Wildlife Management at the Rio das Mortes Xavante Reserve, MT, Brazil

Integrating Indigenous Culture and Scientific Method for Conservation

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Wildlife Management at the Rio das Mortes Xavante Reserve, MT, Brazil

Integrating Indigenous Culture and Scientific Method for Conservation

BIODIVERSITY, PARKS AND RESERVES

SUSTAINABLE USE OF NATURAL RESOURCE

EDUCATION, TRAINING, RESEARCH AND DISSEMINATION

ENVIRONMENTAL POLICY

CERRADO SAVANNA

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2000

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INDEX

PARTICIPANTS

Frans Leeuwemberg has been the principal biologist with the Xavante Wildlife Management Project since its inception. He developed the initial research design and collected and analyzed all the data from 1991 to 1993 that is used in this plan, including numbers of animals killed, Sex ratio and age based on definition.

Manrique Prada Villalobos joined the project as assistent biologist in 1994. He located the track abundance transects and collected most of the data with respect to burns in the study site.

José Fragoso and **Kirsten Silvius** were hired by WWF-Brazil as consultants to evaluate and modify the project design, and later to write the management plan. They design the tracking transect protocol, analyzed track abundance data, re-interpreted Leeuwenberg's demography data based on source-sink model of population dynamics, and wrote the management plan. Frans Leeuwenberg revised the final draft of the plan.

John Butler and **Rosa Lemos de Sá** were project coordinators for WWF. They provide superlative guidance and support at all stages of the project, persisted in resolving all conflicts that arouse, and maintained an active personal interest in the fate of Xavante, their wildlife and their Reserve.

The **Xavante** of the Eteñitepa community welcomed our alien culture and ideas and allowed us to both teach and learn. They taught all of us about wildlife, about the importance of ritual, and how to chose the life one aspires to despite apparently insurmountable obstacles.

Obs.: The Rio das Mortes Management Plan started its implementation in January 1998 with the establishment of the wildlife refuges. The implementation is monitored by three Xavante villages with the help of a biologist hired by WWF. All data gathered during monitoring will be analyzed and published in the future.

1 - INTRODUCTION


Foto: Juan Pratginestós / WWF

Xavante women line up to receive game meat after a wedding ceremony

Eteñitepa village is the dominant community within the 329,000 ha Rio das Mortes Indigenous Reserve. In the late 1980's the community noted a decrease in hunting success for preferred large game species, and hypothesized that wildlife populations were declining in their reserve. Because hunting is a key structuring element in Xavante society and culture, the perceived decline led the community to contact WWF to help them solve this problem. The biologist Frans Leeuwenberg was then contract to determine the status of wildlife populations (Krenak et al. 1992, Leeuwenberg 1994). The Xavante's fear of losing their game populations is related to their strong cultural reliance on hunting as their selected form of obtaining meat. The Xavante were uninterested in substituting the meat of domestic animals for that derived from wild animals, although they have owned cattle at various times as a source of occasional cash or food.

Studies of game use by South American indigenous peoples traditionally evaluate hunting success in reserves or other delimited areas, estimate the proportion of the human population's diet that comes from game, and document patterns - declining or not - in hunting success over time or before and after disturbance (Vickers 1980, Hames 1980, Good 1989, Mazurek 1997). More recently, studies have attempted to evaluate the status of the animal populations themselves, to estimate the impact of hunting and determine whether the communities under study will be able to sustain current levels of game harvest (Leeuwenberg and Robinson in press, Hill et al 1997,Townsend 1995, Robinson and Redford 1991). In addiction to hunting success, Such studies evaluate several demographic indices such as sex ratios, age structure and percent of estimated productivity harvested. Because little or no baseline data exists for most Neotropical game species, it is difficult to detect hunting-induced deviations from a "normal" population.

One anthropological factor that can be combined with other indices to increase the information derived from a study is the correlation of hunting success with distance from the focal hunting community. Information from the literature (Hill 1997, Mazurek 1997, Alvard 1994, Fragoso 1991, Hames 1980) indicates that most hunting occurs near villages; in forest regions most hunting occurs within 10 km of a village, while discussion with the Xavante indicated that in the Cerrado habitats of Mato Grosso, Brazil, where this study took place, the intensive hunting zone could extend out to 15 km. Areas beyond 10 to 15 km from villages are lightly hunted because they generally require overnight trips, or access to motorized vehicles (if there are roads). Hill et al (1997) documented a decrease in signs of hunting (snares, human tracks, etc.) with distance from villages in a Paraguayan forest reserve. Animals tracks also increased with distance from these villages for most mammalian species. Mazurek (1997) also has indirect evidence that animal populations are higher away from villages, because hunting success increased with distance from the village. Demographic indices can be compared between areas known to undergo different hunting pressure, but still within the same habitat/location, to detect effects of hunting on populations.

Several indices are used to evaluate the effects of hunting: 1) survivorship curves based on age structure of hunter-killed animals (Bodmer et al 1994, Leeuwenberg and Robinson in press);

2) the proportion of young to old animals -heavily hunted populations are expected to have more young than old individuals because hunting mortality prevents animals from reaching older age classes; 3) sex ratios - specifically, deviations from a predicted ratio, which varies with the social structure of the species; and 4) comparison with a theoretical sustainable harvest model. Robinson and Redford (1991) estimate maximum productivity of an animal population from a) density, b) reproductive productivity (rmax), c) life history (long-lived animals with low reproductive rates can sustain removal of only a small percentage of their production, whereas shorter-lived animals can sustain a higher percentage removal). They derive a maximum sustainable harvest in terms of animals per km^2 per year. A comparison of actual harvest rates to theoretical sustainable harvest rates can indicate whether hunters are overharvesting a population, assuming that in the locality of the study densities and reproduction are similar to those used by the original model. Townsend (1995) uses this model, but increased accuracy by incorporating reproductive parameters derived from the animals killed during her own study.

None of these indices are very reliable unless sample sizes are large and the biology of the species in general and local population in particular is well known. The social behavior and ecology of a species must also be considered in the interpretation of any index (Fragoso 1994). To elaborate this management plan, we looked for agreement between the largest possible number of indices to determine the status and harvest potential of the Xavante's preferred game species. We only examine the status of the most frequent capture game species, which are those for which sufficient track data could be gathered: Giant anteater (*Myrmecophaga tridactyla*), tapir (*Tapirus terrestris*), marsh deer (*Blastocerus dichotomus*), pampas deer (*Ozotocerus bezoarticus*), white-lipped peccary (*Tayassu pecari*), and collared peccary (*Tayassu tajacu*). The status of brocket deer (*Mazama americana* and *Mazama gouazoubira*) and giant armadillo (*Priodontes maximus*) are commented on, although there is little information available for them (nomenclatures follows Eisenberg 1989, and Redford and Eisenberg 1992). Edentates in general are difficult to analyze, because data sets on sex and age structure and theories on social behavior as related to ecology are not as well developed for this group as for ungulates.

2 - BACKGROUND

There are five villages in the reserve; four will participate in the management plan. The largest of the participating villages, Eteñitepa, has a population of 348 people, Caçula supports 266 people, Tanguro 63 and Cipassé's village has 37 people, for a total population of 714 people. They use an area of 300,000 ha, which excludes the southwest of the reserve (Leeuwenberg 1994). This gives a density of 0.24 people per km². The excluded village, Agua Branca, has 450 people (Leeuwenberg pers. Comm.) who are said to utilize only the southwest tip of the reserve because the northern villages will not allow them to hunt elsewhere (Leeuwenberg 1994). Adding the population of all five villages and dividing by the entire area of the Reserve gives a density of 0.35 people per km². Although the four related villages prefer to ignore the fifth, to the extent of not considering their impact on resources, calculations of human density should be based on this total population. We have been presented with no evidence that members of the Agua Branca community do not impact the Xavante Reserve's game populations, or that the game populations do not use that part of the Reserve. As the human population increases, new strategies may have to be considered for managing wildlife populations. These will rely on sound knowledge of the status of wildlife populations, and the use of adaptive management techniques to avoid problems.

The background work that made the later phases of this project possible was carried out by Leeuwenberg from 1991 to 1993. Here we summarize the direction and results of this first phase, though some of the results are reexamined in more detail for the final management recommendations. Leeuwenberg used three methods to evaluate the status of game populations in the reserve:

1) hunting return per unit of effort in different years when different areas were hunted,
2) population demographics derived from hunter kills (age structure based on skulls and hunter-reported sex ratios), and
3) a comparison of number of animals cropped relative to the Robinson and Redford (1991) theoretical "possible production model".

Based on these indices, Leeuwenberg (1994, 1997 a and b) and Leeuwenberg and Robinson (in press) reported that the hunting of tapir, marsh deer, pampas deer and giant anteater was not sustainable but that white-lipped peccary and collared peccary populations appeared to be stable. Specifically, Leeuwenberg (1994) reported that there were pronounced skews in age distributions towards younger animals in the populations of marsh and pampas deer. For the two peccary species, comparisons with survivorship curves from two populations in Peru showed that they differed from a heavily hunted population, but not from a lightly hunted one, suggesting the Xavante peccary populations are not being over-harvested. Leeuwenberg used the Robinson and Redford MSY (Maximum Sustained Yield) model of hunting to evaluate the status of giant anteaters, tapirs and marsh deer, determining that these species were all being cropped at or above sustainable levels and therefore in danger of over-harvesting.

After one year of study, Leeuwenberg made several management recommendations to the Xavante to reduce hunting pressure on the apparently threatened species. First, he proposed a ban on the hunting of tapir, pampas deer, marsh deer and giant anteaters, long enough for populations to recover. When this strategy proved unsatisfactory to the Xavante, he recommended that they hunt only in previously lightly hunted zones, and abandon hunting in what had

been the most heavily hunted zone, the area around the village to a distance of approximately 10 km. This strategy meant to relieve pressure on the intensively hunted populations nearest the village, was adopted for 18 months (Leeuwenberg pers. comm.). However, because the region was distant from the village, returns per unit of effort actually dropped because the hunters spent more time traveling. The difficulty and time associated with traveling to the new region eventually led to the abandonment of regular hunting in that zone. The Xavante once again intensified their hunting in the zone around the village.

In addition to the Xavante's preference for hunting near the village, Leeuwenberg identified other factors that exacerbated the problem of over hunting: 1) the Xavante had greatly reduced the number of family hunts, in which the entire family moves to areas distant from the village for a prolonged period of time, and 2) hunting by burning the Cerrado vegetation to drive game had intensified beyond the traditional uses of this technique. Fire hunts were being used more frequently and outside the traditional burning period (mid-to late dry season). Leeuwenberg's recommendations that these behaviors be altered to the traditional patterns were either ignored or tried but abandoned by the Xavante due to the logistical and organizational difficulty needed to maintain them.

At this stage, project's funders were interested in obtaining a census or estimate of the animal populations in the Reserve. Leeuwenberg attempted to estimate wildlife densities using visual counts along density-estimating transects. This method proved unsuccessful for several reasons, one important one being that the Xavante participating in transect counts persisted in pursuing and killing any wildlife that was spotted. As hunters, it seemed silly to the Xavante not to give chase to game, when at home people were meat-hungry. When they returned home from censuses without any meat, they felt pressure from the community because they were not fulfilling their social role as meat providers, rather than receiving the social approval and pride that accompanies a successful hunt.

Thus at the time that the project was evaluated in 1994, one of the primary goals was to find a method that measured population abundance without having to sight animals. The results would also have to be presented in a way that could be easily understood by the Xavante. Fragoso and Silvius (1994) suggested using a standardized method of track counts as a means of measuring relative abundance. They also suggested dividing the reserve into three hunting zones to measure the relative impact of hunting, given that hunting was more intensive near the village.

This study protocol was adopted by Leeuwenberg and the newly hired assistant-biologist Manrique Prada. Here we report on the results of this phase of the study, and re-consider and re-analyze Leeuwenberg's (1994) data using different organizational and analytical techniques, such as comparing sex ratios to predicted skewed rather than even ratios, and source-sink population models. We suggest a number of management possibilities, and review the management scenario suggested by Xavante elders after they considered our results, our suggestions and their own analysis of the data.

3 - STUDY PROTOCOL AND HYPOTHESES

To understand the effect of hunting on wildlife populations within Rio das Mortes Reserve, we assumed that hunting pressure is correlated with distance from the village. Leeuwenberg (1994) found that the Xavante, before they moved hunting regions, hunted mainly within 15 km of their village. This is the area that receives most short hunts of a few hours to a day's duration. This was also confirmed during discussions with Xavante elders. Thus, we divided the study region into three hunting zones: zone 1 (Z1) encompassed a band 15 km in radius around the village and represents a heavily hunted area, zone 2 (Z2), corresponded to the next 15 km radius and represents a lightly hunted area, and zone 3 (Z3), the last 15 km radius, represents a lightly hunted or unhunted area (Fig. 17).

We tested the prediction that if populations are declining due to over hunting, then there would be fewer tracks of hunted species in Z1, and that Z2 and Z3 would have similar number of tracks. This should be especially marked for tapir, marsh deer, pampas deer and anteaters, the species pinpointed by Leeuwenberg (1994) as the most vulnerable. Evidence from the literature supports the assumption that where animal densities are highest, one finds a greater abundance of tracks. Significant changes in track number correlated with significant changes in wildlife sightings in an area hunted by the Ache Indians of Paraguay (Hill et al 1997). More tapirs also translated into more tapir tracks in a study of the Central American tapir (Fragoso 1991, 1987). When we refer to higher abundance of animals in this study, we are referring to higher track counts.

We addressed the same hypothesis of decreasing hunting effect with increasing distance from the village by looking at indices based on information gathered by Leeuwenberg. In this second analysis we construct a hunting pressure/productivity ratio by dividing the number of kills per km² by the hypothetical productivity per km² (Robinson and Redford 1991, Leeuwenberg and Robinson in press) and compare ratios for each species between the two zones that were involved in Leeuwenberg's earlier hunting shift experiment (Z1 and Z3 with a bit of Z2). In that earlier work Leeuwenberg succeeded in having the Xavante move their hunting from what is now known as Z1 (hunted in 1991) to mostly Z3, and some regions of Z2 (in 1992). If the hunting-production ratio is less than 1, that species is being harvested at less than the "maximum sustainable yield" (MSY), if it equals 1, the population is being harvested at MSY, if it's greater than 1, the population is being over-harvested. However, because of the assumptions of the model and because animals rarely achieve their maximum production in the wild, if the harvest is anywhere near the maximum production rate, over-hunting is likely to be occurring .

As a third test of the same hypothesis, we examine sex-ratio indices. Leeuwenberg (1994) collected information on the sex of all individuals killed by the Xavante in each year of the hunting shift experiment. We re-consider the sex ratios in relation to the three hunting zones, taking into consideration the biology of the species and using predicted sex ratios different from 1:1 (the conservative baseline used in most studies (Townsend 1995, Leeuwenberg 1994)). We predict that we will find either equal (1:1) or female-biased sex ratios for tapirs, white-lips, pampas dear, and marsh deer in Zones were they are being over-hunted, that is Z1.

For free-ranging unhunted or lightly hunted populations of most ungulate species, adult sex ratios are female-biased; however, one usually observes a male-biased sex ratio in hunter kills originating from these populations. This difference develops due to the social structure and

organization of most ungulates, which leads to higher male mortality rates (Ralls et al. 1980, Fragoso 1994). Thus in a stable population not under intense hunting pressure, in an examination of the sex ratio of hunter-killed animals, one should find a male bias. If one finds an equal or female-biased adult sex ratio, it is likely that the population is over-hunted (Ralls et al., Fragoso 1994). This pattern does not hold true for collared peccaries: they have even rather than female-biased sex ratios in unhunted populations (Fragoso 1994), and their social behavior results in similar mortalities for both sexes. Thus for this species an equal sex ratio in the hunter-killed group is probably not a sign of over-hunting, where it would be for the white-lipped peccary, the marsh deer, the pampas deer, tapirs and possibly giant anteaters.

