Title: Assessing the drivers of connectivity declines for jaguars in the Atlantic Forest

Landscape ecology

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Supplementary information

S.1. Satellite imagery for UPAF15

To construct the land cover map for the Upper Paraná Atlantic Forest for the year 2015 we used 16 Landsat 8 images to cover the study area (Table S1). We searched for images with a minimum percentage of clouds and in the same season of the year to avoid possible errors in the classification, focusing on the autumn months of 2015. The georeferencing of the images downloaded from the USGS site is sufficient for the work (error of approximately one pixel), so geometric correction was not necessary. We performed a pre-processing of the images using ArcGIS 10.5 that included the transformation of the digital number values into reflectance values at the top of the atmosphere, the transformation to the UTM 21 South coordinate system and the subsequent cropping of the images of the edge areas by the study area.

Table S.1. Landsat 8 scenes were selected to generate the land cover/land use map of the Upper Paraná Atlantic Forest region for the most recent analyzed period (UPAF15).

ID	Row	Path	Date
1	223	75	11/05/14
2	223	76	12/04/15
3	223	77	11/05/14
4	223	78	12/04/15
5	223	79	28/04/15
6	224	75	05/05/15
7	224	76	18/05/15
8	224	77	05/05/15
9	224	78	05/05/15
10	224	79	05/05/15
11	225	76	26/04/15
12	225	77	26/04/15
13	225	78	26/04/15
14	226	76	07/08/15

S.2. Image classification for the land-cover map UPAF15

We performed a supervised classification of the images using the maximum likelihood method, the same method used by De Angelo (2009). We used the map descriptions of Izquierdo et al. (2008) and De Angelo (2009) as a reference for the recognition of the spectral reflectance of different land-use types to sample for classification. Each image was analysed separately so that radiometric corrections were not necessary (Song et al. 2001). We used the segmentation method for sampling using the Segment Mean Shift tool in ArcGIS Pro. This method allows grouping similar areas in the image, i.e. it generalises the area to keep all entities as a larger continuous area, rather than keeping them as a more traditional classification that can generate many random pixels scattered throughout the image (Comaniciu and Meer 2002). After segmentation, in each image, we sampled segments of the different land-use classes with which the classification model was developed. We first subdivided the classes for preliminary classification

(Izquierdo et al. 2008) and then combined the subclasses for post-classification processing (Table S2).

Table S.2. Classes and subclasses used for classification based on the work of Izquierdo et al. (2008) and De Angelo (2009).

Class	Subclass	Description
Forest	- Lowland forest or natural wetlands -Slope forest -Upland forest	Different woodland area types can be differentiated in the images. Low areas of natural vegetation, flooded areas and riparian forest were also included as "forest".
Forest plantations		Pine (*Pinus spp*.), eucalyptus (*Eucalyptus sp*.) and araucaria (*Araucaria angustifolia*) forest plantations. Forest plantations of different ages were sampled, but very young forest plantations and areas deforested for planting were not sampled in this class so some of these areas were classified as "bare soil".
Large-scale agriculture	-Annual crops -Perennial crops -Bare soil	Homogeneous crop areas with an area larger than 10 ha. Samples are included in areas with completely bare soil, annual crops (soybean, wheat, maize, etc.) and perennial crops (yerba mate, tea, etc.) recognisable at this scale.
Small-scale agriculture		Corresponds to areas where, in a small area (less than 10 ha), no predominant activity is recognised. It varies throughout the region but, in general, they are areas of small-scale agriculture or livestock farming, and may include small forestry plantations, small portions of native forest, peri-urban areas, among others.
Grasslands and fields	-Grasslands -Fields	Homogeneous areas of grassland and "natural fields" were considered in these categories.
Water bodies		Lotic and lentic water bodies
Urban areas		The central area of cities and towns

Once the classification was done, we constructed a mosaic of all the images using ArcGIS 10.5. As post-classification corrections, we used the Sieve and Clump functions of QGIS 3, to remove loose pixels and correct areas without information. Finally, we transformed the mosaic to a resolution of 330 x 330 m per pixel, the same used by De Angelo (2009) and completed the post-processing according to that analysis from which the cover information for the previous periods was generated.

Due to the extent of the study area and the resolution used, it was not possible to validate the classifications generated with field data. Therefore, the classifications were evaluated at different levels. First, each image was evaluated during the supervised classification process, which allows corrections to be made based on a trial-and-error process between the samples taken in the image and the resulting classification (Huang et al. 2007). For this purpose, previous knowledge of some portions of the study area and works carried out at different scales and at different times of the year were used as references (De Angelo 2009; Di Bitetti et al. 2003; Guerrero Borges 2004; Huang et al. 2007; Izquierdo et al. 2008; Matteucci et al. 2004; Ribeiro et al. 2009). Additionally, classification accuracy was assessed based on sampling points using the stratified random method (Olofsson et al. 2013). Error estimation is calculated by constructing an error matrix (Card 1982), which allows the classification model to be evaluated by counting the number of hits and misses for each of the classes that the model classifies.

For this procedure, a total of 329,853 samples were taken, with an average classification accuracy of 79.9%.

S.3. Cost surfaces

Table S. 3. Friction values expressed in cost units used for the Water, Cities and Routes land-cover classes in the five friction surfaces generated for the analysis (CS1-CS5). These cost surfaces were used to calculate the effective distance between the forest nodes. R' is a specific friction surface based on jaguar habitat suitability models, where R'=1- "habitat model".

Use/cover	**CS1 (ECA)**	**CS2 (ECA_{matrix})**	**CS3 (ECA_{matrix})**	**CS4 (ECA_{matrix})**	**CS5 (ECA_{matrix})**
Water	1000	1000	1000	1000	1000
Cities	1	2000	2360	2525	3182
Routes	1	1000	1180	1263	1590
Other land covers	1	R´ 1973	R´ 1988	R´ 2004	R´ 2015

S.4. Dispersal distances

Table S. 4. Median dispersal distances for the jaguar in the UPAF, which were estimated in cost units for the two scenarios: CS1 representing the distance without considering the composition of the matrix between nodes, and CS4 representing the effective distance considering the composition of the matrix in 2004 (the closest period to the jaguar dispersal data obtained). Data obtained from Haag et al. (2010), Crawshaw Jr. (1995), including genetic and telemetry data, respectively, and from Yaguareté Project camera-trap records obtained between 2004 and 2014 (A. Paviolo, unpublished).

Individual	**Authors**	**Year**	**Distance between centroids (cost units in the CS1)**	**Distance between centroids (cost units in the CS4)**
bPond21	Haag *et al.* 2010	1998	292.898	8.702.878
bPond35	Haag *et al.* 2010	2005	137.379	3.893.052
Sancho	A. Paviolo (unpublished)	2010	110.199	1.548.366
Guaçurarí		2008-2011	29.757	198.225
		2009-2011		
		2010-2011		
Mbareté		2006-2010	22.592	45.184
		2008-2010		
Mitaí		2006-2008	12.865	58.630
		2006-2010		
		2006-2014		
Taarombí		2010-2014	56.719	39.2875
Cría Salada		2011-2014	19.868	79.352
Guasú		2010-2014	22.089	53.616
Aratirí		2010-2014	46.209	30.8277
M13	Crawshaw Jr. 1995	1991-1992	47.269	75.6684
M32	Crawshaw Jr. 1995	1992-1994	63.676	1.140.303
		Median distance	**46.737**	**350.575**

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