Habitat use by Peccaries and Feral Pigs of the Southern Pantanal, Mato Grosso do Sul, Brazil

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Introduction & Objectives:

White-lipped and collared peccaries (*Tayassu pecari* and *Pecari tajacu*, respectively) are abundant and widespread fruit-eating (frugivorous/omnivorous) mammals in Neotropical rain forests (Bodmer, 1989a). Recent studies have shown that their role as fruit predators and dispersers affects the biodiversity of certain forest habitats (Painter, 1998; Altrichter *et al.,* 1999; Silman *et al*., 2003; Keuroghlian & Eaton, 2008; Keuroghlian & Eaton, *in press*). The white-lipped peccaries are the only rain forest ungulates which form large herds (50-300 individuals), so their effects on forest habitats can be dramatic. Extirpation of either peccary species from a rain forest area will cause habitat alterations and additional biodiversity losses (Painter, 1998; Altrichter *et al.,* 2001; Silman *et al.,* 2003; Keuroghlian & Eaton 2008; Keuroghlian & Eaton, *in press*).

Unfortunately, local extinctions of the white-lipped peccary have been reported throughout its vast geographical range (Cullen, 1997; Glanz, 1990; Janson & Emmons, 1990; Leigh & Wright, 1990; Peres, 1996; Kiltie & Terborgh, 1983; Ditt, 2003). In regions with large tracts of intact forest, such as the Amazon, the losses have been due to heavy hunting pressure (Peres, 1996). In the Atlantic Forest of southeastern Brazil, a variety of negative consequences associated with habitat fragmentation have been the principle causes for local extinctions of white-lipped peccaries and population declines of collared peccaries (Cullen, 1997). Keuroghlian *et al* (2008) suggest that preservation of habitat quality and diversity in small Atlantic forest fragments has been important for the maintenance of peccary population densities typical of much larger fragments and continuous forests. Furthermore, white-lipped peccaries have area requirements of at least 2000 to 10,000 ha, depending on the ecosystem (Keuroghlian *et al*. 2004; Fragoso, 1998; Carillo *et al.,* 2002).

Despite increased human interference during the past 50 years, the Pantanal ecosystem is considered to be one of the most well preserved biomes in Brazil. From a conservation perspective, its preservation has resulted from a favourable combination of environmental and socio-economic factors. While extensive flooding produces high quality, seasonally available pastures for grazers, it also limits large-scale development of the region. However, the region is threatened by a variety of environmentally unsound human activities that have intensified over the last 30 years, e.g. large-scale agriculture on the plateaus encircling the Pantanal, gold mining, heavy fishing pressure, and environmentally disastrous development schemes for increasing barge traffic on the Rio Paraguay (Gottgens *et al.,* 2001; Nascimento *et al*., 2001; Oliveira, 2003).

Due to economic pressures, many large fazendas (i.e. ranches) in the Pantanal have been sold and divided into smaller, less viable properties (Alho *et al.,* 1988; Gomes & Villela, 1999; Correa, 1999). As a result, traditional grazing practices, which included the seasonal movement of herds among patches of native savanna, have become less practical and have been abandoned by some ranchers. To make smaller prop-

erties economically viable, ranchers have clear-cut native forests and planted exotic grasses to increase grazing area and productivity. In addition, environmental damage (e.g. erosion and degradation of water quality) and conflicts over uncontrolled burning of pasturelands are likely to increase on small, intensively used cattle ranches. Little is known about the impacts associated with these changes in land use.

Both the white-lipped and collared peccaries are native to the Pantanal region, but there have been no studies on their population dynamics, ranging habits, use of resources, or behavioral ecology. Lourival and Fonseca (1997) showed that both peccary species were favored among hunted native mammals in the Pantanal. Interestingly, peccary hunting is perhaps diluted because of a preference by locals to hunt the introduced feral pig, "porco monteiro" (*Sus scrofa*) (Desbiez, 2007). We have studied the ecology of white-lipped, collared peccaries, and feral pigs, in a relatively pristine region of the Pantanal, Fazenda Rio Negro, which was historically used for cattle ranching. Native wildlife and introduced feral pigs are abundant on the Fazenda. Here we present results of habitat use by the three species and discuss conservation implications.

