

## **Assessing the Assessment, the Relevance of the 2006 Paraguayan Mammal Red List to the Reality of Xenarthra Conservation in 2012**

Author: Smith, Paul

Source: Edentata, 13(1) : 18-28

Published By: IUCN/SSC Anteater, Sloth and Armadillo Specialist Group

URL: <https://doi.org/10.5537/020.013.0101>

---

The BioOne Digital Library (<https://bioone.org/>) provides worldwide distribution for more than 580 journals and eBooks from BioOne's community of over 150 nonprofit societies, research institutions, and university presses in the biological, ecological, and environmental sciences. The BioOne Digital Library encompasses the flagship aggregation BioOne Complete (<https://bioone.org/subscribe>), the BioOne Complete Archive (<https://bioone.org/archive>), and the BioOne eBooks program offerings ESA eBook Collection (<https://bioone.org/esa-ebooks>) and CSIRO Publishing BioSelect Collection (<https://bioone.org/csiro-ebooks>).

Your use of this PDF, the BioOne Digital Library, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](http://www.bioone.org/terms-of-use).

Usage of BioOne Digital Library content is strictly limited to personal, educational, and non-commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne is an innovative nonprofit that sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

## Assessing the assessment, the relevance of the 2006 Paraguayan mammal Red List to the reality of Xenarthra conservation in 2012

PAUL SMITH<sup>A,B</sup>

<sup>A</sup> FAUNA Paraguay, [www.faunaparaguay.com](http://www.faunaparaguay.com), [faunaparaguay@gmail.com](mailto:faunaparaguay@gmail.com)

<sup>B</sup> Para La Tierra, Reserva Natural Laguna Blanca, Departamento San Pedro, Paraguay, [www.paralatierra.org](http://www.paralatierra.org)

**Abstract** The last assessment of the conservation status of mammals in Paraguay took place in 2006 and found just two species of Xenarthra, *Myrmecophaga tridactyla* and *Priodontes maximus*, to be threatened at the national level. Though seriously outdated in a rapidly-changing landscape, this assessment continues to be used today as a tool for national wildlife management decisions. This paper highlights difficulties in the current national assessment process, and suggests solutions with the aim of producing a more accurate reflection of the conservation status of Paraguayan xenarthrans during the next review. The provision to reviewers of regularly updated “crash-courses” in the current issues affecting the conservation of xenarthrans in Paraguay is suggested as a useful tool in reaching this aim, and a revision of the main factors that reviewers should be considering at the time of writing is provided here for each of the Paraguayan species.

**Keywords:** anteater, armadillo, conservation assessment, Dasypodidae, IUCN, Myrmecophagidae

### Evaluando la evaluación. La relevancia de la evaluación de conservación de los mamíferos de 2006 del Paraguay para la realidad de la conservación de Xenarthra en 2012

**Resumen** La última revisión del estado de conservación de los mamíferos de Paraguay se realizó en 2006 y tan sólo dos especies de Xenarthra, *Myrmecophaga tridactyla* y *Priodontes maximus*, fueron consideradas amenazadas a nivel nacional. Esta última revisión sigue siendo la base para decisiones sobre el manejo de vida silvestre en el país, aunque actualmente esté desactualizada ya que Paraguay es un país donde el ambiente está cambiando de forma rápida. El siguiente trabajo identifica las dificultades asociadas con el proceso actual de revisión y ofrece soluciones a algunos de los problemas enfrentados con fines de facilitar el proceso y asegurar una lista más precisa del estado actual de la conservación de los Xenarthra de Paraguay durante la próxima revisión. La presentación a los revisores de una guía actualizada regularmente sobre las amenazas que afectan la conservación de los Xenarthra en Paraguay es sugerida como una herramienta útil para alcanzar este objetivo. Asimismo, se presenta aquí una exposición de los factores principales que los revisores deberían tener en cuenta en el momento de la revisión para cada una de las especies de Paraguay.

**Palabras clave:** Dasypodidae, Myrmecophagidae, oso hormiguero, revisión del estado de conservación, tatú, UICN

## INTRODUCTION

The last assessment of the conservation status of mammals in Paraguay was held in 2005 (SEAM, 2006) yet it is still being used as a baseline for management decisions on wildlife in Paraguay. Since this resolution however, Paraguay has seen considerable agricultural development in the previously largely pristine Chaco region, continuing environmental conflict in the Oriental region and a change in government policy towards greater exploitation

of the national resources of the country, including the lifting of a voluntary moratorium on exports of all species protected under the CITES agreement.

Under the SEAM (*Secretaría del Ambiente* / Ministry of the Environment) project *Proyecto de Conservación y Utilización de la Vida Silvestre* (Project for the Conservation and Utilization of Wildlife - henceforth PCUVS) permits are now being granted to companies that wish to exploit wildlife for profit based on a supposedly sustainable scheme

**TABLE 1.** Approved harvesting quotas for xenarthrans on a single permit issued to the wildlife export company “Animal Business” in 2010. Reproduced from Vinke & Vinke (2012).

Collecting site	<i>Ch.vellerosus</i>	<i>Ch.villosus</i>	<i>Eu.sexcinctus</i>	<i>To.matacus</i>	<i>Ta.tetradactyla</i>
Carmelo Peralta 20,000 ha			45	45	45
Campo Loro 10,475 ha	12		6	12	
10 de Febrero 5,000 ha	10		5	10	
Ebetogue 2,875 ha	52	52	26	51	
Ingapui 5,000 ha	3		2	3	
Chovoreca 20,002 ha	30		15	30	
Totals	107	52	99	151	45

of harvesting quotas (**TABLE 1**), with an established amount payable to the landowners on whose land the individual animals are captured. After passing through the system of governmental controls, animals can then be sold on the international markets for considerably higher sums. The mammal quotas were calculated, at least in part, on the extremely limited and frequently outdated distribution data that are readily available, in tandem with the conclusions of SEAM (2006).

