LEOPARD PILOT POPULATION STUDY AT RUNGWA/PITI ECOSYSTEM, TANZANIA, EAST AFRICA

Final Report

By M. S. Arturo Caso
Proyecto de los Felinos Silvestres de México

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Abstract

The African Leopard (*Panthera pardus*) is one of the most important trophy game animals in East Africa, due to the fact that it is considered by sport hunters as one of the Big Five quarry species. However, there is still a lot of concern about the sustainable amount of hunting for this species in some game reserves of Tanzania. Although leopard appear to be abundant in must places, because of their shy, retiring and semi-nocturnal habits, they are thought to be scarce and even endangered. No proper leopard studies or census have ever taken place in Tanzania's hunting areas. Due to the lack of population studies, the number of licenses issued for this species in game reserves could therefore be-readjusted by the Tanzania Wildlife Authority. For this project we captured seventeen leopards and we were able to radio collared fifteen animals (7M : 8F). A radio-collar with a GPS sensor was attached to each of these leopards and we obtained a mean home range mean value for males of 136.37 km^2 and 21.54 km^2 for females. With this early data about spatial patterns we can come with an idea of how is leopard population at the Rungwa/Piti ecosystem.

Introduction

Although the leopard (*Panthera pardus*) is considered a species that is very adaptable and could be found in certain areas as a very abundant feline, their populations seems to be unknown. The lack of field population studies has created a mostly negative bias on the number allowed to be hunted in the game areas. Tanzania, East Africa is one of the countries with less income per capita and the country needs sport hunting for the welfare of its economy. The big cats of Africa, the leopard and lion (*Panthera leo*), attracts each year sport hunters from every part of the world giving an important amount of income to Tanzania. This income is translated to a better conservation in game areas, leading to improving Tanzania's economy. Anti-hunting organizations blame sport hunting for reducing the leopard population, but these issues are not supported by scientific data.

The Rungwa/Piti eco-system has an extension of over three million has, and it is probably one of the most remote areas in East Africa. The topography, which is made of Miombo woodland, open savannas combined with rocky mountains, represents a very suitable habitat for leopards. This area has been opened for sport hunting for many years. And since just male leopards are hunted here, the population seems to be stable or even may be increasing.

Biology of the Species

Description

The leopard is well known for its versatility as a generalist predator, and shows a number of morphological adaptations to this end, including its size, which shows wide variation across its range. Exceptionally large males weighing over 91 kg have been reported from South Africa's Kruger National Park, where average adult weights are otherwise 58 kg for males and 37.5 kg for females (*Child 1965*).

Despite its relatively small body size, the leopard is still capable of taking large prey. Its skull is massive, giving ample room for attachment of powerful jaw muscles. Its whiskers are particularly long and there are often several extra long hairs in the eyebrows, protecting the eyes and assisting movement through vegetation in darkness (*Skinner and Smithers 1990* periods of time, obtaining moisture requirements from prey (*Bothma and Le Riche 1986*).

Diet

The flexibility of the diet is illustrated by Hamilton's (*1976*) analysis of leopard scats from Kenya's Tsavo West National Park, of which 35% contained rodents, 27% birds, 27% small antelopes, 12% large antelopes, 10% hyraxes and hares, and 18% arthropods. Analysis of leopard scats from a Kruger National Park study area found that 67% contained ungulate remains, of which 60% were impala, the most abundant antelope, with adult weights of 40-60 kg. Small mammal remains were found most often in scats of sub-adult leopards, especially females (*Bailey 1993*). Studies have found average intervals between ungulate kills to range from seven (*Bailey 1993*) to 12-13 days (*Hamilton 1976, Le Roux and Skinner 1989*). At 3,900 m in the Kilimanjaro Mountains of Tanzania, Child (*1965*) reported the leopard's diet to consist mainly of rodents.

The leopard shows several behavioral adaptations which permit it to compete successfully with other large predators, the first being its dietary flexibility. Bertram (*1982*) studied radio-collared lions and leopards in the same area in the northern Serengeti and found that, while their ranges overlapped, leopards preyed on a wider range of animals than did lions, and there was little overlap between their diets. Secondly, leopards often cache large kills in trees. Leopards may also retreat up a tree in the face of direct aggression from other large carnivores. In addition, leopards have been seen to either kill or prey on small competitors, e.g. black-backed jackal (*Estes 1967*), African wild cat (*Mills 1990*) and the cubs of large competitors (lion, cheetah, hyenas, wild dogs: *Bertram 1982*).