Methods

Fazenda Rio Negro (FRN), (19°30' S, 56°12.5' W), is a 7647 ha area dominated by large areas of gallery and cordilheira (*cerradão/cerrado/semi-deciduous*) forests, some open grasslands associated with flooded grasslands (*vazantes*), many Nhecolândia lakes, with low-impact, traditional cattle ranching practiced in the region. 10% of FRN was used for cattle during the study period.

Habitat Availability & Use

We measured habitat availability using ArcView GIS and satellite and aerial images of Fazenda Rio Negro (Eaton 2002). The region was divided into the following habitat categories (Prance & Schaller, 1982; Por, 1995; Eaton, 2006) (Fig.1):

1. Gallery or riparian forests: This habitat covers the higher banks along the Rio Negro. Large portions of the forest become flooded as river water level rises (Eaton, 2003, 2006) and spills over banks, or fills seasonal channels, called *corixos* that penetrate laterally from the river into the gallery forest. Dominant plant species in this habitat are Tucum (*Bactris glaucescens*), *Ficus* sp., Pimentinhas (*Licania Parvifolia* and *Couepia uiti*), Inga (*Inga uruguensis*), Bacupari (*Rheedia brasiliensis*), and Acuri (*Attalea phalerata*).

2. Baias & bordering vegetation: *Baias* are permanent to temporary shallow lakes with low to medium salinities; typically with productive and diverse aquatic plants zones; substrates of silt and aquatic plant detritus. The borders of *baias* are characterized by transitional vegetation, 5 to 50m wide. Distinct vegetation zones follow a seasonally fluctuating moisture gradient and a slight (0.5 to 1m) rise in elevation. The wetter zones consist of flood-tolerant herbaceous plants and bushes, while the higher drier zones consist of grasslands (*campo sujo* and *caronal*) or *cordilheira* forest (see description below). Examples of fruiting tree species that border *baias* are Espinheiro (*Chomelia obtuse*) and Araca *(Psidium guineense).*

3. Salinas and bordering vegetation: *Salinas* are shallow alkaline soda lakes with high salinities; typically with few types of aquatic plants and no fish, but productive algal and invertebrate communities. The borders of *salinas* are also characterized by transitional vegetation, 5 to 50m wide. The vegetation zones follow moisture and alkalinity gradients, as well as a slight (0.5 to 1m) rise in elevation. Depending on the season, the wetter zones consist of a few herbaceous species that are tolerant of moisture and alkaline conditions (high water periods), or bare sand (low-water periods). The higher drier zones almost always

consist of *cordilheira* forest (see description below). Caranda palms (*Copernicia alba*) are characteristic of *salina* borders.

4. Cordilheira (cerrado, cerradão, and semi deciduous forest): This habitat is a mixture of savanna forest formations (*cerrado, cerradão,* and semi deciduous forest) that are typical of the Nhecolândia ecoregion of the Pantanal. These forests are not inundated during the wet season, because they are formed on sandy elevations 1 to 2 meters higher than the surrounding landscape. Typical species encountered are: Pequi (*Caryocar brasiliense*); Lixeira (*Curatella americana*); Taruman (*Vitex cymosa*); Acuri (*Attalea phalerata*); Ximbuva (*Enterolobium contortisiliquu*); Paratudo (*Tabebuia aurea*); Canjiqueira (*Coccoloba cajubensis*); Bocaiuva (*Acrocomia aculeata*); Manduvi (*Sterculia apetala*); and Marmelo (*Alibertia edulis*).