The IUCN Red List Categories and Criteria (2001) recommend that “re-evaluation of taxa against the criteria should be carried out at appropriate intervals” and that “This is especially important for taxa listed under Near Threatened, Data Deficient, and for threatened taxa whose status is known or suspected to be deteriorating.” The regional IUCN guidelines (2003) state that “For the purposes of regional conservation assessments there are important reasons to assess species’ extinction risk and publish Red Lists within specific geographically defined areas.” Whilst an attempt was made to hold a mammal workshop during 2011 logistical factors meant that the meeting did not happen, and the seriously outdated results of the 2006 resolution remain active, despite the criteria for review having been fulfilled many years ago.

Given the chronic lack of reliable and up-to-date scientific data on populations and distribution of xenarthrans in Paraguay, it may be assumed that many of the designations made in the 2006 resolution were the result of inferences or in reference to older field data that were already out of date even at the time of the meeting. In fact only two species of xenarthrans were considered to be threatened at the national level (SEAM, 2006) and at least one xenarthran species (*Bradypus variegatus*) for which no evidence of its presence in Paraguay exists was considered and declared to be under no threat in the country (Morales, 2007).

The SEAM published two further lists of Paraguayan species on 25 May 2010 (though the bicentenary logo suggests that this document was

in fact released in 2011) on a “threatened species” page on their website (<http://www.seam.gov.py/especies-amenazadas.html>). The two lists are entitled “species threatened with extinction” and “species in danger of extinction”. Though they are clearly based in large part on SEAM (2006), neither list has an accompanying definition of the criteria for inclusion, nor makes any reference to IUCN categories. Under these lists *Myrmecophaga tridactyla* is classified as a “species threatened with extinction” and *Priodontes maximus* and *Cabassous chacoensis* are classified as “species in danger of extinction”. The preferential use of these arbitrary categories over the well-defined and established IUCN categories does little to clarify the extent or nature of the threats faced by the species included. Consequently the data upon which management decisions for fauna are being made may be considered to be at best unreliable or confusing and at worst leading to potentially grave consequences for the species affected. In other words, inaccurate threat categories may be exacerbating the problem of the conservation of xenarthrans in Paraguay by failing to reflect the true gravity of the situation at the national level.

This paper does not pretend to substitute for a new IUCN workshop to update conservation statuses in the country, but hopes to provide a succinct summary of available information and relevant issues currently affecting the conservation of xenarthrans in Paraguay that should be considered by workshop participants when the next meeting is finally held, as well as offering some recommendations on the application of IUCN criteria at the national level.

## DASYPODIDAE (ARMADILLOS)

General considerations: Armadillos are often amongst the most conspicuous members of the mammal fauna in Paraguay and their size, approachability, and comical appearances make them objects of curiosity. Because of the ease of capture, frequent diurnal activity and palatability, many species are seen as attractive targets for hunters. At night armadillos do not show reflective eyeshine, and the

habit of some species of foraging on or near roads means that they are frequent victims of roadkill. Reproductive strategies vary considerably between species, with the reproductive capacity of some genera being great, while that of others is extremely low (Smith, 2012).

### Tribe Euphractini

General considerations: The two genera of Euphractine armadillos (*Euphractus* and *Chaetophractus*) contain adaptable and successful species with wide geographical ranges (Wetzel *et al.*, 2008). They are omnivorous and their diet enables them to exploit food resources that most other armadillos are unable to utilize, such as carrion (Dalponte & Tavares-Filho, 2004). Reproduction is seasonal and though two young are typically produced, a short gestation period (*ca.* 2 months) means that a second breeding may be attempted if conditions allow (Neris *et al.*, 2002). Sexual maturity is reached by the end of the first year, meaning that the reproductive potential of these species is higher than that of most other xenarthrans.

#### *Euphractus sexcinctus* - Six-banded armadillo

A common, adaptable and widespread species, this is one of the most frequently-encountered armadillo species in Paraguay. It is found in a variety of habitats, but because of its size it is hunted for food in areas where its range comes into contact with human habitation. It is a frequent roadkill victim as a result of its diurnal activity, and the zigzagging flight behavior makes it difficult to avoid. However, due to its tolerance for habitat disturbance, high reproductive potential, presence in a number of protected areas, and unspecialized ecological requirements it is not under any obvious threats (Morales, 2007; Smith, 2007b).

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Least Concern (LC)

#### *Chaetophractus vellerosus* - Lesser or screaming hairy armadillo

A decline in the number of field observations of this species over the last few years has been noted by naturalists working within the species range in the Paraguayan Chaco. This is a small armadillo that is easily captured by hand and which makes a potentially attractive pet. Though the species may be hunted for food, its small size makes it less attractive to hunters than larger species. Recently permissions have been granted establishing quotas for the harvesting of lesser hairy armadillos by for-profit companies for export abroad under the PCUVS (example **TABLE 1**), and a value of 25,000 Gs (4.31 Euros) has been established per individual. Confirming whether the perceived recent decline in field observations

represents a real population down turn and investigating the potential causal factors should be considered a priority. The effects of harvesting quotas on populations, especially those in the most accessible areas of the species range, need to be closely monitored.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Near Threatened (NT)

Justification: The decline in the number of field observations of this species is probably indicative of a population reduction, and though the causes may not be clear, the inclusion of this species in the PCUVS program does not facilitate a recovery.

