

REVIEW

Discovering the Brazilian bat fauna: a task for two centuries?

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ABSTRACT

1. Brazil is the second most bat species-rich country in the world, but the available information on the occurrence and distribution of bat species in Brazil is still heterogeneous and fragmented.
2. We review the occurrence and distribution of bat species in Brazil, analyse the spatial performance of inventories conducted to date and identify knowledge gaps. We also identify the main factors contributing to the recent increase in the knowledge of the Brazilian bat fauna, and make suggestions for maintaining this momentum into the near future.
3. We plotted record coordinates on a map, grouped them in 0.5 degrees of latitude \times 0.5 degrees of longitude grid cells, and analysed records for each of the five terrestrial biomes in Brazil, and for the 1439 priority polygons for the conservation of Brazilian biodiversity.
4. We identified 5502 formal bat records in Brazil, indicating that less than 10% of the country is minimally surveyed, and that for nearly 60% of Brazil there is not a single record of bat species. Record coverage varies from 79% in the Atlantic Forest to 24% in Amazonia, but none of the Brazilian biomes is well surveyed for bats. Bat species have been recorded in only 15% of the priority areas for Brazilian biodiversity conservation.
5. If the current rate of recording bats in empty grid cells (10% every 4 years) was maintained, it would take 33 years for all cells to have a single record. If the current rate of recording ≥ 20 species in a grid cell (0.8% per year) was maintained, it would take 200 years for the bat fauna of Brazil to be minimally surveyed. Alarmingly, most of the data-poor areas are at the expansion frontiers of the agro-business, near the surrounding deforestation fronts.
6. We make recommendations for scientific research on bats in Brazil, to ensure the conservation of this ecologically important taxon.

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Keywords: bat species distribution, biodiversity inventories, Brazilian biomes, Chiroptera, priority areas for conservation

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INTRODUCTION

To conserve biodiversity, we need to know about the species that comprise it, and the conservation of any taxon requires information on its ecology, distribution and occurrence (e.g. Myers et al. 2000, Olson et al. 2001, Krupnick & Kress 2003, Tear et al. 2005). Acquisition of such data poses a scientific challenge anywhere, but in a continental-size, biome-rich and mega-diverse country like Brazil, this is a Herculean task (see Brandon et al. 2005). Knowledge of the biodiversity of Brazil is heterogeneous: good for groups such as Aves and Primates, but insufficiently documented for others such as insects and micro-organisms (Lewinsohn & Prado 2005).

Our knowledge of mammalian diversity in Brazil is satisfactory. Currently, 687 species have been reported, 24% of them bats, in nine families, 64 genera and 167 species (Paglia et al. in press). Based on those numbers, Brazil is home to 15% of the bat species of the world and the second most bat species-rich country after Colombia, which has 178 species (Alberico et al. 2000). In addition to high diversity, bats also fill a range of ecological roles: they are pollinators and seed dispersers, including plant species used by humans (e.g. Allen-Wardell et al. 1998, Aguiar & Marinho-Filho 2007, Aguiar et al. 2008), predators and prey (e.g. Belwood & Morris 1987, Fenton 1995, Kalka et al. 2008), controllers of insect pests (e.g. Cleveland et al. 2006, Reiskind & Wund 2009) and vectors of diseases (Schneider et al. 2009).

Our knowledge of bat diversity in Brazil has increased recently (e.g. Uieda & Pedro 1996, Reis et al. 2006, Pacheco et al. 2008). In the last 15 years, one genus and five new species of bats have been described, and new records have led to the geographical ranges of species being extended by hundreds and even thousands of kilometres (see Supporting Information Appendix S1). However, information on the occurrence and distribution of bat species in Brazil is still heterogeneous and fragmented (Aguiar & Machado 2005).

Here we review the status, occurrence and distribution of bat species in Brazil, analyse the spatial distribution and performance of inventories conducted to date, and identify gaps in our knowledge. We also identify the main factors contributing to the recent increase of the knowledge on the Brazilian bats and make suggestions for maintaining this momentum into the near future.

METHODS

We generated a data bank on the occurrence of bat species in Brazil using compiled reference data (Aguiar & Machado 2005) and bibliographic search in the Scientific Electronic Library Online (SciELO, www.scielo.org) and the Web of Science (WoS, <http://portal.isiknowledge.com>). We restricted searched records from 1994 to 2009, using one or a combination of the keywords 'Chiroptera', 'bats', 'Brazil', 'Brasil' and 'morcegos', the Portuguese word for bats.

When possible, we identified the geographic coordinates of new records and inserted them into a geographic information system supplied with records obtained from the major zoological collections in Brazil (Aguiar & Machado 2005). We plotted coordinates on a map, and also grouped them in 0.5 degrees of latitude \times 0.5 degrees

of longitude grid cells (c. 3000 km² each). To evaluate the recent increase in knowledge, we divided records into those dates from before 2004 and after 2005.

Using ArcGIS (Anonymous 2009a), we summarized data sets into the grid cells, with the respective number of species in each. We used the 'Spatial Join' command to overlap maps containing single records and grid cells, and R Statistical Package (Anonymous 2009c) to calculate the total number of species in each cell. A cell was considered as minimally surveyed when it contained at least 20 species, a low threshold, considering the 167 bat species in Brazil (Paglia et al. in press). In cells containing ≥ 20 species, data from before 2004 and after 2005 were compared.

