Assessing the extent of occurrence, area of occupancy, territory size, and population size of marsh tapaculo (*Scytalopus iraiensis*)

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Abstract

*Assessing the extent of occurrence, area of occupancy, territory size, and population size of marsh tapaculo (*Scytalopus iraiensis*).*— First described in 1998, the marsh tapaculo (*Scytalopus iraiensis*) is an endangered bird of the family Rhinocryptidae. It is endemic to Brazil and is restricted to the wet flood plains of rivers and streams. Due to its cryptic habits and environments of occurrence, information available on its biology, natural history and distribution is scarce. We compiled occurrence records (99 records), delimited the extent of occurrences (296,584 km^2), calculated the area of occupancy (84 km^2), estimated territory size (5,313 ± 1,201 m^2 per pair), population density (3.76 ± 0.85 individuals per hectare), and population size (31,584 ± 7,140 mature individuals) of marsh tapaculo. The species was recorded in marshes associated to four types of vegetation and in four ecological zones. This new information is extremely important to support revaluation of the species' threat category and to enhance knowledge about this endemic and little known bird from Brazil.

Key words: *Scytalopus iraiensis*, Distribution, Population, Endangered species, Southeastern Brazil.

Resumen

*Evaluación de la extensión de presencia, la superficie de ocupación, el tamaño del territorio y el tamaño de la población del churrín palustre (*Scytalopus iraiensis*).*— Descrito por primera vez en 1998, el churrín palustre (*Scytalopus iraiensis*) es una ave en peligro de extinción de la familia Rhinocryptidae. Es endémica de Brasil y su presencia queda restringida a los planos aluviales de los ríos y los cursos de agua. Debido a sus hábitos crípticos y a los ambientes en los que se halla presente, la información disponible sobre su biología, su historia natural y su distribución es escasa. Compilamos varios registros de presencia (99 registros), delimitamos la extensión de las presencias (296.584 km^2), calculamos la superficie de ocupación (84 km^2) y estimamos el tamaño del territorio (5.313 ± 1.201 m^2 por pareja), la densidad de la población (3,76 ± 0,85 individuos por hectárea) y el tamaño de la población (31.584 ± 7.140 individuos maduros) del churrín palustre. La especie se registró en zonas de marismas asociada a cuatro tipos de vegetación y en cuatro zonas ecológicas. Esta nueva información es fundamental para respaldar la reevaluación de la categoría de situación de peligro de la especie y potenciar el conocimiento de esta ave endémica y poco conocida de Brasil.

Palabras clave: *Scytalopus iraiensis*, Distribución, Población, Especie en peligro de extinción, Sureste de Brasil.

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Introduction

The marsh tapaculo (*Scytalopus iraiensis*) is a species of the bird family Rhinocryptidae. It was first described in 1998 from specimens taken from two municipalities in the metropolitan region of Curitiba (capital of Paraná state, southern Brazil) and its occurrence is known to be restricted to the wet flood plains of rivers and streams (Bornschein et al., 1998). Its habitat is described as upland marshes and also, at Rio Grande do Sul state (south of Brazil), coastal wetlands associated to grasslands and Atlantic Forest biomes (Machado et al., 2005). According to Bornschein et al. (1998, 2001) this bird occurs in dense humid floodplain watercourses, usually surrounded by alluvial forests, ranging from less than 1 ha to approximately 350 ha, with a vegetation height ranging from 60 to 180 cm.

After the species' description, new records were obtained in Paraná, Santa Catarina and Rio Grande do Sul states (south of Brazil) and in Minas Gerais state (southeast of Brazil) increasing the number of locations, municipalities and states with records of marsh tapaculo (Bornschein et al., 1998, 2001; Accordi et al., 2003; Maurício, 2005; Straube et al., 2005; Bencke et al., 2006; Raposo et al., 2006; Corrêa et al., 2007, 2008; Vasconcelos et al., 2008; Fontana et al., 2008; Rodrigues et al., 2008). Despite the new records, knowledge of this species' real distribution is still very basic. New records are expected even in well–studied regions, an expectation reinforced by the species' description fifteen years ago (Bornschein et al., 1998), based on individuals from a metropolitan region with 1.75 million inhabitants (IBGE, 2007), and from records obtained in well–studied locations of Minas Gerais state (*e.g.* Serra da Canastra and Serra do Cipó) as of 2003 (Vasconcelos et al., 2008).

