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OCCURRENCE AND PREDICTIVE DISTRIBUTION OF *Crypturellus noctivagus* (AVES, TINAMIDAE) IN BRAZIL

Luiz Liberato Costa Corrêa[1,2], Stefan Vilges de Oliveira[3], Darliane Evangelho Silva[2] & Maria Virginia Petry[1]*

[1] Universidade do Vale do Rio dos Sinos, Programa de Pós-Graduação em Biologia, Laboratório de Ornitologia e Animais Marinhos, Av. Unisinos, nº 950, Bairro Cristo Rei, CEP 93022-750, São Leopoldo, RS, Brazil.

[2] Universidade do Vale do Taquari, Programa de Pós Graduação em Ambiente e Desenvolvimento, Laboratório de Acarologia, Rua Avelino Talini, nº 171, CEP 95900-000, Lajeado, RS, Brazil.

[3] Universidade Federal de Uberlândia, Faculdade de Medicina, Departamento de Saúde Coletiva, Campus Umuarama, Bairro Umuarama, Av. Pará, nº 1720, CEP 38402-022, Uberlândia, MG, Brazil.

E-mails: lc_correa@yahoo.com.br (*corresponding author); stefanbio@yahoo.com.br; ds_evangelho@yahoo.com.br; vpetry@unisinos.br

Abstract: The Yellow-legged Tinamou (*Crypturellus noctivagus*) is a terrestrial forest bird endemic to Brazil currently threatened with extinction. We aimed to update and predict the potential distribution of the species in Brazil. We thus reviewed an array of scientific publications, field reports and a scitizen science database to compile available data on the occurrence of *C. noctivagus* in Brazil. We built a predictive distribution model using the MaxEnt algorithm and the variables temperature seasonality, percent arboreal coverage, isothermality, precipitation of driest quarter, precipitation seasonality, precipitation of wettest month and topography. The Yellow-legged Tinamou was found in 114 municipalities belonging to 11 states. The predictive model presented a distribution scenario mostly associated with the Atlantic Forest, although it also suggested the occurrence of suitable areas in the Cerrado and Pampa Biomes. The records show that some, but not all populations of *C. noctivagus* are currently within protected areas. This study brought together all available knowledge regarding the distribution of *C. noctivagus* in the wild. Ecological information regarding this group, along with the spatial distribution patterns described here, may be useful tools for the development and implementation of conservation and management actions for the species, in both regional and global scales.

Keywords: suitability; Tinamiform; Tinamous; Yellow-legged Tinamou.

INTRODUCTION

The Yellow-legged Tinamou *Crypturellus noctivagus* (Wied, 1820) is a terrestrial bird endemic to the Atlantic Forest in Brazil. It inhabits well preserved environments, as well as secondary adjacent habitats (Cabot 1992, Sick 1997, Birdlife International 2016). Two subspecies are recognized: *Crypturellus noctivagus zabele* (Spix, 1825), which is found in forests in the Northeast region of Brazil, and *Crypturellus noctivagus noctivagus* (Wied, 1820), which inhabits forests in Southern Brazil (Sick & Teixeira 1979, Magalhães 1994, Tomotani & Silveira 2016). Due to anthropogenic activities such as extensive agriculture, forest fragmentation, hunting for subsistence (Sick & Teixeira 1979, Bencke *et al.* 2003, Piacentini & Straube 2008, Silveira *et al.* 2010) and for folk medicinal purposes (Teixeira *et al.* 2014), *C. noctivagus* is currently considered as "vulnerable" to extinction in Brazil (ICMBio 2016).

However, in regional scales the species presents different degrees of threat or is even considered extinct, such as in the case of Rio de Janeiro state (Piacentini & Straube 2008). Current reviews state the occurrence of *C. noctivagus* in about 60 municipalities in Brazil (Piacentini & Straube 2008, Silveira *et al.* 2010, Birdlife International 2016, Tomotani & Silveira 2016). However, a recent record of a relictual *C. noctivagus* population in Rio Grande do Sul, which was previously considered as regionally extinct (Corrêa *et al.* 2010), highlights the need for new studies concerning the spatial distribution of the species, since other isolated populations may still be unknown by the scientific community.