We analysed bat species' occurrence for each of the five terrestrial biomes in Brazil (Amazonia, Caatinga, Cerrado, Atlantic Forest, Pampa and Pantanal) by overlapping the composite map of species we generated with the map of the Brazilian biomes (Anonymous 2004). We also overlapped the maps generated with 1439 conservation priority polygons identified as 'Áreas Prioritárias para a Conservação, Uso Sustentável e Repartição de Benefícios da Biodiversidade Brasileira', by the Ministry of the Environment (Anonymous 2006). The criteria used to identify these polygons included the need for – or total absence of – data on the occurrence of indicator species (e.g. endemic or endangered species of birds, mammals, reptiles and amphibians). Most of those areas are priorities for biodiversity inventories in Brazil.

RESULTS

Our search produced 99 references from WoS and 116 from Scielo. Excluding duplicated citations, we found 182 references, among which at least 66 mentioned new records for regions, biomes, states or the Brazilian territory (see Supporting Information Appendix S1). The distribution of references by year in WoS and Scielo indicated a progressive increase in the scientific outputs related to bats in Brazil from the year 2000 (Fig. 1).

Overall, we compiled at least 5502 formal bat records in Brazil (Fig. 2). There were records in 330 of the 804 cells covering the country (41% of the total area; Figs 3 and 4). The south and south-eastern parts of Brazil had the highest density of records. Only 8% of the cells (65 of 804) contained records of ≥ 20 species, and just 1.3% of the cells contained ≥ 50 species. The five topmost species-rich cells were in northern Brazil, in Pará (85, 72 and 55 species) and Amazonas (72 and 63 species).

Biomes with a relatively high number of cells with records were the Atlantic Forest and Amazonia, both with >90 cells, while Pampa and Pantanal had ≤ 10 cells with records of bats (Table 1). However, considering the total number of cells within these biomes, there were records for 80% of the Atlantic Forest, 67% of Caatinga, 47% of Pantanal, 41% of Cerrado, 40% of Pampa and 24% of Amazonia.

The biome with the highest number of cells with ≥ 20 species was the Atlantic Forest, followed by, respectively, Amazonia, Cerrado, Caatinga and Pantanal (Table 1). The Pampa had no cells with ≥ 20 species. In the Atlantic Forest, 27% of the cells with records had ≥ 20 species. Conversely, only 11% of the cells in Caatinga reached that threshold. Considering the total number of cells per biome, 22% of the Atlantic Forest, 12% of Pantanal, 7% of Caatinga, 6% do Cerrado and just 5% of Amazonia have been minimally surveyed (Table 1). The mean (\pm standard deviation) number of species was low for all of the Brazilian biomes, from 13.7 (\pm 13.1) species in the Atlantic Forest to only 4.8 (\pm 4.0) species in the Pampa (Table 1). Amazonia

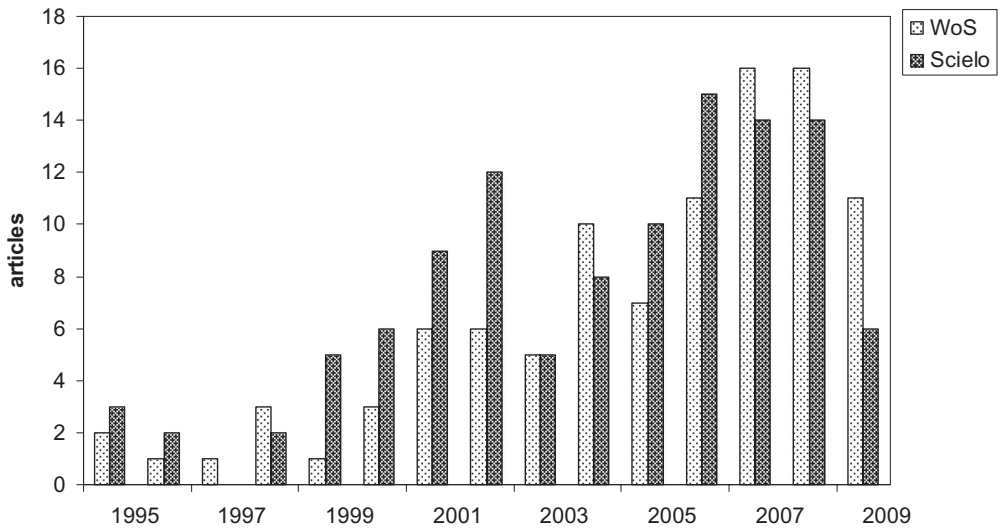


Fig. 1. Numbers of scientific articles on bats in Brazil, published from 1995 to 2009 (up to mid-September), obtained by searching the Web of Science (WoS; light shading) and the Scientific Electronic Library Online (Scielo; dark shading), and included in this review. In total, after removal of duplicates, 182 references were used.

had the highest number of species recorded in a single cell (85), whereas in the Pampa, a maximum of 13 species was recorded (Table 1, Fig. 3).

