Health status survey of wild populations of the dwarf brocket (*Mazama rufina*) and the Andean tapir (*Tapirus pinchaque*) in the massif of Mamapacha (Boyacá, Colombia)

Phase 1: Determining the presence and habitat use of *Mazama rufina* and *Tapirus pinchaque* in the massif of Mamapacha.

Final report

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INTRODUCTION

The massif of Mamapacha, with an estimated area of 27,512 hectares distributed among five communities, is one of the most representative fragments of cloud forest and paramo in the south of the department of Boyacá. Together with the massif of Rabanal, forms the basin of the Garagoa River, which feeds 53% of the water for five populations that sums 200,000 inhabitants and the water for the Chivor dam, which produces 8% of the electric energy consumed by the entire country (Corpochivor 2001). For this reason, the massif was declared Natural Water Protection Reserve and is considered a strategic ecosystem for the future recovery of biological corridors and natural landscapes (Alfonso & Gómez, 2003). However, its most important ecologic areas are owned by some landowners and farmers which used some areas for cattle ranching (Grucon – Corpochivor, 1996). Cattle ranching negatively affect populations of wild ungulates in Colombia's Andean regions. There is believed to be due to direct competition with livestock and the alteration of wild animals' patterns of habitat use and distribution (Chalukian 2003). Livestock also negatively impacts the sanitary status of wildlife, transmitting different pathogens, some of zoonotic character (Peterson, 1991; Nettles, 1992; Frolich et al., 2002; Deem et al., 2004). Perhaps because of its pervasiveness, these negative impacts have received little scientific and public attention in Colombia.

The massif has already been subject of some conservation activities, such as some specific reintroduction programs involving native wildlife species such as Andean bear (*Tremarctos ornatus*) and condor (*Vultur gryphus*) (Alfonso & Gómez, 2003), and the creation of one rehabilitation centre for Andean wildlife (Fernandez et al, 2002). However, little attention has been addressed to the native Andean ungulates. It is known that red dwarf brocket (*Mazama rufina,* Artiocadtyla; Cervidae) is already present in the massif, and the presence of the Andean tapir (*Tapirus pinchaque*, Perissodactyla; Tapiridae) is suspected (Corpochivor 1997, Montenegro 2002). Both of the latter are considered endangered by the Colombian Government (Rodriguez, 1998), and have been legally protected since 1969 (Resolution 574 of 1969). Furthermore, the IUCN/SSC – Deer Specialist Group Action Plan recommends the study of this brocket species, because it's little known (Wemmer, 1998), while the Action Plan for all tapir species by the Colombian government strongly recommends the in-field confirmation of the presence of the Andean tapir in the northern Eastern Cordillera (MAVDT, 2005).

The present project aimed to develop a complete study of the red dwarf brocket and the Andean tapir in the Mamapacha massif, and was designed to be executed in two phases: The first phase was focused in the confirmation and documentation of the two species in the region. The second phase, currently under planning, will be addressed to the approaching of the sanitary, genetic and physiologic aspects, through the direct sampling and monitoring of living free-ranging animals in an attempt to make a complete characterization of the species. This final report corresponds to the first phase of the project.

The goals of this first phase were to determine the suitability of the massif for Andean tapirs and red dwarf brockets, to establish which of these species are currently present, to define their distribution and habitat use, to estimate their population size and to evaluate the impact of the human activities, mainly cattle ranching, over the populations.

METHODOLOGY

Field work

We made five field visits, one in September/2005 (16 days), one in October 2005 (22 days), one in November 2005 (22 days) one in December 2005 (15 days) and one in September 2007 (8 days). We worked a mean of 7 hours per day, giving a total of 641 field working hours. We delayed almost two years for the last visit because of problems in raising the contacts and planning the visits to the community of Miraflores, and the necessity to cancel the visit to the community of Zetaquira because of safety problems in the area of study.

The field work was divided into two activities: the interviews with local people and the field sampling surveys, which consisted in transects of variable size along the different landscapes identified in the massif. We visited four properties in the massif: the “El Secreto” Private Sanctuary with almost 1.200 hectares, the private property named “La Comunidad” with near 700 hectares, the district “Mundo Nuevo” with almost 8000 hectares and the public reserve of Sucuncuca with almost 600 hectares.

