Diversity of bats (Mammalia, Chiroptera) in the *Parque Estadual de São Camilo*, Paraná, Southern Brazil

Diversidade de morcegos (Mammalia, Chiroptera) no Parque Estadual de São Camilo, Paraná, Sul do Brasil

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Abstract: The *Parque Estadual de São Camilo* (PESC) is one of the few forest fragments in the western Paraná, Southern Brazil, a region with a high agricultural activity. The objective of this study was to survey bat species in this park and determine the significance of this area for conservation of bat species. Samples were collected during four nights per month from September 2016 to August 2017, using mist nets placed at eight different sites in the PESC. A total of 380 individuals of three families and 12 species were captured. The most frequent and constant species were *Artibeus lituratus*, *Sturnira lilium*, and *Artibeus fimbriatus*. The most frequent dietary guild found was frugivorous, followed by insectivorous, omnivorous, and carnivorous. A higher species abundance was found in sites at the forest fragment edge. Two Phyllostominae species, *Chrotopterus auritus* and *Phyllostomus hastatus*, were found only in the interior of the forest fragment. Although no endangered bat species were identified, the preservation of forest areas in secondary succession, can benefit species that depends on conserved areas. Finally, we recommend conducting new studies within the park, with particular emphasis on unexplored areas, to shed light on the ecology and population dynamics of bats in PESC.

Keywords: Chiropterofauna. Semideciduous seasonal forest. Protected areas. Atlantic Forest.

Resumo: O Parque Estadual de São Camilo (PESC) é um dos poucos fragmentos florestais no oeste do Paraná, Sul do Brasil, uma região com alta atividade agrícola. O objetivo deste estudo foi realizar um levantamento das espécies de morcegos e determinar a importância do PESC para sua conservação. Os morcegos foram capturados durante quatro noites por mês, de setembro de 2016 a agosto de 2017, utilizando redes de neblina, colocadas em oito diferentes locais no PESC. Um total de 380 indivíduos, pertencentes a três famílias e 12 espécies, foi capturado. As espécies mais frequentes e constantes foram *Artibeus lituratus*, *Sturnira lilium* e *Artibeus fimbriatus*. A guilda alimentar mais frequente encontrada foi frugívora, seguida por insetívora, onívora e carnívora. Houve maior abundância de espécies nas áreas da borda do fragmento florestal. Duas espécies de Phyllostominae, *Chrotopterus auritus* e *Phyllostomus hastatus*, foram encontradas apenas no interior do fragmento florestal. Embora nenhuma espécie de morcego ameaçada tenha sido identificada, a preservação de áreas florestais em sucessão secundária pode beneficiar espécies que dependem de ambientes preservados. Recomendamos a realização de novos estudos no parque, com ênfase especial em áreas não exploradas, a fim de elucidar a ecologia e a dinâmica populacional dos morcegos no PESC.

Palavras-chave: Quiropterofauna. Floresta estacional semidecidual. Áreas protegidas. Mata Atlântica.

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INTRODUCTION

The state of Paraná has three phytogeographic formations in the Atlantic Forest ecoregion: dense ombrophilous forest in the East, mixed ombrophilous forest in high-altitude areas, and semideciduous seasonal forest in the interior of the state (Roderjan et al., 2002). The interior of the state is characterized by intensive agriculture, mainly corn and soybean, especially in the North and West regions (Llanillo et al., 2006). Thus, the semideciduous seasonal forest is the phytogeographic formation most affected by deforestation processes (Llanillo et al., 2006).

Few semideciduous seasonal forest fragments are found in the western Paraná state, and these fragments are small and scattered in the region, except by the *Parque Nacional do Iguaçu* (SOS Mata Atlântica & INPE, 2014). The establishment of protected areas can be one of the most effective tools for the conservation of these few forest fragments and, consequently, the local biodiversity (Hassler, 2005). The *Parque Estadual de São Camilo* (PESC) was established in 1990 as part of the Paraná Biodiversity Project, in the Caiuá-Ilha Grande corridor, to establish the connection between remaining forest fragments and other protected areas (IAP, 2006).

