RHINOWATCH SURVEY REPORT

SINAMATELLA INTENSIVE PROTECTION ZONE
JULY - OCTOBER 1994

A SYSTEMATIC GROUND SURVEY OF BLACK RHINO

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BLACK RHINOS by Justin Tew
Oil Painting, 1995

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1 INTRODUCTION

1.1 THE PROJECT BACKGROUND

The world black rhino (*Diceros bicornis*) population is facing a severe crisis. It has declined dramatically over the last twenty five years. In 1970, an estimated 65,000 animals cut a huge swathe across the African continent, extending from Senegal in the far west to Somalia in the east and covering large areas of East Africa, all the way into Angola, Botswana, Namibia, Zambia, Mozambique, Zimbabwe and South Africa. However, by 1987 this population had been decimated to less than 4,000 (Cumming *et al.*, 1990), and the latest estimates suggest that the world population of this magnificent animal may be less than 2500 (Redmond, 1993). The black rhino has been lost from much of its original range, and in 1993 only three countries were thought to have growing populations - Namibia, South Africa and Kenya.

The cause of this catastrophic decline is the illegal poaching of animals for their horn. The horn is used primarily in Asian countries as an ingredient in traditional medicines, but has also been used extensively for making ceremonial dagger handles in the Yemen. Although the black rhino is protected from legal international trade under CITES Appendix I, the black market value of the African horn to the retailer is currently as much as $10,286 a kilogramme and there is thus a strong financial incentive to illegally poach the horn (Bradley-Martin, 1993)

Several different approaches have been used in attempts to protect the remaining animals. Despite much effort, control of the illegal international trade in rhino horn has proved very difficult, partly because of the difficulty in tracing the trade routes and also because the use of rhino horn is a culturally entrenched tradition. Although recently some progress seems to have been made in this area, it is not sufficient to guarantee the future safety of the rhino. Protecting existing populations on the ground has been most successful where animals have been locally translocated to areas small enough to patrol and fence adequately (Leader-Williams, 1993). Effective protection of a low-density population in a large area is only feasible if sufficient financial resources are available or the poaching threat is small. Nevertheless, whether in game reserves, or larger areas, the effective protection of animals *in situ* is many times more cost-effective than attempts at protection through captive breeding (Leader-Williams, 1993; Alibhai & Jewell, unpubl.). Given that attempts at controlling the illegal trade in rhino horn might not succeed before the wild population has been eliminated, and that captive breeding replacement rates for the black rhino are currently running at a negative value, it is vital that urgent attention be focused on protection of this species *in situ* .

In order to implement an effective management strategy for any *in situ* population, it is essential to have accurate, current information on the abundance and distribution of that population. Any strategy implemented without such information could constitute a waste of valuable and often scarce resources. Despite the threatened status of all five of the rhino species, very little reliable census data for any of these species has been available, and many conservation policy decisions have been based on "guesstimates" (Cumming *et al*, 1990). Rhinowatch was established in 1990 with the aim of providing reliable, current census data for rhino populations to those responsible for formulating rhino conservation policies.

In 1990 Zimbabwe was thought to have more than half of the world population of black rhino (1700 animals) (Cumming *et al*, 1990) and was considered the last stronghold for this species. In particular, the Sebungwe region was thought to have the largest single contiguous black rhino population in the world. However, these estimates were based on non-specific and generally unreliable surveys, which in some cases had been carried out many years earlier. In 1992, Rhinowatch, in conjunction with the Zimbabwean Department of National Parks and Wild Life Management (DNPWLM) undertook a thorough ground census of the black rhino (Alibhai and Jewell, 1993), and other large mammals (Alibhai and Jewell, 1994a) in a part of this region - the Chirisa Safari Area and the Sengwa Wildlife Research Area. The resulting information on population density and distribution in this area was then made available to the Zimbabwean DNPWLM for the updating of the appropriate management strategies.

As a result of this survey the previous most thorough black rhino population estimate for the Chirisa Safari Area of 130 ± 74 (Towindo 1990) was revised to a dramatically reduced 15 ± 3 (Alibhai and Jewell, 1993). This decline in the Chirisa Safari Area population was echoed on many Parks and Wild Life estates, and as a result the estimated population for Zimbabwe dropped from 1700 to less than 300 animals (du Toit, pers. comm.) (Fig 1).

In 1993 the DNPWLM of Zimbabwe formulated an emergency rhino action plan (Department of National Parks, 1993) which designated four areas as intensive protection zones (IPZ) for black rhino. The emergency plan proposed that all black rhino on the Parks and Wild Life estate be translocated into the four newly created IPZ's where they would be intensively protected. The four designated IPZ's are; Matobo, which lies within the boundaries of Matobo National Park; Matusadona, which lies within Matusadona National Park; Sinamatella, which lies within Hwange National Park and Deka Safari Area; and Chipinge, which lies within the Chipinge Safari Area. The Sinamatella IPZ, in Hwange National Park, is the largest designated IPZ at approximately 1,500 km^2. In 1992 several animals were translocated into the Sinamatella IPZ from various outlying areas, including Chizarira National Park and Sikumi Forest Area to join the population already present.