Activity

Leopards are generally most active between sunset and sunrise, and kill more prey at this time (*Hamilton 1976, Bailey 1993*). In Kruger National Park, Bailey (*1993*) found that male leopards and female leopards with cubs were relatively more active at night than solitary females. The highest rates of daytime activity were recorded for leopards using thorn thickets during the wet season, when impala also used them (*Bailey 1993*).

Reproduction

Apparently, leopards don't have an established breeding season, litters could appear during any stage of the year and being prey availability the most important factor for it to happen. Estrus length it about seven days, with a gestation period from 90 to105 days (*Hemmer 1976*). Litter size ranges from 1 to four and first year mortality it is estimated as 40% (*Martin and de Meulenaer 1988*). Interbirth interval averages fifteen months (*Martin and de Meulenaer 1988*; these data include some shorter periods after litters did not survive) to over 2 years (*Schaller 1972, Bailey 1993*).

Age at Independence is considered to be from 13 to18 months (*Bailey 1993, Skinner and Smithers 1990*). Siblings may remain together for several months before separating (*Skinner and Smithers 1990*). Dispersal may be delayed in areas where prey are abundant, especially if adjacent habitat is occupied by resident leopards (*Bailey 1993*). Age at first reproduction averages 35 moths (*Martin and de Meulenaer 1988*). Sex ratio of resident adults in the wild has been reported as 1 male per 1.8 females (*Bailey 1993, Hamilton 1981*).

Habitat and Distribution

Leopards occur in most of sub-Saharan Africa. They are found in all habitats with annual rainfall above 50 mm (*Monod 1965*), and can penetrate areas with less than this amount of rainfall along river courses (*Stuart and Stuart 1989*). Out of all the African cats, the leopard is the only species which occupies both rainforest and arid desert habitats. Leopards range exceptionally up to 5,700 m, where a carcass was discovered on the rim of Mt Kilimanjaro's Kibo Crater in 1926 (*Guggisberg 1975*).

The leopard appears to be very successful at adapting to altered natural habitat and settled environments in the absence of intense persecution. There are many records of their presence near major cities (*Guggisberg 1975, Martin and de Meulenaer 1988*). Hamilton (*1986b*) reports their occurrence in western Kenya in extensively cultivated districts with more than 150 persons/km^2.

However, leopards appear to have become rare throughout much of West Africa (*Martin and de Meulenaer 1988: 11-14*). According to T. Anada (*in litt. 1993*), they have completely disappeared from much of the Western Sahel.

Population Status

The status of the leopard in sub-Saharan Africa has been a matter of controversy since 1973, when it was first listed on CITES Appendix I due to fear about the impact of the then considerable international trade in leopard skins (*Myers 1973*).

Despite the controversy, there appears to be general agreement that the leopard is not currently endangered in Sub-Saharan Africa, but that it is subject to local depletion through exploitation and loss of habitat. Overall, Martin and de Meulenaer (*1988*) estimated the Sub-Saharan population to number 714,000, based on their density/rainfall regression.

There is a lot of controversy about population status on different areas of it's range. J. Hart (*in litt. 1994*) offers a preliminary estimate of one adult leopard per 8-12 km^2 in Zaire's Ituri forest, or 8.3-12.5 leopards per 100 km^2. These estimates are considerably lower than the 40 leopards per 100 km^2 suggested by Martin and de Meulenaer's rainfall/density regression. Yet they are also higher than adult leopard densities estimated for the Seronera woodland area of Tanzania's Serengeti National Park (3.5 [*Schaller 1972*] - 4.7 [*Cavallo 1993*] per 100 km^2), which are among the greater densities on the rainfall/density regression if the rainforest estimates are excluded. In South Africa's Kruger NP, Bailey (*1993*) estimated average leopard density at 3.5 adults per 100 km^2, with much higher densities of up to 30.3 per 100 km^2 in the riparian forest zones, with high prey density.

