CEDARBERG LEOPARD MONITORING PROJECT: Report JUNE 1991

C.T. & M.D. Stuart
African Carnivore Survey
P.O.Box 96
Nieuwoudtville 8180

Cedarberg Leopard Monitoring Project

Brief: To develop a baseline measure of the abundance of leopard (*Panthera pardus*) in the Cedarberg Wilderness Area and to establish methods whereby continuous monitoring of this population can be undertaken.

This project was undertaken by the African Carnivore Survey at the request of the Western Province Branch of the Wildlife Society of Southern Africa. The project was funded by the Society.

INTRODUCTION

At the request of the Western Province Branch of the Wildlife Society of Southern Africa we undertook to determine, as accurately as possible, the number of leopards occurring within the Cedarberg Wilderness Area and sanctuary. Counting the number of individuals in any leopard population is extremely difficult and this is especially so in mountainous terrain. The usual method applied is radio-collaring but this is both time-consuming and very expensive and not suited to continuous and regular monitoring. This method has already been applied in the area with limited results. (Norton & Henley 1987).

We therefore had to investigate the use of methods that would be cost-effective, simple to apply and suited repeated use.

METHODS

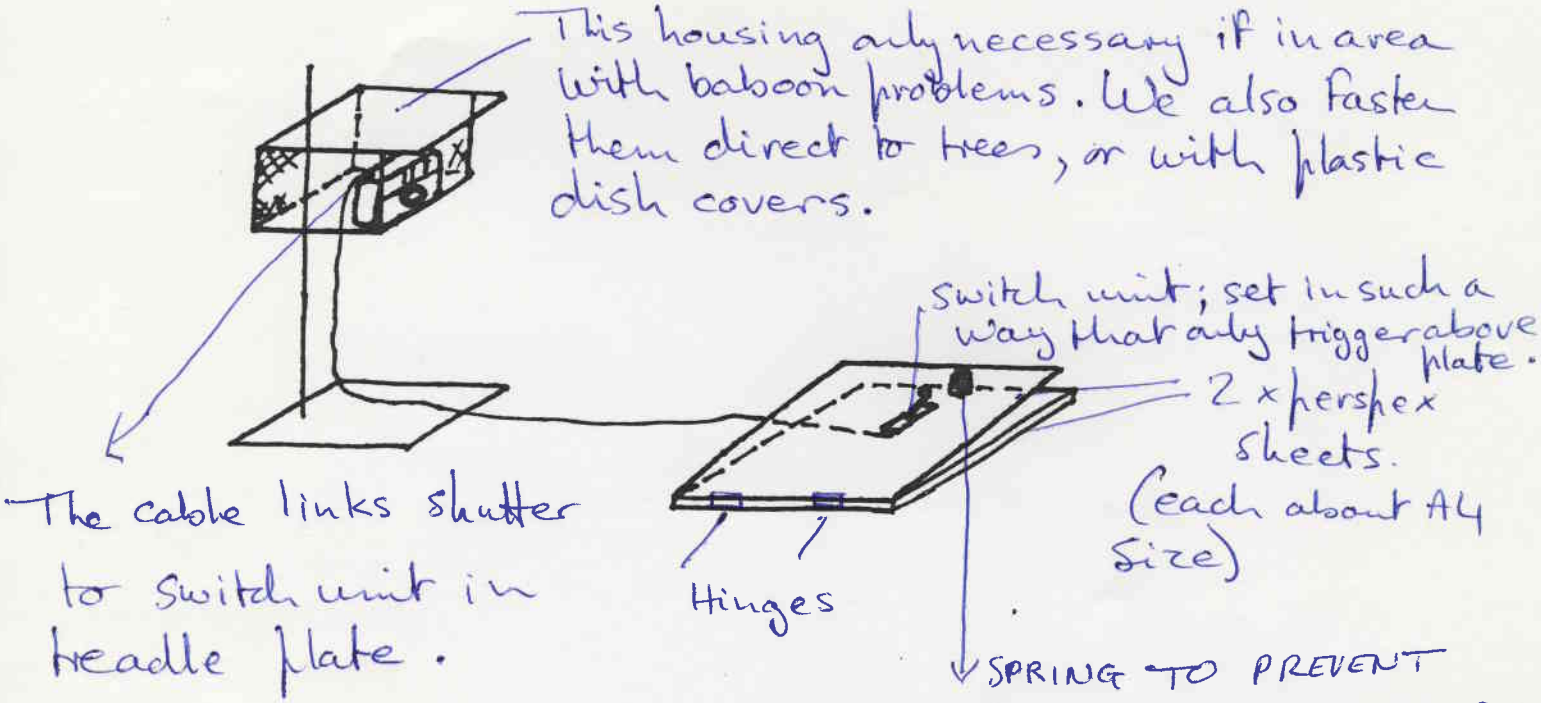
The following methods were investigated, automatic camera sets, drawing/photographing of pugmarks for "finger-printing", sweeps covering all trails during a given period, placing of baits impregnated with coloured glass beads. The latter method was rejected because of the difficulty in obtaining sufficient baits and the very low number of scats encountered in preliminary surveys.

Automatic camera sets:

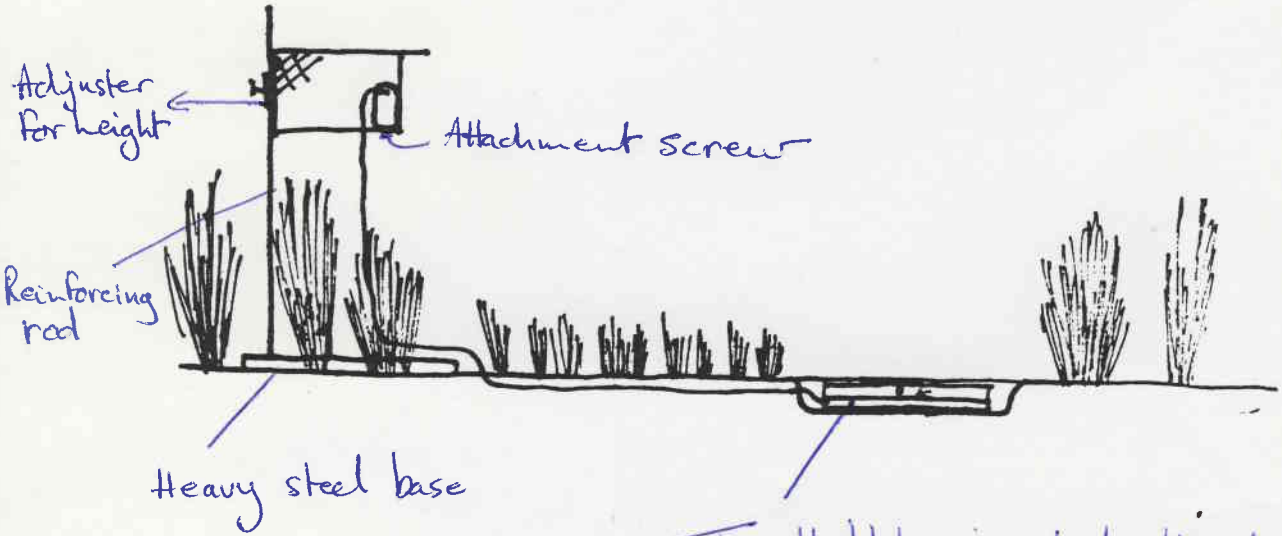
Five complete units were prepared, each consisting of 1 Minolta AF waterproof camera with automatic setting, motordrive and built-in flash; adjustable camera housing on metal stand, hinged wooden treadle-plate with switch-unit and connecting cable. Each camera was modified by attaching a cable-release, which was in turn linked to the switch embedded in the lower board of the treadle-plate. On site the treadle-plate was buried just below the surface of the trail and thinly covered with soil. The camera-housing was located 1 to 1.5m from the treadle-plate.
Early attempts to use infra-red units as the triggering mechanisms were abandoned as being impractical.