5. Grasslands (campo sujo, caronal, and vazantes): Grassland habitat varies substantially in the Rio Negro region, ranging from areas with scattered trees, *campo sujo,* to open savannas with no trees. Of the latter, one of the most extensive types, *caronal,* is dominated by the grass *Elyonurus muticus.* Seasonally flooded grasslands that frequently link *baias* during high-water periods are called *vazantes.*

Figure 1. Terrestrial and aquatic habitat classification of Fazenda Rio Negro, Aquidauana, MS, Brazil
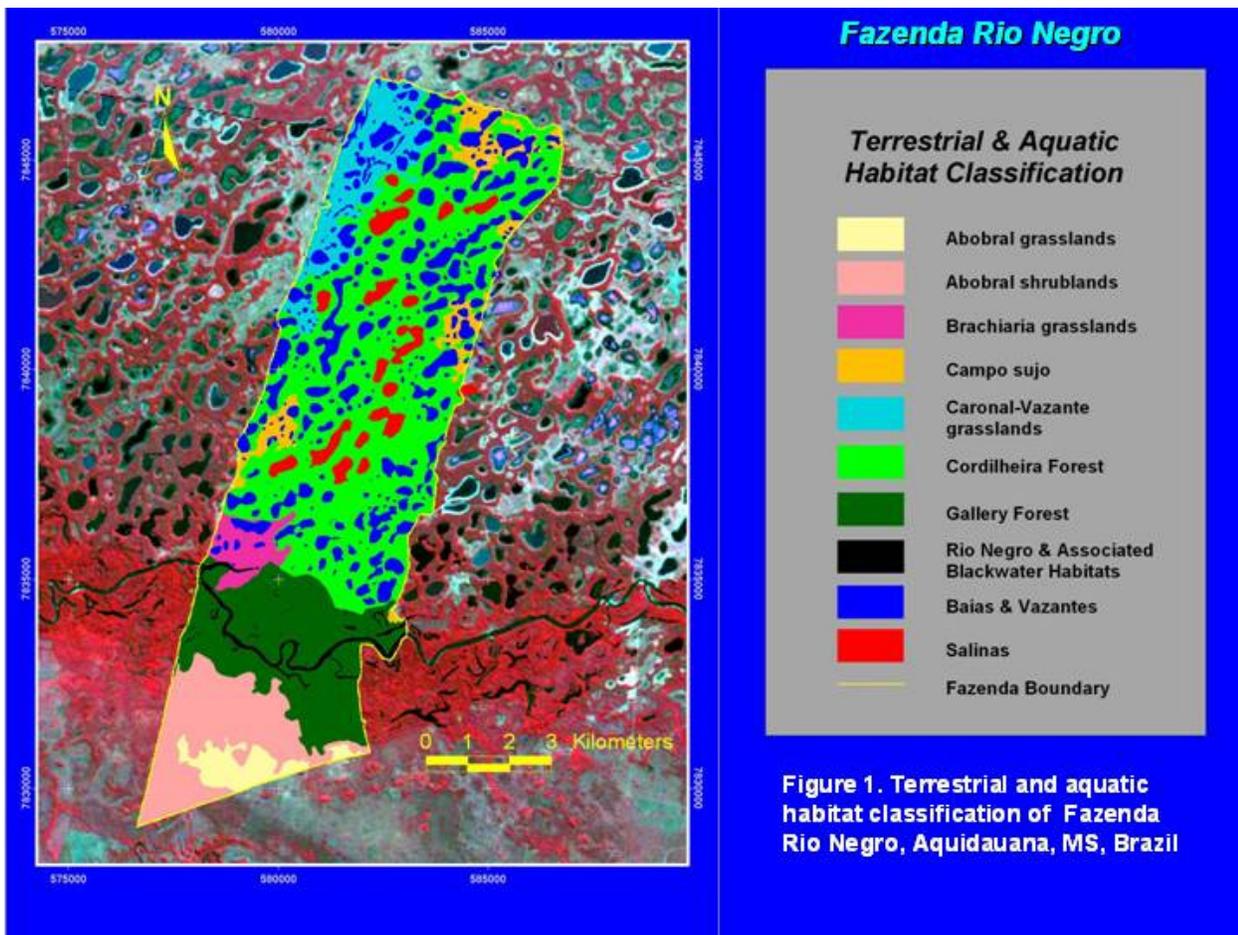
Figure 1: Habitat use by feral pigs, white-lipped & collared peccaries at Fazenda Rio Negro, Aquidauana, Mato Grosso Do Sul, Pantanal, Brazil. Proportions of use were calculated using the number of sightings obtained during transect censuses and relative abundance surveys conducted from 2000 through 2003

To measure habitat use by peccaries (*T. tajacu* and *T. pecari*) and feral pigs (*S. scrofa*), we analyzed a long-term data set, obtained from 2000 through 2003, containing records of animal sightings and the habitats where sightings occurred. The sightings were made during transect censuses and relative abundance surveys, and a GPS unit was used to document locations.