The park's management plan dates from 2006, and the occurrence of only five species of medium and large-sized mammals in the park area is listed in this document (IAP, 2006). Other groups of mammals, such as bats, remain unsampled in the PESC (IAP, 2006). Bats are commonly used in ecological studies because they are potential environmental quality indicators (Fenton et al., 1992; Medellín et al., 2000; Jones et al., 2009). They form a diverse group and represent about a quarter of the world's mammal species (Burgin et al., 2018), presenting high variety of trophic guilds, with frugivorous, insectivorous, nectarivorous, omnivorous, hematophagous, and carnivorous species (Torquetti et al., 2023). This diversity of feeding habits contributes to the maintenance and regeneration of forests (Aguiar & Marinho-Filho, 2007; Henry & Jouard, 2007; Mello et al., 2008); insect population control, including insects that are agricultural pests and vector of human diseases (Aguiar & Antonini, 2008; Williams-Guillén et al., 2008; Kunz et al., 2011); and pollination of many angiosperm species (Sazima et al., 1999; Quesada et al., 2003). Moreover, when compared to other groups of mammals, such as rodents and marsupials, sampling of bat is relatively easy and non-expensive (Jones et al., 2009).

Lists of species of the fauna at protected areas may assist in decision making and in the management of these areas (Mace, 2004), and may show the importance of these semideciduous seasonal forest fragments for the conservation of the local fauna (Rodrigues et al., 2011). Although some animal groups, such as ants and birds have been studied and have a fauna inventory in the PESC (Ladino & Feitosa, 2022; Ribas et al., 2023), the lack of research on other animal groups, particularly the bat fauna, is evident. Given the importance of surveying forest fragments in western Paraná and the limited information available on the chiropterofauna in the area, this study aimed to conduct a bat survey in the *Parque Estadual de São Camilo* and determine the significance of this area for conservation of bat species.

MATERIAL AND METHODS

STUDY AREA

The *Parque Estadual de São Camilo* (PESC) (24° 18' 20" S and 53° 54' 15" W) is located in the municipality of Palotina, western region of Paraná state, southern Brazil (Figure 1). It has an area of 385.34 hectares and belongs to the Atlantic Forest ecoregion, presenting phytogeographical aspects of semideciduous seasonal forest. The PESC is surrounded by large agricultural areas with corn and soybean plantations (Gonçalves et al., 2014; Ribas et al., 2020; Kramer et al., 2023; Ribas et al., 2023).

The PESC vegetation is characterized by dominance of Fabaceae, Apocynaceae, Lauraceae, Meliaceae, and Moraceae species (Roderjan et al., 2002). The interior of PESC is characterized as a regenerating forest fragment,

