

Spatial configuration of the occurrence of bat species (Mammalia: Chiroptera) in eastern Mato Grosso, Brazil

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Abstract: Given the substantial lacunas in the understanding of the occurrence and distribution of bat species in the eastern portion of the Brazilian state of Mato Grosso (Araguaia basin), this study presents an inventory of the species known to occur in the region, highlighting the areas sampled adequately and the species known to occur in conservation units. Georeferenced records of the occurrence of bat species in the region were obtained from published studies, scientific collections, through either the *SpeciesLink* network or directly from the curator, as well as the capture of specimens by our research group between 2008 and 2013. A 0.5° x 0.5° (latitude/longitude) grid was added to the map of the region for the quantification of the bat species richness of each grid cell. A total of 63 chiropteran species were recorded for the study area. Only 10 of the 30 grid cells had records of bats, and just three contained more than 20 species, and were considered to be sampled adequately on a minimal level. Bat species have been recorded in three conservation units, two state and one municipal. The number of species recorded represents 82.7% of the total of chiropterans known to occur in Mato Grosso, although 12 species were recorded in the state for the first time, reinforcing the paucity of data available on the distribution of bats in the region. The high bat species richness recorded in the present study reinforces the importance of eastern Mato Grosso, a transition zone between the Amazon forest and the Cerrado savanna of central Brazil, for the conservation of Neotropical chiropterans.

Keywords: *Cerrado savanna, geographic distribution, conservation units, chiropterans.*

OLIVEIRA, S.L., SOUZA, L.A.S., SILVA, H.K., FARIA, K.C. **Configuração espacial da ocorrência de espécies de morcegos (Mammalia: Chiroptera) no leste de Mato Grosso, Brasil.** *Biota Neotropica*. 15(1): e20140122. <http://dx.doi.org/10.1590/1676-06032014012214>

Resumo: Frente à lacuna existente sobre a real ocorrência e distribuição das espécies de morcegos objetivamos listar as espécies registradas na região leste do estado de Mato Grosso, Brasil, apontando os locais minimamente amostrados e as espécies catalogadas dentro das Unidades de Conservação. Foram consideradas espécies com registros georreferenciados para a região disponibilizados por periódicos científicos, coleções científicas, por meio do sistema *SpeciesLink* ou disponibilizados diretamente pela curadoria, além de capturas realizadas entre 2008 e 2013 pelo nosso grupo de pesquisa. Ao mapa da região leste do estado foi incorporado células de 0,5° latitudinais X 0,5° longitudinais e quantificadas sobre a riqueza de espécies de morcegos em cada célula. Foram registradas 63 espécies para a região. Das 30 células geradas 10 tiveram pelo menos uma espécie registrada e três tiveram mais de 20 espécies sendo consideradas minimamente amostradas. Três Unidades de Conservação tiveram espécies catalogadas, sendo duas estaduais e uma municipal. A região leste teve o registro de 82,7% do total de espécies conhecidas para o estado de Mato Grosso, sendo que 12 ainda não haviam sido assinaladas para o estado demonstrando que ainda pouco se conhece sobre a real distribuição dos morcegos na região. Considerando a alta riqueza encontrada enfatizamos a importância da região leste de Mato Grosso, zona de transição entre Cerrado e Amazônia, e também o potencial do estado na conservação dos morcegos neotropicais.

Palavras-chave: *Cerrado, distribuição geográfica, unidades de conservação, quirópteros.*