The cryptic habits, common to all representatives of this genus, and the flooded environment where the species occurs make research of this tapaculo difficult, accounting thereby for the little information produced and available. To date, only two papers have been published on the species' biology and behavior (Hassdenteufel et al., 2006a, 2006b), and three on the species' distribution (Bornschein et al., 2001; Corrêa & Woldan, 2007; Vasconcelos et al., 2008).

Apart from the little information available at the time of the description, a suggestion was made to include marsh tapaculo in the Brazilian list of endangered species (Bornschein et al., 1998, 2001). Nowadays, this tapaculo is considered 'Endangered' at national and international levels (Machado et al., 2005; BirdLife International, 2012).

This lack of information on biological data and distribution details of the marsh tapaculo can lead to erroneous classification of the threat category. It is therefore extremely important to compile records, delimit the extent of occurrence, measure the area of occupancy, and estimate the territory size, population density and population size in order to reevaluate the threat category and to expand knowledge of this endemic and little known bird from Brazil.

Material and methods

Study area

The study area included the extent of occurrence of marsh tapaculo, from Rio Grande do Sul (RG), Santa Catarina (SC) and Paraná state (PR) in Southern Brazil and São Paulo (SP) and Minas Gerais (MG) state in Southeastern Brazil, between coordinates 19º 07'–32º 19' S and 43º 20'–52º 28' W.

Records

Records of the species were obtained from literature, photos and recordings available on the internet (http://www.xeno–canto.org/ and http://www.wikiaves.com.br/), unpublished records from third persons (personal communication) and bird surveys carried out by the first author between 2002 and 2012. For records taken from the literature, internet information and personal communications, the coordinates used were those provided by the author of each record. When this information was not available and the location could not be specified, the municipality centroid was used.

Due to the species' cryptic habits (Bornschein et al., 2001), the records gathered by the first author were obtained by listening to audio communications stimulated by means of song playbacks. The coordinates for the points where the species was recorded were obtained through a global positioning system (GPS) device.

Extent of occurrence, area of occupancy, territory size and population size

The records were represented in a geographical information system (GIS). The extent of occurrence, defined as the smallest area which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon (IUCN, 2001), was delimited by using the minimum convex polygon method (Mohr, 1947; IUCN, 2001); this was defined as the smallest polygon in which none of the internal angles exceed 180 degrees, and containing all the species points of occurrence (IUCN, 2001). This method, usually used to calculate the home range size (Hayne, 1949; White & Garrott, 1990; Harris et al., 1990), was adapted to the delineation of the extent of occurrence (IUCN, 2001).

By overlaying the records and thematic maps, we identified the vegetal formation (IBGE, 1993) and the global ecological zones (ecozones; FRA, 2000) where the species occurs. Considering the minimum convex polygon method, which incorporate large areas that are not used or occupied by the species (Ostro et al., 1999; Powell, 2000; Burgman & Fox, 2003), and aiming to create a realistic extent of occurrence, this polygon was adjusted using the adjusted polygon method (Mills & Gorman, 1987; Li & Rogers, 2005; Grueter et al., 2009) by excluding the vegetal formation without records of the species. We also excluded small separated areas, created by the polygon adjustment, and great water bodies.

The area of occupancy, defined as the area inside the extent of occurrence occupied by the species (IUCN, 2001), was obtained using the grid cell method. To accomplish this goal, the recorded points were overlaid on a grid, the occurrence cells were identified, and their area was added, resulting in a value in square kilometers. This method, which is usually used to calculate home range size (Adams & Davis, 1967; White & Garrott, 1990), was adapted to calculate the area of occupancy according to IUCN (2001).

The size of the cells is a factor that can influence results, overestimating or, more commonly, underestimating the calculated area (Kool & Croft, 1992; IUCN, 2001; Lehmann & Boesch, 2003; Grueter et al., 2009). Although the choice of cell size was usually a decision with no biological basis or known objective procedures (White & Garrott, 1990), the size of cells used in this research (1 km^2) was defined considering the disjunctive distribution of the habitat where the species occurs. We aimed at not producing overestimated values for the area of occupancy, as is preferable from a conservation point of view (IUCN, 2001).

The size of the territory of the marsh tapaculo was estimated by counting individuals in eight different marshes where the species was recorded. The marshes sampled are in two of the four states where the species occur, Paraná and Santa Catarina. These two states contain 74.75% of the compiled records, justifying the implementation of sample sites in these regions. The marshes studied are distributed in the two main ecological zones, subtropical humid forest and tropical mountain system (94.95% of the records have been collected in these zones), with two main vegetation types, araucaria moist forest and grassland (85.86% of the records come from these vegetation types).

