Áreas para a conectividade de populações de pecari do Chaco (*Catagonus wagneri*) no limite sul de sua distribuição no Chaco Argentino

**Areas for the connectivity of Chacoan peccary (*Catagonus wagneri*) populations at the southern limit of their distribution in the Argentine Chaco**

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**RESUMO**  
A área de distribuição geográfica de populações de mamíferos na ecorregião do Chaco argentino está sendo cada vez mais reduzida e isso se deve, principalmente, a destruição progressiva de habitats. Neste contexto, diversas espécies têm sido afetadas, entre as quais está a endêmica *Catagonus wagneri* (*Tayassuidae*), atualmente classificada como "em perigo" e com tendência de declínio populacional. Neste trabalho foram comparadas as previsões estimadas por três algoritmos para estabelecer a distribuição geográfica potencial desta espécie no limite sul de sua distribuição natural. Foram identificados os locais prioritários para conectividade de paisagem comparando as variações intrínsecas do índice de PC com base em métodos de classificação de dados. Com o uso de transectos, câmeras de armadilha e pesquisas com a população local, foi registrada a presença do pecari do Chaco em 25 ocasiões. A partir dos algoritmos GLM, Random Forest e Maxent (média AUC 0,74) foi obtido um modelo de referência. Usando-o como entrada e o índice de PC, foi avaliada a variação na importância das superfícies de conectividade da paisagem a partir de três métodos de classificação: quantil, intervalo igual e quebras naturais. O modelo de consenso (SDM) ocupa 55.674 km² da Argentina, representando 10% da ecorregião do Chaco Seco. A distribuição não ocupa apenas ecossistemas florestais, mas também ambientes com menor cobertura arbórea.
Foram registrados coeficientes de variação de 170% entre os métodos de classificação para o número de manchas das classes 9 e 10 do habitat prioritário para conectividade da paisagem. O SDM mostra uma distribuição fragmentada em concordância com o processo de mudança do uso da terra do Chaco. Os resultados sugerem uma grande variabilidade do índice de PC em função do método de classificação dos dados nos intervalos das classes, aspecto que não foi discutido em estudos anteriores.

**Palavras-chave:** *Catagonus wagneri*, ecorregião Chaco, distribuição geográfica, conectividade da paisagem, índice de PC, *Tayassuidae*.

**ABSTRACT**

The area of geographical distribution of mammal populations in the Argentine Chaco ecoregion is being increasingly reduced and this is mainly due to the progressive destruction of habitats. In this context, several species have been affected, among which is the endemic *Catagonus wagneri* (Tayassuidae), currently classified as "endangered" and with a trend of population decline. In this work, the predictions estimated by three algorithms were compared to establish the potential geographic distribution of this species at the southern limit of its natural distribution. Priority locations for landscape connectivity were identified by comparing intrinsic variations in the PC index based on data classification methods. With the use of foot transects, trap cameras and surveys with the local population, the presence of chacoan peccary was recorded on 25 occasions. From the GLM, Random Forest and Maxent algorithms (mean AUC 0.74), a reference model was obtained. Using it as an input and the PC index, the variation in the importance of the connectivity surfaces of the landscape was evaluated using three classification methods: quantile, equal interval and natural breaks. The consensus model (SDM) occupies 55,674 km² of Argentina, representing 10% of the Chaco Seco ecoregion. The distribution occupies not only forest ecosystems, but also environments with less tree coverage. Coefficients of variation of 170% were recorded between the classification methods for the number of patches of classes 9 and 10 of the priority habitat for landscape connectivity. The SDM shows a fragmented distribution in line with the Chaco's land use change process. The results suggest a great variability of the PC index depending on the method of classifying data in class intervals, an aspect that was not discussed in previous studies.

**Keywords:** *Catagonus wagneri*, Chaco ecoregion, geographic distribution, landscape connectivity, PC index, *Tayassuidae*.

