TADEU G. DE OLIVEIRA[1], EMILIANO E. RAMALHO[2] AND ROGÉRIO C. DE PAULA[3]

Red List assessment of the jaguar in Brazilian Amazonia

Amazonia is the most important biome for the long-term survival of the jaguar in Brazil due to its relatively well preserved state and continuous area of adequate habitat. In the Brazilian portion of Amazonia the jaguar's present extent of occurrence EOO continues to encompass the whole area of the biome, but the continued loss of habitat in the east and southeast limits of this biome, an area known as the "arch of deforestation", has resulted in a significant reduction and fragmentation of the jaguar's area of occupancy AOO. Based on data from camera trap surveys we assumed an average density of 1-2 jaguars/100 km² for the majority of the biome, with the exception of well-preserved floodplain forest areas where the species is more abundant. Considering this average density, the effective population size to total population size ratio proposed by Frankham (1995, 2009), and the total remaining area of the biome, we estimated the present effective jaguar population size for Amazonia in Brazil to be < 10,000 individuals. In addition the jaguar population is likely to be decreasing in this biome as a result of habitat loss, direct persecution and depletion of prey population. In our evaluation the jaguar should be classified as Vulnerable C1.

Assessment

Vulnerable – Due to the ongoing loss of habitat, substantial poaching of jaguars and their prey, and the fragmentation of populations across portions of its range, and an expected population of mature breeding individuals of <10,000 this species is considered to be Vulnerable (VU C1) in Amazonia.

The Amazon is the most important area to consider for successful long-term jaguar conservation worldwide. Amazonia is a vast biome and includes the most extensive areas of suitable and non-fragmented habitat available to this large felid (ca. 5,300,000 km², Soares-Filho et al. 2006). The Amazon Basin represents approximately 70% of the species' total area of occurrence and also serves to connect populations from other important ecosystems (Sanderson et al. 2002, Zeller 2007). Approximately 3,459,000 km² of all of Amazonia (ca. 65%) is located in Brazil. Thus, it is possible to conclude that the Brazilian Amazon harbours the largest jaguar population worldwide (Seymour 1989).

In Brazil, jaguar populations are classified under different conservation categories because they face different types and levels of threats (from Vulnerable to Critically Endangered). Even inhabiting such a huge area, the jaguar population in Amazonia is estimated at <10,000 mature individuals, based on the effective population size to total population size ratio proposed by Frankham (1995, 2009), which, in association to habitat loss and its expected population loss, made jaguars be considered Vulnerable (VU C1).

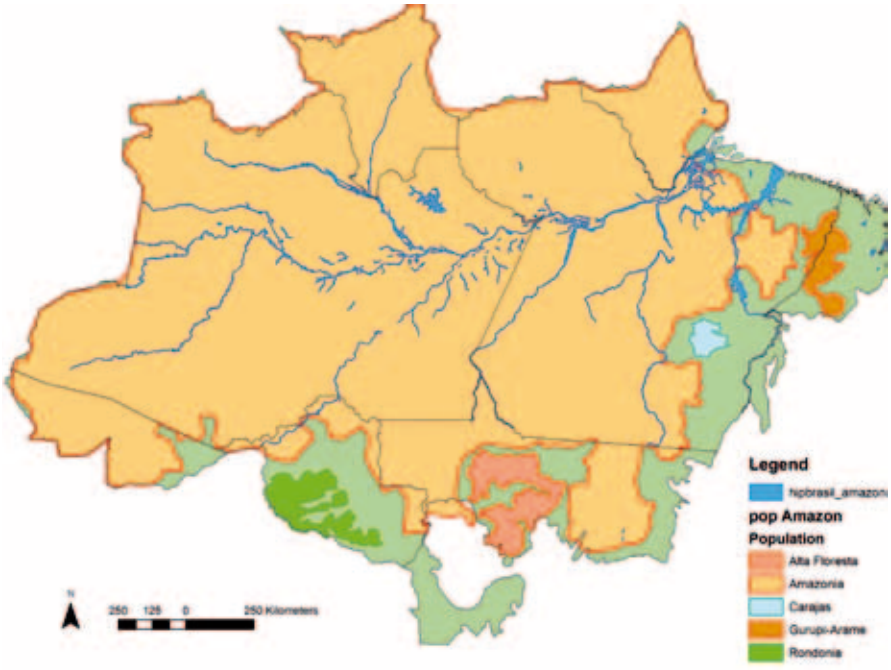

Fig. 1. Jaguar area of occupancy and potential sub-populations in the Brazilian Amazon.

