



## Original Research Article

# The numbers of the beast: Valuation of jaguar (*Panthera onca*) tourism and cattle depredation in the Brazilian Pantanal



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## ABSTRACT

Large carnivores fascinate people because of their beauty and potential as human predators and have therefore become focal species for the ecotourism industry. Wildlife tourism has grown exponentially and has often been used as a financial argument for species conservation. However, carnivores depredate livestock, leading to a direct economic conflict with rural livelihoods, often resulting in lethal retaliation action. Here we show that jaguar ecotourism represents a gross annual income of US\$6,827,392 in land-use revenue across a representative portion the Brazilian Pantanal, the world's largest wetland. Considering the aggregate costs of jaguar depredation on livestock within the same area, we estimate that the resident jaguar population would induce a hypothetical damage of only US\$121,500 per year in bovine cattle losses. This large discrepancy between economic gains and losses reinforces the importance of wildlife tourism as a conservation tool in boosting tolerance of jaguars in private ranches. We also evaluate the partnership between ecotourism and cattle ranchers, in which cattle losses induced by jaguars could be compensated by a system of voluntary donations from tourists, ensuring that both traditional livestock husbandry and ecotourism can co-exist within the same ranches, thereby promoting landscape-scale jaguar conservation.

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## 1. Introduction

Wildlife tourism is often extolled as a critical tool for species conservation (Tisdell, 2012; Gosling, 1999). This type of tourism is a rapidly growing economic activity, especially in emerging economies, where it can generate substantial revenues for rural entrepreneurs, local communities and local governments, which trickle down into the wider service industry (Gosling, 1999; Curtin and Kragh, 2014). However, this economic argument can only hold in public policy negotiations if local revenues generated by wildlife within a given area can be materialized, even if overall estimates of financial benefits are not completely accurate. Assessments of local income generated by wildlife ecotourism activities represent a far more persuasive argument for wildlife conservation compared to, for example, ethical or existential values (Chardonnet et al., 2002).

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Large cats represent some of the most charismatic species appealing to a wide audience, and are therefore of great value to wildlife tourism activities (Skibins et al., 2013). Consequently, traditional communities involved with ecotourism are typically more tolerant of large cats (Hemson et al., 2009). Lions (*Panthera leo*), leopards (*Panthera pardus*) and cheetahs (*Acinonyx jubatus*) are among the most sought-after species by national park visitors in South Africa (Lindsey et al., 2007). Direct contributions of ecotourism to the conservation of large cats in sub-saharan Africa include habitat expansion and restoration, anti-poaching enforcement and patrols, improved livestock husbandry, well-designed livestock compensation, and predator conservation incentive programs (Mossaz et al., 2015). Still, conservation outcomes effectively depend on several factors, including local community participation and appropriate local financial trickle-down (Mossaz et al., 2015). In India, wildlife tourism has grown by 15% annually (Bindra and Karanth, 2013) and the main reasons for visiting protected areas are opportunities to see nature in general, tigers (*Panthera tigris*), and scenic beauty (Karanth and DeFries, 2011; Karanth et al., 2012). In fact, there is an urgent need to establish and enforce regulations to manage ecotourists, resource use, and land-use change around Indian protected areas (Karanth and DeFries, 2011). In 2012, lack of control in tiger tourism resulted in India's Supreme Court temporarily banning tourism access to core areas of tiger reserves. However, this measure generated much criticism, such as increasing the risk of tigers being killed by poachers and reducing tourism revenue for park management (Buckley and Pabla, 2012). In South America, jaguar (*Panthera onca*) tourism is a relatively recent activity (<20 years) that occurs primarily in protected areas and private cattle ranches of the Brazilian Pantanal (Hoogesteijn et al., 2015; Tortato and Izzo, 2017) and a single protected area in Central Amazonia (Nassar et al., 2013). Jaguar tourism has become increasingly governed by state-level directives, including specific regulations in the Pantanal, but the lack of management plans in protected areas remains a barrier to the development of this industry (Tortato and Izzo, 2017).