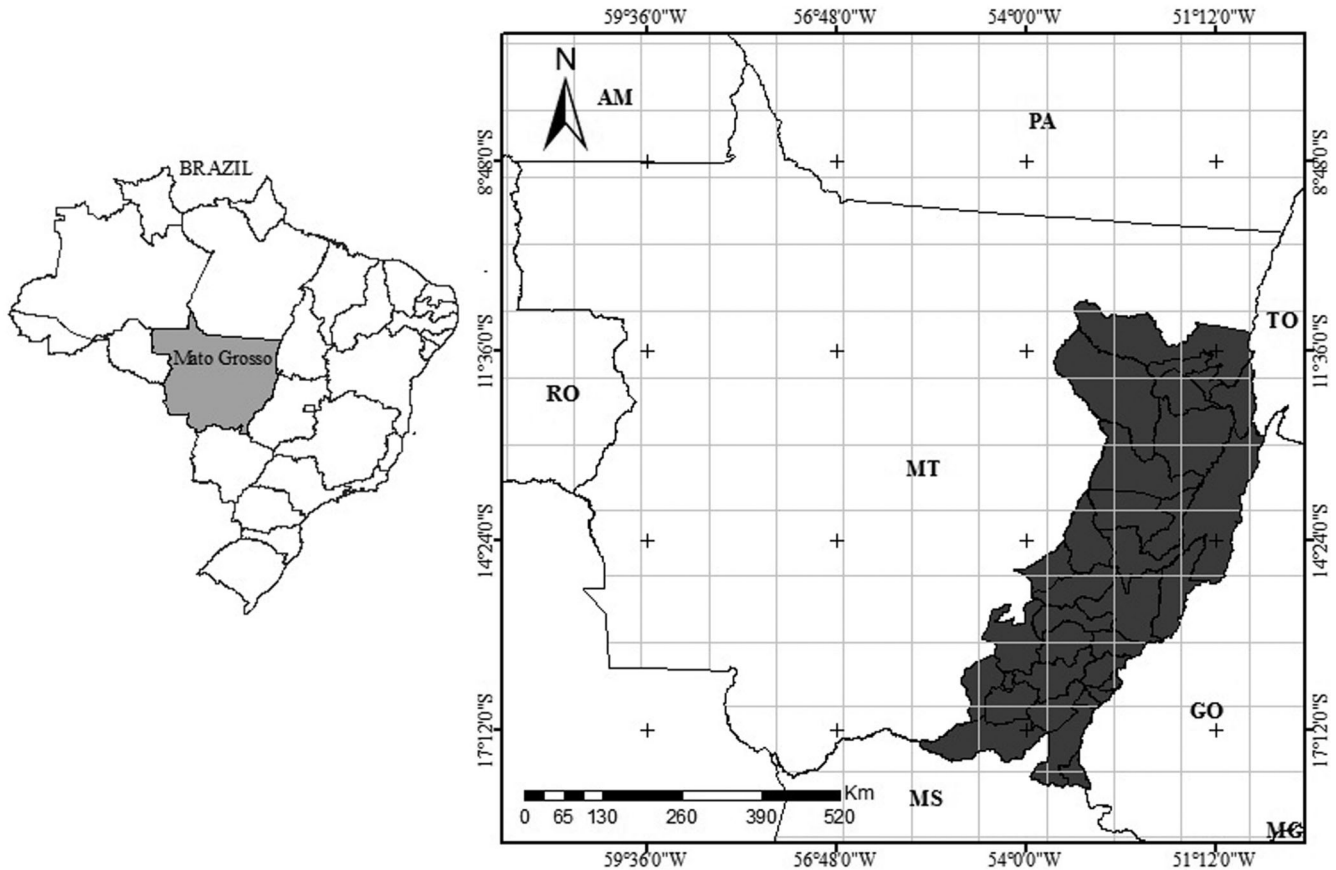


Figure 1. Map of Brazil, showing the state of Mato Grosso and in the inset, the study area in the east of the state and the 0.5° x 0.5° (latitude x longitude) cells established for the present study.

Introduction

The Brazilian state of Mato Grosso encompasses part of three of the country's terrestrial biomes – the Amazon forest, the Cerrado savanna, and the Pantanal wetlands – and thus plays an important role in the conservation of Neotropical biodiversity. The Cerrado, Brazil's second-largest biome, is characterized by a unique configuration of vegetation types with an ample variety of habitats and considerable biodiversity, which is not only poorly-known, but also seriously threatened by the ongoing fragmentation of habitat (Oliveira et al. 2008). This biome, considered to be a hotspot for biodiversity conservation (Myers et al. 2000) has 32 endemic mammal species, of which one is a bat (Ribeiro & Walter 2008; Paglia et al. 2012). Bats are highly mobile, which contributes to their effectiveness as pollinators and seed dispersers, providing important ecological services for dozens of plant species (Mikich & Bianconi 2005).

Despite their ecological importance, the distribution of most bat species in Brazil is still poorly defined. The number of surveys and inventories has increased considerably in recent years, although most of this research has focused on the Atlantic Forest of southeastern Brazil (Bernard et al. 2011). Most research in the Cerrado has been conducted in the states of Goiás, Minas Gerais, and Distrito Federal (Aguilar & Zortéa 2008). Of the 178 bat species known to occur in Brazil, 101 have been recorded in the Cerrado (Paglia et al. 2012; Reis et al. 2013; Nogueira et al. 2014).

