Biodiversity in urban green space: a case study in the neotropics

Nadja Gomes MACHADO¹*, Lidianny Aparecida ROCHA¹, Nágila das Dores SILVA¹, Débora Fabiane Neves da SILVA¹, Fernando Prado FLORÊNCIO², Thiago Borges Semedo FERNANDES²

¹ Instituto Federal de Mato Grosso, Campus Cuiabá - Bela Vista, Cuiabá, MT, Brasil.
² Universidade Federal de Mato Grosso, Instituto de Biociências, Cuiabá, MT, Brasil
* E-mail: nadja.machado@blv.ifmt.edu.br

ABSTRACT: Green areas have become important for biodiversity conservation due to the increase in urban areas and to the fragmentation of natural environments. Our objective was to identify animal and plant species occurrence in a green area surrounded by industries in the county of Cuiabá MT Brazil. We sampled 142 species of plant, mammals, reptiles and birds. Four animal species had been introduced and one species comprised seasonal migration from the northern hemisphere. Species occurrence, such as *Pistia stratiotes*, *Curatella americana*, *Eupetomena macroura* and *Ortalis canicollis* indicated Cuiabá as an ecotone of the Cerrado and the Pantanal. There is, consequently, an ecological importance of the study area for harboring vast biodiversity within a 30-hectare area surrounded by industries. Cuiabá features expansion areas for housing development and commerce which trigger increase in green space and biodiversity losses. No public administration exists for the care for the study area as a biodiversity conservation space and recreation.

Keywords: conservation, ecotone, protected areas.

Biodiversidade em espaço verde urbano: estudo de caso em região neotropical

RESUMO: Áreas verdes tornam-se importantes para a conservação da biodiversidade animal e vegetal à medida que áreas urbanas crescem e o ambiente natural torna-se fragmentado. O objetivo deste estudo foi identificar a ocorrência de espécies de animais e plantas em uma área verde circundada por indústrias em Cuiabá, MT, Brasil. Nós amostramos 142 espécies de plantas, mamíferos, répteis e aves. Quatro espécies de animais eram introduzidas e uma era migrante sazonal do Hemisfério Norte. A ocorrência de espécies tais como *Pistia stratiotes*, *Curatella americana*, *Eupetomena macroura* e *Ortalis canicollis* indicou Cuiabá como um ecotono do Cerrado e o Pantanal. Assim, existe importância ecológica da área de estudo por abrigar vasta biodiversidade dentro de 30 hectares circundados por indústrias. Cuiabá está expandindo áreas para moradia e comércio, o que pode aumentar a perda de espaços verdes e biodiversidade. Não existe manejo público para cuidar da área de estudo como um espaço para a conservação da biodiversidade e oportunidades recreativas.

Palavras-chave: conservação, ecotone, áreas protetidas.

1. INTRODUCTION

The conversion of the Earth’s land surface for urban use is one of the most irreversible human impacts on global biosphere (SETO et al., 2011). Urbanization brought forth changes in land-cover, hydrological systems, biogeochemistry, climate and biodiversity (GRIMM et al., 2008). Worldwide urban expansion is one of the primary causes of habitat loss and species extinction (HAHS et al., 2009).

Therefore, urbanization is actually one of the most relevant threats to biodiversity worldwide (PRETTY et al., 2009) in several developing countries (SETO et al., 2000). Taking the form of housing development in the United States, it is a major threat to protected areas (RADELOFF et al., 2010).

Urban areas affect local climate through modifications in surface albedo and evapotranspiration, whilst increasing use of aerosols and anthropogenic heat sources provide elevated temperatures (ARNFIELD, 2003) and changes in precipitation patterns (SHEPHERD et al., 2002). Urban areas and complex landscapes, within which green or open areas are seen as valuable for human well-being as well as wildlife, are greatly modified (PICKETT et al., 2004). Thus, the association of biodiversity and urban ecosystems has usually concerned the impact of urbanization on biodiversity (SAVARD et al., 2000).

Anyway, many cities have a network of habitat fragments or urban greenways comprising areas of semi-natural habitats, secondary succession, ruderal and pioneer environments and open areas (ANGOLD et al., 2006).