In 1994 Rhinowatch, in collaboration with the DNPWLM, carried out a systematic ground survey cf Black rhino in the newly formed Sinamatella IPZ to establish a baseline figure for the population from which demographic indicators could be taken in future to monitor the success of the IPZ concept.

1.2 THE PROJECT AIMS

The primary aim of the Rhinowatch project was to determine the population density and distribution of the black rhino in the newly established Sinamatella IPZ, and to present the results to the DNPWLM of Zimbabwe, for use in monitoring the success of existing rhino conservation and management strategies. In addition to this, a similar systematic ground survey of large mammals in the Sinamatella IPZ was undertaken and the results presented in a separate report (Alibhai, Jewell and Towindo, in prep.).

The decision to census the Sinamatella population was also based on the recommendations of the Hwange National Park Plan (Jones, 1992) that such a study was required in Hwange National Park because of the very limited data available on the density and distribution of rhino in the park.

1.3 THE STUDY AREA

The Sinamatella IPZ lies within the Hwange National Park and adjacent Deka Safari Area in North Western Zimbabwe (Fig 2).

Sinamatella Intensive Protection Zone is an area of 1530 km^2 which extends from approximately 18° 23' to 18° 48' S and 26° 05' to 26° 40' E, and incorporates northern parts of Hwange National Park and western and southern parts of the Deka Safari Area (Fig 3). Altitude ranges from 840m on the Deka river to 1153m at Bumbuzi, and the area has a mean annual rainfall of 572mm, ranging from 138 to 955mm (Tafangenyasha and Campbell, 1995). The area contains several geological types including pre-cambrian rocks, karoo sediments, kalahari sands and batoka basalt. Woody vegetation types include *Combretum sp.* and *Boscia angustifolia* open scrub and thicket on Lower Karoo sandstone, *Colophospermum mopane* and *Terminalia prunioides* woodland on mudstones, *Colophospermum mopane* and *Acacia sp.* woodland adjacent to riverine vegetation, *Diospyros mespiliformis* and *Combretum mossambicense* riverine vegetation, *Colophospermum mopane* and *Commiphora marlothii* mixed woodland on scree slopes and *Combretum elaeagnoides* and *Diospyros quiloensis* thicket on the escarpments (Rogers, 1993). The IPZ is drained primarily by the Deka river on the northern and western boundary, the Lukosi centrally, and the Inyantue river on the eastern boundary. The rainy season runs approximately from October until March, and all rivers and watercourses are dry 2-3 months after the end of the rains. Water is then only available in the natural springs and man-made dams and waterpoints.

The Rhinowatch project is based at Sinamatella Camp which is centrally situated in the IPZ.