A preliminary 3 by 5 (SPECIES x HABITATS) factorial ANOVA was conducted to test if habitat use (NUMBER OF SIGHTINGS) differed among SPECIES (white-lipped peccaries, collared peccaries, and feral pigs) and HABITATS (gallery, cordilheira, grasslands, baias, and salinas). Because the interaction, SPECIES x HABITATS, was highly significant, it was necessary to compare habitat use among HABITATS within SPECIES categories with 3 one-way ANOVAs. If the ANOVAs produced statistically significant differences ($\alpha = 0.05$), we conducted pair-wise Tukey HSD Multiple Comparison tests to rank habitat categories in terms of use. For all of the above tests, the habitat use response variable, NUMBER OF SIGHTINGS, was natural-log transformed to meet the variance homogeneity assumption. These analyses were conducted using Systat, version 7.0 (1997).

For each species (white-lipped peccaries, collared peccaries, and feral pigs), we ran a Chi-squared test to determine if habitat use (percent of sightings within habitat categories) was random with respect to habitat availability (area of each habitat category at Fazenda Rio Negro). To determine the area of *baia* and *salina* habitats available to peccaries and feral pigs, we calculated the area of the transitional vegetation bordering these lakes, and did not include the open water. Although peccaries and feral pigs frequently enter *baias* and *salinas*, their movements are generally restricted to vegetation zones close to the water's edge.

Results

Habitat Availability & Use
For the 3 by 5 factorial ANOVA comparing habitat use (NUMBER OF SIGHTINGS) among species and habitat categories, the interaction of SPECIES x HABITATS was highly significant ($F = 17.817$, df = 8, 1059, $P \ll 0.0001$). Therefore, for each species, we conducted a separate comparison of habitat use among habitat categories (one-way ANOVAs and Tukey HSD Multiple Comparison post tests). The one-way ANOVAs for all 3 species were highly significant (collared peccary, $F = 4.777$, df = 4, 164, $P = 0.0011$; white-lipped peccary, $F = 27.704$, df = 4, 600, $P \ll 0.0001$; feral pigs, $F = 16.269$, df = 4, 295, $P \ll 0.0001$). Table 1 presents post-test results showing which habitat categories were used significantly more or less than others. Use of gallery forests by white-lipped peccaries was significantly greater than use of all other habitat categories, and *cordilheira* forests and *baias* were used significantly more than grasslands and *salinas* (Table 1, Fig. 2). Collared peccaries were observed significantly more in *cordilheira* forests than in other habitats, and feral pigs significantly more along the borders of *baias* than in other habitats (Table 1, Fig. 2). In addition, feral pigs used *salina* habitats significantly more than gallery forest.

Chi-square analyses indicated that habitat use for all three species was significantly non-random with respect to habitat availability (Table 2). Proportions of habitat availability at Fazenda Rio Negro and habitat use by the three species are presented in Table 2 and Figure 2. The habitat most available at Fazenda Rio Negro is *cordilheira* forest, and the habitat least available is the vegetation bordering *salinas* (Table 2, Figs. 1 and 2).

Table 1: Summary of Tukey HSD Multiple Comparison post-test results comparing habitat use among habitat categories for collared peccaries (CP), white-lipped peccaries (WL), and feral pigs (FP), in the Rio Negro region of the Pantanal, Aquidauana, Mato Grosso do Sul, Brazil. Habitat categories for each species are sorted from most to least used. Habitat categories that share the same letters (A, B, or C in Sig. Diff. columns) were not significantly different in terms of habitat use.