Until 2004, 293 cells had bat records and 45 of them had ≥ 20 species. Since then, 36 empty cells have had new records ($\sim 3\%/year$ – Fig. 3). However, in the same period, only 17 cells reached the threshold of ≥ 20 species ($\sim 0.8\%/year$). Among the cells with previous records, 92 had new records after 2004 (Fig. 4), most of them in the north-eastern and south-eastern regions. Records of ≥ 20 species per cell in regions, which had been poorly sampled or not sampled until 2004, occurred in Amazonas (41 and 27 species in two previously empty cells), Pará (22 species in one cell), Tocantins (23 species in one cell), Bahia (55, 20 and 30 species in three cells), Goiás (23 species in one cell) and São Paulo (25 species in one cell; Fig. 4).

Information on bats in the priority areas for Brazilian biodiversity conservation is scarce: just 15% of the identified polygons had bat species records (Fig. 5). Moreover, only 11% of 219 areas with records had ≥ 20 species and 78% of them have ≤ 10 species recorded (Fig. 6).

DISCUSSION

Knowledge on the occurrence and distribution of bats species in Brazil has increased in the last 15 years, but still less than 10% of the country can be considered minimally surveyed, and in nearly 60% of Brazil there is not a single record of a bat species. None of the Brazilian biomes can be considered well surveyed for bats. The Atlantic Forest has the best knowledge status: records exist for nearly 80% of the biome and 28% of the grid squares have ≥ 20 species. Considering the proportion of the area surveyed, the situation is more critical in Amazonia: data are available for less than 25% of the region. The least well-surveyed biomes in Brazil are the Pampa, without a single area with ≥ 20 species recorded, and the Caatinga, where about only 10% of

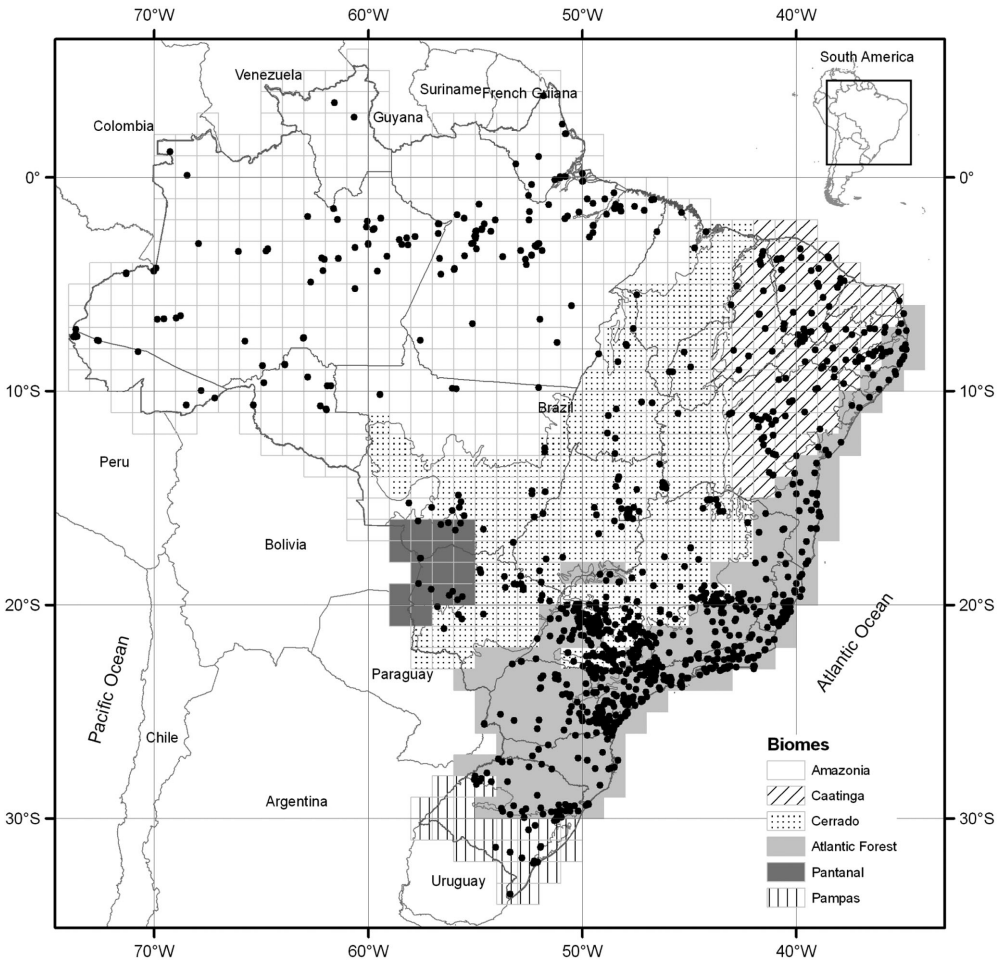


Fig. 2. Terrestrial Brazilian biomes and localities, and the 5502 formal records of bat species (•) used for this review. Grid square cells are 0.5 degrees of latitude × 0.5 degrees of longitude.

squares have minimum species data. This situation is not exclusive for bats and also occurs for other biological groups, such as birds (Silva 1995), small terrestrial mammals (Carmignotto 2004) and reptiles (Colli et al. 2002, Nogueira 2006), for which a similar pattern – few well-studied areas and large knowledge gaps – is observed.

