Regional and Local Connectivity for Jaguars in the Atlantic Forest

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The Jaguar

- The biggest living felid of the American Continent
- It was the largest predator in most of the terrestrial ecosystems of this Continent
- It plays/played a unique role as a keystone species
Jaguar Conservation

- Jaguar Conservation Units (JCUs)
- Least Cost Corridors among JCUs

Sanderson et al (2002); Rabinowitz & Zeller (2010)
The Atlantic Forest of South America

- The Atlantic Forest is a Biodiversity Hotspot

(Olson et al. 2001)
The Atlantic Forest of South America

- The Atlantic Forest is a Biodiversity Hotspot
- One of the most endangered environments of the world

Myers et al. (2000); Mittermeier et al. (2004)
Jaguar Conservation

- Jaguar Conservation Units (JCUs)
- Least Cost Corridors among JCUs

Sanderson et al (2002); Rabinowitz & Zeller (2010)
Atlantic Rainforest’s Jaguars in Decline

IN HER NEWS FOCUS STORY “PREDATORS IN THE "hood" (20 September, p. 1332), V. Morell reported that top predator populations are coming back across much of North America. Meanwhile, predators in Brazil continue to decline. A recent meeting of wildlife experts indicated that the Atlantic rainforest that once stretched along the coast of Brazil and parts of Argentina and Paraguay may soon be the first tropical biome to lose its largest top predator, the jaguar (Panthera onca). Researchers estimated fewer than 250 mature jaguars alive in the entire biome, distributed in eight isolated populations (4). Even worse, molecular analyses demonstrate that local effective population size (a critical parameter for the maintenance of genetic diversity) is below 50 animals (2).

Jaguars are persecuted for their potential impact on livestock, and their prey have been overhunted even in large protected areas (3). Jaguars provide a crucial service in controlling herbivores (capybaras, deer, and peccaries) and smaller predators (pumas, ocelots, foxes, and raccoons), and their overall extinction will likely disrupt predator-prey interactions with unpredictable effects on ecosystem function (4). The Atlantic rainforest is a highly fragmented biodiversity hotspot, with less than 12% of the original area left (5). Although 24% of the remaining areas are large enough to support jaguars, jaguar populations can be found in only 7% of the rainforest (4).

Population supplementation and reintroduction programs may provide new hope for jaguars, but uncontrolled hunting of jaguars and their prey is still widespread in most protected areas, threatening the persistence of this important top predator. In the absence of effective protection and management, the fate of the largest predator of the Atlantic forests is bleak.

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References
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The Jaguar in the Atlantic Forest

- International effort to re-define the AF JCU's
  - Presence data
  - Habitat modeling
  - Camera-trap surveys
  - Management priorities

Paviolo et al. (under review)
Objectives

1) To assess the potential connectivity remaining among the populations and subpopulations of jaguars in the Atlantic Forest

Importance, potentiality and priority of connectivity for the JCU's of the AF.
Methods (1)

- We created a resistance to movement surface, which was calculated as an inverse function of the habitat suitability model.

Mateo-Sánchez et al. (2013); Paviolo et al. (under review)
Methods (1)

- We created a resistance to movement surface, which was calculated as an inverse function of the habitat suitability model.
- We developed a least-cost connectivity analysis to evaluate potential corridors among jaguar subpopulations:
  - Linkage Mapper 0.9
  - Corridor and Least-Cost Path tools of Spatial Analyst in ArcGIS 10.3

Mateo-Sánchez et al. (2013); Rabinowitz & Zeller (2010); www.circuitscape.org/linkagemapper
Results (1)
### Results (1)

<table>
<thead>
<tr>
<th>JCU or PJCU</th>
<th>Sum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campo do Jordão</td>
<td>433,551,503</td>
<td>1,004,266</td>
</tr>
<tr>
<td>Green Corridor</td>
<td>465,154,622</td>
<td>3,807,388</td>
</tr>
<tr>
<td>Itaipu</td>
<td>492,002,033</td>
<td>444,225</td>
</tr>
<tr>
<td>Itatiaia</td>
<td>422,579,703</td>
<td>1,004,266</td>
</tr>
<tr>
<td>Mbaracayú - Morombí</td>
<td>512,286,012</td>
<td>444,225</td>
</tr>
<tr>
<td>Rio Doce</td>
<td>701,313,496</td>
<td>30,316,086</td>
</tr>
<tr>
<td>San Rafael</td>
<td>521,821,138</td>
<td>3,807,388</td>
</tr>
<tr>
<td>Serra do Mar</td>
<td>357,856,303</td>
<td>1,400,370</td>
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<tr>
<td>Serra do Mar North</td>
<td>352,983,175</td>
<td>1,400,370</td>
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<tr>
<td>Serra dos Orgaos</td>
<td>403,448,630</td>
<td>3,591,407</td>
</tr>
<tr>
<td>Upper Parana - Paranapanema</td>
<td>485,750,191</td>
<td>1,601,440</td>
</tr>
<tr>
<td>Linhares - Sooretama</td>
<td>770,924,174</td>
<td>30,316,086</td>
</tr>
</tbody>
</table>
Jaguar Action Plan for the Green Corridor “The Conservation Landscape”

- Approved in 2011 it has specific recommendation for the **main corridors** between the core areas
Forest Protection Law

- Law implemented at a property level in the Green Corridor
Objectives

1) To assess the potential connectivity among the populations and subpopulations of jaguars in the Atlantic Forest

2) To analyze the connectivity among the core areas of the largest JCUs of the AF.

To apply these results in management recommendations at the scale used by the managers.
Methods (2)

- We used graph-based models and Conefor 2.6 to determine the relative importance of the remaining forest patches in these areas for maintaining habitat connectivity.

Conefor
Quantifying the importance of habitat patches and links for landscape connectivity

Methods (2)

- Node definition
Methods (2)

- Link definition (least-cost paths) and model parameters (indirect movement probability)
- Data from three female jaguars
Results (2)

Probability of Connectivity Indexes: $d_{PC}$, $BC(PC)$ & $d_{PC}\text{connector}$

Matínez Pardo et al. (in prep.)
Results (2)

- Combination of the connectivity indexes
- Selection of the most important patches according the different indexes

Matínez Pardo et al. (in prep.)
Results

Matínez Pardo et al. (in prep.)
Conclusions

- Different connectivity analysis tools offered specific solutions for jaguar conservation in the Atlantic Forest.

- Least-cost corridors served as a practical tool for identifying the most isolated subpopulations at a regional scale.

- Graph-based models were important for finding specific forest patches where local actions will have a huge impact for preserving jaguars in the main subpopulations.
¡Muchas gracias!
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