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Research, part of a Special Feature on Do we need new management paradigms to achieve sustainability in tropical forests?

Integrating Ecosystem Management, Protected Areas, and Mammal Conservation in the Brazilian Amazon

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ABSTRACT. The Amazon forest has been converted to a matrix of pristine and modified habitats. Landscape-scale biodiversity conservation requires an understanding of species' distributions over this matrix to guarantee both effective protection and use for present and future generations. In this study, we evaluated how much of the existing and future planned protected areas (PAs) would be contributing to the conservation of Brazilian Amazon mammals (N = 399), including threatened species (N = 51). Currently, almost 37% of Brazilian Amazon is protected and that may increase to 46% if planned PAs are implemented. In the current PA system, 22% are indigenous land and 11% are sustainable use units, e.g., production forests. Only one-fifth of the whole range of mammal species occurring in Brazilian Amazon is actually protected by Brazilian PAs. However, considering only the part of the ranges within the Brazilian Amazon, and therefore under the scope of Brazilian actions, Brazilian PAs assume an important role in the protection of 39% of mammal distribution ranges, particularly the threatened species (39%). These results suggest that an integrated network of protected areas among Amazon countries would be necessary to increase their efficiency in mammal conservation. The need for strengthening of the forest sector and good management practices in Brazil appears critical for the maintenance of large extents of forest and species conservation. Under such a scenario, the contribution of developed nations and international agencies must assume an important role for the maintenance and enlargement of the protected area network in Amazon region.

Key Words: *biodiversity conservation; Brazilian Amazon; distribution ranges; mammal species; protected areas.*

INTRODUCTION

The advance of economic activities and their consequences for Amazon forests have been predicted and disseminated (Nepstad et al. 2001, Margulis 2003, Nepstad et al. 2004). The latest estimate of the deforestation rate for the Brazilian Amazon during the 2003–2004 period was 26,130 km^2 (INPE 2005), almost half of the size of Costa Rica. This is the second highest deforestation rate recorded for Brazilian Amazon. Its causes are associated with cattle ranching, agriculture, and land speculation, with strong consequences to biodiversity conservation.

Landscape management and successful conservation strategies requires an understanding of species' distributions, including which species are restricted to protected areas and which could be adequately protected outside these areas. For slowing the advance of deforestation and conserving the high biological diversity of the region, the Brazilian government has, among other initiatives, invested in a network of protected areas on public lands. The Brazilian conservation units are divided in two main categories: areas of integral protection, e.g., parks, biological reserves, and areas for sustainable use, e. g., national forests, extractives reserves, and sustainable development reserves. In the former category, the use or harvest of natural resources for commercial purposes is not allowed. Besides these two types of protected areas, in public lands there

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are also indigenous lands and military areas. Although they are not considered conservation units by Brazilian law they also have restricted use, not been allowed any economical activities. For the purpose of this study, hereafter, conservation units, indigenous land and military areas are collectively called protected areas (PAs). In addition to the existing PAs, future conservation units are planned for the Brazilian Amazon. The Amazon Region Protected Areas (ARPA) project is a Brazilian government initiative for a system of 28.5 X 10^6 ha of parks and other protected areas, i.e., more than 10% of the Brazilian Amazon, to be implemented over 10 yr (www.mma.gov.br). ARPA also includes the consolidation of some already existing conservation units. It is coordinated by the Ministry of Environment and executed by the Brazilian Environmental Agency (IBAMA), with support from the World Bank, the World Wildlife Fund (WWF) pilot program for tropical forest protection in Brazil (PPG-7), the Global Environmental Facility (GEF), and the German Aid Agency (KFW).

According to Brazilian law, two of the main objectives of the National System of Conservation Units (SNUC; law 9985 of 18 July 2000) are, (1) the maintenance of biological and genetic resources, and (2) the protection of threatened species. To the best of our knowledge, those objectives have never been evaluated on a large scale for the whole network of protected areas, possibly due to the complexity involved in that operation. This evaluation becomes even more important nowadays as the choice of location and design of new protected areas is to be made and given the fact that, in the past, many protected areas were implemented for political reasons and not for their biological relevance.

In this study, we evaluated how much of the existing protected areas and the future planned areas would be contributing to the conservation of Brazilian Amazon terrestrial mammals. We used mammal distribution ranges as a first proxy for this analysis. Mammals are a well-known group, with reliable geographic information and generally used as flagship species to represent other groups.

METHODS

We performed a search on mammal occurrences and distribution ranges in Brazilian Amazonia using the NatureServe’s InfoNatura databases as baseline (Patterson et al. 2003). Theses databases are a joint effort of the NatureServe, IUCN, and Conservation International, and were generated using published articles, reports, and expert inputs in several workshops. The output was species distribution maps, which are updated at least once a year. The maps provide a conservative estimate of the ranges as the methodology used probably results in an over-estimation of the distribution area for some species. However, it is currently the best data available and also has the support and contribution of several mammal experts who participated in the workshops and continue to send their comments to update the databases. Therefore, we used these individual species distribution maps as the starting point of our analyses.

Mammal distribution ranges were superimposed on a map of the Brazilian Amazon and all species with part (> 1%) or all of their ranges within Brazilian Amazonia were selected. The Brazilian part of the range of selected species was then superimposed on a map of protected areas, and a map of the Amazon Region Protected Areas (ARPA). Subsequently, we recorded the percentage of overlap between species ranges and protected areas. This gave a general estimate of the potential effectiveness of the design, size, and location of protected areas (PAs) in protecting mammal species. We also performed analyses using a subset of these data, evaluating the case of threatened species. The list of threatened mammal species corresponds with the IUCN Red List. In a conservative approach, we also included in our analyses mammals in the “near-threatened” category.

We observed a high degree of overlap among PA boundaries. As there is no agreement related to the real contour of those areas yet, we had to assume an arbitrary criterion to remove these areas of overlap every time that occurred. Therefore, we first identified indigenous land boundaries, i.e., the most abundant, then, discounting areas of overlapping, we identified federal conservation units and, finally, state units. This step was important to avoid measuring the overlap between a mammal range and a PA twice in instances when a PA overlays another PA.

RESULTS

Currently, almost 37% of Brazilian Amazon is protected, when overlapping areas are removed (Fig. 1). Once implemented, the Amazon Region Protected Areas (ARPA) project would increase this percentage to 46% (Table 1). Indigenous lands (*N* = 355) occupy almost 21% of the Brazilian Amazon and are by far the most extensive PA network, followed by federal units, i.e., 9.3% of the area, state units (6.6%). Military areas (*N* = 20) cover only a small portion of the Brazilian Amazon (0.5%). The current overlap among different types of PAs may causes differences in area varying from 7.5% for state units to 49% for military areas (Table 1).

