Kwando Carnivore Project

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Camera trap survey to determine the status of leopards in the Mudumu-North Complex, Zambezi Region, Namibia

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Introduction

Baseline population estimates for leopards (*Panthera pardus*) and population monitoring form an important component of conservation efforts for the species. Surveys provide information on the status of leopards which is fundamental to the effective adaptive management process (*Gray et al., 2012; Sharma et al., 2014*).

Leopards are now categorized as Near Threatened in the IUCN Red List and require increased conservation efforts and attention should be given to consumptive management practices (*Balme et al., 2010; Henschel et al., 2008*). Leopards are vulnerable to extinction in fragmented landscapes due to their low densities, large home ranges, persecution (*Cardillo et al., 2005; Purvis et al., 2000*) and consumptive use.

Trophy hunting, and other forms of consumptive use of natural resources, are important components of Namibia's conservation philosophy and a vital source of financial support to conservancies, where livelihoods are tied to benefits derived from natural resource utilization. Leopards are valuable and a sought after addition to trophy hunting quotas in conservancies. The Mudumu-North Complex (MNC) is a landscape network where leopards are regularly hunted in conservancies adjoining protected areas. Research elsewhere has shown that the edges of protected areas may function as population sinks for large carnivores if mortality is not sustained by immigration through reproduction and colonization (*Woodroffe and Ginsberg 1998; Balme et al., 2010)).* causing the decline of carnivore populations inside those protected areas.

We conducted the first comprehensive leopard and large carnivore survey of the MNC from April to November 2014 using camera trapping as the primary survey method. The purpose of the survey was to aquire accurate baseline information on leopards and other large carnivores of the MNC and to test the use of camera trapping for long-term monitoring of large carnivores by conservancies and protected area personnel. Ultimately the goal is to develop long-term large carnivore monitoring system for the Mudumu Complexes. Furthermore, we intended to provide

results and reccommendations affecting the trophy hunting of leopards. The results of this survey are intended to complement and build onto Namibia's national leopard survey carried out in 2011 (Stein *et al., 2011),* in which recommendations included the need to survey leopards in communal conservancies.

STUDY AREA AND METHODS

As part of the Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) the Mudumu Complexes of the east Zambezi Region of Namibia are important areas for wildlife connectivity and dispersal. The national parks of the east Zambezi Region, i.e. Mudumu and Nkasa Rupara, are too small to maintain viable populations of some wildlife species, which depend on being able to move across a network of landscapes, such as the conservancies and woodland areas to connect to protected areas in neighbouring countries such as Angola, Botswana and Zambia. The MNC includes the perennial Kwando river system and its floodplain, the Kwando Core Area of Bwabwata National Park (BNP), four conservancies (Kwandu, Mashi, Mayuni and Sobbe), the Kwandu Community Forest and Mudumu National Park, which together cover an area of 3400km^2