We made transects of different sizes around the area, across the different landscapes. Given the species of Andean ungulates of this study are secretive; we decided to focus our efforts in searching indirect signals such as tracks, feces or beds. Because the topography of the area is very irregular, we used the technique of random sampling (Scwarz & Saber 1999) and plotted track points where we found something, using a GPS navigator Geko 201 (Garmin®). We registered information of date, size, amount of the signals and other particular features related to it, and evaluated the status of the area, taking into account different circumstances, such as the presence of cattle, the level of the traffic of humans and other domestic animals such as dogs, equines (horses, mules or asses) or sheep. We also did a preliminary inventory of the flora as well as an evaluation of the geography for this area. Additionally, we collected samples of feces and ectoparasites of domestic animals in the areas studied. The fecal samples were analyzed microscopically, and the ectoparasites were primarily classified.

Data and image analysis

For the analysis of habitat availability, we decided to divide the landscape in five categories, given the particular conditions we encountered inside the massif. According to that, we defined five main categories and collected track points on each of them:

- Paramo
- Highly conserved cloud forest
- Secondary and moderately intervened cloud forest, with intense successional processes that permanently modified the landscape.
- Formerly forested areas, transformed into grasslands (relative dry plain areas) or sphagnum beds (wetlands)
- Highly degraded landscapes transformed into grasslands or other human transformations.

Using the program TrackMaker®, we constructed a map of the region using 46 LandSat-7 SWIR three band color composite Satellite images downloaded from MapMart® samples webpage (www.mapmart.com) and then plotted all the track points collected. We compared the location and information of each point with the features in the map, in order to calibrate our information and to depict our defined categories and their extents into the map. In order to highlight the differences between the defined landscape categories in the map, we made an additional color treatment on it using the program Corel Draw 12 (Corel ®). We employed the Channel Mixer source, with the RGB color model option and the green out channel.

We manually established the relationship between the signals collected and the different landscapes. We constructed the polygons in the program TrackMacker® and measured their areas in the program MapSource (Garmin™). Then we calculated the extent of each landscape category and based on this information, we estimated the area available for each identified species. Based on the pattern of signals collected during three months, we estimated the home range polygons of some animals. Additionally, we evaluated the impact and potential risk for the identified species, based on the level of traffic of humans and domestic animals.

RESULTS

Preliminary inventory of flora of the region and suitability for the studied species

Given we found sufficient evidence of the presence of brockets in the area, we focused the inventory on the Andean tapir in order to evaluate the suitability of the massif for this species. However, we observed that brockets usually browsed "mortiño" (*Vaccinum*), "diente de león", *Adiantum*, the fern *Campyloneurum* and one species of Euforbeacea in the forest. We also identified sixty species of plants of 22 different families, with the kindly assistance of ecologist Craig Downer and Sr. Eduardo Fernandez, patron of the "El Secreto" private reserve. From these at least six taxonomic groups that constitute major food sources for the Andean tapir in Ecuador's Sangay National Park (Downer, 2001) were identified as occurring abundantly in this location. To wit: (a) in the paramo, the genera *Lupinus* and *Gynoxys* as well as favored genera in the family Ericaceae were encountered in great abundance; and (b) in the Andean cloud forest here occurring, an abundance of the genera *Oreopanax*, *Alchemilla*, and *Neurolepis*, as well as favored genera in the family Ericaceae were likewise encountered. Many other species known to be consumed by the Andean tapir were also observed but in lesser quantity.

Topography and Water

The precipitous topography in combination with abundant springs and full rivers, supplied year-round by the "living sponge" cloud forests and paramo, afford excellent habitat for red dwarf brockets and Andean tapirs. However, perhaps due to the heavy rains that were occurring and which obliterated spore and concur with down-elevation migrations of any possible mountain tapirs still surviving here, we were unable to confirm the presence of mountain tapirs. However, we identified an extensive region of virgin cloud forest on the eastern massif near the communities of Zetaquira and Miraflores and near a large lake named "La Tarea". Here the evidence showed highly presence of brockets and it is more probable that the tapirs will be found. It should be noted that in the area of the "El Secreto" cloud forest, the water in rivers and streams is tainted a golden brown color and that only one species of fish is known to be able to survive in these colored waters (Sr. Eduardo Fernández, pers. comm.). Perhaps this is a factor repelling to the highly aquatic mountain tapirs, but not affected the brockets.