Among federal conservation units (*N* = 127), we distinguished 42 areas of integral protection, i.e., 4.6% of Brazilian Amazon, and 85 areas of sustainable use (4.8%). For state units (*N* = 196), there are 54 areas of integral protection (0.9%) and 142 areas of sustainable use (5.6%).

We recorded 399 mammal species for the entire Brazilian Amazon (Appendix). The overlap of their ranges generated a map, which indicated the areas with potential higher species richness (Fig. 2a). The western Amazon, the region along the Amazon River, and the north of Brazilian Amazon stand out as having the highest species richness. Overlaying PAs and military areas maps and this specie richness map allows a spatial visualization of the contribution of each unit in the conservation of mammal diversity (Fig. 2b–e; see details below).

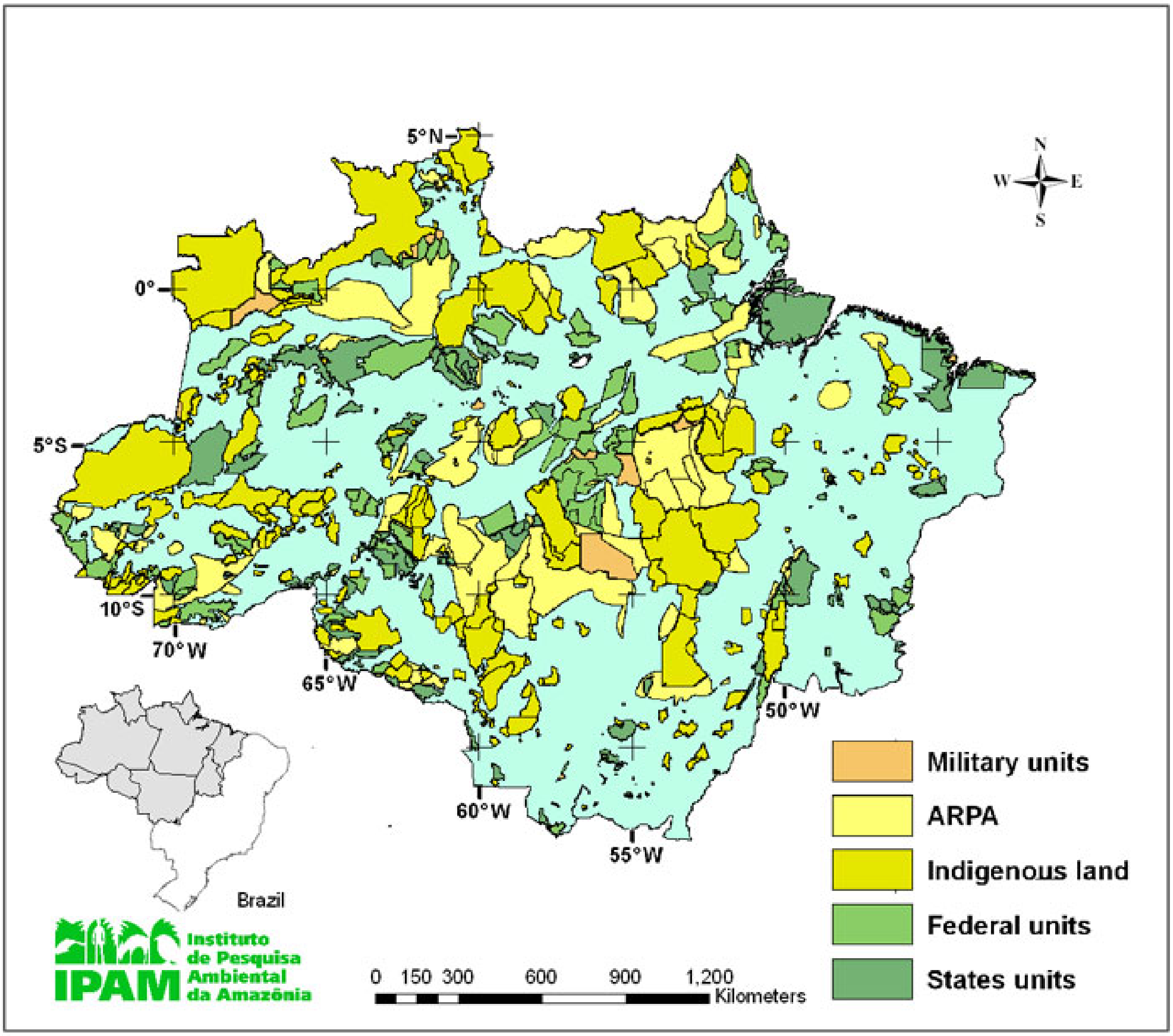
In many cases, the range of a species exceeded the limits of the Brazilian Amazon and even of the Amazon basin. Therefore, we analyzed the contribution of Brazilian PAs considering this perspective. If we consider the whole distribution of a species, here called “Total range”, or only the part their distribution comprising the Amazonia, “Panamazonia”, the Brazilian PAs and military areas overlap with 18.7% and 24% of species ranges, respectively (Table 2). With ARPA implementation, that percentage may increase to 23% and 30%, respectively. The number of Brazilian mammal species that have at least a small part of their ranges inside a federal or state unit is considerable (*N* = 363 and 353, respectively). For indigenous land the number of mammals is slightly higher (*N*= 375). However, the mean proportion of their range within those units regarding their distribution in the Brazilian Amazonia is much lower than indigenous land (Table 2). Considering only part of the ranges effectively within the Brazilian Amazon boundaries, on average, 39% of mammal ranges are already protected within PAs and military areas, with 22% in indigenous lands, 10% in federal units, 7% in state units and 0.3% in military areas (Table 2). With the implementation of ARPA, almost 47% of mammal ranges would be included in PAs.

Among federal units, the percentage of overlapping between mammal ranges and areas of sustainable use (4.78%) or integral protection (4.76%) was very similar. On the other hand, among state units, areas of sustainable use exhibited a higher rate of overlapping (5.7%) than integrally protected areas (1.1%). Those differences have serious conservation implications as areas of sustainable use may have economic exploitation, e.g., extracting of timber, ecotourism, they demand a closer monitoring of impacts.

A similar approach can be used for subsets of the data or for species of special interest. Using as examples groups of mammals that normally receive the attention of conservationists, we observed that for 79 primate species found in the Brazilian Amazon, 28% of their whole range is contained within Brazilian PAs (Table 2). Considering just the part of the range within the Brazilian Amazon, almost 42% of their distribution ranges are included in PAs, i.e., 22% in indigenous land, 12% in federal units, and 8% in state units. The ARPA project would include another 10% of primate ranges, increasing the percentage of protected range to 53% (Table 2). Generally, primates have a more restricted range within the Amazon basin than, for instance, cats (*N* = 8), whose ranges overlapped 31% with PAs and military areas without ARPA and 38% with ARPA (Table 2). Small mammals, such as marsupials (*N* = 28), had 40% of their range contained in PAs, e.g., 19.7% in indigenous land, 8.5% in federal units, and 12% in state units. With ARPA (5%), this rate would increase to 45% (Table 2).