Since most of our measures are attempts to evaluate the "hunted" status of wildlife populations, the strongest support for a hypothesis or prediction occurs when several analyses are in agreement. If we reach a conclusion based on agreement between only two analyses or from only one, the strength of that conclusion is less than when all three agree. In other words, agreement between the analysis of track abundance, harvest/productivity ratios, and demography ratios (sex and age structures) likely reflects actual population and a real difference between zones. We rate the status of the different species within the Xavante reserve through the use of a filtering set of criteria derived from the data and analyses available for the region; we ask the following questions, for each species:

1) Does the species show an increasing trend in track abundance (and therefore population abundance) from Z1, to Z2 and Z3 (a sign of hunting impact on abundance)? A YES equals a score of 1, a NO equals a score of 2.

2) Are the differences in density/tracks between Z1 and Z2 or Z3 statistically significant (indicating potential population sources and sinks within the reserve)? A NO equals a score of 1, a YES equals 2.

3) Do the sex ratios change (from female-biased to even or male-biased) from the heavily hunted Z1 to the less hunted Z2 and Z3? A NO equals a score of 1, a YES equals 2.

4) Is the hunting pressure/production ratio less than 0.8 in any zone? A NO equals a score of 1, a YES a 2.

5) Does the age structure data for the population as a whole indicate an over-hunted population? A YES equals a score of 1, a NO equals 2.

6) Does the evaluation of hunting status for the population as a whole using the Robinson and Redford equations indicate over-harvesting? A YES equals a score of 1, a NO equals 2.

7) Is the population structure age and Sex ratios similar to that expected for an unhunted population in any zone?

Data are not available in all seven categories for all species; to determine status of each species we divided the cumulative score from the above questions by the number of questions that could be answered. A score of at or near one suggests that the species is probably threatened within the reserve, while a score of or near two suggests that the species is unthreatened. The overall scores are presented in the species accounts and in Table 7.

4 - METHODS

4.1 - Sampling of Tracks

Track data were collected by two teams of Xavante lead by Manrique Prada. Data were collected monthly along twenty-four 4 km long transects, from August 1995 to August 1996; due to unforeseen circumstances no sampling occurred in the months of October, 1995, and January, April, and May 1996. Due to access difficulty (there were only two roads in the Reserve), each transect originated (and continued at a right angle to) from one of two roads that radiate in different directions from the village (Fig. 1, see also Fig.17). Only the beginning and end of the

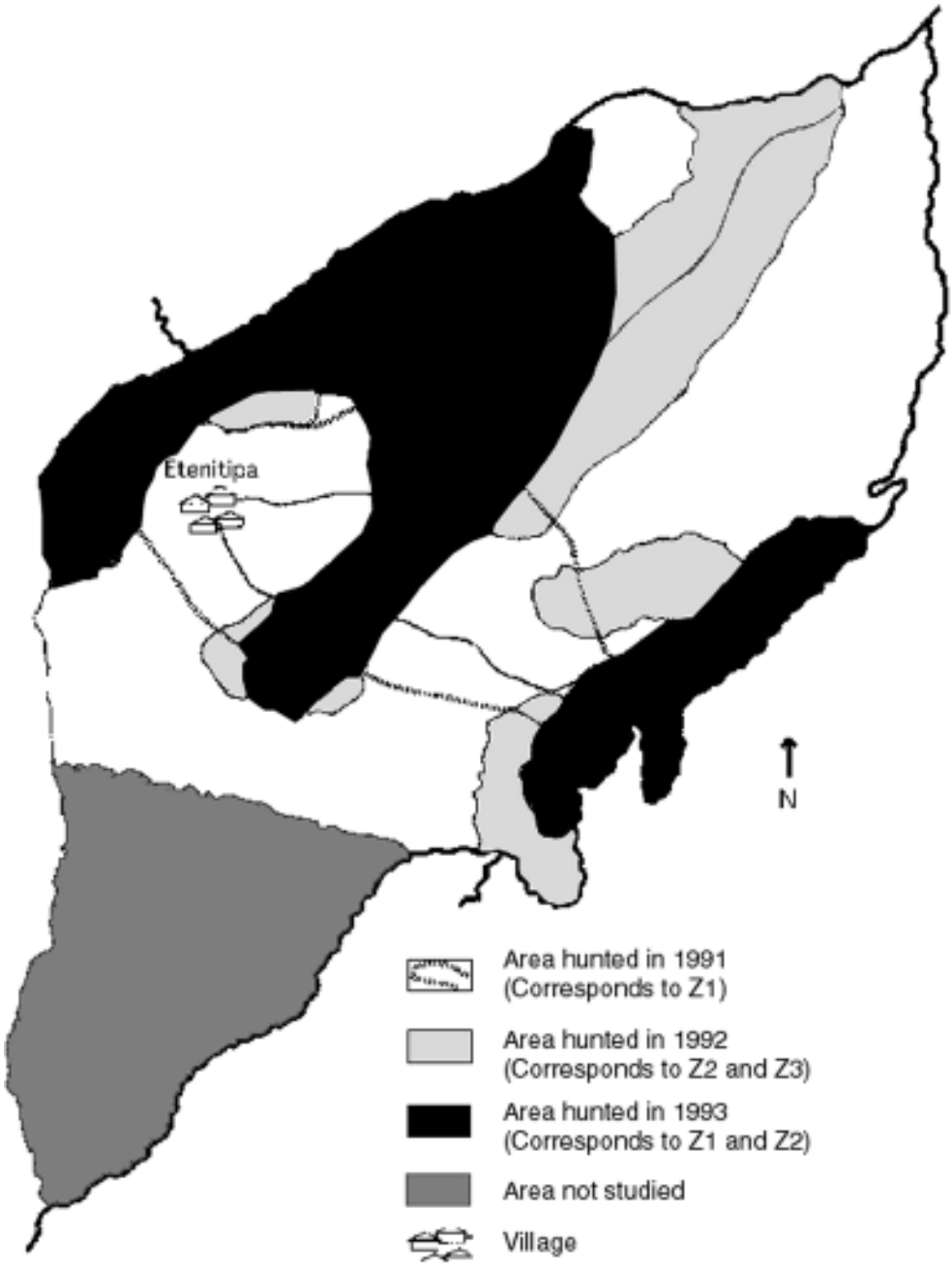

Fig. 1: Areas hunted by the Xavante from 1991 to 1993, and the three hunting "zones" of the transect study (adapted from Leeuwenberg 1997b).

transects were marked, using a combination of GPS location and pacing. We used a stratified random method to place 4 transects per stretch of road within each hunting zone. Thus, each hunting zone contained eight 4 km long transects. Note, however, that in several cases, Prada failed to mark the full transect distance, and measured the transects by time spent walking (Prada pers.comm.). Therefore there is some variation in transect length, but the exact of this variation was not quantified or provided to the consultants. We proceed with the analysis under the assumption that variation was small enough that it did not significantly bias the data.

The data on number and region of kills, sex of killed animals, region of hunting, and population age structure were derived from Leeuwenberg (1994) and Leeuwenberg and Robinson (in press). The data and methodology used to construct the hunting pressure/productivity ratio were derived from Leeuwenberg and Robinson (in press).

4.2 - Statistical Analyses

Parametric and nonparametric statistical methods were used to analyze the track data. This was necessary because not all data were normally distributed and some data sets contained zeros. Additionally, some transects were not searched in some months resulting in an unequal time-sample per transect. This last problem was solved by reducing the time component to the mean number of tracks per transect. After collation, in all cases the means were non-normally distributed, precluding their direct use in an ANOVA analysis. A log (x) transformation normalized the distribution for tapir, collared peccary, pampas deer, giant anteater and marsh deer means. Two-way ANOVAs were used to compare track abundance between hunting zones and vegetation types when testing hypotheses concerning hunting impact. One-way ANOVA's were used to analyze vegetation separately, when the two-way ANOVA suggested a significant effect. Post-hoc pairwise comparisons were conducted using Fishers PLSD test when ANOVAs showed significant effects. The Fishers test controls for Type I errors when multiple pairwise comparisons are made. For the non-normally distributed data sets, and for those with too many cells with zeros, we used the Kruskal-Wallis statistic to test the hypotheses.

5 - RESULTS

A total of 206 transects were run in 9 monthly sampling periods. Zones 2 and 3 had 69 transect runs each, while Zone 1 had 68. Eighty transects were in “campo com murundum” (an open savanna with intermittent mounds), 72 in Cerrado, and 54 in gallery forest.


Foto: Juan Pratginestós / WWF

Xavante Indians returning from hunting

All the larger species preferred by the Xavante, except for collared peccaries, were most common in the zones furthest from the village (Table 1). Detailed descriptions of the population status for each species in each zone are presented below.

The number of transects in each vegetation type was approximately equal in all hunting zones, except for the absence of savanna in Z1 (Table 2). Table 3 presents the results of the statistical tests examining the impact of hunting. Although vegetation type (“campo com murundum”, Cerrado, and gallery forest) formed one of the dependent variables in the ANOVA analysis, for clarity we present the vegetation results separately in Table 4. Only the pampas deer and the giant anteater showed statistically significant vegetation effects.

The hunting pressure/productivity ratio indicated that possibly two species may be overharvested throughout the reserve, five were harvested below maximum levels in one or more zones, and for one species, the pampas deer, the ratio indicates that they were hunted far below the theoretical possible harvest rate (Table 5), but there are confounding lines of evidence for this species which we will discuss later. The sex ratios for killed animals show female bias in all zones for two species, while four species had male-biased sex ratios in at least one hunting zone (Table 6). Collared peccaries exhibited approximately even sex ratios in all three hunting zones. The overall trend was for sex ratios to be female-biased for all species in the Z1, the heavily hunted zone, and for a decrease to occur in the number of females to males killed in Z2 and Z3, the lightly hunted zones (Fig. 2).

TABLE 1: THE MEAN AND STANDARD ERROR FOR THE NUMBER OF TRACKS PER SPECIES IN 8 TRANSECTS PER HUNTING ZONE (Z1, Z2, AND Z3) OVER THE ENTIRE STUDY PERIOD. SAMPLE SIZE N = NUMBER OF TRANSECT RUNS FROM AUGUST 95 TO AUGUST 96.

Species	Mean Nº. Tracks			Standard Error		
	Heavy Hunting (Z1) n=68	Medium Hunting (Z2) n=69	Light Hunting (Z3) n=69	Z1	Z2	Z3
Collared Peccaries	3.46	3.41	3.56	1.71	1.16	0.72
Tapir	3.01	4.45	5.14	1.03	0.95	1.05
Grey Brocket Deer	1.56	0.07	0.29	0.37	0.06	0.14
Pampas Deer	0.96	5.11	1.98	0.54	0.87	0.61
Marsh Deer	0.63	1.16	2.17	0.38	0.62	0.73
White-lipped Peccary	0.57	1.76	2.61	0.55	0.84	1.3
Peba Armadillo	0.56	0.14	0.18	0.18	0.05	0.08
Giant Anteater	0.54	0.84	1.15	0.26	0.14	0.34
Red Brocket	0.32	0.07	0.12	0.13	0.06	0.11
Giant Armadillo	0.16	0.45	0.29	0.05	0.17	0.07
Puma	0.03	0.03	0.03	0.02	0.02	0.03
Mirim Anteater	0.03	0	0	0.02	0	0
Jaguar	0	0.01	0.01	0	0.01	0.01
Total tracks for all species	11.83	17.51	17.54	2.92	1.31	2.75

TABLE 2: THE NUMBER OF TRANSECTS PER PLANT COMMUNITY IN THE HEAVILY (Z1), MODERATELY (Z2) AND LIGHTLY (Z3) HUNTED ZONES OF THE XAVANTE RESERVE

Number of transects	Vegetation			
	Savanna com Murundum	Cerrado	Gallery Forest	Total
Zone 1	0	6	2	8
Zone 2	5	1	2	8
Zone 3	4	2	2	8
Total	9	9	6	24

TABLE 3: PROBABILITY LEVELS OF COMPARISONS OF TRACK ABUNDANCE FOR HUNTED SPECIES IN THREE DIFFERENT ZONES. THE TWO ANOVAS WERE PERFORMED ON DATA TRANSFORMED USING LOG (X). OTHER COMPARISON WERE CONDUCTED USING KRUSKAL-WALLIS TEST.

Species	Dependent Hunting Kruskal-Wallis P	Hunting ANOVA P	Vegetation ANOVA P	Direction of Significance, Fishers	Fishers P 1	Fishers P 2	Fishers P 3
Collared Peccaries	0.6754	0.3039	0.4173	+	+	+	+
Tapir	0.2945	**0.0148**	0.359	1<3, 1=2, 2=3	**0.039**	0.0804	0.7078
Grey Brocket	**0.0093**	*	*	*	*	*	*
Pampas Deer	**0.0031**	0.1008	0.2311	** 1<2, 1=3, 2>3	**0.0271**	0.7934	**0.0175**
Marsh Deer	**0.0263**	**0.035**	0.1397	1<3, 1=2, 2=3	**0.016**	0.1741	0.2085
White-lips	0.1779	*	*	*	*	*	*
Peba Armadillo	0.1544	*	*	*	*	*	*
Giant Anteater	0.1849	0.2532	**0.0159**	1>4, 2>4, 1=2	**0.0176**	**0.0144**	0.8522
Red Brocket	0.2547	*	*	*	*	*	*
Giant Armadillo	0.1433	*	*	*	*	*	*
Puma	0.9324	*	*	*	*	*	*
Mirim Anteater	0.6188	*	*	*	*	*	*
Jaguar	0.8869	*	*	*	*	*	*
All Species	0.2248	**0.01**	0.6427	1<2, 1<3, 2=3	**0.0185**	**0.0339**	0.7659

A "+" INDICATES NO DIFFERENCES WERE SIGNIFICANT A P<.05; (**) INDICATES SIGNIFICANT DIFFERENCES BETWEEN HUNTING ZONES; (*) INDICATES ANOVAS WERE NOT APPLIED TO THESE DATA SETS

TABLE 4: PROBABILITY LEVELS OF COMPARISONS OF TRACK ABUNDANCE FOR HUNTED SPECIES IN "CAMPO COM MURUNDUM", CERRADO AND GALLERY FOREST PLANT COMMUNITIES IN RIO DAS MORTES INDIGENOUS RESERVE. THE ANOVA WAS PERFORMED ON DATA TRANSFORMED USING LOG (X).

Species	Vegetation ANOVA P	Direction of significance, fishers	Fishers P1	Fishers P2	Fishers P3
Collared Peccaries	0.4173	+	+	+	+
Tapir	0.359	+	+	+	+
Gray Brocket	*				
Pampas Deer	0.2311	2=3,2>1, 3=1	0.54	0.02	0.14
Marsh Deer	0.1397	+	+	+	+
White-Lips	*				
6-band. Armadillo	*				
Giant Anteater	0.0159	1>3, 2>3, 1=2	0.0176	0.0144	0.8522
Red Brocket	*				
Giant Armadillo	*				
Puma	*				
Mirim Armadillo	*				
Jaguar	*				
All Species	0.6427	+	+	+	+

+= NO SIGNIFICANT DIFFERENCE

TABLE 5: THE HUNTED STATUS OF DIFFERENT SPECIES PRESENTED AS A RATIO OF OBSERVED HARVESTING LEVELS BY THE XAVANTE IN DIFFERENT YEARS AT DIFFERENT SITES DIVIDED BY THE ESTIMATED PRODUCTIVITY FOR THE SPECIES PER KM^2 DERIVED FROM ROBINSON AND REDFORD (1991). THE DATA WERE DERIVED FROM LEEUWENBERG AND ROBINSON (IN PRESS). ALSO PRESENTED ARE DETERMINATION OF HUNTING STATUS BASED ON POPULATION AGE STRUCTURE AS DERIVED FROM HUNTER KILLED ANIMALS.

