SANDRA M. C. CAVALCANTI[1], FERNANDO C. C. DE AZEVEDO[1,2], WALFRIDO M. TOMÁS[3], RICARDO L. P. BOULHOSA[1], PETER G. CRAWSHAW JR.[4]

The status of the jaguar in the Pantanal

The Pantanal is considered an important area for the conservation of jaguars *Panthera onca* in the long-term. In comparison to other biomes in Brazil, the Pantanal can be considered still relatively well preserved. According to a recent study, the original vegetation cover remains intact in 85% of the Pantanal plain. However, in the uplands of the Upper Paraguay watershed over 50% of the original vegetation has been altered. This situation is worrisome as this area harbors the headwaters of the rivers that are responsible for maintaining the wet and dry cycles of the Pantanal. As opposed to previously reported, only about 63% of the Pantanal biome is actually occupied by jaguars. Habitat fragmentation caused by human presence and intensification of land use is a threat to jaguars in the Pantanal. Other threats include high levels of retaliation from ranchers due to livestock depredation and the lack of enforcement by wildlife authorities, illegal hunting tourism activity, pasture management through the use of annual fires, and the mining industry. The first estimate of a jaguar population in Brazil was conducted in the southern Pantanal (6.5-7.0 jaguars/km^2), although the distribution of the species is heterogeneous, which precludes an accurate estimation of the current population size in this biome. Authorities should recognize the cost associated with grazing cattle in an area where jaguars exist in considerable numbers and regularly prey on cattle. A unique regional policy could address some of the problem, perhaps in the form of tax benefits, special lines of credit, or a regional increase in beef prices. It is important that environmental actions be implemented to increase market value of cattle raised in the region without changing the main characteristics of the Pantanal.

Assessment

Near Threatened – Due to loss of habitat, increased human presence and intensification of land use, as well as poaching of jaguars, this species is considered to be Near Threatened in the Pantanal biome.

Geographic range information

Extent of Occurrence EOO and Area of Occupancy AOO

The Brazilian Pantanal biome encompasses about 140,000 km^2. Results from the range-wide assessment developed by the Wildlife Conservation Society (WCS) in 1999 suggest that 91-100 % of the biome is occupied by jaguars (Sanderson et al. 2002, Marieb 2005). Their extent of occurrence encompasses about 125,000 km^2 (S. Cavalcanti, map adapted from a MMA Pantanal map and results from the Pantanal Landscape Species Workshop, organized by WCS in Corumbá, 2003).

An exercise by Brazilian researchers working in the Pantanal (Pantanal Landscape Species Workshop, 2003) suggests that only about 63 % or 88,200 km^2 of the Pantanal biome is actually occupied by jaguars (Fig. 1). The area of occupancy exclude most of the Taquari Alluvial Fan, parts of the Cáceres sub-region, portions of the Nabileque sub-region (south of Corumbá), and areas in the north-eastern and eastern border of the Pantanal.

Fragmentation

In general, and in comparison to other biomes in Brazil, the Pantanal can be considered still relatively well preserved (Fig. 2). The inaccessibility of much of its area restricts agricultural practices and deforestation on the plains (Fig. 3). Beef cattle ranching on the savannas with flooding native pastures is relatively less destructive of the environment than large scale agricultural fields.

Less than 20 years ago, the deforestation in the Pantanal was quantified as 5,438 km^2 or 3.9% of the Pantanal area (Silva et al. 1992). In 1993 Mourão et al. (2000) observed that much of the upland areas originally covered by forests or savanna woodlands had been cleared and replaced by pastures. Deforestation areas corresponded to 9,490 km^2 or 6.8% of the Pantanal. In 2000 Padovani et al. (2004) quantified the deforested area as 12,182 km^2 or almost 9% of the total Pantanal area.

According to Mourão et al. (2000), deforestation for pastures has started to spread from the east to the Taquari Alluvial Fan (Nhecolândia and Paiaguás sub regions) and along the courses of the Aquidauana and Miranda rivers. The spread of man-made pastures has been especially intense in the Cáceres sub region (area of Corixo Grande) and in the Taquari river watershed, mainly near the city of Coxim.