#### *Chaetophractus villosus* – Large or greater hairy armadillo

Though the Paraguayan range of this species is geographically restricted, this is a common species and the most frequently-encountered armadillo in the most arid areas of the Dry Chaco. Throughout most of its Paraguayan range human population pressure is low, and the small size of this armadillo compared to the abundant game animals in these areas means that it is likely to be under limited hunting pressure. It is able to tolerate considerable habitat modification, and though animals may be killed by dogs or on roads where they come into contact with humans, this is unlikely to have a major effect on the population. Abba & Superina (2010) note that the population of this species may be increasing in Argentina, and while population data for Paraguay are unavailable, they would seem to be stable for the moment. Recently permissions have been granted establishing quotas for the harvesting of large hairy armadillos by for-profit companies for export abroad (example **TABLE 1**). The effects of harvesting quotas on Paraguayan populations need, however, to be closely monitored.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Least Concern (LC)

### Tribe Chlamyphorini

#### *Calyptophractus retusus* - Chacoan fairy armadillo

Virtually nothing is known of the biology or ecological requirements of this species, though it is assumed it gives birth to a single young (Cuéllar, 2001; Cuéllar & Noss, 2004) and may be considered endemic to the Chaco (Abba & Superina, 2010). The species is restricted to areas with loose, sandy soils in the Dry Chaco region and hence the distribution in Paraguay is probably limited to the extreme northwestern Chaco in the Parque Nacional Teniente Agripino Enciso and Parque Nacional Médanos del



Chaco area. All known Paraguayan specimens come from that area and though this species is rarely observed it would seem that the collected specimens do reflect to some degree the limited Paraguayan range. Much of its presumed range is encompassed within the aforementioned national parks, though the protection provided by these parks is due more to their remoteness than the effectiveness of the protected areas system. However, in recent years the areas immediately adjacent to these parks have begun to see more development, and during 2011 several new *estancias* were being cleared directly opposite the northern Médanos del Chaco national park boundary (P. Smith, pers. obs.). Whilst this species may be able to tolerate some degree of habitat modification, the land clearing processes in use in the Chaco, involving bulldozing and burning of large areas, has the potential to cause considerable impact on unprotected populations of this relatively immobile, slow-moving species and will likely lead to a further constriction of the already limited range.

Global: Data Deficient (DD)

National: Previous Designation Least Concern (LC); Recommended Designation Vulnerable (VU) B1ab(iii)

Justification: *Calyptophractus retusus* qualifies as Vulnerable because the known geographic range in the form of area of occupancy is < 2,000 km<sup>2</sup>, severely fragmented and continuing to decline in area, extent, and quality of habitat.

### **Tribe Dasypodini**

General considerations: *Dasypus* armadillos are favored by local hunters in much of their Paraguayan range (Esquivel, 2001), and though *D. novemcinctus* is preferred for its size, the other species are probably not commonly distinguished by most hunters. The superficial similarity of the species of *Dasypus* means that field observations of smaller species are unreliable. The differences between species are subtle and morphological, and considerable confusion has existed over the identity of Paraguayan specimens and resulted in an incomplete knowledge of the distribution of the species. *Dasypus novemcinctus* may be considered a habitat generalist with a preference for forested areas (Meritt, 2008), but this is not the case for the other two species which much more heavily rely on natural grassland habitats (Abba *et al.*, 2007, 2011).

#### *Dasypus hybridus* - Southern long-nosed armadillo

We have been able to trace only two specimens of this species from Paraguay, one 19th Century specimen in the Royal Ontario Museum that lacks specific locality data and another misidentified as *D. septemcinctus* from Estancia Rama, Departamento Canindeyú in the Museo Nacional de Historia Natural del Paraguay. The Canindeyú specimen

is the only recent record (7 December 2006) of the species in Paraguay and no other information is currently available about its distribution or habitat preference in Paraguay. Azara's (1923) description of *Tatuejo-mulita* has been historically attributed to this species and includes the vague statement that it does not "pass north of 26 and a half, but is found to the south". Though the Canindeyú record suggests a wider distribution than Azara was aware of, in modern day Paraguay the area he describes coincides with the region of greatest habitat modification in the country due to large-scale agricultural practices. Abba *et al.* (2007) state that this species is typical of native, undisturbed grasslands in Argentina, though Abba *et al.* (2011) confirm that it is able to persist in highly-modified habitats. Given the lack of records and the large-scale habitat modification of much of its assumed range in Paraguay, the species may be assumed to have declined considerably and is likely threatened.

Global: Near Threatened (NT)

National: Previous Designation Least Concern (LC); Recommended Designation Data Deficient (DD)

Justification: The lack of clear information about the distribution of this species in Paraguay and the paucity of records mean that *D. hybridus* is best considered Data Deficient. A decline in populations in neighboring countries suggests that it may be eligible for uplisting in future. Additional population data are urgently required and a reassessment is recommended as soon as sufficient data become available.

#### *Dasypus novemcinctus* - Nine-banded armadillo

A widespread and adaptable species that is found in a variety of forested areas throughout the country, except the most arid areas of the extreme northwestern Chaco (Frutos & Van den Bussche, 2002; Meritt, 2008). With the reduction in large mammal populations in eastern Paraguay as a result of habitat loss and human pressure, *D. novemcinctus* has become the principal mammalian game species for hunters in the Oriental region. The nine-banded armadillo became more prominent in the diet of the Aché indigenous group between 1980 (when it represented 13.5% of the wild game in the diet) and 1994 (when it represented 43.1% of the diet), and a similar and increasing trend has likely occurred in other areas of eastern Paraguay as habitat loss has continued (Cartes, 2007). The species has very likely experienced a considerable decline in the Oriental region as a result of habitat destruction and hunting pressure, but it is still fairly common in some of the protected areas in eastern Paraguay. Frutos & Van den Bussche (2002) present genetic evidence that the species is in continuous range expansion in Paraguay. In the Central Chaco it is considered a delicacy, even

amongst people who do not depend on wild game for their meat, and is frequently sought by hunters (T. & S. Vinke, pers. comm.).