Overall, a total of 51 Brazilian Amazon mammal species are considered threatened based on IUCN red list, but only 22 species from those are in the Brazilian Environmental Agency (IBAMA) Red List. Considering their whole distribution range, the Brazilian PAs contributed to the protection of 18%,

Fig. 1. Current and future planned protected areas (ARPA) in the Brazilian Amazon.



without ARPA, or 21%, with ARPA, of the total species ranges. Taking into account only part of the range within Brazilian Amazon boundaries, 39%, without ARPA, or 45%, with ARPA, of their ranges overlap with PAs (Table 2).

Considering all Brazilian mammal species, currently 263 species have from 31–50% of their ranges protected by some kind of PAs (Table 3). With ARPA implemented, the majority of species (N = 198) would have from 41–60% of their ranges protected (Table 3).

Table 1. Size (km^2) of protected areas (PAs) in the Brazilian Amazon with and without overlap with other units. PI = integral protection; US = sustainable use.

	Total Area (with overlap)[a]	Total area (%)	Real Area without overlap[b]	Real area (%)	Differences $^{(a-b)}$	Differences (%)
State PAs	359905.41	7.96	332744.77	6.56	27160.64	7.55
IP	63852.03	1.26	46179.59	0.91	17672.44	27.68
SU	296053.38	5.83	286565.18	5.65	9488.20	3.20
Federal PAs	571527.75	11.26	473918.29	9.34	97609.45	17.08
IP	246113.78	4.85	231783.75	4.57	14330.03	5.82
SU	325413.97	6.41	242134.54	4.77	83279.42	25.59
Indigenous land	1063694.34	20.96	106394.34	20.96	0	0.00
Military areas	51418.08	1.01	26271.42	0.52	24946.66	48.71
ARPA	639481.36	14.60	458813.99	9.04	180667.37	28.25
Total without ARPA	2046345.59	40.32	1896628.82	**37.37**	149716.76	7.32
Total with ARPA	2685826.95	52.92	2355442.82	**46.41**	330384.13	14.30

Note: Total area of Brazilian Amazon = 5,075,032 km^2

DISCUSSION

For Amazon mammal species that occur in Brazil, less than one-fifth of their whole distribution range is protected under Brazilian Protected areas (PA) system. This shows that it is unlikely that only Brazilian PAs could protect Amazon mammal species. An integrated network of protected areas among Amazon countries appears necessary to increase the contribution of these areas to mammal conservation. For that, a similar analysis of this study should be done in neighboring Amazon countries to have a broader perspective of the protection status of some species. On the other hand, considering only the part of the ranges within Brazilian Amazon, and therefore under the scope of Brazilian actions, Brazilian PAs play an important role in the protection of 40% of mammal distribution ranges, including the threatened species (39%).

Indigenous lands, although not officially part of the conservation unit system, offer a great potential for the conservation of mammals, i.e., 22% of overlapping. As indigenous lands in Brazil occupy an area almost the size of Bolivia, they have a disproportional relevance in the conservation of fauna compared, for instance, to parks, which are 4 times smaller in size. Even though mammals are subjected to hunting in indigenous land, the potentially negative effect of this activity may be

Fig. 2. Map of richness of mammal ranges ($N = 399$) for Amazonia superimposed on main protected areas: federal conservation units, state conservation units, indigenous land, and Amazon Region Protected Areas (ARPA). The darker the color, the higher the richness.