Identification of individual leopards from photographs of the face is possible because each animal has distinct facial spotting. In this way it is possible to establish an identification key for a population.

Automatic camera sets



As set up in the field



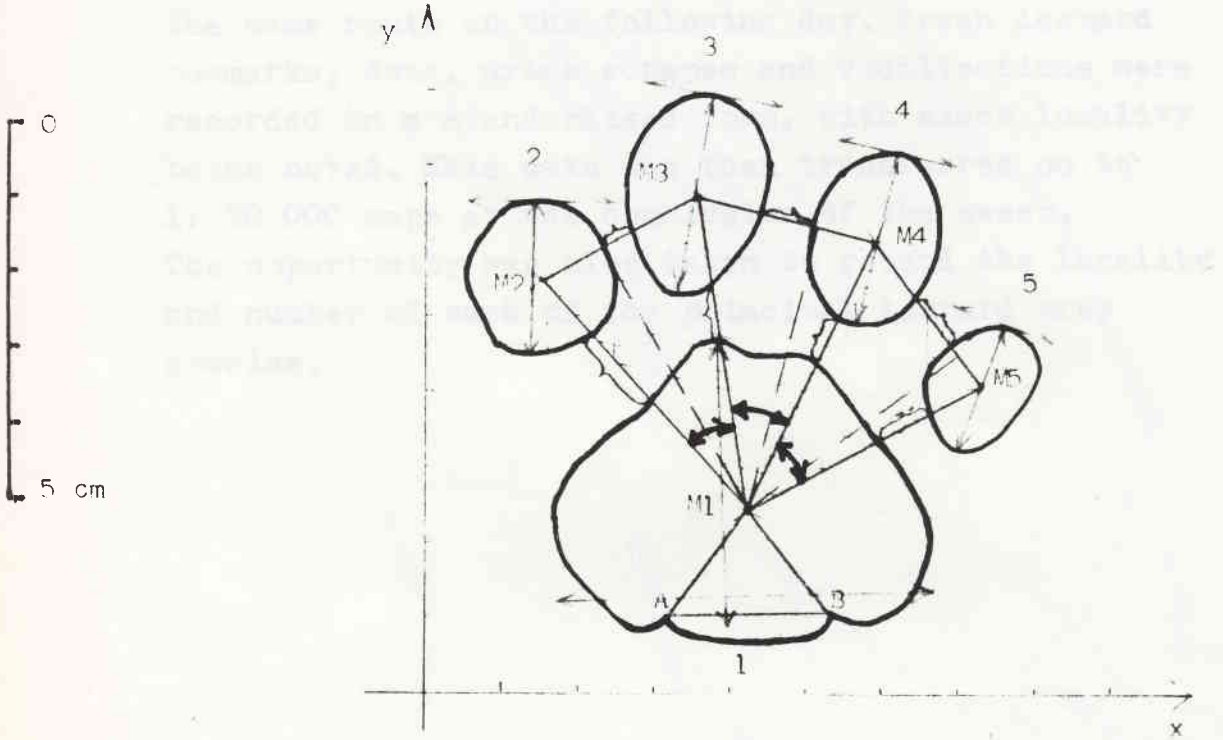
Pugmarks (Tracks):

Individual pugmarks, if fresh and clear, were directly traced onto clear perspex sheets, photo-copied and a series of 38 measurements taken.

In order to remove copying error the pugmarks were photographed with high resolution black and white film and further photographs will be taken and analysed with the use of a specially designed computer programme.

The pugmark of each individual is distinctive and can be used to compile a key for the population.

The initial process was based on the work of Choudhary (1970,1972), Sawarkar (1987) and Seidensticker (1976) amongst others. The use of photography and computer measurement is a direct development from the current survey and holds great promise for application to the Cedarberg and other areas.



——— Distances between pad centre and toe centres, and successive toe centres

{ Distances separating pad from the four toes and successive toes

——— Distances between padcentre and the indentations at the base

——— Lengths and widths of the pad and the four toes

— — — Height of the triangles formed by the pad centre and two successive toe centres

▭ Area of the pentagon joining all centres

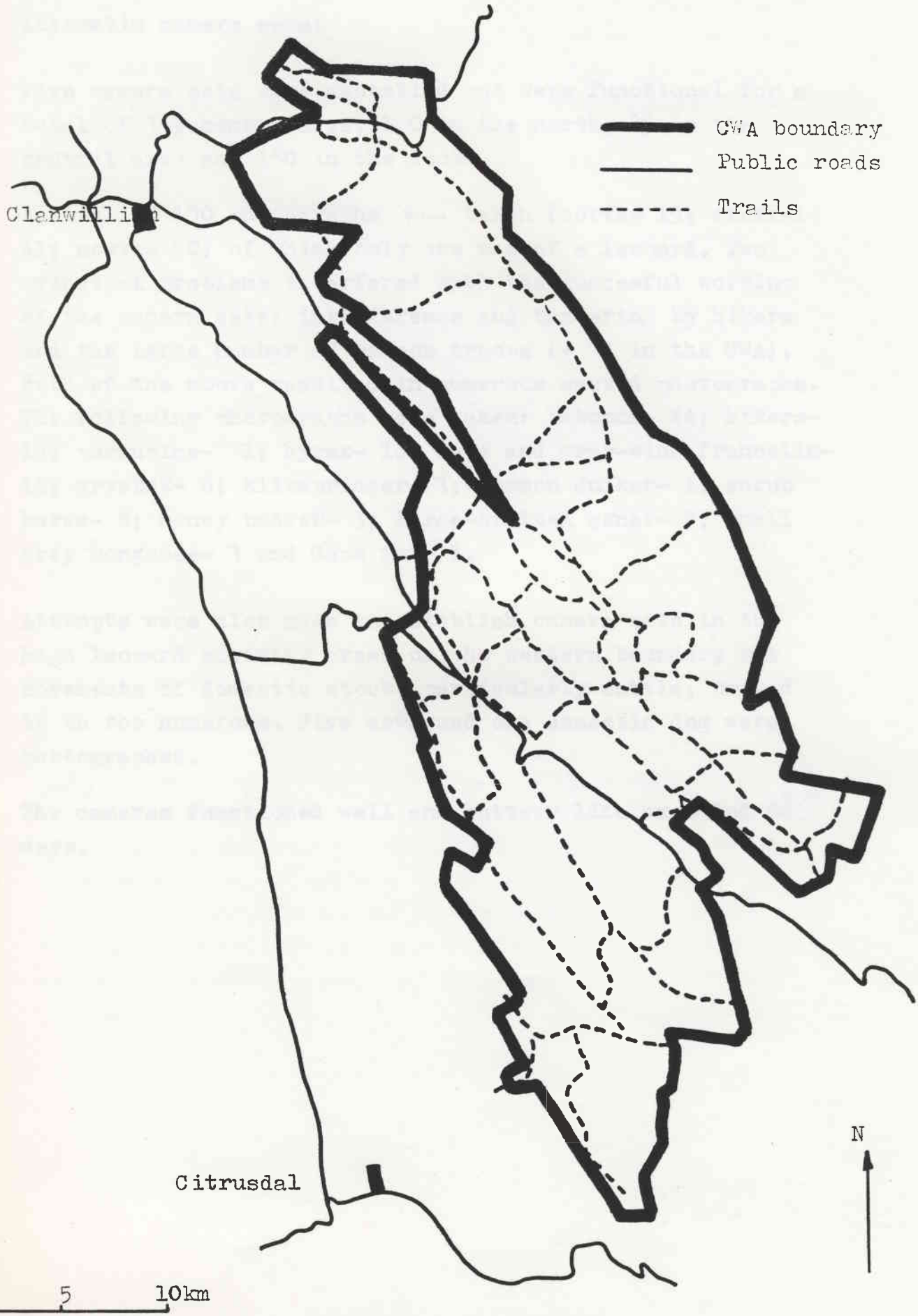
 Angles between the lines from the pad centre to the successive toe centres