These habitats, either stable or transient, may be important features for biodiversity (MCINTYRE et al., 2001). Another benefit is the primary contact with biodiversity and natural environment for many people (JORGENSEN et al. 2002),
and may influence people’s physical and mental well-being (JACKSON, 2003). They also encourage the use of outdoor spaces, increase social integration and interaction among neighbors (COLEY et al., 1997), with several opportunities for recreations (EHRENFEUD, 2000). On the other hand, these habitats help in microclimate stabilization, air and water purification, wind and noise filtering (CHIESURA, 2004) and may be valuable for their possible function as corridors and stepping stones to facilitate species dispersal (KIRBY, 1995).

Although the green city is an ideal of universal appeal that transcends temporal, spatial and cultural divides (HESTMARK, 2000), conflicts with conservation aims emerge (ZHIAO et al., 2006) as human populations grow extraordinarily, especially in developing countries (MEA, 2005; UNITED NATIONS, 2008). Urban green spaces deserve more attention and support for policies and practices (JIM, 2004). On the other hand, low appreciation of green spaces is reflected in recent budget cuts for their maintenance (TYRVAIENI; VAANEN, 1998).

Urban growth changes landscapes and related biodiversity patterns at city level, the backland (rural)-urban interface and even at regional and global scales, due to the cities’ ecological footprint (GRIMM et al., 2008). Since urbanization is a major global trend, the question of whether and to what extent, species of animals and plants may survive in urban settings becomes increasingly vital (KOWARIK, 2011). As many convincing arguments already exist regarding the need to prevent biodiversity losses in (semi-) natural landscapes that are affected by urban growth (HANSEN et al., 2005), current focus lies on species occurrence in an urban green space in a neotropical area. The Neotropical zone is the biogeographic region that includes South and Central America, the Mexican lowlands, the Caribbean islands, and southern Florida, and shares many plant and animal groups.

Current study identifies animal and plant species occurrence in a green area surrounded by industries in the county of Cuiabá MT Brazil.

2. MATERIAL AND METHODS

2.1. Study area

Current study area, a 33-hectare stretch belonging to the Municipality, is a Cerrado remnant in the Industrial District of the city of Cuiabá (Figure 1). The administrative regions of Cuiabá were established by Law 3262 of the 11th January 1994 (CUIABÁ, 1994). Cuiabá is a Brazilian city in an ecotone area comprising the Cerrado (Brazilian savanna) and the Pantanal (wetland), whose origin was due to mining in 1719. However, fast population growth and accelerated urbanization occurred in the 1970s (VILANOVA; MAITELLI, 2009; ROMANCINI, 2011). An ecotone is a transition area between two biomes where two communities meet and integrate, or rather, a transition area between the Pantanal and the Cerrado.

Cuiabá (15°35′S; 56°06′W), the capital of the state of Mato Grosso, at its southern tip, lies near the border of the Pantanal and has an estimated population of approximately 569,830 people with a population density of 157.66 per km² (IBGE, 2014). The area, totaling 3,495.4 km², with an urban area of 258.88 km², lies south of the county, at the left side of the Cuiabá River, a tributary of the Paraguay River. Its average altitude is 165 m above sea level (MATO GROSSO, 2014b). The landform elements include valleys and small hills with less than 5% slope (CASTRO JR., 1990). Vegetation comprises Cerrado remnants, dense woodland, riparian vegetation and exotic plants, represented by fruit, ornamental grasses in backyards, and city squares (GUARIM NETO, 1991).

According to Köppén’s classification, the regional climate is Aw, tropical wet and dry, or savanna climate, whose seasonal regime is controlled mainly by air masses from the tropical zone, especially by the South Atlantic anticyclone factor (NIMER, 1988). The rainfall regime has well defined seasons: dry between May and September (autumn-winter) and wet between October and April (spring-summer), with an average annual rainfall ranging between 1250 mm and 1500 mm (BIUDES et al., 2015). Average annual temperature ranges between 24 and 26°C (MACHADO et al., 2015) with lowest rates during the dry season, when air transported by cold fronts from the south (locally called friagens) may persist for several days (BIUDES et al., 2015).

Cuiabá’s economy is based on industry and commerce, with special emphasis on the growing tourism market, whereas subsistence crops and horticultural species are cultivated in the agriculture sector (MATO GROSSO, 2014a). The city has an industrial district with 183 industries currently operating, including representatives of the following sectors: rubber, food and animal products, timber processing, concrete artifacts and ceramics, chemicals and gases, metallurgical products and fertilizer production (MATO GROSSO, 2014c). One of several environmental problems in Cuiabá is related to many urban fires, especially during the dry season (MACHADO et al., 2014). They increase the concentration of gaseous and solid material suspended in the air (IAP, 2001), causing acid rain (MARQUES et al., 2006) and affecting the population’s health (CARMO et al., 2010).