Each marsh was sampled twice, in March 2011 and April 2012, using song playback to stimulate vocalization. Considering that the species respond well to the playback and could be heard easily (Bornschein et al., 1998), we followed the point count method (Ferry & Frochot, 1970; Hutto et al., 1986). This is one of the most widely used counting methods in bird population studies (Rosenstock et al., 2002) , with an unlimited radius (see Simons et al., 2007). We used an adapted version of the double–observer approach (Nichols et al., 2000; Thompson, 2002), with two observers in each marsh, positioned to visually cover the whole sample area. Due to the species' cryptic habits (Bornschein et al., 1998), we were unable to use other methodologies (such as banding, or observation) to estimate the number of individuals.

For each location sampled we counted the number of individuals vocalizing at the same time, heard in a period of 15 min after playback (done for 10 min). The marshes sampled were vectorized utilizing satellite images, taken in 2010 with 0.5 meter resolution, and the areas were then calculated. Considering the high resolution of the images used and the great facility in marsh identification and delimitation it was possible to vectorize these vegetal formations with great precision, resulting in highly accurate calculations of their areas.

To measure the territory size, the marsh area was divided by the maximum number of individuals vocalizing at the same time after playback, and the average value of this ratio was used. Considering territory as a defended area (Howard, 1920) that provides food, nesting sites and mates (Perrins & Birkhead, 1983), the value obtained would be an estimate of the mean size of the territory occupied by a pair of marsh tapaculo. Population density was then estimated as twice the inverse of territory size, and population size was estimated by multiplying the area of occupancy by the population density value.

Results

Records and occurrence

A total of 99 occurrence records was compiled; 47 from the literature, 22 based on images and recordings from the Internet, six personal communications, and 24 from bird surveys carried out by the first author. The occurrence locations (70) were distributed over 42 municipalities in Paraná, Santa Catarina, Rio Grande do Sul and Minas Gerais states (table 1).

According to the global ecological zones (FRA, 2000), the records were located in four regions: subtropical humid forest (58 records), tropical mountain system (36), tropical moist deciduous forest (3) and tropical rainforest (2).

According to the Brazilian vegetation map (IBGE, 1993) and Brazilian vegetation classification (Veloso et al., 1991), the records were located in marshes within the domains of four types of vegetation: araucaria moist forest (60 records) in its alluvial, montane and cloudy formations (*e.g.* Rio Grande do Sul, Santa Catarina and Paraná); semi–deciduous seasonal forest (7) and its formations submontane and montane (e.g. Minas Gerais); grassland (25) (*e.g.* Rio Grande do Sul, Santa Catarina, Paraná and Minas Gerais); pioneer formation areas (5) (*e.g.* Rio Grande do Sul coastal line); and ecological tension areas (2) between grassland and semi–deciduous seasonal forest (fig. 1).

Extent of occurrence, area of occupancy, territory size and population size

The minimum convex polygon method gave an extent of occurrence of 424,064 km^2. After excluding the vegetal formation without any record of the species, the extent of occurrence obtained was 296,584 km^2 (fig. 1).

We used a 1 km^2 cell grid to calculate the species' area of occupancy (a total of 299,536 cells to cover all of the extent of occurrence), resulting in 84 km^2. This area is distributed over Rio Grande do Sul (6 km^2), Santa Catarina (23 km^2), Parana (44 km^2) and Minas Gerais (11 km^2) states.

The territory size found for the species was 5,313 ± 1,201 m^2 (ranging from 3,589 to 6,990 m^2), resulting in a population density of 3.76 ± 0.85 individuals per hectare. One to five individuals were

Table 1. Records of marsh tapaculo between 1997 and 2013, showing the municipalities, states (MG. Minas Gerais; PR. Parana; RS. Rio Grande do Sul; SC. Santa Catarina), coordinates (*Coordinate of the centroid of the municipality) and source of the records (LKJ. Records collected by the first author; personal communications: PSN. Pedro Scherer Neto; AER. Adrian Eisen Rupp).

