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Macaws, their behavior, and local biodiversity as possible drivers of ecotourism development in Alta Floresta, MT, Brazil

Araras, seu comportamento e a biodiversidade local como possíveis impulsionadores do desenvolvimento do ecoturismo em Alta Floresta, MT, Brasil

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RESUMO - O município de Alta Floresta, Mato Grosso, Brasil, vem se destacando pelo crescimento do turismo ecológico. A cidade tem se tornado um dos principais destinos para a observação de pássaros no Brasil, constituindo o núcleo inicial de ecoturismo da Amazônia mato-grossense. A região tem particular destaque por ser onde são observadas diversas espécies de araras. Dessa forma, visamos relacionar o comportamento dessas espécies com as épocas de turismo mais intenso na região. Aproximadamente 50 ninhos foram localizados, principalmente contando-se com a expertise dos pesquisadores envolvidos e pela participação da população local. Duas espécies, a arara-canindé (*Ara ararauna*) e a arara-vermelha (*A. chloropterus*), foram observadas em processos de nidificação e alimentação na região urbana. Os ninhos estão localizados em áreas limpas e bem conservadas, próximas ao centro da cidade. A observação de araras foi mais frequente entre os meses de agosto e fevereiro, coincidindo com a maior parte dos eventos municipais e acadêmicos da região. Esses dados podem ser utilizados para nortear estratégias para manejo e observação de aves, com ênfase nas espécies de araras, estimulando a preservação dos ambientes ocupados por elas. Idealmente, este estudo poderá ser utilizado na criação de estratégias de estímulo ao turismo em Alta Floresta e região e, principalmente, no apoio a atividades voltadas para a observação de aves e a biodiversidade local.

PALAVRAS-CHAVE: Avifauna. Comportamento animal. Participação da população local. Floresta amazônica. Desenvolvimento sustentável.

ABSTRACT - The city of Alta Floresta, Mato Grosso State, Brazil, has a growing ecotourism industry. It has become a popular destination for birdwatching in the country and represents a hotspot for Amazonian tourism in Mato Grosso State. The region is home to a variety of macaw species. This study therefore sought to determine any associations between species behavior and tourism seasonality in the region. Approximately 50 nests were in this study through scientific expertise and crowdsourcing. Two species—the blue-and-gold macaw (*Ara ararauna*) and the red-and-green macaw (*A. chloropterus*)–were found to engage in feeding and nesting behavior in the city. The nests were in clean and well-maintained areas near the city center. The most frequent macaw sightings occurred between August and February, a period which coincided with academic and municipal events in the region. These findings may

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be used to guide strategies for birdwatching and species management, particularly in the case of macaws; they may also aid in environmental conservation efforts for these species' habitats. This study will ideally be used in the creation of strategies to stimulate tourism in Alta Floresta and the surrounding region, and particularly to support activities focused on birdwatching and local biodiversity.

KEYWORDS: Birds. Animal behavior. Crowdsourcing. Amazon rainforest. Sustainable development.

INTRODUCTION

Increases in human populations generate increasing demands for food, goods, and services that are often limited or scarce (ARRUDA, 2001). The concept of development has therefore changed over time. It first represented an accumulation of capital. Later, socioeconomic development presupposed that any changes would be quantitative and qualitative, with a fair distribution of the results of growth. However, the development of market economies produced a series of negative impacts, including environmental destruction (air, soil, and water pollution, deforestation, stubble burning, erosion, and biodiversity loss) and worsened human health (MARINI; GARCIA, 2005; BENI, 2006; HESSEL; SAITO; OLIVEIRA, 2009).

Environmental destruction and population reduction have become concerns in modern society amid the institutionalization of environmental debate. The current definition of development is thought to encompass local natural resources and is often synonymous with sustainable development. Sustainable development has been used as a way to guarantee the survival of human groups and nature in both the present and the future. However, each place, city, or region may and should select a development process that respects its specific resources and values, and which best leverages its participation in human development as a worldwide phenomenon. Sustainability may be understood as the different options that each place, city, region, or country has as a result of its environmental, cultural, ethical, or moral features when involved in the development process as a whole (BECKER, 1997).