Map construction and description of the area of study

The treated satellite map showing the landscape categories is shown in the figure 1. We achieved the highest contrast for our landscape categories calibrating the red filter in 50, the green filter in 150 and the blue filter in 0, obtaining cyan color for paramo, dark green for Highly Conserved Cloud Forest, bright green for Secondary and Moderately Intervened Andean Rainforest, pale yellowish green for Transformed Grasslands and Sphagnum beds, and whitish yellow for Highly Degraded Areas.

We inspected a total area of 1.697 hectares, 880 in the "El Secreto" sanctuary, 95 in the property "La Comunidad", 569 in "Mundo Nuevo" district and 153 in the "Sucuncuca" reserve, which correspond to 9,8 % of the total area estimated for the massif. We do not provide the maps of each aforementioned local because this information is not available.

The "El Secreto" private sanctuary, in the municipality of Garagoa, is currently an ecoturistic project managed by an ONG created by its owners, for conservation and education. They separated one area of approximately 100 hectares for habitation and agricultural purposes, including almost 90 hectares of timbering of pine and eucalyptus and 10 hectares for lodging, agriculture and sheep calving. The remaining 1100 hectares are almost all Andean cloud forest in different conservation degrees; however, there are important patches of transformed landscapes for ranching purposes inside the rainforest.

The property "La Comunidad", in Garagoa too, is a partially intervened private property, which was abandoned by their owners in 2002 because of the incursion of illegal armed groups. The owners intervened almost 260 hectares for cattle ranching and other agricultural purposes, but they desisted of near 200 hectares 20 years ago, and conserved only 60 hectares for cattle ranching until 2002.

The district "Mundo Nuevo" is a non official district, created by one local politician with non clear purposes. It covers almost the entire area of paramo (almost 3600 hectares) and the most important area of well conserved Andean rain forest in the massif (near 3720 hectares). It is not clear of which municipality it belongs, but near the half is located in the municipality of Miraflores and the other half in Zetaquira.

The reserve of “Sucuncuca” is a public reserve located in the district of “Suna Alta” in Miraflores. It was created to protect the “El Ramo” lake, which is currently used as a strategic water source and provides this resource to the local aqueduct. The reserve is currently occupied by some families that develop cattle ranching near the reserve.

