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# HABITAT USE BY BURNISHED-BUFF TANAGER (*TANGARA CAYANA*) AND GREAT ANTSHRIKE (*TARABA MAJOR*) IN A HUMAN-MODIFIED LANDSCAPE IN SOUTH-EAST BRAZIL

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**Abstract ·** The agricultural expansion in tropical regions is causing loss and reductions habitat, as well as changes in biodiversity. Intrinsic ecological factors, such as trophic level, and habitat conditions, such as vegetation structure, can determine how a particular species uses the habitat. The Brazilian savanna is a world biodiversity hotspot and the most threatened in the country, with a higher deforestation rate than the Amazon. Therefore, it is important to understand how the presence/absence of forest-dependent birds is affected by local characteristics and by landscape features of habitat remnants. Here we study patterns of habitat use in two forest-dependent bird species, Burnished-buff Tanager (*Tangara cayana*) and Great Antshrike (*Taraba major*), to learn how characteristics at the local and landscape scales can influence their occurrence in forest remnants. This work was carried out in a forest remnant area embedded in a human transformed landscape, belonging to the Cerrado biome, Brazilian Savanna. The study area is localized in the municipality of Assis, São Paulo State. The selected area was delimited and divided into 120 quadrants of 22,500 m² each. In the center of each quadrant we positioned one observation point. The points were visited three times and presence/absence data for both species were collected using playback. For each point we recorded local characteristics – interior *vs* edge, canopy height, canopy cover, presence of dead standing trees, dead trees with arthropods, trees with fruits, and grasses; and landscape characteristics – distance to water bodies, distance to floodplain (várzea), distance to nearest farmland, highways, unpaved roads, railroads, and houses. Our results indicate that *T. cayana* was more likely to be present in points located at the forest edge, close to water bodies and with high canopy. In addition, the distance from farming activity was the variable with most influence on the occurrence of *T. major*. The final models for each species predicted patterns of presence/absence correctly in 73% of cases for *T. cayana* and 76% for *T. major*. The results have implications for the conservation of forest specialist species that occupy forest remnants in deeply modified landscapes and can contribute to designing proper management plans.

**Resumo · Variáveis ambientais relacionadas ao uso do habitat da Saíra amarela (*Tangara cayana*) e do Choró-boi (*Taraba major*) em uma paisagem antropizada no sudeste do Brasil**

A expansão agrícola nas regiões tropicais vem causando perdas e reduções de habitat que resultam em mudanças na biodiversidade. Fatores ecológicos intrínsecos, tal como nível trófico e condições de habitat, como a estrutura da vegetação, podem indicar como uma determinada espécie usa o habitat. A savana brasileira é um dos principais pontos de biodiversidade do mundo e a mais ameaçada do país, com uma taxa de desmatamento mais alta que a da Amazônia. Portanto, é importante entender como a presença/ausência de aves dependentes de florestas é afetada pelas características tanto locais quanto da paisagem na qual encontra-se um remanescentes de habitat. Neste trabalho foi estudaado os padrões de uso do habitat de duas espécies de aves dependentes da floresta, Saíra amarela (*Tangara cayana)* e Choró-boi (*Taraba major*). Somado a isso, conhecer como as características ambientais nas escalas local e de paisagem podem influenciar a ocorrência dessas espécies em remanescentes florestais. Este trabalho foi realizado em uma floresta remanescente inserida em uma paisagem humana transformada, pertencente ao bioma Cerrado. A área de estudo está localizada no município de Assis, Estado de São Paulo. A área selecionada foi delimitada e dividida em 120 quadrantes de 22.500 m² cada. No centro de cada quadrante, posicionamos um ponto de observação. Os pontos foram visitados três vezes e dados de presença/ausência para ambas as espécies foram coletados usando *playback*. Inicialmente foram registradas características locais em cada ponto - interior *vs* borda, altura do dossel,

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cobertura do dossel, presença de árvores mortas, árvores mortas com artrópodes, árvores com frutos, e gramíneas; e características da paisagem - distância a corpos de água, distância a várzea, distância da atividade agropecuaria mais próximas, rodovias, estradas não pavimentadas, ferrovias e casas. Os resultados indicaram que *T. cayana* tem maior probabilidade de estar presente em pontos localizados na borda da floresta, próximos a corpos de água e com copas mais alta. A distância da atividade agropecuária foi a variável com maior influência na ocorrência de *T. major*. Os modelos finais para cada espécie previram padrões de presença / ausência corretamente em 73% dos casos para *T. cayana* e 76% para *T. major*. Os resultados, têm implicações para a conservação de espécies florestais especializadas que ocupam remanescentes florestais em paisagens profundamente modificadas e podem contribuir para o planejamento de manejo mais adequados para áreas de floresta remanecentes.