It is important to note that the result of unsustainable development is that many natural habitats are fragmented, altered, or lost. Along the way, numerous species suffer population reduction, and many are now headed toward extinction. In the case of Brazil, the country's natural heritage is recognized as one of the most significant on the planet. This natural wealth is established by the length of coastline and vast amount of land mass, by the diversity and endemism of species and their rich gene pool, and by the ecosystemic variety of the country's biomes, ecoregions, and bioregions (ARRUDA, 2001).

According to the Brazilian Ministry of the Environment, the country has the richest biodiversity in the world and is home to one of the planet's largest and most diverse bird populations, with an estimated 1900 bird species (GUEDES, 2009; PIACENTINI *et al.*, 2015). Brazil also has the largest number of psittacine species, which are most commonly represented by macaws (SICK, 1997).

Of the 344 psittacine species in the world, approximately 88 are found in Brazil, and 17 of these are at risk of extinction. The threatened species include Lear's macaw (*Anodorhynchus leari*), the glaucous macaw (*Anodorhynchus glaucus*), and Spix's macaw

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(*Cyanopsitta spixii*). Macaws are found across almost all of South America. In addition to Brazil, they prefer the regions surrounding large rivers, savannas, and forests of Colombia, Peru, Venezuela, northern Argentina, and Paraguay. Psittacines have morphological, physiological, and behavioral specifications that enable them to ingest a variety of food sources; of these, the morphological adaptations of their beaks are the most noticeable. Macaws' natural diet consists of fruits from different *Arecaceae* palms, in addition to those produced by Amazonian trees such as the japacanim (*Parkia oppositifolia*), the jatoba (*Hymenaea courbaril L.*), and the boxwood *Aspidosperma parvifolium* (SANTOS; VOLTARELLI; PACHALY, 2009).

In the context of the local conditions of this study, these aspects are even more important, since many local bird species are highly threatened by the ecosystem fragmentation and wildlife trafficking that hurt many habitats and species worldwide (MARINI; GARCIA, 2005; HESSEL; SAITO; OLIVEIRA, 2009). The city of Alta Floresta, Mato Grosso State, is located in the Amazon region. It puts ecotourists into close contact with nature and is one of Brazil's most popular destinations for birdwatching. The region's bird species richness is recognized internationally, as are its primate species richness and diversity of Amazonian flora, all of which attract ecotourists and researchers alike. Due to the city's substantial natural potential, its ecotourism industry has grown, and the city has become a hotspot for Amazonian ecotourism in the state (MENEZES, 2016).

Species of the order Psittaciformes are a symbol of the tropical rainforests of the Americas, including the Amazon Rainforest. They are one of the oldest avian lineages with living descendants (SILVA NETO *et al.*, 2013). Corrêa and Guedes (2006) report that conservation measures and educational campaigns may be guided by studies on flagship species, and that the species chosen to represent conservation efforts must be popular and charismatic, which macaws are. Biodiversity conservation studies seek to unveil human impact on natural environments and the resulting changes, focusing on species population conservation, ecosystem maintenance, and ecological relationships that benefit entire biotic communities (MITTERMEIER *et al.*, 2005).

Thus, interventions that align socioeconomic development with environmental conservation may help to maintain local ecosystems without interrupting or reducing options for local economic expansion. Furthermore, the study of bird behavior, and of macaw behavior in particular, may be useful in stimulating local tourism, thus increasing the city's revenue and options for local environmental conservation efforts. This is because it has recently been established that sustainable regional development is possible only if natural resources are taken into account. Social, economic, and environmental factors must be integrated into policies, plans, programs, and projects, since focusing too highly on or ignoring one of these factors will negatively affect animal and human populations' quality of life (BENI, 2006).