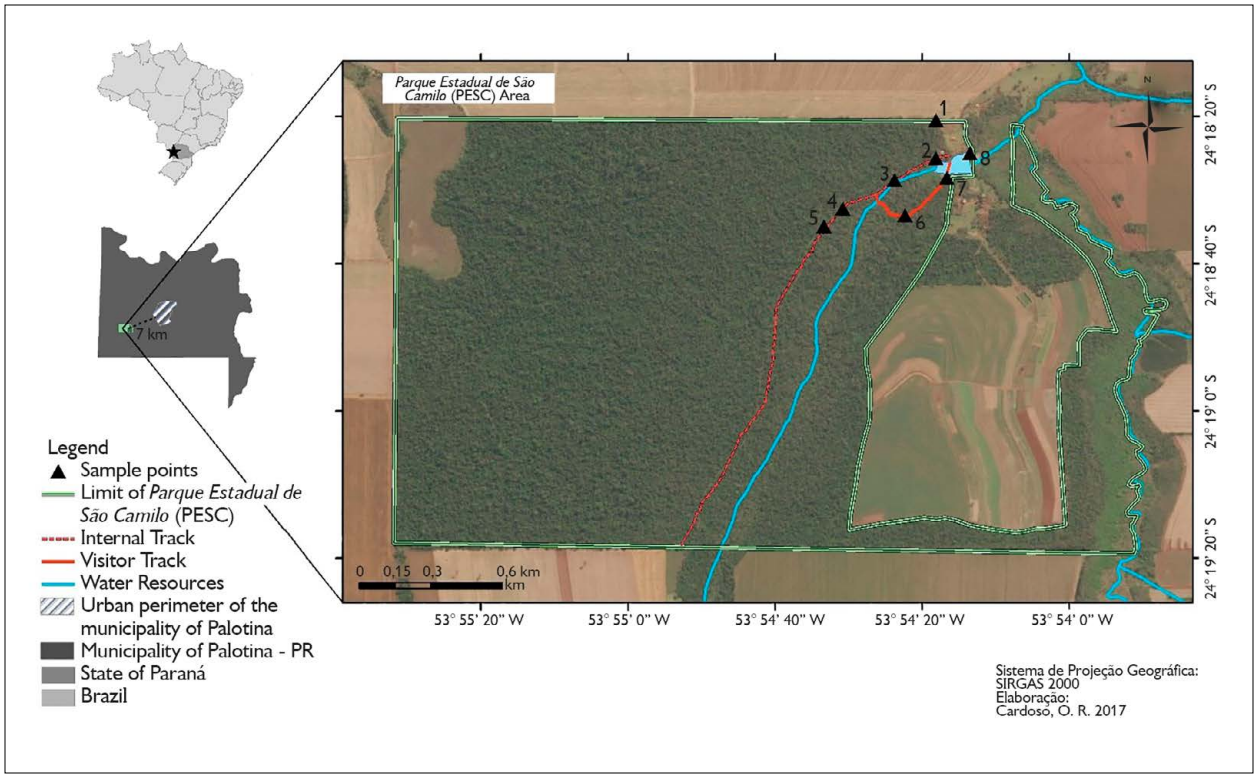

Figure 1. Map of the *Parque Estadual de São Camilo* in the municipality of Palotina, Paraná state, Brazil, and location of the eight (1 to 8) sample sites (triangles). Map: O. R. Cardoso (2017).

featuring clearings and a patchy canopy that covers most of its area (Kozera & Peluci, 2015; Kramer et al., 2023; Ribas et al., 2023). The vegetation is predominantly composed of pioneer and early secondary species, presenting several lianas and Piperaceae species in the understory (Kramer et al., 2023). The climate of the region is Subtropical Humid (Cfa), with hot summers, without a defined dry season, and a low frequency of frosts (Alvares et al., 2013).

SAMPLING OF BATS

Bat specimens were sampled monthly during four nights of third quarter or new Moon from September 2016 to August 2017, totaling 288 hours of sampling in 48 nights. Eight mist nets (12 × 2.5 m, mesh of 20 mm) were used for the sampling. The mist nets were opened after sunset and remained for six hours; they were checked every 20 minutes to prevent harm to the captured bats.

To sample the bat community, mist nets were strategically placed at eight different sites (Figure 1), with one mist net per site. Site 1 was located at the transition between PESC and an agricultural area. Site 2 to 5 consisted of four mist nets (one per location) arranged along an inner trail approximately 6 meters wide that cuts through the park from east to south. These sites were characterized by clearings and areas with closed canopy and located at distances of 60 m, 245 m, 485 m, and 590 m from the PESC edge, respectively. Site 6 was situated on a narrow (1 m) and winding trail designed for visitors, which had a closed canopy. Site 7 was positioned in an area of riparian vegetation next to the lake, at the end of a bridge, while site 8 was an open area next to the lake (Figure 1).

The captured bats were removed from the mist nets, placed in cotton bags, and taken to the field base, where they were identified. The bats were identified

based on the keys by Gardner (2008), Gregorin and Taddei (2002) and Miranda et al. (2011); Nomenclature follow the former two studies and Cláudio et al. (2023) for the genus *Neoeptesicus*. The bats were tagged with numbered metal rings (code: PESC) in order to identify the recaptured individuals. After the screening they were released at the same site where they were captured. At least one specimen of each species was collected as *voucher* material, as well as specimens that were difficulty to identify in the field. Permits to capture and handle the animals were provided by the *Instituto Chico Mendes de Conservação da Biodiversidade* (ICMBio) (License 43560-2). The procedures followed the ethical principles of the *Conselho Nacional de Controle de Experimentação Animal* (CONCEA) and were approved by the *Comissão de Ética no Uso de Animais* (CEUA) of the *Universidade Federal do Paraná*, *Setor Palotina* (CEUA – nº 39/2014). The *voucher* specimens were deposited at the zoological collection of the *Museu de História Natural do Capão da Imbuia* (MHNCI), Curitiba, Paraná state, Brazil, where they are preserved in 70% ethanol (Appendix 1).

DATA ANALYSIS

The sampling effort was calculated using mist net area per hour, following Straube & Bianconi (2002). A rarefaction and extrapolation curves were constructed to assess if the sample effort was adequate for estimating the bat richness of PESC (Chao et al., 2014). This analysis estimated the number of species that could be captured if the number of captures were doubled, and a 95% confidence interval was also estimated. The 'iNEXT' package in the R platform was utilized for these analyses (Hsieh et al., 2016).