Home Range

Leopard home range sizes determined by radio-telemetry have averaged between 30-78 km^2 (males) and 15-16 km^2 (females) in protected areas (Tsavo National Park: *Hamilton 1981;* Kruger National Park: *Bailey 1993;* Serengeti National Park: *Bertram 1982;* Cedarberg Wilderness Area [South Africa]: *Norton and Henley 1987*). Long-term observations of individual female leopards have yielded larger estimates of home range size in protected areas: 23-33 km^2 (*Le Roux and Skinner 1989*) and 37-38 km^2 (*Cavallo 1993*). Bailey (*1993*) found the ranges of adult females were centered on the most prey-rich habitat (riparian vegetation), while the larger male ranges included lower quality habitat. In mountainous terrain interspersed with farms and ranches, Norton and Lawson (*1985*) found leopard home ranges of 338-487 km^2 (for a male and female, respectively), suggesting both severely reduced prey availability and low leopard density. On a Kenyan cattle ranch which maintained wild ungulates, Mizutani (*1993*) found female leopard home ranges to average 18 km2 (n=4) and males 55 km^2 (n=4).

Materials and Methods

Capture and Sedation

We did two trapping periods, one in July-September, 2001, and another in August-September, 2002. Leopards were captured with a steel box trap baited with game animal carcasses given by Professional Hunters. The trapping technique consisted in putting first a bait on a tree branch in a place that leopard tracks were observed or were suitable habitat (specially with water) was found. After the leopard started to eat on the bait, we put the bait inside the trap and this was set on top of a wooden platform (to keep other carnivores i.e. hyenas to enter the trap) besides the tree. A branch was tied from the tree to the wooden platform to help made a way for the leopard to get into the trap's door. The trap floor was covered with grass. The trap was checked every morning before 9:00 am and if a leopard was captured we proceeded to sedate it with the use of a pole syringe. The drug we used was a mixture of ketamine hydrochloride (9 mg/kg) and xylacine (0.9 mg/kg).

Measurements and Handling

After the leopards were completely sedated we took them out of the trap and proceeded to attach a GPS (Global Positional System) radio-collar to the neck of the animal. Then body

measurements as total, body, tail, hind foot, paw, and ear notch length were taken. Also we took weight measurements and also blood, parasite and hair samples of the captured leopards. After all the measurements and samples were taken, leopards were put on an area with enough shade for safely recovery from tranquilization and we kept checking them until they left the area safely. If free water (i.e., water holes, rivers, etc.) was close by, we put the sedated leopard back into the trap for recovery, so there will not be any danger for the leopard to get drowned, and after it was completely recovered we opened the trap's door with a rope to freed the leopard.

Radio-telemetry

Radio-collared leopards were tracked periodically with the VHF signals that the GPS collars also produce. The tracking was made from fixed stations previously established with a hand held GPS. A position was made by triangulation using a portable radio-telemetry equipment (radio-receiver, yagui antenna, and a hand held compass). A bearing was obtained when the compass pointed to the strongest signal and then this procedure were repeated until we got enough difference between the angle of the bearings (> 30° < 150°). Our goal were to obtain more than 30 independent locations per each animal. The GPS collars were progarmed from the factory (Televilt) to take a position every two hours. To recuperate these GPS collars from the leopards, a system was programmed in advance so the collars detached automatically from the leopards. Then each of the GPS collars recuperated was sent back to Televilt in Sweden to get the data locations. All the data obtained either by radio-telemetry and from the GPS sensors were analyzed with the assist of computer radio-telemetry programs like Locate II and CALHOME.

RESULTS

Capture and Handling

During the field study length we captured at Piti East Area eleven adult leopards (6M: 5F), 4 sub-adult female, one male, and one cub of unknown sex, with a total capture of 17 (Table1) The trap was set this way for 20 times. This technique probed to be very effective since we set the trap for this amount of time and we succeeded on capture a leopard seventeen times. Time for a leopard to get captured ran from 1 to 3 days after the trap was set. If we didn't capture a leopard for more than three days in a row, the trap was moved to another location. No other animals besides leopards were captured with this technique.

All the adult leopards were sedated safely and fitted with GPS radio-collars, also three immature females and the male were fitted with them. Plus we took measurements, blood, hair samples, and when available parasites. For the other sub-adult female leopard we got just blood, hair and parasite samples, since the collar was, at the time, too big for her. And leopard number seven even though it was an adult female, her size was very small, so we fitted it with a VHF radio-collar instead. All leopards were released on the same spot of capture when the effects of tranquilization weren't apparent. This time period ran from 3 to 6 hrs. The cub, that I calculated about 2 months old, was just released when found.