2.2. Data collection

Field trips occurred in June, August and October 2010. The aquatic and terrestrial plants were identified on the field by identification key, when possible (POTT & POTT, 2000) and botanical material was collected and compared to the material deposited in the Herbarium of the Federal University of Mato Grosso.
Ten transects, measuring 200 meters each, were established in the study area with sampling points at 5-m intervals. Species were sampled in transects using the point-quarter method (Goldsmith and Harrison, 1976). Briefly, each measurement point was divided into four quadrants, and within each quadrant, the distance to the nearest tree and its circumference greater than 20 cm at breast height (1.3 m above ground) were identified.

Direct evidence, such as visual or auditory observations, and indirect evidence, such as tracks, carcasses, food debris and feces, were used for the inventory of medium and large mammals. Bird species were identified by vocalizations and watching. Reptiles and amphibians were identified by intensive search in existing substrates such as leaf litter, fallen logs, rocks, tree bark, bushes, stone slabs and others.

3. RESULTS

Four aquatic plant species, distributed in 4 families were identified in a lake within the study area (Table 1). Twenty-nine species of terrestrial plants distributed in 17 families were found in the study area (Table 2). The most species-rich family was Fabaceae.

Three reptile species distributed in 3 families were identified, but no amphibian was found (Table 3). Nine species of mammals distributed in 8 families were registered (Table 4). Birds were more abundant group in the study area. Ninety-seven bird species were registered (Table 5), whilst 49 species were Passeriforms and 48 non-Passeriforms. The most species-rich family was Tyrannidae (16 species), followed by Icteridae (7 species).

4. DISCUSSION

All aquatic plants species identified may also be found in the Pantanal (POTT; POTT, 2000). A checklist reported 242 aquatic plant species distributed in 54 families, with Poaceae, Cyperaceae and Leguminosae as the most species-rich families in the Brazilian Pantanal, whilst the most abundant genera

Table 1. Aquatic plant species in an urban green space in Cuiabá, MT, Brazil.

| Family          | Scientific name | Common name           |
|-----------------|-----------------|-----------------------|
| Araceae         | Pistia stratiotes L. | Alface-d’agua, orelha-de-onça |
| Asteraceae      | Eclipta prostrata L. | Erva-de-botão       |
| Typhaceae       | Typha domingiensis Pers. | Taboa              |
| Najadaceae      | Najas guadalupensis (Spreng.) | Lodo              |

Table 2. Terrestrial plant species in an urban green space in Cuiabá, MT, Brazil.

| Family      | Scientific name | Common name |
|-------------|-----------------|-------------|
| Araceae     | Pistia stratiotes | Alface-d’aqua, orelha-de-onça |
| Asterae     | Eclipta prostrata | Erva-de-botão |
| Typhaceae   | Typha domingiensis | Taboa |
| Najadaceae  | Najas guadalupensis | Lodo |

Table 3. Reptile species in an urban green space in Cuiabá, MT, Brazil.

| Family      | Scientific name | Common name |
|-------------|-----------------|-------------|
| Araceae     | Pistia stratiotes | Alface-d’aqua, orelha-de-onça |
| Asterae     | Eclipta prostrata | Erva-de-botão |
| Typhaceae   | Typha domingiensis | Taboa |
| Najadaceae  | Najas guadalupensis | Lodo |

Table 4. Mammal species in an urban green space in Cuiabá, MT, Brazil.

| Family        | Scientific name                        | Common name       |
|---------------|----------------------------------------|-------------------|
| Caviomorphae  | Cavia porcellus                        | Catio             |
| Canidae       | Canis lupus                             | Lobo              |
| Felidae       | Felis catus                             | Gato              |
| Primateae     | Cebus apella                           | Macaco           |
| Hyaenidae     | Crocuta crocuta                         | Cão-de-caça       |
| Rodentemorpha | Microtus oeconomus                     | Coelho           |

Table 5. Bird species in an urban green space in Cuiabá, MT, Brazil.

| Family      | Scientific name | Common name |
|-------------|-----------------|-------------|
| Aves         | Passeriformes   | Pássaro     |
|             | Non-Passeriforms | Pássaro    |

Nativa, Sinop, v.5, n.5, p.320-329, set./out. 2017
Table 4. Mammal species in an urban green space in Cuiabá, MT, Brazil.
Tabela 4. Espécies de mamíferos em um espaço verde urbano em Cuiabá, MT, Brasil.