The observed frequency for each species was calculated by dividing the number of nights in which the species was captured by the number of nights of capture. To evaluated species constancy (C), each species was then classified as common (C > 50%), relatively common (25 < C < 50%), or rare (C < 25%) within the sample (Dajoz, 1983).

Ecological indices, including abundance, species richness (S), Pielou's equitability (J), and Shannon-Wiener diversity (H'), were calculated for each sampling site based on data collected throughout the sampling period. However, due to the low number of specimens captured (n = 2) in site 6, indices were not calculated for it. Indices were calculated in the PAST software (Hammer et al., 2001).

RESULTS

With a sampling effort of 69,120 m²/h, a total of 380 bat specimens belonging to 12 species and three families were captured (Figure 2, Table 1). Throughout the sampling period, 26 individuals were

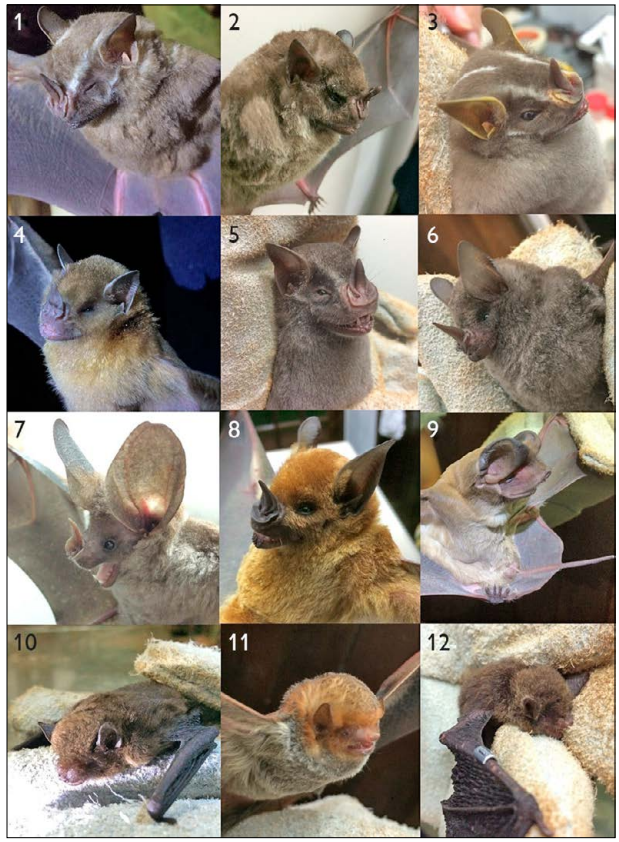

Figure 2. Species registered in *Parque Estadual de São Camilo*, Paraná state, Brazil: 1 - *Artibeus lituratus*; 2 - *Artibeus fimbriatus*; 3 - *Platyrrhinus lineatus*; 4 - *Sturnira lilium*; 5 - *Artibeus planirostris*; 6 - *Carollia perspicillata*; 7 - *Chrotopterus auritus*; 8 - *Phyllostomus hastatus*; 9 - *Eumops glaucinus*; 10 - *Neoeptesicus furinalis*; 11 - *Lasiurus blossevillii*; 12 - *Myotis nigricans*.

Table 1. Observed frequency (OF), feed habit, and constancy index (CI) of bat species, and sample sites in which they were found in the *Parque Estadual de São Camilo*, Paraná state, Brazil. C= Common (C > 50%); RC = Relatively Common (25 < C < 50%); R = Rare (C < 25%). Simple sites number as in Figure 1.

Taxa	OF (%)	Feed habit	CI	Sample Sites
Phyllostomidae				
Stenodermatinae				
Artibeus fimbriatus Gray, 1838	10.5	Frugivorous	C	1, 2, 3, 4, 5, 7, and 8
Artibeus lituratus (Olfers, 1818)	40.0	Frugivorous	C	1, 2, 3, 4, 5, 7, and 8
Artibeus planirostris (Spix, 1823)	0.8	Frugivorous	R	1 and 3
Platyrrhinus lineatus (E. Geoffroy, 1810)	1.3	Frugivorous	R	1, 2, and 3
Sturnira lilium (E. Geoffroy, 1810)	33.2	Frugivorous	C	1, 2, 3, 4, 5, 6, 7 and 8
Carolliinae				
Carollia perspicillata (Linnaeus, 1758)	4.7	Frugivorous	RC	1, 2, 3, 4, 5, 7, and 8
Phyllostominae				
Chrotopterus auritus (Peters, 1856)	0.5	Carnivorous	R	3 and 4
Phyllostomus hastatus (Pallas, 1767)	4.5	Omnivorous	R	2, 3, 4, and 5
Vespertilionidae				
Vespertilioninae				
Neoeptesicus furinalis (d'Orbigny & Gervais, 1847)	0.5	Insectivorous	R	2 and 8
Lasiurus blossevillii (Lesson & Garnot, 1826)	0.3	Insectivorous	R	7
Myotinae				
Myotis nigricans (Schinz, 1821)	3.4	Insectivorous	RC	1, 2, 3, 4, and 6
Molossidae				
Molossinae				
Eumops glaucinus (Wagner, 1843)	0.3	Insectivorous	R	8