MATERIALS AND METHODS

This study was performed in the developed urban area and surrounding lands of the city of Alta Floresta in northern Mato Grosso State, Brazil (09º52'32''S, 56º05'10''W). It is located within the Amazon biome. The city has many swamps, wetlands and trees, including a large amount of buriti palms (*Mauritia flexuosa*). Other areas of the city have other palm tree species. The animals studied were macaw species that make their nests in the urban area of the city and its surroundings.

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Social media platforms were key tools in the project. The use of social media was used to publicize the project and to engage in crowdsourcing. The social media accounts provided a space for communication between researchers and the local population, who exchanged information about the birds and their nesting sites. With the information received from social media, the nests were marked on a map of the city. After this mapping, the team visited the nests and recorded their exact geographic coordinates. The team also recorded and characterized the area surrounding each nest, taking notes on the extent to which the area was preserved from waste, trash, and environmental degradation. The nests were visited using a Mitsubishi L200 pickup truck, and pictures were taken using a Canon EOS Rebel T5i professional camera.

After the nests were located, they were monitored monthly, and any macaw species that occupied them were recorded. As a part of this monitoring process, the presence of other species and the birds' activities in the nest were also recorded. These activities included exploration, defensive behavior, and feeding. The data obtained from this monitoring process were organized, analyzed, and compared to data in the literature.

As mentioned previously, tourism plays an important role in the economies of cities like Alta Floresta. This city is located in the region surrounding the Amazon Rainforest. It has a strong hospitality network and an airport with daily flights. The city has gained attention for its natural beauty and has received tourists from all over the world in search of contact with nature, sport fishing, and birdwatching. The city's event calendar was used to consider the data obtained on macaw behavior in the context of the tourist seasons in the region. The city receives more tourists for events such as fishing season and the ExpoAlta Farming Expo. This information allowed us to infer the periods of the year with greater human presence and activity.

RESULTS

From August to October 2020, content and images were created and published on social media for this project in order to advertise the campaign and exchange information with local residents through crowdsourcing efforts. The material was shared on social media, and a cell phone number was designated and advertised to receive messages about bird nests. An article on the project was also published in the local newspaper, *O Diário*, on September 25 (Figs. 1-4).

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Fig. 1 Social media profiles and posts for the macaw nesting project. These included an Instagram profile for the project (left), the first post on profile, which asked residents if they'd seen any macaw nests and which included the project's logo (center), and an update to the project's Facebook page to meet study demands by providing a description of the project and information on the associated university (right).

Fig. 2 Screenshots from the project's Facebook profile showing how the project was advertised and how local residents reacted (likes and shares).

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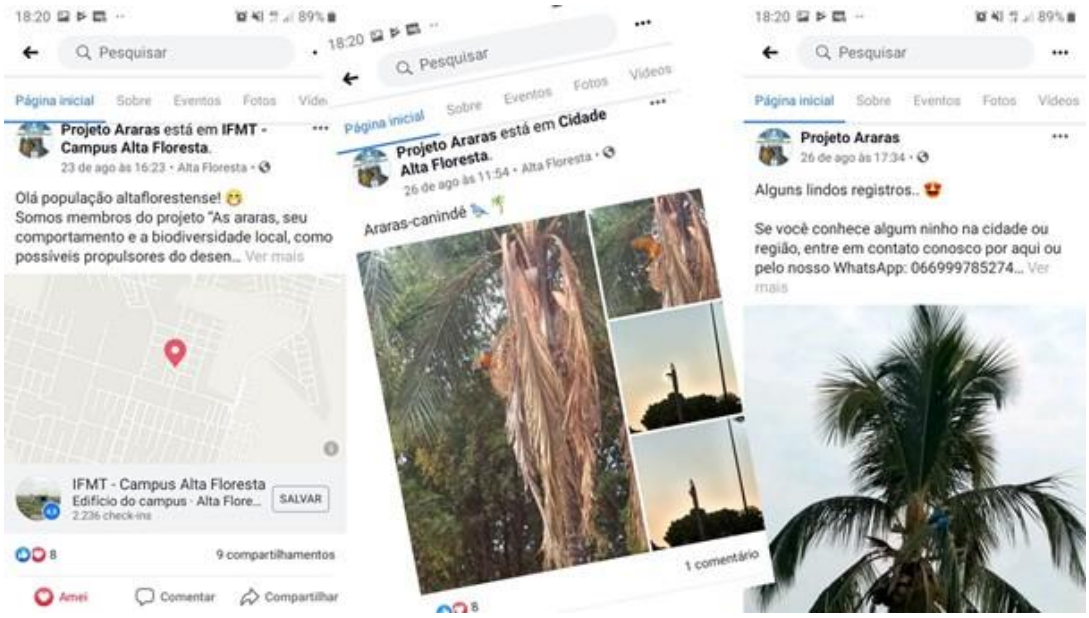