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Least Concern (LC)

#### *Dasypus septemcinctus* - Seven-banded armadillo

The seven-banded armadillo is extremely poorly represented in Paraguayan collections and the extent of its Paraguayan range is unclear. *Dasypus septemcinctus* was for a long time confused with *D. hybridus* until Hamlett (1939) clarified its diagnostic characters, rendering older bibliographical references to the species in Paraguay of questionable value unless they provide specific morphological information that facilitates a correct identification. In Paraguay sight records must be considered unreliable because of the danger of confusion with juvenile *D. novemcinctus*. Though notably smaller than adult nine-banded armadillos, the species can only be reliably distinguished from juveniles of that species using morphometric characteristics that require the close examination of the specimen (Hamlett, 1939). This species is associated principally with arid grassland habitats in most of its range and is able to tolerate moderate habitat modification (Aguiar & Fonseca, 2008). Silva & Barros-Henrique (2009) estimated an area of between 6,700 and 27,800 ha as necessary to maintain a viable population of seven-banded armadillos. The paucity of records and the preference for natural grasslands mean that the species is probably locally distributed in Paraguay, but perhaps overlooked because of confusion with *D. novemcinctus*.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Data Deficient (DD)

Justification: The lack of clear information about the distribution of this species in Paraguay and the paucity of records suggest that it is best considered Data Deficient.

### **Tribe Priodontini**

#### **Genus Cabassous**

General considerations: *Cabassous* armadillos are myrmecophagous and fossorial in habits, meaning that they are rarely observed and poorly represented in specimen collections. The wide use of pesticides in agricultural areas restricts food availability. No data are available on their population density in Paraguay, but they may be assumed to be naturally uncommon and probably locally distributed. *Cabassous* are slow moving and easily captured by hand, their main defense consisting of rapid

burrowing into the substrate. Little is known about their reproductive ecology, but typically a single young is born and consequently their capacity for population growth is limited (Wetzel, 1980).

#### *Cabassous chacoensis* - Chacoan naked-tailed armadillo

This species is surprisingly well-represented in Paraguayan specimen collections, but the specimen records are clumped and the area of occupancy documented by them is small, concentrated in the highly-sampled Central Chaco area. Though the distribution may be larger than currently assumed, there have been very few recent field records of the species. However, like all *Cabassous* armadillos it is difficult to observe and hence likely under-recorded, most often being seen prior to thunderstorms when it leaves its burrow (T. & S. Vinke, pers. comm.). Meritt (2008) reports just two sight records in the Paraguayan Chaco despite 20 years of field work and associates the species with open thorn forest or thorn scrub with porous, non-clay soil. Such soils are rare in the Paraguayan Chaco and are the most suitable for certain types of agriculture (especially peanuts, sesame, and sorghum), but *C. chacoensis* may even be found in pasture lands provided the correct soil type is available. The species is commonly mistaken for an abandoned juvenile *Priodontes maximus* and is sometimes taken into captivity with the intention to raise it and force fed with milk until it eventually dies (T. & S. Vinke, pers. comm.). Abba & Superina (2010) note that the global population may have declined by as much as 25% over the last 10 years as a result of increased human activity in the species range and that it is on the verge of being considered globally Vulnerable. The alarming increase in change of land usage in the Paraguayan Chaco may be inferred to be having a deleterious effect on populations of this poorly known species. Increased contact with humans, roads, and dogs also undoubtedly represent a major threat to this small and relatively defenseless armadillo.

Global: Near Threatened (NT)

National: Previous Designation Least Concern (LC); Recommended Designation Vulnerable (VU) A2c

Justification: *Cabassous chacoensis* qualifies as Vulnerable because of an inferred and continuing population size reduction of at least 30% over the last 10 years resulting in a decline in the area of occupancy, extent of occurrence, and quality of habitat.

#### *Cabassous unicinctus* - Southern naked-tailed armadillo

The presence of this species in Paraguay was documented by Smith *et al.* (2012), though a specimen in the Museo Nacional de Historia Natural del Paraguay (MNHN) dating from 1989 was also

located. The identification of the MNHNP specimen as *Cabassous tatouay* suggests that they have been confused in the past, and that all *Cabassous* armadillos captured in the Oriental region may habitually have been assumed to be *C. tatouay*. Currently known only from three localities in Departamentos San Pedro and Amambay, the known distribution of the species is associated with the *cerrado* eco-region of northern Paraguay. Ecological factors (e.g., fossorial habits) contribute to *Cabassous* armadillos being difficult to observe (Tomas *et al.*, 2009), but they are likely to be present throughout the Paraguayan *cerrado* at low density. Local people in San Pedro know the species but avoid eating it on account of its “strong smell” and one person interviewed claimed that people in the area do not eat it because of the belief that its consumption causes severe stomach pains (Smith, 2011). The principal threat to *C. unicinctus* at the global level is the conversion of its habitat to agriculture (Abba & Superina, 2010), and some degree of threat can perhaps be inferred at the national level given the restricted known range. Bonato *et al.* (2008) suggested that reproduction is seasonal and estimated that juveniles made up 9% of the population of *C. unicinctus* in their study area. The species is present in Parque Nacional Cerro Corá and the private Reserva Natural Laguna Blanca, though the latter is currently protected for a period of just five years since its declaration in 2010 (Decreto 3893 under Artículo 26 of Protected Areas Law 352/94).

Global: Least Concern (LC)

National: Previous Designation NOT LISTED; Recommended Designation Near Threatened (NT)

Justification: *Cabassous unicinctus* qualifies as Near Threatened because of an apparent association with the threatened *cerrado* habitat, presumed low density of occurrence, and increasing habitat degradation within the Paraguayan range. If the species proves to be more widespread than is currently known, then it may be eligible for downlisting given its occurrence in at least two protected areas.