The most current information on the status of the vegetation cover in the Pantanal reveals that in the last 9 years (2001-2009) deforestation has accounted for an additional 6% of the area of the Pantanal. The data derives from a recent ongoing survey initiated in the middle of 2008 and carried out by 5 Non-Governmental Organizations (WWF-Brazil, SOS Mata Atlântica, Conservation International, Avina, and Ecoa) with the support of researchers from EMBRAPA Pantanal. According to the study the original vegetation cover remains intact in 85% of the Pantanal plain. However, in the uplands of the Upper Paraguay watershed over 50% of the original vegetation has been altered. This situation is worrisome as this area, adjacent to the plain, harbors the headwaters of the rivers that are responsible for maintaining the wet and dry cycles of the Pantanal (Harris et al. 2005).

In addition to deforestation and fires, human presence causes habitat fragmentation. Over the past several decades, ranches in the Pantanal have decreased in size as land has been subdivided among family members. This division has increased access to areas that were formerly remote and had little movement of vehicles and people. This trend is likely to continue, or even intensify, thereby increas-

Fig. 1. Extent of Occurrence EOO and Area of Occupancy AOO for the jaguar in the Brazilian Pantanal.

Fig. 2. Aerial photograph of a ranch in the northern Pantanal, in the district of Poconé, Mato Grosso, Brazil (Photo S. Cavalcanti).

ing access to prime jaguar habitat. This fragmentation of land decreases its profitability; to maintain economically viable operations, many ranchers opt to increase herd size. This intensification in grazing pressure increases the need for open pastures and introduced grasses which further modifies native habitats.

Ecology and population information

Population size

The few formal attempts to describe jaguar occurrence in the Pantanal have indicated that the jaguar has a heterogeneous distribution in the region (Quigley & Crawshaw 1992). The lack of information for most of the different subtypes of the Pantanal precludes an accurate estimation of the current population size in this biome. It is believed however that the Pantanal still holds a large population of jaguars (Soisalo & Cavalcanti 2006).

In one of the pioneering studies of jaguars in the late 1970's, Crawshaw & Quigley (1991) estimated a population of 3.2 jaguars/100 km^2 in the southern Pantanal. The authors noted however, their data was only speculative. More recently Soisalo & Cavalcanti (2006) published the first estimate of a jaguar population in Brazil based on camera-trap data in conjunction with GPS radio-telemetry data. Their data indicate that in the southern Pantanal, jaguars occur at a density of 6.5-6.7 jaguars/100 km^2. These results are consistent with the estimate of 7.0 jaguars/100 km^2 Azevedo & Murray (2007) reported for the same general area.

Fig. 3. Aerial image of a ranch in the southern Pantanal during the wet season, showing the area's inaccessibility (Photo S. Cavalcanti).

Population trends

Over the past several years there has been increased speculation on the numbers of jaguars in the Pantanal. Ranch owners and cowboys claim that jaguar numbers have increased (Marchini 2003). The suggestion that jaguar numbers are increasing is controversial among government officials, environmentalists and livestock producers throughout the country. There is little evidence whether the presumed increase in jaguar/livestock conflicts are related to increased numbers of these carnivores, increased number of cattle, increased contact due to habitat fragmentation, or increased attention from the media.

Until recently this controversy could not be evaluated due to a lack of baseline data on population numbers. Information on jaguar populations in the Pantanal have been published in the last few years (Soisalo & Cavalcanti 2006, Azevedo & Murray 2007). Although the data from these two studies are consistent at 6.5-7.0 jaguars/100 km^2, it would be unreasonable to assume a stable trend as the studies cover a short period of time. In order to evaluate the trend of the jaguar population in the Pantanal additional estimates from subsequent time periods are needed.

Subpopulations

Within the Pantanal there are no significant barriers that could potentially hinder jaguar dispersal. However, there are regions that are significantly affected by factors such as human presence, density of roads and towns, etc. These areas may hamper jaguar movement to a degree, although it is unclear whether they would separate individuals into subpopulations. Jaguars could possibly be divided into 2 subpopulations (Fig. 4) which would be reasonably connected by the lowland corridor along the Paraguay River. The southern population would be separated from the northern population by the area to the southeast of Corumbá near Fazenda Bodoquena and its surroundings, which has been severely deforested, but probably does not keep jaguars from moving between the two areas.

Extreme fluctuations

Given the diversity of prey species characteristic of the Pantanal and the ability of jaguars to readily switch prey (Cavalcanti & Gese

2010), it is unlikely that jaguar populations undergo severe fluctuations in the biome. Nevertheless, this statement may depend on the time scale being considered. In the late 1970's, jaguars were almost extinct over most of the Pantanal (Schaller 1979) and presently they appear to exist in considerable numbers (Soisalo & Cavalcanti 2006, Azevedo & Murray 2007).