Table 1. Leopard captures at Piti East Area from Jul- Sep. 2001 and Aug-Sep 2002

ID/Age	Sex	Weight (lbs)	Date of Capture	Place of Capture	UTM
1	Female	65	07/24/01	Mlima Mbili	533373-9206545
2	Female	75	07/27/01	Mpaka River	505378-9209330
3	Male	85	07/28/01	Mdabulu	519983-9218353
4	Female	60	08/01/01	Mlima Mbili	531211-9204490
5	Male	120	08/02/01	Mpaka River	511009-9206286
Cub	Unknown	Unknown	08/05/01	Mpaka River	512658-9205412
6a Sub-adult	Female	43	08/19/01	Mbuga Mgeleka	518267-9207212
6	Male	85	09/08/01	Rungwa River	523132-9231132
7*	Female	60	09/12/01	Mpaka River	512658-9205412
8	Female	65	09/27/01	Sipa River	532647-9216869
9 Sub-adult	Female	--	08/13/02	Rungwa River	520411-9231971
10 Sub-adult	Male	--	08/18/02	Piti River	501509-9211659
11 Sub-adult	Female	45	08/20/02	Mpaka River	505467-9209326
12	Male	100	08/25/02	Sipa River	533832-9214353
13	Male	90	08/27/02	Sipa River	532647-9216869
14 Sub-adult	Female	60	09/01/02	Piti River	510567-9201076
15	Male	110	09/05/02	Piti River	508489-9202979

*.- Probably the mother of the cub captured, since she was caught in the same spot.

Radio-telemetry

Even though the GPS radio collars expressed a problem on the drop-off system and therefore seven of the first radio-collars were dropped prematurely, we obtained sufficient data for home range analysis for the dry season (Table 2). However, the collar for female leopard number eight remained with her for 8 months so we were able to analize diferences between her home range during dry and wet seasons. For this female leopard eight, we obtained a home range value of 9, 600 has. during the dry season and 5, 700 has. during the wet season, with a total home range of 7,420 has. As a way of back up we also radio-tracked leopards periodically using the VHF signals that these collars also produced. All data was analyzed using computer programs Locate II and CALHOME. Mean home range (95% minimum convex polygon) for three males was 13,637 has. (rank from 8,701 to 16,470 has) and 2,154 has. for five females (rank from 742 to 3,661 has) (Table 2).

There were overlapping of home ranges between male and female and between animals of the same sex (Fig. 1), however due to our limited data we could not establish how much is the value of such overlapping and therefore the new seven collars that we set last september will probably give us enough information to calculate population dynamics for this study area. To date, with the data obtained by the GPS collars, we were also able to have an idea of how was the habitat use of the leopards in the study area (Fig. 2).

Table 2. Home range values of radio collared leopards at Piti East Area.

Leopard #	Sex	No. of Locations	H. R. km^2	Dist. Bet loc.	Collar Type	Hab. Type
1	Female	620	19.91	946.1	GPS	Mountains
2	Female	500	36.61	619.28	GPS	Ripa-Miom
3	Male	470	87.01	561.83	GPS	Miom-Mbuga
4	Female	350	17.66	1,019.45	GPS	Mountains
5	Male	403	164.70	967.57	GPS	Ripa-Miom
6	Male	207	157.40	902.0	GPS	Ripa-Miom
7	Female	38	26.08	n/a	VHF	Ripa-Miom
8	Female	1,658	7.42*	601.0	GPS	Ripa-Miom
				Mean H.R. Males.-		**136.37** km^2
				Mean H.R. Females.-		**21.54** km^2

*.- Female leopard 8 has her collar for eight months and her home range included wet and dry seasons (see text).