Even though jaguar tourism is potentially a high profitable activity, local people still engage in the persecution and killing of large cats like jaguars and pumas. Killing is often induced by cultural factors that goes back several generations (Marchini and MacDonald, 2012; Treves and Bruskotter, 2014; Porfirio et al., 2016). However, the single most important driver of hunting and persecution of large cats is livestock depredation, resulting in economic losses to local ranchers and farmers, a conflict that generates retaliatory culls (Treves and Karanth, 2003), often through professional bounty hunters (Michalski et al., 2006). In fact, over 75% of all felid species worldwide are persecuted and killed because of their real or perceived threats to livestock (Inskip and Zimmermann, 2009). Assessing the potential or realized costs and benefits involved in large carnivore conservation is an intractable task to be integrated into land management (Dickman, 2010), but benefits accrued from tourism can clearly help compensate the costs of co-existing with large apex predators (Walpole and Leader-Williams, 2002). Therefore, ecotourism that singles out particular flagship species should enable the creation of conservation offset programs that compensate for losses for traditional ranchers, thereby providing financial support to mitigate human-wildlife conflicts (Hemson et al., 2009; Dickman, 2010; Hazzah et al., 2014; Bauer et al., 2017).

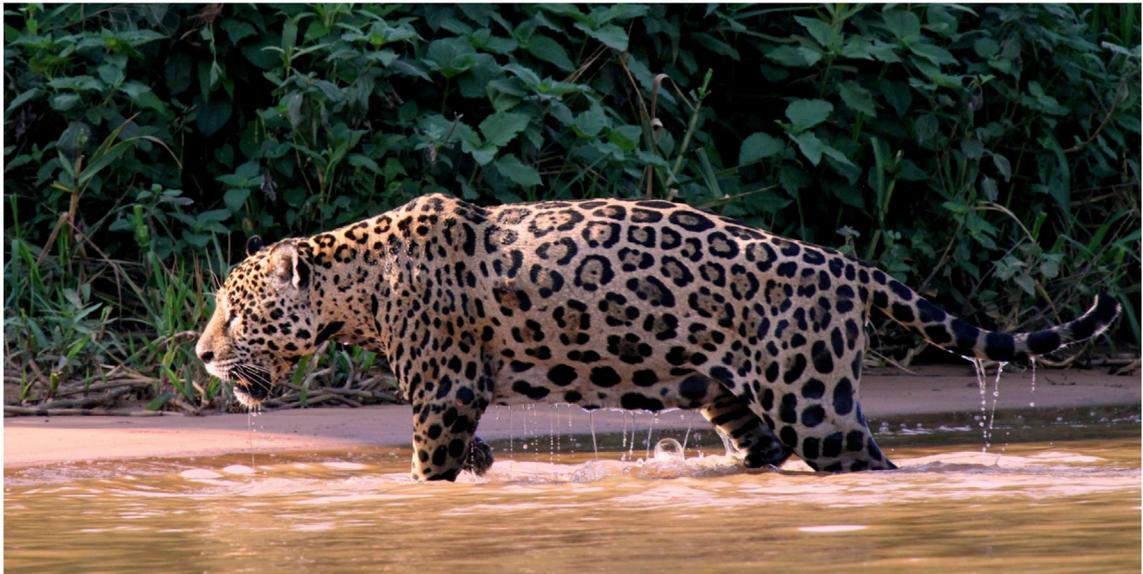
Wildlife is highly visible and abundant in the Brazilian Pantanal, the world's largest sheet-flow continental wetland. Indeed, the Pantanal is widely considered to be the most important wildlife tourism epicenter in Latin America (Chardonnet et al., 2002), comparable to the best protected parks in East African savannas. Illegal hunting is the main threat to the population viability of jaguars in the Pantanal (Quigley and Crawshaw Jr. 1992; Crawshaw Jr. 2002), and is mainly driven by supposedly economic losses induced by jaguars on cattle herds in private ranches (Zimmerman et al., 2005; Boulhosa and Azevedo, 2014). These losses are proportionately low compared to the complete inventory of cattle herd size of any given ranch or farm, but ranges widely, for example, from US\$350 to US\$22,400 per year within a single ranch in the Pantanal (Tortato et al., 2015). Therefore, any benefits brought about by jaguar tourism to ranches with a mixed financial portfolio must also take into account cattle losses from jaguar depredation.