Tabla 1. Registros del churrín palustre entre 1997 y 2013 en los que se muestran los municipios, los estados (MG. Minas Gerais; PR. Parana; RS. Rio Grande do Sul; SC. Santa Catarina)*, las coordenadas (*Coordenadas del centroide del municipio) y los autores de los registros (LKJ. Registros recopilados por el primer autor; comunicaciones personales: PSN. Pedro Scherer Neto; AER. Adrian Eisen Rupp).*

Municipality	State	Coordinate	Source
Bambuí	MG	20° 14' S, 45° 58' W	Vasconcelos et al., 2008
Catas Altas	MG	20° 07' S, 43° 27' W	Vasconcelos et al., 2008
Itabira	MG	19° 36' 04" S, 43° 18' 03" W*	Silva, 2012
Mariana	MG	20° 19' 46" S, 43° 19' 55" W*	Silva, 2011
Moeda	MG	20° 19' 50" S, 43° 59' 35" W*	Franco, 2013
Morro do Pilar	MG	19° 11' 05" S, 43º 23' 38" W	Faria, 2011
Morro do Pilar	MG	19° 15' S, 43° 31' W	Araújo, 2011
Morro do Pilar	MG	19° 15' S, 43° 31' W	Araújo, 2011
Morro do Pilar	MG	19° 15' S, 43° 31' W	Araújo, 2011
Morro do Pilar	MG	19° 15' S, 43° 31' W	Rodrigues et al., 2008
Ouro Preto	MG	20° 23' 29" S, 43° 36' 39" W*	Silva, 2012
Santa Bárbara	MG	20° 08' S, 43° 31' W	Vasconcelos et al., 2008
Santa Bárbara	MG	20° 00' S, 43° 28' W	Vasconcelos et al., 2008
Santana do Riacho	MG	19° 15' S, 43° 31' W	Vasconcelos et al., 2008
São João Batista do Glória	MG	20° 28' S, 46° 26' W	Vasconcelos et al., 2008
Bituruna	PR	26° 18' 03" S, 51° 30' 12" W	LKJ
Bituruna	PR	26° 18' 09" S, 51° 30' 09" W	LKJ
Bituruna	PR	26° 18' 20" S, 51° 29' 31" W	LKJ
Castro	PR	24° 47' 58" S, 49° 50' 30" W*	IAP, 2009
Cruz Machado	PR	25° 48' S, 51° 05' W	Straube et al., 2005
Cruz Machado	PR	25° 47' S, 51° 07' W	Straube et al., 2005
Cruz Machado	PR	25° 45' S, 51° 05' W	Straube et al., 2005
Curitiba	PR	25° 37' 16" S, 49° 19' 47" W	LKJ
Curitiba	PR	25° 28' 50" S, 49° 20' 02" W	PSN verbally 2011
Curitiba	PR	25° 28' 59" S, 49° 11' 15" W	Straube et al., 2009
Curitiba	PR	25° 35' 58" S, 49° 15' 59" W	Straube et al., 2009
General Carneiro	PR	26° 18' 54" S, 51° 29' 26" W	LKJ
General Carneiro	PR	26° 35' S, 51° 19' W	Straube et al., 2005
Guarapuava	PR	25° 14' 13" S, 51° 17' 04" W	IAP, 2009
Guarapuava	PR	25° 26' 00" S, 51° 13' 00" W	LKJ
Guarapuava	PR	25° 25' 34" S, 51° 13' 40" W	LKJ
Lapa	PR	25° 48' S, 50° 14' W	Bornschein et al., 2001
Palmas	PR	26° 33' 25" S, 51° 34' 09" W	IAP, 2009
Palmeira	PR	25° 26' S, 50° 12' W	Bornschein et al., 2001
Pinhais	PR	25° 26' S, 49° 07' W	Bornschein et al., 2001
Piraí do Sul	PR	24° 27' S, 49° 50' W	Bornschein et al., 2001
Piraquara	PR	25° 27' S, 49° 07' W	Bornschein et al., 2001
Ponta Grossa	PR	25° 14' 51" S, 50° 00' 35" W	PSN verbally 2011

Table 1. (Cont.)