The delimitation of the spatial distribution of endemic and/or threatened species through the use of predictive models is an important tool that allows to investigate several ecological aspects of a species, as well as subsidize conservation proposals trough the definition of the species distribution (Mackey & Lindenmayer 2001, Elith *et al.* 2006, Júnior & Siqueira 2009, Marini *et al.* 2009). Among several predictive models, the MaxEnt (*Maximum Entropy*) algorithm allows to correlate the species occurrence to bioclimatic variables, and predict areas of environmental suitability for the species (Phillips *et al.* 2006, Soberón 2007, Philips & Dudik 2008, Olivero *et al.* 2016). It is also possible to insert environmental variables in the prediction, such as topography, forest vegetation (Rajão *et al.* 2010, Oliveira *et al.* 2015) and land use (Santos *et al.* 2017).

Recent studies regarding tropical birds provided distribution predictions for: *Eudromia* spp. (Echarri *et al.* 2009), *Alectrurus tricolor*, *Nothura minor*, *Penelope ochrogaster*, *Taonis cusnanus* (Marini *et al.* 2009), *Guarouba guarouba* (Laranjeiras *et al.* 2009), *Drymophila squamata*, *D. ferruginea*, *D. rubricollis*, *D. genei*, *D. ochropyga*, *D. malura* (Rajão *et al.* 2010), *Polystictus superciliaris* (Hoffmann *et al.* 2015) and *Tinamus osgoodi* (Negret *et al.* 2015). Such studies have delimitated suitable environments for the occurrence of these species, as well as possible ecological corridors that may reflect on both restriction and expansion of the distribution.

In this study we update occurrence records and predict the potential distribution of *Crypturellus noctivagus* in Brazil, and suggest important areas of environmental suitability for the species and conservation prospects.

MATERIAL AND METHODS

Ocurrence data

We reviewed a broad array of scientific publications and ornithologist's field reports to compile data on occurrence records (geographical coordinates) of *C. noctivagus* in Brazil (Appendix I). We also conducted an extensive search in the database Enciclopédia das Aves do Brasil (WikiAves: http://www.wikiaves.com.br/; Appendix II). Wikiaves is a scitizen science database fed by birdwatchers and ornithologists and is considered the most complete collection of wild bird photographs and audio records in Brazil (*e.g.*, Marcondes & Silveira 2015, Neto 2017, Silveira *et al.* 2017).

We only considered studies published between 2000 and 2017, in order to comprise only current occurrence records of *C. noctivagus* in the wild. Data from scientific collections/museums were not used in this study, because we considered them as historical records of *C. noctivagus*. Records were assembled, considering the exact or approximated location, by using high resolution satellite images from Google Earth, in geographic coordinates (latitude/longitude), in decimal degrees, Datum WGS-84 (Oliveira *et al.* 2015, Sabattini *et al.* 2017). Duplicate records were excluded (Oliveira *et al.* 2017, Santos *et al.* 2017).

Environmental and climatic data

We used bioclimatic variables (from Bio1 to Bio19, available at http://www.dpi.inpe.br/Ambdata/ and ww.worldclim.org, see Appendix III for description) and topography, percent arboreal coverage and land use. Bioclimatic variables represent data from 1950 to 2000, interpolated to the resolution of 30 arc-seconds (1km). Temperature values are provided in ºC (*Celsius degrees*) and precipitation values in mm (millimeters). The information concerning topography (elevation) is provided by SRTM (*Shuttle Radar Topographic Mission*), in a horizontal resolution (spatial resolution) of 1km and vertical resolution (altitude) of 1 m (INPE 2013). The layer representing percent arboreal coverage were provided by the sensor MODIS. The *raster* image has a 500 m spatial resolution with a temporal resolution of 2000 to 2010, and the raster image of land use was prepared in 2010 with a 1: 5.000.000 scale, *Datum* WGS-84 (FAO 2010).