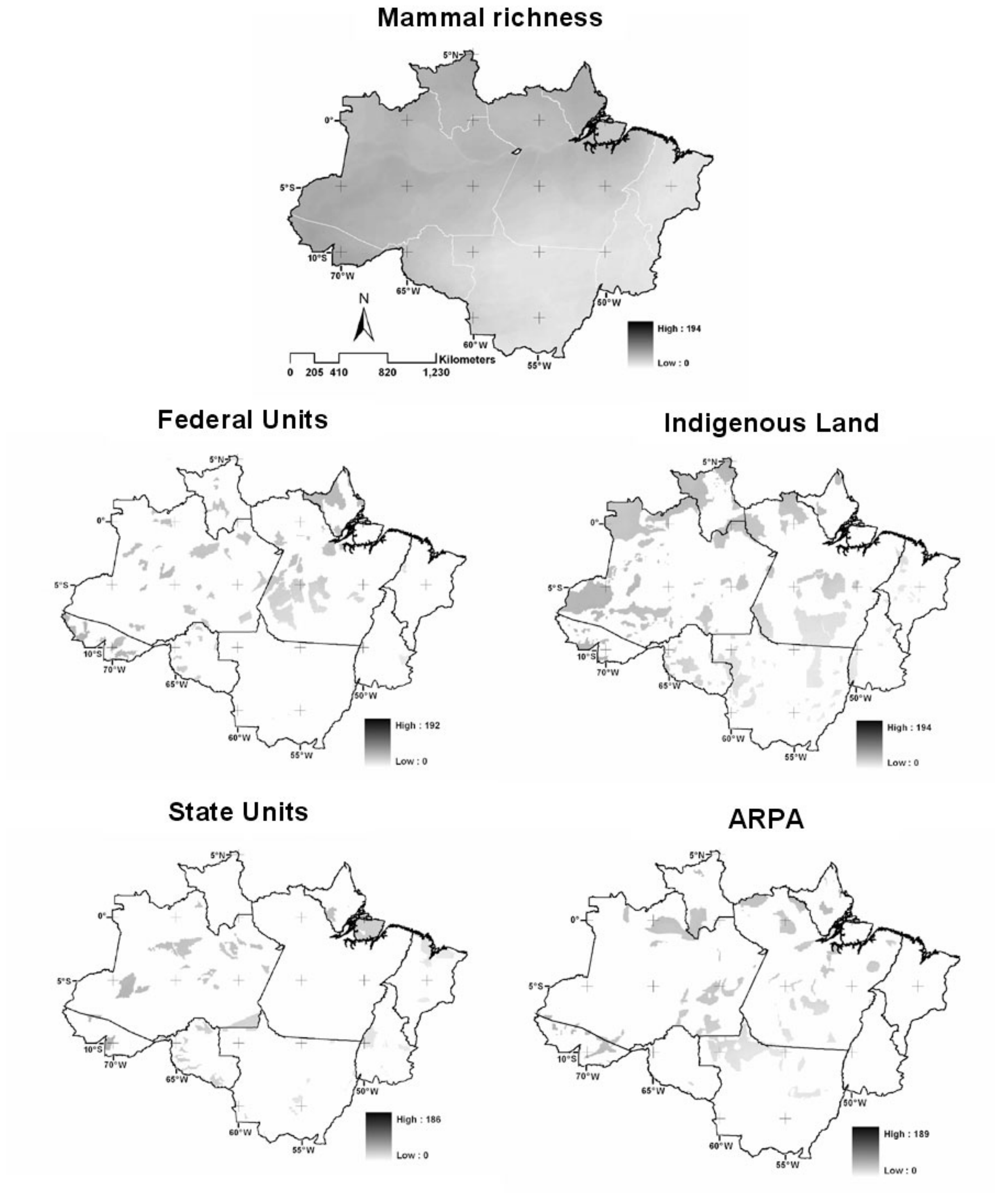


Table 2. Percentage of overlap between mammal ranges and protected areas in the Brazilian Amazon, considering their total range, part of their ranges in Amazonia, i.e., “Panamazonia”, and only part of their ranges in the Brazilian Amazon (“Braz. Amaz.”). IL = indigenous land; FED = Federal units; ST = State units; MI = military areas.

Groups	Range	ARPA	IL	FED	ST	MI	With ARPA	Without ARPA
Total (*N* = 400)	Total range	4.5	9.9	5.0	3.6	0.1	23.2	18.7
	Panamazonia	5.6	13.0	6.3	4.9	0.2	30.0	24.4
	Braz. Amaz.	8.1	22.1	9.8	7.2	0.3	47.4	39.4
Primates (*N* = 79)	Total range	8.5	14.0	7.9	5.8	0.2	36.4	27.9
	Panamazonia	8.7	14.6	8.06	6.2	0.2	37.7	29.1
	Braz. Amaz.	10.5	21.8	12.1	8.3	0.2	52.8	42.4
Cats (*N* = 8)	Total range	2.2	5.2	2.3	3.4	0.1	13.3	11.1
	Panamazonia	4.7	11.0	4.8	4.8	0.3	25.6	20.9
	Braz. Amaz.	6.8	16.5	6.9	7.1	0.4	37.7	30.9
Marsupials (*N* = 28)	Total range	2.5	8.9	3.8	7.4	0.1	22.7	20.1
	Panamazonia	3.3	11.2	5.0	9.2	0.1	28.8	25.5
	Braz. Amaz.	5.0	19.7	8.0	11.7	0.2	45.1	40.1
Threatened species (*N* = 51)	Total range	2.9	7.8	3.1	6.7	0.1	20.7	17.7
	Panamazonia	3.9	11.3	4.2	8.3	0.2	27.9	24.0
	Braz. Amaz.	5.6	20.4	6.8	11.7	0.2	44.8	39.1

minimized given the size of these lands compared to the low density of the indigenous population. That may allow a rapid recovery of game species although we do need more research on this subject. A recent study showed no difference regarding the inhibition of deforestation or fire between indigenous land and parks in Brazilian Amazon (Nepstad et al. 2006). The authors also concluded that as indigenous lands are usually located in areas of agricultural frontier expansion while parks are located in remote areas, the former would have an important role as barriers for deforestation and forest fires.

Federal and state units together include only 17% of the mammal ranges. That may be not enough for effective protection. Overall, sustainable use category, that which allows the performance of economic activities within its boundaries, comprises the largest amount of area (11%) compared to integral protection (6%), indicating the relevance of a good forest management to avoid

Table 3. Number of mammal species in different categories of range overlap with protected areas.

Range overlap (%)	# species without ARPA	# species with ARPA
0-0.9%	3	2
1-10%	10	8
11-20%	32	12
21-30%	35	26
31-40%	154	37
41-50%	109	154
51-60%	25	88
61-70%	14	31
71-80%	4	12
81-90%	2	6
91-100%	8	9

species losses in those areas. Among these units, state units would be the most fragile regarding conservation not only because the sustainable use category occurs in higher number and size, but also because within this category, the models of use allow large economic and demographic use, e.g., “APA” area of environmental protection, but which may include an urban area. Also, it worth to notice that state units comprises a higher portion of threatened species ranges within their areas compared to federal units.

With the Brazilian government effort to increase PAs from 37–46% of Brazilian Amazon area in the next 10 yr, the protected fraction of mammal ranges would be 1.2 times larger than what already exists. That alone would already be extremely positive, but there is a chance that with the same size but better design and location of those areas, the biological relevance of these additional areas could be improved. For instance, detailed evaluations of other parameters, such as other taxa, the presence of species of interest, areas of higher richness, relevant environmental variables, and proximity to human communities may be used to decide between different types of categories of protection. Additionally, it would be necessary to consider the impoverishment of forests due to logging (e.g., Azevedo-Ramos et al. 2005, 2006) and hunting within and outside the protected boundaries. Those actions would probably result in better conservation of an important fraction of Amazon fauna. The evaluation of these effects was beyond the objectives of this study, but they certainly need to be investigated for a better estimate of the status of protection of mammals in PAs and to better determine alternatives to mitigate the negative impacts.

Several parks, reserves, and indigenous land were analyzed for the direct and indirect effects of land use outside their boundaries. For instance, disturbances outside the protected limits can reduce by 15% the rainfall inside parks in tropical Africa (Roy et al. 2005). Plant richness of tropical forests is highly correlated to precipitation (Givnish 1999, Taplin and Lovett 2003) and plants have great influence on the richness of other taxa (Kay et al.

1997, Andrews and O'Brian 2000). Therefore, an evaluation of the influence of the surroundings on the ecosystem health of PAs is necessary to better guarantee the protection of biodiversity inside conservation units and indigenous land. For that and also to guarantee a largescale, integrated approach, it would be necessary to adopt a landscape approach as new management paradigm for PAs.

In a recent study that evaluated future scenarios of development for Panamazonia, we estimated that keeping the current trend of relatively little governance and increasing the infrastructure network, i.e., mainly roads, 30% of mammal species (N = 382) would have less than 60% of their range remaining due to accumulated deforestation until 2050 (Soares-Filho et al. 2006). The fact that currently, without ARPA, almost 61% of mammal ranges occur outside protected areas, reinforces the necessity of valuing forestry activities outside those boundaries that guarantee larger vegetation cover, larger and better ecological corridors, and genetic flux among population. With the implementation of ARPA, we would have 47% of mammal ranges within PAs. That demonstrates the importance of ARPA for a better protection of this group, but also indicates that actions that increase governance and better land use outside these units are of extreme importance to maximize the conservation of this animal group and biodiversity in general. Environmentalists and the Brazilian government should keep this in mind, to distribute their efforts and resources proportionally.