Fig 1. Home ranges of male and female leopards at Piti East Open Area

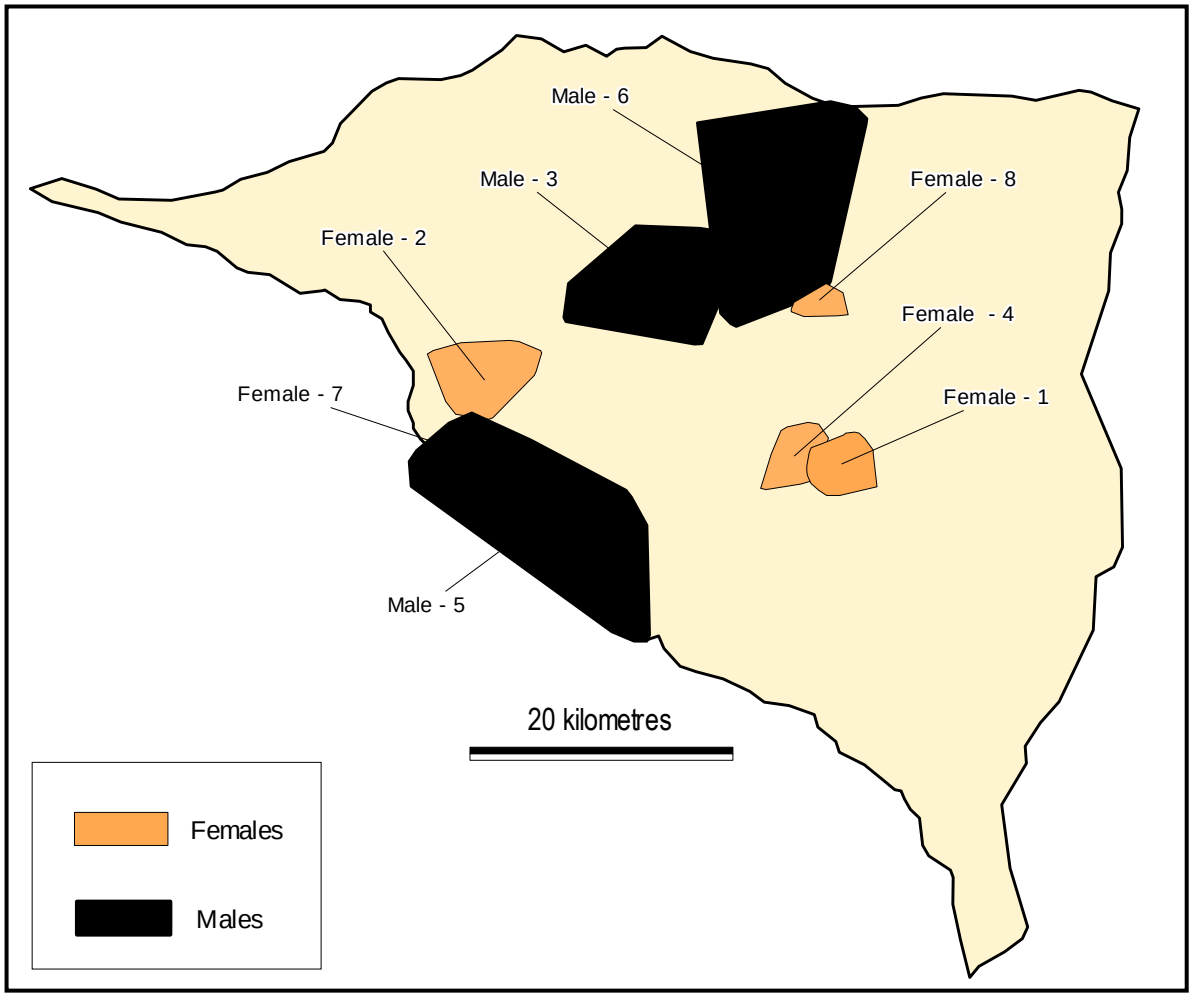
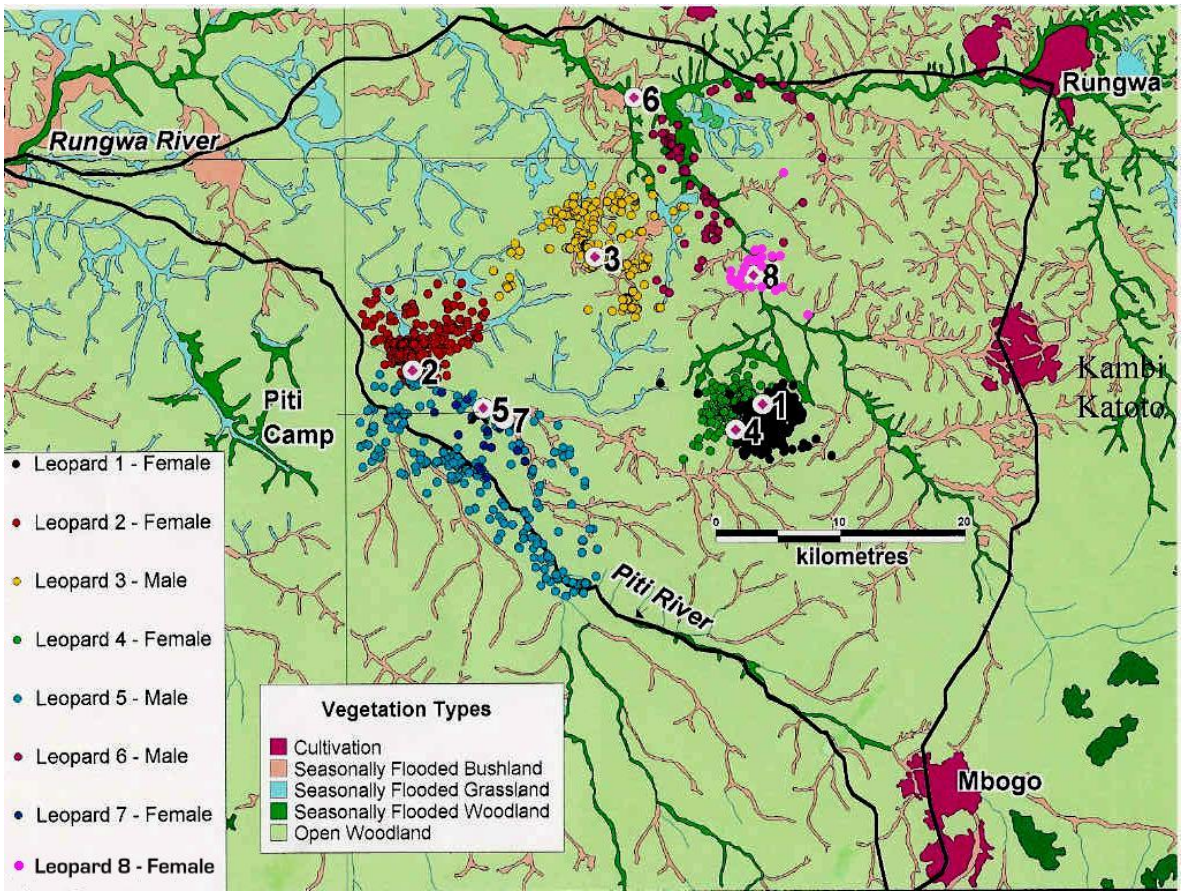