recaptured in different months, resulting in a total of 406 captures. The rarefaction curve did not reach its asymptote, and the extrapolation curve and the 95% confidence interval with twice the number of captures, between 8 and 17 species were expected (Figure 3). The recorded number of species represents about 70% of the estimated bat richness for this area. All species examined in this study were classified as low concern according to the International Union for Conservation of Nature's Red List of Threatened Species (IUCN, 2022).

Phyllostomidae was the most abundant (n = 363 specimens; 95.5%), followed by Vespertilionidae (n = 16; 4.2%), and Molossidae (n = 1; 0.3%). The most frequent subfamily of the Phyllostomidae were Stenodermatinae (90% of the captures), followed by Phyllostominae (5%), and Carollinae (5%). *Artibeus lituratus*, *S. lilium*, and *A. fimbriatus* were the most frequent species, accounting for 84% of the sampled specimens, and were the only species classified as constant in the sample. *Carollia perspicillata* and *M. nigricans* were relatively common, and the other seven species were rare (Table 1).

The 26 recaptured specimens were *A. lituratus* (n = 9), *A. fimbriatus* (n = 7), *S. lilium* (n = 6), and *P. hastatus* (n = 4). Most of them (73%) were recaptured in other sites than that they were captured. The shortest

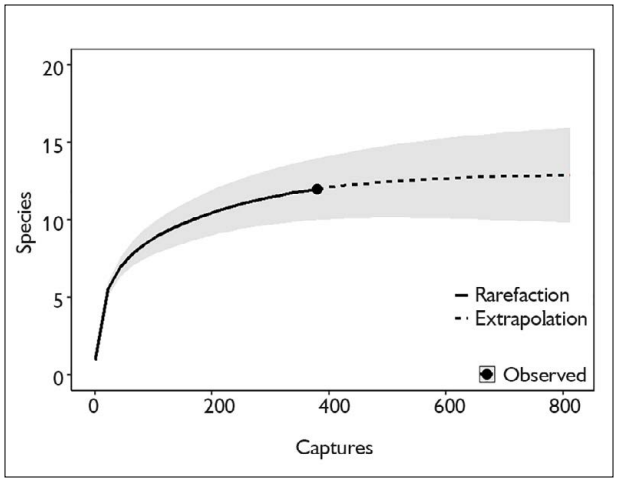

Figure 3. Estimated species accumulation curves (solid line) and extrapolated (dotted line) of bat assemblage at the *Parque Estadual de São Camilo*, Paraná state, Brazil. The dotted line is a representation of the doubled number of captures. The shaded area represents the 95% confidence interval.

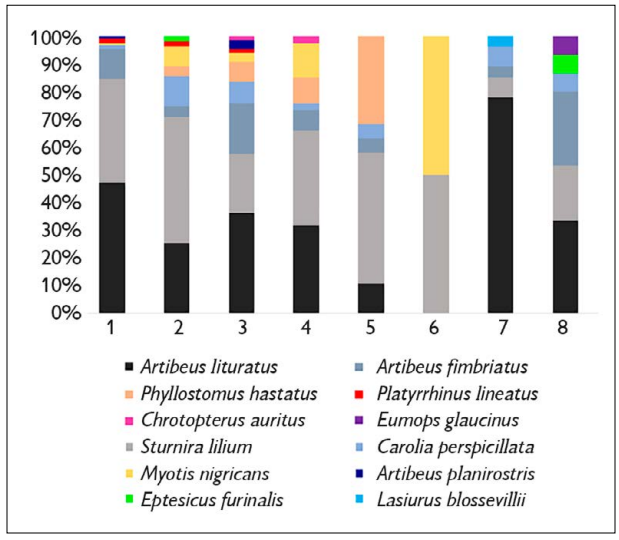

Figure 4. Frequency of species per sample site (1 to 8), considering the 12-bat species captured in the *Parque Estadual de São Camilo*, Paraná state, Brazil.

recaptures occurred one month after the first capture, while the longest occurred 10 months later. A specimen of *P. hastatus* that was captured in January 2017 at site 4 was recaptured three times during three consecutive months (April, May, and June 2017) in different sample sites, but all on the inner trail (sites 5, 3, and 2, respectively).