The conservation of the current 37% or future 46% of Brazilian Amazon Forest within PAs is a monumental effort for a developing country like Brazil. The role of large forest areas, like the Amazon Basin, is of undeniable importance for global climate and the conservation of genetic resources. Deforestation in the Brazilian Amazon releases about 200 X 10^6 tons of C/yr, that is, 2–3% of total human emissions (Houghlton 2001). This increases to 10%, if emissions from logging and forest fire are included (Nepstad et al. 1999). Additionally, one third of the global biodiversity is in Amazonia.

In this sense, the strengthening of the forest sector in Brazil as an economical alternative to ranching and agriculture becomes critical for the maintenance of large extents of forest. Also, new economic mechanisms taking advantages of the carbon market, such as compensated reduction of deforestation (Moutinho and Schwartzman 2005, Santilli et al. 2005), should not be underestimated as new economic sources for conservation. Of equal importance is the contribution of developed nations and international agencies for the maintenance and enlargement of these protected area networks.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol11/iss2/art17/responses/

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APPENDIX. List of Brazilian Amazon mammals used for the analyses.

Order	Family	Scientific Name
Artiodactyla	Cervidae	*Blastocerus dichotomus*
Artiodactyla	Cervidae	*Mazama americana*
Artiodactyla	Cervidae	*Mazama gouazoubira*
Artiodactyla	Cervidae	*Odocoileus virginianus*
Artiodactyla	Cervidae	*Ozotoceros bezoarticus*
Artiodactyla	Tayassuidae	*Pecari tajacu*
Artiodactyla	Tayassuidae	*Tayassu pecari*
Carnivora	Canidae	*Atelocynus microtis*
Carnivora	Canidae	*Cerdocyon thous*
Carnivora	Canidae	*Chrysocyon brachyurus*
Carnivora	Canidae	*Pseudalopex vetulus*
Carnivora	Canidae	*Speothos venaticus*
Carnivora	Felidae	*Herpailurus yaguarondi*
Carnivora	Felidae	*Leopardus pardalis*
Carnivora	Felidae	*Leopardus tigrinus*
Carnivora	Felidae	*Leopardus wiedii*
Carnivora	Felidae	*Lynchailurus braccatus*
Carnivora	Felidae	*Panthera onca*
Carnivora	Felidae	*Puma concolor*
Carnivora	Mustelidae	*Eira barbara*
Carnivora	Mustelidae	*Galictis vittata*
Carnivora	Mustelidae	*Lontra longicaudis*
Carnivora	Mustelidae	*Mustela africana*
Carnivora	Mustelidae	*Pteronura brasiliensis*
Carnivora	Procyonidae	*Bassaricyon beddardi*
Carnivora	Procyonidae	*Nasua nasua*

(con'd)

Carnivora	Procyonidae	*Potos flavus*
Carnivora	Procyonidae	*Procyon cancrivorus*
Chiroptera	Emballonuridae	*Centronycteris maximiliani*
Chiroptera	Emballonuridae	*Cormura brevirostris*
Chiroptera	Emballonuridae	*Cyttarops alecto*
Chiroptera	Emballonuridae	*Diclidurus albus*
Chiroptera	Emballonuridae	*Diclidurus ingens*
Chiroptera	Emballonuridae	*Diclidurus isabellus*
Chiroptera	Emballonuridae	*Diclidurus scutatus*
Chiroptera	Emballonuridae	*Peropteryx kappleri*
Chiroptera	Emballonuridae	*Peropteryx macrotis*
Chiroptera	Emballonuridae	*Rhynchonycteris naso*
Chiroptera	Emballonuridae	*Saccopteryx bilineata*
Chiroptera	Emballonuridae	*Saccopteryx canescens*
Chiroptera	Emballonuridae	*Saccopteryx gymnura*
Chiroptera	Emballonuridae	*Saccopteryx leptura*
Chiroptera	Furipteridae	*Furipterus horrens*
Chiroptera	Molossidae	*Cynomops abrasus*
Chiroptera	Molossidae	*Cynomops paranus*
Chiroptera	Molossidae	*Cynomops planirostris*
Chiroptera	Molossidae	*Eumops auripendulus*
Chiroptera	Molossidae	*Eumops bonariensis*
Chiroptera	Molossidae	*Eumops glaucinus*
Chiroptera	Molossidae	*Eumops hansae*
Chiroptera	Molossidae	*Eumops perotis*
Chiroptera	Molossidae	*Eumops trumbulli*
Chiroptera	Molossidae	*Molossops neglectus*
Chiroptera	Molossidae	*Molossops temminckii*
Chiroptera	Molossidae	*Molossus bondae*

(con'd)

Chiroptera	Molossidae	*Molossus molossus*
Chiroptera	Molossidae	*Molossus rufus*
Chiroptera	Molossidae	*Neoplatymops mattogrossensis*
Chiroptera	Molossidae	*Nyctinomops aurispinosus*
Chiroptera	Molossidae	*Nyctinomops laticaudatus*
Chiroptera	Molossidae	*Nyctinomops macrotis*
Chiroptera	Molossidae	*Promops centralis*
Chiroptera	Molossidae	*Promops nasutus*
Chiroptera	Mormoopidae	*Pteronotus davyi*
Chiroptera	Mormoopidae	*Pteronotus gymnonotus*
Chiroptera	Mormoopidae	*Pteronotus parnellii*
Chiroptera	Mormoopidae	*Pteronotus personatus*
Chiroptera	Natalidae	*Natalus stramineus*
Chiroptera	Noctilionidae	*Noctilio albiventris*
Chiroptera	Noctilionidae	*Noctilio leporinus*
Chiroptera	Phyllostomidae	*Ametrida centurio*
Chiroptera	Phyllostomidae	*Anoura caudifer*
Chiroptera	Phyllostomidae	*Anoura geoffroyi*
Chiroptera	Phyllostomidae	*Artibeus concolor*
Chiroptera	Phyllostomidae	*Artibeus jamaicensis*
Chiroptera	Phyllostomidae	*Artibeus lituratus*
Chiroptera	Phyllostomidae	*Artibeus obscurus*
Chiroptera	Phyllostomidae	*Carollia brevicauda*
Chiroptera	Phyllostomidae	*Carollia castanea*
Chiroptera	Phyllostomidae	*Carollia perspicillata*
Chiroptera	Phyllostomidae	*Chiroderma salvini*
Chiroptera	Phyllostomidae	*Chiroderma trinitatum*
Chiroptera	Phyllostomidae	*Chiroderma villosum*
Chiroptera	Phyllostomidae	*Choeroniscus godmani*

(con'd)