Geographic range

Extent of occurrence EOO

The current extent of occurrence of jaguars in Amazonia still includes the entire basin, as it has historically. During the "Jaguars in the new millennium" workshop held in Mexico in 1999, which resulted in the species' range extension map that is currently being used (Sanderson et al. 2002), it was noted that there is a huge gap in a major portion of the central-southern part of Amazonia in Brazil. This gap is primarily due to a significant lack of knowledge about the area and not to the actual absence of the species, as there are valid records of its occurrence from this region (Ferraz et al. 2012, this issue).

Area of occupancy AOO

The area of occupancy for jaguars in Amazonia is basically all of the basin where natural cover still remains and where the species has not been extirpated due to hunting, a threat mostly presented by conflict with the interests of cattle rancher. This means that the species has mostly disappeared from parts of what is known as the "deforestation arch", which essentially borders the eastern and southern limits of the area. More specifically, this "arch" includes eastern and southern Pará, western Maranhão, northern Mato Grosso and Rondônia. According to INPE's estimates, the total deforested area of the Brazilian Amazon is 733,321 km² (INPE 2010), or about 18.4% of the originally forested area.

Within most of the area, there still appears to be a single, large panmictic population. However, along the deforestation arch, habitat fragmentation and isolation of small populations has already begun. The most immediate effects of fragmented habitat are likely to be the functional isolation of populations in the areas of Gurupi (W-Maranhão and E-Pará), Carajás (SE-Pará), SW-Rondônia, and NE-Mato Grosso from the main population of Amazonia (Fig. 1).

In the forested ecoregion of the Tocantins River in eastern Amazonia, which includes

E-Pará and W-Maranhão, jaguars have disappeared from the seasonally flooded fields of Baixada Maranhense, an area that is similar to the Pantanal in this respect, and from the deforested areas of these states (T. G. de Oliveira, pers. comm.). In other parts of the deforestation arch, the species' area of occupancy has also been considerably reduced because of habitat destruction, and in some cases further amplified by poaching and direct conflict with cattle ranchers. For example, this difficult situation has been observed in the regions of Alta Floresta-MT (Michalski et al. 2006) and Bico do Papagaio-TO/PA/MA (Oliveira 2002, T. G. de Oliveira, pers. comm.).

Fig. 2. Jaguar camera-trapped in the várzea forest of Mamirauá Sustainable Use Reserve (Photo E. E. Ramalho).

Ecology and population information

Population size

The Amazonian jaguar population is thought to have a high probability of survival (Sanderson et al. 2002), and is considered as something like an insurance policy for the long-term persistence of the species. There are only two population estimates for jaguars in the Brazilian Amazon available at this time. One population estimate comes from the Mamirauá Sustainable Use Reserve, an area of várzea forest at the confluence of the Amazon and Japurá Rivers, where the population density was calculated to be 10/100 km^2 (Ramalho 2008). This very high density is likely due to the relatively high productivity of várzea forest and the large population of caimans, which are the jaguar's main prey item in Mamirauá (Ramalho 2006). In Cantão State Park, which is a transitional area between the Amazon and Cerrado biomes, jaguar population density was estimated to be 2.58/100 km^2 (Astete 2008). None of these areas are like the typical terra firme forests that characterize most of the Amazon area, so these estimates cannot be considered as representative of the entire region and, thus, do not facilitate a realistic estimation of the species' population size for the whole biome. In the Bolivian Amazon, jaguar density at Madidi National Park was estimated to be 2.84/100 km^2 (Silver et al. 2004), whereas in the Colombian Amazon, densities were estimated to be 4.5/100 km^2 in Amacayacu National Park and 2.5/100 km^2 in unprotected areas (Payan 2008).

Sollmann et al. (2008) extrapolated from the estimate of Silver et al. (2004) for the protected areas where jaguars are found in the Brazilian Amazon and calculated a population size of 51,920 individuals. Given the high degree of variability in habitat quality and anthropogenic threats within the Amazon basin however, it is unreasonable to expect a single population estimate from the Bolivian Amazon to be representative of the entire biome in Brazil.