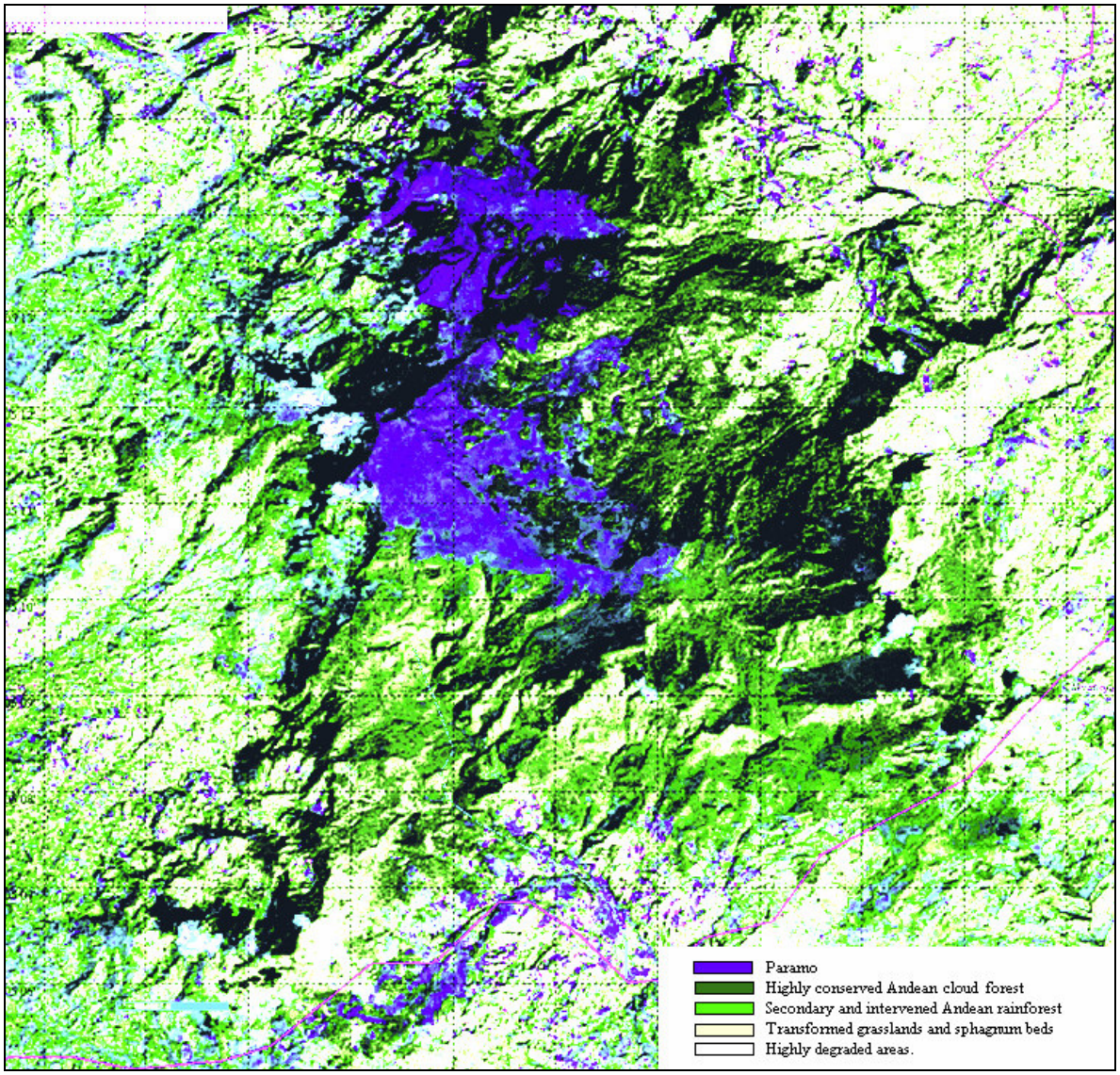

Figure 1. Map of defined categorical landscapes in the Mamapacha massif. The area of paramo presented mild to moderated human alterations. Based on conversations with local people, we deduced that the extended sphagnum beds were originated after the transformation into grasslands of partially inundated rainforests. These areas were progressively occupied by sphagnum because it is more aggressive than the grass in wetlands.

Image analysis and landscape polygons

The map of polygons is shown in the figure 2. According to this, the total area of the massif is 17.286 hectares. We estimated 2.338 hectares of paramo, 6.490 hectares of well conserved Andean rainforest, 3.656 hectares of secondary or moderately intervened Andean rainforest, and 4.801,6 hectares of transformed landscapes. The highly degraded landscapes were seen only in the periphery of the massif.