Sweeps:

Sweeps involved coverage of all trails, pathways and jeep-tracks at the same time. The extensive network of man-made routes within the Wilderness affords the easiest and most rapid assessment method.

Each sweep involved 19 teams of two people per team, with the two longest trails being covered on horse-back and jeep-tracks covered by vehicle. Each team was allocated a section of trail and at the end of the first day each team established its own camp, retracing the same route on the following day. Fresh leopard pugmarks, dung, urine scrapes and vocalisations were recorded on a standardised form, with exact locality being noted. This data was then transferred on to 1: 50 000 maps at the conclusion of the sweep. The opportunity was also taken to record the locality and number of each of the principal leopard prey species.

Extent and location of the trail network within the Cedarberg Wilderness Area.



RESULTS

Automatic camera sets:

Five camera sets were assembled and were functional for a total of 359 camera days; 120 in the north, 89 in the central area and 150 in the south.

A total of 150 photographs was taken (north= 19; central= 41; south= 90) of which only one was of a leopard. Two principal problems interfered with the succesful working of the camera sets: interference and tampering by hikers and the large number of baboon troops (+ 24 in the CWA). Both of the above resulted in numerous wasted photographs. The following photographs were taken: baboons- 44; hikers- 18; porcupine- 21; hyrax- 18; Cape and grey-wing francolin- 15; grysbok- 6; klipspringer- 3; common duiker- 1; scrub hares- 6; honey badger- 3; large-spotted genet- 2; small grey mongoose- 3 and Cape fox- 1.

Attempts were also made to establish camera sets in the high leopard activity areas on the western boundary but movements of domestic stock, particularly cattle, proved to be too numerous. Five cows and one domestic dog were photographed.

The cameras functioned well and battery life exceeded 56 days.

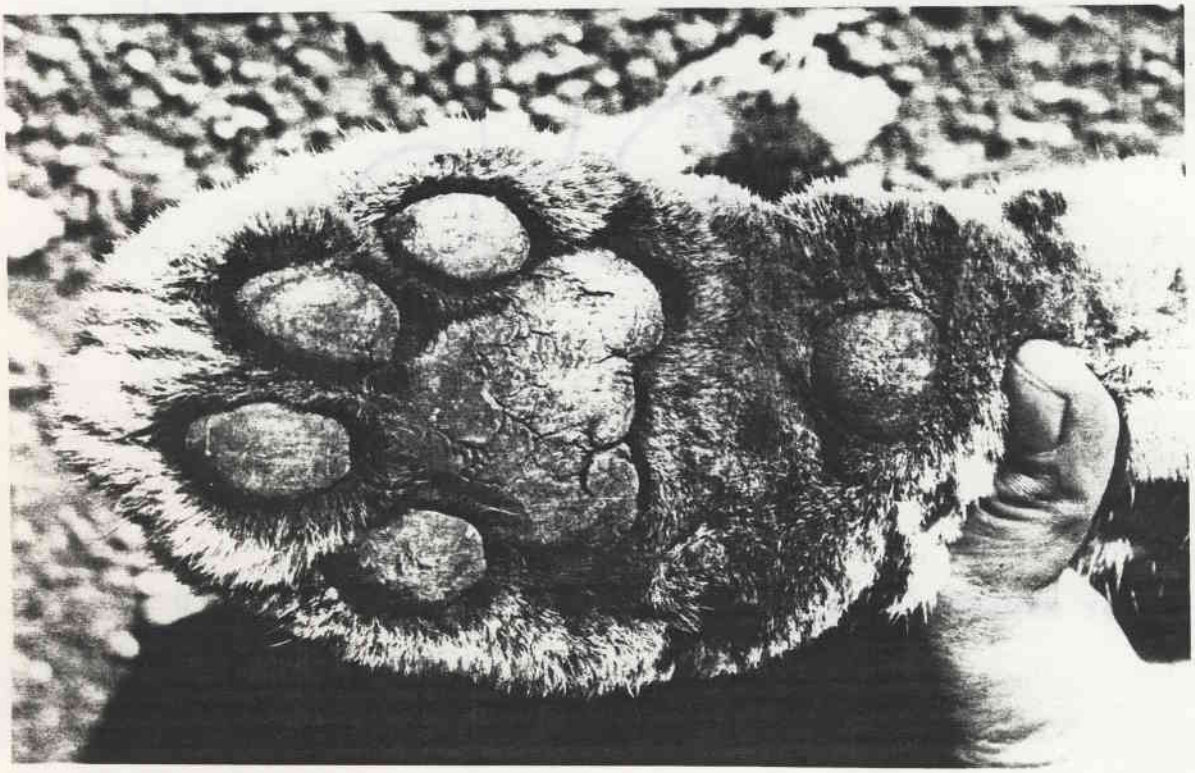
Pugmarks (tracks):

Eight pugmark tracings were made from known animals held in the Tygerberg Zoo. Two female leopard walked on dry, damp and wet sand and four sets of tracings were made by CTS and four by MDS and these were then subjected to a series of 38 measurements to establish range of variation. Only the pugmarks left by the front, left paws were used. The range of difference between the tracings of CTS and MDS had an average of 14,2%. Track size in dry sand was on average 24% greater than in wet sand.