Chiroptera	Phyllostomidae	*Choeroniscus minor*
Chiroptera	Phyllostomidae	*Chrotopterus auritus*
Chiroptera	Phyllostomidae	*Dermanura anderseni*
Chiroptera	Phyllostomidae	*Dermanura cinerea*
Chiroptera	Phyllostomidae	*Dermanura glauca*
Chiroptera	Phyllostomidae	*Dermanura gnoma*
Chiroptera	Phyllostomidae	*Dermanura phaeotis*
Chiroptera	Phyllostomidae	*Desmodus rotundus*
Chiroptera	Phyllostomidae	*Diaemus youngi*
Chiroptera	Phyllostomidae	*Diphylla ecaudata*
Chiroptera	Phyllostomidae	*Ectophylla macconnelli*
Chiroptera	Phyllostomidae	*Glossophaga commissarisi*
Chiroptera	Phyllostomidae	*Glossophaga longirostris*
Chiroptera	Phyllostomidae	*Glossophaga soricina*
Chiroptera	Phyllostomidae	*Glyphonycteris daviesi*
Chiroptera	Phyllostomidae	*Glyphonycteris sylvestris*
Chiroptera	Phyllostomidae	*Lampronycteris brachyotis*
Chiroptera	Phyllostomidae	*Lichonycteris obscura*
Chiroptera	Phyllostomidae	*Lionycteris spurrelli*
Chiroptera	Phyllostomidae	*Lonchophylla handleyi*
Chiroptera	Phyllostomidae	*Lonchophylla thomasi*
Chiroptera	Phyllostomidae	*Lonchorhina aurita*
Chiroptera	Phyllostomidae	*Lonchorhina inusitata*
Chiroptera	Phyllostomidae	*Macrophyllum macrophyllum*
Chiroptera	Phyllostomidae	*Micronycteris behnii*
Chiroptera	Phyllostomidae	*Micronycteris hirsuta*
Chiroptera	Phyllostomidae	*Micronycteris megalotis*
Chiroptera	Phyllostomidae	*Micronycteris microtis*
Chiroptera	Phyllostomidae	*Micronycteris schmidtorum*

(con'd)

Chiroptera	Phyllostomidae	*Mimon bennettii*
Chiroptera	Phyllostomidae	*Mimon crenulatum*
Chiroptera	Phyllostomidae	*Phylloderma stenops*
Chiroptera	Phyllostomidae	*Phyllostomus discolor*
Chiroptera	Phyllostomidae	*Phyllostomus elongatus*
Chiroptera	Phyllostomidae	*Phyllostomus hastatus*
Chiroptera	Phyllostomidae	*Phyllostomus latifolius*
Chiroptera	Phyllostomidae	*Platyrrhinus brachycephalus*
Chiroptera	Phyllostomidae	*Platyrrhinus helleri*
Chiroptera	Phyllostomidae	*Platyrrhinus infuscus*
Chiroptera	Phyllostomidae	*Platyrrhinus lineatus*
Chiroptera	Phyllostomidae	*Platyrrhinus recifinus*
Chiroptera	Phyllostomidae	*Pygoderma bilabiatum*
Chiroptera	Phyllostomidae	*Rhinophylla fischerae*
Chiroptera	Phyllostomidae	*Rhinophylla pumilio*
Chiroptera	Phyllostomidae	*Scleronycteris ega*
Chiroptera	Phyllostomidae	*Sphaeronycteris toxophyllum*
Chiroptera	Phyllostomidae	*Sturnira lilium*
Chiroptera	Phyllostomidae	*Sturnira tildae*
Chiroptera	Phyllostomidae	*Tonatia brasiliense*
Chiroptera	Phyllostomidae	*Tonatia carrikeri*
Chiroptera	Phyllostomidae	*Tonatia saurophila*
Chiroptera	Phyllostomidae	*Tonatia schulzi*
Chiroptera	Phyllostomidae	*Tonatia silvicola*
Chiroptera	Phyllostomidae	*Trachops cirrhosus*
Chiroptera	Phyllostomidae	*Trinycteris nicefori*
Chiroptera	Phyllostomidae	*Uroderma bilobatum*
Chiroptera	Phyllostomidae	*Uroderma magnirostrum*
Chiroptera	Phyllostomidae	*Vampyressa bidens*

(con'd)

Chiroptera	Phyllostomidae	*Vampyressa pusilla*
Chiroptera	Phyllostomidae	*Vampyrodes caraccioli*
Chiroptera	Phyllostomidae	*Vampyrum spectrum*
Chiroptera	Thyropteridae	*Thyroptera discifera*
Chiroptera	Thyropteridae	*Thyroptera lavali*
Chiroptera	Thyropteridae	*Thyroptera tricolor*
Chiroptera	Vespertilionidae	*Eptesicus brasiliensis*
Chiroptera	Vespertilionidae	*Eptesicus furinalis*
Chiroptera	Vespertilionidae	*Eptesicus fuscus*
Chiroptera	Vespertilionidae	*Histiotus velatus*
Chiroptera	Vespertilionidae	*Lasiurus blossevillei*
Chiroptera	Vespertilionidae	*Lasiurus cinereus*
Chiroptera	Vespertilionidae	*Lasiurus ega*
Chiroptera	Vespertilionidae	*Myotis albescens*
Chiroptera	Vespertilionidae	*Myotis nigricans*
Chiroptera	Vespertilionidae	*Myotis riparius*
Chiroptera	Vespertilionidae	*Myotis simus*
Chiroptera	Vespertilionidae	*Rhogeessa tumida*
Didelphimorphia	Caluromyidae	*Caluromys lanatus*
Didelphimorphia	Caluromyidae	*Caluromys philander*
Didelphimorphia	Caluromyidae	*Caluromysiops irrupta*
Didelphimorphia	Didelphidae	*Chironectes minimus*
Didelphimorphia	Didelphidae	*Didelphis albiventris*
Didelphimorphia	Didelphidae	*Didelphis marsupialis*
Didelphimorphia	Didelphidae	*Philander andersoni*
Didelphimorphia	Didelphidae	*Philander mcilhennyi*
Didelphimorphia	Didelphidae	*Philander opossum*
Didelphimorphia	Glironiidae	*Glironia venusta*
Didelphimorphia	Marmosidae	*Gracilinanus agilis*

(con'd)