The captured species are from four trophic guilds. The most frequent guild was frugivorous (90.5%), followed by insectivorous (4.5%), omnivorous (4.5%) (only *P. hastatus*) and carnivorous (0.5%) (only *C. auritus*). Frugivorous species were found in all sampled sites, but they were more frequent in the forest edge (Site 1), especially the three most abundant species — *A. lituratus*, *S. lilium* and *A. fimbriatus*. *Phyllostomus hastatus* and *C. auritus* were found only in the interior of the forest fragment, in the inner trail, usually at distances greater than 200 m from the forest fragment edge. Insectivorous species were captured near the lake and in sites near the forest fragment edge, except *M. nigricans*, which was found mainly in the sites at the interior of the forest fragment (Figure 4).

The highest abundance of bats was found in Site 1 (transition area between the forest fragment and an agricultural area), but it presented low diversity and equitability (Table 2). The highest species richness and diversity were found in Site 3 (inner trail, 245 m from the edge). The second highest diversity and the highest equitability were found in Site 8 (open area by the lake) (Table 2).

Table 2. Ecological indexes per sample site of bats in the *Parque Estadual de São Camilo*, Paraná state, Brazil.

	1	2	3	4	5	7	8	General
Abundancy	155	55	66	41	19	27	15	380
Richness	7	8	9	7	5	5	6	12
Diversity (H')	1.16	1.48	1.74	1.59	1.26	0.82	1.58	1.59
Equitability (J)	0.60	0.71	0.79	0.81	0.78	0.51	0.88	0.64

DISCUSSION

The number of bat species recorded (12 species) represents 19% of the species found in the Paraná state (Passos et al., 2010), and 31% of the species found in semideciduous seasonal forests (Miretzki, 2003). Batista & Aranha (2017) conducted a preliminary survey of bats in the municipality of Palotina and recorded 12 species. While *Molossus molossus* (Pallas, 1766), *Molossus rufus* E. Geoffroy, 1805, and *Eumops auripendulus* (Shaw, 1800) were not found in PESC, the present study identified new species for the municipality: *C. perspicillata*, *C. auritus*, and *P. hastatus*, increasing the total number of recorded bat species in Palotina to 15 species.

Bats surveys in other semideciduous seasonal forest fragments in the Paraná state, in areas similar in size to the PESC, or using the same sampling methodology or similar sample effort, found a similar species richness (Bianconi et al., 2004; Ortêncio-Filho et al., 2005; Brito et al., 2010; Gazarini & Pedro, 2013). However, a higher species richness than that found in the present study was found in larger and less impacted forest fragments, such as the Iguaçu National Park (Sekiama et al., 2001), in the floodplain region of the Paraná River (Ortêncio-Filho & Reis, 2009), as well as in a long-term study, including complementary methodologies to mist nets, in the *Parque Estadual Mata dos Godoy* and in the *Parque Municipal Arthur Thomas* (Reis et al., 2003). In the present study, the use of complementary methodologies to mist nets, such as active search for diurnal roosts and canopy sampling, would result in a higher number of species captured in PESC (Reis et al., 2003; Carvalho et al., 2013).

Regarding species frequency and constancy, studies conducted in both Brazil and the Neotropical region commonly report a high frequency of Phyllostomidae species as found in the present study. While Brazil has 92 recorded species, the family is represented by 226 species in the Neotropical region (Nogueira et al., 2014; Díaz et al., 2021). Moreover, the use of ground-level mist nets favors the capture of frugivorous Phyllostomidae species, as insectivorous species have the most accurate echolocation system, detecting the nets (Pedro & Taddei, 1997). On the other hand, Molossidae species fly above the canopy, thus, they are rarely captured in mist nets in forest fragments (Dias et al., 2002; Gazarini & Pedro, 2013), but are commonly caught in nets set over lakes or streams in open areas (Costa et al., 2012). The only specimen of the family Molossidae recorded was captured at the site by the lake. Active search for diurnal roosts also may results in more captures or records of Molossidae species (Reis et al., 2006).