Fig 2. Habitat use of eight leopards at Piti East Open Area.



Habitat use analysis shown that leopards tended to use areas where cover was present specially close to rivers where riparian habitat was available. This is very well expressed graphically on males numbers 5 and 6 movements (Fig. 2). During the dry season, two females (1 and 4) that lived in areas with mountains expressed smaller home ranges than females (2 and 7) living in the Miombo forest (Table 2). This may be related to two factors, a higher diversity on prey species and more cover in mountain areas. The smallest home range was the one obtained for leopard 8 but this is related, as stated before, to both seasons (dry and wet) that are included in her home range. Also this female was pregnant when captured in September of 2001 and probably had her litter 2 to 3 months after her capture. This may affected her home range value, because on most carnivore species females on the first month of lactation express very small home ranges.

The explanation of why male leopards in the study area expressed such big home ranges if we compare with other areas of Africa, may be related not to a low availability of prey or over hunting but to a lack of cover due to burning of habitat during the dry months. This study was planned to be of a yearly basis so we could compare home range sizes during the dry and wet seasons, however because of the failure on the drop-off systems of the collars,

we were just be able to track these leopards during the dry season before the collars dropped. However, as stated before, leopard female 8 had her collar for eight months and teh differences between her home ranges for the dry and wet seasons were apparent and we think that is surely related to a difference on cover. This year we left 7 collars on leopards (4 M : 3 F) and we are planning to recuperate them in July 2003. With these collars' data we will be able to establish overlapping and total home range for the leopards at Piti East so it will be easyer to meassure how is the leopard population at the study area.

Samples collected

During this field work, we collected blood samples from captured leopards and tissue samples from hunted ones, and we are in the process of sending these samples to Switzerland for different studies. Also, we collected hair and ecto-parasite samples from captured leopards and from hunted individuals we also collected internal parasites. Parasite samples are going to be analyzed by the National University of Mexico.

Body Measurements

Besides the body measurements that we got from adult captured leopards we also took measurements from six male leopards that were hunted during the 2001 and 2002 seasons at Piti East and Rungwa hunting blocks. The next table (Table 3) express the results.

CONCLUSIONS

This field sessions could be considered as the first stage of a complete population study, because although we don't have enough data to conclude yet, the info that we will obtain with the new collars' data will be enough to evaluate which is the leopard population at Piti East area. To date, our results as a pilot project are very important because many new techniques were tested. This study was the first who used GPS radio-collars on wild leopards and the first that found home range values for the *Miombo* leopard. Also, Mr. Roger Hurt a B.S. Student at Newcasttle University, is analyzing activitty of the radio-collared leopards as a part of his Final research Project.