Population density in terra firme forests in Brazil is estimated to be 1-4/100 km^2, with a mean of 1-2/100 km^2, or even lower in areas with less suitable habitat. Following an approach similar to that of Sollmann et al. (2008), but using the species' occurrence adequacy modelling in the biome (Ferraz et al., in prep.) and taking into account the areas that are currently deforested (INPE 2010), the expected mean density, and the effective population size, these results would be quite different. We considered two estimates of the effective population size, one less conservative (i.e., Ne = 0.4N; Nowell & Jackson 1996) and the other more restrictive, having been based on genetic factors applied to big felids and other top predators (Ne = 0.1N; Frankham 1995, 2009). By this approach, we get an expected population size ranging from 10,580 to 21,160 jaguars (the less conservative estimate), or of only 2,645–5,290 individuals (the genetically based estimate), that are effectively contributing to the gene pool in all of the Brazilian Amazon. When we consider extinction risk analysis, the total population size (N) is of little use and can even give us a false sense of security. What really matters is the number of individuals that effectively contribute to the gene pool, i.e., the effective population (Ne; Frankham 2009).

Using the same procedures and the same density estimates, but also considering the area of remaining natural vegetation capable of supporting jaguar populations and accounting for dispersal throughout the entire biome (cut of 2-37, see Nijhawan et al. 2012), the effective population size estimate is 14,974-29,948 (less conservative Ne) and 3,744-7,487 (genetically based Ne) mature individuals. It is important to emphasize that all of the estimates presented here are merely speculative and do not take into account an array of important factors to consider, including the great degree of habitat heterogeneity in the region. It is crucial that data from more direct methods (e.g., camera trapping) be obtained from several areas of the Brazilian Amazon before a reasonably accurate estimate for jaguar populations can be proposed. Jaguar populations throughout the deforestation arch are being seriously depleted and animals are already being extirpated from some areas (Michalski et al. 2006, E. Carvalho Jr., pers. comm., T. G. de Oliveira, pers. comm.). However, given the previous estimates, the size of the area and expected density, the effective population size for the Brazilian Amazon is estimated to be above or below 10,000 mature individuals, depending on Ne estimator. This projection essentially renders the Amazonian population as the jaguar stronghold and underscores its importance to the long-term survival of the species.

Taking into account the population estimates for Cerrado and, especially Atlantic Forest

Fig. 3. Burning forest along the deforestation arch in southeastern Pará (Photo. T.G. de Oliveira).

and Caatinga biomes (see Amorim Moraes Jr 2012, Beisiegel et al. 2012, de Paula et al. 2012, all this issue), would make jaguars Vulnerable worldwide. However, this has not happened because of the enormous size of Brazilian Amazonia, which favours the persistence of viable effective populations of greater than 10,000 mature individuals.

Seven Jaguar Conservation Units (JCUs) were established for the Brazilian Amazon at the "Jaguars in the New Millennium Workshop" in 1999, but these were re-evaluated, increased in size and reduced in numbers during the 2010 Brazilian Jaguar Population Habitat Viability Analysis Workshop (Nijhawan 2012, this issue).

If the scenario for future environmental degradation that was presented by Soares-Filho et al. (2005, 2006) for 2050 proves to be accurate, it is likely that jaguar populations in Amazonia will be restricted to the proposed JCUs. This would be the case because these JCU's were delineated based not only on the presence of protected areas and their eco-regional importance, but also on predictions for habitat loss (Soares-Filho et al. 2005, 2006). Population estimates for these areas are presented in Table 1.

Population trends

The jaguar population appears to be declining throughout much of its range where human presence is greater, due primarily to higher levels of habitat destruction and the hunting of jaguars and their prey (Silveira et al. 2008, R. C. de Paula, pers. comm., T. G. de Oliveira, pers. comm.). Unfortunately, due to a lack of formal research, there is no valid quantitative data to corroborate this assumption. The population decline in Amazonia is probably much higher along the deforestation arch, where it is known that the species has already disappeared from several areas where it used to occur, which can safely be inferred from knowledge of the high rate of deforestation and from various sources of indirect evidence (Michalski et al. 2006, E. Carvalho Jr., pers. comm., T. G. de Oliveira, pers. comm.). Taking the Bico do Papagaio region (which occurs in the border area of Pará, Tocantins and Maranhão), where there are high levels of deforestation and hunting pressure both on jaguars and their prey (observed over a 13 years period from 1997 to 2009) as an example, signs of the presence of jaguars declined abruptly (T. G. de Oliveira, pers. comm.). This tendency could be confirmed at Alta Floresta (MT), where the mean rate of large cat removal was found to be 0.56 animals/100 km^2 of remaining forest, which is a significant portion of the large felid population in the area (Michalski et al. 2006).