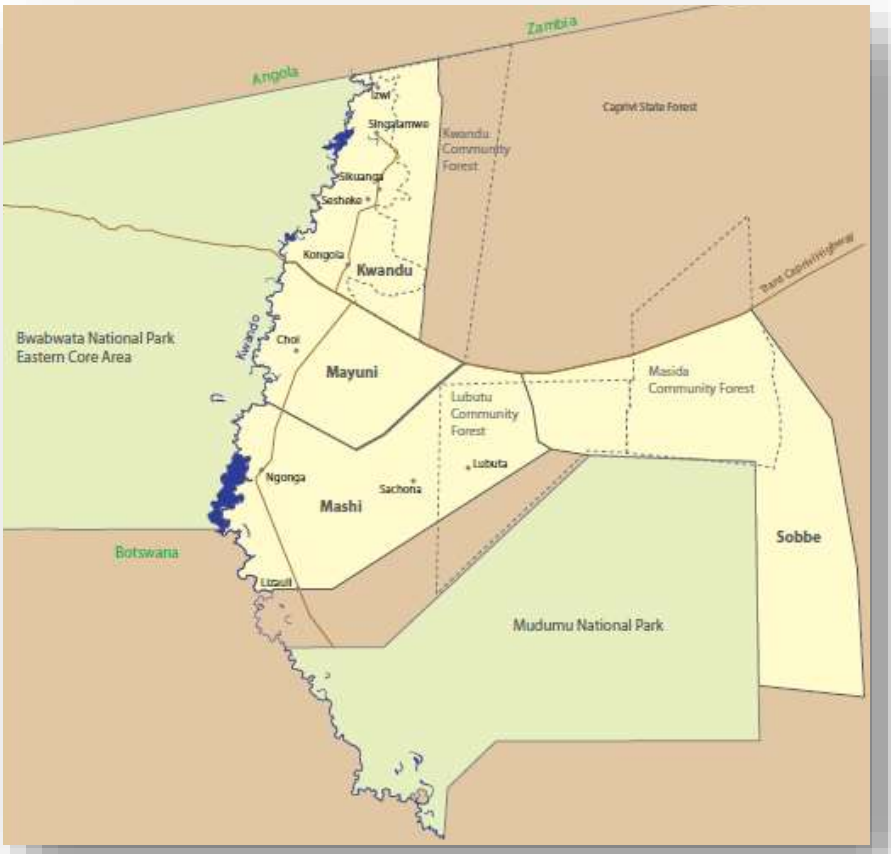

Figure one: Map of the Mudumu North Complex showing the network of landscapes made up of conservancies, community forests and protected areas that cover 3400 km^2 (Source: Natural Resource Working Group of NACSO)

The broadleaved woodlands grow on nutrient deficient Kalahari sand, with Angolan and Zambezi teak, false mopane, silverleaf *Terminalia* and *Combretum* species being the predominant woody vegetation. Low lying more productive clay substrate in localized omurambas are dominated by camel thorn and leadwood trees (*NACSO, 2009*).

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Although it is known that five of the six terrestrial Namibian large carnivore species occur in the MNC, population estimates were only available for spotted hyaenas and lions *(O. Aschenborn, pers. comm.; Hanssen 2011, 2014*). However, no systematic, simultaneous and comprehensive surveys had been conducted in the MNC. During a collaboration between Kwando Carnivore Project (KCP), MET and the conservancies of the MNC a camera trapping survey of large carnivores was carried out between April and November 2014 over an area of approximately 1900 km^2 of the MNC. Community game guards (CGGs) received intensive training on processing camera traps before deployment and both CGGs and MET personnel from Mudumu National Park (MNP) acquired extensive experience on the correct deployment of camera traps and survey design while participating in field work.

The total survey area included a portion of the State Forest lying south of the border with Zambia, but excluded the Sobbe Conservancy, which lies east of Mudumu National Park and the Kwando Core Area of BNP, which lies on the western side of the Kwando River. Areas of high human density were also excluded as leopards will move through these areas, but are unlikely to reside there (*Braczkowski, 2014*). The components of the survey area and their size are presented in Table 1.

Table 1: The land-use and size of the network landscape of the survey area in the MNC.

Area	Size in km^2	Land use
Kwandu Community Forest	190	Harvest of forest products/Trophy hunting
State Forest	525	Harvest of forest products
Conservancies (Mayuni and Mashi)	448	Agropasterlism/Trophy hunting
Mudumu National Park	737	Tourism
Total study area	**1900**	

In order to survey the study area at a reasonably high intensity, the survey area of 1900 km^2 was divided into three blocks of which each was surveyed over a period of 6 to 8 weeks. Between 58 and 70 Panthera Version IV digital camera traps were set up in paired format in each block with an attempted camera station spacing of 4 km. This intensity was reduced to a 3 km spacing in the western riverine stratum of MNP, based on the assumption that home ranges of leopards are likely to be smaller where wildlife (prey) densities are high. Additional single cameras were set up at three ephemeral pans in block one in order to maximize the opportunity of "capturing" leopards visiting pans to drink. An additional camera station consisting of two cameras was set up at Sintika waterhole in MNP (block 3) for the same reason. A total of 97 camera stations were set up throughout the study area (see Figure 2). Block sizes and number of camera stations in each are presented in Table 2.