**Key words**: Anthropic factors · Fragmentation · Presence-absence models · Riparian forests · Tamnophilidae · Thraupidae

## INTRODUCTION

The Cerrado, is a savanna biome in Brazil, a mosaic formed by different phytophysiognomies, such as woodlands, savannas, grasslands, and riparian and dry forests (Silva & Bates 2002, Klink & Machado 2005). It is the second largest biome in South America after the Amazon, with an extension of 2,036,448 km$^2$ (Ab'Sáber 1977). A very large part of the Cerrado area is within the Brazilian territory (80%), extending marginally to Paraguay and Bolivia. In terms of biodiversity and habitat loss, the Cerrado is a world biodiversity hotspot (Silva & Bates 2002), the most threatened biome in Brazil and South America, with deforestation rates of 50 to 60% in the last 35 years (Klink & Machado 2005, Sano et al. 2010, Rocha et al. 2011). For that reason, it is urgent to know how forest dependent bird species use the remnant habitats and what are the effects of the human activities in the matrix -commonly referred as human-modified areas that surround the remains of natural habitat (Prevedello & Vieira 2010, Powell et al. 2015). Rapid changes in land use lead to a highly heterogeneous landscape composed by open fields, patches of remnant habitat and urbanized areas whose proportions vary (Dunning et al. 1992). Therefore, the differences in proportion and composition of the landscape may favor some species to the detriment of others (Sisk et al. 1997, Renjifo 2001, Carrara et al. 2015). For instance, a study conducted with frugivorous tropical birds – including several species of *Tangara* – has shown that the intensity of agricultural activity is a significant limiting factor for the dispersion of this functional group along the landscape (Luck & Daily 2003).

Different avian species have different behaviors and habitat requirements (dos Anjos 2001), which in turn can also influence their presence/absence in a forest remnant. For example, some insectivores live in the forest understory and are forced to move among fragments due to the availability of resources (Boscolo & Metzger 2009). Habitat variables, such as floristic composition and vegetation structure, are important for the presence/absence of resident legitimate dispersers (e.g., Golden-cheeked Woodpecker *Melanerpes chrysogenys* and Nutting's Flycatcher *Myiarchus nuttingi*) and seed predators (e.g., Orange-fronted Parakeet *Aratinga canicularis*), because a more complex vegetation in structure and composition creates different opportunities for nesting and foraging (Almazán-Núñez et al. (2015). Others studies have detected the same effect – habitat traits, such as structure vegetation, edge effects, food availability and others, are associated with occurrence of species and groups of species in remnants of tropical forests (Tews et al. 2004, Uezu & Metzger 2011, Cintra & Naka 2012, Stratford & Stoufer 2015, Ulrich et al. 2017). However, the influence of the structure of the remnant habitat on patterns of habitat use by species can vary not only due to difference in ecological traits but also due to changes caused by fragmentation at different scales.

The aim of our study was to evaluate how two species with different ecological characteristics use the habitat in a highly disturbed landscape. The two study species are the Great Antshrike (*Taraba major*), an insectivore and forest specialist, that inhabits the forest interior and that is rarely found in other habitat types, and the Burnished-buff Tanager (*Tangara cayana*), a frugivore and forest generalist that uses a variety of forest habitats including forest interior, secondary forests, and forest edges.