Wildlife valuation studies usually consider “non-use values” through different methodologies such as contingent valuation (Nijkamp et al., 2008). Here, we consider “use values” as market prices to measure the positive economic impact that a jaguar population can represent in terms of annual revenues derived from tourism, compared to livestock casualties induced by jaguars on the basis of the same spatial scale in the Brazilian Pantanal. We also value the potential for this tourism industry to create a compensation scheme for cattle losses through voluntary donations. We therefore discuss the operational feasibility of this compensation scheme, and the overall importance of tourism as a conservation tool for the highest-density jaguar population anywhere on Earth.

## 2. Methods

### 2.1. Study region

The Pantanal biome — the world's largest floodplain — is located in the central portion of South America and is widely recognized by its wildlife abundance, the main attraction for thousands of tourists who visit the region each year. The Brazilian Pantanal covers an area of 140,000 km<sup>2</sup>, only 2.5% of which is officially protected under the categories of national park, state park and private reserve (Harris et al., 2005). This study was conducted in the Encontro das Águas State Park (hereafter, EASP) and its surrounding landscape. The EASP encompasses an area of 108,000 ha, located in the municipal counties of Poconé and Barão de Melgaço, more precisely in the locality of Porto Jofre, state of Mato Grosso, Brazil. Land-use revenues in this region were traditionally based on extensive, low-yield cattle ranching, but sport fishing and wildlife-oriented tourism have gradually increased over the two last decades. Jaguar tourism within the EASP and neighbouring areas occurs primarily along rivers and streams (Tortato and Izzo, 2017) (Fig. 1). Porto Jofre is a major ecotourism destination, within which field



**Fig. 1.** An adult male of Jaguar (*Panthera onca*) along the margin of the Três Irmãos River, in the Encontro das Águas State Park. Photo credit: Rafael Hoogesteijn.

observation of jaguars is the most established attraction. Other wildlife fills in the background scenario, but has a secondary role in the choice and marketing of this destination (FRT, unpublished data). Traditional ranching of adapted cattle breeds has been the most important economic activity in the Pantanal for over 250 years (Wilcox, 1992), and occupies over 80% of the biome (Seidl et al., 2001), including all ranches around the EASP area. Comparing these two main economic activities of the Pantanal, wildlife tourism is potentially more widespread because it can occur in both strictly protected areas and private landholdings (Hoogesteijn et al., 2015; Tortato and Izzo, 2017). Cattle ranching is legally prohibited in formal protected areas, such as EASP.

## 2.2. Calculating minimum revenues from jaguar tourism

The daily earnings from seven tourism lodges were used to calculate the minimum revenue originating from jaguar tourism. Although other lodges outside this area may also offer customer-designed packages for jaguar observation, these packages are relatively unstable and unpredictable. Therefore, we opted for a conservative approach in considering only lodges that work specifically with jaguar tourism within the EASP and surrounding region. This minimum revenue was obtained by multiplying the per guest daily values (DV) of room and board for each lodge, the total number of visiting tourists in 2015 (NT) and the minimum daily occupation rate (MD). The values that the local jaguar population represents for each lodge were then summed across all lodges.

Information relating to daily revenues and number of tourists in 2015 was obtained through direct interviews with the owners and/or managers of each lodge. Minimum daily revenues were based on packages exclusively designed to observe jaguars, offered by leading tour operators working in the study area, which were standardized as a minimum package duration of 3 days. For the purposes of this paper, we restricted our revenue estimates to those generated by packages from established lodges only, thereby ignoring additional revenues from more independent tourists who arranged their own customized tours with free-lance local guides and services. In addition, we deliberately excluded other minor tourist expenditure, including the purchases of crafts, restaurant meals, trips or other local services. The total value of these incidentals are far more difficult to estimate, even if they contribute to local service chains. We therefore simply assume that revenues estimated here could be severely conservative, but are reliable and stable, and our estimates can be easily reproduced by other studies.