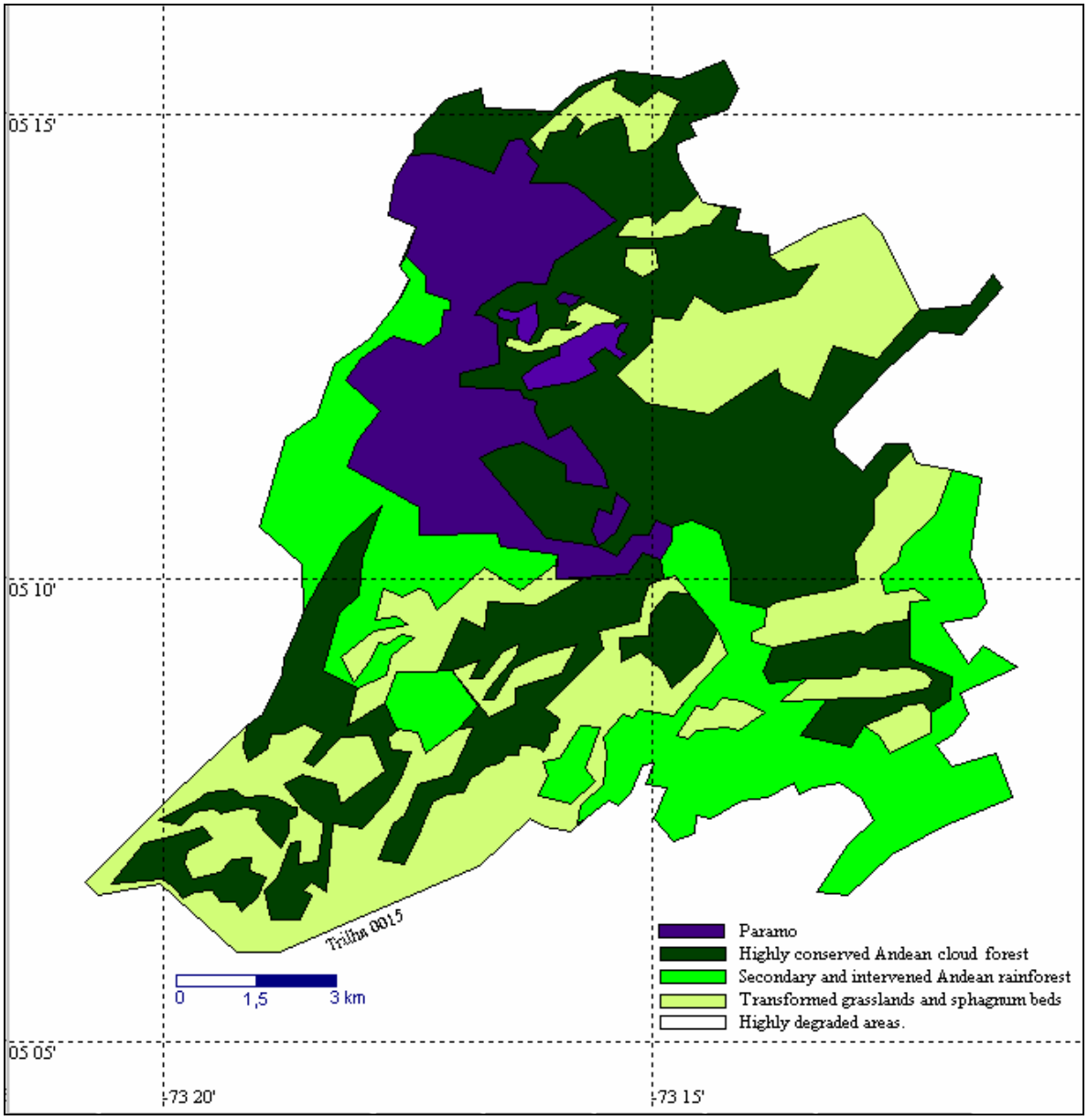

Figure 2. Map showing the landscape polygons. According to that, 13,5% to its area is paramo, 37,5% is highly conserved Andean cloud forest, 21% is secondary and moderately intervened Andean rainforest and 28% is transformed grasslands and sphagnum beds. It means that 49% of the massif has been or is currently under human intervention and only 37,5% remains conserved. This is a very critical situation for the native Andean Ungulates in the region.

We only found signals and testimonials of red dwarf brocket and one testimonial and no signals of Andean tapir. No testimonials or signals of other ungulates such as white tailed deer (*Odocoileus virgininanus*) or red brocket (*Mazama americana*) were collected. The signals of red dwarf brocket were tracks and evidences of browsing. No feces, beds or direct sights were obtained, except by one hind limb collected by one local inhabitant in the forests near the paramo, at 3,100 m of altitude. We found intense activity in the well preserved rainforest in "La Comunidad" and "Mundo Nuevo", and moderate activity in "El Secreto and Sucuncuca". The higher levels of activity were seen in well preserved rainforest and no activity was registered in the highly degraded areas. Scant activity was

registered in the secondary forests of “Sucuncuca” and the transformed landscapes of “El Secreto”.

We detected high traffic of humans and domestic animals in “El Secreto”. One to three people transited the area daily, accompanied by two to three dogs. Additionally, cattle ranching are still carried out in two patches inside the forest: “El Higuerón” with near 30 hectares in extension and “La Esmeralda” with near 67 hectares. Another patch of mayor extent is “Las Clavelinas” with near 250 hectares; this patch is currently abandoned, but the effects of transformation remains evident in the satellite image. The last one is the area of zonal paramo “Florencia”, almost 272 hectares of former rainforest landscape, transformed into grasslands 30 years ago, but then affected by the process of “paramization” (transformation of Andean rainforest into paramo), being today the combination of secondary rainforest and paramo. By polygon measurements we calculated 299 hectares of Highly Conserved Rainforest, and 454 hectares of secondary rainforest (including 272 hectares of zonal paramo).

The property “La Comunidad” has very low traffic because it was abandoned by their owners since 2002. Based on the map analysis we calculated 447 hectares of highly conserved Andean rainforest and 278 hectares of grasslands and sphagnum beds. Given only 60 hectares were maintained as grasslands until 2002, we considered that the dilation in the forest recovery has been produced by the extent of sphagnum beds, which may difficult the process. No other categories were seen. One of their owners that visits the property each three to six months reported that brockets have been always frequent in their property, he always find tracks in his visits, and also he and his brothers captured almost 15 individuals 15 years ago but released them. His brother reported to have seen one brocket been predated by and Andean bear in 1994.