**1 INTRODUCTION**

The chacoan peccary, *Catagonus wagneri* (Rusconi, 1930), also known as tagúá or quimilero, is a wild artiodactyl belonging to the Tayassuidae family, being endemic to the semiarid forests of the Dry Chaco of South America (Sowls, 1984, 1997). It was believed extinct until in 1975 the researcher Ralph Wetzel and collaborators announced the discovery of live specimens in the west of the Paraguayan Chaco. Its current population status is the "endangered" category (UICN) (Altrichter *et al.* 2015), in sharp decline due mainly to poaching and degradation and loss of habitat (Altrichter, 2005). In Argentina, it is also categorized as endangered (Ojeda *et al.*, 2012), and comes into Appendix I of CITES.
The chacoan peccary presents the most restricted geographical distribution of the family (Yahnke et al., 1997; Gasparini et al., 2013), being located in western Paraguay, southeastern Bolivia, and northern Argentina. (Redford and Eisenberg, 1992; Sowls, 1984; Taber, 1993). It has a total geographical range of approximately 140,000 km² (Sowls, 1984). In Paraguay, the species formerly occurred in all departments of the Chaco region. In Argentina, quimilero occurs in Chaco, Formosa, Salta and Santiago del Estero Provinces. It persists in the Bolivian dry Chaco in the departments of Chuquisaca, Santa Cruz, and Tarija (Maffei et al. 2002).

The historical distribution range of the *C. wagneri* was reduced by about 40% (Altrichter and Boaglio, 2004; Periago et al., 2015) and they are considered a conservation priority because, in addition to the degree of threat, remains as an evolutionary relict of a common ancestor to the Tayasuids in the Pliocene dispersion (Todd, 1985; Gongora and Moran 2005). Quimilero´s current density would be very low in some portions of the Chaco (Nuñez-Regueiro et al. 2015). In recent years, several groups have studied the geographical distribution of quimilero (Camino, 2016; Altrichter et al. 2016; Torres et al., 2017; Torres et al. 2019), however, there are no models to determine the contribution to landscape connectivity of the sectors that still harbor populations of those.

**MODELING THE POTENTIAL DISTRIBUTION**

Species distribution models attempt to provide detailed predictions of distributions by relating the presence or abundance of species to environmental predictors. As such, distribution models have provided researchers with an innovative tool to explore diverse questions in ecology, evolution, and conservation (Elith et al., 2006; Peterson et al., 2011). SDMs are correlative models that use environmental and/or geographic information to explain observed patterns of species occurrences (Elith and Graham, 2009). A common application of that method is to predict species ranges with climate data as predictors (Hijmans and Elith, 2013). There are many modeling techniques (GLM, GAM, GARP, ENFA, Maxent, etc.) that can be used according to the records available for each species, the environmental data and the required precision of the models (Burgman et al., 2005; Guisan and Zimmermann, 2000).

We compared the predictions made by three algorithms to establish the potential geographic distribution of *Catagonus wagneri* in the southern limit of its geographic range. Two algorithms of presence-absence were used, a generalized linear model (GLM, McCullagh and Nelder, 1989) as regression method and random forests (RF; Breiman, 2001a) as a learning machine using R statistical environment (R Core Team, 2018). Maximum entropy was used for presence-only data,
without knowing previously the probability of detection of the species (MacKenzie et al., 2002). For this, the Maxent 3.3.3k software version was used (Phillips et al., 2013).

LANDSCAPE CONNECTIVITY

Landscape connectivity is the degree to which landscape facilitates or impedes movement between source patches and possesses the attribute of being able to be measured (Taylor et al., 1993). It is currently considered essential in the processes of wildlife and biodiversity conservation (Fahrig and Merriam, 1985), landscape planning and management (Noss and Daly, 2006), for the mitigation of the adverse effects derived from the fragmentation of the landscape, habitat and global climate change (Crooks and Sanjayan, 2006). When analyzing landscape connectivity, two approaches are presented, the first one conceives connectivity as an emergent feature of the landscape as a whole (Tischendorf and Fahrig, 2000), where a single metric describes the degree of general connectivity.

On the other hand, based on metapopulation theory (Levins, 1970; Merriam, 1984; Hanski and Gilpin, 1991), an analysis of functional connectivity based on the description of the importance of habitat patches is carried out (Moilanen and Hanski, 2001; Frank and Wissel 2002; Nicholson et al., 2006). The development of new metrics such as the integral connectivity index (IIC) and the probability of connectivity (PC), that have been shown to have improved performance compared to other existing indices and to be particularly suited for landscape conservation planning and change monitoring applications. Both metrics are based on the structure of graphs and on the concept of measuring habitat availability at the landscape scale (Pascual-Hortal and Saura, 2006; Saura and Pascual-Hortal, 2007).