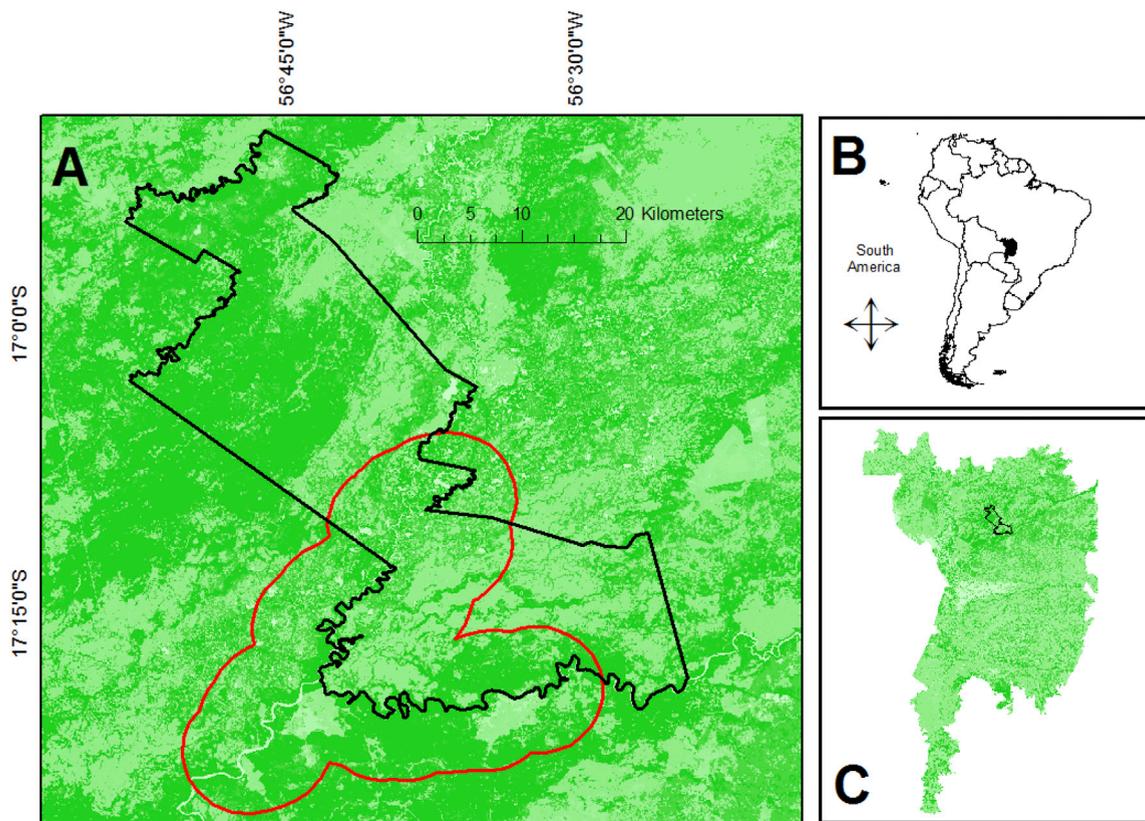
## 2.3. Spatial scale of jaguar tourism and livestock damage

Defining a spatial scale of tourism economics is important to compare the gains and losses related to a flagship species such as jaguars, rendering the evaluation replicable and robust. The spatial scale considered in this study was based on 349 known GPS locations where tourists observed jaguars along the main rivers and streams of EASP and the neighbouring landscape. These locations were obtained from geographic coordinates obtained in situ and provided by tour guides. Considering the extreme localities along the whole catchment, the entire stretch of rivers used by tourists was defined as the potential jaguar tourism area. Considering the mean maximum distance moved by any given adult jaguar within their home

ranges in this area (Devlin, 2017), we created a buffer area of 5850 m from any riverbank, which resulted in a total area of 81,000 ha, corresponding to the approximate total area where all jaguars observed by all tourists likely maintain their territories (Fig. 2). Considering this area only, we used a carrying capacity (or stocking density) estimate of 0.2 cattle heads or animals per hectare, which is a realistic estimate for the ranches neighbouring the EASP area, and consistent with grazelands at other tropical wetlands with natural grasses (Hoogesteijn and Chapman, 1997; Sarmiento and Pinillos, 1999; Hoogesteijn and Hoogesteijn, 2010). We therefore established that the maximum size of the bovine herd in a similar area at this carrying capacity would be ~16,200 animals.