Distribution modeling of **Crypturellus noctivagus**

Modelling environmental suitability requires presence records (in decimal degrees), raster layers of environmental and/or anthropic variables which synthesize biotic and abiotic characteristics of the environment, and the algorithm to generate the distribution model (Brotons *et al.* 2004, Soberón & Peterson 2005, Phillips *et al.* 2006, Philips & Dudik 2008, Olivero *et al.* 2016). We used the MaxEnt algorithm (*maximum entropy*), version 3.3.3. (Phillips *et al.* 2006, Philips & Dudik 2008).

We performed a pre-test using all variables in order to select the ones that better fitted the predictive model for *C. noctivagus* distribution using a jackknife resampling (50 replicates). We excluded variables that did not contribute (Phillips *et al.* 2006). In this step, we divided 20% of the spatial dataset for testing the model, and the other 80% was used for calibration and model generation. The test consists of a verification of the hit rate of the model using a low percentage of points. In calibration, the model's precision is evaluated (*e.g.*, Phillips *et al.* 2006, Elith *et al.* 2006). The variables with the highest contribution were: Isothermality (Bio3) which corresponds to mean diurnal range, mean of monthly (Bio2) and (Bio7) temperature annual range; temperature seasonality (Bio4); precipitation of wettest month (Bio13); precipitation seasonality (Bio15); precipitation of driest quarter (Bio17); topography and percent arboreal coverage. We performed a new round using only these variables, using the standard MaxEnt software settings, in an optional analysis with 500 replicates. Model accuracy was tested using the model's sensibility and specificity, through Receiver Operating Characteristics (ROC) and evaluation of the Area Under Curve (AUC). AUC values ≥ 0.75 indicate a good model performance (Elith *et al.*, 2006, Sóberon 2007). We generated a heat map of the species' range in Brazil with the average value of the model output.

RESULTS

Our review shows that *C. noctivagus* currently occurrs in 114 municipalities and 11 states of Brazil (Table 1). Occurrence records were distributed in areas from low altitude rain forests to forests in altitudes up to 700 m above the sea level. Our predictive model showed a high mean performance rate of AUC 0.95. Temperature seasonality (Bio4), percent arboreal coverage, isothermality (Bio3) and topography are the variables that most contribute to the spatial distribution of *C. noctivagus* (Table 2). The species is mainly distributed in forests that follow the coastal region from the Cerrado biome to the Pampa Biome (Figure 1).

Through presence spots, the maximum and adjacent limits of the species distribution are expressed in Figure 1. They clearly reflect the existence of populations which are (or would be) isolated from each other. The model also indicates suitable areas for the species occurrence beyond its currently known distribution limits. Such areas are located along the Midwest region of the Brazilian territory. These areas still have remnants of Atlantic Forest, thus presenting environmental similarity to the known occurrence records.

Many populations occur within protected areas, such as Conservation Units, Ecological Stations, Reserves and/or Parks, such as in the states of Santa Catarina (SC), Paraná (PR), São Paulo (SP), Bahia (BA), Minas Gerais (MG), Piauí (PI), Ceará (CE), and Paraíba (PA) (Table 3). However, other populations, even though vulnerable, are located in private and unprotected forest fragments, such as the relictual population of Pampa, in Rio Grande do Sul.

DISCUSSION

Environmental, bioclimatic and topographic variables contribute significantly to the delimitation of accurated models of species distribution in the Neotropics (Echarri *et al.* 2009, Hoffmann *et al.* 2015, Negret *et al.* 2015, Sabattini *et al.* 2017). In the case of *C. noctivagus*, which is considered a forest bird (Magalhães 1994, Tomotani & Silveira 2016), the percent arboreal coverage increment of the model contributed to the delimitation of possible ecological corridors to connect populations across its distribution.