While almost half of Brazilian species (81) are known to occur in Mato Grosso, most of the studies have focused on sites in the vicinity of the state capital, Cuiabá, while major lacunas still exist in the north and east of the state (Aguilar & Zortéa, 2008, Bernard et al. 2011, Reis et al. 2013). The areas of Cerrado in eastern Mato Grosso are among those considered to be of the highest priority for the conservation of species, and have been identified by some authors (Horta et al. 2002; Bernard et al. 2011) as extremely important for the maintenance of bat species. Given this interest, the region's biodiversity has been the focus of numerous studies (e.g. Pine et al. 1970, Silva & Anacleto 2011, Sousa et al. 2011, 2013a, b, Oliveira et al. 2013), although its bat fauna is still relatively poorly studied.

Considering the need for new data and the updating of the inventory of the state's bat fauna, the present study compiled the data available on the occurrence of bat species in its eastern region. The study emphasizes the areas considered to be most adequately sampled, and the species recorded in three of the region's conservation units.

Material and Methods

The present study focused on eastern Mato Grosso (Brazil), within an area delimited to the south by the municipalities of Alto Araguaia, Alto Taquari, and Itiquira, and to the north by São Félix do Araguaia, including the basins of the Araguaia and das Mortes rivers (Figure 1). The region is characterized by