Didelphimorphia	Marmosidae	*Gracilinanus emiliae*
Didelphimorphia	Marmosidae	*Marmosa lepida*
Didelphimorphia	Marmosidae	*Marmosa murina*
Didelphimorphia	Marmosidae	*Marmosops impavidus*
Didelphimorphia	Marmosidae	*Marmosops neblina*
Didelphimorphia	Marmosidae	*Marmosops noctivagus*
Didelphimorphia	Marmosidae	*Marmosops parvidens*
Didelphimorphia	Marmosidae	*Marmosops pinheiroi*
Didelphimorphia	Marmosidae	*Metachirus nudicaudatus*
Didelphimorphia	Marmosidae	*Micoureus constantiae*
Didelphimorphia	Marmosidae	*Micoureus demerarae*
Didelphimorphia	Marmosidae	*Micoureus regina*
Didelphimorphia	Marmosidae	*Monodelphis americana*
Didelphimorphia	Marmosidae	*Monodelphis brevicaudata*
Didelphimorphia	Marmosidae	*Monodelphis domestica*
Didelphimorphia	Marmosidae	*Monodelphis emiliae*
Didelphimorphia	Marmosidae	*Monodelphis kunsi*
Didelphimorphia	Marmosidae	*Monodelphis maraxina*
Didelphimorphia	Marmosidae	*Thylamys velutinus*
Lagomorpha	Leporidae	*Sylvilagus brasiliensis*
Perissodactyla	Tapiridae	*Tapirus terrestris*
Primates	Aotidae	*Aotus infulatus*
Primates	Aotidae	*Aotus nancymaae*
Primates	Aotidae	*Aotus nigriceps*
Primates	Aotidae	*Aotus trivirgatus*
Primates	Aotidae	*Aotus vociferans*
Primates	Atelidae	*Alouatta belzebul*
Primates	Atelidae	*Alouatta caraya*
Primates	Atelidae	*Alouatta nigerrima*

(con'd)

Primates	Atelidae	*Alouatta seniculus*
Primates	Atelidae	*Alouatta ululata*
Primates	Atelidae	*Ateles belzebuth*
Primates	Atelidae	*Ateles chamek*
Primates	Atelidae	*Ateles marginatus*
Primates	Atelidae	*Ateles paniscus*
Primates	Atelidae	*Lagothrix cana*
Primates	Atelidae	*Lagothrix lagothricha*
Primates	Atelidae	*Lagothrix poeppigii*
Primates	Callitrichidae	*Callimico goeldii*
Primates	Callitrichidae	*Callithrix penicillata*
Primates	Callitrichidae	*Cebuella pygmaea*
Primates	Callitrichidae	*Mico acariensis*
Primates	Callitrichidae	*Mico argentatus*
Primates	Callitrichidae	*Mico chrysoleucus*
Primates	Callitrichidae	*Mico emiliae*
Primates	Callitrichidae	*Mico humeralifer*
Primates	Callitrichidae	*Mico intermedius*
Primates	Callitrichidae	*Mico leucippe*
Primates	Callitrichidae	*Mico manicorensis*
Primates	Callitrichidae	*Mico marcai*
Primates	Callitrichidae	*Mico mauesi*
Primates	Callitrichidae	*Mico melanurus*
Primates	Callitrichidae	*Mico nigriceps*
Primates	Callitrichidae	*Mico saterei*
Primates	Callitrichidae	*Saguinus bicolor*
Primates	Callitrichidae	*Saguinus fuscicollis*
Primates	Callitrichidae	*Saguinus imperator*
Primates	Callitrichidae	*Saguinus inustus*

(con'd)

Primates	Callitrichidae	*Saguinus labiatus*
Primates	Callitrichidae	*Saguinus martinsi*
Primates	Callitrichidae	*Saguinus midas*
Primates	Callitrichidae	*Saguinus mystax*
Primates	Callitrichidae	*Saguinus niger*
Primates	Callitrichidae	*Saguinus nigricollis*
Primates	Cebidae	*Cebus albifrons*
Primates	Cebidae	*Cebus apella*
Primates	Cebidae	*Cebus kaapori*
Primates	Cebidae	*Cebus libidinosus*
Primates	Cebidae	*Cebus macrocephalus*
Primates	Cebidae	*Cebus olivaceus*
Primates	Cebidae	*Saimiri boliviensis*
Primates	Cebidae	*Saimiri sciureus*
Primates	Cebidae	*Saimiri ustus*
Primates	Cebidae	*Saimiri vanzolinii*
Primates	Pitheciidae	*Cacajao calvus*
Primates	Pitheciidae	*Cacajao melanocephalus*
Primates	Pitheciidae	*Callicebus baptista*
Primates	Pitheciidae	*Callicebus bernhardi*
Primates	Pitheciidae	*Callicebus brunneus*
Primates	Pitheciidae	*Callicebus caligatus*
Primates	Pitheciidae	*Callicebus cinerascens*
Primates	Pitheciidae	*Callicebus cupreus*
Primates	Pitheciidae	*Callicebus dubius*
Primates	Pitheciidae	*Callicebus hoffmannsi*
Primates	Pitheciidae	*Callicebus lucifer*
Primates	Pitheciidae	*Callicebus lugens*
Primates	Pitheciidae	*Callicebus moloch*

(con'd)

Primates	Pitheciidae	*Callicebus purinus*
Primates	Pitheciidae	*Callicebus regulus*
Primates	Pitheciidae	*Callicebus stephennashi*
Primates	Pitheciidae	*Callicebus torquatus*
Primates	Pitheciidae	*Chiropotes albinasus*
Primates	Pitheciidae	*Chiropotes chiropotes*
Primates	Pitheciidae	*Chiropotes sagulatus*
Primates	Pitheciidae	*Chiropotes satanas*
Primates	Pitheciidae	*Chiropotes utahicki*
Primates	Pitheciidae	*Pithecia albicans*
Primates	Pitheciidae	*Pithecia irrorata*
Primates	Pitheciidae	*Pithecia monachus*
Primates	Pitheciidae	*Pithecia pithecia*
Rodentia	Caviidae	*Cavia aperea*
Rodentia	Caviidae	*Cavia tschudii*
Rodentia	Caviidae	*Galea flavidens*
Rodentia	Caviidae	*Galea spixii*
Rodentia	Caviidae	*Kerodon rupestris*
Rodentia	Ctenomyidae	*Ctenomys minutus*
Rodentia	Ctenomyidae	*Ctenomys nattereri*
Rodentia	Cuniculidae	*Cuniculus paca*
Rodentia	Dasyproctidae	*Dasyprocta azarae*
Rodentia	Dasyproctidae	*Dasyprocta fuliginosa*
Rodentia	Dasyproctidae	*Dasyprocta leporina*
Rodentia	Dasyproctidae	*Dasyprocta prymnolopha*
Rodentia	Dasyproctidae	*Dasyprocta punctata*
Rodentia	Dasyproctidae	*Myoprocta acouchy*
Rodentia	Dasyproctidae	*Myoprocta exilis*
Rodentia	Dasyproctidae	*Myoprocta pratti*

(con'd)