If the current rate of recording bats in empty grid cells (10% every 4 years) was maintained, it would take another 33 years before all cells in the whole of Brazil had at least a single bat species record. If the current rate of recording ≥ 20 species in a grid cell (0.8% per year) was maintained, it would take 200 years for the bat fauna of Brazil to be minimally surveyed.

The current rate of habitat destruction taking place in the Brazilian biomes presents a challenge: there is not enough time to survey and gain better knowledge of the bat faunas present in those species rich habitats, but their conservation is already necessary. The most recent estimates indicated that between 30% and 52% of the Caatinga, nearly 55% of the Cerrado, 40% of Pantanal and 93% of the Atlantic

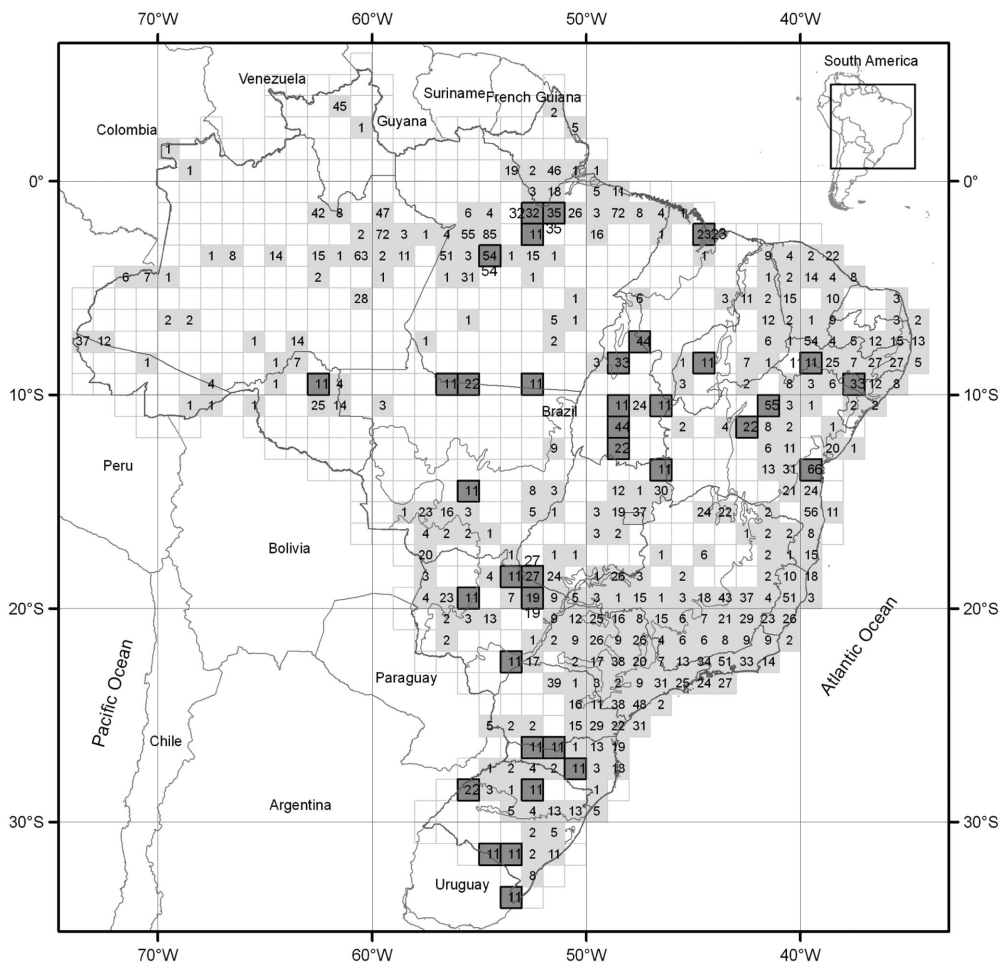


Fig. 3. Numbers of bat species recorded in each of the 804 grid cells in Brazil (each cell is 0.5 degrees of latitude \times 0.5 degrees of longitude). 330 cells (41%) had records of at least one species of bat. Cells in dark grey were data-empty before 2005.

Forest have already been severely damaged or destroyed to give way to pastures and agriculture (Harris et al. 2005, Klink & Machado 2005, Leal et al. 2005, Tabarelli et al. 2005). Most of the remaining habitat is in critical condition, and minimal proportions of the land are under strict protection, as parks and reserves.

Recording bats is important, but it is not enough to conserve them. Bats play a major role in gene flow within and between plant populations, through pollination and seed dispersal (Lobova et al. 2009, Quesada et al. 2009). In the Brazilian Cerrado, bats are responsible for the pollination of pequi (*Caryocar brasiliensis*) and dispersal of baru nut (*Dipteryx alata*), which are exploited by rural people, and which in some poorer regions provide up to 55% of the annual income of families (Chávez-Pozo & Ortiz 1997). The lack of bat pollination and seed dispersal may affect not only plant populations, but also people that count on their fruit production, quality and availability (Aguiar et al. 2008). Bats are also important in the control of agricultural pests, a service studied in the northern hemisphere (Lee & McCracken 2005), but