Species	Status Hunting Pressure Ratio			Status Age Structure
	Z1	Z3 & Some Z2	Z1	
	1991	**1992**	**1993**	
Collared Peccaries	0.09	0.07	0.08	not over-hunted
Tapir	**1.33**	0.70	**1.23**	
Grey Brocket Deer	0.01	0.00	0.00	
Pampas Deer	0.14	0.12	0.17	over-hunted
Marsh Deer	0.87	0.87	**1.07**	over-hunted
White-lipped Peccary	0.21	0.09	0.21	not over-hunted
Giant Anteater	**1.59**	**1.60**	**1.50**	
Red Brocket	0.01	0.00	0.01	

TABLE 6: THE SEX RATIO OF ANIMALS KILLED BY XAVANTE HUNTERS OVER THREE YEARS IN TWO TO THREE REGIONS OF THEIR RESERVE (FROM LEEUWENBERG, 1994)

Species	Sex Ratio Male:Female Per Zone and Year		
	Z1	Mostly Z2 & Z3	Z1
	1991	**1992**	**1993**
Collared Peccaries	1 : 1.1	**1 : 0.8**	1 : 1.0
Tapir	1 : 1.4	**1 : 0.5**	1 : 1.6
Pampas Deer	1 : 4.8	**1 : 1.6**	1 : 2.2
Marsh Deer	1 : 2.3	**1 : 0.3**	1 : 2.0
White-lipped Peccary	1 : 1.9	**1 : 0.6**	1 : 1.3
Giant Anteater	1 : 1.8	**1 : 1.1**	1 : 1.7
Peba Armadillo	1 : 0.5	**1 : 1.4**	1 : 0.9

TABLE 7: POPULATION STATUS SCORE BASED ON SEVEN DECISION-MAKING INDICES THAT MEASURE HUNTING IMPACT. INDICES EXPLAINED IN TEXT. AN OVERALL SCORE NEAR 2 INDICATES A STABLE POPULATION, A SCORE NEAR 1 INDICATES A POPULATION STRONGLY IMPACTED BY HUNTING. INSUFFICIENT DATA WERE AVAILABLE FOR THE TAMANDUA, PUMA AND JAGUAR AND THESE ARE NOT INCLUDED IN THE TABLE. GA = GIANT ANTEATER, PD = PAMPAS DEER, MD = MARSH DEER, T = TAPIR, CP = COLLARED PECCARY, WLP = WHITE-LIPPED PECCARY, GA = GIANT ARMADILLO, GB = GREY BROCKET DEER, RB = RED BROCKET DEER, PA = PEBA ARMADILLO.

Index	GA	PD	MD	T	WLP	CP	GA	GB	RB	PA
1. Increasing trend	1	1	1	1	1	2	1	2	2	2
2. Source-sink dynamics	1	2	2	2	1	1	1	2	*	*
3. Sex ratio change	1	1	2	2	2	2	*	*	*	2
4. Harvest/Productivity	1	2@	1	2	2	2	*	*	2	*
5. Age structure	*	1	1	*	2	2	*	*	*	*
6. H/P entire population	1	1	1.5	1	2	2	*	*	*	*
7. Normal population?	*	2	1	*	*	2	*	*	*	*
Total Score	1	1.4	1.4	1.6	1.7	1.9	?1	2	2	2

* = DATA INSUFFICIENT FOR THIS CATEGORY
@ = PREFERRED SPECIES, LOW SCORE SUSPICIOUS
? = PRESENT STATUS UNKNOWN

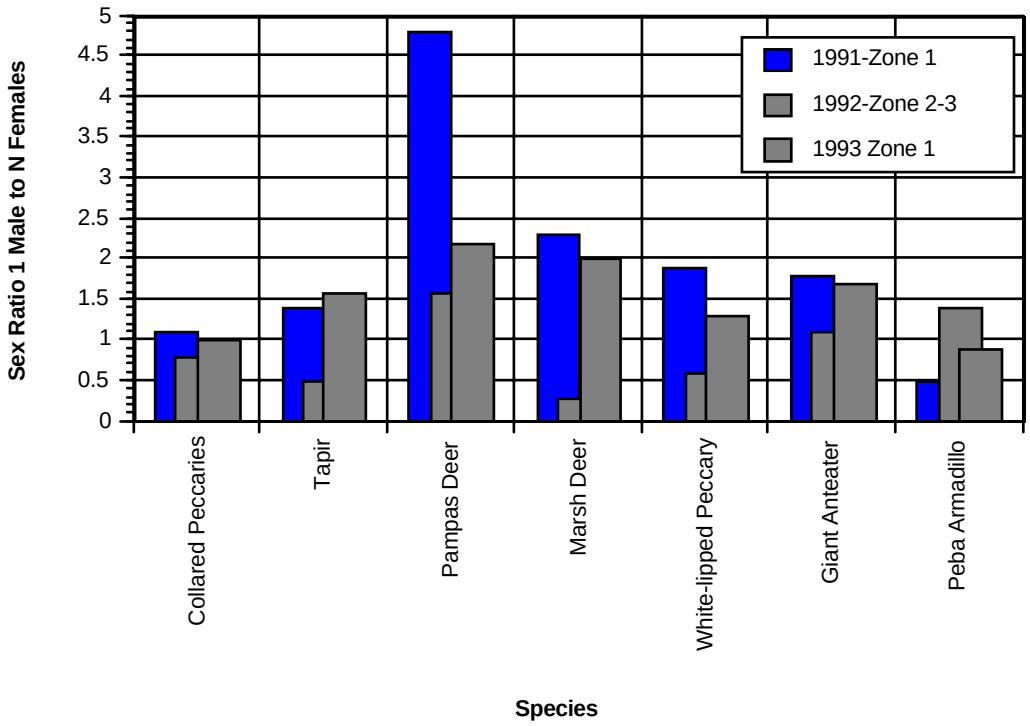

FIGURE 2: THE SEX RATIO OF ANIMALS KILLED BY XAVANTE HUNTERS OVER THREE YEARS IN TWO TO THREE REGIONS OF THEIR RESERVE (FROM FRANS LEEUWENBERG, 1994). SHOWN IS THE NUMBER OF FEMALES PRESENT PER EACH MALE.

6 - SPECIES ACCOUNTS

In this section we describe and interpret the index results for each species. We also give a management recommendation for each species based on the rule of providing maximum meat returns for the Xavante, which implies hunting the current source population while sink areas are allowed to recover. As explained in the discussion, this is based on the assumption that sink areas are created by hunting, not by low habitat quality (this is supported by overall inverse correlation between track abundance and hunting success). Note, however, that several management options, based on different rules and desired hunting yields, are available. These are developed and presented in the discussion.

6.1 - Giant Anteater (*Myrmecophaga tridactyla*)

Natural History

Females bear one young after a gestation period of 142-190 days (Nowak 1991). The young remain with the female for a year, until she becomes pregnant again, although they are weaned at 4-6 weeks. They are sexually mature at about 2.5 years of age, and in captivity one animal lived for 25 years and 10 months (Nowak 1991). Despite its very specialized diet (ants and termites), the species can be found in almost any habitat, although it probably attains its highest densities in Cerrado and savannas. Reported densities are 7 Individuals per km^2 (Eisenberg 1989), and one animal per 1.3 km^2 in Minas Gerais (Montgomery and Lubin 1977). Unhunted populations on cattle ranches in the Pantanal (Mato Grosso) reached densities of 17.02 animals per Km^2, but density was patchy within the areas (Lourival and Fonseca 1997). Reports of home range sizes vary from 1 km^2 (Eisenberg 1989) through 9 km^2 (Pinto da Silveira 1969) to 25 km^2 in Minas Gerais (Montgomery and Lubin 1977), although in this same area one female used a home range of 3.7 km^2, and a male of 2.7 km^2. Home ranges tend to be larger in areas with low termite mound densities or availability, and in such cases individual home ranges overlap (Eisenberg 1989). The giant anteater is listed as vulnerable by the International Union for the Conservation of Nature (IUCN), and as Appendix 2 by CITES (Nowak 1991). Because the Xavante are one of very few human populations that rely heavily on anteaters, there is no data from other hunting studies for comparison of hunting success, harvest rates, and demographic indices. Lourival and Fonseca (1997) calculated a productivity of 7.14 ind/km^2 per year for unhunted populations on 3 cattle ranches in Mato Grosso, suggesting a sustainable harvest of 2.86 ind/km^2 per year based on the Robinson and Redford MSY model. Anteater densities were unusually high in that study, higher than those reported for cattle ranches in other habitats.

Status at Rio das Mortes: **Threatened, Score 1**

Transect Results: The number of tracks detected for this species seems low overall, although we have no standard for comparison. Tracks increased in number with increasing distance from the village (Figure 3) (Z3 > Z2 > Z1) but the differences were not significant (Table 3). There was a significant vegetation effect; post hoc Fishers PLSD tests indicated that there were significantly more tracks in both “campo com murundum” and in Cerrado than in gallery forest, (Table 4), but there was no difference in track abundance between “campo com murundum” and Cerrado. A significant zone x vegetation interaction term indicates that in Zone 2 anteater tracks occurred in gallery forest more frequently than in the other zones.

Hunting effect: Trend (statistically not significant) toward fewer tracks in hunted area (Fig. 3).

Source-Sink: No distinct source area within reserve, because no significant difference in track levels between zones. We suggest that the source population for the reserve may be adjacent lands owned by European descent Brazilians. European descent peoples (used throughout this paper to mean people descended of any Old World stock) do not eat giant anteaters, believing that killing one brings bad luck (Lourival and Fonseca 1997) or disliking the taste of the meat (Leeuwenberg pers. comm.).

Hunting pressure-productivity ratio: Greater than 1.5 in all zones indicating over-harvested in all zones (Table 5). Leeuwenberg and Robinson (in press) also report that giant anteaters are probably over-hunted as the actual harvest rate greatly exceeds the maximum production rate. Since by definition Z3 is not heavily hunted, either the Xavante actually are hunting in this zone, or the animals' home ranges are large enough that hunting near the village impacts the entire reserve. On the few occasions that the Xavante hunted in Z3 during Leeuwenberg's study, they killed many anteaters because they are easily spotted, tracked, and killed.

Sex ratios: Female-biased in Z1 over two years (1991, 1993), apparently 1:1 in Z2 and Z3 in 1992 (Table 6). The sex ratio data indicates that more females than males are killed in zone 1, but similar proportions were killed in zone 3. If, as in the case of ungulates, an equal or female-biased sex ratio is considered an indication of over-hunting, then one can assume that the equal sex ratio observed in killed giant anteaters indicates that the population is being over-hunted. On the other hand, if sex ratios are 1:1 in normal anteater populations, and males and females are equally susceptible to hunting, then the population in zones 2 and 3 may not be showing as strong an effect of hunting as in Z1.

Age structure: Leeuwenberg (1997b) reports that the proportion of animals less than one year old was 6.2, 11.5 and 5.8 percent respectively in 1991, 1992 and 1993. The higher proportion of very young animals in the farther zones hunted in 1992 could be due to a variety of factors not necessarily related to hunting; since juvenile animals were not distinguished from adults, the age structure of the population cannot be described.

Conclusions: The hypothesis that the population is being over-hunted was supported by the three different analyses (Table 7): the track data indicated increasing numbers with distance from the village, although it was non significant, while the hunting-productivity and the sex ratio analyses supported the hypothesis of over-hunting in Z1, Z2 and Z3. The population is strongly impacted by hunting.

Recommendations: The role of outside lands as a source for dispersing animals should be investigated. There should be a moratorium on hunting giant anteaters until this can be determined. If the source population is off of the reserve, the Xavante can continue hunting this group at present levels as long as populations remain undisturbed on adjacent lands. However, ranch lands in this region are being converted to croplands, which provide fewer resources for anteaters.

Since it is unlikely that the Xavante will stop killing giant anteaters altogether, we recommended that they be hunted only in Zone 3, the area most distant from the village. We suggest that Z1 and Z2 function as no-hunting reserves for giant anteaters indefinitely until track surveys show that populations have increased significantly beyond the baseline presented here. The track counts

and sex ratios suggest that Z 3 is least impacted by hunting, although it too appears over-hunted.

Xavante Decision: The Xavante decided not to place any special hunting bans on this species; it will only be unhunted in the areas designated as no-hunting refuges for all species. This gives the anteater a refuge for 5 years in Z 2, for 2 years in Z 1, and for 2 years in Z 3. This decision agrees well with the recommendations from data analysis, as long as the reserve in Zone 2 has appropriate habitat for anteaters.

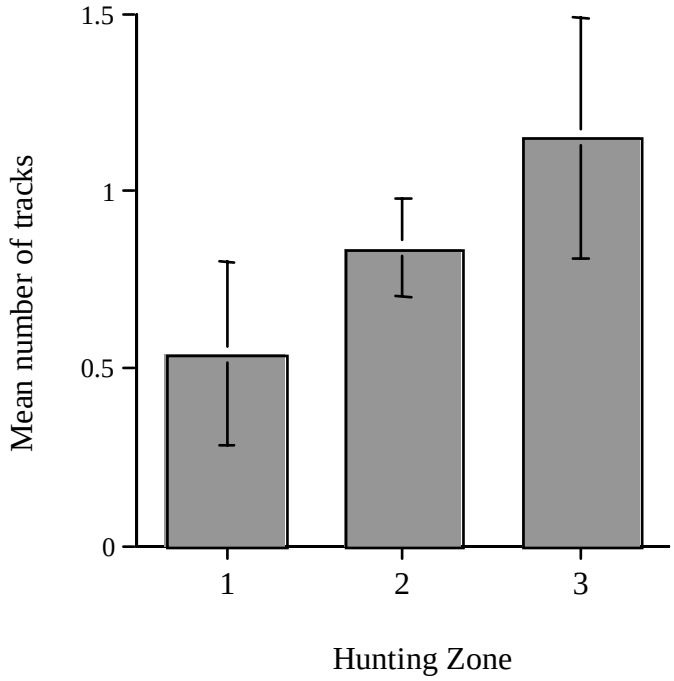

FIGURE 3. THE MEAN NUMBER OF GIANT ANTEATER (*MYRMECOPHAGA TRIDACTYLA*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED).

6.2 - PAMPAS DEER (*OZOTOCERUS BEZOARTICUS*)

Natural History

Pampas deer use savannas, Cerrado and open habitats, but avoid extensive heavily treed areas (Eisenberg 1989). They are mainly grazers but will also browse, and do well wherever grassy areas occur. Females bear a single fawn after a 7 month gestation period and fawns remain with the female for at least a year (Nowak 1991). Females give birth every 10 months (Redford 1982). Group size is small, including many single animals and averaging 2.19 and 1.36 in studies in the pampas of Argentina (Jackson and Langguth 1987) and Emas National Park in western Goias, Brazil (Redford 1982). The sex ratio in the unhunted Emas population was 1:1.3, and the percentage of young in the population was low (2.3 to 6 %; only 13-20 % of the females observed with young during censuses). In one conservation experiment in the Argentinean pampas, the species showed a good capacity for population recuperation in a 3,500 ha reserve: a population of less than 15 animals tripled in size three years after a hunting ban, and attained a size of 90 individuals 6 years after the ban (Jackson and Langguth 1987).

The species is listed on Appendix 1 of Cites, but is unlisted by IUCN (Nowak 1991).

Status at Rio das Mortes: **Threatened, Score 1.4.**

Transect Results: The greatest number of tracks were observed in Z2, while Zones 1 and 3 had low numbers (Table 1). A two way ANOVA revealed no significant hunting and vegetation effects on track abundance (Table 3). Paired comparisons using the Fishers PLSD test indicated that the number of tracks were significantly greater in Zone 2 than in Zones 1 and 3, but statistically similar in Zones 1 and 3 (Table 3). There was no interaction between vegetation and area. An ANOVA analysis did not detect a vegetation effect for this species (Table 4). However, post hoc analysis using the PLSD test indicated that "campo com murundum" was preferred over Cerrado. There were too few tracks in gallery forest to permit a statistical comparison. Few tracks in gallery forest indicates that this is not a preferred habitat for pampas deer, as expected from its natural history.

Hunting Effect: Significantly fewer tracks near the village indicates hunting is having an effect on the population (Fig.4).

Source-sink: Within the Xavante Reserve, track numbers increased significantly from Z1 to Z2 (Table 3), suggesting that the reserve supports a source population.

Hunting pressure-productivity ratio: The hunting-productivity ratio was far less than 1 in all zones, indicating that pampas deer were being killed at below MSY in all zones.