The composition of the bat community in the PESC was also similar to those found in other semideciduous seasonal forest fragments in the state of Paraná, with few exceptions. *Artibeus lituratus*, and *S. lilium* are commonly the most abundant species in semideciduous seasonal forest fragments (Sekiama et al., 2001; Ortêncio-Filho et al., 2005; Gazarini & Pedro, 2013). *Carollia perspicillata* is abundant in some forest fragments (Bianconi et al., 2004; Ortêncio-Filho & Reis, 2009; Silveira et al., 2011), but in other locations it has a low frequency (Sekiama et al., 2001; Gazarini & Pedro, 2013; Silva et al., 2013) as in the present study. Further studies should evaluate the variation in the abundance of *C. perspicillata* among different localities in the state of Paraná, given that this species can be found in forest fragments with similar sizes and phytophysiognomy, yet with widely varying abundances. This variability may be explained by local and landscape factors such as resource availability, the presence or absence of competitors and predators, and the presence or absence of ecological corridors (Borray-Escalante et al., 2022; Pena-Cuellar & Benitez-Malvido, 2021; Stevens, 2022), but requires further investigation.

The species *Phyllostomus hastatus*, that usually had only one to three specimens frequently captured in studies using mist nets (Miretzki & Margarido, 1999; Ortêncio-Filho & Reis, 2009; Gazarini & Pedro, 2013), had 17 specimens captured in the PESC, with four recaptures. This observation suggests a larger population of this species within the PESC. The abundance of the frugivorous species *P. lineatus* varies throughout its geographic distribution (Reis et al., 2003; Esbérard et al., 2010; Gazarini & Pedro, 2013). In urban forest fragments of Palotina several specimens

were found (Batista & Aranha, 2017). Therefore, the species was expected to be more abundant in the PESC, but it was considered rare in the area. Few records of *E. glaucinus* are known from the state of Paraná (Miretzki, 2003; Reis et al., 2006; Manhães, 2017). The species had already been recorded in Palotina by capturing an individual that was found lying on the ground (Batista & Aranha, 2017).

Regarding the trophic guilds, frugivorous species were more frequent. This pattern is common in forest fragments in the Neotropical region due to the high availability and variety of fruit species throughout the year (Dias et al., 2002; Passos et al., 2003; Gregorin et al., 2008; Moratelli et al., 2010). Moreover, frugivorous species were captured mainly in the forest fragment edge because their diet is based mainly on pioneer plant species (Cecropiaceae, Moraceae, Piperaceae, and Solanaceae) that are more abundant during the first stages of the forest succession and in degraded forests (Mikich, 2002; Passos et al., 2003; Silveira et al., 2011). These fruits are commonly found in great abundance in altered environments, such as clearings and edges of forests (Schulze et al., 2000; Silva et al., 2013); consequently, frugivorous specimens forage more in these environments. Although the highest abundance of frugivorous species was found in the edge areas of PESC, the constant frequency of these species in the interior of the forest can be explained by the predominant vegetation composition in the area. PESC is characterized as a forest fragment in an advanced stage of regeneration, with clearings and a discontinuous canopy covering most of the park, which consequently maintains vegetation rich in pioneer and early secondary species (Kozera & Peluci, 2015; Kramer et al., 2023). The abundant presence of pioneer species, especially from the Piperaceae family (Kramer et al., 2023), combined with a greater diversity of resources such as prey and water bodies within the forest, may have played a significant role in the observed diversity and equitability within the forest. These plants were consistently observed near mist nets at all points within the forest.

On the other hand, insectivorous species exhibit, in general, greater activity in forest fragment edges (Morris et al., 2010; Silva et al., 2013; Barros et al., 2014), and forested areas at the first hours after sunset (Almeida et al., 2014), indicating that these species seek shelter in the interior of the forest and forage in the forest edge. The exception to this pattern is the genus *Myotis*, which avoids edges and remains in the interior of forests (Morris et al., 2010). The presence of water bodies also affects the distribution of insectivorous bats, because they attract many insects and, consequently, foraging bats (Costa et al., 2012; Barros et al., 2014; Dias-Silva et al., 2018). Throughout this study, this pattern of behavior happened, with insectivorous species predominantly captured at the edge of PESC and in locations near water bodies, whereas *M. nigricans* was primarily captured inside the forest.