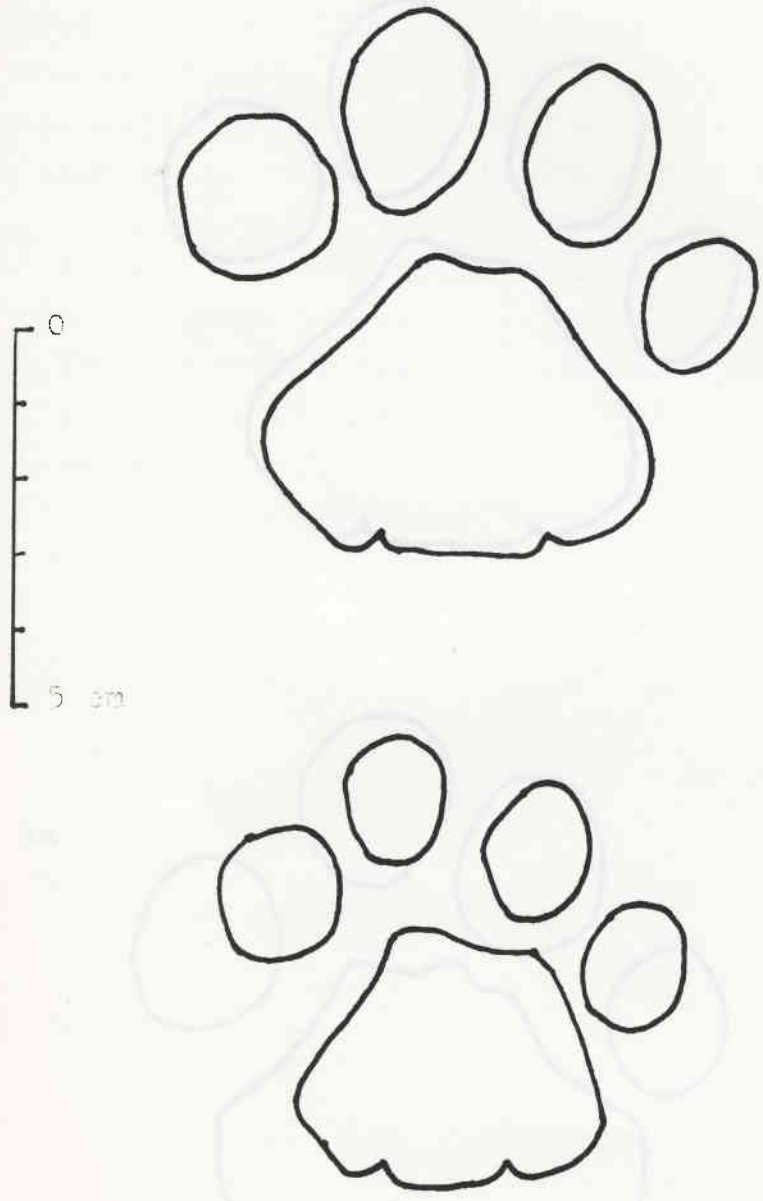
We therefore concluded that only pugmarks on damp, or firmer surfaces would give a useable result.

A total of 18 paw series were traced in the Wilderness but during the rainy season this total should be much higher. After analysis we were able to show with certainty that at least 8 individual leopards were involved but probably more. Even when tracks were located in ideal substrate the differences between the tracings of CTS and MDS were such that we feel that human error is too great. Despite extensive coaching of the 4 forest guards and the leopard officer it was felt that an alternative method had to be established.

Note We are currently reassessing this method and are currently developing a computer programme that will base analysis and individual identification on sterioscopic high resolution, black and white photographs. This is a "world first" and should have wide application for counting leopard populations in the Cedarberg and other areas. It is hoped that this will be completed by the end of September.

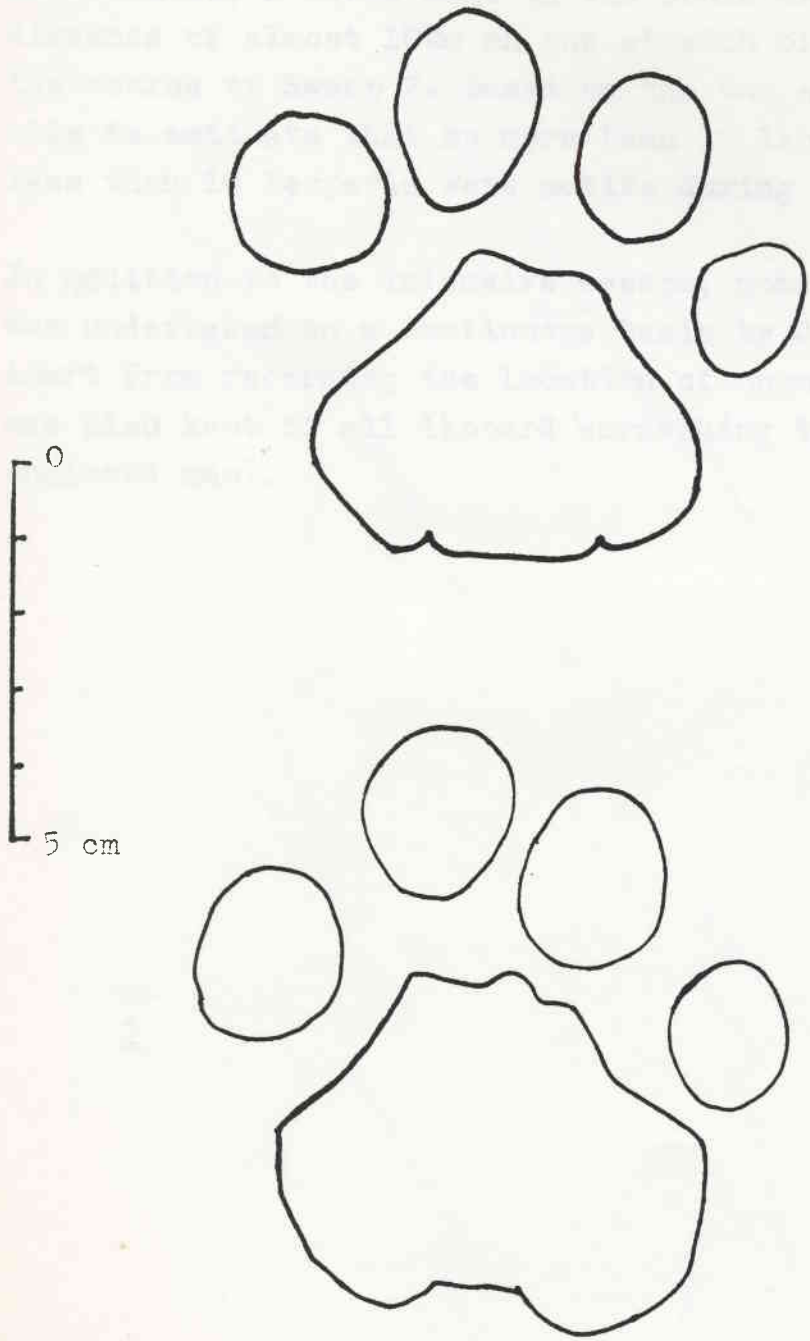


Front paw of the same leopard in soft sand (top) and damp, compacted ground (bottom)



22. 5. 91 De Rif, Cedarberg Wilderness Area. Tracks very fresh.