The concept of habitat availability consists of considering a patch as a space where connectivity exists, measuring the available (achievable) habitat in the landscape through a single metric, which integrates the area of connected habitat that exists within the patches (intrapatch connectivity) with the available area through the connections between the different patches of habitat (interpatch connectivity) (Pascual-Hortal and Saura, 2006; Saura, 2008). In particular, PC is based on a probabilistic connection model that allows continuous modeling of the viability of the connection or dispersion resistance (Saura and Rubio, 2010). The purpose of this work is to identify the priority sites for landscape connectivity in the southern portion of the geographic distribution range of the Chacoan peccary.
2 MATERIALS AND METHODS

The Gran Chaco is a large plain that covers an approximate area of 1.1 million km$^2$ (Naumann, 2006), extending through Argentina, Paraguay, Bolivia and Brazil, being one of the main biogeographical regions, and the largest ecoregion in South America after Amazonia (Dinerstein et al., 1995). The study area is a sector of the south center of the Dry Chaco ecoregion (Cabrera, 1994), in particular the Semi-arid Chaco subregion (Mateucci et al., 2012; Morello et al., 2012), which corresponds approximately to the political limit of the Santiago del Estero Province in Argentina, between 24 ° - 31 ° south latitude and 60 ° - 66 ° west longitude (Fig. 1).

The quebrachal forests are the predominant type of vegetation in the area. This physiognomy is characterized by the dominance of the red quebracho (Schinopsis lorentzii) and white quebracho (Aspidosperma quebracho-blanco), which can reach a height of 20 m (Morello and Adamoli, 1974). The subtropical warm continental climate hosts the South American heat pole, understood as the territory where absolute maximums exceed 47 ° C (Prohaska, 1959). The average precipitations are distributed in a gradient ranging from 500 to 600 mm and from the PP / EVT ratio, every month of the year there is a soil moisture deficit (Morello et al., 2009).

During the last two centuries, the Gran Chaco ecoregion has been subjected of an accelerated process of land-use change and replacement of natural ecosystems with productive human activities such as cattle raising, intensive agriculture and selective logging (Eva et al., 2004; Morello et al., 2006; Carranza et al., 2015). This phenomenon is more intense in the Argentine Chaco, which has been highly degraded (Brassiolo and Grulke, 2008), and where populations may begin to disappear or become less abundant since optimal habitats for large and medium-sized native mammals have been altered or destroyed (Ojeda et al., 2008; Giraudo 2009; Quiroga et al., 2014). 52% of large and medium-sized mammalian species native to Argentina are considered to be vulnerable, near threatened or endangered (Ojeda, 2012).
Fig. 1 Study area with black dots indicating the presence sites of quimilero. The colored polygons indicate the different complexes of the Dry Chaco ecoregion in Argentina (Mateucci et al. 2012).

SAMPLING TECHNIQUES

The geographical data of quimilero presence was generated from the compendium of thirteen years of field campaigns, started in 2006 to the present, totaling 65 incursions to the different protected areas and other natural environments of the territory of Santiago del Estero, to generate biodiversity inventories and baselines of protected areas and zones of the territorial ordering of the National Law of Native Forests N° 26.331. We chose to work only with field data generated in our samples to reduce possible biases of secondary information from collections or museums (Anderson and Martínez-Meyer, 2004).

The methodologies used in the data collection were 1) linear transects of variable length from 2 to 8 km (Stephens et al., 2006) with a distance between them not less than 2 km. A total of 500 km were covered; 2) Interviews with rural inhabitants through inquests of semi-structured format (Giraudo et al., 1998; Bolkovic, 1999), selecting only those of high reliability from the comparison with field guides (Canevari and Vaccaro, 2007) and photographic material, discerning between photographs of different peccaries (Rabinowitz, 1997); 3) Hunting events of the quimilero detected by chance, in which permission was requested to the settler to generate photographic records and concession for possession of the specimen rests (Fig. 2b). Also, the hunter was accompanied to the point where the capture of the peccary occurred to take note of the geographical coordinates; 4) trap camera records, located by standard procedures (Trolle and Kéry, 2003), in slightly disturbed native forest environments (Fig. 2a). In all cases, duplicate presence records or with distances less than 5 km were eliminated to reduce spatial autocorrelation (Brown, 2014).
GENERATION OF BINARY PREDICTION MAPS

In the present analysis, 23 environmental variables were used as predictors. The 19 bioclimatic variables of Worldclim for current conditions were considered (~1960-1990) (Hijmans et al., 2005), with a spatial resolution of 30 arcseconds corresponding to zones 33 and 43, being mosaics of 30 x 30 degrees. The slope topographic variable was generated from the altitude layer (Worldclim 1.4) by using the Qgis software version 2.18.15 (QGIS Development Team, 2016). A categorical variable was incorporated referring to the type of land cover, which has 20 different types of land uses (Tateishi et al., 2014) and a buffer distance variable generated from a vector layer of settlements of local population (IGN, 2019).