## MATERIALS AND METHODS

**Study area.** The study was carried out between August 2014 and September 2015 in the municipality of Assis (22°39'42"S, 50°24'44"W), western São Paulo state, Brazil. The areas selected were in the buffer zone of the Assis Ecological Station, which aims to preserve the forest remnant areas close to the conservation unit. The region is predominantly agricultural, also including pastures, roads and scattered housing complexes. Some areas have forest fragments of forested savanna (cerradão). The study areas for our surveys were: 1) Pinga Road (22°37'22.43"S 50°28'2.57"W), with an elevation variation between 536 and 561 m a.s.l.; and 2) Água do Cervo neighborhood (22°36'00.00"S 50°27'00.00"W), with an elevation between 514 and 545 m a.s.l. (Figure 1). According to Köppen's classification, the climate in Assis-SP is Cwa, with rainy summers and dry winters. The annual average temperature is 22.1 °C.

The study area has a phytophysiognomy corresponding to remnants of savanna, forested savanna, riparian forest (permanent protection areas) and

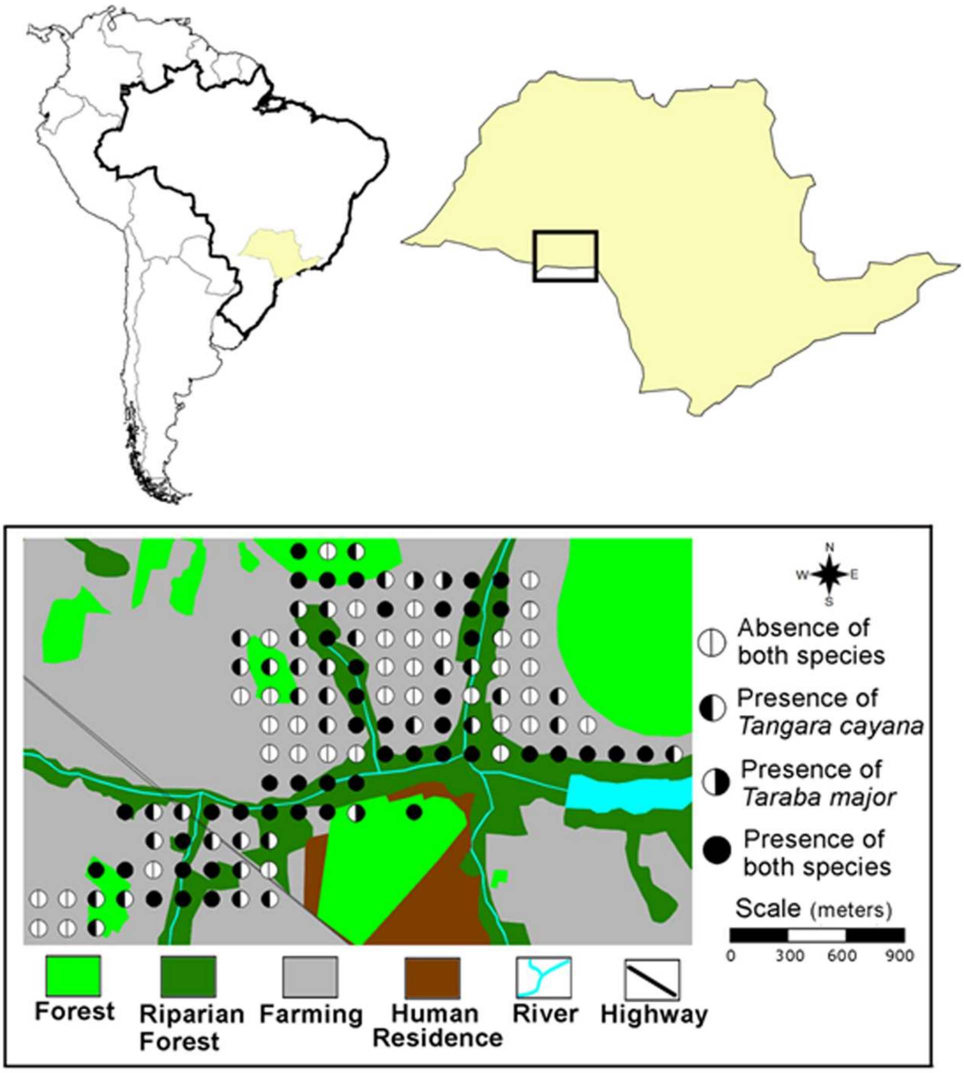


**Figure 1.** Map of the study area in São Paulo State, Brazil. The map depicts types vegetation, land use, and presence of water bodies and roads. Circles represent sampling points indicating the presence/absence of both study species Burnished-buff Tanager (*Tangara cayana*) and Great Antshrike (*Taraba major*).