Table 1. Records of *Crypturellus noctivagus* (Aves, Tinamidae) in Brazil, representing the states (Federation Units - UFs) and its respective municipalities. Conservation status of the species: Vulnerable (VU), Critically Endangered (CR), Endangered (EN) and Not Evaluated (NE). Information about conservation status for the states Rio Grande do Sul (RS) (FZB 2014), Santa Catarina (SC) (CONSEMA 2011), Paraná (PR) (Straube *et al.* 2004), São Paulo (SP) (Silveira *et al.* 2010), Minas Gerais (MG) (Piacentini & Straube 2008) and Espírito Santo (ES) (Simon *et al.* 2005). States in Brazil with occurrence of *C. noctivagus*: Bahia (BA), Piauí (PI), Ceára (CE) and Paraíba (PA). However, with conservation status not yet evaluated for the species.

UF	Municipalities of occurrence	Status
RS	São Sepé and Formigueiro.	CR
SC	Blumenau, Garuva, Gaspar, Ilhota, Itapoã, Joinville, Praia Grande, São Francisco do Sul, and São Martinho.	EN
PR	Antonina, Guaraqueçaba, Guaratuba, Martinhos, Morretes, Paranaguá, and Pontal do Paraná.	EN
SP	Bertioga, Cananéia, Eldorado, Guapiara, Ibiúna, Iguape, Iporanga, Itanhaém, Jacupiranga, Juquiá, Luiz Antônio, Mongaguá, Miracatú, Paulo de Faria, Paranapiacaba, Pariquera-açu, Pedro de Toledo, Peruíbe, Ribeirão Grande, Santos, Sete Barras, São Miguel do Arcanjo, São Sebastião, Tapiraí, and Teodoro Sampaio.	EN
BA	Barreiras, Boa Nova, Brotas de Macaúbas, Contendas do Sincorá, Coribe, Correntina, Ibicoara, Ilhéus, Itanagra, Jaborandi, Jeremoabo, Lagoa Real, Morro do Chapéu, Mucugê, Mucuri, Muquém de São Francisco, Pedra Branca, Poções, Santa Terezinha, São Desidério, São Félix do Coribe, and Vitória da Conquista.	NE
MG	Bom Jesus do Galho, Botumirim, Capitão Enéas, Caratinga, Dionísio, Francisco de Sá, Itacambira, Itacarambi, Ipaba, Itinga, Janaúba, Januária, José Gonçalves de Minas, Juramento, Leme do Prado, Marliéria, Montes Claros, Pedras de Maria Cruz, Piracicaba, Timóteo, and São Francisco.	CR
SE	Capela, Japaratuba, Pacatuba, Pirambu, and Poço Redondo.	CR
ES	Linhares and Sooretama	CR
PI	Alvorada do Gurguéia, Bom Jesus, Brejo do Piauí, Canto do Buriti, Caracol, Cristino Castro, Coronel José Dias, Morro Cabeça no Tempo, Santa Luz, Curimatá, Jurema, Pimenteiras, Redenção do Gurguéia, and Tamboril do Piauí.	NE
CE	Barbalha, Crato, Macaúba, and Parambu.	NE
PB	Rio Tinto, Mamanguape, and Fagundes.	NE

Table 2. Predictive variables used in the environmental suitability model for *Crypturellus noctivagus* (Aves, Tinamidae) in Brazil. Temporal resolution (TR) and percentage of variable contribution (%).