Table 2: Number of camera stations and land-use designation per survey block

Block no	Area in km^2	Camera stations	Land use designation
1	690	34	Kwandu Community Forest and State Forest
2	648	35	Mashi/Mayuni Conservancies and north MNP
3	537	29	South MNP

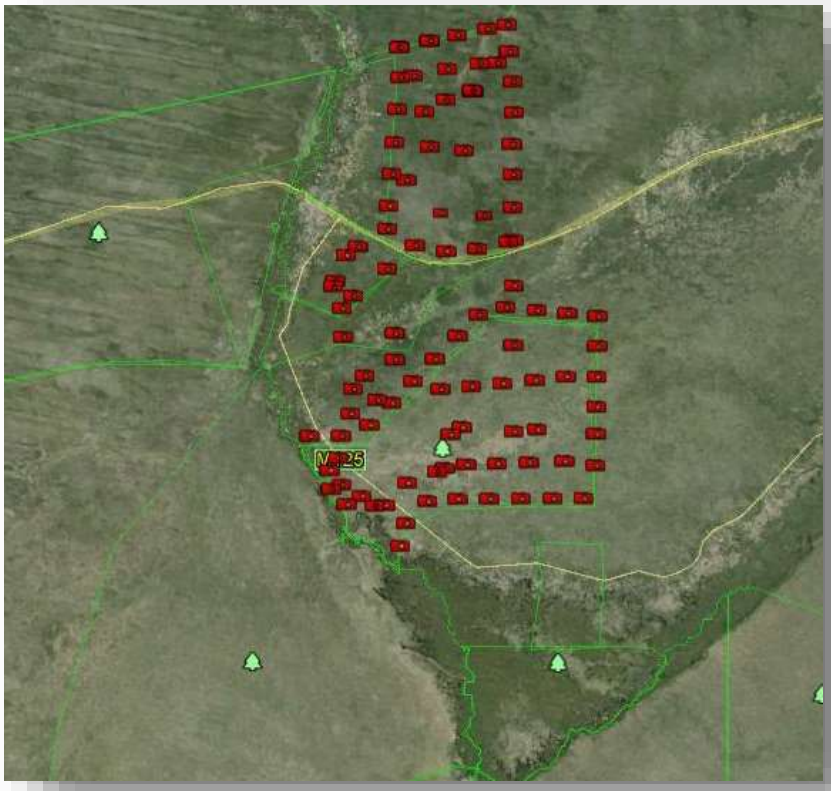

Figure 2: A map showing the layout of the camera trap grid used to survey 1900 km^2 of the Mudumu North Complex from April to November 2014.

Data collection

The digital camera traps were programmed to take two photos one second apart when the passive infra-red sensor was triggered, with flash programmed to be active after sunset, ideally resulting in photos of both sides of animals walking through the camera station. The batteries and/or cameras were replaced and photographs downloaded onto memory sticks approximately every two to three weeks. Downloaded photographs are automatically filed in date format by the Panthera Camera Trap File Manager software. Over 220 000 photographs were taken during the survey, which were reduced to 42 976 photos of wildlife species, livestock, human and vehicle activity. Photos were imported into Adobe Lightroom 3 where all photos of large carnivores were tagged by species name, camera station ID code, age and sex class and survey area. Leopards were tagged in 209 of the 42 976 photographs. Photos of leopards were examined and individuals identified by their coat patterns on both left side (n = 93) and right (n = 85). Data transcribed into MS Excel spreadsheets included unique ID, sex and age, camera trapping ID, camera station geographical locations and date of capture.

Data analysis

Each sampling session consisted of a period of 24 hours totalling 70 sampling sessions. Data from the three blocks were lumped together where the first camera trapping day in each block were considered sample session one for the entire survey area, independent of date. Although two small cubs were recorded, only adults and independent

sub-adults were included in the analysis. Data was analysed for density and home range using Spacially Explicit Capture Recapture (SECR) and SpaceCap models within R. A population estimate was calculated by extrapolating density over the survey area.

Results

Leopard distribution

A total of 22 adult and sub-adult leopards comprising six adult males, thirteen adult females and three sub-adult females were identified in 110 capture events of which 101 were temporally independent. Two small cubs were excluded from the analysis. Mean capture rate was 11 for male leopards (range 1 to 23) and 3 for females (range 1 to 8). Leopards were "captured" throughout the study area with the exception of areas of intense human settlement and disturbance, i.e. the areas surrounding the power carrier south of the state forest, the areas adjacent to the tar road and the north eastern corner of Mayuni conservancy, which is intensively settled and farmed (see Figure 3). Leopard activity in the riverine stratum in western MNP, Mashi conservancy adjacent to MNP and the southern boundary of MNP is very low due to the intensity of human activities.