| Family               | Scientific name                        | Common name                  |
|----------------------|----------------------------------------|------------------------------|
| Didelphidae          | Phalerion opossum (Linnaeus, 1758)     | Tachá                        |
| Dasypodidae          | Dasypus novemcinctus (Linnaeus, 1758)  | pe-vermelho                  |
| Leporidae            | Sylvilagus brasiliensis (Linnaeus, 1758) | aracuá-do-pantanal          |
| Canidae              | Canis familiaris (Linnaeus, 1758)      | cão doméstico                |
| Cervidae             | Mazama americana (Erxleben, 1777)      | veado-mateiro                |
| Bovidae              | Bos taurus                             | boi, vaca                    |
| Caviidae             | Cavia aperea (Erxleben, 1777)          | Preá                         |
| Caviidae             | Hydrochoerus hydrochaeris (Linnaeus, 1766) | capivara                   |
| Dasyproctidae        | Dasyprocta azara (Lichtenstein, 1823)  | Cutia                        |

Continues on the next page.
were Nymphaea, Utricularia, and Echinodorus (POTT; POTT, 1997). Aquatic plants are often classified ecologically by their life-forms, such as floating (P. stratitae), amphibious (E. prostrata), emergent (T. domingensis) and fixed submersed (N. guadalupensis), with emergent and amphibious life-forms as the most abundant (POTT; POTT, 2000). In general, the concept of aquatic plant is debatable and varies according to each author.

Several terrestrial plant species, such as T. aurea, C. americana, C. brasiliense and B. gaudichaudi, are native to both the Cerrado and the Pantanal, (LORENZI, 1998; ASSUNÇÃO; FÉLFILI, 2004). Curatella americana often makes up the predominant landscape of Cerrado in central Brazil (SOUZA; LORENZI, 2008), with pantropical distribution (Dilleniaceae). Brazil represents the center of diversity in the Neotropics (LORENZI, 1998), indicating that a considerable amount of taxonomic research has still to be done on the Cerrado flora. In fact, the flora may be much richer than generally presumed.

Considering mammals, Canis familiaris and B. taurus are non-native species from Brazil. Direct and indirect impacts...
of domestic dogs on the native fauna have become frequent (GALETTI; SAZIMA, 2006; CAMPOS et al., 2007). In addition, domestic dogs are possible disease carriers, such as leishmaniasis and rabies, whose diseases are an important threat to native species (BUTLER; DU TOIT, 2002; CURI et al., 2006).

All native bird species identified in this study are found in the Cerrado and other Brazilian biomes as specified below (MARINHO-FILHO et al., 2002). Sylvilagus brasiliensis is included as a vulnerable species on the red list of the state of Paraná, whilst M. americana is an endangered species in the red list of the states of Rio Grande do Sul and Rio de Janeiro (CHIARELLO et al., 2008). Dasypota azara is included as a vulnerable species on the IUCN red list (CATZEFILS et al., 2008).

The domestic pigeon and house sparrow occurred in study area, but they are non-native species of Brazil. The original worldwide distribution of domestic pigeon is difficult to determine due to a long history of domestication and feral populations (GIBBS et al., 2001). Pigeons occur on all the major continents, except Antarctica (GIBBS et al., 2001). Columba livia may be considered a negative indicator species of environmental quality in urban space, because areas with higher levels of human interference support high populations, being dependent on resources produced by humans for its survival (AMÂNCIO et al., 2008). The house sparrow species hails from Europe and it occurs throughout Brazil (BRASIL; AMATO, 1992). Pitangus sulphuratus is a major potential seed disperser in the Cerrado biome (FRANCISCO; GALETTI, 2002), but it cannot be regarded as a bio-indicator of urban environmental quality because no correlation between its abundance and human intervention has been found (AMÂNCIO et al., 2008).

Several species, such as A. brasiliensis, T. furcata, A. leucocephala and M. bonariensis, show a nomadic movement in search of the most favorable areas for their survival due to seasonal availability of food caused by flood pulses (NUNES; TOMAS, 2008). Other species recorded in the study area, such as T. dominicus, A. alba, E. caerulea, M. americana, P. picazuro, S. suiriri, M. maculatus, T. melancholica, and S. leucoptera, are intra-continental migrants from the southern and northern regions of South America (NUNES; TOMAS, 2008). Tringa solitaria recorded in the study area is an an intercontinental migrant fleeing the harsh winter in the Northern Hemisphere toward the southern portion of South America (NUNES; TOMAS, 2008). These species arrive in Brazil in April when the austral winter starts, for breeding, which result in cyclical downturns in food supply (ANTAS; PALO-JÚNIOR, 2004). Migrants and nomads match 40% of birds occurring in the Pantanal (NUNES et al., 2008) and reflect the seasonality and heterogeneity in the Pantanal landscape.