Data	Type	TR	%
Bio4_br	Temperature Seasonality	1950-2000	49.7
Veg_br	Percent arboreal coverage	2001-2010	13.8
Bio3_br	Isothermality	1950-2000	11.4
Topography_br	Elevation	2000	11.2
Bio17_br	Precipitation of Driest Quarter	1950-2000	6.6
Bio15_br	Precipitation Seasonality	1950-2000	6.5
Bio13_br	Precipitation of Wettest Month	1950-2000	0.8

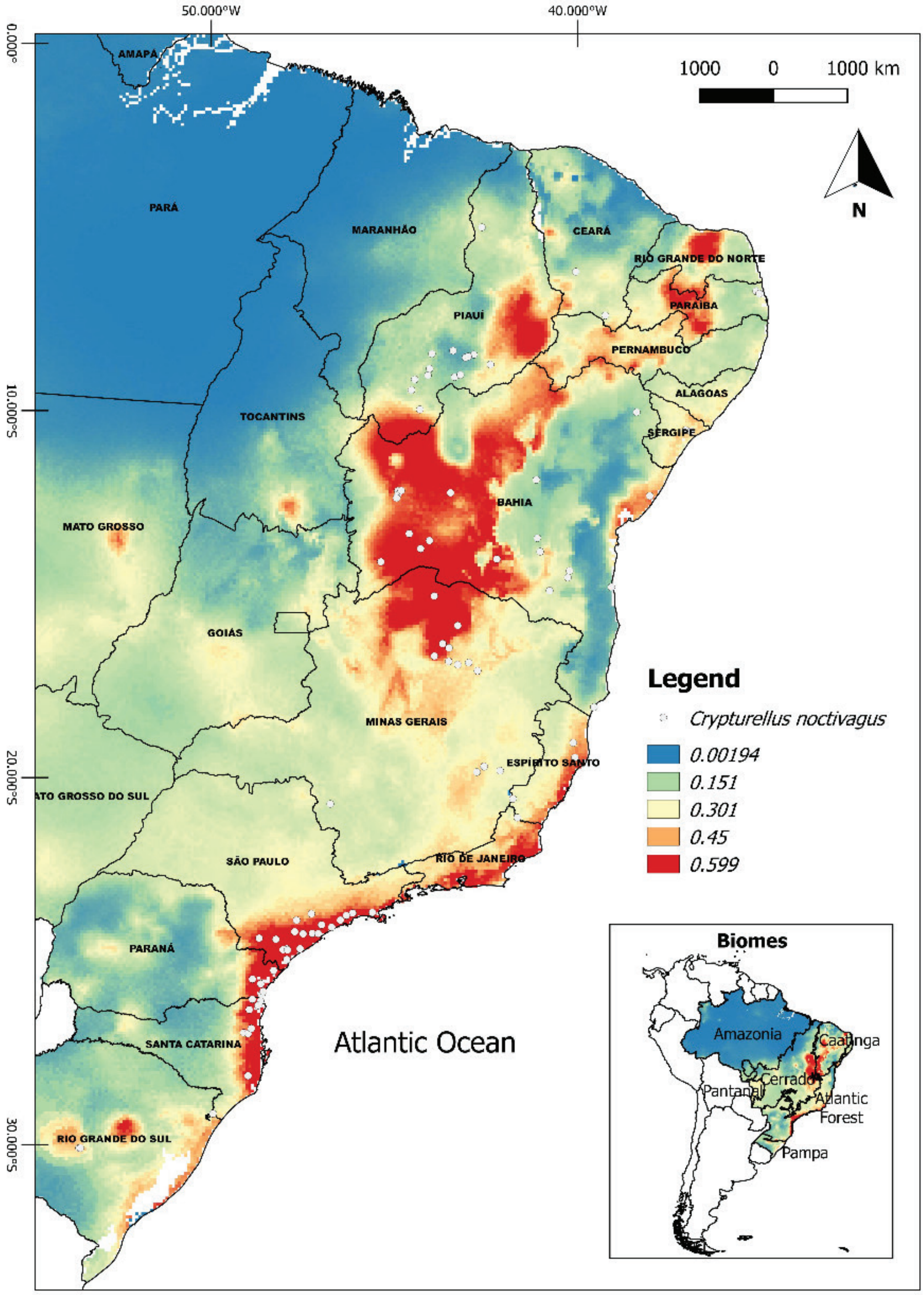

Figure 1. Predictive model of environmental suitability for the occurrence of *Crypturellus noctivagus* (Aves, Tinamidae) in the Brazilian territory. White dots represent currrent occurrence records. Warm colors represent a high probability of environmental suitability for the occurrence of the species. While cold colors indicate low probability and yellow and orange indicates moderate probability.