swamp forest (mata de brejo), besides secondary forests and stands of *Pinus* sp. (Pincaeae) and *Eucalyptus* sp. (Myrtaceae), with understory in regeneration. Some fragments with pastures and areas of cultivation of sugarcane (*Saccharum officinarum,* Poaceae), manioc (*Manihot esculenta,* Euphorbiaceae) and cereals can also be found (Figure 1).

**Data collection**. The fixed-points method (Bibby et al. 2000) was used to sample birds. The study area was delimited and divided into 120 quadrants of 150 m x 150 m each (Figure 1), and the center of each quadrant was taken as observation point, which was located in the field with the aid of a GPS device. Quantum GIS Geoprocessing software version 1.9 was used to make the quadrant mesh and position survey points. The visits in the study area were always carried out in the morning, from 06:00 to 10:00 h, to determine presence or absence of the two focal species.

Binoculars (10x40) and a photographic camera were used to aid the search and identification of the bird species. Both species were attracted using playback. For playback, a sound system with a sound box was used to reproduce the vocalizations with an intensity of 90 to 100 Db to attract the birds that were in the surroundings of each collection point. The playback lasted 5 minutes, and every minute of playback was followed by 30 seconds of silence to detect vocal responses of the focal species or see it directly (Boscolo et al. 2006).

False-negatives can have a significant impact on the estimates of predictive models. Hence, if the focal species were absent in the first and second visit to a sampling point a third visit was carried out to confirm (as far as possible) its absence, to increase the precision of the model estimates (Tyre et al. 2003). Therefore, the first visit was made to all the spots in the first four months of the research; the second visit was made to the spots where one or both species were not found, in the following four months of the research, and finally, the third visit was made to the spots where the species were not found in the first or second visit, in the last four months of the research.

**Environmental variables**. For each sampling point we recorded the following variables at local and landscape level variables.

Local variables were: (1) Interior *vs* edge: If a point was within 5 m of the forest edge (based on a digital map of the area) it was classified as edge, other points were classified as forest interior; (2) Presence of dead standing trees (this included large trees killed by disease, lighting strikes, drought, water logging , or others); (3) Presence of dead trees with arthropods (as determined by the presence of termites, beetles, ants, tunnels, and other hollow areas created by insect activity; this included dead twigs, branches and trunks); (4) Presence of trees with fruits, and (5) presence of grasses covering more than 30% of the quadrant. The occurrence of these variables was determined by walking through the area after the beginning of the playback. (6) Canopy cover (%) was assessed using fisheye lens (Sigma 10mm F/2.8 EX DC HSM) and digital camera (Nikon D-750 FX). At each point, five images were obtained: one at the survey point and four at a distance of 10m from the point, in each cardinal direction. Pictures were analyzed using Image J 1.4vsoftware. The image was transformed into black and white, and canopy cover is computed as the percentage of black relative to the whole area. (7) Canopy height (m): pictures to determine canopy height were also taken at the same points where the images were taken for the canopy. For this purpose, the highest tree at the point was selected, and a graduated rod was placed next to the stem of the tree, and using Image J we estimated its height. We averaged the height values across all points to obtain canopy height for each point. (8) Sky conditions: clear sky or overcast, assessed at the beginning of collection at each sampling point.

The landscape-level variables recorded, which were obtained using a georeferenced digital map with land use layers and the program Quantum Gis 1.9,were: (1) Distance to water bodies (m): distance between each point and the nearest water body (river and spring); (2) distance to floodplain (m): the floodplain (várzea) areas -permanently or seasonally flooded areas with herbaceous or shrubby vegetation- were plotted in a digital map and we computed the distance between each point and the nearest floodplain; (3) distance to nearest farmland; (4) distance to the nearest highway; (5) distance to the nearest unpaved road; (6) distance to the nearest railroad; and (7) distance to the nearest houses (m).