Left front paws of two different leopards



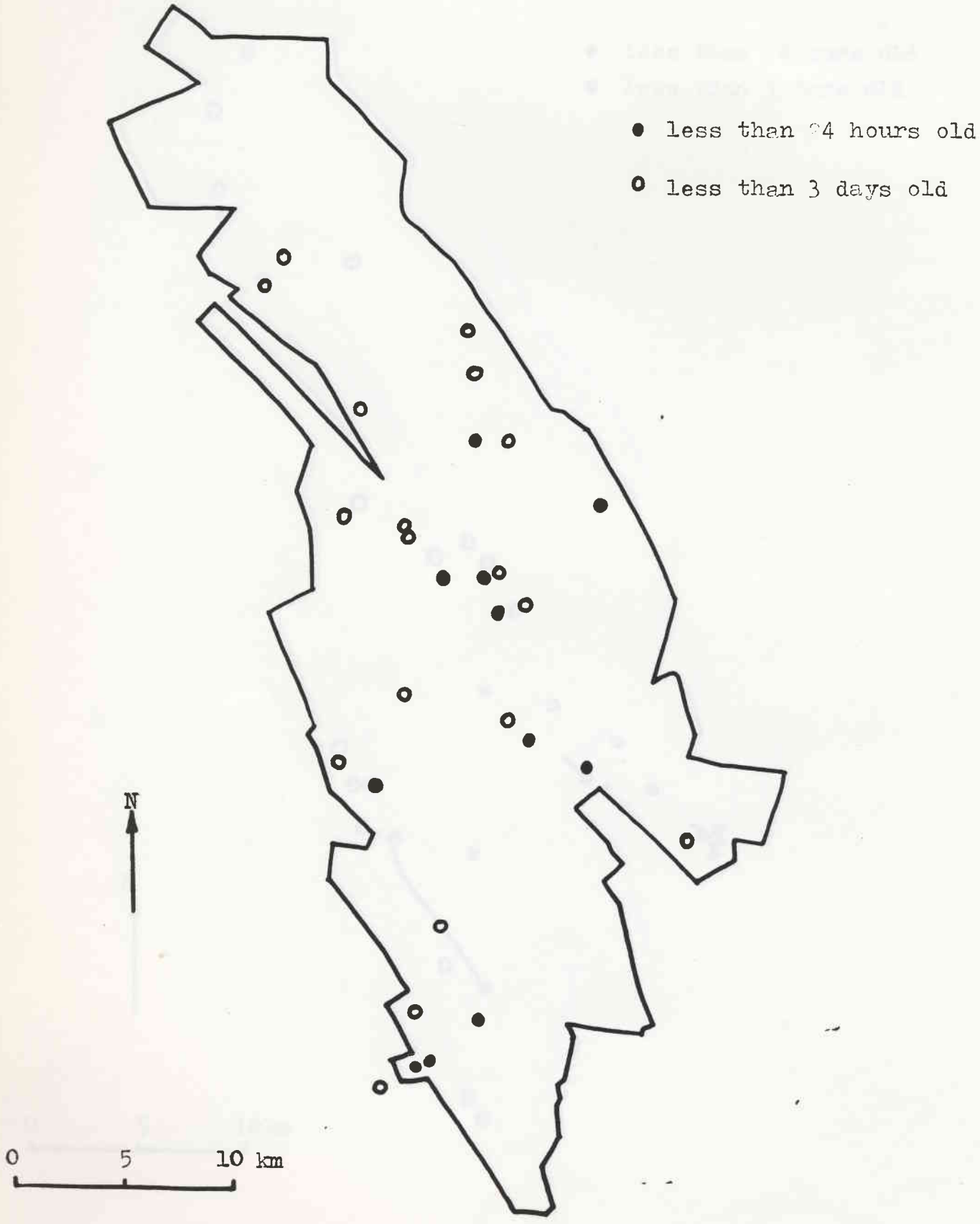
22. 5. 91 near De Rif, Cedarberg Wilderness Area.

Sweep:

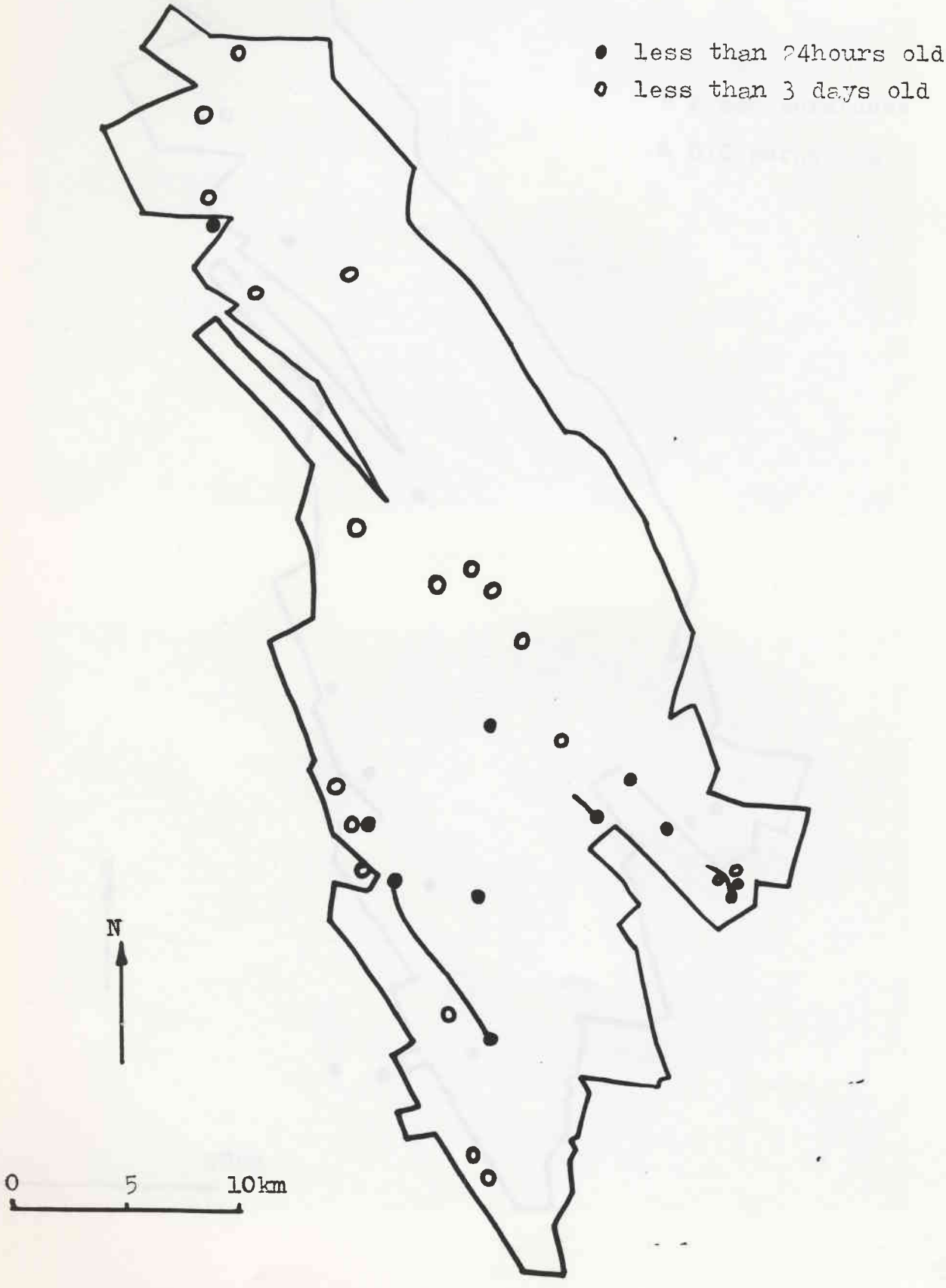
Two sweeps were undertaken, on the 9/10 April and 22/23 May. Maps of the sweeps are attached. Because of the dense network of trails and the general mobility of leopards it seemed feasible to presume that each leopard would cross or follow one trail during a given 36 hour period. For example, a large male in the south-west covered a distance of almost 10km on one stretch of trail during the course of Sweep 2. Based on the two sweeps we were able to estimate that no more than 15 leopards but no less than 10 leopards were active during this period.