Other life history information

Jaguars are challenging to study. Nevertheless, our knowledge on jaguars has increased since the first field studies in the mid 1980's as several studies have helped uncover different aspects of their ecology and life history (Crawshaw et al. 2004, Novack et al. 2005, Polisar et al. 2003, Scognamillo et al. 2003, Cullen et al. 2005, Palmeira et al. 2008, Harmsen et al. 2009).

The reproductive profiles of female jaguars indicate a lack of an established mating season, i.e., asynchrony, suggesting they associate with males throughout the year (Cavalcanti & Gese 2009). The breeding pattern suggests successful mating taking place at roughly two-year intervals and offspring becoming independent at an approximate age of 18-24 months. Male offspring tend to disperse further than females (Quigley & Crawshaw 2002), thus being the key element in colonizing new areas and in linking subpopulations with dispersal movements.

Cavalcanti & Gese (2009) suggest that the mating system in jaguars may be one of a polygynous and promiscuous nature; a male likely mates with several females and a female mates with several males.

Soisalo & Cavalcanti (2006) found a male: female ratio of 1.5:1 and 1.2:1 during 2003 and 2004, respectively. In a different study area, Azevedo & Murray (2007) reported a male:female ratio of 0.6:1. This might represent different methodological approaches adopted by the two studies or the presence of transient males on the former studied population.

Although there is still a lack of consistent information on jaguar dispersal, jaguars have been reported to disperse over 60 km in the Atlantic Forest (Iguaçu National Park, Crawshaw et al. 2004) and 30 km in the Pantanal (Quigley & Crawshaw 2002, S. Cavalcanti, unpubl. data).

The locations of female jaguars suggest a pattern of spatial avoidance among females during the wet season. Home range overlap among males is extensive both in the wet and in the dry seasons, suggesting that males do not maintain exclusive ranges. Overlap between males and females occurred both in the wet and dry seasons (Cavalcanti & Gese 2009).

Threats

One of the main threats to jaguars in the biome comes from high levels of retaliation from ranchers due to livestock depredation. Historically, jaguars have been killed in the Pantanal as a way to curtail livestock depredation by the large cats (Crawshaw & Quigley 1991, Lourival & Fonseca 1997) even though the amount of damage incurred by jaguars may be less significant than that incurred by other sources of mortality (such as droughts, malnutrition and diseases; Hoogesteijn et al. 1993).

Jaguar persecution goes beyond the economic aspect as it has also a cultural aspect (Cavalcanti et al. 2010). Jaguar hunts are viewed as an act of bravery and dexterity among cowboys, a way to increase their personal status within the community (Banducci Jr. 2007), and therefore remains a common practice in the Pantanal (B. Rondom, pers. comm., V. Correia, pers. comm).

Another serious threat comes from the lucrative illegal hunting tourism activity involving national and international hunters (Almeida 1990, Azevedo & Murray 2007, B. Fiori, pers. comm.).

Although jaguars are fully protected at the national level across most of its range (IUCN 2009), cultural traditions in the Pantanal coupled with the characteristics of the area and the lack of enforcement by wildlife authorities contribute to the regular illegal shooting of these cats. The illegal nature of this hunting makes it difficult to quantify and monitor its effect on the population. The shooting of jaguars remains a regular activity even in areas where landowners have banned the practice.

Fig. 4. Possible jaguar subpopulations within the Pantanal biome.

Increasing deforestation for the implementation of pastures of native and exotic grasses for grazing cattle is another threat that likely disrupts jaguar movements and habitat use (Fig. 5). As previously mentioned, deforestation is more severe in the southeast and north-west borders of the plain.

Pasture management through the use of annual fires, although controversial, also im-