On the other hand, E. macroula, G. chopi and A. badius are residents in the Pantanal (NUNES et al., 2008), whilst other species are widespread in Brazil, such as M. ferox (ANTAS; PALO JÚNIOR, 2004), C. amazona (SIGRIST, 2009), C. plancus (CARVALHO; MARINI, 2007), L. verreauxi (FRISCH; FRISCH, 2005), R. magnirostris (MARINI et al. 2007), and G. aequinoctialis (CRBO, 2008). Fourteen species restricted to some Brazilian biomes were recorded, namely, C. minuta in the Cerrado and Amazon rainforest (CRBO, 2008), P. rufifrons in the Cerrado and Caatinga, A. flavirostris in the Cerrado and Pantanal (ANTAS; PALO JÚNIOR, 2004), O. canicollis in the Pantanal, C. turdinus in the Cerrado and Amazon rainforest (SIGRIST, 2009) and B. chiriri and S. coerulescens in the Cerrado (CRBO, 2008). Several studies are extant on biodiversity in urban areas. However, it should be underscored that none of these studies surveyed plants, reptiles, mammals and birds within the same area as has been done in current study. Araújo et al. (1997) surveyed tree species in an urban forest in Araguaí, Brazil. Yokimaki (1999) studied the breeding of 22 bird species in urban parks in northern Finland. Bastin and Thomas (1999) studied plant species distribution in urban vegetation fragments in Birmingham, UK. Mörberg (2001) investigated resident bird species in urban forest remnants in Stockholm. Franchin & Marçal-Júnior (2004) determined the avifauna richness in an urban park in Uberlândia, Brazil. Dantas & Souza (2004) forwarded a quantitative inventory of trees in Campina Grande, Brazil. Barros et al. (2006) carried out bats’ inventories in three areas of urban forests in Juiz de Fora, Brazil. Reis et al. (2006) also surveyed bats in an urban park in Londrina, Brazil. Brun et al. (2007) studied the employment of trees in the maintenance of fauna biodiversity in urban areas. Lutinski et al. (2013) surveyed diversity of urban ants in ten cities in southern Brazil. Sacco et al. (2013) studied bird species that use the urban area in Pelotas, Brazil.

CITIES are more than just buildings and people. Some of the world’s most famous cities are known for their open spaces as they are for their culture, such as the Ibirapuera Park in São Paulo (Brazil), Phoenix Park in Dublin, Central Park in New York (USA), the Bukit Timah Nature Preserve in Singapore, and Hyde Park in London (England). These parks are attractions for dwellers and visitors. They increase the attractiveness of the urban settlement environment, offer relaxation, restoration, stress reduction, escape from the city milieu and provide sites for social interaction (BARBOSA et al., 2005; JAMES et al., 2009; SEARLE, 2011). These places should provide high-quality recreation experiences for urban residents (ARNBERGER, 2012). Thus, public urban green spaces play an important role in urban sustainability.

Humanity is increasingly urban, but continues to depend on nature for its survival since towns and cities depend on the ecosystems beyond the city limits, and benefit from internal urban ecosystems (BOLUND; HUNHAMMAR, 1999). Due to growing and increasingly urbanized populations (CLARK, 1951), the demand for more land to be released for development may be intense. Seto et al. (2011) revealed that urban land expansion rates were higher than or equal to urban population growth rates, suggesting that urban growth is becoming more expansive than compact.

Cuiabá is constantly expanding its housing development areas, with an increase in green space losses, and consequent liability in biodiversity. There is no public plan to take care of the study area in Cuiabá as a space for conserving biodiversity and opportunities for recreations.

5. CONCLUSION

Species occurrence indicated Cuiabá as an ecotone area composed of species from the Cerrado (Brazilian savanna) and the Pantanal (wetland). The ecological importance of the area for harboring biodiversity within an urban area of 30 hectares surrounded by industries is self-evident.
6. ACKNOWLEDGMENTS

We would like to thank Borrachas Drebor Ltda for its financial support. Thanks are also due to Campus Cuiabá - Bela Vista of Instituto Federal de Mato Grosso (IFMT) for its logistical support.