Sex Ratios: The sex ratio data indicates that females are killed more frequently than males in all zones, but the bias towards females is phenomenal in Z1 (Table 6), varying from 4.8 females killed for every male in Z1 in 1991, to 3 to 1 in Z3.

Age Structure: All pampas deer caught in three years were 4 years old or less, and most were 1.5 years old or less (Leeuwenberg 1994). This is the most aberrant age structure reported for any of the animals in the study, and proportion of young is much higher than that described for unhunted populations (see above). The lack of old animals is serious enough for Leeuwenberg (1994) and Leeuwenberg and Robinson (in press) to suggest a strong impact of hunting (Table 5).

Conclusions: The various analysis present somewhat conflicting results with regard to determining the harvested status of populations (Table 7). The harvesting/productivity ratio seems to indicate that populations are being cropped well below sustainable levels; however, this result conflicts with three other indicators (sex ratios: strongly female-biased all zones, age structure skewed towards young animals, track data indicates strong hunting effect). A harvesting/productivity ratio less than 0.2 for this species is also counterintuitive given the strong preference of the Xavante for this species. With the exception of the harvest/productivity ratio, the other evidence presented here indicates pampas deer abundance are well below their potentials in all zones, and that few animals are being caught because few animals are present. Since Pampas deer are also highly preferred by European descent peoples (Lourival and Fonseca 1997), the low abundance in Z3 may result from illegal hunting by from people living adjacent to the reserve. They have been observed hunting within the Xavante reserve border regions by Leeuwenberg (pers. comm.) and Prada (pers. comm). The high number of tracks in Z2 may be related to the creation of an area for the grazing of cattle, which would also benefit pampas deer (but note that there is conflicting evidence information on the reaction of pampas deer to cattle pasture: Pinder (1997) states that

cattle do not negatively impact pampas deer populations, whereas Leeuwenberg and the Xavante (Leeuwenberg pers. Comm.) perceive that in the Rio das Mortes Reserve pampas deer avoid areas with cattle). This zone also supports large areas of “campo com murundum”, the plant community most preferred by this deer (Table 2). The variation in abundance may also be related to the increased hunting in Z3 by the Xavante since the opening of a road in 1993. The savannas in Z3 also flood seasonally, making them unavailable to pampas deer for part of the year. This factor would reduce their numbers (and tracks) during the flooded period.

Recommendations: Pampas deer should not be hunted in the zone nearest the village, nor in Z3, the area furthest from the village, for three years. Tracks should be monitored in the third year to determine the effect if any of the recommendations. The sex ratio data suggest that there may be no source population in the reserve, except for possibly Z2, where there are 1.6 females killed for every male, a low number relative to the 4.8 females killed for every male in Z1. The Xavante should consider developing non-hunting reserves for pampas deer.

Xavante Decision: The Xavante decided not to place any special hunting bans on this species; it will only be unhunted in the areas designated as no-hunting reserves for all species. This gives the pampas deer a no-hunting area for 5 years in Z 2, for 2 years in Z 1, and for 2 years in Z 3. This decision goes counter to the recommendation of hunting primarily in Z 2.

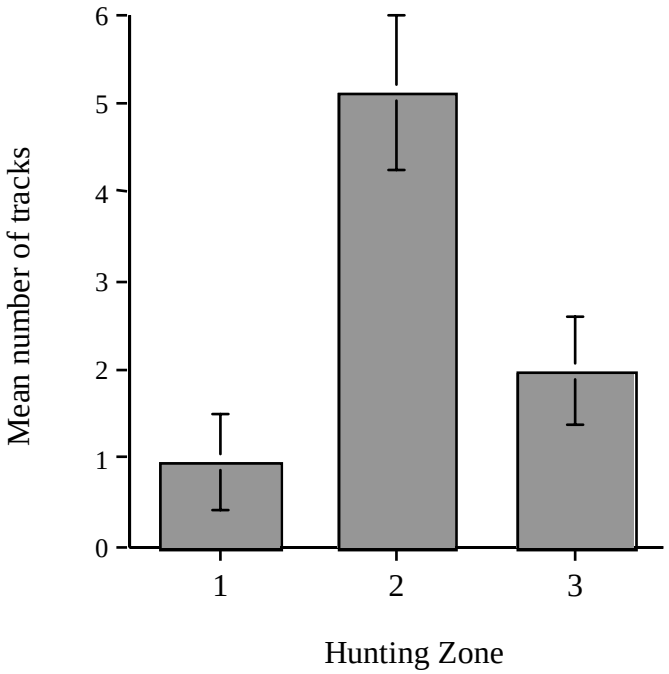

FIGURE 4. THE MEAN NUMBER OF PAMPAS DEER (*OZOTOCEROS BEZORTICUS*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED).

6.3 - MARSH DEER (*BLASTOCERUS DICHOTOMUS*)

Natural History

The largest deer found in South America (up to 125 kg), marsh deer are habitat specialists on marshes and wetlands. They actively select marshes for feeding and use nearby fields for resting, ruminating, and travelling (Pinder 1997). On the one hand this makes them vulnerable to

over-hunting and habitat destruction, but on the other hand it may provide temporal refuges from hunting when their habitats are heavily flooded in the rainy season (Townsend 1994). Females produce young after approximately seven months of gestation, and the young are weaned by about 12 months (Redford and Eisenberg 1992). Pinder (1997) reports denisties of about 0.5 animals per km^2 in the Rio Parana area of Mato Grosso do Sul; Schaller and Vasconcellos (1978) reported densities ranging from 1 deer per 3.8 square km to one per 42 square km in the same area (about 0.3 ind/km^2), and a sex ratio of 0.6: 1. Two other studies also report female-biased sex ratios in the wild (Pinder 1997, Beccaceci 1994). As a grazer/browser it does well in a variety of Cerrado habitats as long as there are marshes and wetlands nearby. The marsh deer is listed as vulnerable by the International Union for the Conservation of Nature (IUCN), and on Appendix 1 by CITES (Nowak 1991).

Status at Rio das Mortes: **Threatened, Score 1.4**

Transect Results: Marsh deer were most abundant in the hunting zone furthest from the village where we encountered an average of 2.17 tracks per transect (Fig. 5). The lowest number of tracks were observed in Z1, the heavily hunted zone. A two way ANOVA detected a significant difference between hunting areas (Table 3). The Fishers PLSD tests revealed Z 3 contained significantly more tracks than Z 2, but zones 1 and 2 had a similar number of tracks. There was no interaction between area and vegetation. An ANOVA analysis did not detect a vegetation effect for this species (Table 3 and 4). Nor did a post hoc analysis using the PLSD test to detect differences in track abundance between plant communities.

Hunting Effect: The trend for track number to increase from Z1, to Z2 and Z3 (Fig. 5) indicates a strong hunting effect.

Source-sink: The population abundance increased significantly from Z1 to Z3, with no difference detected between Z2 and Z3 (Table 3). This suggests that Z3 (and possibly Z2) may serve as source population for the other zones.

Harvest Pressure/Productivity Ratio: The harvest/productivity ratio was near 1 in all zones (Table 5), suggesting that over-hunting is occurring throughout the reserve.

Sex Ratios: The sex ratio analysis indicated that two females were being killed for every male in Z 1 during both of the years sampled (Table 6). In contrast, in Z2 and Z3 three males were killed for every female. The sex ratios in Z1 was strongly female-biased (Table 6), suggesting over-harvesting.

Age Structure: Age structure seems normal though somewhat skewed toward younger animals. About 70 % of animals caught in three years were $\leq$ 2 years old, but animals up to 8 years old were captured (Leeuwenberg 1994). Leeuwenberg and Robinson (in press.) interpret this skew as indicating that hunting is “significantly” impacting the population.

Conclusions: The hypothesis that marsh deer were over-hunted in Z1 relative to the other zones could not be rejected; all three analyses were in agreement. Only in the zones furthest from the village were marsh deer perhaps not over-hunted, as evidenced by the sex ratio and track analyses. Most of the indicators suggest that this species is over-harvested throughout the reserve, but the sex ratio and track data indicate the possibility of a source population in Z3.

In a 40,000 ha reserve in Bolivia containing both forest and savanna habitat, Townsend (1994) found a slightly male-biased ratio in a sample of 78 hunter-killed marsh deer. Forty five percent of 56 animals were young or juveniles, a lower proportion than in the Xavante study. This suggests that sex ratios and age structure do not covary with hunting pressure: in Townsend's study the same number of animals were caught in two years as the Xavante caught in three years, suggesting that hunting pressure is higher (harvest to productivity ratio was .51/.08). However, in this area the presumed source population is outside the reserve, and sex ratios were not separated by distance/subpopulation, which may explain the discrepancy. Pinder (1997) found a very low proportion of young and juveniles (less than 10 %) during aerial censuses in Mato Grosso do Sul, near the Paraná river, but information was not given as to whether the population was hunted or not.

Recommendations: One of our analyses indicates over-harvesting is occurring in all zones, but two others suggest the possibility of source populations within the reserves (sex ratios and track data) (Table 7). This lack of agreement between these indicators makes it difficult to confidently accept the hypothesis that marsh deer are being over-hunted overall. However, an examination of Leeuwenberg and Robinson's (in press) data suggest that this species be listed as of special concern, especially because of it's low "status" score. Marsh deer should not be hunted in zone 1 or 2 for a period of 3 years since both these zones seem to be equally impacted by hunting. Hunting for this species should only occur in Z3, and after 3 years transects should be conducted in all zones to determine the impact (if any) of the recommendations. Alternatively, Z3 could be maintained as a population source reserve for the other two zones. The populations in Z3 appear not to be hunted by European descent Brazilians living adjacent to the reserve. This may be because their meat is considered unpalatable by this group in Mato Grosso (Lourival and Fonseca 1997).

Xavante Decision: The Xavante decided to apply special hunting bans for this species. In addition to the fixed reserves, marsh deer will not be hunted in Pu'upre Refuge (in Z 3) for one year after the overall 2 year no hunting ban has been lifted. This gives the marsh deer 3 years of no hunting in the Pu'upre Refuge. This decision agrees well with the recommendations from the data analysis, using the option of protecting the source and hunting in the sink.

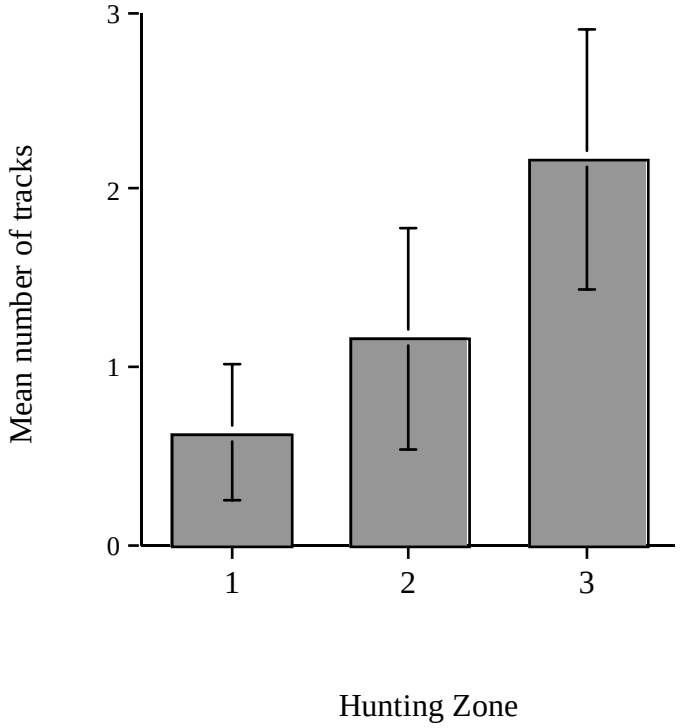

FIGURE 5. THE MEAN NUMBER OF MARSH DEER (*BLASTOCERUS DICHOTOMUS*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE(STANDARD ERROR BARS PRESENTED).

6.4 - TAPIR (*TAPIRUS TERRESTRIS*)

Natural History

The Brazilian tapir bears one young after a gestation period of 385-412 days (Nowak 1991). The calf remains with the female for 10 to 11 months, and females can bear young once every two years. Young animals attain sexual maturity at 3 to 4 years, and in captivity animals can live for 35 years. Tapirs are the largest terrestrial mammals in South America (Eisenberg 1989). The only home range data for the Brazilian tapir is for an Atlantic rainforest isolate in Sao Paulo: after three months, a female tapir used a 60 ha area; after four months she had used a 152 ha area (Medici pers. comm.) suggesting great seasonal variability in range use. Fragoso (pers. obs.) has observed a free ranging semi-domesticated adult male lowland tapir ranging as far as 20 km in a straight line distance in a savanna/Cerrado region of Roraima in northern Brazil. A population density of 0.8 animal per square kilometer is reported for Baird's Tapir (*Tapirus bairdii*) in Central America (Nowak 1991). Tapirs are generalist herbivores that feed on leaves, fruits and grasses (Fragoso 1994, 1997, Eisenberg 1989, Nowak 1991), and can occur in a variety of habitats, including the Gran Chaco desert region of Paraguay, where they feed on cactus (A. Taber pers. com). They may require forested areas as shade (Fragoso 1987).

Olga Montenegro (pers. comm. Of unpublished data) reports observing slightly more females than males at a salt lick in Peru (1:1.71 for all animals, 1:2.6 for adults), but it is unclear if this reflects the underlying population structure or whether females are more likely to visit the salt lick than males. The Brazilian tapir is listed on Appendix 2 by CITES, and unlisted by the IUCN (Nowak 1991).

Mazurek (1997) found an even sex ratio among 131 tapirs killed by five the Waimiri-Atroari communities in the central Brazilian Amazon. One possible explanation for an even rather than a male-biased ratio is that the Waimirin-Atroari have recently started exploiting previously unhunted populations distant from their villages by using trucks on recently built roads to reach them. These distant populations should show the typical male-biased sex ratio for hunted ungulates, while populations nearer the village could be female-biased. Since Mazurek combines data from all distances, one cannot tell whether the sex ratio varies with distance from the village, and combining all data could even out sex ratio. The large number of animals caught in one year by five villages with a population of 256 people does suggest that in the other studies reviewed here either tapir productivity is low, or the populations are being held at low levels by over hunting.

Townsend (1995) did not have a large enough sample to examine sex ratio. Hill et al (1997) found an increase in track counts with increasing distance from villages from which hunters depart.

Status at Rio das Mortes: **Vulnerable, Score 1.6**

Transect Results: Tapirs were most abundant in Z3, where they averaged 5.14 tracks per transect (Table 1). Their tracks were least common in Z1, reaching only 3.01 tracks per transect. Zone 2 averaged 4.54 tracks per transect. A two way ANOVA found significant differences between hunting areas but not between vegetation types (Table 3). There were no significant differences in track counts between the three vegetation communities (Table 4). Nor was there significant interaction between hunting and vegetation (Table 3). Thus, tapirs appear to use all plant communities equally, and hunting pressure does not seem to alter their use of the different communities. A post hoc Fishers PLSD test revealed that the differences in track counts between zones 1 and 3 were significant but not between 1 and 2 and 2 and 3 (Table 3).

Hunting Effect: Fewer tracks are observed in the heavily hunted area, and there is significant increase in the number of tracks with distance from the village, so hunting is reducing the population (Fig. 6).

Source-Sink: Within the Xavante Reserve, population abundance varied significantly from Z1 to Z3 (Table 3), indicating the possible existence of a source population in Z3.

Hunting Pressure/Productivity Ratio: The hunting/productivity ratio of 0.7 (Table 4) indicates that tapirs were not over-harvested in Z2 and Z3. However, they were over-hunted in Z1, where the hunting ratio was greater than 1, in 1991 and 1993 (Table 5). That is, the harvest rate for tapirs is at the maximum capacity the population can support, based on the theoretical model.

Sex Ratios: The sex ratios were female-biased in Z1 over two years with 1.4 to 1.6 females killed for every male (Table 6). This indicates over-hunting in Z1. However, in Z3/Z2, two males were killed for every female.