Municipality	State	Coordinate	Source
Quatro Barras	PR	25° 23' S, 49° 05' W	Bornschein et al., 2001
Quatro Barras	PR	25° 23' 38" S, 49° 06' 06" W	PSN verbally 2011
Quatro Barras	PR	25° 23' 38" S, 49° 06' 06" W	PSN verbally 2011
Quatro Barras	PR	25° 23' 38" S, 49° 06' 06" W	PSN verbally 2011
São João do Triunfo	PR	25° 47' S, 50° 13' W	Bornschein et al., 2001
São João do Triunfo	PR	25° 50' S, 50° 14' W	Bornschein et al., 2001
São José dos Pinhais	PR	25° 39' 52" S, 49° 05' 42" W*	Whittaker, 2011
São José dos Pinhais	PR	25° 34' 15" S, 49° 03' 26" W	Athanas, 2008
São José dos Pinhais	PR	25° 34' 12" S, 49° 03' 25" W	Luijendijk, 2010
São José dos Pinhais	PR	25° 34' 59" S, 49° 03' 37" W	By, 1998
São José dos Pinhais	PR	25° 36' S, 49° 09' W	Minns, 2002
São José dos Pinhais	PR	25° 36' S, 49° 09' W	Bornschein et al., 2001
São José dos Pinhais	PR	25° 36' S, 49° 06' W	Bornschein et al., 2001
São José dos Pinhais	PR	25° 37' S, 49° 06' W	Bornschein et al., 2001
São José dos Pinhais	PR	25° 30' S, 49° 09' W	Bornschein et al., 2001
São José dos Pinhais	PR	25° 33' S, 49° 00' W	Bornschein et al., 2001
São José dos Pinhais	PR	25° 34' S, 49° 03' W	Bornschein et al., 2001
São José dos Pinhais	PR	25° 38' S, 49° 09' W	Bornschein et al., 2001
São José dos Pinhais	PR	25° 36' S, 49° 10' W	Bornschein et al., 2001
Teixeira Soares	PR	25° 21' S, 50° 25' W	Bornschein et al., 2001
Tijucas do Sul	PR	25° 48' S, 49° 09' W	Bornschein et al., 2001
Tijucas do Sul	PR	25° 47' S, 49° 09' W	Bornschein et al., 2001
Tijucas do Sul	PR	25° 48' S, 49° 08' W	Bornschein et al., 2001
Tijucas do Sul	PR	25° 51' S, 49° 06' W	Bornschein et al., 2001
Tijucas do Sul	PR	25° 50' S, 49° 12' W	Bornschein et al., 2001
Tijucas do Sul	PR	25° 47' S, 49° 08' W	Bornschein et al., 2001
Tijucas do Sul	PR	25° 52' S, 49° 13' W	Bornschein et al., 2001
Bom Jesus	RS	28° 28' 55" S, 50° 42' 48" W	Fontana et al., 2008
Cambará do Sul	RS	29° 09' 34" S, 50° 07' 35" W	Patrial, 2006
Cambará do Sul	RS	29° 09' 34" S, 50° 07' 35" W	Bencke et al., 2006
Rio Grande	RS	32° 18' 16" S, 52° 25' 19" W	Jacobs, 2008a
Rio Grande	RS	32° 18' 16" S, 52° 25' 19" W	Jacobs, 2008b
Rio Grande	RS	32° 18' 16" S, 52° 25' 19" W	Mauricio, 2005
Rio Grande	RS	32° 18' 57" S, 52° 25' 19" W	Andretti, 2010a
Rio Grande	RS	32° 18' 57" S, 52° 25' 19" W	Andretti, 2010b
Viamão	RS	30° 10' 02" S, 50° 52' 12" W*	Fenalti, 2011
Viamão	RS	30° 06' S, 50° 52' W	Accordi et al., 2003
Água Doce	SC	26° 45' 56" S, 51° 36' 46" W*	Corrêa et al., 2008
Campo Alegre	SC	26° 05' 34" S, 49° 13' 38" W	LKJ
Campo Belo do Sul	SC	27° 50' 51" S, 50° 46' 20" W*	Espínola, 2011
Campo Belo do Sul	SC	27° 59' 45" S, 50° 52' 15" W	Rupp, 2010
Campo Belo do Sul	SC	27° 58' 47" S, 50° 48' 29" W	Rupp, 2010
Jaraguá do Sul	SC	26° 15' 37" S, 49° 13' 47" W	LKJ
Lages	SC	28° 01' 09" S, 50° 20' 21" W*	Corrêa et al., 2008

Table 1. (Cont.)