#### *Cabassous tatouay* - Greater naked-tailed armadillo

The largest of the *Cabassous* is known from few Paraguayan specimens, and sight records are rare. As a large, slow-moving species it presumably represents an attractive target for hunters, though because of its low density it is likely hunted opportunistically rather than specifically targeted. In the period 1980 to 1996 only 24 individuals were taken by the indigenous Aché of the well-protected Mbaracayú Biosphere Reserve, representing just 0.8% of the wild game biomass that they consumed (Cartes, 2007). The recent discovery of *C. unicinctus* in eastern Paraguay (Smith *et al.*, 2012) raises the possibility that at least some of the previous sight records attributed to *C. tatouay* in fact refer to *C. unicinctus* and whilst the range of the species in the country

is apparently wide, populations are probably localized and small. The species is known to be present in several at least nominally protected areas within the Atlantic Forest and *cerrado* eco-regions, but no details on its population status are available and habitat fragmentation throughout the Oriental region has been severe.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Vulnerable (VU) A2c

Justification: *Cabassous tatouay* qualifies as Vulnerable because of an inferred and continuing population size reduction of at least 30% over the last 10 years resulting in a decline in the area of occupancy, extent of occurrence, and quality of habitat.

#### Genus *Priodontes*

General considerations: The same ecological considerations as for *Cabassous* are valid for *Priodontes*, though the exceptional size of this species makes it more conspicuous and more attractive to hunters, and, hence, under more intense pressure. Carter & Encarnação (1983) estimated home range sizes of 450 ha in Brazil. It is somewhat nomadic in behavior and though home ranges may overlap, the size of these ranges results in extremely low densities even in favorable habitats (Silveira *et al.*, 2009).

#### *Priodontes maximus* - Giant armadillo

Though specimen collections suggest a much wider geographic range for this species in Paraguay, it has in fact disappeared relatively recently from much of its former range in direct relation to the expansion of human habitation. *Priodontes maximus* is naturally rare and patchily distributed throughout its global range (Abba & Superina, 2010) and is now extinct in most of eastern Paraguay, though it may still occur locally in remote areas removed from human interference (Neris *et al.*, 2002). If such pockets of populations do persist they must be considered unsustainable given the current rates of human population growth and expansion of development in the Oriental region. All recent records are from the Chaco but there are no data available on the sustainability of these populations. With 286,000 ha of forest suffering a change of land use to agriculture in the Chaco during 2011 (Guyra Paraguay, unpublished data) and deforestation rates showing no sign of decreasing, the remaining giant armadillo populations must now be coming into increasingly frequent contact with humans, and the resultant habitat fragmentation will seriously restrict the availability of suitable habitat for this species. Though it is officially protected in Paraguay (SEAM, 2006), the enforcement of such protection measures are ineffective in the remote areas in which this species persists and where there is little knowledge of, or respect for,



environmental legislation. In fact, most recent records of giant armadillos in Paraguay are the result of hunters breaking this legislation and their infractions being reported in the national press. This was highlighted most recently during August 2010 when one hunter became the subject of investigation only after he had posted images of a hunted *Priodontes* on his Facebook account and these images reached the newspapers. The giant armadillo may thus be assumed to be on the verge of a serious population decline in Paraguay.

Global: Vulnerable (VU) A2cd

National: Previous Designation Endangered (EN); Recommended Designation Critically Endangered (CR) A4c

Justification: *Priodontes maximus* qualifies as Critically Endangered because of an inferred, projected, and continuing population reduction of at least 80% based on a decline in area of occupancy, extent of occurrence, and habitat quality.

### Genus *Tolypeutes*

#### *Tolypeutes matacus* - Southern three-banded armadillo

Ecological factors mean that this species is active both by day and night, and as a result of its non-fossorial behavior is more commonly encountered than other armadillos in the Paraguayan Chaco (Abba & Superina, 2010). As with all Tolypeutine armadillos the reproductive capacity is low, with a single young typical (Abba *et al.*, 2007).

This armadillo is confiding and easily captured by hand, making it a popular pet and the “preferred armadillo for the table” in the Chaco (H. del Castillo, pers. comm.). It is said to have the best flavor amongst the armadillos, and it is usually “cooked in the shell”, with hollowed out carapaces often found around hunters camp fires (Meritt, 2008).

The demand for three-banded armadillos in the pet trade means that since 2010 permissions have been granted establishing quotas for their harvesting by for-profit companies for export abroad under the PCUVS (example **TABLE 1**), and a value of 45,000 Gs (7.41 Euros) has been established per individual. On 10 February 2011 ABC newspaper reported that a permission granted by the SEAM to animal traders Johanna Aquino and Patricia Karina Varela for the export of 151 wild individuals of *T. matacus* (in addition to other species), represented an estimated market value of US\$ 52,850 in this species alone, and at least one other permission of this kind was granted to Wildlife Services S.A. (Bryce Owen) during the same year (T. & S. Vinke, pers. comm.). However, ineffective control measures once permits are granted have resulted in substandard transportation methods and alleged abuses of the system (Vinke & Vinke, 2012),

though judicial cases brought against permit holders have been unsuccessful.

Perhaps as a direct result of this trade, local naturalists based in the Chaco report an alarming decline in three-banded armadillos and other species habitually included on these permits in areas around the Mennonite Colonies (T. & S. Vinke, pers. comm.), compared with just a few years ago. In the most recent global conservation assessment for xenarthrans Abba & Superina (2010) cite Redford & Eisenberg (1992) that the species is “abundant in most xeric parts of the Paraguayan Chaco”, but whilst this may have been the case until relatively recently, it is no longer an abundant species in Paraguay and in fact appears to be in a steep and rapid decline. The availability of more recent published information may even have been sufficient for three-banded armadillos to have qualified for listing in a globally threatened category during the last global review.