**Species studied**. The two selected species (*Tangara cayana*, Thraupinae and *Taraba major*, Thamnophilidae) were chosen because: (1) they occupy different strata in the forest, (2) they occupy different ecological niches, and (3) they have different degrees of forest dependency. On the other hand, they also possess attributes that facilitate the interpretation and collection of data, such as: (1) they have the same reproductive period, (2) they respond to playback, (3) they are easily identified by their habits and plumage and (4) they are commonly found in fragmented and riparian areas.

*Tangara cayana*, originally distributed in the Cerrado of Brazil, has expanded its distribution throughout the South American continent, from the Guianas and Venezuela to the Amazon, and from Central and Northeastern Brazil to Paraná and Paraguay (Savit & Bates 2015). It is considered to be a forest generalist species; it is arboreal (lives in tree canopies) inhabiting the edge or the interior of forest, and occasionally flies up to 300 meters into open areas to access isolated trees to feed (Sick 2001, Willis & Oniki 2003, Tubelis et al. 2004). This species can be seen in pairs or family groups, usually in trees with fruit and flowers (Tubelis et al. 2004, Hilty 2011). It is considered to be a nuclear species in the mixed flocks, since it can attract other species to join them. It breeds from August to November (Willis & Oniki 2003, Carlson & Burns 2012).

*Taraba major*, ranges from the Guianas and Venezuela to Bolivia, Argentina, Paraguay, and Brazil. In Brazil, it occurs in the north and northeast, reaching the states Mato Grosso do Sul, Goiás, and Paraná (Ridgely & Tudor 1994). It is considered to be a forest specialist and inhabits the understory (Sick 2001, Pinho & Marini 2012). This species lives in secondary forests (*capoeiras*), close to rivers and swamps, and feeds on arthropods and small vertebrates, such as fish, frogs, and lizards (López et al. 2005, Zimmer & Isler 2016). It breeds from September to December (Lara et al. 2012).

**Statistical analysis.** Multiple Logistic Regressions (MLR) were used to create occurrence probability models, as well as to evaluate which variables may influence the presence of the birds studied (Pearce & Ferrier 2000). First, we assessed a full model including all independent variables. The statistical significance of all independent variables was assessed by comparing model with and without each variable one at a time. Next we computed a simplified model that only included significant independent variables ($p < 0.05$) using a backwards model simplification procedure.

To assess the fit of the final (simplified) logistic regression model, the AUC (Area Under the Curve) with application in the receiver operating characteristic curve (ROC curve) criterion was adopted. AUC has been widely used in the literature to evaluate species distribution models and it measures the ability of a model to discriminate where the species is present and where it is not (Elith et al. 2006). The area below the ROC curve provides the measure to compare performances of the distribution model of the species

**Table 1.** Results from logistic regression model (range and *p*-values by Wald) assessing the effect of all 16 environmental predictors on the presence/absence of Burnished-buff Tanager (*Tangara cayana*) and Great Antshrike (*Taraba major*) across 120 survey points in the municipality of Assis, western region of the state of São Paulo, Brazil.

| Variable | *Tangara cayana* | | *Taraba major* | |
|---|---|---|---|---|
| | ***p* value** | **Odds ratio** | ***p* value** | **Odds ratio** |
| Sky conditions | 0.75 | 6.26 | 0.60 | 0.52 |
| Forest edge | 0.03 | 4.16 | 0.27 | 0.30 |
| Canopy cover (%) | 0.26 | 0.98 | 0.91 | 0.99 |
| Distance from farms (m) | 0.65 | 0.99 | 0.02 | 1.02 |
| Distance from unpaved roads (m) | 0.47 | 0.99 | 0.28 | 0.99 |
| Distance from the railway (m) | 0.87 | 0.99 | 0.39 | 1.00 |
| Distance from water bodies (m) | < 0.001 | 0.99 | < 0.001 | 0.98 |
| Distance from the highway (m) | 0.19 | 0.99 | 0.79 | 1.00 |
| Distance from residences (m) | 0.96 | 1.00 | 0.80 | 0.99 |
| Canopy height (m) | 0.002 | 1.16 | 0.05 | 1.12 |
| Forest interior | 0.14 | 15.74 | 0.68 | 0.50 |
| Várzea region | 0.38 | 1.00 | 0.09 | 1.01 |
| Fruit trees | 0.12 | 0.45 | 0.29 | 2.22 |
| Dead trees with insects | 0.49 | 1.57 | 0.74 | 0.76 |
| Dead trees | 0.45 | 2.14 | 0.39 | 1.97 |

under study; the larger area, the better the model. Thus, AUC values range from 0.5, which indicates that percentages of true positives and false positives do not differ (poor model) or are close to 1.0 (good predictive model), which indicates that the percentage of true positives is greater than that of false positives (Kuhn & Copeland 2011).