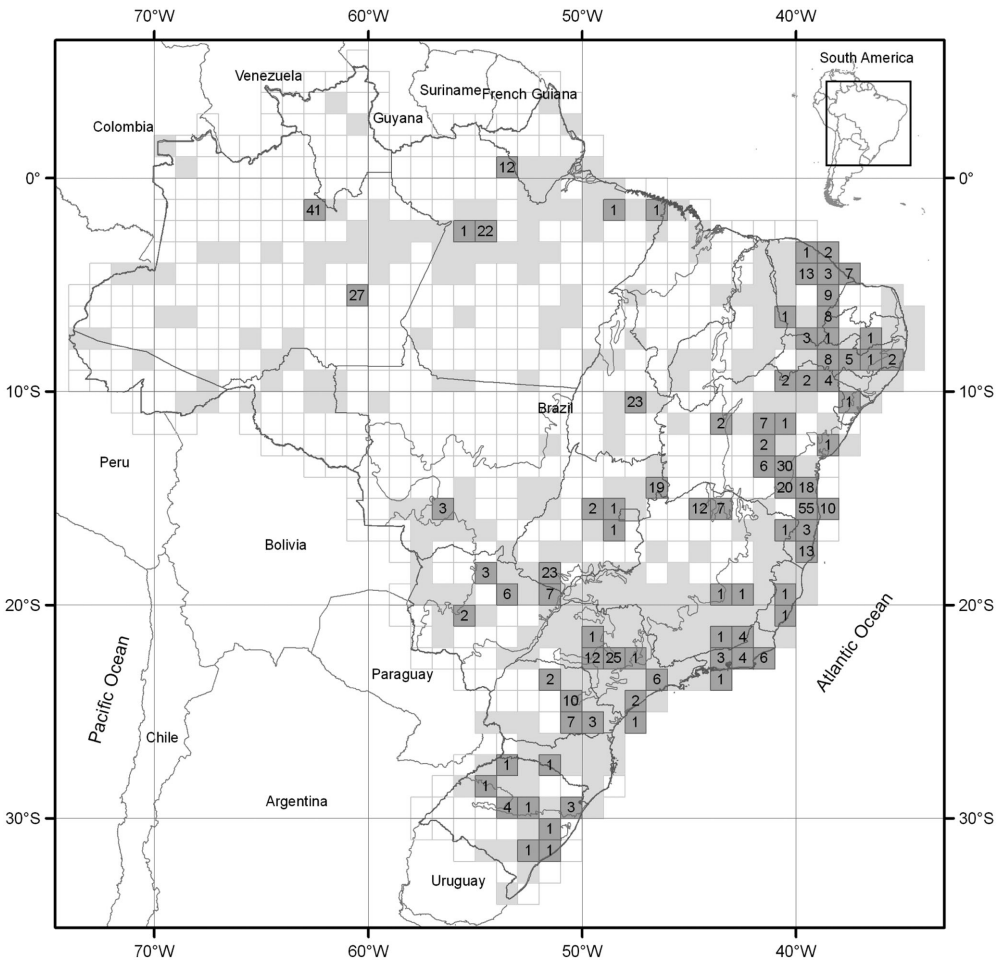


Fig. 4. Grid cells (0.5 degrees of latitude × 0.5 degrees of longitude) with records of bat species in Brazil. Cells in dark grey had previous inventories and species added after 2005. Numbers represent the number of species added.

ignored in Brazil (Aguar & Antonini 2008). The identification and conservation of the bat species involved with these environmental services are important in a country that has agro-business as a main source of income, and that seeks a more sustainable model for its agro-economy.

Bats are relatively well-studied in the Atlantic Forest because this biome has a long history of scientific inventories, a high concentration of researchers, financial resources, and well-established scientific institutions and zoological collections (see Lewinsohn & Prado 2005, Brito et al. 2009). On the other hand, grid cells with higher numbers of species in Pará, Amazonas and Bahia are directly associated with high-effort, bat-oriented inventories (Kalko & Handley 2001, Bernard & Fenton 2002, Sampaio et al. 2003, Faria et al. 2006, Presley et al. 2009). Thus, two strategies have been applied: a long history of short-term, low-effort inventories, covering a broader area (such as for most of the Atlantic Forest), and the execution of more intensive, high-effort, area-focused inventories (as in Amazonia and Bahia).

Table 1. Number of grid cells (0.5 degrees of latitude \times 0.5 degrees of longitude) with records of bat species in each of the Brazilian terrestrial biomes

Biome	Grid cells (a)	Cells with records (b)	% (b/a)	Cells with ≥ 20 spp. (c)	% of the total cells (c/a)	% of the cells with records (c/b)	Maximum number of spp. in a single cell	Mean number of species per cell	Standard deviation
Amazonia	389	93	23.9	20	5.1	21.5	85	10.8	17.1
Caatinga	70	47	67.1	5	7.1	10.6	54	9.3	9.7
Cerrado	179	73	40.8	11	6.1	15.1	43	9.0	9.9
Atlantic Forest	124	99	79.8	27	21.8	27.3	56	13.7	13.1
Pantanal	17	8	47.1	2	11.8	25.0	23	7.0	7.9
Pampa	25	10	40.0	0	0.0	0.0	13	4.8	4.0