In the present study, *C. auritus* and *P. hastatus* were found only in the interior of the forest fragment. *Chrotopterus auritus* is a carnivorous bat species that feeds on other vertebrates, but can also include fruits in its diet (Uieda et al., 2007; Gual-Suárez & Medellín, 2021). Carnivorous bats have preference for preserved environments due to the better opportunities for lurking, hunting, and a higher abundance of prey in comparison to areas impacted by human activities (Gorresen & Willig, 2004). Consequently, they can be considered as one of the most suitable groups for evaluating the effects of human activities on Neotropical forests (García-Morales et al., 2013). The presence of these bats in PESC may be indicative of a high-quality environment.

Phyllostomus hastatus is an omnivorous bat species with a diverse diet that includes fruits, arthropods, and small vertebrates (Santos et al., 2003). Omnivorous bats have been shown to have neutral responses to most anthropogenic areas due to their adaptable feeding behavior (García-Morales et al., 2013). Despite being found in degraded areas, preserving its natural habitat remains essential for the conservation of the population of this species (Rocha et al., 2017; Resende et al., 2019). The exclusive capture of *P. hastatus* as well as its recaptures inside the forest suggest a possible preference of the species for more preserved environments in the PESC, possibly

at the expense of a higher quality of resources for their maintenance.

The PESC, a valuable forest fragment situated in a highly degraded region, serves as a habitat for endemic and endangered fauna species, as evidenced by the study conducted by Ribas et al. (2023). Although no endangered bat species were specifically identified, the preservation of forest areas in secondary succession, exemplified by the PESC, has been proven to enhance both taxonomic and functional diversity among bats. This phenomenon particularly benefits old-growth specialists like carnivorous phyllostomids, as demonstrated in previous studies by Farneda et al. (2018), Rocha et al. (2018), and Brändel et al. (2020), which is further supported by the presence of *C. auritus* in this study.

Based on these findings, we propose conducting additional research in the PESC, with a specific focus on previously unexplored areas, such as the northwestern region of the park. This region, as described by Ribas et al. (2023), exhibits a distinct landscape compared to the rest of the park, providing an opportunity to expand our inventory of bat species. Moreover, implementing methodologies like daytime roost surveys can enhance the documentation of bat species in PESC, particularly those that are not easily captured using mist nets. The present study highlights PESC as an excellent research laboratory, emphasizing the significance of investigating the population dynamics and ecology of bats in order to gain comprehensive insights into their behavior within this important conservation area.

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AUTHORS' CONTRIBUTION

Mateus Rocha Ribas contributed with conceptualization, data curation, research, methodology, writing (original draft, review and editing), validation, visualization; Sara Cristina Batista with conceptualization, data curation, funding acquisition, research, methodology, project management, resources, supervision, validation, visualization, writing (original draft); and José Marcelo Rocha Aranha with acquisition of funding, project administration, resources, supervision, validation, visualization.

Appendix 1. List of species collected in the *Parque Estadual de São Camilo*, in the municipality of Palotina, western Paraná state, Brazil, from September 2016 to August 2017, deposited in the zoological collection of the *Museu de História Natural do Capão da Imbuia*. Abbreviation: CTX – *Setor de Taxonomia*.

Field number	Species	CTX No.
PESC 01	*Neoeptesicus furinalis* (d'Orbigny & Gervais, 1847)	CTX 10239
PESC 02	*Artibeus lituratus* (Olfers, 1818)	CTX 10240
PESC 03	*Myotis nigricans* (Schinz, 1821)	CTX 10241
PESC 04	*Phyllostomus hastatus* (Pallas, 1767)	CTX 10242
PESC 05	*Artibeus fimbriatus* Gray, 1838	CTX 10243
PESC 06	*Neoeptesicus furinalis* (d'Orbigny & Gervais, 1847)	CTX 10244
PESC 07	*Chrotopterus auritus* (Peters, 1856)	CTX 10245
PESC 10	*Myotis nigricans* (Schinz, 1821)	CTX 10246
PESC 11	*Artibeus planirostris* (Spix, 1823)	CTX 10247
PESC 13	*Lasiurus blossevillii* (Lesson & Garnot, 1826)	CTX 10248
PESC 14	*Carollia perspicillata* (Linnaeus. 1758)	CTX 10249
PESC 15	*Eumops glaucinus* (Wagner, 1843)	CTX 10250
PESC 16	*Sturnira lilium* (E. Geoffroy, 1810)	CTX 10251
PESC 17	*Artibeus lituratus* (Olfers, 1818)	CTX 10252
PESC 18	*Platyrrhinus lineatus* (E. Geoffroy, 1810)	CTX 10253