Municipality	State	Coordinate	Source
Ponte Alta do Norte	SC	27° 07' 39" S, 50° 22' 54" W	LKJ
Ponte Alta do Norte	SC	27° 07' 06" S, 50° 24' 12" W	LKJ
Ponte Alta do Norte	SC	27° 07' 41" S, 50° 22' 53" W	LKJ
Ponte Alta do Norte	SC	27° 07' 15" S, 50° 25' 23" W	LKJ
Ponte Alta do Norte	SC	27° 07' 33" S, 50° 23' 12" W	LKJ
Ponte Alta do Norte	SC	27° 09' 19" S, 50° 22' 28" W	LKJ
Ponte Alta do Norte	SC	27° 07' 30" S, 50° 25' 11" W	LKJ
Santa Cecília	SC	27° 05' 30" S, 50° 23' 42" W	LKJ
Santa Cecília	SC	26° 45' 08" S, 50° 21' 53" W	LKJ
Santa Cecília	SC	26° 46' 00" S, 50° 22' 28" W	LKJ
São Cristóvão do Sul	SC	27° 17' 08" S, 50° 18' 00" W	LKJ
São Cristóvão do Sul	SC	27° 19' 21" S, 50° 16' 34" W	LKJ
São Cristóvão do Sul	SC	27° 18' 38" S, 50° 17' 45" W	LKJ
São Cristóvão do Sul	SC	27° 16' 41" S, 50° 19' 31" W	LKJ
São Cristóvão do Sul	SC	27° 19' 42" S, 50° 16' 17" W	LKJ
Três Barras	SC	26° 12' S, 50° 12' W	Corrêa et al., 2007
Urupema	SC	27° 58' 28" S, 49° 58' 04" W	AER verbally 2011

found vocalizing in the marshes sampled, with an area from 3,589 to 30,422 m^2, and this number remained constant in the two samples made in each marsh (table 2), reinforcing the efficiency of the method used. The estimated population size, based on the population density and in the area of occupancy, was 31,584 ± 7,140 mature individuals.

Discussion

Occurrence and environment

The expected occurrence in the state of São Paulo, considered by Vasconcelos et al. (2008), was corroborated by the existence of the vegetal formations and ecological zones with known occurrences for the species. The inclusion of São Paulo state in the polygon of the extent of occurrence delimited herein is thus justified. The expected distribution for this state extends from the border with the state of Paraná to the Minas Gerais border, covering an area of approximately 150 km from east to west starting at the Serra do Mar (fig. 1).

The presence of records in the tropical moist deciduous forest (3) and tropical rainforest (2), a few kilometers (11 km maximum) off the boundaries with the mountain tropical system, might be associated with the scale used for mapping the global ecological zones. It is thus convenient to consider only the subtropical humid forest and the mountain tropical system as ecological zones for the species' occurrence.

Occurrence of the marsh tapaculo in the vegetation types where the species were found (araucaria moist forest, semi–deciduous seasonal forest, grassland, pioneer formation zone and ecological tension areas between grassland and semi–deciduous seasonal forest) is directly associated with the presence of pioneer formation areas with fluvial influence, plant communities that occur throughout Brazil in floodplains and flooded depressions (Veloso et al., 1991). The vegetation structure in these communities is quite varied, although the species seems to be restricted to environments dominated by Cyperaceae and/or Poaceae (Bornschein et al., 1998, 2001; Vascocelos et al., 2008).

These vegetal formations suffered greatly from the impact of the Brazilian Federal Government incentive program called Pro–Várzea (established in the 1970s to take advantage of the wetlands for agricultural production, financing the drainage of the wetlands), but are now protected by the Brazilian Forest Code and considered permanent preservation areas. However, the lack of specific data on the alteration of wetlands in Brazil makes it difficult to evaluate and measure the changes that have occurred herein.

On the other hand, we can use the deforestation rates of the Atlantic Forest in the states where the