Fig. 3 Additional posts on the project's Instagram profile and Facebook page, including posts to describe the project and share a video on macaw sightings (left), as well as crowdsourced photos shared by local residents (center and right).

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Fig. 4 Article published about the project in the *O Diário* newspaper on September 25 (left and center), as well as a story requesting information on nesting sites on the projects Instagram profile (right).

The nests were mapped using the information provided by local residents. The team also searched the region to identify nests not reported by locals. In the end, approximately 50 nests were located and marked on the map of Alta Floresta provided by City Hall (Fig. 5). The nests and specimens were detailed and recorded, as were the areas surrounding the nests. No nests were found in the outskirts of the city or in more preserved areas of forest. The analysis revealed that the nesting sites were largely urban and were concentrated close to the city center (Fig. 5). These areas are clean and well maintained, with no visible trash or pollution (Fig. 6).

Fig. 5 A map of the city of Alta Floresta, Mato Grosso State (provided by City Hall). The red dots

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indicate nesting sites, and the numbers indicate the number of nests seen at that site.

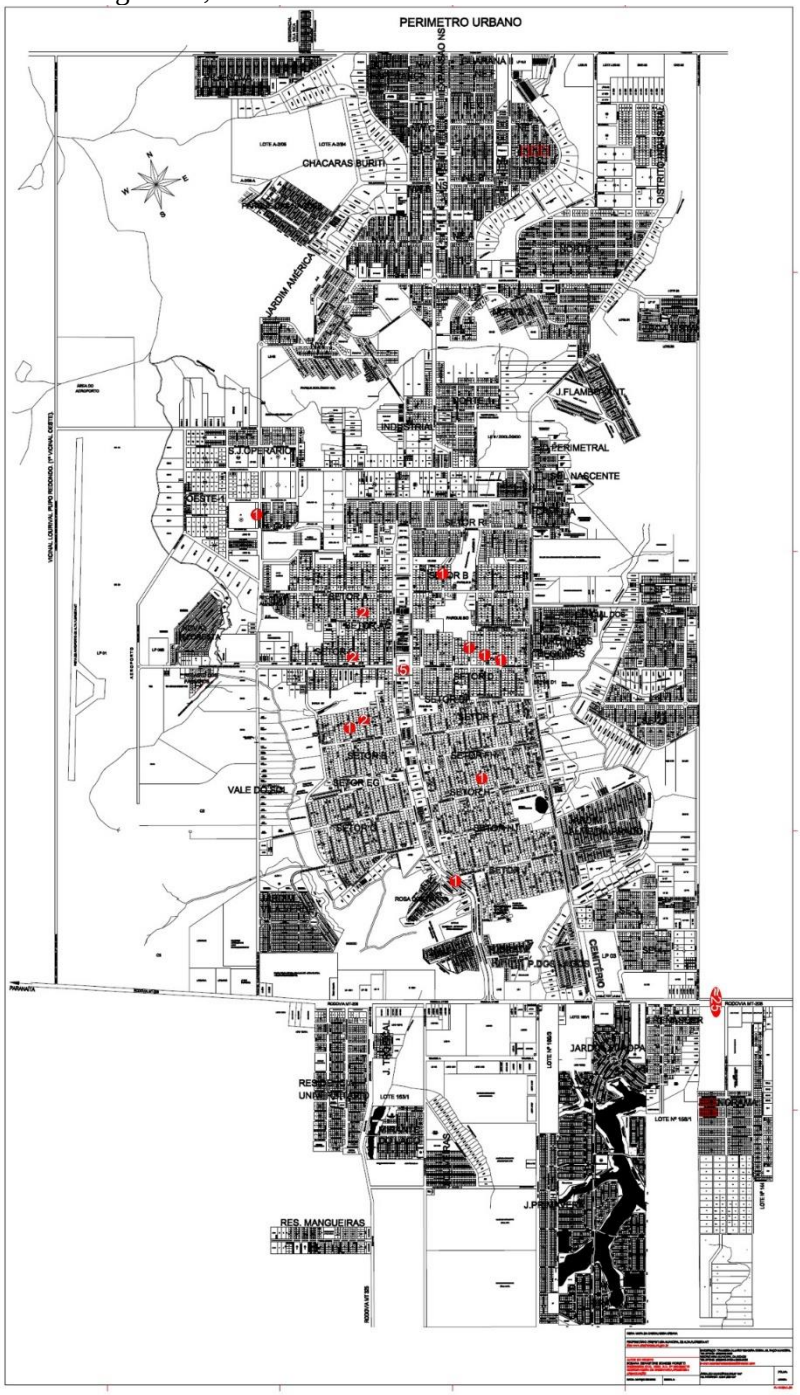

Fig. 6 Photos taken of the areas surrounding the nesting sites. These areas are largely urban, clean, and well maintained, with no visible trash or pollution.

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Two macaw species were found to nest and feed in the urban area of Alta Floresta: the blue-and-gold macaw (*Ara ararauna*) and the red-and-green macaw (*A. chloropterus*). Blue-and-gold macaws were photographed extensively in the region over the course of the project. However, the red-and-green macaws seemed to be less comfortable around humans and were harder to photograph (Fig. 7). The feeding and reproductive behaviors observed herein were consistent with those reported in the literature. Both macaw species were observed in greater numbers on the outskirts of Alta Floresta from August to February. The number of specimens observed overall decreased after February, but neither species went undetected in the city at any time during the study period.

Fig. 7 Photos of red-and-green macaws (*Ara chloropterus*) and blue-and-gold macaws (*A. ararauna*) taken in the urban area of Alta Floresta Mato Grosso State.