Relative Use	CP Habitats	Sig. Diff.	WL Habitats	Sig. Diff.	FP Habitats	Sig. Diff.
most	Cordilheira	A	Gallery	A	Baia	A
↓	Salina	B	Cordilheira	B	Salina	B
↓	Baia	B	Baia	B	Grassland	B C
↓	Grassland	B	Grassland	C	Cordilheira	B C
least	Gallery	B	Salina	C	Gallery	C

Table 2: Habitat availability at Fazenda Rio Negro, Aquidauana, Mato Grosso do Sul, Brazil and habitat use by feral pigs (FP), white-lipped peccaries (WL), and collared peccaries (CP). Proportions of use were calculated using the number of sightings during transect censuses and relative abundance surveys conducted from 2000 through 2003. Results of Chi-square tests to determine if habitat use was random with respect to availability are also shown.

Habitat categories	Habitat Availability		Habitat Use		
	Area (ha)	Proportion[a]	WL (N = 220)	CP (N = 38)	FP (N = 92)
Gallery	1220	0.18	0.45	0.08	0.01
Cordilheira	2984	0.43	0.24	0.47	0.08
Baia	1356	0.20	0.20	0.16	0.58
Grassland	980	0.14	0.06	0.11	0.09
Salina	326	0.05	0.04	0.18	0.24
Abobral	1016				
Chi-square:		X^2 :	119.95	16.68	158.85
		df :	4	4	4
		P value :	$\ll 0.001$	< 0.005	$\ll 0.001$

[a] The calculation of proportional habitat availability did not include Abobral vegetation, because the region was inaccessible for censuses and surveys.
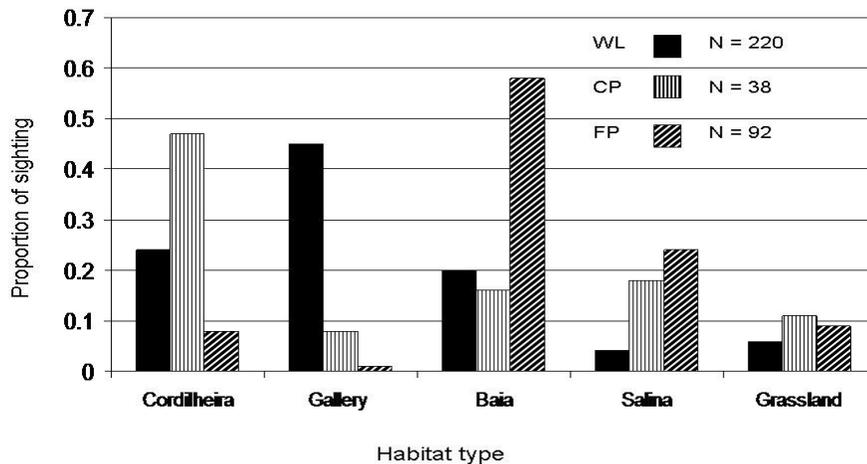
Figure 2: Habitat use by feral pigs, white-lipped & collared peccaries at Fazenda Rio Negro, Aquidauana, Mato Grosso Do Sul, Pantanal, Brazil. Proportions of use were calculated using the number of sightings obtained during transect censuses and relative abundance surveys conducted from 2000 through 2003.

Discussion & Conservation Implications

Habitat Availability & Use

Habitat use trends indicated that there is a strong association between white-lipped peccaries and forested areas, especially gallery forest. Other studies have also shown that white-lipped, as well as collared peccaries, prefer forest cover, but collared peccaries appeared to use open habitats to a greater extent (Bellantoni & Krausman, 1993; Taber *et al.*, 1994; Fragoso, 1994, 1999; Ilse & Hellgren, 1995; Carrillo, 2000; Reyna-Hurtado & Tanner 2005; Keuroghlian & Eaton, 2008; Desbiez *et al.*, in press). Similar to our results from the Pantanal, white-lipped peccaries from other regions have affinities for specific humid habitats, such as palm-dominated swamps and gallery forests, while collared peccaries use them less (Bodmer, 1990; Fragoso, 1994, 1999; Ilse & Hellgren, 1995; Keuroghlian & Eaton, 2008). Collared peccaries in our study showed a close association with the drier *cordilheira* forests. Contrary to the peccaries, feral pigs showed a strong preference for open aquatic habitats, such as *baias* and *salinas*. Desbiez *et al.* (in press) found that habitat use overlap between the feral pig and the peccaries was low, and niche overlap was highest between the native peccaries. Keuroghlian *et al* (2004) suggested that periodic range expansions of collared peccaries were related to avoidance of white-lipped peccaries and concomitant shifts in diet during these periods of interspecific overlap. Resource overlap between the two peccary species results in behavioral changes to avoid the consequences of direct aggressive encounters. Even minimal peccary and feral pig overlap could exacerbate already existing behavioral alterations related to the high niche overlap between the peccary species.