The modeling was carried out in two successive stages, the first for the determination of the most important variables, and the final one for the selection of the binary map corresponding to the highest AUC (area under the curve). In both stages a cross-validation process was carried out (Stockwell, 1992) with a balanced sampling, dividing the data into 5-fold of equal size, performing 5 runs of a divided sample, randomly separating 25% of training data for testing.

For binary outputs two thresholds were established, "maximum training sensitivity plus specificity" in maxent and "prevalence" for GLM and RF. The highly correlated covariables were discarded, and for the case of Maxent, the jackknife test was used to select those that would produce in their absence a greater decrease in training gain and a greater increase acting individually. For GLM the absolute value of the t statistic was used for each parameter of the model. In the case of Random Forest, the importance was calculated from the permutation of the OOB data: for each tree, the prediction error is recorded in the part of the output information (error rate for the classification, MSE for the regression). Then, the same is done after permutation of each prediction variable. The difference between the two is averaged across all the trees and is normalized by the standard deviation of the differences. In this way, we obtained the variables for the final models of each algorithm. For GLM and RF the 'dismo' (Hijmans et al. 2017), 'randomForest' (Breiman and Cutler 2018) and the 'raster' (Hijmans et al. 2018) packages of the R program were used.

GRAPH BUILDING

A consensus model was generated from the distribution maps of the three algorithms considered (Thuillier, 2003) (GLM, RF, Maxent), by using the "Fuzzy intersection" geoalgorithm and the "min (a, b) non-interactive" SAGA interface operator. The vectorization of this model allowed to obtain the quimilero's habitat patches. To characterize the attribute of each patch of habitat a combination of quality-weighted habitat area (Minor and Urban, 2007) and the probability of occurrence derived from the SDM´s was used (Pascual-Hortal and Saura, 2008).
For the first, a supervised classification of a Terra Modis 2017 satellite scene of 250 m of spatial resolution was carried out, obtaining a thematic map with types of environmental coverage to which different weighting values were assigned, with forest ecosystems being relatively the most important. These classification values were multiplied by the area of each patch, thus configuring the final value of $a_i$ according to Saura and Rubio (2010). Based on the work of Taber et al. (1994), we chose a home range of 300 hectares to filter the number of habitat patches considering the spatial requirements of the quimilero.

From the average dispersion distance of 2.2 km obtained by radiotelemetry in the study by Taber et al. (1993) and due to the lack of information regarding dispersion distances in hostile environments, we selected a probability of 0.5 for a hypothetical distance of 1 km following the procedure of Rivas et al. (2017). The patches of habitat ranked according to the PC index were compared with the complexes of the Dry Chaco ecoregion (Matteucci et al. 2012).

CHOROPLETH MAPS

We classify the data set of the PC index into three class intervals, "quantile", "natural breaks" and "equal interval" to obtain choropleths maps (Coulson, 1987), with 10 number or classes each one, that allow us evaluate the variation in the number of patches and surfaces identified with the greatest potential contribution to the connectivity of the quimilero populations. For this purpose the basic display options of the Qgis software were used.

3 RESULTS

After 13 years of sampling and survey field campaigns, has been confirmed the presence of quimilero in 25 opportunities. 2 were camera traps (Fig. 2), 5 people hunting events and 18 through indirect signs such as footprints and cactus browsing in transects on foot.
SDM COMPARISON

Three final models were obtained, which together have an average AUC value of 0.74. Both algorithms, Maxent and GLM, produced consistent predictions that were better than random ones, while RF did not (Table 1). The maxent model has the highest geographic precision in the determination of sites with real and potential presence of the species (Fig. 3c) while presenting the lowest percentage of overestimation in sites of confirmed absence. The GLM model overestimates the presence of the quimilero (Fig. 3a), showing distribution in ecoregions such as Espinal, Yungas and even Puna, for which there are no paleontological or historical records of the species (Gasparini et al., 2013). On the other hand, RF shows precision in confining the presence to the Chaco Seco ecoregion (Fig. 3b), while underestimating the latitudinal distribution, limiting it to approximately

Fig. 2 Quimilero recorded by camera trap (A) and fur derived from a poaching event (B).
28 ° S, which would exclude own records for the Sierras de Sumampa and Ambargasta protected area and new records for the Salinas Grandes complexe (Torres et al., 2017).