Bat species in eastern Mato Grosso, Brazil

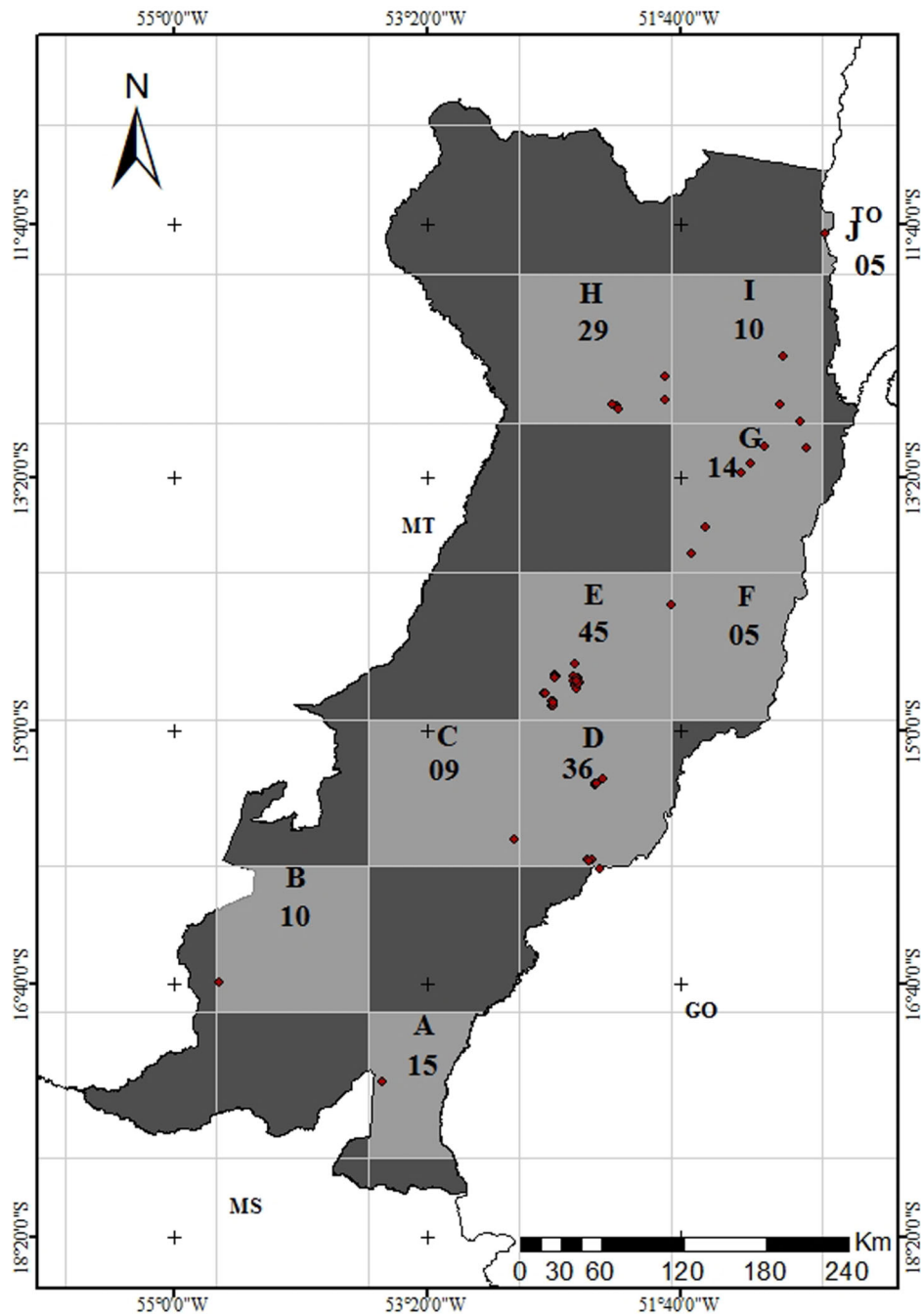


Figure 2. Map of eastern Mato Grosso showing the $0.5^{\circ} \times 0.5^{\circ}$ cells in which at least one bat species has been recorded, identified by the letters A–J. The numbers refer to the species richness recorded in each cell. \blacklozenge = sites at which specimens were captured.

the diverse habitats typical of the Cerrado biome, which suffers the influence of the neighboring areas of the Amazon forest in the north. The region's climate is of the AW in the Köppen classification systems, and is characterized by distinct dry and rainy season, with mean annual temperatures of between 23°C and 25°C (Silva et al. 2008). It also includes conservation units, such as the Araguaia and Serra Azul state parks, which provide important infrastructure for research.

Georeferenced records of the occurrence of bats within this region were obtained from published studies (Pine et al. 1970, Silva & Anacleto 2011, Sousa et al. 2011, 2013a, b; Oliveira

et al. 2013), scientific collections with records available on the *SpeciesLink* network: (CM–UNEMAT, ZUEC-MAM – UNICAMP and MCP-Mammals – PUC/RS), or made available by their curators (CCMZ-UFPR), and the capture of specimens by the authors of the present study within the region between 2008 and 2013. The voucher specimens resulting from these captures were deposited at the Nova Xavantina campus of the Mato Grosso State University (UNEMAT).

The spatial distribution of bat species in the region was mapped using procedures adapted from Bernard et al. (2011), which included the incorporation of a $0.5^{\circ} \times 0.5^{\circ}$ (latitude/

Table 1. List of the bat species recorded in eastern Mato Grosso, Brazil. The letters refer to the respective grid cells (see Figure 2). The species not recorded previously for Mato Grosso (Reis *et al.* 2013) are indicated by an asterisk (*). Sources are: (1) present study (specimens collected between 2008 and 2013); (2) Oliveira *et al.* (2013); 3 – Sousa *et al.* (2013a); 4 – Sousa *et al.* (2013b); 5 – Silva & Anacleto (2011); 6 – Sousa *et al.* (2011); 7 - Pine *et al.* (1970); 8 – CM - UNEMAT; 9 – MCP-Mammals – PUC/RS; 10 – ZUEC-MAM - UNICAMP; 11 – CCMZ-UFPR.