In the Pantanal, cattle losses caused by jaguars vary widely both spatially and temporally (Azevedo and Murray, 2007; Cavalcanti and Gese, 2010; Tortato et al., 2015). We therefore consider annualized loss estimates within the context of the EASP region. To obtain an estimate of the total number of domestic animals killed by jaguars, we searched for published and unpublished data within the wider EASP area. A hypothetical estimate of damage caused by jaguars was obtained by multiplying the annualized proportional loss reported in the literature and by individual ranch managers by the estimated maximum number of cattle that the area could support. We then multiplied this number by the market value of each animal (estimated at US\$300 per head averaged for all sex/age classes) obtained from all updated livestock auction websites (e.g. <http://www.noticiasagricolas.com.br/cotacoes/boi>). In summary, we first defined the total area used by all jaguars observed by tourists within the study area and then created a hypothetical scenario in which realistic rates of annual cattle depredation by jaguars were estimated for an area of the same size within the wider EASP landscape. We could then assess the costs and benefits of coexisting with a wild jaguar population at a comparable spatial scale. We could then assess both the hypothetical cattle damage induced by jaguars and the minimum value of tourism revenues that are directly attributed to jaguar tourism.

Finally, we interviewed the owners of all seven major ecotourism lodges within the study area for information on the scale and growth of jaguar tourism activity. During these interviews, we specifically obtained information on the absolute and relative seasonal occupation rate (rooms and beds) over the last 6 years (2010–2015), and annualized the data accordingly. Additionally, we interviewed most of the tour guides operating in the study area ( $N = 30$ ) and asked them when (which year) they started working with jaguar tourism.



**Fig. 2.** Map of the wider study landscape centered at the Encontro das Águas State Park (EASP) (black line polygon in panel A), including the park and surrounding landscape within private cattle ranchers delineated by a tourism buffer zone (red line polygon), which represents the total projected area used by the jaguar population under observation by ecotourists. Upper inset map of South America shows the Brazilian Pantanal biome (solid black area in B). Lower inset map (C) shows the entire Brazilian Pantanal region and the location of the EASP reserve (black polygon). Dark and light green areas (in A and C) indicate forest and grassland habitats, respectively, which are typical of the landscape mosaic of the Pantanal.

## 2.4. Compensation system through jaguar tourism

To evaluate the financial viability of a compensation scheme for livestock losses caused by jaguars, we further deployed a willingness-to-pay questionnaire, which was systematically applied to all tourists at the time of their final-day checkout from all major hotels and lodges across the entire study area from 1 August to 30 October 2015. The issues addressed by this questionnaire involving the compensation scheme were:

- 1) Jaguars attack cattle and other domestic species. This leads ranchers to persecute and kill this species. Compensation systems are alternatives to minimize this conflict.  
Do you agree that these losses should be compensated financially?  
( ) Yes; ( ) No
- 2) Can jaguar tourism be a source of funds for this compensation system?  
( ) Yes; ( ) No
- 3) How much in relation of your daily accommodation rate (%) would you be prepared to donate for this compensation system? ( ) 1%; ( ) 2%; ( ) 3%; ( ) 4%; ( ) 5%; ( ) 6%; ( ) 7%; ( ) 8%; ( ) 9%; ( ) 10%. Another value (%) \_\_\_\_.

The results of questions 1 and 2 are presented as percentages, whereas question 3 was defined as the average daily percentage available for the compensation scheme.

## 3. Results

### 3.1. Minimum revenues from jaguar tourism

The total annual revenue that jaguars represented for seven local lodges across the Brazilian Pantanal in 2015 was US\$6,827,625, and values per lodge ranged from US\$81,000 to US\$3,105,000 (Table 1).

### 3.2. Livestock damage caused by jaguars

We estimated a total herd size of 16,200 animals grazing on the same 81,000-ha area defined here as supporting the regional scale jaguar tourism. In addition, we considered an annual mortality rate of 2.5% from jaguar depredation of this overall herd size, based on a study carried out in an area bordering the EASP (Hoogesteijn et al., 2015). Considering this herd size and annual loss rate, this yields an annual hypothetical loss of US\$121,500. Subtracting this hypothetical cost due to jaguar damage incurred to cattle from the total minimum value of jaguar revenue would result in a total minimum net benefit of US\$6,706,125 for the study area in 2015.