Age Structure: Leeuwenberg (pers. Comm.) reports that if data from 1991-1993 are joined with some new data collected in 1995, a sample size of 38 hunted tapirs is available. Of these animals, twenty-six were classified in age class 1, six in age class 2, four in age class 3, and two in age class 4. This shows a skew toward animals, a sign of over-hunting. However, the data have been separated by area or year, and represent sample from a changing population over 5 years, so it cannot be used to interpret source-sink scenarios.

Conclusions: The hypothesis that the population is being over-hunted was supported for Z1 by the three different analyses. The hypothesis was not supported for Z3, where the three status measures indicated a stable population. Leeuwenberg and Robinson (in press) also found that the harvesting of the population as a whole was higher than productivity, and reported that over-hunting was occurring throughout the reserve. Thus, the indicators suggest that this species is over-harvested in the two zones nearest the village, but a source population exists in zone 3, and possibly Z2. The sex ratio and track count data suggest that Z3 may be serving as a population source of tapirs for Z1 and possibly Z2, which appear to be sinks (Table 7).

If we assume that Fragoso's observation of the distance movements of a lowland tapir in Roraima (20 km in a straight line) approximates the movements of tapirs in the Xavante reserve, then it's likely that individual tapirs in the reserve may roam over more than one hunting zone. In other words, a tapir killed in Z1 could have originated in Z2 and therefore the zones can't be managed separately.

Recommendations: Since the number of tracks is highest in Z3 and equal between Z2 and Z3, and since it is likely that tapirs from Z2 range into Z1, we suggest that tapirs be hunted only in Z3. Due to their low birth rate (a maximum of 1 birth every two years), we recommend that tapirs not be hunted in Z1 for 5 years, to permit the recovery of the population. At the end of a three year period transects should be conducted to determine if a noticeable increase has occurred in the population. An alternative to regulated hunting would be the creation of non-hunting tapir reserves.

Xavante Decision: The Xavante decided to establish special tapir hunting bans. In addition to the overall bans in designated areas, tapirs will not be hunted for an additional 3 years in the Arobonipo'opa Refuge (see below) in Z1/Z2. This gives the tapir a 3 year hunting ban in Z 1, and a 5 year hunting ban in the Uiwedehu Refuge (see below) of Z2, and 2 year hunting ban in the Pu'upre Refuge. This decision agrees well with the recommendations from data analysis.

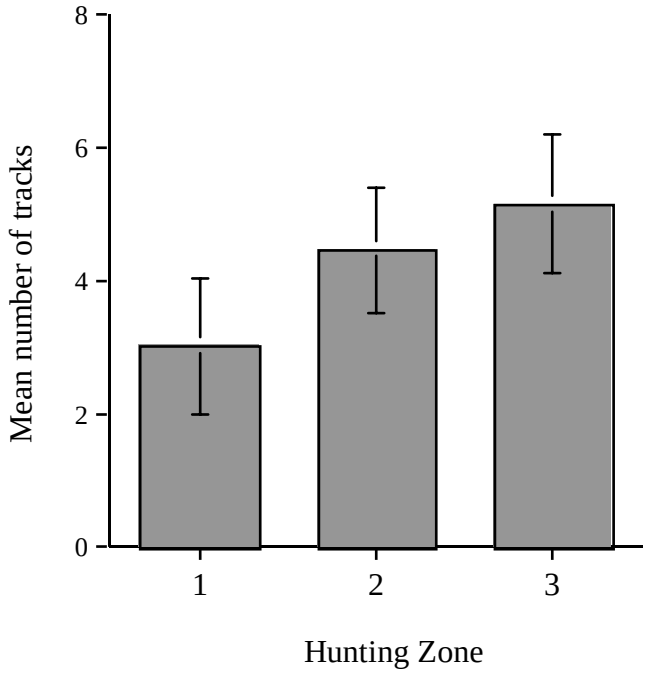

FIGURE 6. THE MEAN NUMBER OF TAPIR (*Tapirus terrestris*) tracks per hunting zone in the Rio das Mortes Xavante Indigenous Reserve (standard error bars presented).

6.5 - WHITE-LIPPED PECCARY (*TAYASSU PECARI*)

Natural History

Females begin reproducing at about 18 months, and two young are born after a gestation of about 156 days (Roots 1966, Eisenberg 1989). White-lipped peccary herds can range over huge areas; in the northern Amazon a herd of 39 animals ranged over 21 square km of forest, while another with 130 individuals ranged over 109 square km (Fragoso in press, 1994). Movements of this scale suggest that the Xavante are potentially killing animals from only one or a few herds, regardless of the hunting zone in which kills occur. White-lipped peccaries are omnivorous and are not habitat specialists (Fragoso 1994, Kiltie 1981, Bodmer 1989). They may require a mix of large scale habitats rather than any one specific type in order to match seasonal variation in food supplies for the large herd size (Fragoso in prep.). The white-lipped peccary is listed on Appendix II of CITES.

Mazurek (1997) found a slightly female-biased sex ratio (60 % of 166 hunter killed animals). Hill et al's (1997) encounter rate with white-lipped peccaries was too low to detect distance effects. Townsend (1995) found a 1:1 sex ratio for 173 hunter killed animals.

Status at Rio das Mortes: **Vulnerable but Stable, Score 1.7**

Transect Results: An ANOVA analysis detected no significant differences between track abundance for the three zones (Table 3). However, there was a trend for track number to increase from Z1, to Z2 and Z3, indicative of a hunting effect (Fig. 7). A Kruskal-Wallis analysis with hunting zone as the independent variable and mean number of tracks per eight transects as the dependent, showed no difference between the three zones (df=2, P=0.1779; Table 3). The lack of significance from both statistical tests may result from too many cells containing zero data in Z1. There was no interaction between vegetation and area, and no significant difference in use of vegetation types.

Hunting Effect: There was a trend for track number to increase from Z1, to Z2 and Z3 suggesting a hunting effect, or at least a decrease in visitation rates near the village (white-lips tend to temporarily abandon areas where they have been hunted, Fragoso, pers. obs.). However, the large area used by white-lip peccaries suggests that the three zones support a single population, and so Z2 and Z3 would be impacted by hunting occurring in Z1. Therefore the lack of a significant difference is not surprising.

Source-Sink: Within the Xavante Reserve, the population abundance did not vary significantly between any zones (Table 3), indicating that the reserve as a whole maintains a source population.

Hunting Pressure/Productivity Ratio: The hunting/productivity ratio was less then 0.5 in all zones (Table 5), indicating that white-lips were not being over-hunted in any zone (Table 4), corroborating the results of the track analysis.

Sex Ratios: In Z1 the Xavante killed almost two females for every male in 1991; after a one year hunting ban the ratio dropped slightly but was still female-biased (Table 6). In contrast, two males were killed for every female in Z3. This indicates over-hunting in Z1 but not the other zones, suggesting there may be at least two herds in the total hunted areas, one which tends to

use Z1 and has been more heavily impacted by hunting. This conclusion is derived from a comparison of the sex ratios of free-ranging unhunted populations, to the ratios of animals captured from this population using a dart rifle (Fragoso 1994), and ratios of an unhunted free ranging population in Paraná (Cristina Castellanos unpubl. data) and the general trend towards higher male-biased mortality in ungulates (Ralls et al. 1980)

Age Structure: The age structure was normal, with about 50 % of all animals caught in all three years $\leq$ 3 years of age, and animal up to 12 years old captured. Leeuwenberg and Robinson (in press) found that the survivorship curves of white-lip populations at Rio das Mortes did not differ from that of a lightly hunted area in Peru (Bodmer et al 1994, Bodmer 1995) but did differ from that of a heavily hunted area, and concluded that white-lips were not over-hunted in the Rio das Mortes Reserve.

Conclusions: The hypothesis that white-lips were being over-hunted could not be unequivocally accepted: two of the three indicators showed no over-hunting, while the third (sex ratios) indicated possible over-hunting in Z1. There was a also trend for track number to increase from Z1, to Z2 and Z3 (Fig. 7), suggesting that there is a hunting effect. Leeuwenberg and Robinson (in press) found a normal population age structure for this species and reported over-harvesting was not occurring. Thus, the indicators suggest that the population is not over-harvested (Table 7); however, the herd or herds using Z1 were exhibiting symptoms of the onset of over-harvesting.

Recommendations: We could not accept the hypothesis of over-hunting for the white-lip population; however, the analysis of sex ratios presented evidence of over-hunting for the herd/herds using Z1. In this zone, hunting pressure was high enough to shift the sex ratio from male to female-biased. We suggest that white-lips not be hunted in the first two zones for three years. Hunting could continue in the Z3. Three years are recommended as the non-hunting time period because this time period would allow breeding females the possibility of giving birth to about six young. This birth rate coupled with an increased survival rate should be sufficient to increase the herd/herds using Z1, though once hunting starts again they may again be reluctant to approach the area. At the end of the three year period the transects should be re-surveyed and the impact of the change in hunting patterns evaluated. Hunting could then be rotated to the zone with the most tracks. Alternatively, the Xavante could continue their present hunting pattern for this species, since the distant zones were little disturbed by their present harvesting rate.

Xavante Decision: No special hunting bans for this species. This agrees with the recommendations from data analysis, and the fixed refuges established for the next 2-5 years will provide some protection for the species. However, it is unlikely that refuge size will not include an entire home range, and herds could be strongly affected by hunting pressure outside the no-hunting zone if pressure increases above current levels.

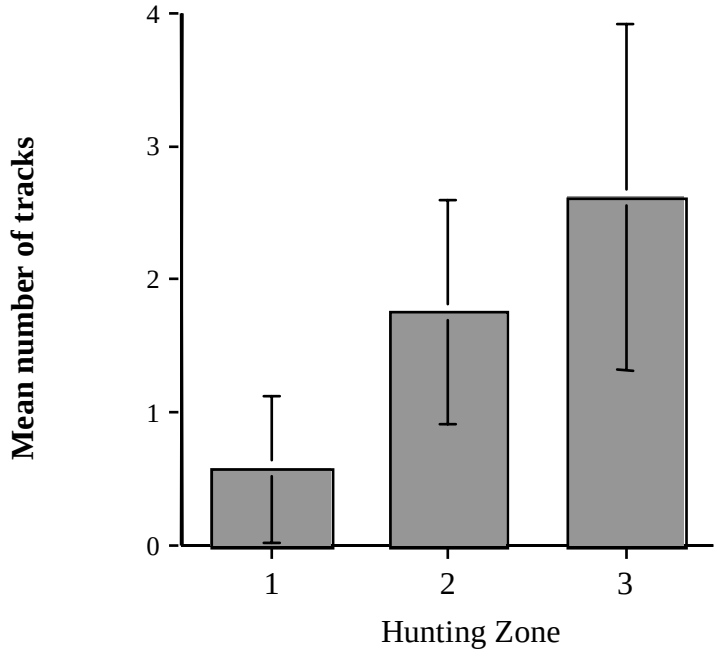

FIGURE 7. THE MEAN NUMBER OF WHITE-LIPPED PECCARY (*TAYASSU PECARI*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED)

6.6 - COLLARED PECCARY (*TAYASSU TAJACU*)

Natural History

Collared peccary females bear from 1 to 4 young after a gestation period of 145 days; normal litter size is two (Sowls 1984). The young remain with the female for 2 to 3 months. In captivity they have lived to 24 years and 7 months of age (Nowak 1991). Collared peccaries are about half the size of white-lips in areas where they coexist (20 versus 40 kg; Fragoso 1994). They occupy a variety of habitats but appear to differentiate their habitats at finer scales than white-lips (Fragoso in prep.). In the Amazon rain forest, groups of 12 to 36 animals have a home range of 10 to 12 square km (Fragoso 1994). In fragments of forest in Central America, small groups of from 3 to 10 animals range over 2 to 3 square km (Suarez 1993). Collared peccaries are omnivorous and feed on almost the same foods as white-lips, except they do not crack open hard nuts (Kiltie 1982, Fragoso 1994, Bodmer 1989). Their reproductive output is fractionally greater than white-lips (Sowls 1984). Despite this small difference in reproduction, collared peccaries everywhere seem to resist hunting pressure well, persisting in areas where white-lips have disappeared, and to use disturbed areas, feeding on gardens and not avoiding human presence (Suarez 1993). Collared peccaries could be in the category of animals whose populations are enhanced by human disturbance near the village, but because they are hunted frequently they don't show a peak in abundance near the village.

Mazurek (1997) found higher hunting success for collared peccaries far from the village than near it, a result counter to those of this study and Hill et al's (1997). Sex ratios were slightly male-biased (58 % of 358 animals). Hill et al (1997) had higher encounter rates with collared peccaries near Ache Indian villages than in the central areas of the reserve, most distant from all hunters. Townsend (1995) found even to slightly male-biased sex ratio (121 out of 228 animals, again indicating no over-hunting.

Status at Rio das Mortes: **Stable, Score 1.9**

Transect results: Collared peccary tracks were equally distributed among all three hunting zones and vegetation types (Table 1, Fig. 8) and there were no significant differences in track counts between the hunting zones (Table 3). There were no significant differences in the abundance of tracks between "campo com murundum", Cerrado and gallery forest (Table 4). There was an interaction effect between hunting zone and vegetation: fewer tracks occurred in Cerrado habitat in Z 2 than in other zones.

Hunting Effect: No effect was detected, track abundance similar in heavily hunted and unhunted zones.

Hunting Pressure/Productivity Ratio: The hunting pressure data indicated that collared peccaries were hunted well below MSY in all zones (Table 5).

Sex Ratios: The sex ratio analysis indicates that there was no sex bias in the number of collared peccaries killed for any zone (Table 6).

Age Structure: About 42 % of animals caught over the three years where $\leq$ 3 years old, and animals up to thirteen years old where captured. This shows a normal, predicted age structure, without an excess of young animals or a lack of old animals. Leeuwenberg and Robinson (in press) found that the collared peccary survivorship curve at Rio das Mortes did not differ significantly from either the heavily hunted or the lightly hunted sites in Peru (Bodmer et al 1994, Bodmer 1995), and concluded that collared peccaries in the reserve were not over-harvested.

Conclusions: All the indicators show that collared peccaries are not over-harvested, and that they could probably be cropped at higher rates (Table 7). It seems that the hunting of collared peccary populations has not affected abundance or sex ratios.

Recommendations: No changes are recommended specifically for this species.

Xavante Decision: No special hunting bans for collared peccaries. They will receive protection along with other species in the refuges. Note that in the event of other species experiencing population declines, the Xavante could harvest higher numbers of collared peccaries.

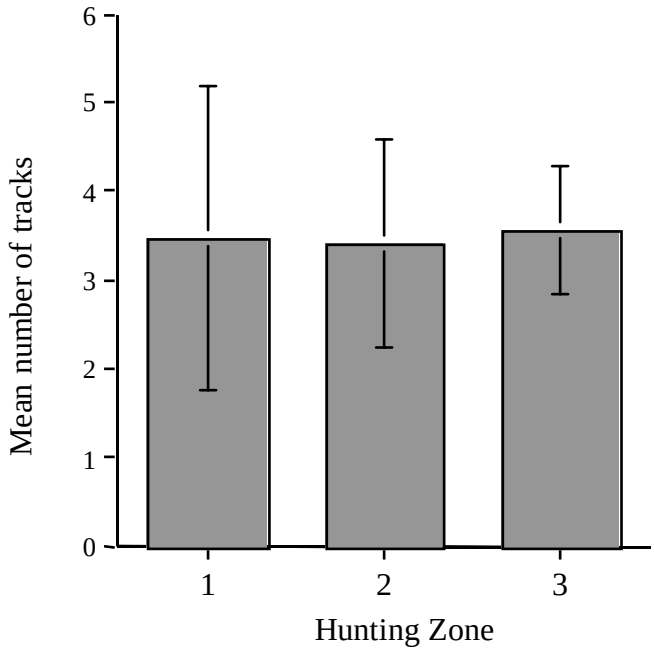

FIGURE 8. THE MEAN NUMBER OF COLLARED PECCARY (*TAYASSU TAJACU*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED).