Family/ Subfamily / Species	Grid cells									
	A	B	C	D	E	F	G	H	I	J
EMBALLONURIDAE										
Emballonurinae										
<i>Centronycteris maximiliani</i> (J. Fisher, 1829) *	-	-	-	-	-	-	8	-	-	-
<i>Peropteryx macrotis</i> (Wagner, 1843)	-	-	-	1	1	-	-	-	-	-
<i>Saccopteryx bilineata</i> (Temminck, 1838)	-	-	-	10	-	-	-	7	-	-
<i>Saccopteryx leptura</i> (Schreber, 1774)	-	-	-	-	1	-	1	7	-	-
<i>Rhynchonycteris naso</i> (Wied-Neuwied, 1820)	-	-	-	10	1, 4	-	-	7	-	-
PHYLLOSTOMIDAE										
Desmodontinae										
<i>Desmodus rotundus</i> (E. Geoffroy, 1810)	-	11	9	1	1, 4, 8	-	-	-	-	-
Glossophaginae										
<i>Anoura caudifer</i> (E. Geoffroy, 1818)	-	-	-	1	1, 4, 5	-	-	-	-	-
<i>Anoura geoffroyi</i> Gray, 1838	11	-	9	1	-	-	-	-	-	-
<i>Glossophaga soricina</i> (Pallas, 1766)	11	-	9	1, 8	1, 4, 5, 8	-	1, 8	7	1	1
<i>Lonchophylla dekeyseri</i> (Taddei, Vizotto & Sazima, 1983)	11	11	-	1	1	-	-	-	-	-
Phyllostominae										
<i>Chrotopterus auritus</i> (Peters, 1856)	-	-	-	1	-	-	-	-	-	-
<i>Lampronnycteris brachyotis</i> (Dobson, 1879) *	-	-	-	1	1	-	-	-	-	-
<i>Lonchorhina aurita</i> Tomes, 1863 *	-	-	-	-	8	-	-	-	-	-
<i>Lophostoma brasiliense</i> Peters, 1867	11	-	-	1	1, 4, 8	-	-	-	-	-
<i>Lophostoma silvicolum</i> d'Orbigny, 1836	-	11	-	1	1, 4	-	1	-	-	-
<i>Micronycteris microtis</i> Miller, 1898 *	-	11	-	-	-	-	-	-	-	-
<i>Micronycteris minuta</i> (Gervais, 1856)	-	-	-	1	-	-	-	-	-	-
<i>Micronycteris schmidtorum</i> Sanborn, 1935 *	11	11	-	-	-	-	-	-	-	-
<i>Mimon benettii</i> (Gray, 1838)	-	-	-	1	-	-	-	-	-	-
<i>Mimon crenulatum</i> (E. Geoffroy, 1803)	11	-	-	-	1, 2	-	-	7	1	-
<i>Phylloderma stenops</i> Peters, 1865	-	-	-	-	1	-	-	-	-	-
<i>Phyllostomus discolor</i> Wagner, 1843	11	11	-	-	1, 4, 8	-	-	-	-	-
<i>Phyllostomus elongatus</i> (E. Geoffroy, 1810)	-	-	-	-	1, 4, 5	-	-	-	-	-
<i>Phyllostomus hastatus</i> (Pallas, 1767)	-	-	-	-	1, 4, 5, 8	-	-	-	-	-
<i>Tonatia bidens</i> (Spix, 1823)	-	11	-	1	-	-	-	-	-	-
<i>Tonatia saurophila</i> Koopman & Williams, 1951 *	-	-	-	1	-	-	-	-	-	-
<i>Trachops cirrhosus</i> (Spix, 1823) *	-	-	-	1	1, 3, 4, 8	-	-	-	-	-
<i>Vampyrum spectrum</i> (Linnaeus, 1758)	-	-	-	-	4, 6	-	-	-	-	-
Carollinae										
<i>Carollia perspicillata</i> (Linnaeus, 1758)	11	11	9	1, 10	1, 4, 5, 8	1, 8	1, 8	7	1	1
<i>Rhinophylla pumilio</i> Peters, 1865	-	-	-	1	1	-	-	7	-	-
Stenodermatinae										
<i>Ametrida centurio</i> Gray, 1847	-	-	-	-	-	-	-	7	-	-
<i>Artibeus concolor</i> Peters, 1865 *	-	-	9	-	-	-	-	-	-	-
<i>Artibeus lituratus</i> (Olfers, 1818)	-	-	-	1, 10	1, 4, 5	1	1	7	1	1
<i>Artibeus obscurus</i> (Schinz, 1821)	-	-	-	-	1	-	-	-	-	-
<i>Artibeus planirostris</i> (Spix, 1823)	11	11	-	1, 10	1, 4, 5, 8	1, 8	1	7	1	1
<i>Chiroderma trinitatum</i> Goodwin, 1958	-	-	-	-	-	-	-	7	-	-
<i>Chiroderma villosum</i> Peters, 1860	-	-	-	1	1, 4, 5	-	-	7	-	-
<i>Dermanura cinerea</i> (Gervais, 1856)	11	11	-	1	1	-	-	7	-	-
<i>Dermanura gnoma</i> (Handley, 1987)	-	-	-	1	1	-	1	-	-	-
<i>Mesophylla macconnelli</i> Thomas, 1901	-	-	-	-	-	-	-	7	-	-
<i>Platyrrhinus brachycephalus</i> (Rouk & Carter, 1972)*	-	-	-	10	-	-	-	-	-	-
<i>Platyrrhinus incarum</i> (Thomas, 1912)	-	-	-	1	1, 4, 5	1	1	7	1	1
<i>Platyrrhinus lineatus</i> (E. Geoffroy, 1810)	11	-	-	1	1, 4, 5, 8	-	1	7	-	-
<i>Sturnira lilium</i> (E. Geoffroy, 1810)	11	-	-	1	1, 4, 5, 8	-	-	-	-	-
<i>Sturnira tildae</i> de la Torre, 1959	-	-	-	-	-	-	-	7	-	-

Continued on next page

Table 1. Continued.