Table 3. Body Meassurements of 22 leopards of Piti East and Rungwa Areas.

Leopard ID	Sex	Total L.	Cir. Head	Paw Wide	Canine	Weight	Place
Leop1 C	Female	1.83 m	38 cm	6.8 cm	2.5 cm	65 lbs	Piti
Leop2 C	Female	1.78 m	36.5 cm	6.5 cm	2.8 cm	75 lbs	Piti
Leop3 C	Male	1.99 m	44 cm	8.0 cm	3.0 cm	90 lbs	Piti
Leop4 C	Female	1.90 m	40 cm	6.5 cm	2.4 cm	60 lbs	Piti
Leop5 C	Male	2.08 m	48 cm	7.8 cm	3.7 cm	115 lbs	Piti
Leop6 C	Male	1.95 m	43 cm	7.0 cm	3.3 cm	85 lbs	Piti
Leop6aC	Female*	1.67 m	36.5 cm	6.2 cm	2.2 cm	43 lbs	Piti
Leop7 C	Female	1.69 m	38 cm	6.0 cm	2.2 cm	55 lbs	Piti
Leop8 C	Female	1.79 m	38.5 cm	6.0 cm	2.6 cm	65 lbs	Piti
Leop9 C	Female*	1.66 m	37 cm	6.5 cm	2.8 cm	---	Piti
Leop10C	Male*	1.87 m	42 cm	7.5 cm	3.2 cm	---	Piti
Leop11C	Female*	1.62 m	33.2.5	5.5 cm	2.3 cm	45 lbs	Piti
Leop12C	Male	1.93 m	44 cm	6.8 cm	3.2 cm	100 lbs	Piti
Leop13C	Male	2.01 m	43 cm	7.2 cm	3.0 cm	90 lbs	Piti
Leop14C	Female*	1.70 m	35.4 cm	5.4 cm	2.2 cm	60 lbs	Piti
Leop15C	Male	2.16 m	45.5 cm	7.3 cm	3.2 cm	110 lbs	Piti
Leop1 H	Male	2.02 m	44 cm	7.3 cm	3.3 cm	90 lbs	Rungwa
Leop2 H	Male	2.03 m	43 cm	7.5 cm	3.2 cm	105 lbs	Rungwa
Leop3 H	Male	1.66 m **	48cm	7.4 cm	3.0 cm	95 lbs	Rungwa
Leop4 H	Male	1.94 m	47 cm	7.4 cm	3.4 cm	95 lbs	Piti
Leop5 H	Male	2.18 m	53 cm	7.6 cm	3.8 cm	135 lbs	Rungwa
Leop6 H	Male	2.06 m	52 cm	7.4 cm	3.5 cm	147 lbs	Rungwa

Mean values for adult leopards : **Male (n = 12)** **Female (n = 5)**

Total Length	**2.03 m**	**1.80 m**
Circ. of Head	**46.2 cm**	**38.2 cm**
Paw Wide	**7.4 cm**	**6.4 cm**
Canine	**3.3 cm**	**2.5 cm**
Weight	**105 lbs**	**64 lbs**

C.- Capture; H.- Hunted;

***.- Sub-adult leopards were not included in the measurement analysis**

****.- male with one quarter of the tail cut, not included in the mean for total length**

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Background of Project Leader

Arturo Caso was the Project Leader on this project. Mr. Caso obtained his bachelor degree in Animal Science from Monterrey Tec, has a M.S. in Range and Wildlife Management from Texas A&M University-Kingsville, and he is finishing his PhD in Biology at the National University of Mexico (UNAM). Since May of 1991 to date, he has conducted field studies on felids like the ocelot, jaguarundi, and jaguar in Northeast Mexico and South Texas. Also, he is representing Mexico in the US Fish and Wildlife Service's Cat Recovery Team, is a member of the IUCN Cat Specialist Group and The Border Cats

Working Group. He has been contracted to do ocelot, jaguarundi, and jaguar population studies and also consulting for U.S. conservation organizations like the Caesar Kleberg Wildlife Research Institute, the Dallas Zoo, U.S. Fish and Wildlife Service, The Nature Conservancy, and the Wildlife Habitat Council. Also, Mr. Caso has been in Africa five times, first he went as a hunter to Botswana with Safari South Company and he has traveled as an observer on two different Safaris to Tanzania with Robin Hurt Safaris LTD.