6.7 - GIANT ARMADILLO (*PRIODONTES MAXIMUS*)

Natural History:

Female Giant Armadillos bear 1-2 young after a gestation period of four months. Young are weaned within 4 to 6 weeks, and are sexually mature in 9 to 12 months (Nowak 1991). Individuals have lived for as long as 12 to 15 years in captivity. Adults attain weights of up to 45 kg (Eisenberg 1989). They are habitat generalists using both Cerrado and closed forest. The home range size is poorly known, but in one area individuals ranged over 453 ha, and moved up to 2.8 km in a straight line over one night (Carter 1983).

Status at Rio das Mortes: **Unknown** (Table 7)

Transect Results: There were no significant differences in track abundance between the three zones (Table 3). Few tracks of this species were encountered in any zone (Table 1), suggesting low densities throughout the reserve. The greatest number of giant armadillo tracks were observed in the two zones furthest from the village, with the medium and lightly hunted zones having similar numbers of tracks (Fig. 9). Track counts were too low to permit an evaluation of the use of plant communities.

Hunting Effect: There appears to be a hunting effect, with tracks increasing as hunting pressure decreased (Figure 8).
There are no other data available for this species. A review of Leeuwenberg's 1994 report indicates that hunter success per unit effort and per area for this species declined overall from 1991 to 1993. However, samples sizes are too low (20 animals killed in three years) to accept this as a real trend, as variation could have occurred by chance.

Conclusions: More information must be gathered on this species to determine if the apparent low densities result from over-hunting or poor habitat.

Recommendations: Giant Armadillos should not be hunted throughout the reserve; however, this recommendation will probably be unacceptable to the Xavante. Instead, we recommend that this species be hunted only in Z3. The relatively high birth rates and short gestation period for this species suggest that the population would recover quickly if protected; however this recommendation assumes that the population is low due to over-harvesting. The low population density could also be due to other factors. We have too little information to be able to make any conclusive statements**.** Designating a non-hunting area for all species would permit us to determine if the present low densities result from over-harvesting.

Xavante Decision: No special bans for this species. It will receive protection in the established protected zones along with other species. This decision conflicts with the recommendation to avoid hunting the species as much as possible, due to its unknown status.

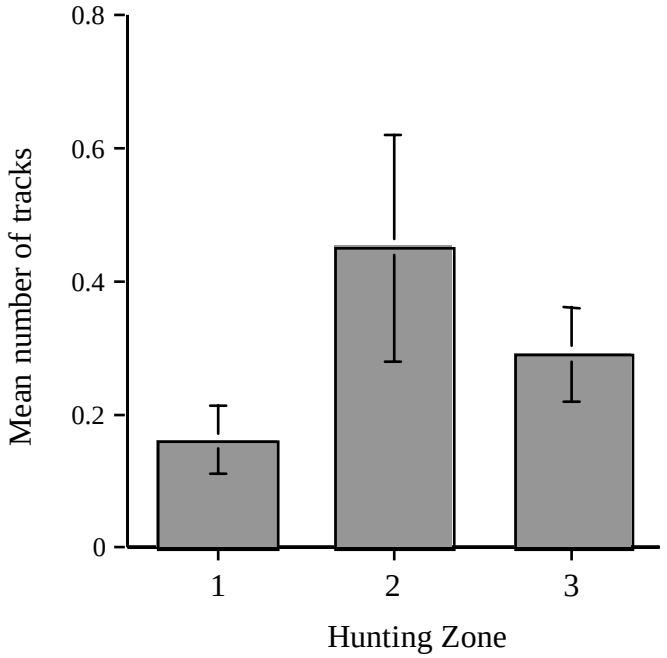

FIGURE 9. THE MEAN NUMBER OF GIANT ARMADILLO (*PRIODONTES MAXIMUS*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED)

6.8 - GRAY BROCKET DEER (*MAZAMA GOUAZOUBIRA*)

Natural History

Females give birth to one young after a gestation period of around 206 days (Nowak 1991). Little is known of the natural history of this deer. It prefers edge habitats and forest, and consumes fruit and browse (Bodmer 1989, Eisenberg 1989). Townsend (1995) estimated 1.5 gestations per female per year, for a productivity of 0.38 young per individual per year. Leeuwenberg (1994) reports that this is not a preferred game species for Xavante; thus few were killed during the study (Leeuwenberg 1994).

In forest habitat, Hill et al (1997) had greater encounter rates with brocket deer (two species not differentiated) near Ache villages than in the center of the reserve, distant from all hunting foci. This suggests that human disturbance may enhance habitats for brocket deer and lead to an increase in their populations near such habitats.

Status at Rio das Mortes: **Stable, Score 2**

Transect Results: The greatest track number for this species occurred in Z1 near the village, with the fewest observed in Z3 (Table 1). The Kruskal-Wallis analysis indicated that these differences were significant. The highest grey brocket abundances appear to occur in wooded areas. We observed significantly more tracks in Cerrado then in "campo com murundum", and in gallery forest then "campo com murundum"; however, the number of tracks did not differ between Cerrado and gallery forest (Table 4). There was no interaction between hunting zone and habitat.

Hunting Effect: There are higher gray brocket densities in the most intensely hunted zone, the opposite trend observed for all previous species. If brocket were being hunted near the village, something else is compensating for the hunting effect.

Source-sink: The entire area is a source.

Hunting Pressure/Productivity Ratio: The hunting pressure/productivity ratio indicates that this deer is being hunted at far below theoretical productivity levels. The number of animals harvested declined over three years.

Sample sizes of hunter-killed animals were too small to examine sex ratio and age structure.

Conclusions: Since this species is not heavily hunted by the Xavante, we have little data to work with. However, because densities were higher in Z1 near the village (Fig. 10), it may be that Xavante farming and hunting activities benefit populations of this deer. Xavante gardens may increase forage and other food types for this species, in areas with abundant cover since gardens are located in forested zones near streams. A decrease in the density of other deer species due to Xavante hunting may also have reduced competition from these other deer. Bodmer (pers. comm.) Leeuwenberg and Lara Resende(1993) and Pinder and Leeuwenberg (1997) also found that gray brocket appeared to prefer areas around gardens.

Recommendations: No special restrictions are required at this time for this species. To reduce hunting pressure on the other deer species and giant anteaters, the Xavante could consider increasing the cropping of gray brocket deer. The decline in hunting returns for this species between years probably results from the Xavante moving to new hunting areas with an abundance of preferred game.

Xavante Decision: No special management for this species. This agrees with the recommendations based on data analysis (Table 7), except for the suggestion that more brockets be taken to relieve pressure on other species.

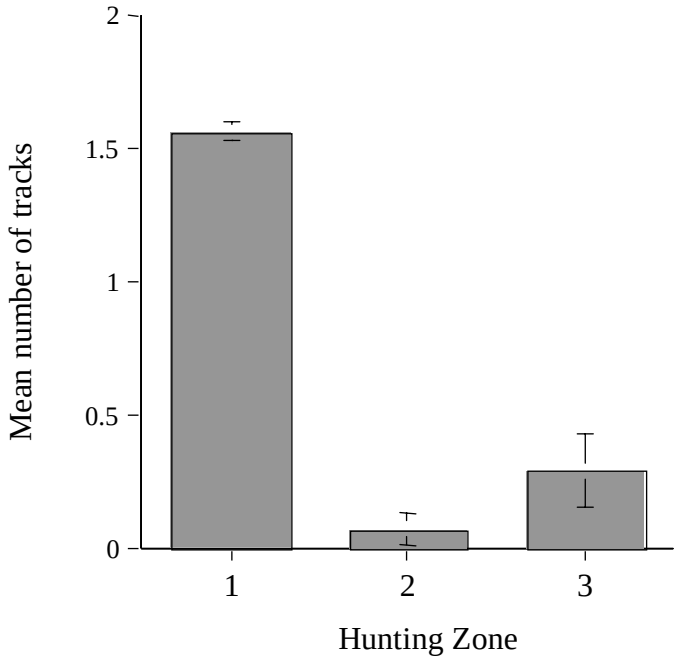

FIGURE 10. THE MEAN OF GRAY BROCKET DEER (*MAZAMA GOUAZOUBIRA*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED).

6.9 - OTHER SPECIES

Few individuals of other species were killed and few of their tracks were encountered (Table 1). This reflects the Xavante hunter's focus on a few large bodied mammals as game. Here we present the raw data collected for other species but which cannot be analyzed due to small sample sizes. As Leeuwenberg (1994) indicates, the hunters may actually kill more individuals of these species than they record, probably because they are consumed in the field, or without being identified to the community due to their small body size.

6.9.1 - RED BROCKET DEER (*MAZAMA AMERICANA*)

Natural History:

Females are sexually mature at about 13 months of age, and bear one young after a 225 day gestation period (Branan and Marchinton 1987). They are a long-lived species, surviving for up to 13 years and 10 months of age in captivity (Walker 1991). Reproductive potential is the same as that for grey brocket deer. In this as well as other hunting studies (Hill et al 1997, Townsend 1994), both brocket deer are poorly represented in hunting samples, indicating either that they are not a favored species or that they occur at low densities. In Surinam their density has been estimated at one per square km in forest (Branan and Marchinton 1987). In that study (hunting pressure not identified), 126 hunter-killed red brockets had a sex ratio not significantly different from 1:1. Average age was 2.4 years, and 41 % of individuals were greater than 2 years old.

Status at Rio das Mortes: **Stable, Score 2**

Transect Results: Not enough tracks were encountered to say anything conclusive about this species (Table 1); although, like the gray brocket, abundance may be highest near the village (Fig. 11).

Conclusions: Since this species is irregularly hunted by the Xavante, there is little data to consider. Tracks were most abundant in Z1 near the village (Fig. 11); it may be that Xavante farming and hunting activities benefit populations of this deer. Xavante gardens may increase forage and other food types for this species, in areas with abundant cover since gardens are located in forested zones near streams. Bodmer (pers. Comm.) also found that red brocket appeared to prefer areas around gardens in Peru.

Recommendations: No special requirements are needed at this time for this species. To reduce hunting pressure on other deer species and giant anteaters, the Xavante could consider increasing their cropping of red brocket deer. As with the gray brocket deer. As with the gray brocket deer, the decline in hunting returns for this species between years probably results from a move to new hunting areas by the Xavante, to regions with an abundance of preferred game (Leeuwenberg 1994).

Xavante Decision: No special management for the species; it will be protected in general reserves. Agrees well with recommendations from data analysis.

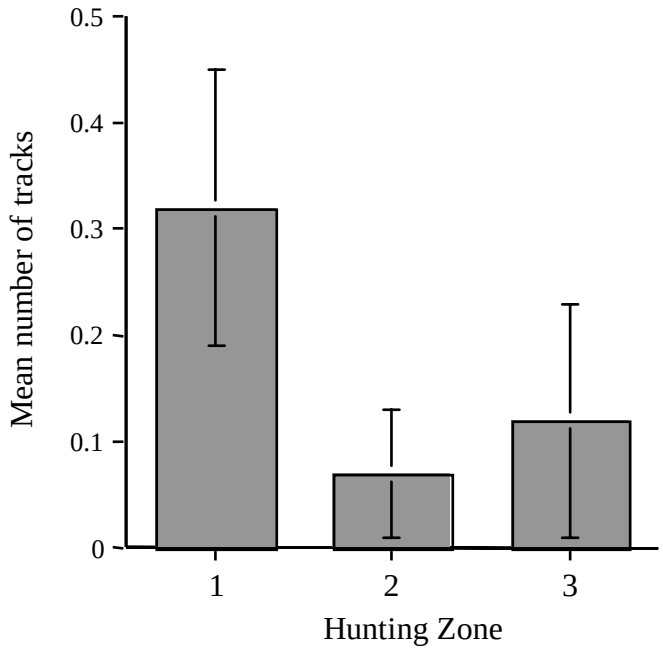

FIGURE 11. THE MEAN OF RED BROCKET DEER (*MAZAMA AMERICANA*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED).

6.9.2 - SIX-BANDED ARMADILLO (*EUPHRACTUS SEXCINCTUS*)

Natural History

This armadillo is omnivorous, feeding on everything from small vertebrates to plant matter. It is most common in Cerrado, and other mixed plant communities (Emmons 1990). It does less well in forests**.**

Status at Rio das Mortes: **Stable, Score 2**

Transect Results: A Kruskal-Wallis test did not detect a significant hunting effect (Table 3). However, like the brocket deer, there was a trend towards higher track numbers in Z1 (Fig. 12).

Sex Ratios: Sex ratios are skewed towards more males then females in Z1 (Table 6), with the opposite occurring in Z2, and an even ratio in Z3. No other data is available for this species.

Conclusions: The Xavante rarely report kills of small bodied armadillos (Leeuwenberg 1994). These animals are often consumed before hunters return to the village, making it difficult to determine how many are actually killed.

Recommendations: If the Xavante were to reduce their cropping of the two over-hunted deer species, and giant anteaters, they could make up some decline in meat consumption by increased hunting of this species.

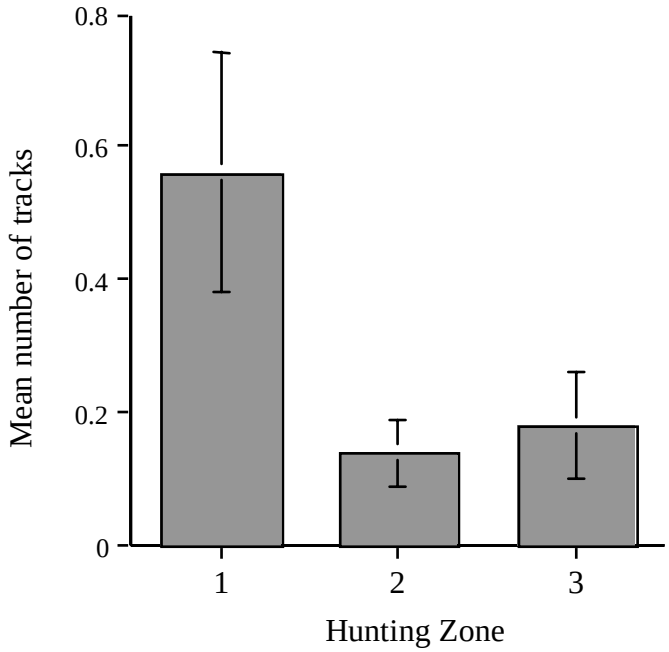

FIGURE 12. THE MEAN NUMBER OF SIX BANDED ARMADILLO (*EUPHRACTUS SEXCINCTUS*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED).

6.9.3 - RARE SPECIES: JAGUAR (*PANTHERA ONCA*), PUMA (*FELIS PARDALIS*), MIRIM ANTEATER (*TAMANDUA TETRADACTYLA*)

The jaguar, puma and mirim anteater all occur within the reserve (Table 1), but track counts (Figs. 13, 14 and 15) and kills suggest they occur at very low densities (Leeuwenberg 1994, Prada pers. obs.). The two cat species are highly threatened wherever they occur (jaguar and puma are both listed on Cites Appendix 1), are killed by ranchers, and the Reserve therefore acts a refuge for them. The Xavante should continue practices which do not conflict with the ecology of these cats. The killing of cattle by cats leads to conflict with cattle ranchers, and the death of many large cats. If cattle are grazed in the reserve it should be clear that cats that destroy cattle should not be killed.

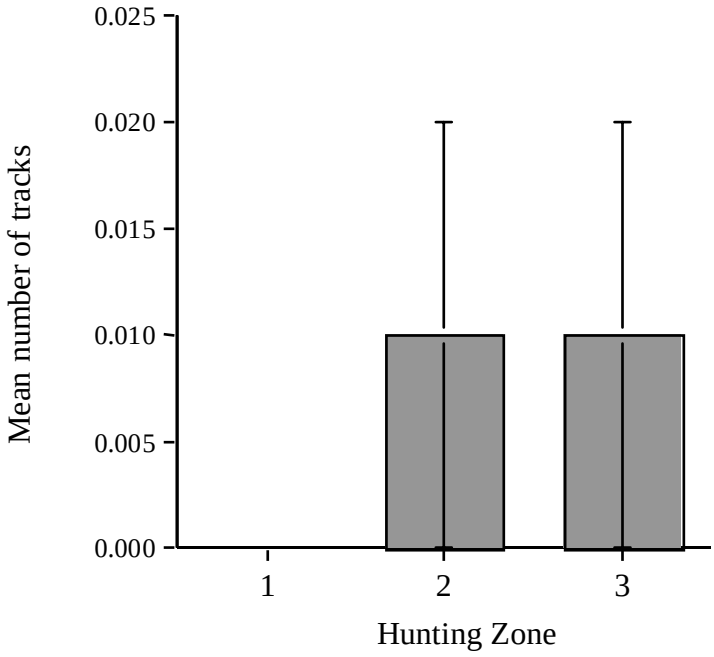

FIGURE 13. THE MEAN NUMBER OF JAGUAR (*PANTHERA ONCA*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED).