### 3.3. Development of jaguar tourism

Lodge owners did not have accurate data on the exact number of tourists they serviced in their lodges over the past few years. However, they provided indirect data that clearly shows an increase in jaguar-tourism activities in the region. First, they confirmed that the demand for room and board services increased over the last 5 years and will continue to increase in 2017 and 2018, with only a few booking vacancies left in the high season between August and October. In addition, they carried out marked structural refurbishments to their hotels to accommodate the growing demand for beds, which recently increased by 20% from 184 beds in 2010 to 221 beds in 2016.

In a second approach, we assessed the daily accommodation rates of four hotels that provided detailed financial data for 2015 and 2016. These data show a mean increase of 24.5% in transaction daily rates, or well above the Brazilian inflation rate over the same period (~10.7%). Interviews with 30 tour guides that specialized on jaguar tourism showed that half of them

**Table 1**

Minimum value generated by jaguar-based nature tourism in 2015 for seven lodges (named anonymously, A to G) in the Porto Jofre area, Pantanal of Poconé, Mato Grosso, Brazil. The minimum staying period was defined as 3 days at all lodges. Even when in several cases, the total length of packages (days) was longer, we use this minimum staying time for our estimates.

Lodges	Daily value (US\$)	No. of tourists (2015)	MJV <sup>a</sup> (US\$)
A	450	400	540,000
B	430	1745	2,251,050
C	900	1150	3,105,000
D	300	470	423,000
E	200	500	300,000
F	135	315	127,575
G	150	180	81,000
<b>Total</b>			<b>US\$ 6,827,625</b>

<sup>a</sup> Minimum transaction value of jaguar tourism per lodge.

began this activity 10 years earlier. Therefore, there has been a gradual increase in the lodging capacity available to tourists, per capita daily rates charged, and the number of tour guides allocated to jaguar tourism, all of which clearly reinforces the overall evidence of increasing demand for jaguar-oriented tourism in the Pantanal.

#### 3.4. Financial compensation from jaguar tourism

During the months of August, September and October 2015 we interviewed a total of 137 tourists who visited the EASP region. Having been informed of the existence of a conflict between jaguars and cattle ranchers, tourists became aware that observed jaguars can take both wild and domesticated prey outside the park, with 96% agreeing that a compensation scheme would be required to cover the costs of jaguar depredation on livestock. In fact, 95% of all informants believed that jaguar tourism could be a tangible source of revenues for this compensation scheme and 80% agreed to, on average, donate an additional 6.8% ( $SD \pm 3.9\%$ ) of the value of their all-inclusive daily rates to be allocated to this compensation scheme. Considering the average daily lodging costs per tourist of US\$412, these 6.8% would represent a daily average of US\$ 28  $\pm$  15 per tourist in willingly paid fees to support the jaguar compensation program.