The rate of deforestation in Amazonia has fluctuated since 2000, from -31 to +18%, or a mean annual rate of -0.875% (INPE 2010). In this way, areas subjected to greater degrees of human pressure, notably those areas most impacted by urban sprawl, cattle ranching, agriculture and industrials activities, the jaguar population is markedly declining. In areas with less anthropogenic pressure, population declines appear to be more moderate while in the more isolated and pristine areas it may be assumed to be more or less stable.

Subpopulations

Satellite images of the remaining vegetation cover in Amazonia (INPE 2010) show that there is some degree of connectivity among most areas. As such, there do not appear to be any completely isolated jaguar populations in the Brazilian Amazon just yet. However, given the current trends of habitat loss and fragmentation that are being observed throughout the region, it is not unreasonable to predict the existence of one core population and 4–5 subpopulations sometime in the future (Fig. 1).

Considering the scenario where certain subpopulations become isolated, and applying certain of the population parameters used in Vortex to model extinctions (see Desbiez et al. 2012, this issue), such as 12 individuals being lost to hunting every two years (except in the case of the Carajás subpopulation where the hunting rate is six animals/2 years), the overall probability of extinction varies from 17% to 99% (Table 2). If we apply a scenario where habitat loss over a 20 year period occurs at a rate of 2%/year for the Carajás and Rondônia subpopulations and 3% for the Alta Floresta and Gurupi-Arame subpopulations (following their mean annual deforestation rate), the probability of extinction would be 100% for each of these subpopulations, except for Carajás (Table 2).

Table 1. Expected population of mature jaguars that would be contributing to the genetic pool of the important Jaguar Conservation Units in Amazonia, considering population densities between 0.01 – 0.02 individuals/km^2.

Parameter	JCU 1	JCU 2	JCU 3	JCU 4	JCU 5
Area (km^2)	1,686,246	417,681	12,131	37,940	93,080
Expected effective population (N_e = 0.4N) minimum – maximum	6,745 – 13,490	1,671 – 3,341	49 – 97	152 – 304	372 – 745
Expected effective population (N_e = 0.1N) minimum – maximum	1,686 – 3,372	418 – 835	12 – 24	38 – 76	93 – 186

Other life history information

Even the most basic information on jaguar biology in Amazonia is scarce, as very few studies have yet to be conducted (e.g., Emmons 1987, 1989, Kuroiwa & Ascorra 2002, Silver et al. 2004, Payan 2008). In Brazil, besides a couple of studies on population parameters (Astete 2008, Ramalho 2008), the only life history investigations have been conducted at Mamirauá (Ramalho 2006, Ramalho & Magnunsson 2008) and in a transitional area between Amazonia and the Cerrado (Nuno 2007). In the seasonally flooded, várzea forests of the Amazon River basin, high jaguar population density estimates and numerous records of mothers with cubs at the Mamirauá Reserve, suggests that várzea habitat could be very important to the species for successful reproduction in Amazonia (Ramalho 2008; Fig. 2). In this ecosystem, during the dry season (where the forest floor is completely exposed) the main prey species of jaguars are spectacled and black caimans *Caiman crocodiles* and *Melanosuchus niger*, sloths *Bradypus variegatus* and howler monkeys *Alouatta seniculus*. Among these prey items, the spectacled caiman is the most important in terms of both frequency of occurrence and biomass (Ramalho 2006). This suggests that jaguar conservation planning in the seasonally flooded forests of the Amazon should be directly associated with caiman conservation efforts. No studies have been conducted yet to determine which species are jaguar prey during the wet season, but field observations at the Mamirauá Reserve indicate that jaguars tend to prey more upon arboreal mammals during the flooding period (E. Ramalho, pers. comm.). Observations from the mangrove forests of the Maracá-Jipioca Ecological Station (Amapá state) suggest that, during the progression of the dry season, jaguars tend to concentrate around the disappearing muddy ponds where catfish become isolated, and take full advantage of this abundant and easily obtained resource. Other prey species that are known to be consumed by jaguars include white-tailed deer *Odocoileus virginianus*, agoutis *Dasyprocta agouti* and capybaras *Hydrochaeris hydrochaeris*, but not feral buffalos *Bubalus bubalis* (T. G. de Oliveira, unpubl. data). At Cantão State Park (TO), a transitional area between Amazonia and the Cerrado, jaguar prey varied, but in terms of biomass, larger prey (> 10 kg) such as peccaries *Tayassu spp.*, tapirs *Tapirus terrestris*, and cattle predominated (Nuno 2007).