Collinearity occurs when two independent variables present a high correlation. Multicollinearity involves three or more correlated independent variables. Collinearity may result in unreliable estimates, in addition to preventing the separation of the individual effects of independent variables. Therefore, it is not possible to investigate the influence of one of the separately correlated predictor variables over the dependent variable. One of the ways to evaluate the multicollinearity between the quantitative variables is to utilize the Variance Inflation Factor (VIF). If the VIF is higher than 10, then the set of variables presents multicollinearity, and one of the solutions to this problem is the exclusion of one or more of the highly correlated independent variables (Zuur et al. 2010)**.** The multicollinearity tests performed for both *T. cayana* and *T. major* showed variance inflation factors (VIF) lower than 10, which allowed for the evaluation of all variables by logistic regression analysis. The statistical methods used rely on the assumption of the absence of spatial autocorrelation (Zeilhofer *et al*. 2009). To test for spatial autocorrelation we computed Moran's I index, which ranged between 0.05 and 0.11 for the study variables indicative of low levels of spatial autocorrelation (Legendre 1993). For the data analysis the statistical software NCSS version 9.0 (NCSS 2013) was used.

## RESULTS

Of the 120 points visited, we detected at least one focal species in 82 of them (69%) with a total of 79 records for *T. cayana*, and 48 records for *T. major*. In 45 points (54.8%), we found both species.

The best model for the presence of *T. cayana* included five variables: distance from water bodies, canopy height, forest edge, and distance from farming activity, while the best model for *T. major* included three variables: canopy height, distance from water bodies, and distance from farming activity (Tables 1, 2). The probability of *T. cayana* being present is higher in points with higher canopy that are closer to the edge and to water bodies. For *T. major*, this probability is higher in points closer to water bodies, further away from agricultural activities and in points with higher canopy. For the final model, the accuracy reached 73% for *T. cayana* and 77% for *T. major* (Table 3).

## DISCUSSION

Our results support the assumption that habitat characteristics at the local and landscape scales can influence the presence of forest-dependent bird species that occupy different trophic levels and forest strata. The logistic regression models showed that a set of variables is associated with the presence/absence of both species, but these variables were not the same in each case. The probability of occurrence of *T. cayana* was higher in sampling points located at the forest edge and with high canopy trees, while for *T. major*, the distance from

**Table 2.** Results from final logistic regression model including only significant effects depicting odds ratios (OR), their 95% Confidence interval (95%CI) and associated *p* value (Wald test) for *incorrect see above* across 120 survey points of Burnished-buff Tanager (*Tangara cayana*) and Great Antshrike (*Taraba major*) in the municipality of Assis, western São Paulo state, Brazil.

| Variable | *Tangara cayana* | | | *Taraba major* | | |
|---|---|---|---|---|---|---|
| | Odds ratio | 95% CI | *p* | Odds ratio | 95%CI | *p* |
| Distance from water bodies | 0.99 | 0.98–0.99 | 0.0006 | 0.98 | 0.98–0.99 | 0.00001 |
| Canopy height | 1.16 | 1.05–1.27 | 0.0017 | 1.11 | 0.01–0.20 | 0.02178 |
| Forest edge | 3.63 | 1.18–11.17 | 0.0241 | | | |
| Distance from farms | | | | 1.02 | 1.01–1.03 | 0.01150 |

**Table 3.** Final model equations obtained from the Logistic Regression analysis, coefficients, their *p*-values and the values of the Area under the ROC Curve (AUC) for Burnished-buff Tanager (*Tangara cayana*) and Great Antshrike (*Taraba major*) across 120 survey points in the municipality of Assis, western São Paulo state, Brazil.