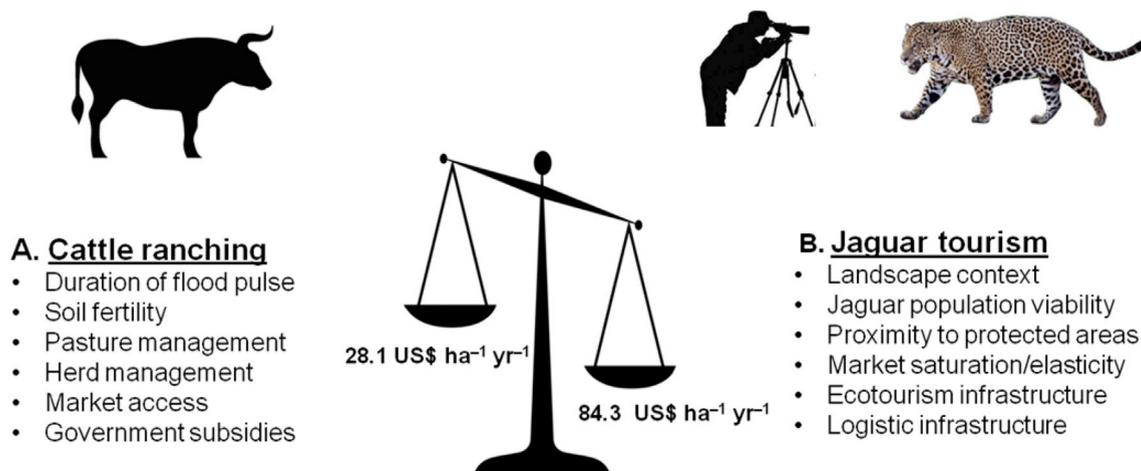
### 4. Discussion

Our study provides the first transaction estimates of the minimum monetary value of jaguar-based tourism anywhere in the Americas in relation to livestock losses through jaguar depredation. Realistic estimates of costs and benefits were expressed in terms of monetary values (Tortato et al., 2015). Positive monetary values represent a powerful counter-argument to safeguard populations of large carnivores and other 'problem species', thereby upholding the main justification for a jaguar conservation program. Similar estimates have already been used for other flagship species, such as sharks (Anderson and Waheed, 2001; Gallagher et al., 2015), macaws (Munn, 1992) and lions (Thresher, 1981), but these assessments typically consider animal values per individual and have been criticized for lacking data on population demography and spatial requirements, thereby inflating the degree of uncertainty of estimates per unit area (Catlin et al., 2013). In this study, we consider an entire operational jaguar population to circumvent the problems described by Catlin et al. (2013). For example, there are individuals within any population that, because of their behaviour or location of their territories, can be more easily observed than others, and therefore have an intrinsically higher value for observational tourism. In addition, prey selection even within a single jaguar population can be widely variable (Cavalcanti and Gese, 2010), so that livestock depredation costs vary significantly across different individual jaguars

In terms of observed costs and benefits of providing safe habitat to a jaguar population, the benefits accrued from tourism far outweighed the costs of cattle losses in private ranches. From our viewpoint, this statement reinforces one of the many arguments that can be used to justify jaguar conservation. In fact, the monetary argument is no more powerful than an ecological or the moral argument, but it can reach a wider societal audience and can easily sway even the most hostile stakeholders to facilitate benign policy decisions that can achieve unanimous consensus (Brauer, 2003). In addition, in our estimates of gross financial income we considered only the direct revenues obtained from the daily accommodation rates from the seven lodges included in this study. This value is clearly low and highly conservative, and underestimates the total amount and distribution of tourism revenues, since it does not consider many other ancillary expenses, including travel costs, wages and tips for guides, and other elements of the service industry such as purchases in restaurants and craft markets. Thus, notwithstanding the fact that the value of jaguar in this study was underestimated and is valid only at a landscape scale, jaguars could still generate a revenue of nearly US\$7 million for an 81,000 ha area in 2015. This is equivalent to a minimum crude revenue of US\$84.3 per hectare, which is approximately three-fold higher than the approximate land-use revenue from traditional bovine cattle ranching estimated for a typical farm across the Brazilian Pantanal (Moraes, 2008) (Fig. 3). Again, this is a conservative estimate since the growing demand for wildlife tourism, particularly in the Pantanal, will accelerate even faster in years to come.

One could argue against the long-term reliability of jaguar tourism in footing the bill of Pantanal conservation over the years. However, as our data show, the current perspective is a rapidly escalating value. If we consider the total number of jaguar-seeking tourists in our study landscape in 2015 ( $\approx 4760$ ) and extrapolate the average increase in per capita lodge prices between 2015 and 2016, the ~US\$6.83 million value in 2015 likely increased to ~US\$8.47 million in 2016.

One problem that remains to be solved is the sheer asymmetry in costs and benefits by different stakeholders in the Pantanal. This is particularly expressed as the growing conflict between the tour operators, who capitalize on profits from a high-density jaguar population, and the landowners outside the protected area, whose land help support the jaguar population but occasional incur costs in cattle depredation by the same jaguars. To add insult to injury, local landowners in the cattle business do not receive any financial benefit from any level of jaguar tolerance. In our study area, tour operators do not actually own any land, but promote river-based observation tours of jaguars that may be preying on cattle on neighbouring cattle ranches, which clearly support critical habitat and a natural prey base for jaguars. This could be feasibly solved by a compensation scheme for cattle losses. Compensation schemes have often been proposed to mitigate human-wildlife conflicts (Schwerdtner and Gruber, 2007). In its most common form, it includes the quid pro quo reimbursement of private parties for damage induced by wild species to personal property or livestock (Wagner et al., 1997; Nyhus et al., 2005). A critical bottleneck in implementing these systems, however, is to raise funds to make offset payments possible, often through conservation initiatives from NGOs, private funds or government agencies (Wagner et al., 1997; Nyhus et al., 2005; Bulde and



**Fig. 3.** Schematic representation of key determinants of the balance of land use revenues for Pantanal ranches based on the (A) traditional bovine cattle ranching economy; (B) jaguar tourism economy; or both. Data on cattle revenues from Moraes (2008).