Fig. 4. Rice fields at the Gurupi Biological Reserve. Eastern Amazonia is becoming a new frontier for agriculture (especially soybean) following the boom and decline of timber exploitation.

Threats

The major threats to jaguars in Amazonia are habitat loss, habitat fragmentation and hunt-ing of both jaguars and their prey (see Supporting Online Material SOM Table 1 at www.catsg.org/catnews). Jaguar population declines in Amazonia are noticed especially where human encroachment is greatest, notably along the deforestation arch. In most of this area jaguar populations have been severely reduced or extirpated due to a combination of habitat loss, hunting of their preferred prey and predator removal (Oliveira 2002, Michalski et al. 2006). Historically, the major threat was poaching for the skin trade.

Habitat loss

Habitat loss is the most serious threat to the Amazonian jaguar population and, thus, to the long-term survival of the species. The total area deforested in Amazonia reached 733,321 km^2 in 2008 (i.e., 17.6%, INPE 2010), or about the size of Turkey. The rate of habitat loss has also fluctuated considerably over the years (Fig. 3). Between 1989 and 2009 it was estimated at 17,743 km^2/year, with a slight increase after the year 2000, to 18,650 km^2/year (INPE 2010).

Although considerable tracts of land are protected as preserves, sustainable use areas or indigenous reservations, future conservation scenarios are grim. Recent models predict that up to 40% of Amazonian forests will be lost by 2050 (Soares-Filho et al. 2006). Most protected areas are essentially just 'paper reserves', with little to no direct management or enforcement of the law. Some of these areas, which are under very restrictive categories, also have human settlements inside of their boundaries, causing both direct habitat loss and habitat degradation. Such is the case of the Gurupi Biological Reserve.

Habitat loss in Amazonia is mostly due to cattle ranching, but is increasingly more related to large-scale agriculture (Soares-Filho et al. 2006). There is also a potentially large amount of habitat loss due to land usage and development associated with the roads being paved across the region (Soares-Filho et al. 2005). Typically, after timber resources are totally depleted in an area, the degraded forest is then cleared for pasture or agriculture (Fig. 4). It has been observed, however, that jaguars will use forest that has been heavily disturbed by timber exploitation, as long as there is a suitable prey base (Oliveira 2002).

Hunting

In the 20th century, especially during the 1960s, the greatest threat to jaguars in Amazonia was hunting for the skin trade (Smith 1976, Oliveira 1994, Nowell & Jackson 1996). During that time, it has been estimated that more than 15,000 jaguars were killed for their pelage every year in Brazil (Smith 1976). This threat was ameliorated in Brazil, for the most part, through the Federal Protection of Fauna Law in 1967 (Lei Federal 5197/67) and the inclusion of jaguars in Appendix I of CITES. These measures made jaguar hunting and commercialization illegal in Brazil and internationally.

Table 2. Expected population parameters and probability of extinction of predicted jaguar sub-populations in Amazonia after 100 years.

Parameter	SW-Rondônia	NE-MT – Alta Floresta	Carajás PA	Gurupi/ Arame MA
Area size – km^2	48,678	67,292	12,940	34,746
Expected density N/km^2	0.01	0.01	0.03	<0.01
Expected total population size – N	487	673	388	347
Expected effective population – N_e	195	269	155	139
Without Deforestation				
Probability of extinction	84%	17%	18%	99%
Final genetic diversity (%)	0.94	0.97	0.92	0.91
Number of jaguars after 100 years	626	930	201	136
With Deforestation (per 20 years)	*2%*	*3%*	*2%*	*3%*
Probability of extinction	100%	100%	45%	100%
Final genetic diversity (%)	0	0	0.90	0
Number of jaguars after 100 years	0	0	130	0