Table 1 Comparison of the statistical values AUC and Standard deviation in the final models of the three algorithms used.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Threshold</th>
<th>AUC</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxent</td>
<td>maximum training sensitivity plus specificity</td>
<td>0.93</td>
<td>0.03</td>
</tr>
<tr>
<td>GLM</td>
<td>prevalence</td>
<td>0.73</td>
<td>0.30</td>
</tr>
<tr>
<td>Random Forest</td>
<td>prevalence</td>
<td>0.58</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Fig. 3 Potential distribution models of the quimilero from three algorithms. a. GLM, b. RF c. Maxent. Gray pixels indicate potential presence of the species.
The territorial occupation of the consensus model obtained from the three algorithms considered occupied a total of 55,674 km$^2$ in Argentina, which represents approximately 10% of the Argentina portion of the Dry Chaco (Fig. 5). This percentage would be in accordance with the analyzes of Altrichter and Boaglio (2004) and Periago et al., (2015), which stipulate a remarkable reduction in the distribution area of the species.

Fig. 4 surface occupied by the SDM consensus in each complex of the Dry Chaco ecoregion.
As can be seen from Fig. 4, the distribution of quimilero not only occupies forest ecosystems with a higher arboreal stratum as “Bosques y Arbustales del Centro” complexe but also environments with less arboreal coverage as “Llanos y Valles Interserranos” complexe. Even so, there may be an overestimation regarding the high surface area occupied at Salinas Grandes complexe, ecosystem that throughout large sectors would be devoid of minimum conditions for the subsistence of the species.

Fig. 5 Choropleth maps representing the importance variation of habitat patches for landscape connectivity, from three methods of classifying PC index values in class intervals, a. quantile; b. equal interval; c natural breaks (Jenks).
The “quantile” classification method of the PC index (Fig. 5a), shows the most uniform distribution with the greatest geographic extension of habitat patch assessments for the most relevant classes for connectivity (classes 9 and 10). The classification methods “equal interval” and “natural breaks” (Fig. 5b and 5c) show greater geographical concordance in the ranking of importance of habitat patches. They exhibit a markedly bipolar spatial pattern with two regions of greater relevance located north and south of the study area. One of them is in the center of the Chaco ecoregion (Northern Argentina, western Paraguay, and Southeast Bolivia). The other is at the southwest end of the Dry Chaco in Argentina (Provinces of Santiago del Estero, Catamarca, Córdoba, and La Rioja). Between 24 ° and 27 ° south latitude, these two methods show a decrease in the class intervals assigned to habitat patches ranging between classes 1 and 5. In specific sectors, this would differ with the location of certain national and provincial protected areas such as the Copo Conservation Unit (Copo National Park, Copo Provincial Park, and Copo Multiple Use Reserve), which are priority for biodiversity conservation and landscape connectivity (Perovic et al., 2008; Quiroga, 2013; Nori et al., 2016).
Table 2: Variation in the importance of the number of patches and connectivity surfaces of the landscape from three classification methods of PC index.

<table>
<thead>
<tr>
<th>Classification method</th>
<th>Number of patches</th>
<th>Partial areas (Km$^2$)</th>
<th>Total area (Km$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>class 9</td>
<td>class 10</td>
<td>class 9 area</td>
</tr>
<tr>
<td>quantile</td>
<td>185</td>
<td>185</td>
<td>2.802</td>
</tr>
<tr>
<td>natural breaks</td>
<td>2</td>
<td>1</td>
<td>22.303</td>
</tr>
<tr>
<td>equal interval</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>coefficient of variation (CV %)</td>
<td>170</td>
<td>170</td>
<td>145</td>
</tr>
</tbody>
</table>

Of the total habitat patches identified in the study area (N= 1.847; SD: 1.65), the "quantile" classification method was the one that identified the largest number of habitats most relevant for landscape connectivity (Table 2). On the other hand, "equal interval" and "natural breaks" only identified 3 and 1 patch of the maximum classes respectively, showing a great variation between classification methods. Besides, these two methods highlight those patches with greater surface area, masking the relative contribution to the connectivity of smaller patches.