Rondeau, 2005). Obviously, given the glaring inequality observed between the revenue generated from tourism and inevitable losses to livestock producers, a logical solution would be for tour operators to raise much needed funds to fuel compensations. Our results show that 80% of all tourists visiting our study area would be happy to donate additional funds to this compensation scheme. Considering the willingness-to-pay fraction of the minimum number of tourists who paid for room and board across our study area in 2015, it would require each of these 3808 tourists to voluntarily donate only US\$32 as a one-off payment for all the hypothetical landscape-scale damage inflicted by jaguars on the cattle herds. Four fifths of all tourists suggested that they would be willing to donate on average of US\$84 over a 3-day stay, which far exceeds the value of this payment. Our results therefore demonstrate the financial feasibility of a relatively doable compensation scheme through wildlife tourism, which would create a ‘win-win’ scenario for both of these main economic activities.

Most cattle ranchers (94%) in the Brazilian Pantanal, agreed that they would like to receive assistance for jaguar livestock depredation issues, yet only 20% accrued any benefits from ecotourism that may include jaguar observation (Zimmerman et al., 2005). We propose that before creating a compensation scheme through wildlife tourism, it would be necessary to put into practice best management practices, including the implementation of anti-depredation strategies in terms of livestock management (e.g. Michalski et al., 2006; Hoogesteijn and Hoogesteijn, 2014; Quigley et al., 2015). This is because a sufficiently tempting compensation scheme can encourage a decrease in efforts to prevent damage in the first place (Bulde and Rondeau, 2005). A proposal between ‘best-management’ practices and a tourism-based compensation scheme has already been implemented in Africa (Mossaz et al., 2015), where the total amount to be compensated depended on the context in which any animal was killed (Bauer et al., 2017). For example, livestock killed by lions in well-managed landholdings received higher compensation values (Bauer et al., 2017). The large-scale management of cattle herds in the Brazilian Pantanal, where individual farms frequently contain large pasture areas (>3000 ha) and large bovine herds (>1000 animals), makes it difficult to control for losses and, consequently, the operational viability of a compensation system such as implemented in African pastoral systems (Hemson et al., 2009; Hazzah et al., 2014; Bauer et al., 2017). Our solution to mitigate losses dictate that a stable compensatory partnership from tourism operators to livestock ranchers should be considered as a reward to ranchers for, first and foremost, protecting jaguars within their properties, rather than simply as a payment for incidental cattle losses to jaguars (Hoogesteijn et al., 2005). Furthermore, to ensure that ranchers are unable to overestimate losses caused by jaguars, it would be appropriate to consider the annual loss percentages already available for portions of the Pantanal (eg. Azevedo and Murray, 2007; Cavalcanti and Gese, 2010; Tortato et al., 2015; Hoogesteijn et al., 2015), whereby the amount to be rewarded per ranch is already pre-determined but can be reviewed on an annual or biannual basis.

## 5. Conclusions

In this study we demonstrated for seven tour operators in a typical region of the Brazilian Pantanal, that jaguars represents an annual revenue 56 times higher than the annual hypothetical damage caused within cattle ranches with an area equivalent to that required to support a jaguar population under conditions of frequent human contact. We also showed that regional losses caused by jaguars on cattle herds could be rewarded by a system of voluntary payments from willing tourists, and the implementation viability of anti-depredation strategies by ranchers, ensuring that traditional livestock and tourism activities can coexist side by side. In summary, our results demonstrate that the ecotourism industry should be explicitly considered by government agencies as a major revenue generator in the Pantanal, with added advantage of operating as an environmental conservation tool not only for jaguars, but also for the entire ecosystem.

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