Nowadays the hunting of jaguars is due mostly to conflicts with ranchers who lose livestock to predation, and the occasional killing due to the fear of attack on humans and 'sport' hunting. The hunting threat varies in intensity throughout the Amazon basin, but is nevertheless prevalent anywhere there is cattle ranching activity. Eastern Amazonia and the deforestation arch can be considered areas of medium to high conflict (Oliveira 2002, Michalski et al. 2006, Boulhosa & Michalski 2009). There has been no accurate mapping of the most critical areas of conflict along the deforestation arch. However, Michalski et al. (2006), based on interviews with landowners in Alta Floresta (MT), reported an alarming number of 110-150 jaguars and pumas (combined) having been killed within a one year period due to conflicts with ranchers. We believe that throughout all of the deforestation arch, from Rondônia to Maranhão, the increasing contact between farmers and jaguars is directly proportional to the increase in conflicts and, consequently, in jaguar mortality due to retaliation. We speculate that this trend might intensify from west to east, reaching the highest levels in eastern Pará and western Maranhão. Therefore, unlawful predator removal could pose a significant, if not the most significant cause of jaguar mortality in these areas. In Amapá, an important area for jaguar conservation because of its extensive system of protected areas, excessive hunting due to livestock depredation represents an inferred decrease in population. There are even several municipalities (Amapá, Tartarugalzinho, Ferreira Gomes) where there are expert jaguar hunters who can be hired to kill problem animals. According to interviews with local people in these areas, an average of one jaguar is killed every month (R. C. de Paula, pers. comm.).

Jaguar hunting in Amazonia goes on virtually unnoticed by authorities, with very few cases actually reported, a situation that could be attested to several sites (T. G. de Oliveira, pers. comm., CENAP, unpubl. data). Hunting of jaguars does not seem to compromise population stability within protected areas (Ramalho & Carlos 2010), the opposite of what is observed in the most impacted/fragmented areas, close to or far from protected areas (Oliveira 2002, Michalski et al. 2006). New studies are desperately needed to assess the different impacts of hunting on jaguar populations within Amazonia.

Reduction on the prey base

Loss of the prey base is often associated with both cattle ranching practices as well as with other forms of human encroachment in Amazonia. The loss of prey should be more pronounced in the most fragmented and human influenced areas, such as in Eastern Amazonia and along the deforestation arch in Rondônia and Mato Grosso. The prey species most often taken by humans are the same as those that are preferred by jaguars (Jorgenson & Redford 1993, Oliveira 1994). This exploitative competition between humans and jaguars is most detrimental to the latter. Field observations have been showing that jaguar occurrence in fragmented areas and places disturbed by logging seems to be more associated with the loss of the prey base than it is to habitat degradation (Oliveira 2002, T. G. de Oliveira, pers. comm.). The combined effect of habitat loss and fragmentation, and the hunting of prey, associated or not with livestock conflicts, would lead to the local disappearance of jaguars in several areas.

Conservation information

At least two large blocks of interconnected protected areas could help guarantee the long-term persistence of genetically viable jaguar populations under a scenario of complete isolation in the Brazilian Amazon. One such area is "Calha Norte", which is centered around the Montanhas do Tumucumaque National Park (Amapá/N-Pará), and includes 63,000 km^2 of protected land (part of JCU-1). The other area is southwestern Pará, which includes a mosaic of protected areas around Terra do Meio, and includes 77,220 km^2 of protected land (part of JCU-2).

It is important to mention the large mosaic of protected areas in the State of Amapá, which are functionally connected to the great Calha Norte corridor, thus forming JCU-1. This state network of protected areas serves as refugia for jaguars. The Amapá Biodiversity Corridor, which is ca. 100,000 km^2, connects 12 different state and federally protected areas, consisting of both totally protected and sustainable use areas. Included among these areas there are Montanhas do Tumucumaque and Cabo Orange National Parks, the Maracá-Jipioca Ecological Station, and the Lago Piratuba Biological Reserve. Unfortunately, with the exception of the first park, illegal jaguar hunting has been observed in all of them.