The states of São Paulo, Minas Gerais, Bahia, and Piauí are the most representative in number of occurrences, especially due to Atlantic Forest remnants extant in such regions, of which *C. noctivagus* depends on (Sick & Teixeira 1979, Sick 1997, Piacentini & Straube 2008). Records also occurred in regions further south in Paraná and Santa Catarina. The city of Praia Grande (SC) is the southern limit of occurrence within the Atlantic Forest Biome. Beyond these records, about 1000 km away from Praia Grande, there is a single relictual population of *C. noctivagus* which is completely isolated from others, between the municipalities of São Sepé and Formigueiro and within the Pampa Biome (Corrêa *et al.* 2010, Corrêa

Table 3. Conservation Units (CUs) and Ecological Stations, Reserves and/or Parks with occurrence records of *Crypturellus noctivagus* (Aves, Tinamidae) in each state.

States (UF)	Areas
Santa Catarina (SC)	Parque Botânico do Morro do Baú
	Reserva Biológica Estadual do Sassafrás
	Reserva Volta Velha
Paraná (PR)	Área de Proteção Ambiental Guaratuba
	Parque Estadual do Palmito
	Parque Nacional do Superagüi
	Reserva Salto Morato
São Paulo (SP)	Estação Ecológica de Jataí
	Estação Ecológica de Paulo de Faria
	Estação Ecológica Estadual da Ilha do Cardoso
	Estação Ecológica Juréia - Itatins
	Mosaico do Jacupiranga
	Parque Estadual Carlos Botelho
	Parque Estadual Intervales
	Parque Estadual Morro do Diabo
	Parque Estadual Serra do Mar
	RPPN - Serra dos Itatins
Bahia (BA)	Estação Ecológica do Raso da Catarina
	Floresta Nacional Contendas do Sincorá
	Parque Municipal - Povoado da Sucupira
	RPPN - Fazenda Lontra/Saudade
Minas Gerais (MG)	Parque Estadual do Morro do Chapéu
	Parque Estadual do Rio Doce
	Parque Nacional Cavernas do Peruaçu
	Reserva Biológica de Sooretama
	RPPN Fazenda Macedônia -Ipaba
	RPPN Feliciano Abdala
Espirito Santo (ES)	Reserva Biológica de Sooretama
Piauí (PI)	Parque Nacional da Serra das Confusões
	Parque Nacional Serra da Capivara
Paraíba (PA)	Reserva Biológica Guaribas
Ceará (CE)	Floresta Nacional Araripe
	RPPN Olho d'água do Urucu -Parambu

& Petry 2018). The predictive model also suggests the existence of other isolated populations between the states of Espírito Santo, Ceará and Paraíba. It is likely that other populations exist in these regions but are not completely inventoried, probably due to the lack of ornithological studies.

Although the two subspecies of *C. noctivagus* were subdivided based on subtle differences (Magalhães 1994, Sick 1997, Tomotani & Silveira 2016), tinamid birds may present differences even between populations that are closely related (Cabot 1992, Schelsky 2004, Laverde-R. & Cadena 2014, Negret *et al.* 2015). The predictive model indicated connections between some populations of *C. noctivagus* in adjacent areas, which comprises regions of Atlantic Forest, Cerrado and Caatinga Biomes.