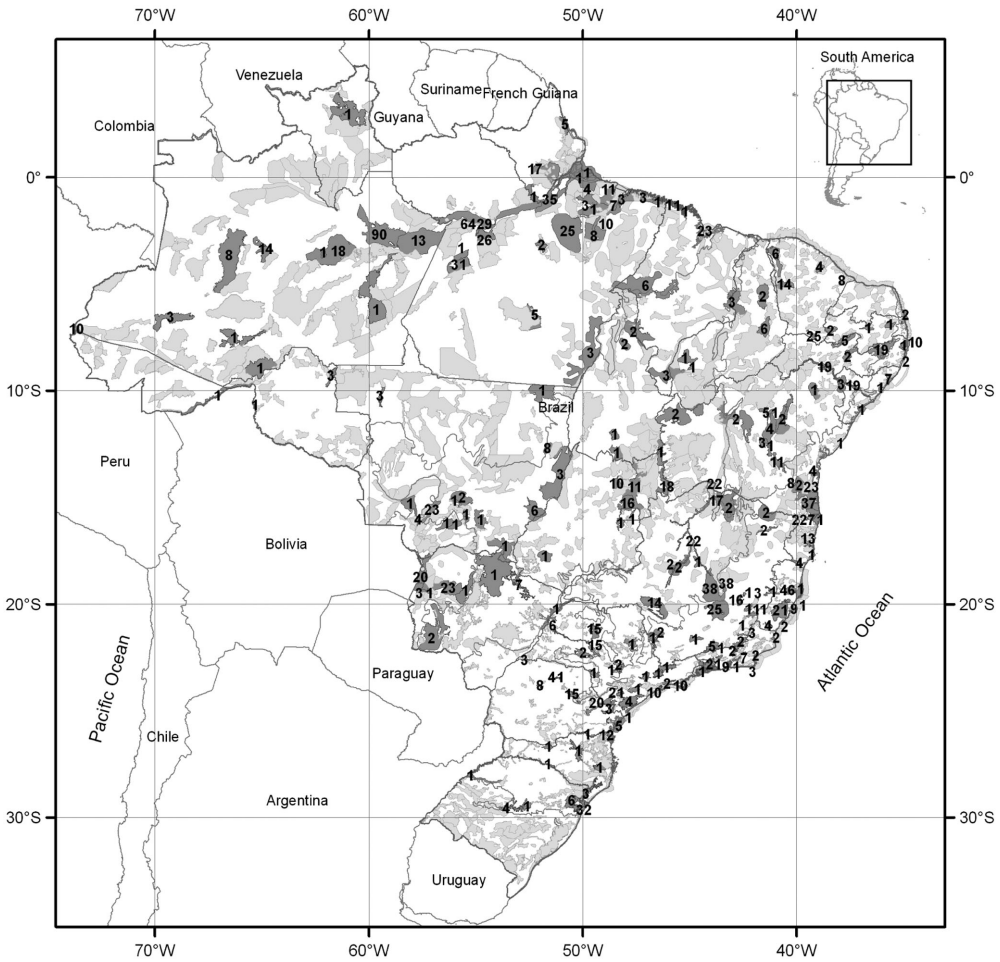


Fig. 5. Priority areas for the conservation of Brazilian biodiversity according to the Ministry of Environment of the Brazilian government. Dark grey areas are those with bat species records; the respective number of species recorded is shown.

We need to adopt both strategies to speed up the acquisition of knowledge about the Brazilian bat fauna. Considering the ecological importance of bats, Brazil should increase its support for long-term ecological studies involving bats, and start to address still unanswered questions such as possible migration patterns among species, factors causing fluctuations in their populations, the effects of climate change and deforestation on species, and a more precise definition and quantification of the role of bats in providing environmental services.

Knowledge gaps

Tocantins is the Brazilian State with least samples for bats. The other most significant data gaps are in the northern portion of Mato Grosso, northern and southern Amazonas state, north-eastern and southern Pará, southern Rondônia, northern Amapá, central to southern Rondônia, western Bahia, central to southern Maranhão, western Piauí, the whole State of Rio Grande do Norte, central to north-western

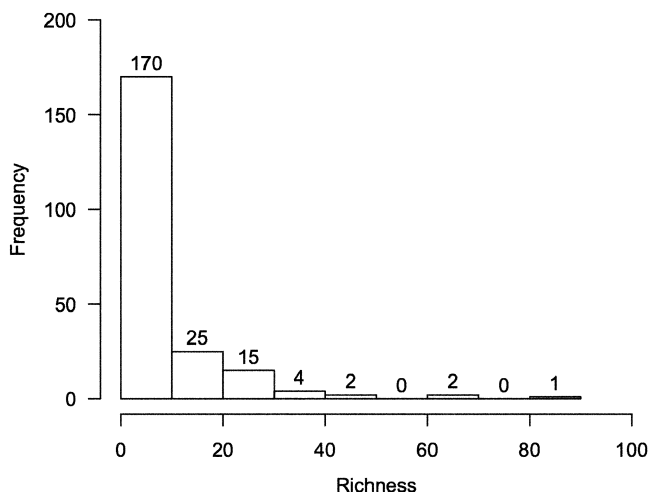


Fig. 6. Frequency histogram of bat species richness in the 219 priority areas for the conservation of biodiversity in Brazil.

Minas Gerais, central Goiás, southern Mato Grosso do Sul, western Paraná and western Rio Grande do Sul (Figs 2 and 3). It is alarming that, with a few exceptions, most of those areas are located at the expansion frontiers of Brazilian agro-business and near the surrounding deforestation fronts.