4 DISCUSSION

POTENTIAL DISTRIBUTION

The ecoregion of the dry Chaco is not stranger to a global environmental problem such as the defaunation process (Giraudo, 2009; Ojeda et al., 2002; Ojeda et al., 2008; Periago et al., 2015). The accelerated transformation of their ecosystems by intensive productive systems, such as technified agriculture and livestock, has led to a process of fragmentation, reduction of habitats and loss of connectivity (Morello and Rodriguez, 2009). Also, the poaching (Altrichter, 2005; Altrichter, 2006) and introduction of exotic species (Ceballos and Simonetti, 2002) cause that approximately 70% of the species of medium and large mammals be in population decline, of which 32% are considered endangered, vulnerable or near threatened. One of these species is the quimilero, which suffers a decrease in the population density and shrinkage in the dispersion due to the fragmentation and loss of dry Chaco habitat (Taber et al., 1993; Camino, 2016). Many studies have shown that the optimum of ecological conditions for quimilero is the aridity and heat conditions of the dry Chaco (Sowls, 1984; Taber et al., 1993; Camino, 2016). The potential consensus distribution model generated in the present study is in general agreement with the SDM obtained by other authors (Torres and Jayat, 2010; Altrichter et al., 2016; Gasparini et al., 2013). Even so, there are specific differences in some sectors. The binary output of the SDM generated by Altrichter et al., (2016) postulates a continuous distribution surface along the Chaco ecoregion in a similar way to the model with cut-off threshold II of Torres and Jayat (2010). On the contrary, our model shows a fragmented distribution in patches of different sizes following a design similar to that of metapopulations, more
like to that shown by the threshold of cut I in Torres and Jayat (2010). We consider that this fragmentation in the distribution of quimilero populations suggests a concordance with the process of land-use change and deforestation of the dry Chaco. When comparing the three algorithms used, we estimate that the model that displays the best performance in ecological terms was maxent, predicting the potential presence of quimilero in latitudes where it was recently found by other researchers (Torres et al., 2017).

IMPORTANCE OF HABITATs FOR CONNECTIVITY

While the literature is extensive about the comparison of the three components of the PC index, dPCintra, dPCflux, and dPCconnector (Saura and Rubio, 2010), which provide valuable information separately, we find that PC can also provide variability on its own for connectivity analysis depending on the method of classifying data in class intervals used. Our results show a significant variation in the identification of habitats patches importance for the general connectivity of the landscape through the PC index (Pascual-Hortal and Saura, 2006), based on the method of classifying data in class intervals (Robinson, 1985; Wonka, 1980). While the potential to generate multiple maps from one data set has long been known (Coulson, 1987), this aspect was not considered in previous studies of this particular field (Jenks and Coulson, 1963). We detected variations of approximately 33% in the total surface of classes 9 and 10, and a maximum amplitude of 185 in the patch numbers of the same class among classification methods (Table 2). If we consider the total classes, the method that detects the highest variability among them is natural breaks, while the quantile was the one that identified the highest relative proportion of priority sites for connectivity. Due to the population status of the quimilero and the degradation of the forest ecosystems that still house them, the quantile method would be the most appropriate to identify priority conservation sites for the species, since it has less relative influence on the surface size of the patches. Considering that the use of this type of model has a wide application in planning and conservation efforts, we suggest that this aspect needs to be considered more frequently in environmental management tasks.

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DATA AVAILABILITY STATEMENT
The datasets analysed during the current study are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS
Federico Rivas and Miguel Brassiolo, conceived the ideas; Federico Rivas conducted the fieldwork, collected and analysed the data; Federico Rivas led the writing with assistance from Miguel Brassiolo and Ivan Crespo Silva. All authors read and approved the final manuscript.
REFERENCES


Nori J, Torres R, Lescano JN, Cordier JM, Periago ME, Baldo D (2016) Protected areas and spatial conservation priorities for endemic vertebrates of the Gran Chaco, one of the most threatened ecoregions of the world. Diversity and Distributions, 22(12), 1212-1219.


Quiroga VA (2013) Ecología y conservación del yaguareté (Panthera onca) y el puma (Puma concolor) en el Chaco semiárido argentino: su relación con la disponibilidad de presas y la presencia humana en la región. Mastozoología Neotropical, 20(2).


Rusconi C (1930) Las especies fósiles argentinas de pecaríes ("Tayassuidae") y sus relaciones con las del Brasil y Norte América. Coni.

Saura S, Rubio L (2010) A common currency for the different ways in which patches and links can contribute to habitat availability and connectivity in the landscape. Ecography, 33(3), 523-537.


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