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The official city event calendar was used to establish data on tourist seasonality. According to the calendar, events are distributed throughout the year, but are more frequent between May and December. These events include City Birdwatching Day in April, the ExpoAlta Farming Expo and Farmer and Rancher Week in May, the Laço Livre Rodeo in June, Family Farming Week in July, Cycling Week in August, Bird Day in October, a charity walk in November, and a Teles Pires River Cleanup Day in December. Fishing season lasts from March to October. It is important to note that these events attract a large number of visitors to the region and increase tourism to the city.

City Birdwatching Day on April 28 and Bird Day on October 5, which were approved by Law No. 004/2020, are very important to birdwatching tourism in the city and its outskirts. The city's official Bird Day in October enables the stimulation of tourism in the region, since it corresponds to a period with the increases in sightings and macaw nesting behaviors, as seen in this study.

Other events that coincide with increased macaw sightings in the region include academic conferences and activities organized by the local public universities (Mato Grosso State University [UNEMAT] and the Federal Institute of Mato Grosso State [IFMT]). These events are typically held between August and October and may be leveraged to increase the city's publicity of ecotourism among locals.

DISCUSSION

Analysis of macaw behavior in the city of Alta Floresta, Mato Grosso

During the data collection period of this study, approximately 50 macaw nests were identified, and two species inhabit the region, *Ara ararauna* and *A. chloropterus*. These data were obtained due to the expertise of the researchers involved, but also counting on the help and registration of the local population, also called crowdsourcing. Similar reports have been provided by CALDERAN *et al.* (2019) in a study performed in the city of Campo Grande,

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Mato Grosso do Sul State. In their study, 159 nests were found in urban areas in greater Campo Grande. It is important to note that the city had successfully engaged local residents in blue-and-gold macaw (*Ara ararauna*) conservation efforts, and as a result, many nests were found in households or on residential land, as in our study in Alta Floresta. It is important to note that "natural backyards" may serve as an important tool for creating awareness in conservation campaigns. In addition to improving residents' well-being through contact with nature, these residential spaces provide shelter and complementary food sources for wild animals, particularly if fruit trees are planted (BARBOSA, 2018).