In addition to the intensive sweeps, monitoring of activity was undertaken on a continuous basis by CTS and MDS. Apart from recording the location of pugmarks, a record was also kept of all leopard scratching trees (see enclosed map).

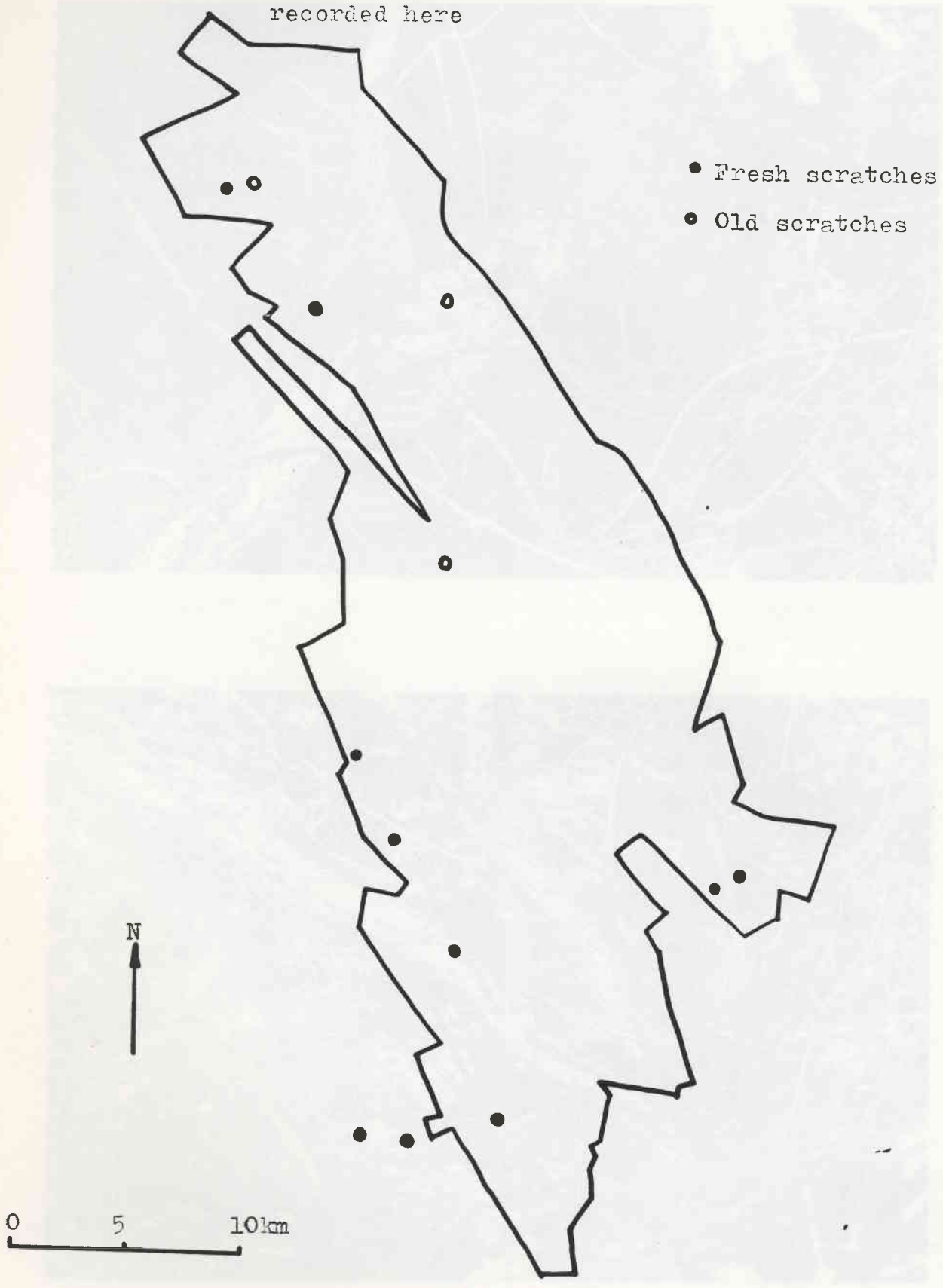
SWEEP 1. 9/10 April 1991



SWEEP 2. 22/23 May 1991



Distribution of leopard scratching trees within the Cedarberg Wilderness Area. It should be noted that many were reported for the outer sanctuary area but are not recorded here