Calha Norte, in conjunction with the Biodiversity Corridors of Amapá and Central Amazonia, with a total area of 363,000 km^2, would represent the most important area for jaguar conservation worldwide. However, deforestation modelling for Amazonia until 2050 (Soares-Filho et al. 2005, 2006) suggests that the western portion (closest to the border of Brazil with Venezuela, Colombia and Peru) will represent the largest continuous block of natural areas for jaguars if the predicted deforestation scenario prevails. As the delineation of the current JCU's considered not only the presence of protected areas, but also the likelihood of deforestation, it is reasonable to assume that these areas could act as mega-areas/reserves and ensure the long-term persistence of viable jaguar populations. With regard to the mosaic of protected areas including Terra do Meio in central and southwestern Pará, jaguars were not readily recorded throughout all of the preserves. At some of these preserves, such as the Terra do

Meio Ecological Station, Rio Pardo National Park, and the Altamira National Forest, there are reports of jaguar hunting, mostly due to conflicts with cattle ranchers (Beisiegel 2009, Paula & Lemos 2009). In Amazonia in general, wherever there is a significant number of livestock and environmental degradation (e.g., in the deforestation arch), there are bound to be conflicts with humans that are detrimental to the jaguars.

Considering just those preserves that are totally protected from human exploitation, their combined size alone is considerable in Amazonia. However, their actual effectiveness remains questionable, as most are paper reserves. Because the Amazon is the main stronghold for the species, and given the enormous area requirements of jaguars (Oliveira 1994), it is of paramount importance to secure the connectivity between protected areas in the basin, so that their size may be large enough to guarantee the long-term conservation of viable jaguar populations. Effective management and law enforcement in protected areas is also important.

References

Astete S. E. 2008. Ecologia da onça-pintada nos Parques Nacionais da Serra da Capivara e Serra das Confusões, Piauí. Universidade de Brasília, Brasília, Brazil.

Beisiegel B. M. 2009. Inventário e Diagnóstico da Mastofauna Terrestre e Semi-aquática de médio e grande portes da Estação Ecológica da Terra do Meio e do Parque Nacional da Serra do Pardo, PA. Relatório Técnico. CENAP/ICMBio/MMA. Atibaia. 64pp.

Boulhosa R. & Michalski F. 2009. The value of long-term projects: helping to conserve large felids in the southern Brazilian Amazon. Oryx 43, 462.

Emmons L. H. 1987. Comparative feeding ecology of felids in a Neotropical rainforest. Behavioral Ecology and Sociobiology 20, 271-283.

Emmons L. H. 1989. Jaguar predation on chelonians. Journal of Herpetology 23, 311-314.

Frankham R. 1995. Effective population size/adult population size ratios in wildlife: a review. Gentical Research 66, 95-107.

Frankham R. 2009. Genetic considerations in reintroduction programmes for top-order, terrestrial predators. *In* Reintroduction of top-order predators. Hayward M. W. & Somers M. J. (Eds). Oxford University Press, Oxford, UK, pp. 371-387.

INPE 2010. Estimativas anuais de desmatamento desde 1998 até 2008. <www.obt.inpe.br/prodes/prodes_1988_2009.htm>.

Jorgenson J. & Redford, K. H. 1993. Humans and big cats as predators in the Neotropics. *In* Mammals as predators, Symposium of Zoological Society of London, 65. Dunstone N. & Gorman M.L (Eds). Claredon Press, Oxford,, UK, pp. 367-390.

Kuroiwa A. & Ascorra C. 2002. Dieta y densidad de posibles presas de jaguar (*Panthera onca*) en las inmediaciones del Tambopata Research Centre (Zona Reservada Tambopata-Candamo, Madre de Dios). *In* El Jaguar en el nuevo milenio. Medellin R. A.,Chetkiewicz C., Rabinowitz A., Redford K. H.,Robinson J. G., Sanderson E. & Taber A. (Eds). Universidad Nacional Autonoma de Mexico/Wildlife Conservation Society. Mexico City, pp. 419-436.

Michalski F., Boulhosa R. L. P., Faria A. & Peres C.A. 2006. Human-wildlife conflicts in a fragmented Amazonian Forest landscape: determinants of large felid depredation on livestock. Animal Conservation 9, 179-188.

Nowell K. & Jackson P. 1996. Wild cats: status survey and conservation action plan. IUCN/SSC Cat Specialist Group, International Union for Conservation of Nature (IUCN), Gland.

Nuno A. 2007. Conserving carnivores: A. Attitudes of Portuguese high school students towards carnivores. B. Feeding habits of the jaguar: local and regional perspectives. MSc, University of Leeds, United Kingdom, 115 pp.

Oliveira de T.G. 1994. Neotropical cats: ecology and conservation. EDUFMA, São Luís, Brazil.