Rodentia	Dinomyidae	*Dinomys branickii*
Rodentia	Echimyidae	*Carterodon sulcidens*
Rodentia	Echimyidae	*Clyomys laticeps*
Rodentia	Echimyidae	*Dactylomys boliviensis*
Rodentia	Echimyidae	*Dactylomys dactylinus*
Rodentia	Echimyidae	*Echimys chrysurus*
Rodentia	Echimyidae	*Echimys grandis*
Rodentia	Echimyidae	*Isothrix bistriata*
Rodentia	Echimyidae	*Isothrix pagurus*
Rodentia	Echimyidae	*Lonchothrix emiliae*
Rodentia	Echimyidae	*Makalata didelphoides*
Rodentia	Echimyidae	*Makalata macrura*
Rodentia	Echimyidae	*Mesomys hispidus*
Rodentia	Echimyidae	*Mesomys stimulax*
Rodentia	Echimyidae	*Proechimys amphichoricus*
Rodentia	Echimyidae	*Proechimys brevicauda*
Rodentia	Echimyidae	*Proechimys cayennensis*
Rodentia	Echimyidae	*Proechimys cuvieri*
Rodentia	Echimyidae	*Proechimys echinothrix*
Rodentia	Echimyidae	*Proechimys gardneri*
Rodentia	Echimyidae	*Proechimys goeldii*
Rodentia	Echimyidae	*Proechimys hoplomyoides*
Rodentia	Echimyidae	*Proechimys kulinae*
Rodentia	Echimyidae	*Proechimys longicaudatus*
Rodentia	Echimyidae	*Proechimys oris*
Rodentia	Echimyidae	*Proechimys pattoni*
Rodentia	Echimyidae	*Proechimys quadruplicatus*
Rodentia	Echimyidae	*Proechimys roberti*
Rodentia	Echimyidae	*Proechimys semispinosus*

(con'd)

Rodentia	Echimyidae	*Proechimys simonsi*
Rodentia	Echimyidae	*Proechimys steerei*
Rodentia	Echimyidae	*Thrichomys apereoides*
Rodentia	Erethizontidae	*Coendou bicolor*
Rodentia	Erethizontidae	*Coendou melanurus*
Rodentia	Erethizontidae	*Coendou nycthemera*
Rodentia	Erethizontidae	*Coendou prehensilis*
Rodentia	Erethizontidae	*Coendou roosmalenorum*
Rodentia	Erethizontidae	*Coendou spinosus*
Rodentia	Hydrochaeridae	*Hydrochaeris hydrochaeris*
Rodentia	Muridae	*Bolomys urichi*
Rodentia	Muridae	*Calomys callosus*
Rodentia	Muridae	*Holochilus sciureus*
Rodentia	Muridae	*Kunsia tomentosus*
Rodentia	Muridae	*Microryzomys minutus*
Rodentia	Muridae	*Neacomys dubosti*
Rodentia	Muridae	*Neacomys guianae*
Rodentia	Muridae	*Neacomys minutus*
Rodentia	Muridae	*Neacomys musseri*
Rodentia	Muridae	*Neacomys paracou*
Rodentia	Muridae	*Neacomys spinosus*
Rodentia	Muridae	*Neacomys tenuipes*
Rodentia	Muridae	*Necromys lasiurus*
Rodentia	Muridae	*Nectomys squamipes*
Rodentia	Muridae	*Neusticomys venezuelae*
Rodentia	Muridae	*Oecomys auyantepui*
Rodentia	Muridae	*Oecomys bicolor*
Rodentia	Muridae	*Oecomys concolor*
Rodentia	Muridae	*Oecomys mamorae*

(con'd)

Rodentia	Muridae	*Oecomys paricola*
Rodentia	Muridae	*Oecomys rex*
Rodentia	Muridae	*Oecomys roberti*
Rodentia	Muridae	*Oecomys rutilus*
Rodentia	Muridae	*Oecomys trinitatis*
Rodentia	Muridae	*Oligoryzomys chacoensis*
Rodentia	Muridae	*Oligoryzomys fulvescens*
Rodentia	Muridae	*Oligoryzomys microtis*
Rodentia	Muridae	*Oryzomys emmonsae*
Rodentia	Muridae	*Oryzomys macconnelli*
Rodentia	Muridae	*Oryzomys nitidus*
Rodentia	Muridae	*Oryzomys perenensis*
Rodentia	Muridae	*Oryzomys yunganus*
Rodentia	Muridae	*Oxymycterus amazonicus*
Rodentia	Muridae	*Oxymycterus angularis*
Rodentia	Muridae	*Oxymycterus roberti*
Rodentia	Muridae	*Peromyscus leucopus*
Rodentia	Muridae	*Pseudoryzomys simplex*
Rodentia	Muridae	*Rhipidomys gardneri*
Rodentia	Muridae	*Rhipidomys leucodactylus*
Rodentia	Muridae	*Rhipidomys macconnelli*
Rodentia	Muridae	*Rhipidomys mastacalis*
Rodentia	Muridae	*Rhipidomys nitela*
Rodentia	Muridae	*Rhipidomys wetzeli*
Rodentia	Muridae	*Scolomys juruaense*
Rodentia	Muridae	*Sigmodon alstoni*
Rodentia	Muridae	*Thalpomys cerradensis*
Rodentia	Muridae	*Zygodontomys brevicauda*
Rodentia	Sciuridae	*Microsciurus flaviventer*

(con'd)

Rodentia	Sciuridae	*Sciurillus pusillus*
Rodentia	Sciuridae	*Sciurus aestuans*
Rodentia	Sciuridae	*Sciurus alphonsei*
Rodentia	Sciuridae	*Sciurus gilvigularis*
Rodentia	Sciuridae	*Sciurus ignitus*
Rodentia	Sciuridae	*Sciurus igniventris*
Rodentia	Sciuridae	*Sciurus spadiceus*
Xenarthra	Bradypodidae	*Bradypus tridactylus*
Xenarthra	Bradypodidae	*Bradypus variegatus*
Xenarthra	Dasypodidae	*Cabassous chacoensis*
Xenarthra	Dasypodidae	*Cabassous tatouay*
Xenarthra	Dasypodidae	*Cabassous unicinctus*
Xenarthra	Dasypodidae	*Chaetophractus villosus*
Xenarthra	Dasypodidae	*Dasypus kappleri*
Xenarthra	Dasypodidae	*Dasypus novemcinctus*
Xenarthra	Dasypodidae	*Dasypus septemcinctus*
Xenarthra	Dasypodidae	*Euphractus sexcinctus*
Xenarthra	Dasypodidae	*Priodontes maximus*
Xenarthra	Dasypodidae	*Tolypeutes matacus*
Xenarthra	Dasypodidae	*Tolypeutes tricinctus*
Xenarthra	Megalonychidae	*Choloepus didactylus*
Xenarthra	Megalonychidae	*Choloepus hoffmanni*
Xenarthra	Myrmecophagidae	*Cyclopes didactylus*
Xenarthra	Myrmecophagidae	*Myrmecophaga tridactyla*
Xenarthra	Myrmecophagidae	*Tamandua tetradactyla*