the area of the *Vereda*, in the case of *C. moschata* (Arantes & Melo, 2011; Mcgranahan & Wonkka, 2021). They could also have traveled in search for places with greater availability of resources, as in the case of *A. alba* (Sick, 1997).

Forest birds may also have moved to recently burned areas in search for food (Cavalcanti, 1992). In this work, the species *Galbula ruficauda*, *Herpsilochmus longirostris*, *Myiothlypis leucophrys,* and *Myiothlypis flaveola*, which are forestry, were registered both on the edges of forests, edges of *Vereda* and in the *Cerrado*, as in the case of *M. flaveola*. According to Cavalcanti (1992), bird species can use recently burned areas opportunistically, especially insectivorous ones. After a fire event, birds explore the exposed soil in search for insects that were previously buried (Lopes & Vasconcelos, 2011). Moreover, after the first rains, herbivorous insects take advantage of the regrowth to feed themselves and reproduce, becoming an abundant food resource for insectivorous and omnivorous birds (Cintra & Sanaiotti, 2005).

In the *Vereda*, species that had not been registered by Malacco et al. (2013) or that were also registered by the authors, but in other areas of the club, such as *Chrysuronia versicolor*, *Heliomaster furcifer*, *Cyanoloxia brissonii*, *Pyrocephalus rubinus* were observed. This possibly occurred due to the presence of greater availability of resources in the dry season in the *Vereda*, time when such species were registered.

Birds of prey, such as *Falco femoralis* and *Geranoaetus albicaudatus* seek recently burned areas in search for food resources (Reis, 2015). *G. albicaudatus,* for example,

was registered only once, shortly after the fire. The other raptor species registered in this study maintained their presence in the observation areas throughout the research.

The presence of raptors shortly after a fire event has also been observed by other authors, such as Woinarski (1990), Reis (2015), McGranahan, and Wonkka (2021). These birds are seen hunting animals that flee fire, or even carcasses. However, of the 19 raptor species registered by Malacco et al. (2013) only nine were registered in the current survey, considering the species *Coragyps atratus*. One of the missing species was *Urubinga coronata*, a bird of prey that is rare in the region and which is threatened with extinction due to habitat loss (ICMBIO, 2018).

In the survey by Malacco et al. (2013). nine nocturnal species were registered, two of which were seen in the current survey, *Nyctidromus albicollis* and *Hydropsalis torquata*. Although this study did not include nocturnal sampling, these species were registered because they have a crepuscular habit, being active until moments before dawn (Kilpp & Prestes, 2013). In addition, a new species for the area was registered, *Hydropsalis maculicaudus*, minutes before sunrise, and only in the first sampling in the marsh areas of the *Vereda*, possibly looking for insects close to the ground.

The endemic species of the *Cerrado* biome, *Melanopareia torquata*, *Saltatricula atricollis,* and other residents of the reserve, such as *Cypsnagra hirundinacea*, *Neothraupis fasciata*, *Schistochlamys melanopis*, *Sporophila collaris*, were not registered in the current survey (Lima-Silva, 2009; Almeida, 2009; Arantes & Melo, 2011; Malacco et al., 2013).

The species *S. collaris* was not seen, possibly because it is a migratory species, which was generally seen in the dry season, and which has a habitat requirement related to some grass species (Lima-Silva, 2009; Malacco et al., 2013). Therefore, its registration would depend on the availability of resources in the dry season, which may not have been sufficient.

The species *Saltatricula atricollis* was commonly seen in the *Cerrado* and the *Vereda* by Almeida (2009) and Arantes and Melo (2011), presenting greater abundance in the rainy period, in December and January, when there were more food resources,

and at the beginning of the dry period, due to high seed availability. However, the fire may have interfered with the quality of the habitat for this species, as well as for *M. torquata*, *C. hirundinacea*, *N. fasciata* and *S. melanopis*, which are generally found in open *Cerrado* areas and are highly sensitive to disturbances (Cavalcanti & Alves, 1997; Tubelis & Cavalcanti, 2000; Sendoda, 2009), with the exception of *S. melanopis*, which is registered in *veredas* and forests (Tubelis, 2009).

Besides the fire, the fact that 48 bird species were not registered can be attributed to the sampling time, as the previous study referred to a compilation of eleven years of sampling using several methodologies. Even though the birds may have taken refuge in adjacent areas, such as forests, currently the reserve is surrounded by monocultures, as well as a subdivision under construction; therefore, over the years, the reserve may become more isolated, enhancing a reduction of species diversity.

Another factor that may have contributed to the failure to register more species is that at the time the previous study was carried out, there was no highway present in the back of the reserve; instead, there was only a dirt road, thus the vegetation cover around the reserve was larger, which contributed to the diversity of species. The continuous use of parts of the reserve as cycling trails, and the proximity to the highway, may also have led to a possible disturbance and consequently scared birds away. However, further studies are required that prove a possible loss of species, due to the expansion of agriculture and construction, very close to the reserve.

5 CONCLUSIONS

More severe and infrequent fires, such as the one that occurred in the Vegetation Reserve, altered the bird community in such a way that the richness did not stabilize and the species composition changed, as there were unregistered bird species that did not resemble the registered ones of the previous study. Therefore, it is clear that the effects of fire on birdlife are severe and long-lasting, potentially altering the return of species, or even modifying richness and composition.

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