Family/ Subfamily / Species	Grid cells									
	A	B	C	D	E	F	G	H	I	J
<i>Uroderma bilobatum</i> Peters, 1866	-	-	-	10	1, 4, 5, 8	-	1, 8	7	1	-
<i>Uroderma magnirostrum</i> Davis, 1968	-	-	-	-	1, 5	-	-	7	-	-
<i>Vampyressa pusilla</i> (Wagner, 1843) *	-	-	9	-	-	-	-	-	-	-
MORMOOPIDAE										
<i>Pteronotus gymnotus</i> Natterer, 1843	-	-	-	1	8	-	-	-	-	-
<i>Pteronotus parnellii</i> (Gray, 1843)	11	-	9	1	1, 4, 5	1	-	7	-	-
NOCTILIONIDAE										
<i>Noctilio albiventris</i> Desmarest, 1818	-	-	-	-	1, 5	-	1, 8	-	-	-
MOLOSSIDAE										
<i>Cynomops abrasus</i> (Temminck, 1827)	-	-	-	-	4	-	-	7	-	-
<i>Cynomops milleri</i> (Osgood, 1914)	-	-	-	-	-	-	-	7	-	-
<i>Eumops glaucinus</i> (Wagner, 1843)	-	-	-	-	1	-	-	-	-	-
<i>Molossops temminckii</i> (Burmeister, 1854)	11	-	-	1	1, 4, 5	-	1, 8	7	1	-
<i>Molossus molossus</i> (Pallas, 1766)	-	-	9	-	1, 4, 5	-	-	7	1	-
<i>Molossus rufus</i> E. Geoffroy, 1805	-	-	-	10	1, 5	-	-	7	-	-
<i>Nyctinomops laticaudatus</i> (E. Geoffroy, 1805)	-	-	-	1	-	-	-	-	-	-
VESPERTILIONIDAE										
<i>Eptesicus andinus</i> J. A. Allen, 1914	-	-	-	-	-	-	-	7	-	-
<i>Eptesicus brasiliensis</i> (Desmarest, 1819)	-	-	-	8	8	-	-	-	-	-
<i>Eptesicus diminutus</i> Osgood, 1915 *	-	-	-	8	4	-	-	-	-	-
<i>Eptesicus furinalis</i> (d'Orbigny & Gervais, 1847)	-	-	-	-	1	-	-	-	-	-
<i>Lasiurus blossevillei</i> (Lesson & Garnot, 1826)	-	-	-	-	-	-	-	7	-	-
<i>Lasiurus ega</i> (Gervais, 1856)	-	-	-	-	-	-	-	7	-	-
<i>Myotis nigricans</i> (Schinz, 1821)	-	-	9	-	1, 4, 5	-	8	-	8	-
<i>Myotis riparius</i> Handey, 1960 *	11	-	-	-	1	-	-	-	-	-
<i>Rhogeessa io</i> Thomas, 1903	-	-	-	-	1	-	-	7	-	-

longitude) grid using ArcGis 9.2 in the Environmental Analysis Laboratory (LANA) at UNEMAT, Nova Xavantina. The grid cells were scored according to the number of bat species recorded, and those with at least 20 species were considered to be adequately sampled on a minimal level, as established by Bernard et al. (2011). The outlines of the local federal, state, and municipal conservation units – provided by the Mato Grosso State Environment Secretariat (SEMA/MT) – were then added to the map in order to quantify the number of bat species recorded in each of these protected areas.

Results

Ten of the 30 cells demarcated for the present study returned at least one record of a bat species (Figure 2), and in three of these (D, E, and H), more than 20 species have been recorded. These cells were thus considered to have been adequately sampled on a minimal level. No records of bats were found for the other 20 cells.

A total of 67 bat species were recorded, representing 40 genera and five families (Table 1), including 12 species not included in the most recent inventory published for the state (Reis et al. 2013). Cells D, E, and H were the most diverse, with 36, 45, and 29 species, respectively (Figure 2), whereas cells F and J presented the lowest number of species, with five each.

Three of the conservation units found within the study area were sampled, providing the first data on their bat faunas. Two of these – the Serra Azul State Park and the Araguaian Chelonians State Wildlife Refuge – are administered by the

Mato Grosso state government, while the other, the Bacaba Municipal Park, is run by the municipality of Nova Xavantina. A total of 25 bat species were recorded in both the Serra Azul and Bacaba parks, while only eight species were registered for the Araguaian Chelonians State Wildlife Refuge (Figure 3; Table 2).

Discussion

The number of bat species recorded in eastern Mato Grosso corresponded to 82.7% of the total known to occur in the state as a whole (Reis et al. 2013). While a number of recent studies (e.g. Sousa et al. 2013a, Carrijo et al. 2013) have confirmed the occurrence of some species, many are known only in scientific collections. This is reinforced by the fact that 12 of the species had not been recorded previously in the state of Mato Grosso.