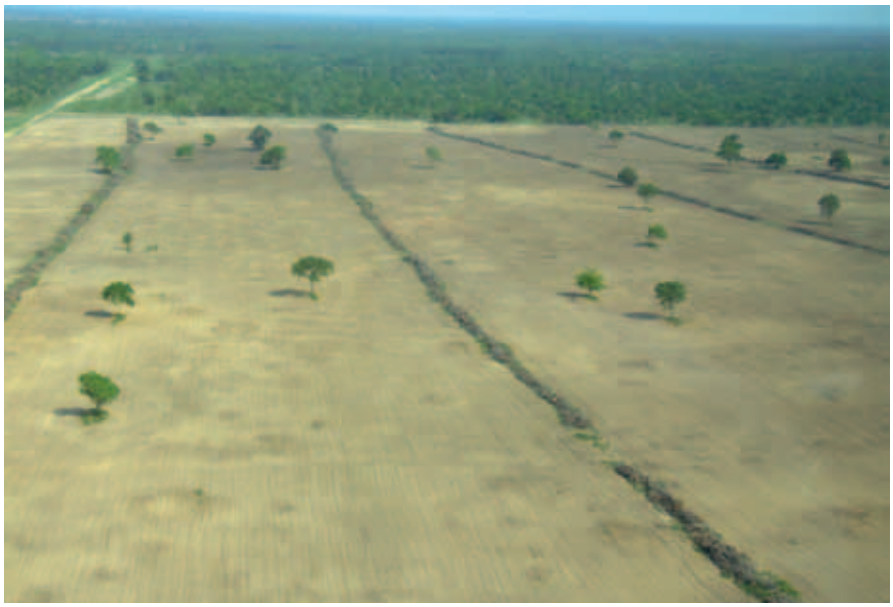

Fig. 5. Area in the southern Pantanal formerly covered by native trees deforested for the implementation of pastures for cattle grazing (Photo W. Tomas).

Fig. 6. Pasture management through the use of annual fires in the Pantanal (Photo S. Cavalcanti).

pacts important natural habitats and kills several prey species. It also probably changes jaguar density in some areas, by disrupting their movements and habitat use. These effects may be especially severe in dry years, when shrubs and trees are less resistant to fire (Fig. 6).

Charcoal production is a potential indirect threat for jaguars in that it may generate incentives for additional deforestation. Wood for charcoal production is usually obtained from sites that have been legally deforested for pasture implementation (Fig. 7). In that sense, it is a legal activity. However, given that wood selling for charcoal production enhances the economic viability of pasture implementation, it tends to be an incentive for the creation of additional pastures and consequent deforestation.

The mining industry is considered a great threat to the Pantanal environment and indirectly to jaguars, both in the north, where there is gold and diamond extraction, and in the south, where there is iron, manganese and limestone extraction (Fig. 8). The district of Poconé has presently fourteen large gold mines and two-hundred smaller excavation sites (PM Pocone 2010). This recent gold mining activity has created great environmental problems, including water and soil contamination with mercury, river sedimentation and changes in the banks of rivers and lakes.

Fig. 7. Furnaces for charcoal production installed in Pantanal ranches on areas that have been recently deforested. Not only they make pasture implementation economically more viable, but also help with the "cleaning" of recently cut areas (Photo W. Tomas).

Locations

The persecution of jaguars by ranch employees occurs throughout the Pantanal biome. It affects both male and female jaguars in all age classes as it is done both opportunistically and in a preventive manner, even before depredations occur. The practice of sport hunting is more localized, but because of its illegal nature, it is difficult to determine precisely where it happens and how much impact it poses to jaguars.

Increasing deforestation is most intensive near the borders of the Pantanal plain, but it happens throughout the biome as well. Considering the ongoing survey carried out by WWF-Brazil, SOS Mata Atlântica, Conservation International, Avina, and Ecoa, the current rate of deforestation in the Pantanal is about 0.67%/year or 6% over the last 9 years. Considering the total area of 140,000 km^2, the annual area being deforested in the plain is about 938 km^2/year, which is quite significant. Considering the non-overlapping home ranges of female jaguars, the total area deforested every year is almost the size of the area occupied by 20 jaguars. But this figure is likely an underestimate given that not all the 140,000 km^2 of the plain is covered by forests.

Another significant threat, the use of annual fires for management of pastures, happens throughout the biome and during drier years may affect even the lower areas of the Pantanal, where most of the jaguars are found. Charcoal production as a threat in the form of incentive for additional pasture implementation is particularly serious in the Miranda/Aquidauana regions, near the southern border of the plain.

Conservation measures

Authorities should recognize the cost associated with grazing cattle in an area where jaguars exist in considerable numbers (Soisalo & Cavalcanti 2006) and regularly prey on cattle. An unique regional policy could address some of the problem, perhaps in the form of tax benefits, special lines of credit, or a regional increase in beef prices. It is important that environmental actions be implemented to increase market value of cattle raised in the region without changing the main characteristics of the Pantanal. Certain

actions have already been tested or put into place, such as organic certified cattle ranching. With the objective of making business ventures economically viable while maintaining the region's environmental and social balance, local ranchers have participated in the organic certified cattle ranching (ABPO Organic Pantanal, http://assets.wwfbr.panda.org/downloads/organic pantanal.pdf, January 2010). Although the international protocols of meat production do not include actions for wildlife conservation, ABPO follows an internal protocol that establishes some environmental directives important from a conservation standpoint.