Gabor and Hellgren (2000) showed how the presence of feral pigs affects peccary densities where they occur sympatrically. Desbiez *et al.* (2004) compared density estimates of feral pigs and the two peccary species at Fazenda Rio Negro and Fazenda Nhumirim. White-lipped peccaries were the most abundant species at both locations (7,5 ind./km² and 9.6 ind./km² at FRN and Fazenda Nhumirim, respectively). Collared peccary density estimates at Fazenda Nhumirim (5.5 ind./km²) were greater compared to feral pigs (3.5 ind./km²), and at FRN there were 3.7 ind./km² for collared peccaries and 6.35 ind./km² for fe-

ral pigs (Desbiez *et al*., 2004), i.e data from Fazenda Rio Negro showed higher feral pig densities compared to collared peccary densities, and Fazenda Nhumirim showed the opposite trend. Although these data represent only two sites, they appear to support the findings of Gabor and Hellgren (2000), that feral pigs can affect peccary densities (in this case collared peccaries).

Our preliminary results on habitat use and availability have clear conservation implications. The non-random use of habitats observed for white-lipped and collared peccaries, and feral pigs, illustrates the importance of habitat diversity, especially diversity of forest types and their associated fruiting species. The Pantanal landscape is heterogeneous; peccary and pig populations and habitat use will vary according to the habitat types available (e.g. presence or absence of rivers vs. flooded grasslands). One of the next steps is to analyze these data seasonally to understand the importance of forest heterogeneity, habitat use, and existing population densities during periods of fruit scarcity. One hypothesis suggested by these results is that areas in the Pantanal that have been deforested in the past, or are currently being deforested, will negatively affect peccary populations and increase favourable habitat for feral pigs (Desbiez *et al.,* in press).

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The Destiny of the Neotropical Forest Architects: An Evaluation of the Distribution and Conservation Status of the White-lipped Peccaries

Reduced version of the executive summary prepared by Rafael Reyna-Hurtado

This is a summary of a project that began in 2005 to evaluate and update the status of the distribution of the white-lipped peccary (*Tayassu pecari*), and the lowland tapir (*Tapirus terrestris*). Here we present a reduced version only for the evaluation process of the white-lipped peccary. The authors of all the processes, including both species, are introduced at the end of the document. The complete report is already available for the public and soon will be published in a special edition of this newsletter. To receive a PDF copy of it, please write to Andrew Taber (taber@wildlifetrust.org).

This study provides range-wide information for conservation planning and a baseline against which to evaluate future changes in the species' status and distribution. It also provides an indication of ecosystem health across its ranges since the species is highly susceptible to human pressures and is useful for monitoring habitat conservation status. To undertake this survey, top peccary biologists from fourteen countries across the Neotropics provided data and contributed to the analysis and conclusions. Salient findings are outlined below.

The white-lipped peccary is one of the most ecologically and economically important mammal species of the Neotropics. It has an enormous range extending across tropical and subtropical habitats from Southern Mexico to northern Argentina. This species together with tapirs are so- called architects of ecosystems across the Neotropics because of their vital roles in structuring plant communities. White-lipped peccaries have long been key food sources for subsistence hunters throughout the region and international trade in peccary products has also been economically significant, although threatening to the species where harvesting is unsustainable. As a result of over-hunting and habitat destruction, the species is considered endangered or threatened in a number of countries, and is listed on Appendix II of CITES (Convention on International Trade in Endangered Species).