Global: Near Threatened (NT)

National: Previous Designation Least Concern (LC); Recommended Designation Vulnerable (VU) A3cd

Justification: *Tolypeutes matacus* qualifies as Vulnerable because of a projected population size reduction of at least 30% over the next 10 years resulting from a decline in the area of occupancy, extent of occurrence, and quality of habitat and related to actual and potential levels of exploitation.

### Myrmecophagidae (Anteaters)

General considerations: Like all xenarthrans, anteaters do not show reflective eyeshine at night yet are even more susceptible to roadkill deaths than armadillos because of their poor eyesight, slow movements, and a tendency to stand on their hind legs in defensive position in the middle of the road when approached by a vehicle. Though in most of the country they do not figure in the diet of local people, they are treated as objects of curiosity and may be attacked by dogs in areas close to human habitation (Lacerda *et al.*, 2009). The wide use of pesticides in agricultural areas restricts food availability. Reproductive strategies are slow and costly in anteaters, with high investment in a single offspring and as a result the capacity for the recovery of diminishing populations is limited (Jerez & Halloy, 2003). In areas where populations are diminishing this can rapidly result in inbreeding and high genetic homogeneity (Collevatti *et al.*, 2007).

#### *Myrmecophaga tridactyla* - Giant anteater

Threats to this species are well understood, but have not ceased and it is not known whether they are reversible (Abba & Superina, 2010). Though casual observations seem to suggest that giant anteater populations remain healthy in the Chaco region, the species has all but disappeared from most of the



Oriental region where the density of human populations is much greater and the conversion of natural habitats to agriculture is most severe (Neris *et al.*, 2002). The rapid expansion of the agricultural frontier in the Chaco and the massive deforestation that has accompanied this over the last few years has the potential to rapidly alter the situation in western Paraguay; and *M. tridactyla* is probably undergoing a considerable associated decline. In eastern Paraguay it apparently persists only in the more remote areas of the northern Orient, an area that continues to undergo major land use changes.

The species is uniquely susceptible to death from wildfires, its long pelage being extremely flammable (Silveira *et al.*, 1999), and fire is commonly used in Paraguay for clearing of grassy habitats. Though the giant anteater is not generally hunted for food in most of the country, its slow movements, large size, and approachability mean that it is an attractive victim for sport hunters. A notable exception, however, is the Ayoreo indigenous group who considers it one of the most highly prized food species. It is commonly hunted out of areas surrounding their communities, and they may even travel in pursuit of the species (T. & S. Vinke, pers. comm.). It does not fare well near to busy roads, and a total of 12 roadkill victims were counted along the length of the Ruta Trans-Chaco (approximately 630 km) on 12 October 2007 (Smith, 2007a).

An additional and perhaps rarely considered threat to *M. tridactyla* in the Humid Chaco and Pantanal areas is associated with the natural and periodic flooding that affects this region. Though this is a natural process, flooding drives the species to islands of higher ground where it can still get access to food. This may act to concentrate populations, making them more vulnerable to predators, whilst accelerating habitat fragmentation has the potential to drive them into increasingly close contact with humans who also seek to settle high ground in this region. Flooding may be an as yet unconfirmed factor in sudden increases in the species presence on and around the raised areas of the Ruta Trans-Chaco. If this is the case, it would be extremely dangerous for inferences on population densities to be based on sight records or roadkill individuals associated with this major thoroughfare (one of the few roads that is permanently accessible in this region), and extrapolations to the Chaco as a whole may result in over-estimation of real populations. Given its low fecundity and the potentially irreversible consequences of habitat change in the core areas of the species Paraguayan range, a future population decline seems inevitable.

Global: Vulnerable (VU) A2c

National: Previous Designation Vulnerable (VU); Recommended Designation Vulnerable (VU) A4c

Justification: *Myrmecophaga tridactyla* qualifies as Vulnerable because of an inferred, projected, and continuing population reduction of at least 30% over a continuing ten year period based on a decline in area of occupancy, extent of occurrence, and habitat quality. Additional population data are urgently required and a reassessment is recommended as soon as sufficient data become available.

#### *Tamandua tetradactyla* - Southern tamandua

This adaptable species is able to tolerate a high degree of habitat degradation, and occurs throughout the country in all the major eco-regions. Though habitat fragmentation, coupled with the extensive use of pesticides in agricultural areas, is undoubtedly having a negative effect on populations, the species is unlikely to be declining fast enough to warrant threatened status yet. It remains common in the Humid Chaco and northern Oriental region, but it is a frequent roadkill victim. The reproductive capacity of this species is low, with sexual maturity reached at two years of age and a single young born annually after a gestation period of around 160 days (Redford & Eisenberg, 1992).

The tamandua is not seen as an attractive target for hunters in Paraguay and is more likely to be treated with curiosity by local people unfamiliar with the species. Such curiosity can, however, have negative consequences, with the animal either being captured and kept as a pet, handed over to zoos (in a misguided attempt to do the right thing), or unintentionally mistreated or killed. Since 2010 permissions have been granted establishing quotas for the harvesting of tamanduas by for-profit companies for export abroad under the PCUVS (example **TABLE 1**), and a value of 160,000 Gs (27.59 Euros) has been established per individual. Thomas and Sabine Vinke (pers. comm.) report a decrease in the number of roadkill tamanduas in the Chaco over the last few years, and this may represent a population decrease. Populations in areas where permits are active must be closely monitored.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Least Concern (LC)

## DISCUSSION

The designation of Red List categories is a serious process that depends to no small degree on the availability of reliable and up-to-date information for its success. The accuracy of such assessments thus depends in no small part on a thorough and taxon-specific understanding of the relevant threats

by each of the decision makers. Whilst decisions can be reached based on general concerns on habitat loss or extrapolation of issues applicable to a broad range of taxa (IUCN, 2001), the consideration of species-specific threats undoubtedly leads to much more reliable and effective results. The recognition that decision makers cannot be experts on all taxa, implies that some groups of species may be receiving more attention than others and that conservation threats may unconsciously be over-estimated or under-estimated as a byproduct of the knowledge base or interests of the group of assessors.