The feeding and reproductive behaviors of *A. ararauna* e *A. chloropterus* observed herein were consistent with those reported in the literature. *A. ararauna* is known to feed primarily on palm tree fruits and seeds (TUBELIS, 2009; RAGUSA-NETTO, 2011). Other studies have reported a certain seasonality to this species' feeding, with the animals prioritizing the seasonal variations in food sources in the region (SANTOS; RAGUSA-NETTO, 2014). These same seasonality preferences were observed herein. *A. chloropterus* is considered a more opportunistic species, exhibiting a greater diversity in its food sources, even when seasonality is taken into account (NUNES; SANTOS JR., 2011; SCHERER-NETO; TERTO, 2011). This difference in the types of foods consumed by different macaw species was not observed herein, though particularly because of our limited access to the nests, which would have revealed food scraps or other clues to the birds' diets. Based on the information we were able to obtain, we must conclude that the two species exhibited similar feeding and diet patterns.

However, their feeding habits differed in terms of the time of day and the specificity of the food sources. *A. ararauna* has been reported to feed most often at sunrise and sunset (RAGUSA-NETTO, 2006; TUBELIS, 2009), and these habits were also observed herein. Tubelis (2010), however, reported changes in the times of day in which these birds fly to search for food, with afternoon flights in October and morning flights in February. This difference may be correlated with food availability in different seasons (seasonality). Ferreira (2013) and Lee (2017) report that *A. chloropterus* tends to search for food from late morning to early afternoon, which corroborates what was observed in this study.

A search of the literature produced findings on defense and calling behavior only for *A. ararauna*. Other studies have reported warning calls and nest defense (LOCATELLI *et al.*, 2013; BARBOSA, 2015), as well as sentry behavior with specific calls (TUBELIS, 2009). Though the latter behavior has rarely been reported in scientific publications, we observed it herein, including warning calls and close swooping. Only one record of *A. chloropterus* vigilance behavior was obtained, but it was not sentry behavior or any other defense strategy, similar to reports by Lee (2017).

Regarding the period of sightseeing of these species, both species were observed in greater numbers from August to February. In a similar report, Ragusa-Netto (2006) observed a substantial increase in *A. ararauna* observations in September (the end of the dry season), and our findings were consistent. According to the author, this increase may correlate with the reproductive season of this species, during which time the animals return to nesting sites, as has been observed in studies on *A. chloropterus*, and since it is known that these species reuse nests (GUEDES, 1993; BIANCHI, 1998) and prefer to reproduce during the rainy season (RENTON, 2002). The breeding season seems to last from May to March LOCATELLI *et al.*, 2013; BARBOSA, 2015; ALMEIDA, 2016; CALDERAN *et al.*, 2016; CARRARA *et al.*, 2019) and to vary depending on research specifications: some studies define the start of the

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reproductive period as the time when courting begins, while others treat the start of the breeding season as the start of the mating season or as the time when eggs are laid (oviposition). While some researchers establish eclosion (hatching) as the end of the reproductive period, others end the season when the fledglings leave the nest. Both species prefer to build nests in the trunks of dead palm trees (CALDERAN *et al.*, 2016), and fledglings typically leave the nest in December or January (FERREIRA, 2013; BARBOSA, 2015), habits which were observed herein.

Macaw behavior in the context of tourism seasonality

The peak of observation of the two macaw species considered in this study, corresponding to their feeding and reproduction behavior in the Alta Floresta region, coincides with the period of greatest movement in the city. This is because between the months of August and February the largest number of events are held in the region, attracting residents of nearby cities, as well as tourists, to the city of Alta Floresta. This "coincidence" can then be exploited for purposes of ecotourism and valuing local biodiversity in the region's economic and social development.