The extension of the district of “Mundo Nuevo” is not known, but the local Environmental Authorities estimated it in near 8.000 hectares. It covers the entire paramo extension and the two major forest patches in the massif, one of most of 2.000 hectares and other of 920 hectares. These patches are connected and have round shape, which brings them protection against the deleterious border effect. However, an important extent of this area has been transformed into grasslands, and some patches are present in the lesser fragment. The owner of the district originally planned to parcel the entire area in several plots and sell them to farmers, but the unfavorable conditions of the landscape limited his aspirations. Today this region is the most important for conservation purposes in the massif. One long-time inhabitant reported that brockets are very frequent in the area and they have been both in forest and paramo, but they strongly preferred the forested areas. He showed us one hind limb of one brocket that was probably predated by an Andean bear. He also told us about the sight of one animal that he described as a large, dark, furry animal “similar to a bear but with a prolonged snout forming a trunk”. The witness saw this animal twice in the paramo zone during the dry season in March and again in May of 2005. It should be noted that the inhabitants here are not familiar with the Andean tapir and do not even recognize its common names, such as *danta de montaña* (Spanish). For this reason, they may confuse it with the Andean bear. Other sight was reported by Montenegro (2002) in the same forest patch.

The reserve of “Sucuncuca” is an intervened area of almost 400 hectares, 85 % of them are secondary forest and the remaining 15 % are transformed landscapes. We counted 11

livestock units, each of approximately two hectares in extent and with 14 bovines in mean. They were located at less than one kilometer from the secondary forest patch and the "El Ramo" lake. This lake of approximately one hectare in extension feeds water to the aqueduct of Miraflores, which is directly managed by the local Municipality. The long-time inhabitants told us that brockets were frequent in Sucuncuca, near the lake, until 30 years ago, when the forest was degraded. In this time, they told that brockets were persecuted by dogs and killed by hunters. Since 20 years ago, the reserve was declared, and since then the area was progressively recovered, however, brockets have been rarely reported. In a speech with some functionaries of the aqueduct, two Andean bears were seen in August of 2007 near the lake. We saw signals of these animals in our visit in September 2007 and also found some old signals in the secondary forest that remained the browsing of red dwarf brockets. Because of the lack of the presence of other conspicuous signals such as tracks, we decided to ignore the browsing, until solid evidence has been obtained.

Patterns of animal distribution, habitat use and density estimates

For the studies of density, distribution and habitat use, we analyzed the data obtained in three months of observations in "El Secreto" and one month in "La Comunidad". We determined the presence of two animals in "El Secreto" near the "El Higuerón" patch and one animal in "La Comunidad" in one forest patch near transformed areas. We considered this condition a sampling bias, because we preferred those areas for logistical reasons. The figure 3 shows the polygons of the three brockets and the local livestock. Based on the signals obtained we estimated home range polygons of 43, 48 and 49 hectares for each animal respectively, giving a mean of 43,6 hectares per animal. We found signals almost entirely in the rainforest patches, and partial overlapping with cattle in "El Higuerón". We calculated the carrying capacity of the massif dividing the total highly conserved Andean rainforest extension by the estimated home range mean, and obtained a tentative number of 149 red dwarf brockets.

The estimated mean is closely approximated to that reported by Ribero et al (2005) for one male red brocket in the Chiquitano forest in Bolivia They estimated a home range of 50 hectares for the red brocket, a medium-sized Mazama deer with body mass ranging between 30 to 40 Kg.

We considered a positive aspect the fact to finding animals in linear forest patches, because it denotes plasticity and relative tolerance to human intromission. However, this condition makes the animals vulnerable to hunters and dogs. According to information of the local inhabitants, some animals were hunted or captured in such areas. A similar situation was reported by Cújar (2006) to be happened to the population of red dwarf brockets of the Ecological Reserve Cachalúy in the department of Santander, near the border between Colombia and Venezuela.

Another aspect to taking into account is that almost 50% of the highly preserved cloud forest (almost 3,000 hectares in "Mundo Nuevo"), probably may hold one population of approximately 67 animals which is too low. Small populations undergoes random fluctuations of its genetic frequencies (genetic drift) as a result of stochastic effects, and tend to reduce its genetic variability, which increases homozygosis, lower the evolutionary potential and fitness, and probably lead to extinction, in a phenomenon known as endogamic depression (Lande, 1988, Westemeier et al, 1998).