Oliveira de T.G. 2002. Evaluación del estado de conservación del jaguar en el este de la Amazonia y noreste de Brasil. *In* El Jaguar en el nuevo milenio. Medellin R. A.,Chetkiewicz C., Rabinowitz A., Redford K. H., Robinson J. G., Sanderson E. & Taber A. (Eds). Universidad Nacional Autonoma de Mexico/Wildlife Conservation Society. Mexico City, pp. 419-436.

Paula R.C., Lemos F. G. 2009. Avaliação Ecológica Rápida para o diagnóstico faunístico do mosaico de UCs da Terra do Meio, Estado do Pará – Componente Mastofauna. Relatório Técnico. ICMBio/MMA. Atibaia. 63pp.

Payan E. 2008. Jaguars, ocelots and prey ecology accross sites with different hunting pressures in Colombian Amazonia. PhD Thesis, University College London and Institute of Zoology, Zoological Society of London.

Ramalho E. E. 2006. A dieta e o uso do habitat da onça-pintada (*Panthera onca*) em uma área de várzea, Reserva de Desenvolvimento Sustentável Mamirauá, Amazônia Central, Brasil. Unpubl. MSc. Thesis., Instituto Nacional de Pesquisa da Amazônia, Manaus, Amazonas, Brazil.

Ramalho, E. E. 2008. Jaguar population dynamics in the varzea floodplain forests of Mamirauá. Report to WCS Jaguar Conservation Program.

Ramalho E. E. & Carlos H. S. A. 2010. Impacto da caça sobre populações de onça-pintada (*Panthera onca*) e puma (*Puma concolor*) na Reserva de Desenvolvimento Sustentável Uacari, Estado do Amazonas, Brasil. IX Congresso Internacional sobre Manejo da Fauna Silvestre na Amazônia e América Latina, Santa Cruz de La Sierra, Bolivia.

Sahil, N., Beisiegel, B., Moraes Jr., E.A., Cavalcanti, S.M.C., Oliveira, T.G., Paula, R.C. 2012. Unidades de Conservação, Áreas Prioritárias e Corredores de Dispersãopara Onças-Pintadas no Brasil. Em: R.C.Paula, A.Desbiez, S.M.C. Cavalcanti. (Org.) 2012. Plano de Ação Nacional para a Conservação da Onça-Pintada. SérieEspécies Ameaçadas. ICMBio. Brasília.

Sanderson E., Redford K.H., Chetkiewicz C.B., Medellin R., Rabinowitz A., Robinson J.G. & Taber A.B. 2002. Planning to save a species: the jaguar as a model. Conservation Biology 16, 58-72.

Seymour, K. L. 1989. *Panthera onca*. Mammalian Species 340, 1-9.

Silveira L., Boulhosa R., Astete S. & Jácomo, A. T. A. 2008. Management of domestic livestock predation by jaguars in Brazil. Cat News, Special Issue 4: 26-30.

Silver S. C., Oto L. E. T., Marsh L. K., Maffei L., Noss A. J., Kelly M. J., Wallace R. B., Goméz H. & Aiala G. 2004. The use of camera traps for estimating jaguar *Panthera onca* abundance and density using capture/recapture analysis. Oryx 38, 148-154.

Smith, N. J. H. 1976. Spotted cats and the Amazon skin trade. Oryx 13, 362-371.

Soares-Filho B. S., Nepstad D. C., Curran L., Cerqueira G. C., Garcia R. A., Ramos C. A., Voll E., Mcdonald A., Lefebvre P., Schlesinger P. & McGrath D. 2005. Cenários de desmatamento para a Amazônia. Estudos Avançados 19, 137-152.

Soares-Filho B. S., Nepstad D. C., Curran L., Cerqueira G. C., Garcia R. A., Ramos C. A., Voll E., Mcdonald A., Lefebvre P. & Schlesinger P. 2006. Modelling conservation in the Amazon basin. Nature 440, 520-523.

Sollmann R., Tôrres N. M. & Silveira, L. 2008. Jaguar conservation in Brazil: the role of protected areas. Cat News, Special Issue 4, 15-20.

Zeller K. A. 2007. Jaguars in the new millennium data set update: the state of the jaguar in 2006. Wildlife Conservation Society, New York.

[1] Universidade Estadual do Maranhão / Instituto Pró-Carnívoros <tadeu4@yahoo.com>

[2] University of Florida / Instituto de Desenvolvimento Sustentável Mamirauá

[3] Centro Nacional de Pesquisa para Conservação dos Predadores Naturais/Instituto Pró-Carnívoros