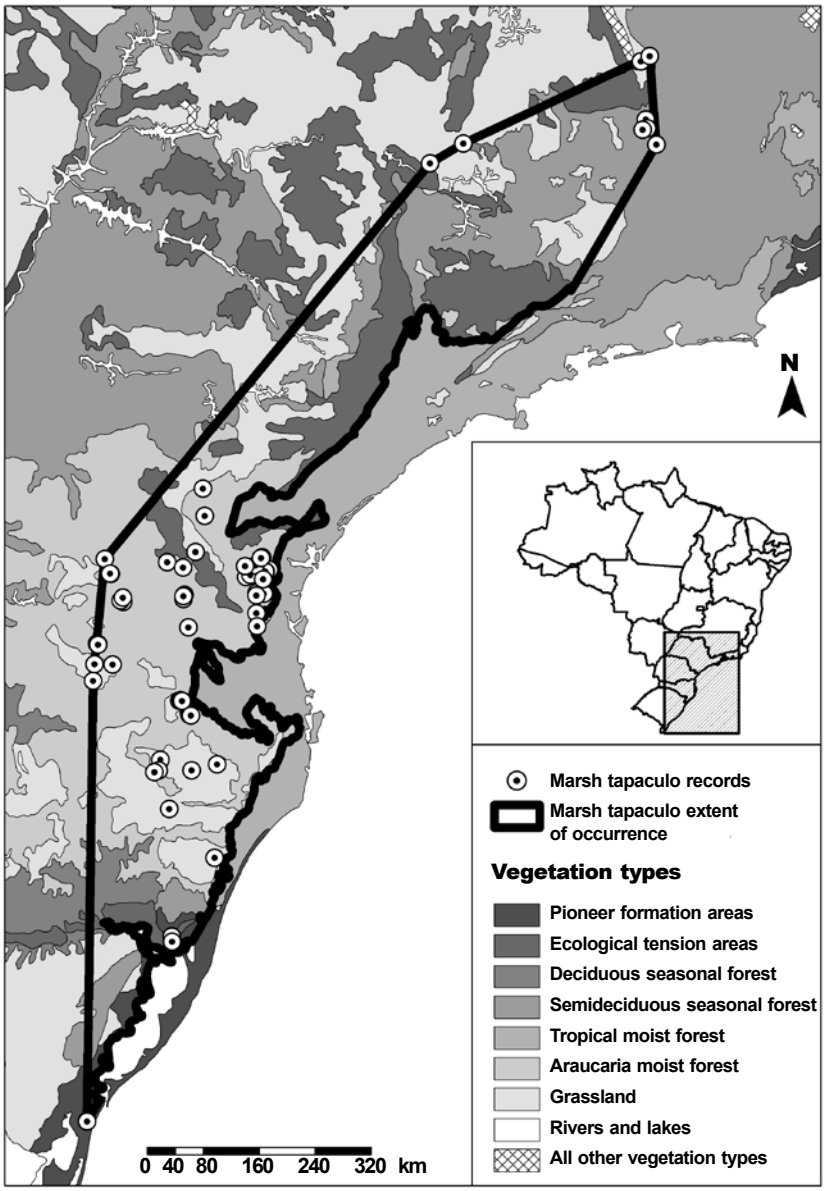

Fig. 1. Map of vegetation types with the location of marsh tapaculo records between 1997 and 2012 and the extent of occurrence delimited through the adjusted polygon method.

Fig. 1. Mapa de los tipos de vegetación con la ubicación de los registros del churrín palustre entre 1997 y 2012 y la extensión de la presencia delimitada mediante el método del polígono ajustado.

marsh tapaculo occur to understand and measure the process of alteration in other vegetal formations associated with these forests. The deforestation rate was 1.23 from 2005–2008 and 0.45% from 2008–2010 in the state of Minas Gerais, 0.51 and 0.17% in Paraná, 0.31 and 0.18% in Rio Grande do Sul, 1.19 and 0.17% in Santa Catarina, and 0.11 and 0.02% in São Paulo (Fundação SOS Mata Atlântica & Instituto Nacional de Pesquisas Espaciais, 2009, 2011).

Considering these rates of deforestation, the reduction in the extent of suitable habitat and consequently the reduction in the species' population cannot be considered significant (≥ 30%). The species' sensitivity to environmental changes, specially caused by fire and by natural or anthropogenic changes in the vegetal structure, is still not fully understood, and therefore does not allow a more significant discussion about the impact of these changes on populations of the species.

Table 2. State of the marshes used to calculate the territory size of marsh tapaculo, with the number of vocalizing individuals at the same time after playback on two sample dates (March 2011 and April 2012), measures of marsh areas (Ma, in m^2) and territory size (Ts, in m^2): S1. Sample 1; S2. Sample 2. (For abbreviations of states, see table 1.)

Tabla 2. Estado de las marismas utilizadas para calcular el tamaño del territorio del churrín palustre, número de individuos que emiten sonidos al mismo tiempo después de reproducir una grabación en las dos fechas del estudio (marzo de 2011 y abril de 2012), mediciones de las superficies de las marismas (Ma, en m^2 y tamaño del territorio (Ts, en m^2): S1. Muestra 1; S2. Muestra 2. (Para las abreviaturas de los estados, ver tabla 1.)