The conservation status of *C. noctivagus* has only been defined for some states, mainly due to lack of data regarding the species biology (Simon *et al.* 2005, Piacentini & Straube 2008, Silveira *et al.* 2010, CONSEMA 2011, FZB 2014). The occruence records assembled in this study comprise the greatest collection of current records of *C. noctivagus* in wildlife, thus contributing to fill this knowledge gap and to update the species conservation status. However, population data may be considered speculative for this group.

According to Birdlife International (2016), some populations that occur within Conservation Units (CUs) are likely declining moderately. Birdlife estimates about 30 mature individuals per each CU. In this sense, the presence of *C. noctivagus* in protected areas is extremely important for its local conservation (Carrara *et al.* 2013, Birdlife International 2016). Populations located outside protected areas are suppressed and restricted to small forests of about 150-450 ha, which comprise fragmented forest remnants under high anthropogenic pressure (Sousa 2009, Corrêa *et al.* 2010, Corrêa & Petry 2018). In this specific case, with a reduced matrix and absence of forest connections, specialist species become highly susceptible to biogeographic isolation (Marini 2001, Antongiovanni & Metzger 2005, Marini & Garcia 2005). Due to the intense effects of fragmentation, hunting and stochastic events, some populations of *C. noctivagus* may become locally extinct (Bencke *et al.* 2003, Silveira *et al.* 2010).

The use of the MaxEnt algorithm and occurrence points, along with bioclimatic variables, topographic variables and percent arboreal coverage, contributes to the understanding and prediction of the current distribution of *C. noctivagus*, a forest bird considered threatened with extinction in Brazil. In the face of the existence of many isolated populations, we highlight the need to investigate how the genetic structure of such populations is being affected, especially when regarding to small populations. Finally, any ecological information concerning *C. noctivagus* in the wild should be reported in literature, in order to guide management and conservation actions, which must be adopted for some critical populations, both at local and regional scales.

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Appendix I. Scientific publications and books reporting occurrence records of *Crypturellus noctivagus* in the Brazilian territory.

Author	Year	Author	Year
Costa-Neto & Oliveira	(2000)	Nobrega *et al.*	(2011)
Ribon & Maldonado-Coelho	(2001)	Cavarzere *et al.*	(2012)
Santos	(2004)	Olmos & Albano	(2012)
Straube & Urben-Filho	(2005)	Santos *et al.*	(2012)
Vasconcelos & Neto	(2007)	Schunck *et al.*	(2012)
Santos	(2008)	Silveira & Santos	(2012)
Souza	(2009)	Vasconcelos *et al.*	(2012)
Almeida & Teixeira	(2010)	Carrara *et al.*	(2013)
Corrêa *et al.*	(2010)	Loss	(2014)
Lima	(2010)	Teixeira *et al.*	(2014)
Lopes *et al.*	(2010)	Tomotani & Silveira	(2016)
Silveira *et al.*	(2010)	Birdlife International	(2016)
Antunes *et al.*	(2011)	Freitas *et al.*	(2016)
Loures-Ribeiro *et al.*	(2011)	Souza & Júnior	(2017)

Appendix II. Sources reporting occurrence records of *Crypturellus noctivagus* in the Brazilian territory provided by WikiAves online database.