7. REFERENCES

ALVES, R. R. N.; VIEIRA, K. S.; SANTANA, G. G.; VIEIRA, W. L. S.; ALMEIDA, W. O.; SOUTO, W. M. S.; MONTENEGRO, P. F. G. P.; PEZZUTI, J. C. B. A review on human attitudes towards reptiles in Brazil. Environmental Monitoring and Assessment, Dordrecht, v. 184, p. 6877-6901, 2012. http://dx.doi.org/10.1007/s10661-011-2465-0

AMÂNCIO, S.; SOUZA, V. B.; MELO, C. Columbia livia e Pitangus sulphuratus como indicadoras de qualidade ambiental em área urbana. Revista Brasileira de Ornitologia, São Paulo, v. 16, n. 1, p. 32-37, 2008.

ANGOLD, P. G.; SADLER, J. P.; HILL, M. O.; PULLIN, A.; RUSHTON, S.; AUSTIN, K.; SMALL, E.; WOOD, B.; WADSWORTH, R.; SANDERSON, R.; THOMPSON, K. Biodiversity in urban habitat patches. Science of the Total Environment, Amsterdam, v. 360, p. 196-204, 2006. http://dx.doi.org/10.1016/j.scitotenv.2005.08.035

ANTAS, P. T. Z.; PALO-JÚNIOR, H. Guia de aves: espécies da reserva particular do patrimônio natural do SESC Pantanal. Rio de Janeiro: SESC Nacional. 249p. 2004.

ARAÚJO, G. M.; GUIMARÃES, A. J. M.; NAKAJIMA, J. N. Fitosociologia de um remanescente de mata mesófila semidecídua urbana, bosque John Kennedy, Aragüari, MG, Brasil. Revista Brasileira de Botânica, São Paulo, v. 20, n. 1, p. 67-77, 1997.

ARNBERGER, A. Urban Densification and Recreational Quality of Public Urban Green Spaces - A Viennese Case Study. Sustainability, v. 4, p. 703-720, 2012. http://dx.doi.org/10.3390/su4040703

ARNFIELD, A. J. Two decades of urban climate research: A review. Tropical Ecosystems in Mato Grosso, Brazil. Neotropica, Porto Alegre, v. 18, n. 4, p. 703-720, 2004. http://dx.doi.org/10.3390/su4040703

ASSUNÇÃO, S. L.; FELFILI, J. M. Fitosociologia de um fragmento de cerrado sensu stricto na APA do Paranoá, DF, Brasil. Acta Botanica Brasiliaca, Porto Alegre, v. 18, n. 4, p. 903-909, 2004.

BARBOSA, O.; TRATADO, J. A.; ARMSWORTH, P. R.; DAVIS, R. G.; FULLER, R. A.; JOHNSON, P.; GASTON, K. J. Who benefits from access to green space? A case study from Sheffield, UK. Landscape and Urban Planning, Amsterdam, v. 83, p. 187-195, 2007. http://dx.doi.org/10.1016/j.landurbplan.2007.04.004

BARROS, R. S. M.; BISAGGIO, E. L.; BORGES, R. C. Morcegos (mammalia, chiroptera) em fragmentos florestais urbanos no município de Juiz de Fora, Minas Gerais, Sudeste do Brasil. Biota Neotropical, Campinas, v. 6, n. 1, BNO22060120006, 2006.

BASTIN, L.; THOMAS, C. D. The distribution of plant species in urban vegetation fragments. Landscape Ecology, Dordrecht, v. 14, p. 493-507, 1999. http://dx.doi.org/10.1023/A:1008036207944

BIUDES, M. S.; VOURLITIS, G. L.; MACHADO, N. G.; ARRUDA, P. H. Z.; NEVES, G. A. R.; LOBO, F. A.; NEALE, C. M. U.; NOGUEIRA, J. S. Patterns of Energy Exchange for Brazilian Tropical Ecosystems in Mato Grosso, Brazil. Agricultural and Forest Meteorology, Amsterdam, v. 202, p. 112-124, 2015. http://dx.doi.org/10.1016/j.agrformet.2014.12.008

BOLUND, P.; HUNHAMMAR, S. Ecosystem services in urban areas. Ecological Economics, Amsterdam, v. 29, p. 293-301, 1999.