Embrapa Pantanal has been conducting a 7-year project with the main objective of establishing sustainability criteria/indicators that are specific for Pantanal ranches and include environmental issues. The focal point of the different criteria for ranch evaluation and decision making is biodiversity conservation. This could result in a certification or a stamp of approval program. The adoption of low impact production systems together with an added value to Pantanal meat products can be beneficial for jaguar conservation. This added value via a possible certification program could compensate, throughout the market system, the economic losses caused by jaguar depredation and the lower profitability from lower impact production systems. Embrapa Pantanal has been taking the necessary steps to increase the value of low impact systems, working with ABPO in the search for a strategy that could join both initiatives (organic cattle and sustainability). The institution also works toward a system that is applicable to other production systems, such as the traditional Pantanal ranches that are not part of the organic meat initiative.

Traditional ranchers should focus on increasing their production potential, curtailing losses due to rudimentary herd management and poor husbandry practices, which can be more significant than jaguar depredation (Hoogesteijn et al. 1993). Although predation on cattle in the Pantanal will likely always occur, the results from recent studies (Azevedo & Murray 2007, Cavalcanti & Gese 2010) illustrate the importance of maintaining native prey populations as a possible means of minimizing these conflicts.

The establishment of private reserves inside ranches is another important measure towards conservation of jaguars in the Pantanal. Private reserves act as a guarantee of maintenance of the original natural landscape without human modification. Benefiting from local and federal governments, local ranchers have converted part of their lands into private reserves, or RPPNs. Currently, more than 2,100 km^2 of land are set aside as private reserves in the Pantanal (Harris et al. 2005) and this figure is likely to increase. The recent purchase of large tracts of land by owners that are committed to conservation in the northern Pantanal has produced a mosaic of private ranches interspersed with state and federal parks to create an almost continuous corridor that adds up to roughly 300,000 km^2 encompassing the areas of SESC Pantanal, Mata do Bebe, Encontro das Águas and Guirá State Parks, Pantanal National Park, São Bento, Porto Jofre and Baía Vermelha Ranches, RPPNs Penha, Acurizal, Dorochê, Rumo a Oeste, and Novos Dourados. Such initiatives in strategic locations would definitely contribute to reduce the decline in jaguar distribution or population size.

Long-term ecological studies are also vital for the conservation of jaguars in the Pantanal. Some recent long-term studies have provided important information on jaguar's spatial organization, food habits, density estimates, genetics and predation impact on livestock in the Pantanal (Soisalo & Cavalcanti 2006, Azevedo & Murray 2007a, 2007b, Eizirik et al. 2008, Cavalcanti & Gese 2009, 2010). However, there is a lack of studies on demographic parameters such as age at first reproduction, litter size, age at dispersal, dispersal distances, population sizes, etc, human/predator conflicts and jaguar prey base availability which precludes implementation of management actions. This type of information can contribute to better management decisions that not only minimize cattle depredation by jaguars but that also contribute to increasing acceptance of jaguars by ranchers.

Fig. 8. Gold mining near the municipality of Poconé, in the state of Mato Grosso, Brazil (Photo R. Boulhosa).

Current research projects

1. *Jaguar Ecology in the Pantanal – The Northern Corridor*. Coordinator: Peter G. Crawshaw Jr. and Panthera. The objectives of the project include the foraging, spatial, and social ecology of jaguars, as well as examining demographic parameters of the studied population.

2. Indicators of Sustainability. Coordinator: Embrapa Pantanal – CPAP. This program encompasses 4 or 5 integrated projects, that have been developed since 2002 to implement a ranch evaluation/certification system for the Pantanal.

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[1] Instituto Pró-Carnívoros, Av. Horácio Neto, 1030, Atibaia, SP, 12945-010, Brazil
< scavalcanti@procarnivoros.org.br>

[2] Departamento de Ciências Naturais, Universidade Federal de São João del Rei, Praça Dom Helvécio, 74, Campus Dom Bosco, São João del Rei, MG, 36301-160, Brazil

[3] Centro de Pesquisa Agropecuária do Pantanal, Embrapa Pantanal, Rua 21 de Setembro, 1880, Corumbá, MS, 79320-900, Brazil

[4] ICMBio/Cenap, Av. dos Bandeirantes, s/n, Balneário Municipal, Atibaia, SP, 12941-680, Brazil