| Species | Model | *p* | AUC |
|---|---|---|---|
| *Tangara cayana* | 8.323 + 3.661*(Forest edge=1) - 0.009*Distance from water bodies + 0.199*canopy height | 0.00003 | 0.903 |
| *Taraba major* | 0.996 + 0.020 * Distance from farming activity - 0.011 * Distance from water bodies + 0.113 * canopy height | 0.00002 | 0.891 |

farming activities was the landscape variable that had the most marked negative effects on the presence/absence of this species. Canopy height and distance from water bodies had similar influence on both species: the probability of occurrence being higher with a decrease in distance to the nearest water body and increase in canopy height. Forest fragments are important refuges to birds in an agricultural landscape (Saab 1999, Lees & Peres 2008), and these fragments may also constitute thermal refuges (Martin et al. 2015, Del Pliego et al. 2016, Keppel et al. 2017).

The generalist behavior of *T. cayana* was supported by our results, since sightings occurred in different environments, with a higher incidence at the edge of the forest. Savit & Bates (2015) comment that *T. cayana* it is one of the most frequent species in the Cerrado. The presence of *T. cayana* at the edges could be due to higher availability of fruit and nectar (Stiles 1975, Levey 1988, Rodewald & Brittingham 2004). In degraded landscapes with low food supply, some species tend to move more in search of food (Gillies et al. 2011), which may explain the presence of *T. cayana* in all the environments evaluated.

Another important variable to define the species' presence was canopy height. *Tangara cayana* is one of the major tropical frugivores that disperse the seeds of numerous canopy tree species in human-modified riparian forest strips (Pizo 2004). The fruiting trees of Cerrado riparian forest comprise ca. 84 woody species belonging to 45 families (Silva *et al*. 2011). Therefore, for a frugivorous species such as *T. cayana* a riparian forest can be considered the main source of fruit when compared to the non-riparian environment in the Brazilian savanna (Keuroghlian & Eation 2008).

Our results suggest that *T. major* is an understory specialist that may be affected by the alterations of the local habitat and of the landscape (Leck 1979, Sigel et al. 2006). A study conducted on understory insectivorous and forest specialist birds has shown that some species are very sensitive to anthropic changes and avoid recently created edges but recolonize edges after a recovery period of 20 to 30 years (Powell et al. 2015). Another study carried out with species of insectivorous birds in riparian forests in the Amazon reinforces this relationship with the old riparian forest, showing that *T. major* depends on primary and secondary forests (> 20 years) (Lees & Peres 2008). In our study, *T. major* presence was apparently not affected by edge, probably because edges are old (> 30 years) in our study site (Durigan et al. 2010). This hypothesis can explain the positive effect of canopy height on *T. major* presence, since older forests have higher trees (Lieberman et al. 1985, Rozendaal et al. 2015). The effect of canopy height and density on the occurrence of antbirds has been reported before (Skemske et al. 1981, Cody 2000, Stratford & Stoufer 2015). Seavy et al. (2009) observed that seven of the 16 passerine species residents in a riparian forest increased in abundance with canopy height. Finally, in the study region *T. major* seems to be sensitive to farming activities, becoming less frequent near farming areas. These usually open and dry environments are inhospitable for this species. The effect of proximity to water bodies could be explained by food availability, especially for *T. major*. Riparian strips often harbor high numbers of insects

(Whitaker et al. 2000), and some species specialize on this habitat type (Lees & Peres 2008). Beltzer (1987) studied the diet of *T. major* and found that, besides insects, crustaceans and aquatic mollusks were also consumed, all food items commonly found in riparian forests. Riparian forests often constitute important corridors that interconnect forest fragments, increase the foraging area of forest species.

**Conclusions.** Our results show that distance from water body and forest height influenced in the presence of both species. Moreover, forest edge was important for *T. cayana* and distance from farming activities was important for *T. major* presence. Both species are to some extent dependent on the riparian forest, too, even though the response to the degree of landscape anthropization differed between species. These results have important implications for the conservation of forest specialist species that occupy riparian forests, and can contribute to the implementation of management actions in buffer zones to ameliorate the impacts associated to farming activities.

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