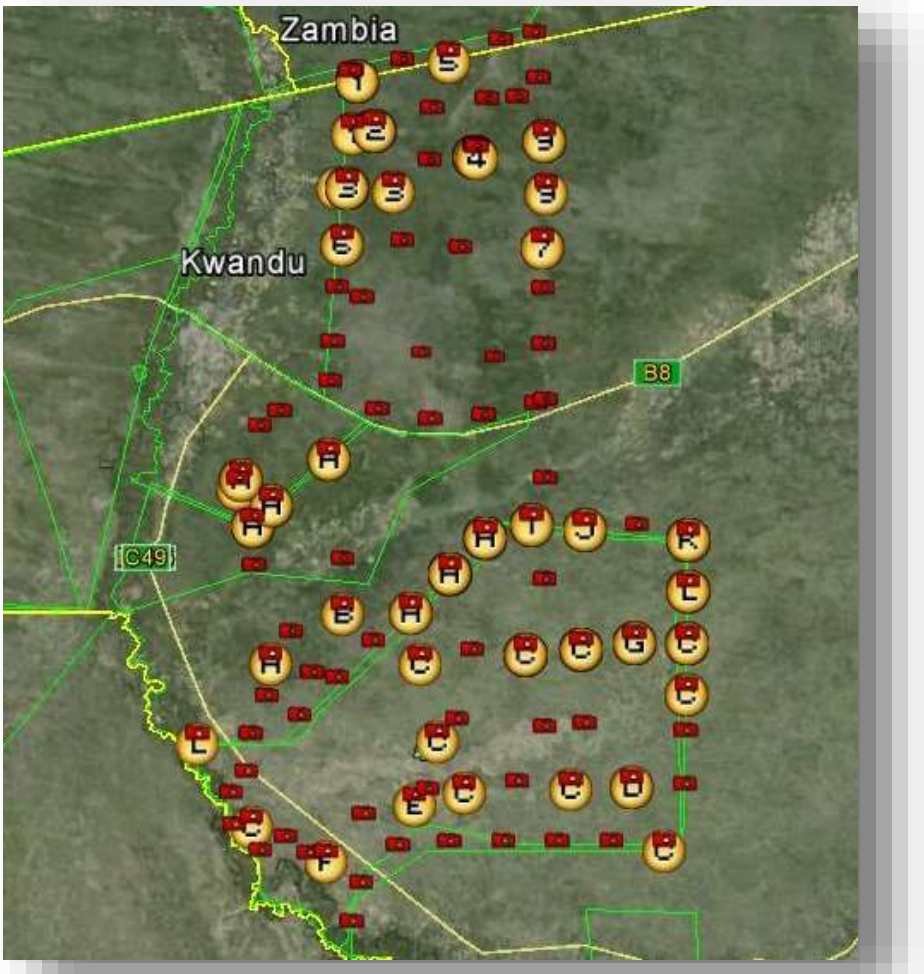

Figure 3: A map depicting where where successful captures took place in relation to the camera trapping grid.

Leopard numbers in conservancies were far lower than elsewhere and resident adult males and sub-adults were absent. Sex and age structure of leopards per land-use designation are presented in Table 3.

Table 3: Sex and age structure of leopards in the different land-use designations of the MNC

Land use	Area in km^2	Males	Females	Sub-adult	Total
Forest	715	3	4	3	10
Conservancy	448	-*	2	-	2
Protected area	737	3	7	-	10

*A male leopard photographed in Mayuni Conservancy originated from Mudumu National Park

Density, home range and population estimate

Overall leopard density in the MNC is low with a mean density of 0.583 leopards/100 km^2 (range 0.372 to 0.915/100 km^2; CL 95%), and home ranges are large with a mean home range estimate of 779.66 km^2 (range 633 to 1231 km^2; CL 95%). This resulted in a population estimate of 11 leopards (range 7 – 17) permanently living within the 1900 km^2 study area of the MNC and the state forest, and another 11 transient individuals that were not likely to have been resident.