	Vocalizing indiv.			
State	S1	S2	Ma	Ts
PR	1	1	6,990	6,990
PR	1	1	3,589	3,589
PR	2	2	12,614	6,307
PR	4	4	18,121	4,530
SC	4	4	24,203	6,051
SC	2	2	9,535	4,768
SC	2	2	8,363	4,182
SC	5	5	30,422	6,084
Mean				5,313

Extent of occurrence, area of occupancy, territory size and population size

The increasing number of records in the 14 years since the species' description shows a significant growth in the extent of occurrence, going from only one state with records until 2001 (Bornschein et al., 2001) to four states in 2008 (Vasconcelos et al., 2008). The extent of occurrence presented by BirdLife International (2012), 490 km^2, is based on only 20 locations of occurrence, a much smaller number than that presented here: 70 locations and 42 municipalities. This difference in the amount of data used could explain the greater extent of occurrence, area of occupancy and population size presented here.

The territory size found for marsh tapaculo (5,313 ± 1,201 m^2), another factor that contributes to the increase in the estimated population size, is consistent with the value obtained for a species with similar body mass and environment (marsh antwren *Stymphalornis acutirostris*): an average of 2,500 m^2 (Reinert et al., 2007) and 7,000 m^2 (Reinert, 2008) in tidal marshes and 32,000 m^2 in saw grass marshes (Reinert et al., 2007). There is no available information about the size of territory in relation to other species with similar body size and environment. Averages for territory sizes of forest species with body mass of 10 to 15 g range from 6,000 to 150,000 m^2 (Greenberg & Gradwohl, 1985; Silva, 1988; Terborgh et al., 1990; Skutch, 1996). An unpublished estimate, from Banhado do Maçarico in the state of Rio Grande do Sul (the southernmost locality known for the species), found a population density of 0.5 individuals of marsh tapaculo per hectare (40,000 m^2 territory size) (BirdLife International, 2012). The difference between this value and that obtained here could be explained by the location of marshes sampled in relation to the extent of occurrence of species and/or by differences in vegetation structure of marshes sampled. Such variation can also be observed in the territory size of marsh antwren (2,500 and 32,000 m^2), which varies with the vegetation structure of the marshes (Reinert et al., 2007).

The area of occupancy calculated for marsh tapaculo (84 km^2) represents only 11.24% of the environment considered suitable for this species in one state, Paraná (747 km^2) (Bornschein et al., 2001). Furthermore, the area of occupancy obtained through the grid cell method is influenced by the sampling intensity (Grueter et al., 2009), generating underestimated values when the species is not recorded in points where it occurs. It is therefore expected that the area of occupancy will increase as the number of records increase. This projection is confirmed by the increasing number of new records in recent years and from unpublished information. The growing numbers of searches for the species inside and outside the known range of occurrence will also contribute to increasing the range of occurrence and area of occupancy.

As it is expected that the area of occupancy will extend, the population size for marsh tapaculo is also expected to increase. Thus, given the significant growth of knowledge for the species' distribution presented here, the population size obtained is much larger than the estimates presented previously, 250 to 999 mature individuals (BirdLife International, 2012), and this number tends to increase as new records are made in different localities.

Threat category

The species was classified as 'Endangered' based on the little information available covering aspects of distribution and population. The information compiled and the results presented here show that a revaluation of the threat category is needed. The urgency for this review and for a change in the threat category, due to the fact that the original category is considered misclassified, is recommended by IUCN (2001).

Thus, considering the current extent of occurrence (> 20,000 km^2), area of occupancy (< 100 km^2), population size (> 10,000 individuals) and habitat conditions, the criteria needed to include the marsh tapaculo in the IUCN red list (BirdLife International, 2012) (criteria A3c+4c, B1ab (i, ii, iii, iv, v), C2a(i))

and in the Brazilian red list (Machado et al., 2005) (criteria B2ab) is not obtained for any of the threat categories ('Critically Endangered', 'Endangered' or 'Vulnerable').

Despite the small size of the area of occupancy, caused by the disconnected characteristics of the species' habitat, the number of locations where the marsh tapaculo was recorded was much greater than ten, and no fluctuations in the extent of occurrence, area of occupancy, number of locations or sub–populations, and number of mature individuals were observed. Revaluation of the species' threat category is thus strongly recommended.

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