In this context, Calderan *et al.* (2019) found that blue-and-gold macaw conservation in the city of Campo Grande was considered important for all the residents. They are colorful and charismatic birds that charm people and attract attention to themselves. They inspire people to look around their city more and, in doing so, to be more likely to conserve their environment in efforts to improve the macaws' quality of life, as well as that of other species (INGOLD, 1995; GUEDES, 2012).

When tourism is nature-based, it becomes an important ally in conservation efforts. It may ultimately aid in conserving biodiversity and the presence of threatened species in the wild. Despite municipal and tourism agencies' efforts to promote destinations with favorable characteristics, such as biodiversity and ecological perspectives, nature should represent not only an attraction, but also a competitive advantage in the sustainable development of a tourist destination (SANTOS, 2006). The city of Alta Floresta offers a substantial advantage in this regard and should therefore consider these issues. Furthermore, the economic value of biodiversity may render it self-sustainable (DINIZ; BERMANN, 2012).

Ecotourism is a type of tourism that provides tourists with the experience of observing and better understanding ecosystem dynamics (WEARING; NEIL, 2001). This activity functions as a tool for putting humans closer to nature, and, in doing so, forces people to question their values, learn from experience, and seek out better solutions to daily problems. It is therefore an educational activity that can leverage people's contact with nature to improve their understanding of the importance of nature conservation in a more contextualized way (NEIMAN; MENDONÇA, 2005). Ecotourism therefore contributes to environmental education and conservation projects in that it serves as a way to provide scientific information and possible changes in behavior by making tourists and locals alike become more sensitive to environmental issues and more likely to value their own culture and other cultures (CORRÊA; GUEDES, 2006; OPPLIGER, 2013).

Ecotourism can also become a potential source of funding for research (BRIGHTSMITH; STRONZA; HOLLE, 2008). In recent decades, ecotourism has become a major economic activity worldwide. It requires the conservation of natural resources by economically and culturally promoting sustainability (HAROON, 2002; TAKESAWA;

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LOBO, 2006). In Brazil, the cities of Alta Floresta, Paranaíta, and Novo Mundo together represent a hub for Amazonian ecotourism in Mato Grosso State. These cities already offer hotels and other infrastructure for birdwatching, sport fishing, and adventure travel (TURISMO RURAL MATO GROSSO, 2017). These activities may serve as an effective method for promoting the conservation of threatened species and their habitats by providing economic incentives to local companies and residents (BOOKBINDER *et al.*, 1998; HAROON, 2002; BRIGHTSMITH, 2008).

FINAL CONSIDERATIONS

In this study, macaws were found to be distributed in greater numbers between August and February; sightings decreased but continued in the other months. This period of increased observation coincides with most large tourism events in the city, as well as with academic events at the local public universities. We therefore conclude that this project was useful for highlighting the importance of ecotourism as a tool for regional development. This study also provides a way to collect data and leverage ecotourism as a way to obtain more information on bird sightings in a given city. The information gathered on the city of Alta Floresta may contribute to future local public policy decisions.

It is important to note that, despite environmental conservation efforts, particularly those for species at risk of extinction, both conservation itself and the study of natural resources typically require greater investments than governments can provide. Many conservation projects suffer from a lack of investment; funding for this type of research is scarce (Frickmann Young 2005). Furthermore, data from the Hyacinth Macaw Project, known locally as the Projeto Arara Azul (Rechetelo et al. 2010), shows that the creation of tourism infrastructure and activities such as birdwatching tourism are prioritized less than research activities. However, tourism and research efforts could be combined to jointly serve as a cycle in which conservation tourism pays for research to allow these activities to become self-sustaining in the long term. As projects such as ours and the Hyacinth Macaw Project have shown, studies on macaw behavior provide the information necessary for more organized birdwatching tourism activities, thus optimizing researchers' time and, most importantly, raising money for additional research.

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