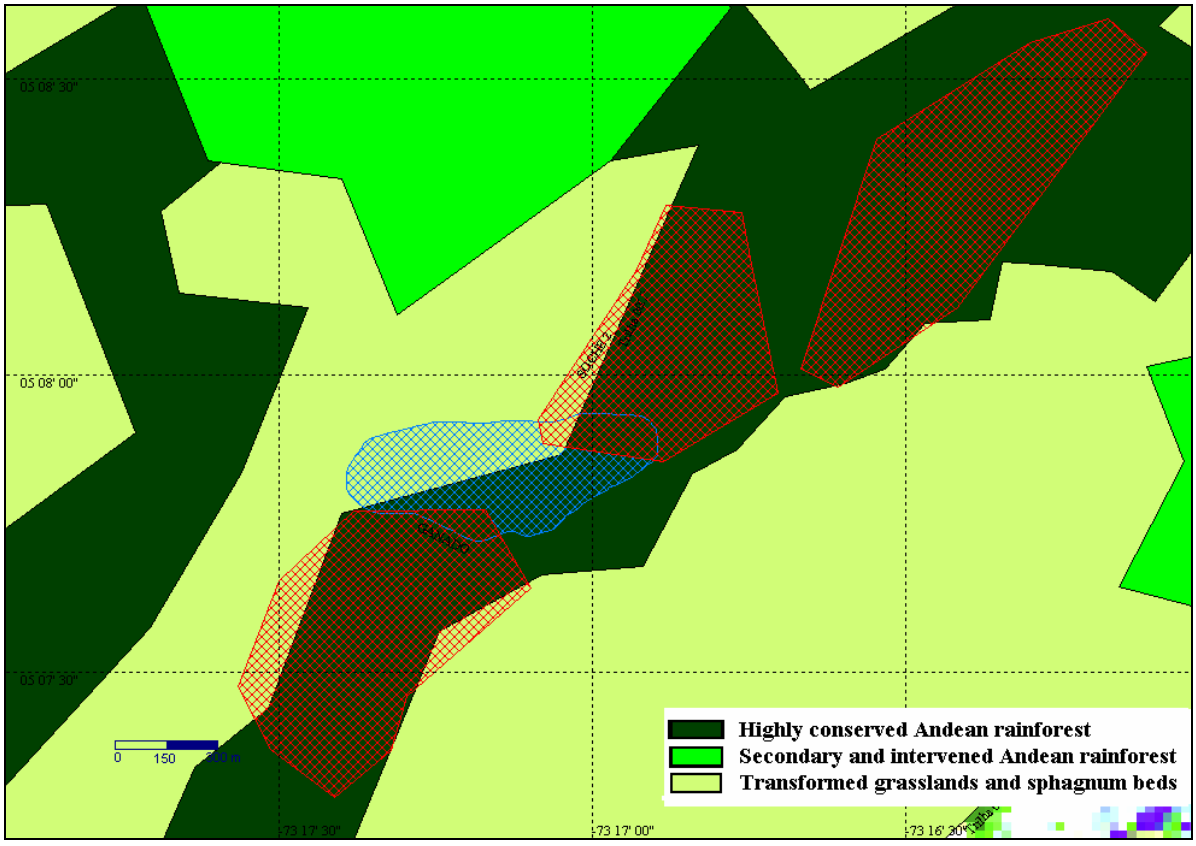

Figure 3. Estimated home range polygons of the three red dwarf brockets (red polygons) in the Private Reserve "El Secreto". Note that all of them are closely related to the highly conserved Andean rainforest, and they are in a linear forest patch. Also note the proximity and partial overlapping of cattle (blue polygon). Apparently the brockets were not affected by the presence of the cattle.

Sanitary evaluation

We analyzed a pool of feces from the cattle and sheep from October to December 2005. We also analyzed blood samples from cattle, sheep and three brockets kept in captivity. Hematological values were under normal parameters, and mild to moderate infestations with *Coccidia* (Apicomplexa) and Strongilid worms (Nematoda: Ancylostomatidae) were detected both in cattle and sheep. A fecal sample from and unknown herbivore (probably a free- living brocket) was found with a highly infestation of strongylid larvae. One sheep died in November 2005 because a severe infestation with strongylids.