Discussion and recommendations

In 2004, the CITES leopard hunting quota for Namibia was increased by 150% from 100 leopards to 250 leopards per year. In 2010, this quota was fulfilled for the first time, which led to MET carrying out a national leopard survey. This survey was designed to provide MET with a detailed understanding of the national leopard population and a strategy for objectively monitoring the harvest of trophy hunted leopards throughout the country. One of the objectives of this survey was to categorize regions of the country into sections where leopards live at high, medium and low density and ascribe density estimates to each in order to extrapolate a population estimate. These density estimates were based on questionnaire surveys, spoor surveys and camera trapping over three study sites (*adapted from Stein, 2011*). Density estimates from the National Leopard Survey Report were as follows:

High density ≈3.1 leopards/100 km^2

Medium density ≈ 2.0 leopards/100 km^2

Low density ≈ 1.2 leopards/100 km^2

A revised adaptive management strategy was proposed by Stein (2011), whereby quotas were based on leopard density that are variable in different habitats and regions. Quotas can be revised and adapted based on improved information from surveys and monitoring. Proposed sustainable offtake of male leopards based on leopard density is presented in Table 4.

Table 4: Sustainable annual offtake of male leopards based on leopard density (Stein, 2011)

Density category	Leopard density per 100 km^2	Offtake per 1000 km^2 per year
High	3.1	0.5
Medium	2.0	0.35
Low	1.2	0.21

Before the revised quota setting strategy was proposed, leopard quotas in the Zambezi Region were based on presence/absence data in conservancy event books and were often very high. Some conservancies within the Mudumu Complexes were allocated one leopard every year. Based on the new system, leopard quotas are now allocated in three year blocks and have been drastically reduced to a total quota of 5 leopards over three years (2014 – 2016) for the entire Mudumu Complex, which has seven separate hunting concessions (*O. Aschenborn, pers. comm).*

However, the results of this survey clearly indicate that leopards densities and numbers in the MNC are extremely low; less than half (0.6 leopards/100 km^2) of the lowest density category in the national leopard survey. This result is surprising considering that MNC has rapidly recovering wildlife populations. When looking at the results more closely, areas with the least interference from people have higher leopard numbers. These included the state forest (east of human settlement in the Kwandu Conservancy) and Mudumu National Park. It is clear, therefore, that leopards avoid areas of high human activity, are sensitive to land-use change, and may not have recovered yet from the earlier very high trophy hunting quota. Just to emphasise point one and two no leopards were photographed at cameras close to fields and human settlements, and to emphasise the last point no sub-adut or resident adult male leopards where photographed in the conservancies during the survey.

The low leopard numbers overall, and specifically the lack of sub-adult and adult males within the Mashi and Mayuni conservancies is cause for concern. Utilization can result in lower leopard densities immediately adjacent to protected areas (*Balme, et al. 2010*). High hunting quotas over an extended period of time in the conservancies surrounding Mudumu National Park have likely resulted in the conservancies becoming a population sink for the entire Mudumu Complexes. High mortality rates bordering parks impact within protected areas resulting in populations living well below carrying capacityed even if populations inside park boundaries are protected (*Balme et al., 2010, Woodroffe and Ginsberg, 1998*). This would explain the extreme low density of leopards over the entire study area. There is anecdotal evidence that leopard numbers in Mudumu South Complex (MSC) are even lower.

Trophy hunting systems based on arbitrary quota setting without baseline information and strong monitoring systems can lead to disastrous declines even in populations within protected areas (*Balme et al., 2010; Packer et al., 2010; Whitman et al., 2004; Woodroffe and Ginsberg 1990*). Leopard populations in protected areas that act as a source for consumptive use in adjacent areas should be at or close to carrying capacity (*Balme et al., 2010*) and adaptive management strategies can minimize the impact of utilization (*Balme et al., 2009*). Leopard numbers in the Mudumu Complexes are currently below carrying capacity. This is supported by estimates that leopards in similar habitats in BNP occur at twice these densities at 1.18 to 2.4 leopards/100 km^2 *(Funston, et al., 2014)*. High quotas in Mudumu Complex conservancies over an extended period of time has resulted in overall low leopard density. MET's leopard quota for the Mudumu Complexes would be correct if leopard numbers were not already reduced before its implementation.