BRASIL, M. C.; AMATO, S. B. Análise faunaestica dos helmintos de pardais (Passer domesticus L., 1758) capturados em Campo Grande, Rio de Janeiro, RJ. Memórias do Instituto Oswaldo Cruz, Rio de Janeiro, v. 87, n.1, p. 43-48, 1992. http://dx.doi.org/10.1590/S0074-02761992005000009

BRUN, F. G. K.; LINK, D.; BRUN, E. J. O emprego da arborização na manutenção da biodiversidade de fauna em áreas urbanas. Revista da Sociedade Brasileira de Arborização Urbana, v. 2, n. 1, p. 117-127, 2007.

BUTLER, J. R. A.; DU TOIT, J. T. Diet of free-ranging domestic dogs (Canis familiaris) in rural Zimbabwe: implications for wild scavengers on the periphery of wildlife reserves. Animal Conservation, Cambridge, v. 5, p. 29-37, 2002. http://dx.doi.org/10.1017/S136794300200104X

CAMPOS, C. B.; ESTEVES, C. F.; FERRAZ, K. M. P. M. B.; CRAWSHAW JR., P. G.; VERDADE, L. M. Diet of free-ranging cats and dogs in a suburban and rural environment, south-eastern Brazil. Journal of Zoology, v. 273, p. 14-20, 2007. http://dx.doi.org/10.1111/j.1469-7988.2007.00291.x

CARMO, C. N.; HACON, S.; LÔNGO, K. M.; FREITAS, S.; IGNOTTI, E.; PONCE DE LEON, A.; ARTAXO, P. Associação entre material particulado de queimadas e doenças respiratórias na região sul da Amazônia brasileira. Revista Panamericana de Saúde Pública, v. 27, n. 1, p. 10-6, 2010.

CARVALHO, C. E. A.; MARINI, M. Á. Distribution patterns of diurnal raptors in open and forested habitats in south-eastern Brazil and the effects of urbanization. Bird Conservation International, v. 17, p. 367-380, 2007. http://dx.doi.org/10.1017/S1367943007000882

CASTRO JR., P. R. Carta Geotécnica de Cuiabá. Cuiabá: Fundação Universidade de Mato Grosso/Prefeitura de Cuiabá. (mimeo.) 1990.

CASTRO, A. A. J. F.; MARTINS, F. R.; TAMASHIRO, J. Y.; SHEPHERD, G. J. How Rich is the Flora of Brazilian Cerrados? Annals of the Missouri Botanical Garden, v. 86, n. 1, p. 192-224, 1999. http://dx.doi.org/10.2307/2666220

CATZEFLIS, F.; PATTON, J.; PERCEQUILLO, A.; BONVICINO, C.; WEKSLER, M. Dasyprocta azarae. The IUCN Red List of Threatened Species. Version 2014.1. <www.iucnredlist.org>. Downloaded on 20 July 2014.

CBRO (Comitê Brasileiro de Registros Ornitológicos). Listas das aves do Brasil. 8ª ed. 37 p. 2008.

CHIARELLO, A. G.; AGUIAR, L. M. S.; CERQUEIRA, R.; MELO, F. R.; RODRIGUES, F. H. G.; SILVA, V. M. F. Mamíferos Ameaçados de Extinção no Brasil. In: MACHADO, A. B. M.; DRUMMOND, G. M.; PAGLIA, A. P. Livro Vermelho da Fauna Brasileira Ameaçada de Extinção. I. ed. v. 2 - Brasilia, DF: MMA; Belo Horizonte, MG: Fundação Biodiversitas,1420 p. 2008.

CHIESURA, A. The role of urban parks for the sustainable city. Landscape and Urban Planning, v. 68, p. 129-138, 2004. http://dx.doi.org/10.1016/j.landurbplan.2003.08.003

CLARK, C. Urban Population Densities. Journal of the Royal Statistical Society. Series A, v. 114, n. 4, p. 490-496, 1951.

COLEY, R.; KUO, F.; SULLIVAN, W. Where does community grow? The social context created by nature in urban public housing. Environment and Behavior, v. 29, p. 468-494, 1997. http://dx.doi.org/10.1177/001391659702900402

COLLI, G. R.; BASTOS, R. P. The character and dynamics of the cerrado herpetofauna. In: Oliveira, O. S.; Marquis, R. J. (Org.). The cerrados of Brazil: ecology and natural history of a neotropical savanna. New York: Columbia University Press. 223p. 2002.
COOKE, R. G. Los hábitats alimentarios de los indígenas precocolombinos de Panamá: Food habits of the precocolombian indians of Panama.

Revista Médica de Panamá, v. 6, n. 1, p. 65-89, 1981.