The low number of cells considered to be adequately sampled in this analysis also emphasizes the paucity of the data available on the occurrence and distribution of bat species in the region. The configuration of the cells also reflects the highly asymmetric distribution of the available knowledge of the region's bat fauna, a problem identified almost 20 years ago by Uieda & Pedro (1996).

Bernard et al. (2011) noted that, while the number of inventories of bat populations has grown considerably in recent years, most studies have tended to be concentrated in areas adjacent to universities that have active research groups. In fact, two of the cells considered to be adequately sampled in this analysis (D and E) coincide with the region's two major

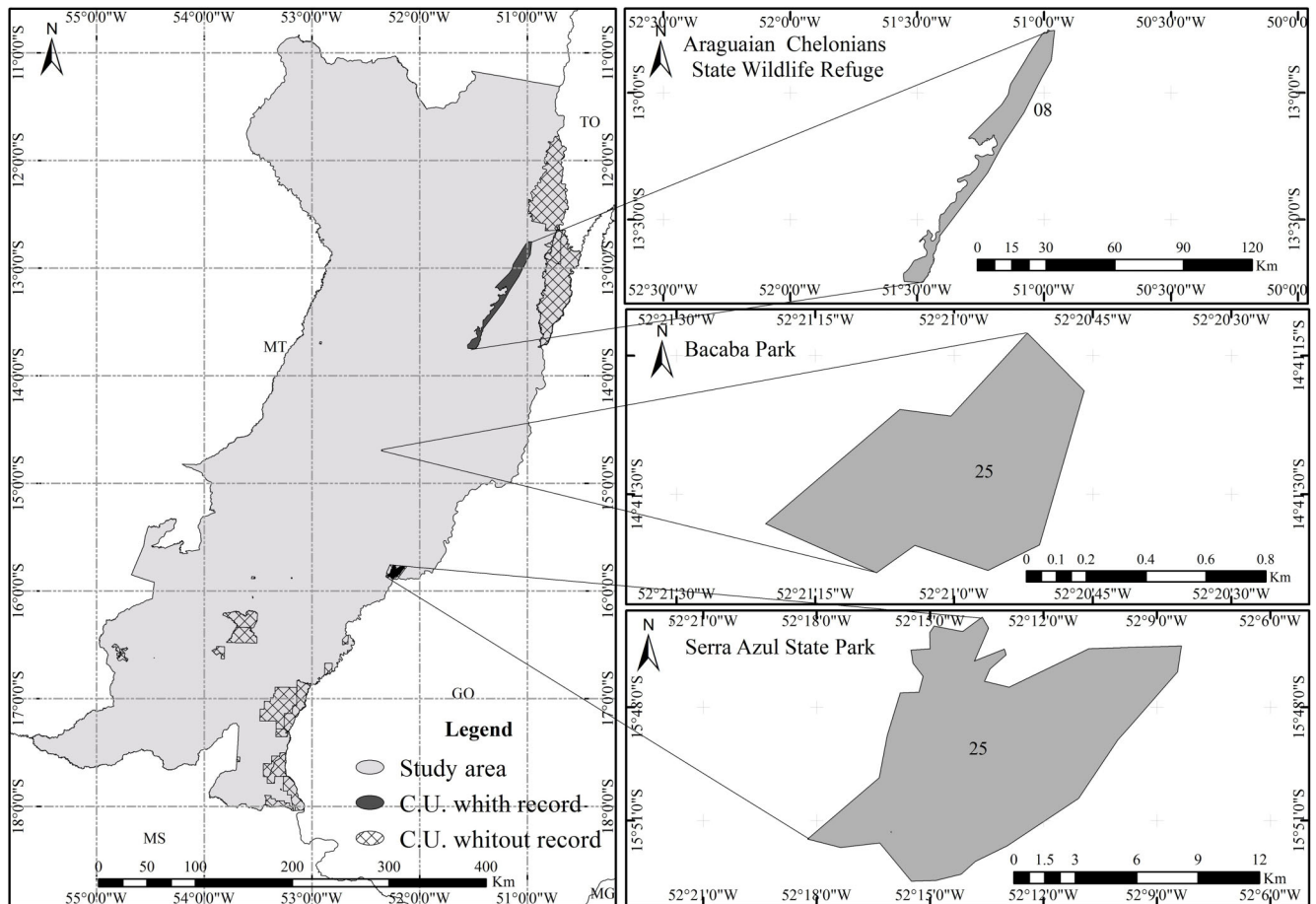


Figure 3. Conservation units found within the study area, highlighting the three areas in which at least one bat species has been recorded. The numbers refer to the species richness recorded in each unit.

university centers, the Araguaia campus of the Federal University of Mato Grosso, and the Nova Xavantina campus of UNEMAT, respectively, reinforcing the importance of such research groups, as well as the need for further fieldwork in areas that have been the focus of little or no investigation.