Literature Cited

Bailey, T.N. 1993. *The African leopard: a study of the ecology and behavior of a solitary felid.* Columbia Univ. Press, New York.

Bertram, B.C.R. 1982. Leopard ecology as studied by radio tracking. *Symp. Zool. Soc. Lond.* 49:341-352.

Bothma, J. du P. and Le Riche, E.A.N. 1984. Aspects of the ecology and the behaviour of the leopard *Panthera pardus* in the Kalahari Desert. *Koedoe Suppl.*:259-279.

Cavallo, J. 1993. A study of leopard behaviour and ecology in the Seronera Valley, Serengeti National Park. *Serengeti Wildlife Research Centre Scientific Report* 1990-1992: 33-43.

Child, G.S. 1965. Some notes on the mammals of Kilimanjaro. *Tanganyika Notes and Records* 64:77-89.

Estes, R.D. 1967. Predators and scavengers I. *Nat. Hist.* 76(2):20-29.

Guggisberg, C.W.A. 1975. *Wild cats of the world.* David and Charles, London.

Hamilton, P.H. 1976. *The movements of leopards in Tsavo National Park, Kenya, as determined by radio-tracking.* M.S. thesis, Univ. of Nairobi, Nairobi.

Hamilton, P.H. 1981. *The leopard* (Panthera pardus) *and the cheetah* (Acinonyx jubatus) *in Kenya: ecology, status, conservation, management.* Unpubl. report for the U.S. Fish Wildl. 137 pp.

Hamilton, P.H. 1986b. Status of the leopard in Kenya, with reference to sub-Saharan Africa. Pp 447-459 in S.D. Miller and D.D. Everett, eds. *Cats of the world: Biology, conservation and management.* National Wildlife Federation, Washington D.C.

Hemmer, H, 1976. Gestation period and postnatal development in felids. Pp 143-165 in R.L. Eaton, ed. *The world's cats* vol 3. Carnivore Research Institute, Univ. Washington, Seattle.

Jackson, P. 1989. *A review by leopard specialists of The status of leopard in sub-Saharan Africa by Martin and de Meulenaer.* Information document No. 3 submitted to the seventh meeting of the Conference of the Parties to CITES (Lausanne, 1989).

Le Roux, P.G. and Skinner, J.D. 1989. A note on the ecology of the leopard (*Panthera pardus* Linnaeus) in the Londolozi Game Reserve, South Africa. *Afr.J.Ecol.* 27:167-171.

Martin, R.B. and de Meulenaer, T. 1988. *Survey of the status of the leopard* (Panthera pardus) *in sub-Saharan Africa.* CITES Secretariat, Lausanne.

Mills, M.G.L. 1990. *Kalahari hyaenas: the comparative behavioural ecology of two species.* Unwin Hyman, London.

Mizutani, F. 1993. Home range of leopards and their impact on livestock on Kenyan ranches. In N. Dunstone and M.L. Gorman, eds. Mammals as predators. *Proc. Symp. Zool. Soc. Lond. 65.* Clarendon, Oxford.

Monod, T. 1965. Comment-Discussion Section. Pp 547-654 in Howell, F.C. and Bourlière, F. (eds.). *African Ecology and Human Evolution.* Methuen, London.

Myers, N. 1976. The leopard *Panthera pardus* in Africa. *IUCN Monograph No. 5.,* Morges, Switzerland.

Norton, P.M. and Henley, S.R. 1987. Home range and movements of male leopards in the Cedarberg Wilderness Area, Cape Province. *S. Afr. J. Wildl. Res.* 17:41-48.

Norton, P.M. and Lawson, A.B. 1985. Radio tracking of leopards and caracals in the Stellenbosch area, Cape Province. *S. Afr. J. Wildl. Res.* 15(1):17-24.

Schaller, G.B. 1972. *The Serengeti lion.* Univ. of Chicago Press, Chicago.

Skinner, J.D. and Smithers, R.H.N. 1990. *The mammals of the southern African subregion,* 2d edn. Univ. of Pretoria Press, Pretoria.

Stuart, C.T. and Stuart, T. 1989. *Leopard in the lower Orange River basin -- a survey of their conservation status.* Unpubl. report, African Carnivore Survey, Nieuwoudtville, South Africa.

Project Photos