COSTA, G. C.; NOGUEIRA, C.; MACHADO, R. B.; COLLI, G. R. Squamate richness in the Brazilian Cerrado and its environmental-climatic associations. Diversity and Distributions, v. 13, p. 714-724, 2007. http://dx.doi.org/10.1111/j.1472-4642.2007.00369.x

CUIABÁ. Lei nº 3.262 de 11 de Janeiro de 1994.

CURI, N. H. A.; MIRANDA, I.; TALAMONI, S. A. Serologic evidence of Leishmaniasis infection in free-ranging wild and domestic canids around a Brazilian National Park. Memórias do Instituto Oswaldo Cruz, v. 101, n. 1, p. 99-101, 2006. http://dx.doi.org/10.1590/S0074-02762006000100019

DANTAS, I. C.; SOUZA, C. M. C. Arborização urbana na cidade de Campina Grande - PB: Inventário e suas espécies. Revista de Biologia e Ciências da Terra, v. 4, n. 2, p. 1-18, 2004.

EHRENFEID, J. G. Evaluating wetlands within an urban context. Ecological Engineering, v. 15, p. 253-265, 2000. DOI:10.1016/S0940-1290(99)00122-0

FITCH, H. S.; HENDERSON, R. W.; HILLIS, D. M. Exploitation of iguanas in Central America. In: BURGHARDT, G. M.; STANLEY, A. Iguanas of the World: Their Behavior, Ecology and Conservation. Noyes Publications New Jersey, pp. 397-415, 1996.

FRAGA, C. N.; JUDICE, D. M.; PENEDO, T. S. A. DILLENIACEAE. In: MARTINELLI, G.; MORAES, M. A. (Orgs.). Livro Vermelho da Flora do Brasil. Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, Rio de Janeiro. 1100p. 2013.

FRANCIN, A. G.; MARÇAL-JÚNIOR, O. A riqueza da avifauna no Parque Municipal do Sabiá, zona urbana de Uberlândia (MG). Biotemas, v. 17, n. 1, p. 179-202, 2004.

FRANCISCO, M. R.; GALETTI, M. Aves como potenciais dispersoras de sementes de Ocotea pulchella Mart. (Lauraceae) numa área de vegetação de cerrado do sudoeste brasileiro. Revista Brasileira de Botânica, v. 25, n. 1, p. 11-17, 2002.

FRISCH, J. D.; FRISCH, C. D. Aves Brasileiras e Plantas que as Atraem. 3ª ed. Dalgas Ecoltec - Ecologia Técnica Ltda. 166p. 2005.

GALETTI, M.; SAZIMA, I. Impacto de cães ferais em um fragmento urbano de Floresta Atlântica no sudoeste do Brasil. Natureza & Conservação, v. 4, n. 1, p. 58-63, 2006.

GIBBS, D.; BARNES, E.; COX, J. Pigeons and Doves of the World: A guide to the pigeons and doves of the World. The Pica Press, Sussex. 560p. 2001.

GOLDSMITH, F. B.; HARRISON, C. M. Description and analysis of habitats and distribution patterns in the Neotropical islands of Panama. Clusterson, v. 8, n. 3, p. 275-286, 1990.

GIBBS, D.; BARNES, E.; ROBERTS, T. Social organization of crows in two urban environments. Animal Behaviour, v. 35, n. 1, p. 38-42, 1987.

GIBBS, D.; BARNES, E.; ROBERTS, T. Social organization of crows in two urban environments. Animal Behaviour, v. 35, n. 1, p. 38-42, 1987.

GIBBS, D.; BARNES, E.; ROBERTS, T. Social organization of crows in two urban environments. Animal Behaviour, v. 35, n. 1, p. 38-42, 1987.

GIBBS, D.; BARNES, E.; ROBERTS, T. Social organization of crows in two urban environments. Animal Behaviour, v. 35, n. 1, p. 38-42, 1987.
YLI-PELKONEN, V.; NIEMELA, J. Linking ecological and social systems in cities: urban planning in Finland as a case. *Biodiversity Conservation*, v. 14, p. 1947-1967, 2005. http://dx.doi.org/10.1007/s10531-004-2124-7

ZHAO, S. Q.; DA, L. J.; TANG, Z. Y.; FANG, H. J.; SONG, K.; FANG, J. Y. Ecological consequences of rapid urban expansion: Shanghai, China. *Frontiers in Ecology and the Environment*, v. 4, p. 341-346, 2006. http://dx.doi.org/10.1890/1540-9295(2006)004[0341:ECORUE]2.0.CO;2