Such species-specific information is not always readily available, yet it is a duty of all participants in conservation assessment workshops to reach a conclusion that is as reflective of the current situation as possible. The reliance on outdated information, a handful of generalized publications or guesstimation of perceived trends based on personal and perhaps limited field experience is prone to serious errors influenced by the differing ecologies and behaviors exhibited by different species. With national conclusions also contributing to the decision making process on a global level, such errors of judgment could be having additional knock-on consequences for global conservation. At least two species that occur in Paraguay - *Cabassous chacoensis* and *Tolypeutes matacus* - may even have qualified for higher global threat statuses if more accurate national assessments had been available to the global evaluators. In order to combat this uncomfortable reality, the provision of country-specific summaries of important factors for consideration, such as this attempted here for xenarthrans, may be a valuable preparative tool for decision makers.

In Paraguay conservation planning meetings organized by the national IUCN committee aim to be inclusive, with numerous attendees and representatives of different organizations and agencies invited to contribute. Whilst this inclusive attitude is to be commended, it creates logistical difficulties that may have played a role in the infrequency of such meetings, with the availability of invitees complicating the fixture of suitable meeting dates. Additionally, time pressures associated with attempting to review multiple groups in a short space of time undoubtedly lead to insufficient consideration of some issues and rush the decision-making process to comply with the time constraints. One solution to this could be the holding of meetings for different taxonomic groups at different times (rather than attempting to assess all the mammals in one sitting), whilst summaries of this nature (that can and should be updated prior to each meeting) may also facilitate the process by providing decision makers with a crash course in taxon-specific issues in advance of the meeting as well as offering the opportunity for those unable to attend the meeting to offer their own comments for

consideration. Similar techniques aimed at streamlining the process are already being employed in neighboring countries such as Brazil.

A failure to address these factors in Paraguay has probably played a significant role in the infrequency of these meetings, the greatly inaccurate categories that are currently in place for mammals, and the unconscious role of these categorizations in potentially damaging decisions on wildlife management in Paraguay. The 2006 national threat categories proposed for Paraguayan xenarthrans fail to reflect the current level of threat faced by the species they are charged with protecting and are in urgent need of radical review lest they become complicit in the steep population declines that they aim to prevent. The regular and accurate updating of Red List categories for mammals is a basic requirement in their effective conservation, and the current infrequent and cumbersome review process employed for mammals in Paraguay is failing to achieve these aims. The preparation of frequently updated species summaries of this nature will assist in the streamlining of this process and may contribute towards a more effective conservation protocol for Paraguayan mammals in future.

## ACKNOWLEDGEMENTS

I thank Karen Colmán and Thomas Vinke for the provision of documentation that was invaluable to the preparation of this manuscript. Thomas and Sabine Vinke, Dr. Robert Owen, Dr. Agustín Abba, and Sergio Rios provided important comments that greatly improved the manuscript.

## REFERENCES

- Abba, A. M. & M. Superina. 2010. The 2009/2010 armadillo Red List assessment. *Edentata* 11: 135–184.
- Abba, A. M., S. F. Vizcaíno & M. H. Cassini. 2007. Effects of land use on the distribution of three species of armadillos in the Argentinean pampas. *Journal of Mammalogy* 88: 502–507.
- Abba, A. M., G. H. Cassini & F. C. Galliari. 2011. Nuevos aportes a la historia natural de la mulita pampeana *Dasypus hybridus* (Mammalia, Dasypodidae). *Iheringia* 101: 325–335.
- Aguiar, J. M. & G. A. B. da Fonseca. 2008. Conservation status of the Xenarthra. Pp. 215–231 in: *The Biology of the Xenarthra* (S. F. Vizcaíno & W. J. Loughry, eds.). University Press of Florida, Gainesville.
- Azara, F. de. 1923. *Viajes por la América meridional*. Calpe, Madrid. 259 pp.
- Bonato, V., E. G. Martins, G. Machado, C. Q. da Silva & S. F. dos Reis. 2008. Ecology of the armadillos