Each state should have a regularly updated species list for conservation-oriented studies, but most of the lists currently available are clearly outdated. In the Brazilian Amazonia, for example, the available data indicate 116 species in Pará, 109 in Amazonas, 83 in Amapá, 76 in Mato Grosso, 56 in Acre, 47 in Rondônia, 42 in Roraima and only 21 in Maranhão (Bernard & Sampaio 2008). The last four states are clearly and unquestionably under-sampled. The situation is similar in the Caatinga and Pantanal.

The Brazilian government has made significant efforts to pinpoint priority areas for the identification, quantification and conservation of biodiversity in the country (Anonymous 2006). Astonishingly, we identified that in 85% of those priority areas, there is not a single bat species record. Therefore, because of their conservation importance and political support, new bat species inventories should be made for those areas as a priority in the short-term. Moreover, an analysis performed by Aguiar and Machado (2005) pointed out another 142 areas lacking formal protection that should be considered as a priority for bat inventories. Based on the existence and location of established bat research groups in Brazil, the same authors indicated that 58% of those areas were less than 300km away from the nearest research group and therefore could be reached with relatively low investment.

Positive contributing factors

We identified four main factors which are contributing to a better knowledge of the occurrence and distribution of bats in Brazil: (i) an increase in the number of studies designed to describe and protect Brazilian biodiversity, and the inclusion of bats among the surveyed groups; (ii) an increase in the number of bat studies carried out in conservation units and protected areas; (iii) more concern for and a subsequent

refining of the systematics of Chiroptera in Brazil; and (iv) the performance of long-term, high capture-effort inventories exclusively focused on bats. These factors are discussed in more detail below.

Conservation studies

Brazilian biomes are being better studied. Financial resources specifically for the study of endangered habitats have been made available by the government, non-governmental organizations and the private sector; areas previously inaccessible for research due to the lack of funds have started to be sampled for bats as well as for other taxa. Areas in the Atlantic Forest have been better surveyed because of their conservation priority status, resulting in new findings: *Lasiurus ebanus*, a new species, was described in the southern forest remnants (Fazzolari-Correa 1994); *Choeroniscus minor*, previously known only in the Amazon Basin, was recorded in the last large forest remaining in Minas Gerais (Aguiar et al. 1995); sampling in fragments in Espírito Santo and São Paulo extended the distribution of *Micronycteris brachyotis* and *Artibeus gnomus* by 1000 and 1500km, respectively (Taddei & Pedro 1993, Aguiar et al. 1995); and the distribution of *Lionycteris spurrelli* was extended 850km to the northeast because of records in fragments of Pernambuco (Lira et al. 2009).

Surveys in the vulnerable regions of Nhecolândia, the lowlands of Rio Taboco and the headwaters of Rio Negro, one of Pantanal's main tributaries, resulted in the first record of *Mimon crenulatum* in the biome (Camargo & Fischer 2005) and extended southwards the distribution of *Vampyressa pusilla* (Longo et al. 2007). At Corumbá, in Pantanal's emerging metallurgical industry, records of *Chrioderma doriae* extended its known distribution by 630km to the west (Bordignon 2005).

Surveys at Complexo Jauru, a priority area for inventories in the Cerrado biome, produced the first records of *Lophostoma silvicolum*, *Lionycteris spurelli*, *Lonchophylla mordax* and *Lophostoma brasiliense* for the state, as well as for the biome in the case of the last two species (Bordignon 2006). Surveys near Brasília, a Cerrado hotspot for conservation, resulted in the first record of *Myotis keaysi* for Brazil, *Pygoderma bilabiatum* for the federal district (Aguiar 2000) and of *Diaemus youngi* for Central Brazil (Aguiar et al. 2006).

Research in conservation units

In some areas of Brazil, conservation units or reserves represent the only remaining places where the original natural habitats that once covered those regions can be investigated. Bat research in those areas is producing noteworthy records. In Rio de Janeiro, samplings between 1997 and 2006 in Poço das Antas and Tinguá Biological Reserves resulted in the first records of *Mimon crenulatum* and *Myotis riparius* for the state (Mello & Pol 2006, Dias & Peracchi 2007). In Mato Grosso, surveys in the Serra das Araras Ecological Station resulted in the first records of *Artibeus gnomus* and *Artibeus anderseni* for the Cerrado, and extended westward the distribution of the endangered *Lonchophylla dekeyseri* (Gonçalves & Gregorin 2004). In Acre, at Serra do Divisor National Park, Nogueira et al. (1999) noted the first records of *Promops centralis* and *Sturnira magna* in the country. In Amapá, sampling in Montanhas do Tumucumaque National Park, Amapá National Forest, Rio Iratapuru Sustainable Development Reserve, Lago Piratuba Biological Reserve and the Curiaú Reserve

added 35 new records to Amapá's previous list of 48 species, including the first record of *Mimon bennettii* in northern Brazil (Martins et al. 2006, Bernard & Sampaio 2008).