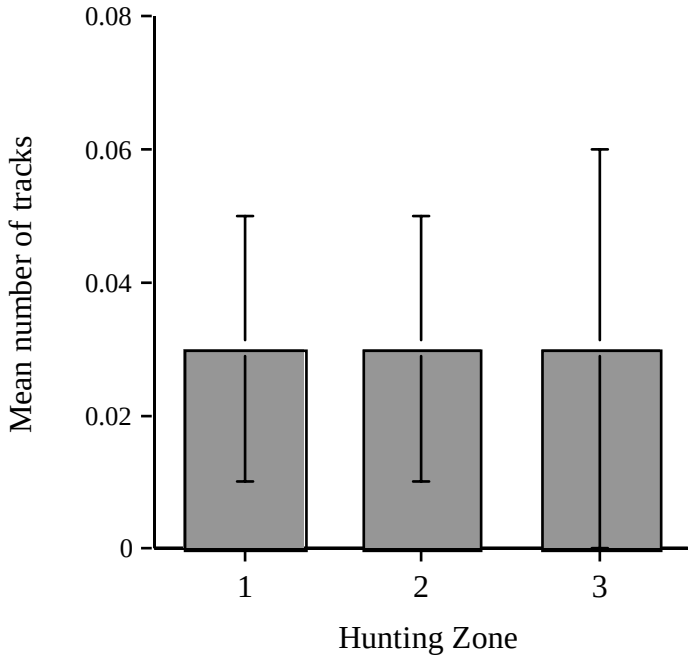

FIGURE 14. THE MEAN NUMBER OF PUMA (*FELIS CONCOLOR*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED).

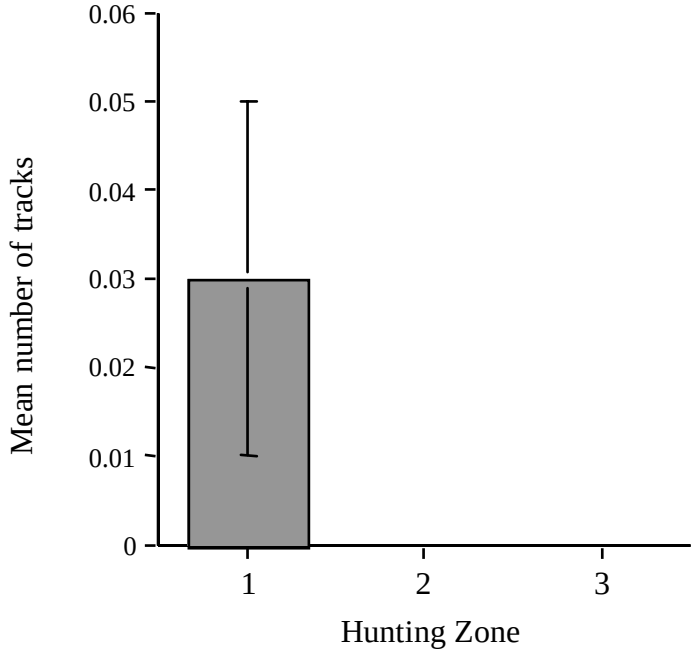

FIGURE 15. THE MEAN NUMBER OF LESSER ANTEATER (*TAMANDUA TETRADACTYLA*) TRACKS PER HUNTING ZONE IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE (STANDARD ERROR BARS PRESENTED).

7 - DISCUSSION: STATUS IMPLICATIONS AND MANAGEMENT OPTIONS

7.1 - MODELS FOR MANAGING THE WILDLIFE HARVEST

The data gathered through the different studies on the Xavante Reserve suggest that at this point none of the preferred game species are severely over-harvested or in danger of local extinction (with the caveat that we do not have enough data on some of the species, especially the giant armadillo, which is in general considered susceptible to over-hunting and has become locally extinct at other sites). Some species are of concern due to their history of disappearance following over-hunting and habitat disturbance in other areas: white-lipped peccaries, giant anteaters, and tapir, but to date their populations do not seem to be rapidly declining in the Xavante reserve. We therefore proceed on the assumption that management for some level of sustained or variable yield is possible for all of the primary game species in the reserve.

Townsend (1995) suggested that the wildlife harvest in a 40,000 ha Siriono Indian reserve depended on the entry of animals from surrounding source areas where they were not being hunted. In the case of the Xavante, source-sink models also apply, but at different scales. Since the reserve is large (329,000 ha), and almost completely surrounded by agricultural areas, most animals probably have greater populations within the reserve than outside (though note that the presence of one large ranch across the Rio das Mortes may sustain large animal populations, as discussed later). The reserve is large enough, and has a great enough variety of habitats, for most species to have source-sink dynamics within the reserve. The sinks are created by hunting in some areas only, as suggested by Navaro et al. (1997) for Culpeo foxes on Argentinean ranches. In that study, sustainable harvest of foxes on ranches that commercialized skins depended on an influx of animals from interspersed ranches that did not carry out fox hunting. Based on the status evaluation for each of the hunted species

in the Xavante Reserve, several alternative source-sink based models for managing wildlife are possible. To these models, based on the perspective of the health of the animal populations only, must be added 1) traditional Xavante management practices (use of fire for hunting which improves habitats for some species while allowing higher harvests), 2) cultural needs and taboos, which make some biologically feasible management scenarios culturally unfeasible (note the refusal to stop hunting anteaters and pampas deer), 3) community development needs, such as border protection, road construction for patrolling boundaries and access to remote hunting areas (which affects decisions on where to hunt, because hunting maintains a presence), and 4) the dynamics between the four villages (really five; see below) that share the reserve, all of which are related but separated due to disagreements or power struggles (a traditional form of village fissioning which may ensure ecologically sustainable localized population densities (Good 1989). These dynamics affect the placement of reserves due to "tragedy of the commons" attitudes: one village will not place their non-hunting area near another village, because they do not trust that village to respect hunting bans.

7.2 - Individual Source-Sink Scenarios

We have identified 4 classes of response types in the species hunted by the Xavante. We consider management strategies for the different response types using a source-sink population model.

7.2.1 - Model 1: Entire Reserve as a Sink; Surrounding Region as a Source

Response type one is exemplified by the giant anteater. Because of the evenness of tracks, sex ratios, and harvesting/productivity ratios for this species between years and hunting zones, we believe the entire reserve is a population sink for giant anteaters. Most individuals recruited to the population probably originate from outside the reserve. Since European-descent peoples do not hunt this species, we predict/expect that the density of giant anteaters is higher outside the reserve than inside (recall densities of 17 animals/km^2 in Pantanal ranches).

7.2.2 - Model 2: Area Near Village is a Sink; Zones 2 and 3 are Sources

An example of this type of organization comes from the track, sex ratio and hunting return data for tapir, marsh deer and pampas deer. Three sets of independent data support the idea of a source-sink type of structure occurring within the reserves for these species: 1) tapir and marsh deer tracks were significantly higher in zones 3 than 1 (tracks higher in Z2 for pampas deer), 2) sex ratios were highly skewed towards females in zone 1, and 3) the Xavante experienced a change in tapir harvest rate when they began hunting in zone 3. For white-lipped peccary and giant armadillo there was also a trend for increasing track density in the zones furthest from the village. The change in indicator values between zones suggests that regions distant from the village are source areas for the zone by the village. Thus the source-sink model applies to animals with this response type, with the source lying within the reserve but distant from the village.

7.2.3 - Model 3: Entire area is a Source: Species not Affected by Hunting Pressure

Collared peccaries exemplified this model. Their tracks are equally common in all zones, sex ratios do not change between areas, and harvest rates per area are about the same. This response type suggests that the entire area continues to be a source for the species.

7.2.4 - Model 4: Entire Area is a Source but Xavante Activities Increase Density near Village

Hunting for both species of *Mazama* can be higher, because their populations appear to be highest in regions of human activity. Xavante activity may be improving habitats for these species, rather than negatively impacting it. It is possible that collared peccaries also fall into this category, but that because they are a preferred species their populations are simultaneously decreased by hunting near the village, eliminating an enhancement effect. Note that Hill et al. (1997) found a similar response by hunted populations of brocket deer and collared peccaries in a Paraguayan forest habitat.

7.3 - Possible Management Scenarios

7.3.1 - Source-Sink Dynamics: Highest Harvesting Returns

The greatest abundance of most species preferred by the Xavante occurs in zones 2 and 3 (Fig. 16, Table 3). If the Xavante are concerned with maximizing their return for preferred species we recommended they consider a rotational hunting system, with one area remaining fallow for five years, a second for three years, and the third zone harvested. MSY and population cycling theory suggest that the highest productivity levels for animal populations are maintained when they are constantly cropped but at a level below that which initiates density dependent declines in reproduction. If this strategy were adopted, we recommend Z3 be the first to undergo harvesting. Game harvesting would continue there until returns begin dropping off. The Xavante could then rotate hunting to Z2, followed three years later (or when returns begin dropping) by Z1. Shifting zones when returns drop, instead of calculating the actual population level required for MSY, is recommended because MSY calculations are hard to carry out, especially when the biology of the species is unknown and there is great danger of over-harvesting the population (Caughley and Sinclair 1994)

7.3.2 - Source-Sink Dynamics: Medium Returns Over A Longer Time

The Xavante could consider instituting permanent wildlife reserves as part of the management plan. Population source-sink dynamics theory assumes that a source exists for areas where populations cannot sustain themselves. The areas around Xavante villages are population sinks for wildlife. This situation has not yet seriously impacted wildlife populations (species extirpations), probably because of a low human population density in the reserve. The human population density within the reserve is 0.35 people per square km, and all people live within five villages. They are not distributed across the landscape, which results in default wildlife refuges in zones between villages, and for areas distant from all villages. The formal designation of

these areas as wildlife reserves would ensure the maintenance of wildlife populations even as human population densities increase. Future generation of Xavante would perhaps be more willing to accept such reserves if they were already in place when they were born. This type of management would also provide a biological/ecological benchmark of what relatively undisturbed wildlife populations are like in the Cerrado (reproductive data, densities, etc.). A rotational hunting system does not provide such ecological information for animal species because every few years the system is perturbed by hunters and wildlife harvesting.

7.3.3 - Kill and Season Limits to Prevent Over-hunting of Some Species Only

Leeuwenberg (1994) evaluated the use of closed seasons and non-hunting years for species of concern as a means of increasing population size. He concluded that this strategy conflicted with Xavante cultural values, and would not work. For example, he recommended closed seasons for giant anteater and tapir, recommendations that were rejected by the Xavante. We do not believe that at this point in time the Xavante can successfully adopt a closed season/year method for managing wildlife.

7.3.4 - No Formal Management

The Rio das Mortes Reserve continues to maintain source areas for all hunted species, with the possible exception of the giant anteater. The Xavante, through informal methods, such as regulation resulting from logistical considerations and cultural traditions (the distance hunters must travel is related to the motivation for the hunt; hunters will travel further and stay out longer when hunting for wedding celebrations than for subsistence), have been managing wildlife sustainably. They can continue with their present pattern of hunting as long as their populations remain at low densities. They could also strengthen the cultural traditions that helped prevent over-hunting in the past, such as the concept of "owner of a wildlife species," which spiritually linked a Xavante elder with a particular animal species (Leeuwenberg pers. obs.). For example, the "owner of the pampas deer," through the spiritual link, communicated the concerns of the spirit of the pampas deer to the Xavante community. The spirit of the deer informed the man if too many were being killed, if reproduction was low, if they were being driven from their homes. Using this information, the "owner" of the deer would direct the Xavante in their hunting practices with regard to the species. He could suggest changing hunting areas, the killing of only males, etc. The institution of "owners" of animal species should be re-vitalized and used in whatever management strategy the Xavante decide upon. The young men who monitor wildlife populations could report back to the owners of each species, who now as in the past would help direct the communities' response to wildlife population problems.

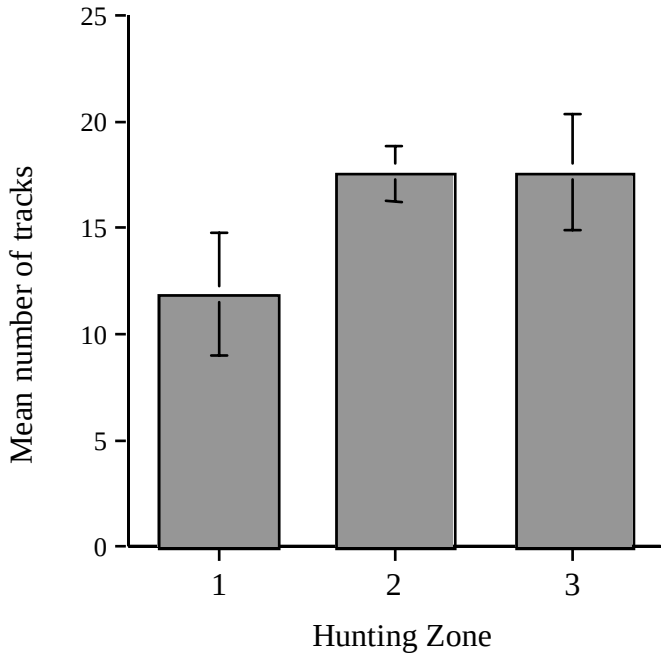

FIGURE 16. THE MEAN NUMBER OF TRACKS OF ALL SPECIES HUNTED BY THE XAVANTE PER HUNTING ZONE (STANDARD ERROR BARS PRESENTED).

8 - NEGOTIATING TOWARDS A WILDLIFE MANAGEMENT PLAN

After analyzing the data, generating various management scenarios, and translating the information into popular language, the first version of the plan was presented to the Eteñitepa Village, and eventually to three other villages that agreed to participate in a management plan. Leeuwenberg (and for the first visit, Fragoso and Prada) visited the Xavante three times during this period, each visit lasting about 9 days. They used traditional Xavante approaches when disseminating information and prompting discussion. The objectives here were to ensure that all community members understood the results and recommendations of the work, that they were discussed, and to record the decisions made by the Xavante. These discussions occurred over three months. A secondary goal during this period was to stimulate the participation of all five villages in the formation and adoption of a management plan. A fourth meeting in Brasilia brought together representatives from four of the villages, WWF staff, and the field biologists. The final objective was met at the Brasilia meeting where a plan was agreed upon by the elders of the four villages, WWF staff and the biologists. Note that the fifth village in the Reserve, Agua Branca, has not been included in any of these plans, because it does not belong to the same Xavante group as the four other villages in the Reserve.

8.1 - XAVANTE DECISION MANAGEMENT PLAN

One of the main contributions of the second part of the management study has been the use of source-sink models as a means of understanding the population dynamics of wildlife on the reserve. This model was adopted and adapted by the Xavante as the core of their plan. Essentially, they chose the first part of the rotational refuge system, with some modifications and the addition of selective hunting bans: they recommended the designation of three non-hunting refuges (Appendix 1). We have several interpretations on how the areas were chosen: on practical side, the areas have obvious boundaries, and will allow monitoring of Reserve boundaries (R. Lemos de Sa, pers. Comm.); on the ecological side, they are viewed by the Xavante as “production areas” for species of concern (Leeuwenberg pers. comm.). Since the refuges include parts of all hunting zones, they will protect both current source and sink areas. The areas will not be permanent refuges - at the end of two to five year periods their status will be re-considered, and a decision made as to whether or not to maintain them. The final decision will be based on the status of wildlife populations in and outside of these protected areas. Special consideration will be given to two of the species of special concern - the marsh deer and the tapir - in the wildlife areas; if a decision to open the areas occurs, these two species will continue to be unhunted for an additional few years.