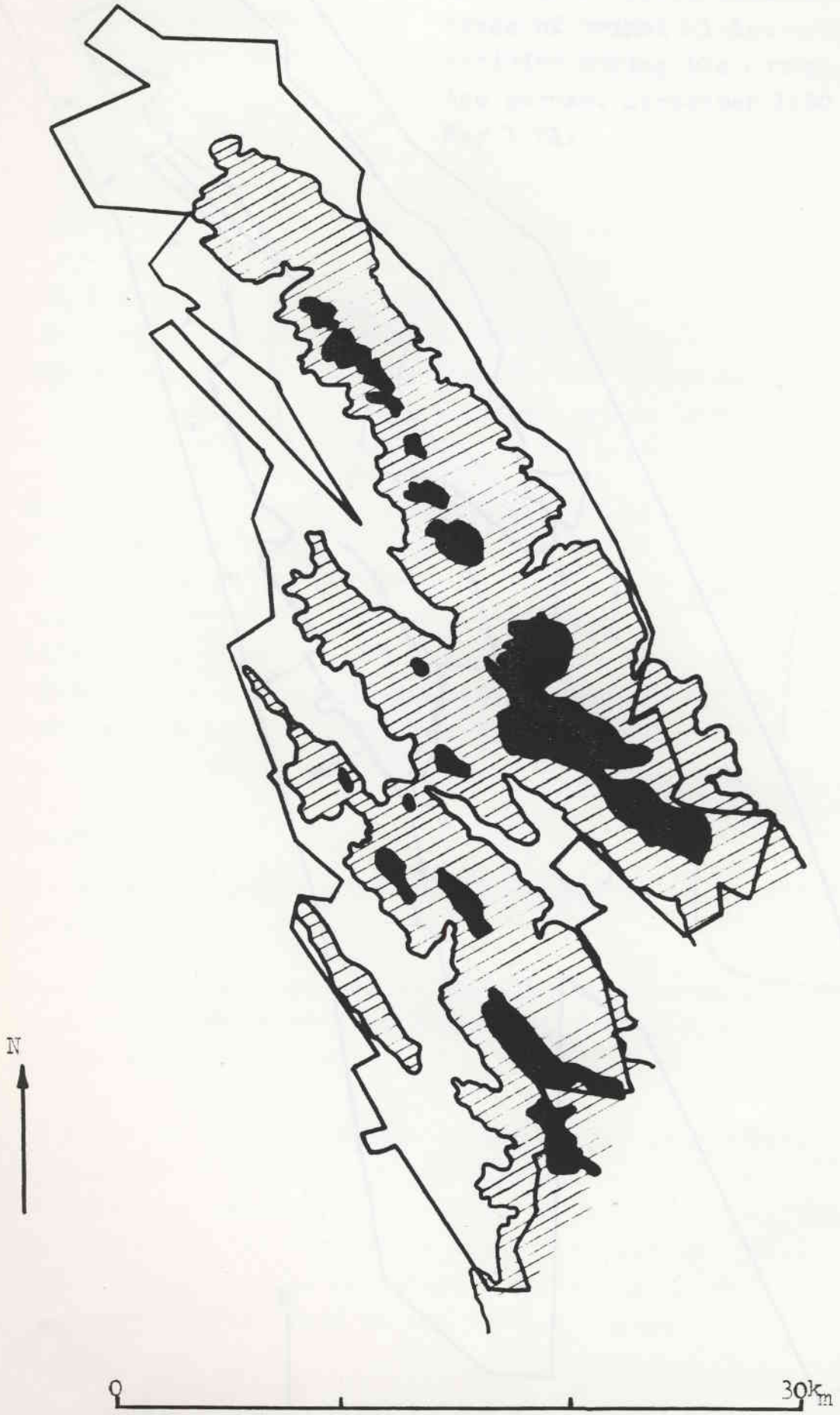
Leopard scratching trees

DISCUSSION & CONCLUSIONS

During the course of this survey it was found that leopards did not utilise the area above 1500m altitude within the Cedarberg Wilderness Area. This amounts to some 8% of the total surface area. Only 13% of the total leopard tracks encountered were located between the 1200 and 1500m contours, with 82% of all sign recorded below the 1200m contour line. In fact regular and frequent leopard activity was only recorded in 27% of the Wilderness Area. Apart from the obvious altitudinal preferences, other areas were not frequented. Between September and November 1990 two adult leopards were active in the northern sector, in the vicinity of the Pakhuis Pass. In November two adult male leopards were killed on an adjacent farm. From that time until April 1991 no leopard activity was noted.

The eastern sector of the Wilderness borders on the fairly densely settled agricultural extensions of Wuppertal and a combination of factors has resulted in extremely low potential leopard prey densities both inside and outside the conservation area. During the course of the survey leopard sign was only rarely encountered here. In the south-west, to the east of the Sneeuberg, leopard tracks were only encountered twice. Regular investigations indicated that prey densities in this area were probably the lowest in the entire Wilderness. The two attached maps show areas over 1500m and 1000m within the Wilderness and the red hatched area indicates where most leopard sign was encountered during the course of the survey period.

Areas over 1500m (black) and 1000m to 1500m within the Cedarberg Wilderness Area



It has become obvious to us that probably less than 40% of the Cedarberg Wilderness Area is being used on a regular basis by leopards, other areas not being used at all, or only marginally. It would therefore seem that extrapolating leopard population size from established home range areas could lead to an over-estimation of numbers.

What complicates this issue further is that during the course of the survey most leopards active in the Wilderness were also moving on farmland, particularly in the north, west and south. Contrary to general thinking potential leopard prey species are still widespread and fairly abundant on adjacent farmland. In addition there is an extension of the leopard population into the southern catchment block within the sanctuary and extending to the east outside the sanctuary. According to local farmers leopard have only extended into the latter area within the past three years.

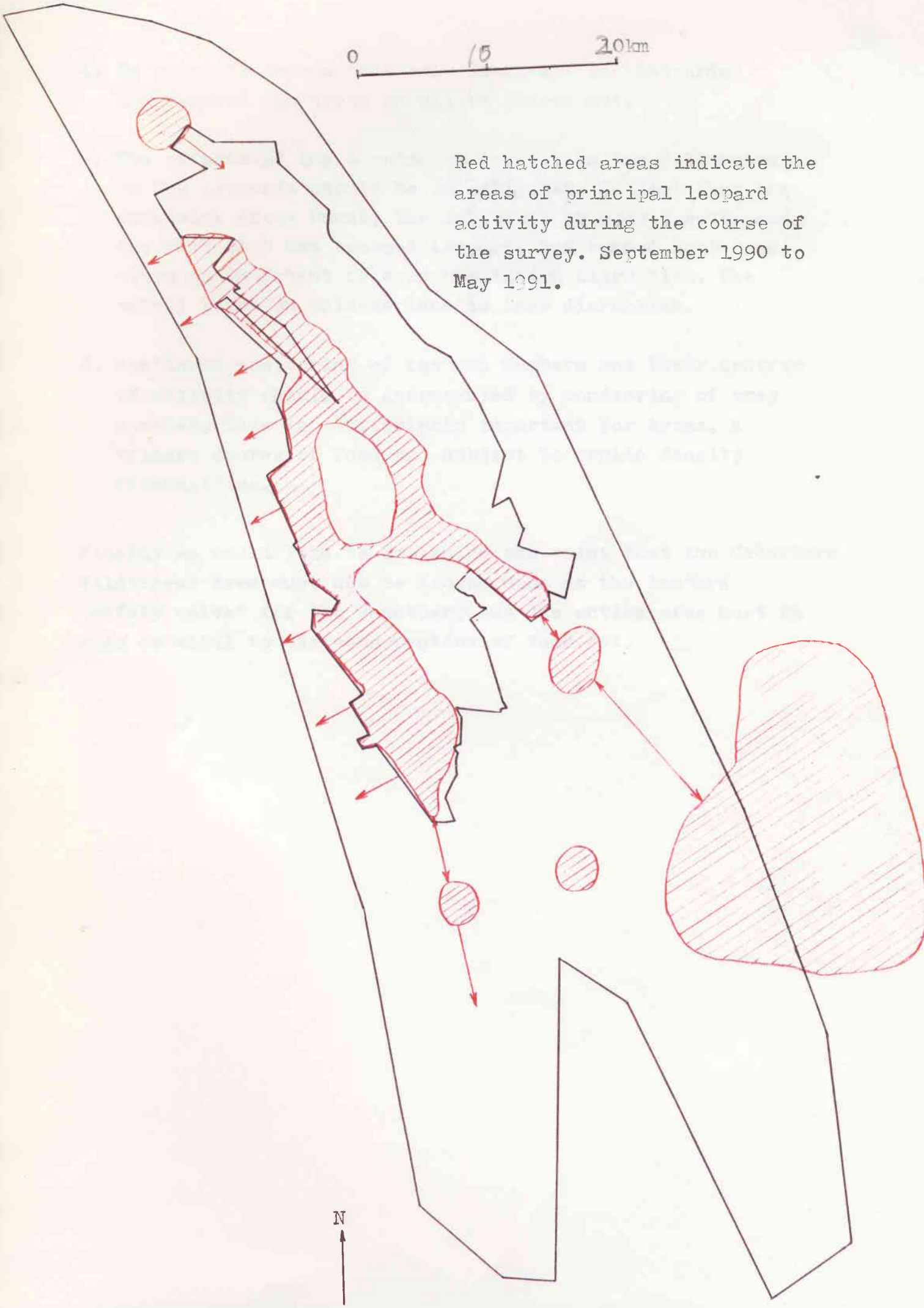
A possible indication of a decline in leopard numbers within the sanctuary is the decline in the number of leopards killed: 1988 = 10; 1989 = 6 and in 1990 = 5. The most worrying factor is that 6 of these animals were adult females, and at least one of these was pregnant. In addition five of the 21 leopards killed over the three year period were accidentally trapped in mechanisms set for caracal and baboon.