The advance of systematics

Refinements in the taxonomy and systematics of Brazilian bats, together with an increase in revisions and examinations of museum specimens' resulted in the following new taxa for Brazil: *Micronycteris sanborni*, *Eptesicus taddeii*, *Thyroptera devivoi* and *Xeronycteris vieirai* (Simmons 1996, Gregorin & Dietchfield 2005, Gregorin et al. 2006, Miranda et al. 2006).

Revisions also contributed to the refinement of species distribution in the country: *Eumops patagonicus* was confirmed in Brazil, correcting its distribution in the southern cone of South America (González 2003, Bernardi et al. 2009); the vulnerable *Chiroderma doriae* is now not restricted to the Atlantic Forest *sensu stricto*, being also present in more open and xeromorphic areas (Gregorin 1998b); *Natalus stramineus* had its distribution extended beyond the Amazon Basin, down to the Cerrado of Central Brazil (Taddei & Uieda 2001); after records in Pantanal, *Molossus pretiosus* was included in the country list, extending its known distribution by nearly 3000km (Gregorin & Taddei 2000); *Promops centralis* had its distribution extended through the Amazon Basin (Gregorin 2000); *Neoplaticyops mattogrossensis* and *Molossops neglectus* had their distributions extended by hundreds of kilometres based on specimens from Amazonas, São Paulo and Rio de Janeiro (Gregorin 1998a, Gregorin & Taddei 2000, Gregorin et al. 2004); and *Thyroptera discifera* was recorded in the Atlantic Forest, extending its known distribution nearly by 1300km to the west (Gregorin et al. 2006).

Some taxonomic studies have suggested disruptive distributions for some Brazilian bat species and indicated the potential for the division of species in complexes of new ones (Tavares 2008). Experts have suggested that Brazilian collections should have their specimens checked for misidentifications and new species descriptions. However, such a task is compromised by the small number of taxonomists in Brazil, especially those focused on bats. Brazil is among the four most species-rich countries for birds, mammals and reptiles (Anonymous 2005), yet, the ratio of taxonomists to numbers of species is among the lowest in the world, as much as 40 times lower than in the USA (Anonymous 2009b). Efforts are urgently required to build Brazil's next generation of taxonomists, and the exchange of information and specimens between Brazilian and foreign institutions must receive support.

Long-term inventories

High capture-effort, bat-oriented inventories are a recent strategy in Brazil, providing more complete species lists including up to 95% of species expected locally (Bernard & Fenton 2002, Sampaio et al. 2003, Faria et al. 2006). Long-term inventories resulted in the first records in Brazil of *Micronycteris homezi* and *Thyroptera lavalii*, while the record of *Lasiurus castaneus* in Manaus was the first in South America (Bernard & Fenton 2002, Sampaio et al. 2003). In southern Bahia, inventories recorded 59 species, 40 genera and seven bat families for the area, extending the distribution of *Vampyroides caraccioli* by 3000km and adding 29 species to the state list (Faria et al. 2006). Thanks to such efforts, 78 species are currently known in Bahia.

Other factors

Brazil is currently experiencing significant investments in infrastructure, including investments in large hydro-electrical plants, power lines, roads, ports, and large mine and tourism complexes. The legal requirements for environmental impact assessments (EIAs) for those projects have created the opportunities, means and logistics for research teams to perform inventories in areas never sampled before. The quality of those inventories is heterogeneous and debatable, but such opportunities are contributing new records to the Brazilian fauna and flora. Fortunately, bats are included among the biological groups surveyed, with noteworthy records. *Eumops maurus* was recorded for the first time in Brazil during EIA for two hydro-electrical plants in Goiás and Tocantins (Sodré et al. 2008). The record extended by nearly 3000km, the known range of the species in South America. Other EIAs have produced possible new bat species and other organisms for Brazil, but sadly the results are frequently embargoed by the contractors, who are fearful that the publication of the data could delay construction.

Recommendations

Bat science in Brazil requires and deserves more investment considering the diversity of bats, their ecological role and importance, and the environmental services they provide. We believe that the adoption of the following steps could significantly contribute to the improvement of our knowledge of Brazilian bat species.

1. Significantly increase the number of bat inventories carried out in Brazil, prioritizing the data-poor areas now identified.
2. Stimulate long-term, high capture-effort inventories and monitoring in areas previously sampled.
3. Significantly increase the number and frequency of revisions of specimens already in Brazilian museums and collections.
4. Invest in the immediate training of bat taxonomists.
5. Stimulate the depositing, sharing and exchanging of data and collected material among reference collections and taxonomists already established in Brazil and abroad.
6. Stimulate the publication of occurrence data in an accurate and informative format, with the inclusion of geographical coordinates, capture effort, collector and identification responsibility, and destination of the specimens collected.
7. Stimulate the creation of an online data bank on the occurrence and distribution of Brazilian bat species.
8. Stimulate the exchange of information on and the adoption of new research techniques among Brazilian and foreign researchers and institutions.

Factors mentioned here are not isolated and, in fact, the biology, ecology and systematics of bats can and should be addressed together in Brazil. Our knowledge on the occurrence and distribution of bats in Brazil still cannot be considered refined, and filling bat data gaps in large portions of the country remains a scientific challenge due to the size of Brazil and the logistical constraints involved in reaching some areas. A concerted effort is still needed to discover more about the Brazilian bat fauna, but the requirements for success are clear and the perspectives are positive.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix S1. New records of bat species in the Brazil since 1994.

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