It is is likely that leopard density in the Mudumu Complexes will recover to capacity if hunting quotas for the next three years are drastically reduced or withheld altogether. Quotas could then be reassigned based on the results of an intensive leopard survey in 2018/2019.

Camera trapping proved to be a very effective and useful tool for detailed leopard population monitoring for the Mudumu North Complex. Repeated surveys every three years would be a good basis for setting quotas.

References

Balme, G.A., Hunter, L.T.B. & Slotow, R. 2009. Evaluating methods for counting cryptic carnivores. Journal of Wildlife Management. 73: 433–441.

Balme, G.A. 2010. Edge Effects and the impact of non-protected areas in carnivore conservation: leopards in the Phinda-Mkhuze Complex, South Africa. Animal Conservation 13: 315 - 323

Braczkowski, A. 2014. Counting cats: a user-friendly manual to perform spacially explicit capture recapture analyses on wild felid populations using secr and SPACECAP in R. Wildlife Conservation Research Unit, University of Oxford and Panthera Foundation, New York.

Cardillo, M., Mace, G.M., Jones, K.E., Bielby, J., Biminda-Emonds, O.R.P., Sechrest, W., Orme, C.D.L. & Purvis, A. 2005. Multiple causes of high extinction in large mammal species. Science 309: 1239 – 1241.

Funston, P.J., Hanssen, L.C. & Moeller, M.L. 2014. Large Carnivore Survey, Bwabwata National Park, July, 2014. Report submitted to the Ministry of Environment and Tourism. Namibia.

Gray, T. N. E. Prum, and S. 2012 Leopard density in post-conflict landscape, Cambodia: evidence from spatially explicit capture-recapture. Journal of Wildlife Management. Vol. 76 No. 1: 163–169.

Hanssen, L.C. 2011. Spotted hyaena ecology and human wildlife conflict in the Caprivi Region of Namibia, 2011. Report submitted to the Namibian Ministry of Environment and Tourism.

Hanssen, L.C. 2014. Status Report: Lions of the Zambezi Region. Report submitted to the Namibian Ministry of Environment and Tourism.

Henschel, P., Hunter, L. Breitenmoser, U., Purchase, N., Packer, C., Khorozyan, I., Bauer, H., Marker, L., Sogbohossou, E. & Breitenmoser-Wursten, C. 2008. Panthera pardus. In: IUCN 2013 Red List of Threatened Species. Version 2013.2. www.iucnredlist.org

Mills, M.G.L. 1991. Conservation management of large carnivores in Africa. Koedoe. 34: 81- 90.

NACSO. 2009. Conservancies in the Mudumu North Complex. Brochure of the Namibian CBNRM Support Organisation. Namibia Nature Foundation, Windhoek, Namibia.

Packer, C., Hilborn, R., Mosser, A., Kissui, B., Borner, M., Hopcraft, G., Wilmshurst, J., Mduma, S. & Sinclair, A.R.E. 2005. Ecological change, group territoriality, and population dynamics in Serengeti lions. Science. 307: 390–393.

Packer, C., Brink, H., Kissui, B.M., Maliti, H., Kushnir, H. & Caro, T.M. 2009. Effects of trophy hunting on lion and leopard populations in Tanzania. Conservation Biology: 25: 142–153.

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Purvis, A., Gittlement, J.L., Cowlishaw, G. & Mace, G.M. 2000. Predicting extinction risk in declining species. Proc. Roy. Soc. Lond. Ser. B267, 1947 – 1952

Sharma, K., Bayrakcismith, R., Tumursukh. L., Johanson, O.,Sevger, P., McCarthy, T. 2014. Vigorous Dynamics Underlie a Stable Population of the Endangered Snow Leopard Panthera uncia in Tost Mountains, South Gobi, Mongolia. PloS One

Stein, A. 2011.Namibian National Leopard Survey – 2011. Final Report. Ministry of Environment and Tourism. Namibia

Whitman, K. Starfield, A.M., Quadling, H.S., and Packer, C. 2004. Sustainable trophy hunting of African Lions. Nature 428: 175 – 178.

Woodroffe, R. and Ginsberg, J.R. 1998. Edge effects and Extinctions of Populations inside Protected Areas. Science. 280: 2126 - 2128