Another sanitary finding was one animal observed in September 2005 that showed lameness of the hind limb because of the presence of a vesicle in the left hind hoof. This finding may be compatible with vesicular diseases, and given that both serovars of Vesicular Stomatitis (Indiana and New Jersey) were diagnosed in Garagoa in 2001 (Orjuela et al. 2003) there is the probability that this animal was infected by the disease. The owners don't agree with sampling the animal, so there was not possible to confirm the diagnosis.

Conclusions

The present research revealed us that the red dwarf brocket is closely related to the Andean cloud forest, and each alteration on this landscape seriously affects the future of the species. This brocket deer seems to be variably sensitive to human activities and its degree depends

on the type of activity. However, they apparently tolerate lower to moderated alterations in the forest and even accept the cattle ranching but only with lower human traffic. We have no evidence of mutual transmission of diseases between brockets and cattle; however, this topic must be reviewed, given the evidence of parasitic and vesicular diseases in the cattle in the area.

This species showed to be highly sensitive to direct human intervention, not only for de risk of poaching but because the human presence almost always lead the presence of dogs. We consider the dogs to be the most serious menace for the red dwarf brocket in the massif; because they usually hunt not only for eating but also for satisfying their natural predator behavior.

Some of our observations indicated that the massif is now endangered because the human pressure still continues. We found some indicators that the recovery of the forest is not satisfactory because some particular conditions in the area, such as the wetlands, which seems to delay or even stop the processes of forest recovery. It would be probable that several intervened and transformed areas never recover again, so those landscapes may be completely lose for the red dwarf brocket. This condition may be critical in those private reserves with currently human occupation.

In the other hand, the study also indicates that there is appropriate Andean tapir habitat in the Mamapacha wilderness and does by no means eliminate the possibility that Andean tapirs – however reduced in population – still find a secret and relatively safe place to dwell somewhere in the wild region of Mamapacha.

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Software

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Budget report

The following relation of costs corresponds to 89 days of field work and 181 days of office and analysis work, and also includes the acquisition of field and scientific equipment. The item "expeditions" represents the expenses of three researchers for 22 days, two researchers during 59 days and one researcher during eight days. The expenses per day per researcher were approximately £6,33. Idea wild contributed with the donation of one refurbished laptop computer IBM T21 Pentium III 800 MHz, and the Tapir Specialist Group Conservation Fund contributed with US$ 1.000,00 (approximately £625,00.

The second phase of the project was temporally suspended because of two circumstances (1) the lack in acquiring sufficient funds for its execution, and (2) the difficulty to reach one National Supporting Institute in order to obtain the corresponding permit for accessing the Genetic Resources (samples for cytogenetics and molecular genetics).

Item Contributor	Counterpart	Rufford	TSGCF	Idea Wild	Total by parts
Operative Costs					
Internet		£274,07	£56,50		£330,57
Cell phone service		£65,43	£12,34		£77,77
Basic services (phone, energy, water, etc)		£555,60	£277,80		£833,40
Total by item					£1.241,74
Report production					
Computers		£299,83		£309,00	£608,83
Office and books		£40,74	£40,74		£81,48
Maps		£5,00			£5,00
Total by item					£695,31
Equipment					
Field equipment	£104,00	£253,07	£27,50		£384,57
Cientific equipment		£1.107,43			£1.107,43
Total by item					£1.492,00
Expeditions					
Lodging		£111,00	£7,40		
Transport		£197,53	£22,22		£219,75
Food		£454,32	£29,63		£483,95
Consumables		£360,98	£150,87		£511,85
Total by item					£1.215,55
Total cost (by contributor)	£104,00	£3.725,00	£625,00	£309,00	£4.644,60

Compared with the proposed budget, we can conclude that we were able to reduce almost all the expected costs. It was because of two circumstances: (1) the use of digital equipment and rechargeable cells, which reduced the use of many consumables and (2) the buying of some expensive scientific equipment at very low cost (refurbished equipment). WE believe that this actions not only reduces costs but also contribute with the conservation of the environment.

In the other hand, we had some expenses higher than expected, such as the operative expenses and additional cost in computer reparations. Additional costs on the operative expenses item were due to the use of Internet and cell phone services. However, we were able to control the costs of Internet, when finding available free wireless services. The unexpected expenses in the reparation of computers (£299,83) may be considered a typical contingency, which representing 6,5% of the total cost of the project, is under the accepted 10% of contingencies.