Author	Year	Finder	Author	Year	Finder
Massarioli, M.	(2002)	[WA9338]	Holderbaum, J. M.	(2013)	[WA1089946]
Santos, S. S.	(2003)	[WA381856]	Holderbaum, J. M.	(2013)	[WA1281651]
Massarioli, M.	(2004)	[WA9337]	Oliveira, R. C.	(2013)	[WA876652]
Pacheco, J. F.	(2005)	[WA1275029]	Prudente, C. A.	(2013)	[WA899222]
Albano, C.	(2007)	[WA523225]	Swarofsky, F.	(2013)	[WA928948]
Hirsch, T.	(2008)	[WA63630]	Trinchão, L.	(2013)	[WA1134562]
Albano, C.	(2009)	[WA95476]	Almeida, L. M.	(2014)	[WA1516697]
Merzvinskas, M.	(2009)	[WA49688]	Florencio, V. E.	(2014)	[WA1431510]
Kaseker, E. P.	(2010)	[WA251118]	Jane, L.	(2014)	[WA1472518]
Souza, M. J.	(2010)	[WA329285]	Vallejos, M. A.	(2014)	[WA1328466]
Almeida, J. S.	(2011)	[WA295882]	Rezende, M. A.	(2014)	[WA1765189]
Corrêa L.L.C.	(2011)	[WA531971]	Willian, M.	(2014)	[WA1517962]
Rupp, A. E.	(2011)	[WA476771]	Bianco, A.	(2015)	[WA1811922]
Souza, R. A.	(2011)	[WA510721]	Bianco, A.	(2015)	[WA1811922]
Ghizoni-Jr., I. R.	(2012)	[WA779526]	Luz, G. S.	(2015)	[WA1784136]
Kaseker, E. P.	(2012)	[WA551357]	Rodrigues, P. P.	(2015)	[WA1705313]
Lepage, R. A.	(2012)	[WA652924]	Swarofsky, F.	(2015)	[WA1827371]
Quental, J. G.	(2012)	[WA817664]	Bianco, A.	(2016)	[WA2359315]
Sanches, D.	(2012)	[WA823757]	Florencio, V. E.	(2016)	[WA2399902]
Souza, M. J.	(2012)	[WA585083]	Girão, W.	(2016)	[WA2019235]
Albano, C.	(2013)	[WA990463]	Machado, J. C	(2016)	[WA2356042]
Barreiros, M.	(2013)	[WA1205696]	Santos, M. G.	(2016)	[WA2000594]
Bete, D.	(2013)	[WA870008]	Silva, C. A.	(2016)	[WA2281841]
Dalessandro, R.	(2013)	[WA945441]	Breves, L. A.	(2017)	[WA2648449]
Dias, M. F.	(2013)	[WA1182338]	Santos, M. G.	(2017)	[WA2445764]
Endo, W.	(2013)	[WA1065052]	Rodrigues, G. K.	(2017)	[WA2686260]

Appendix III. Variables used to test the elaboration of the predictive model of *Crypturellus noctivagus* in Brazil. Temporal resolution (TR).

Data	Type	TR
Bio1_br	Annual mean temperature	1950-2000
Bio2_br	Mean Diurnal Range (Mean of monthly (max temp - min temp)	1950-2000
Bio3_br	Isothermality (BIO2/BIO7) (standard deviation *100)	1950-2000
Bio4_br	Temperature Seasonality (standard deviation *100)	1950-2000
Bio5_br	Max Temperature of Warmest Month	1950-2000
Bio6_br	Minimum temperature of coldest month	1950-2000
Bio7_br	Temperature annual range (BIO5/BIO6)	1950-2000
Bio8_br	Mean Temperature of Wettest Quarter	1950-2000
Bio9_br	Mean temperature of driest quarter	1950-2000
Bio10_br	Mean Temperature of Warmest Quarter	1950-2000
Bio11_br	Mean Temperature of Coldest Quarter	1950-2000
Bio12_br	Annual Precipitation	1950-2000
Bio13_br	Precipitation of Wettest Month	1950-2000
Bio14_br	Precipitation of Driest Month	1950-2000
Bio15_br	Precipitation Seasonality (Coefficient of Variation)	1950-2000
Bio16_br	Precipitation of Wettest Quarter	1950-2000
Bio17_br	Precipitation of Driest Quarter	1950-2000
Bio18_br	Precipitation of Warmest Quarter	1950-2000
Bio19_br	Precipitation of Coldest Quarter	1950-2000
Topography_br	Elevation	2000
Veg_br	Percent arboreal coverage	2001-2010