The ongoing expansion of agricultural and energetic (hydroelectric dams) frontiers in the state should be accompanied by new studies of environmental impacts and the monitoring of fauna (Brasil 2000). Systematic species inventories (including Chiroptera) are legally required for the concession of licenses for the implementation of any project that may potentially cause environmental degradation (Brasil 1986, 1997). However, the available data on the occurrence of bat species in Mato Grosso do not correspond to the ongoing advances in major development projects, in both the public and private sectors, and there is a clear need for better access to the records and specimens produced by these projects, in order to consolidate the scientific understanding of the state's chiropteran fauna.

Eastern Mato Grosso is considered to be of major importance for the conservation of the biological diversity of the Neotropical region (e.g. Myers et al. 2000, Horta et al. 2002, Bernard et al. 2011) and is located within the Cerrado's principal agricultural frontier, in the Arc of Deforestation on the southern rim of the Amazon basin (Nogueira et al. 2008).

The conservation units already established in this region will obviously play a fundamental role in the investigation of its biodiversity, and this will demand concerted actions between research institutions (on local and regional scales) and local administrators, given the intrinsic interest of researchers and the need for inventories, which are an integral component of the management plan of any conservation unit (Brasil 2000).

The occurrence of species restricted to specific types of habitat, such as *L. dekeyseri*, which is endemic to the Cerrado (Reis et al. 2013), and *L. brachyotis*, *T. bidens*, *T. cirrhosus*, and *M. crenulatum*, which are considered to be sensitive to habitat disturbance (Mendellin 2000), reinforce the important of integral protected areas, even those associated with human activities, such as the Serra Azul State Park, in which all these species were recorded. This type of information provides material for projects in environmental education, which are essential for the effective creation of parks at any level, whether federal, state or municipal (Brasil 2000).

A reliable understanding of the distribution of species is essential for the demarcation of new protected areas, as well as the evaluation of any new development projects to be established in the region. The results of the present study, which highlight the diversity of bats in the Brazilian state of Mato Grosso, reinforce its importance, and especially that of

Table 2. List of the bat species recorded in each of the three conservation units. The occurrence of a given species in a unit is indicated by an "x". PESA: Serra Azul State Park; PMB: Bacaba Municipal Park; RVSQA: Araguaian Chelonians State Wildlife Refuge.

Family/ Subfamily / Specie	PESA	PMB	RVSQA
EMBALLONURIDAE			
Emballonurinae			
Saccopteryx leptura	-	x	-
PHYLLOSTOMIDAE			
Desmodontinae			
Desmodus rotundus	x	x	-
Glossophaginae			
Anoura caudifer	x	x	-
Anoura geoffroyi	x	-	-
Glossophaga soricina	x	x	x
Lonchophylla dekeyseri	x	-	-
Phyllostominae			
Lamproncycteris brachyotis	x	-	-
Lophostoma brasiliense	-	x	-
Lophostoma silvicolum	x	x	x
Micronycteris minuta	x	-	-
Mimon crenulatum	x	x	x
Phyllostomus discolor	-	x	-
Phyllostomus elongatus	-	x	-
Phyllostomus hastatus	-	x	-
Tonatia bidens	x	-	-
Trachops cirrhosus	x	x	-
Carollinae			
Carollia perspicillata	x	x	x
Rhinophylla pumilio	x	x	-
Stenodermatinae			
Artibeus lituratus	x	x	x
Artibeus planirostris	x	x	x
Chiroderma villosum	x	x	-
Dermanura cinerea	x	x	-
Dermanura gnoma	x	x	-
Platyrrhinus incarum	x	x	x
Platyrrhinus lineatus	x	x	x
Uroderma bilobatum	-	x	-
MORMOOPIDAE			
Pteronotus gimnotus	x	-	-
Pteronotus parnellii	x	x	-
MOLOSSIDAE			
Molossops temminckii	x	x	-
Molossus rufus	-	x	-
VESPERTILIONIDAE			
Eptesicus diminutus	x	-	-
Myotis sp.	x	-	-
Roghesia io	-	x	-
Total	25	25	08

the eastern region, for the preservation of Neotropical chiropterans.

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