- Cabassous unicinctus* and *Euphractus sexcinctus* (Cingulata: Dasypodidae) in a Brazilian cerrado. *Journal of Mammalogy* 89: 168–174.
- Carter, T. S. & C. D. Encarnação. 1983. Characteristics and use of burrows by four species of armadillos in Brazil. *Journal of Mammalogy* 64: 103–108.
- Cartes, J. L. 2007. Patrones de uso de los mamíferos del Paraguay: importancia sociocultural y económica. Pp. 167–186 in: *Biodiversidad del Paraguay, una aproximación a sus realidades* (D. A. Salas-Dueñas & J. F. Facetti, eds.). Fundación Moisés Bertoni, USAID, GEF/BM, Asunción, Paraguay.
- Collevatti, R. G., K. C. E. Leite, G. H. B. de Miranda & F. H. G. Rodrigues. 2007. Evidence of high inbreeding in a population of the endangered giant anteater *Myrmecophaga tridactyla* (Myrmecophagidae) from Emas National Park. *Genetics and Molecular Biology* 30: 112–120.
- Cuéllar, E. 2001. The tatujeikurajoyava (*Chlamyphorus retusus*) in the Izozog communities of the Bolivian Gran Chaco. *Edentata* 4: 14–16.
- Cuéllar, E. & A. Noss. 2003. Mamíferos del Chaco y de la Chiquitania de Santa Cruz, Bolivia. Editorial FAN, Santa Cruz de la Sierra, Bolivia. 202 pp.
- Dalponete, J. C. & J. A. Tavares-Filho. 2004. Diet of the yellow armadillo *Euphractus sexcinctus* in south-central Brazil. *Edentata* 6: 37–41.
- Esquivel, E. 2001. Mamíferos de la reserva natural del Bosque Mbaracayú, Paraguay. Fundación Moisés Bertoni, Asunción, Paraguay. 95 pp.
- Frutos, S. D. & R. A. Van den Bussche. 2002. Genetic diversity and gene flow in nine-banded armadillos in Paraguay. *Journal of Mammalogy* 83: 815–823.
- Hamlett, G. W. D. 1939. Identity of *Dasypus septemcinctus* Linnaeus with notes on some related species. *Journal of Mammalogy* 20: 328–336.
- IUCN. 2001. IUCN Red List categories and criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. 30 pp.
- IUCN. 2003. Guidelines for application of IUCN Red List criteria at regional levels: Version 3.0. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. 26 pp.
- Jerez, S. del V. & M. Halloy. 2003. El oso hormiguero *Myrmecophaga tridactyla*: crecimiento e independencia de una cría. *Mastozoología Neotropical* 10: 323–330.
- Lacerda, A. C. R., W. M. Tomas & J. Marinho-Filho. 2009. Domestic dogs as an edge effect in the Brasília National Park, Brazil: interactions with native animals. *Animal Conservation* 12: 477–487.
- Meritt, D. 2008. Xenarthrans of the Paraguayan Chaco. Pp. 294–299 in: *The biology of the Xenarthra* (S. F. Vizcaíno & W. J. Loughry, eds.). University Press of Florida, Gainesville.
- Morales, M. A. 2007. Diversidad de mamíferos en Paraguay. Pp. 133–149 in: *Biodiversidad del Paraguay, una aproximación a sus realidades* (D. A. Salas-Dueñas & J. F. Facetti, eds.). Fundación Moisés Bertoni, USAID, GEF/BM, Asunción, Paraguay.
- Neris, N., F. Colman, E. Ovelar, N. Sukigara & N. Ishii. 2002. Guía de mamíferos medianos y grandes del Paraguay: distribución, tendencia poblacional y utilización. SEAM, Asunción, Paraguay. 165 pp.
- Redford, K. H. & J. F. Eisenberg. 1992. *Mammals of the Neotropics, Volume 2. The Southern Cone: Chile, Argentina, Uruguay, Paraguay*. The University of Chicago Press, Chicago. 430 pp.
- SEAM. 2006. Resolución número 524/06, por la cual se aprueba el listado de las especies de flora y fauna amenazadas del Paraguay.
- Silva, K. F. M. & R. P. Barros Henriques. 2009. Ecologia de população e área de vida do tatu-mirim *Dasypus septemcinctus* em um cerrado no Brasil central. *Edentata* 8–10: 48–53.
- Silveira, L., F. H. G. Rodrigues, A. T. de A. Jácomo & J. A. F. Diniz Filho. 1999. Impact of wildfires on the megafauna of Emas National Park, central Brazil. *Oryx* 33: 108–114.
- Smith, P. 2007a. Giant anteater *Myrmecophaga tridactyla*. FAUNA Paraguay handbook of the mammals of Paraguay 2. 18 pp. <<http://www.faunaparaguay.com/mamm2Myrmecophagatridactyla.pdf>>. Downloaded on 25 March 2012.
- Smith, P. 2007b. Six-banded armadillo *Euphractus sexcinctus*. FAUNA Paraguay handbook of the mammals of Paraguay 5. 16 pp. <<http://www.faunaparaguay.com/mamm5Euphractussexcinctus.pdf>>. Downloaded on 26 June 2012.
- Smith, P. 2011. Southern naked-tailed armadillo *Cabassous unicinctus*. FAUNA Paraguay handbook of the mammals of Paraguay 40. 11 pp. <<http://www.faunaparaguay.com/mamm40Cabassousunicinctus.pdf>>. Downloaded on 25 March 2012.
- Smith, P. 2012. Xenarthra. FAUNA Paraguay handbook of the mammals of Paraguay family account 2a. 35 pp. <<http://www.faunaparaguay.com>>.



com/2aXenarthra.pdf>. Downloaded on 25 March 2012.

- Smith, P., R. D. Owen, K. Atkinson, H. del Castillo & E. Northcote-Smith. 2012. First records of the southern naked-tailed armadillo *Cabassous unicinctus* (Linnaeus, 1758) (Xenarthra: Dasypodidae) in Paraguay. *Edentata* 12: 53–57.
- Tomas, W. M., A. R. Camilo, Z. Campos, R. M. Chiaravalloti, A. C. R. Lacerda, P. A. L. Borges, I. M. Medri, A. P. Nunes, M. A. Tomas, C. S. Goulart, H. B. Morzele, V. A. Lopes & M. Aragona. 2009. Ocorrência de tatu-de-rabo-mole *Cabassous unicinctus* (Cingulata, Dasypodidae) no Pantanal, Brasil. *Embrapa Boletim de Pesquisa e Desenvolvimento* 87: 1–19.
- Vinke, T. & S. Vinke. 2012. Legal wildlife trade. Schildkröten im Fokus Online, Bergheim 2: 1–15. <[http://www.schildkroeten-im-fokus.de/pdf/2012\\_1vinke\\_en.pdf](http://www.schildkroeten-im-fokus.de/pdf/2012_1vinke_en.pdf)>. Downloaded on 25 March 2012.
- Wetzel, R. M. 1980. Revision of the naked-tailed armadillos genus *Cabassous* McMurtrie. *Annals of the Carnegie Museum of Natural History* 49: 323–357.
- Wetzel, R. M., A. L. Gardner, K. H. Redford & J. F. Eisenberg. 2008. Order Cingulata Illiger, 1811. Pp. 128–156 in: *Mammals of South America, Volume 1: Marsupials, Xenarthrans, Shrews, and Bats* (A. L. Gardner ed.). The University of Chicago Press, Chicago.

*Received: 14 April 2012; Accepted: 25 July 2012*