At this point a decision has made as to how long to initially protect each area. However, there has been no discussion of for how long an area will be hunted, after the initial refuge status is lifted. Discussions need to be continued with the communities to ensure that over-hunting or continuos hunting does not occur in these areas, but rather that core hunting and refuge areas rotated even after the 2-5 year period. As a general rule, we recommend a re-evaluation of the status of game populations in each refuge three years after hunting is reinitiated, with a decision then being made about a new rotation of hunting vs. no-hunting zones.

There was no special considerations (in the form of hunting bans) taken for two other species of concern, the giant anteater and the pampas deer. Note, however, that Leeuwenberg (pers. comm.)

feels that particular refuge areas were chosen because the Xavante hunters view them as good habitats ("production areas") for pampas deer, marsh deer, tapir and anteaters, and that therefore this represents special consideration of these species. We assume that the absence of hunting bans on pampas deer and anteater is because of the strong cultural need for hunting and eating these species, and an unwillingness to transfer pressure on to other species. The decision is extremely important culturally. The trend form many native communities, as they become acculturated and their animal populations limited by habitat loss, is toward an abandonment of traditional hunting preferences and taboos (Townsend 1995, Ulloa et al. 1996). The Xavante are refusing to allow this to happen, and all efforts should be made to support this decision without causing the extinction of the species. The anteater will probably receive suitable protection in the refuges, but the pampas deer probably will not (see species accounts for an explanation). More data should be gathered on this species to locate highly productive habitats, if any, for special protection. Because this species feeds preferentially in burned areas, habitat improvement through burning at the correct time of year should be studied.

8.2 - The Wildlife Refuges

Approximately 29% (around 96,000 ha) of the 329,000 ha Rio das Mortes Reserve were defined as wildlife refuges.

Uiwedehu Wildlife Refuge: Uiwedehu, which means buritizal, a forest with buriti palm (*Mauritia flexuosa*), is located south of the village of Eteñitepa. This approximately 400 km^2 area (40,000 ha) extends from the village of Caçula eastward to the Reserve's border on the Rio das Mortes. Most of this refuge falls within Hunting Zone 2 of the transect study. It will protect a mix of vegetation types, dominated by open savanna, Cerrado, and gallery forest. Hunting will not be permitted in this region for a five year period, beginning in January 1998 and extending to December 2002. At the end of this period the community will meet and discuss reinstating the zone as a hunting area, after evaluating data from the ongoing monitoring program for this region. If hunting restarts, all species would be hunted. We recommend that three years after hunting is reinstated, game population status be re-evaluated and hunting be rotated elsewhere if necessary at that time. The area would then be redesignated as a wildlife refuge. The decision would depend on the results of the continuing monitoring program.

Arobonipo'opa Wildlife Refuge: Arobonipo'opa, which means the long-nailed bat, also covers an area of approximately 400 km^2. It is located north and west of the Village of Eteñitepa (Figure 17). Most of this reserve falls within Hunting Zone 1 of the transect study. To the west it borders with farmland, to the north with the Corixão river. The vegetation includes dry forest, Cerrado, savanna and gallery forest. This area will be maintained as a wildlife refuge for two years beginning in January 1998 and extending to December 1999 for all species. The hunting ban will continue for tapirs only for an additional year.

Pu'upre Wildlife Refuge: Pu'upre, meaning red swamp, consists of mainly gallery and scrub forest occurring along an approximately 150 km^2 rectangular area along the eastern end of the reserve (Fig 17). It borders the Rio das Mortes and falls within hunting zone 3 of the transect study. This wildlife reserve will not be hunted for two years (from January 1998-December 1999). After evaluating the status of wildlife here in the year 2000, hunting may begin, but marsh deer will be protected for an additional year, until December 2000.

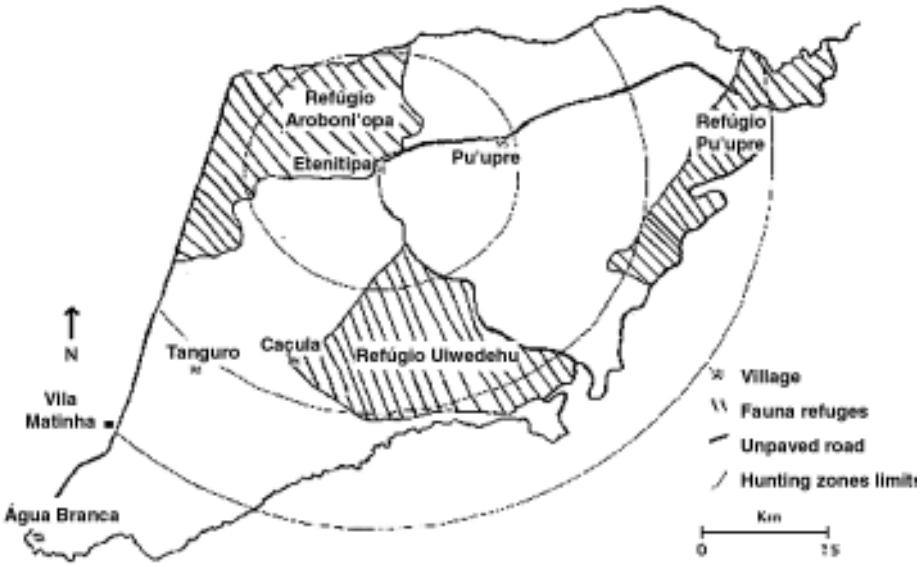

FIGURE 17: THE THREE PROPOSED WILDLIFE REFUGES IN THE RIO DAS MORTES XAVANTE INDIGENOUS RESERVE. ALSO DELINEATED ARE THE 15 KM RADIUS HUNTING ZONE BOUNDARIES (Z1, Z2 AND Z3) RADIATING OUTWARD FROM THE FOCAL VILLAGE OF ETEÑITEPA.

8.3 - ALTERNATIVE PROTEIN SOURCE

The Xavante proposed an increased reliance on fishing, by extending their traditional fishing season, as a way to relieve pressure on game populations. It is unclear why they are willing to shift pressure onto fish, but not onto potentially under-used game species, such as brocket deer or collared peccary. One practical reason is that it will allow them to patrol the Rio das Mortes to detect illegal fisherman or hunters trespassing on Reserve Lands (Leeuwenberg, pers. comm.)

8.4 - HUNTING WITH FIRE

Fire hunts have been used extensively by the Xavante as a means of very quickly obtaining many animals. Traditionally this method was used sparingly, and usually only during the beginning of the dry season (Leeuwenberg 1994). Over-use of fire when hunting can quickly eliminate wildlife from an area and lead to changes in vegetation. For the Xavante, integration into mainstream Brazilian culture led to the abandonment of the traditional burning pattern: fire hunts now occur more frequently and outside the traditional burn period.

The Xavante have decided to return to the traditional fire regime and burn-hunt, so that the burn cycle follows what has been recommend for the plant communities of the Cerrado region (see Leeuwenberg 1994):

1) In tabocal and mesophitic forest, fires will be set only from August to September.

2) In campo sujo vegetation, test fires will be lit in April to determine suitability for burning, and

fires will be set between July and August. Open habitats will be burned earlier (late july, prior to a traditionally expected short rain known as the “rain of the caju” (Leeuwenberg pers. comm.) and more densely treed habitats will be burned later (August-September).

3) In Cerrado and cerradão, fires will be set only in August.

4) In campo limpo, fires will be set only between July and August.

It may be possible to create a small-scale mosaic of burned habitat to supply food for pampas deer; a larger scale mosaic is probably not useful given the lack of alternative habitats for the deer outside the reserve and the potential for large fires to destroy crucial habitat.

8.5 - Hunting by Xavante from Other Indigenous Areas

In 1997, Xavante from other reserves have been allowed to hunt in Rio das Mortes Reserve on special occasions, particularly for wedding hunts. This has been perceived as a potential problem. The Xavante of the Rio das Mortes Indigenous Reserve have decided that this will be allowed only when the marriage involves of a community within the Rio das Mortes Reserve, excluding the community of Agua Branca. Since hunting within the reserve by Xavante from outside Rio das Mortes a recent, non-traditional development, the four communities of Rio das Mortes have agreed to ban the hunts by non-reserve Xavante.

8.6 - Monitoring Wildlife Populations In and Out of “Wildlife Refuges”

A meeting with all four villages will be held every three months in order to evaluate and monitor the compliance of management rules by the communities, and to resolve problems.

8.7 - Future Monitoring of Wildlife Populations

A management plan must be “adaptive”, that is it must be constantly fine-tuned, and occasionally undergo major re-organization, when unexpected ecological and human-induced changes occur. Additionally, what we and the Xavante have devised is essentially an experimental plan, designed to provide information on wildlife populations as well as food for Xavante. This plan must be occasionally re-evaluated to determine the response of wildlife populations to the management techniques and institute any necessary changes. With this in mind, the Xavante must continue monitoring populations, both in the hunted areas and wildlife refuges. New track-sampling transects should be delineated following the transect protocol previously used. Equal numbers of transects should be placed in each of the wildlife refuges, and a corresponding number placed in the hunted regions: that is, eight randomly placed transects per wildlife refuge, and an equal number in each of the three hunted regions. Care should be taken that the transects sample all available habitat types, with samples sizes for each type adequate to statistical analysis (not necessarily proportional to the habitat’s abundance in the Reserve, as this may not give a statistically valid sample size, referencing to availability of habitat is made after random sampling). Sampling should also be representative of seasonal changes, with an equal number of runs in the wet

and dry seasons, and in the flooded and non-flooded seasons too if these do not completely overlap with the rainy and dry seasons.

Xavante from each community would be responsible for running the transects located near their village. A biologist working together with previously trained members of Tsuptor and Cipasse's communities will ensure the old transect protocol is adhered to. This involves making sure that the original design is adhered to (4km long transects) rather than continuing the erroneous sampling methodology of timing the transects. The biologist along with the previously trained para-biologists can train the new recruits. The biologist should be responsible for ensuring that data collection is conducted en a rigorous and scientific manner, and for putting the information together for statistical analysis. All data must clearly be stated to be the property of the community and of the project's funders, not of the biologist would be free to publish the data after it is been turned over to the community and the funding agency both in its raw and analyzed forms, within a month after collection.

We also suggest that a biologist continue working with the Xavante to monitor population status using data derived from hunter killed animals, as in the past. This data would allow comparisons between populations before and after hunting in the Wildlife refuges, and in and out of hunting reserves. Construction of a small "museum" for storage and exposition of skulls and other materials, with standardized labeling, may encourage continuity in collection and serve as an educational tool for community members working with wildlife management, and to train other communities interested in managing their wildlife. The Xavante are already trained in collection methodology; Leeuwenberg's contribution would be in keeping the para-biologists motivated, to collate the information collected, and to analyze the results. He would also be responsible for overseeing the training of the new para-biologists from the other villages. If such work (population monitoring and hunted animal analysis) is to continue, it is essential that suitable housing for biologists and storage areas be constructed.

8.8 - Illegal Hunting By Non-Xavante, And Patrolling Wildlife Refuge

To maintain the "wildlife preserves" as unhunted regions will require that the reserve boundaries be patrolled. This is especially true where refuges abut non-Xavante lands, and along the rivers. Leeuwenberg and Prada have observed illegal hunting and fishing within the Reserve by Brazilians of European descent. It's possible that the low population abundance of pampas deer in Z3 is due to poaching by non-Xavante hunters from outside the reserve. The Xavante are willing to patrol the borders of the Reserve, and to enforce the no-hunting status of the wildlife refuges; however they need certain equipment to prevent illegal hunting. We recommend that they enter into negotiation with WWF to obtain equipment needed to maintain the integrity of the Reserve and its wildlife. For example, boats and motors will be required for patrolling the rivers, and radios for maintaining contact between patrols and with the home bases at the villages when poachers and other intruders are sighted. Equally as important will be finding sufficient money for the maintenance of patrols, equipment, and to purchase consumable goods. WWF could take a leadership role in this context.

8.9 - Land Use In Areas Adjacent To The Rio das Mortes Indigenous Area

Presently, the 329,000 ha of Reserve land is sufficient to maintain the wildlife species that have intra-Reserve source populations. However, it is possible that the entire reserve is a population sink for the giant anteater. If true, this points to the importance of land use around Rio das Mortes. One side of the reserve borders a large ranch where hunting is not permitted and this rule is strictly enforced (with the possible exception of the Xavante). Other areas of the reserve also abut ranches, while some border with intensively and extensively managed agricultural fields and pastures. These fields cover huge areas around the reserve, and do not support wildlife to any great degree. As more ranch land is converted to agricultural fields, the Xavante will have to consider the impact of this activity on wildlife source-sink dynamics within the reserve. This makes the giant anteater, together with widely ranging species such as tapir and white-lipped peccary, species of concern. Steps should be taken to ensure connection of the Rio das Mortes Reserve either directly or through corridors, with nearby intact Cerrado habitat. The importance of the Xavante Reserve as a habitat protection unit and source of animals for degraded Cerrado habitats should be emphasized when funds are sought for further conservation efforts.

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APPENDIX 1- AGREEMENT BETWEEN XAVANTE FROM ALL FOUR VILLAGES OF THE RIO DAS MORTES RESERVE DURING THE MEETING HELD IN BRASILIA, BETWEEN 11 AND 12 DECEMBER 1997, ON THE GAME MANAGEMENT PLAN.

Wildlife refuges (map):

Area 1: “uiwedehú” (a forest with buriti palm)

a) hunting forbidden for 5 years – from January 1998 to December 2002.

Area 2: “aroboñipo’opa” (long-nailed bat)

a) hunting forbidden for 2 years – from January 1998 to December 1999.
b) tapir hunting forbidden for 3 years - from January 1998 to December 2000.

Area 3: “pu’upré” (red swamp)

a) hunting forbidden for 2 years – from January 1998 to December 1999.
b) march deer hunting forbidden for 3 years - from January 1998 to December 2000.

Hunting with fire:

Return to the traditional burn-hunt schedule:

1) In tabocal and mesophitic forest (area 2) - fires will be set only from August to September.
2) In campo sujo vegetation, test fires will be lit in April to determine suitability for burning, and fires will be set only between July and August.
3) In Cerrado and Cerradão, fires will be set only in August.
4) In campo limpo, fires will be set only between July and August.

General rules:

1) Do not invite groups from outside the reserve to hunt in the area (this is not part of the Xavante tradition).
2) Intensify fishing during the dry season (from July to November).

Monitoring:

Meetings between all four villages will be held every three months in order to monitor the compliance of management rules, and to resolve problems. Meeting schedule:

- March – Eteñitepa Village
- June – Caçula Village
- September - Eteñitepa Village
- December – Caçula Village

Estando de acordo com as regras descritas acima, assinamos o documento,

Pela Aldeia Etêniritipa/Pimentel Barbosa

Cacique Suptó Xavante

Conselheiro

Pela Aldeia Etenipa

Cacique Cipassé Xavante

Conselheiro

Pela Aldeia Tanguro

Cacique André Surupredo Xavante

Conselheiro

Pela Aldeia Caçula

Cacique Ivan Xavante

Conselheiro

Pelo WWF - Fundo Mundial pela Natureza

Rosa Lemos de Sá - Coordenadora do Projeto

Robert Buschbacher- Diretor Técnico

Aldeia Pimentel Barbosa, 7 de abril de 1998

WWF´s mission is the conservation of natural resources and the maintenance of biological processes. To this end, in 1990 WWF and the Xavante community of Eteñitepa agreed to work together to promote sustainable hunting in the Rio das Mortes Indigenous Reserve in Mato Grosso. The Reserve is one of the largest remaining areas of well preserved Cerrado. The integration of Indigenous knowledge and scientific methods by this project represents an umprecedented initiative to maintain the richness of the Xavante culture as well as Cerrado biodiversity.

WWF-Brazil is an autonomous non-governmental organization dedicated to the conservation of nature, working in all regions of the country with the objective of harmonizing human activity, the preservation of biodiversity and the wise use of renewable natural resources, to benefit Brazilians of today and future generations. WWF has worked in Brazil since 1971, currently implementing 60 programs and projects, and is part of the world's largest nature conservation network.

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