To summarise:

1. The area utilised within the Wilderness is smaller than expected.

2. Leopards"share" home ranges with the Wilderness and private land and do not just make occasional forays from the former into the latter.

3. We estimate that during the period of the study there were 12 to 15 leopards in and overlapping with the Wilderness, with a possible total of 30 to 40 adult leopard occurring throughout the Wilderness and sanctuary with linking animals extending towards the Groot Winterhoek. NOTE: This is not a final figure.



Red hatched areas indicate the areas of principal leopard activity during the course of the survey. September 1990 to May 1991.

4. In order to ensure that only stock-killing leopards are removed gin traps should be phased out.

5. The effects of the burning policy within the Wilderness on the leopards should be investigated. We feel that the extensive areas burnt, the influence on prey species and the fact that two trapped leopards had burned foot-pads plays an important role in population disruption. The patchy burns on private land is less disruptive.

6. Continued monitoring of leopard numbers and their centres of activity should be accompanied by monitoring of prey species. This is particularly important for hyrax, a primary source of food and subject to cyclic density fluctuations.

Finally we would like to emphasize the point that the Cedarberg Wilderness Area must not be looked upon as the leopard "safety valve" for the sanctuary but the entire area must be seen as vital to the conservation of this cat.

References:

Note: A comprehensive reference list will appear with the final report and resulting scientific papers.

CEDERBERG LEOPARD MONITORING PROJECT

Final Report on Pugmark - Analysis

African Carnivore Survey

In our report of June 1991 the principles of the leopard pugmark - analysis were outlined. At that stage the measurements of the known-animals series at Tygerberg Zoo were arrived at through geometrical and manual methods, which needless to say were extremely time consuming and therefore unsuitable for a bigger sample.

The series of 18 paws traced in the Wilderness Area up to June 1991 was only subjected to a gross optical examination mainly concentrating on obvious form and size differences. This comparative study showed clearly that at least 8 different individual leopards could be identified.

As noted in the June - Report there definitely was a necessity to look into more objective ways to picture, measure and compare individual leopard tracks. The first step was to computerize the collected data and this was achieved using a digitizer. A programm was than worked out to determine the 38 measurements for each paw. (See the illustration in the June - Report.) Due to difficulties in finding a standard method it was decided to leave out some of the measurements, reducing the total number of values per paw to 30. These values were then subjected to statistical analysis, comparing each paw with every one of the total series. Several different methods of comparison were used:

- Correlation
- Chi - square test
- Standard deviation
- Scaling
- Cluster analysis.

The Tygerberg paw series - tracks of known animals under controlled conditions - was to function as the basis of our work. With the measurements from this series we hoped to prove that the variation in the measurements of two different individuals was so significant to enable us to draw conclusions towards the number of individuals involved in a series of tracks drawn in the wild.

At the same time the measurements of one paw drawn by two people or two tracks of the same paw of the same animal should not differ significantly. Only then could this method be applied to identify individual leopards.

Results:

Correlation is expressed as a value, with 1 beeing the best fit, i.e. showing the correlation of identical measurements. The more the correlation value differs from 1 the bigger is the difference between the two compared paws.

Tygerberg - series: The left paw was drawn in all cases.

Ground	Animal	Drawer	Correlation
dry	♀ 1	CTS TDS	2.9
dry wet	♀ 1	CTS	2.5
wet	♀1 ♀2	CTS	2.9

Cederberg - series: Near De Rif we followed the track of one animal over several metres and TDS traced the left front paw of this animal on two different places with similar ground conditions: the correlation was 3.1. Two tracks of animals that could not have been the same leopard if one regards time and locality had a correlation of 2.8.
In both series together the correlation ranges between 2.0 and 5.3 with 73% of the total of 326 values falling between 2.5 and 3.5. The best correlation of 2.0 was found between track No. 18 and No. 15; No. 18 being from female 1 in Tygerberg Zoo and No. 15 drawn in the vicinity of Shadowpeak in the Cedarberg Wilderness on the 11th of March 1991.

These results show 1) The measurements vary too much depending on ground conditions and the person drawing the track.
2) The measurements between two different individuals do not vary sufficiently to show a clear difference.

Chi - square test:

Calculations for a chi-square test were done on the measurements of the paws of the two leopard females in Tygerberg Zoo, and the probability p was determined according to the relevant table. Two paws were compared at a time, a p-value greater than 0.5 showed the difference to be insignificant speaking for the two tracks coming from the same animal. A p-value smaller than 0.5 showed the differences to be significant, pointing to the fact that the two tracks were made by two different animals.

The chi-square values for all area - measurements were extremely high, so unduly influencing the grand total. Thus it was decided to exclude those six measurements from the calculation. Also excluded were the two values with the biggest and smallest difference respectively.

The following table showes the results.

Ground	Animal	Drawer	chi-square	p (21 df)
dry	1	CTS TDS	4.17	>0.9
wet	2	CTS TDS	5.64	>0.9
dry wet	1	TDS	16.65	0.5 - 0.9
dry wet	1	CTS	9.692	>0.9
wet	1 2	CTS	53.58	<0.001
wet	1 2	TDS	36,04	0.01-0.05

A very significant difference was found between the tracks of female 1 and female 2 ($p<0.001$ / $0.01<p<0.05$) but no significant difference was shown when the same track was drawn by two people ($p>0.9$ in both cases) and when the same animal stepped onto different soil types ($p>0.9$/ $0.5<p<0.9$). These results confirmed the expectations, with one major problem remaining: the series can be regarded as being statistically to small.

In a second study with known animals (21 tracks of seven leopards) 12 pairs were compared with a chi-square test. Only in five cases did the results confirm the expectations. This leads to the conclusion that the chi-square test is not suitable to differentiate individuals from their tracks alone.

As further trials of comparison the following calculations were applied: Standard deviation (SD), scale, and (1-scale)x$(SD)^2$, but no useful results were obtained.
Lastly the measurements were also subjected to a cluster analysis but this did not show any conclusive pattern.

We came to the conclusion, that an analysis of leopard tracks with the above outlined methods is not suitable to identify individual animals and can therefore not be recommended as a tool to help assess and monitor leopard populations.
A subjective optical assessement and interpretation of obvious characteristics or markers, i.e. signs of old injuries, strong indentations,etc., might be more suitable to identify certain animals.

We would like to thank Prof. Dr. H. Rüther at the Dep. of Surveying at UCT for his time, enthusiasme and - still ongoing - work on this project. Our thanks go also to John Spence, his staff and the leopards at Tygerberg Zoo for their cooperation, as well as to Viv Wilson, Chipangali Wildlife Orphanage , Zimbabwe.

Report sent with letter on 20/4/92.

Do not recommend tracks or automatic cameras at this stage.

Only sweep:- regular basis - at least 3 to 4 times per annum. & every year. At min. a summer & winter sweep.

To monitor seasonal & annual trends, both in density & areas of utilisation. Also NB- monitor pop. trends of principal prey species.

To look in some detail at influences of extensive burns on leopard & principal prey species.