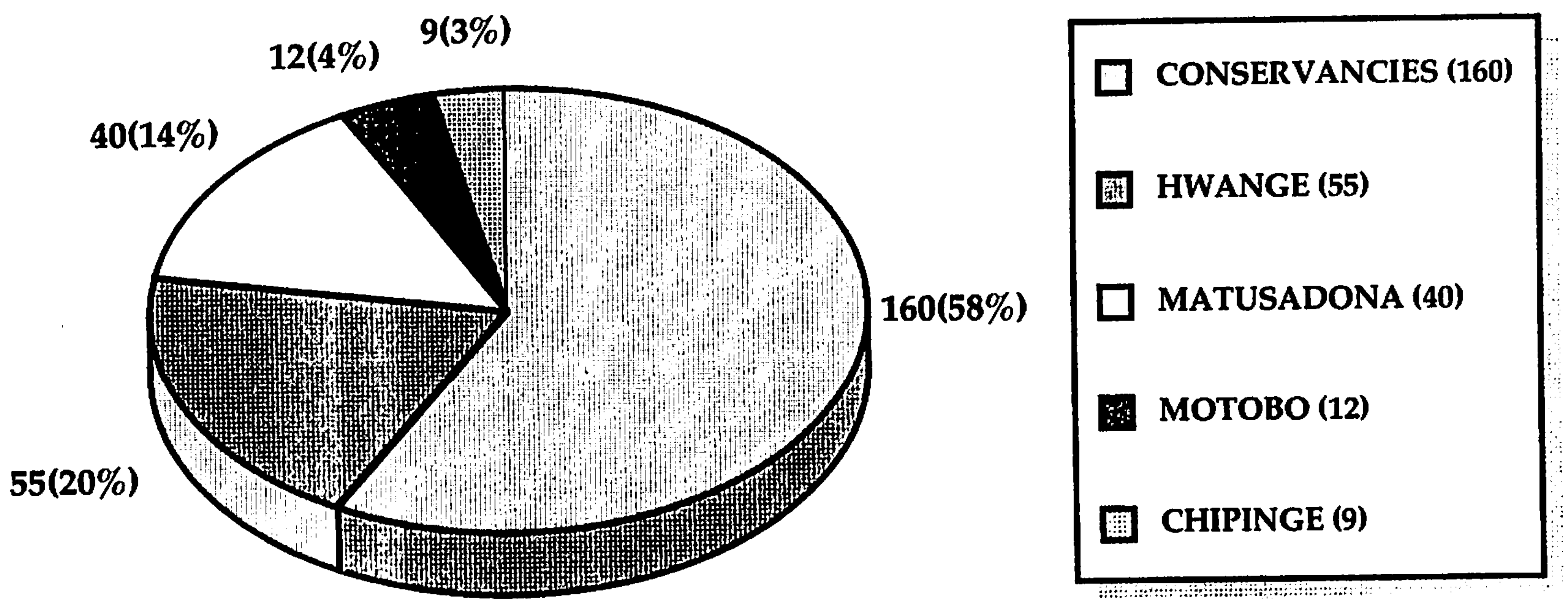


FIG. 1. 1994 ESTIMATES OF BLACK RHINO NUMBERS IN CONSERVANCIES AND STATE LAND, ZIMBABWE. TOTAL POPULATION ESTIMATE = 276

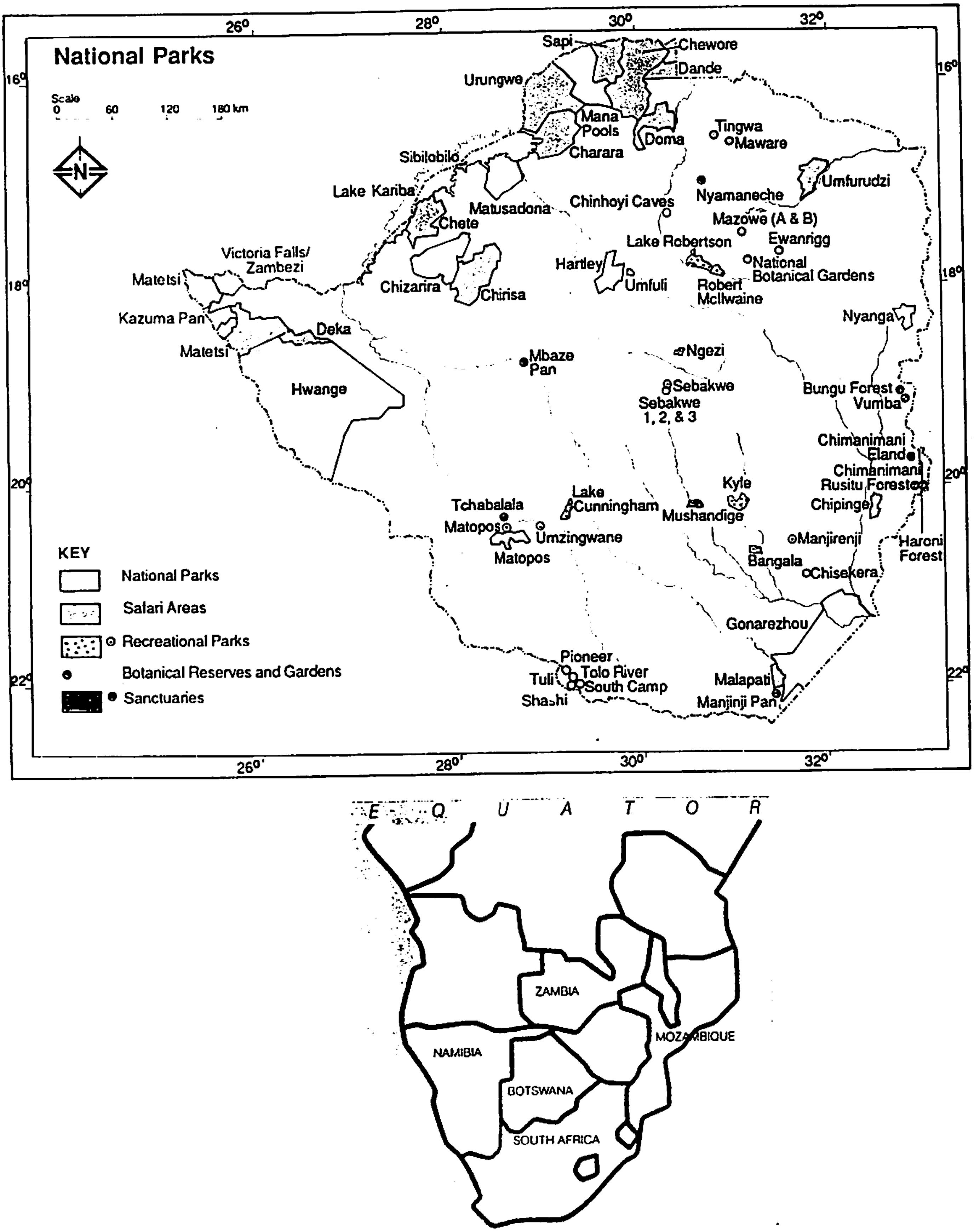


FIG.6. MAP OF ZIMBABWE SHOWING HWANGE NATIONAL PARK

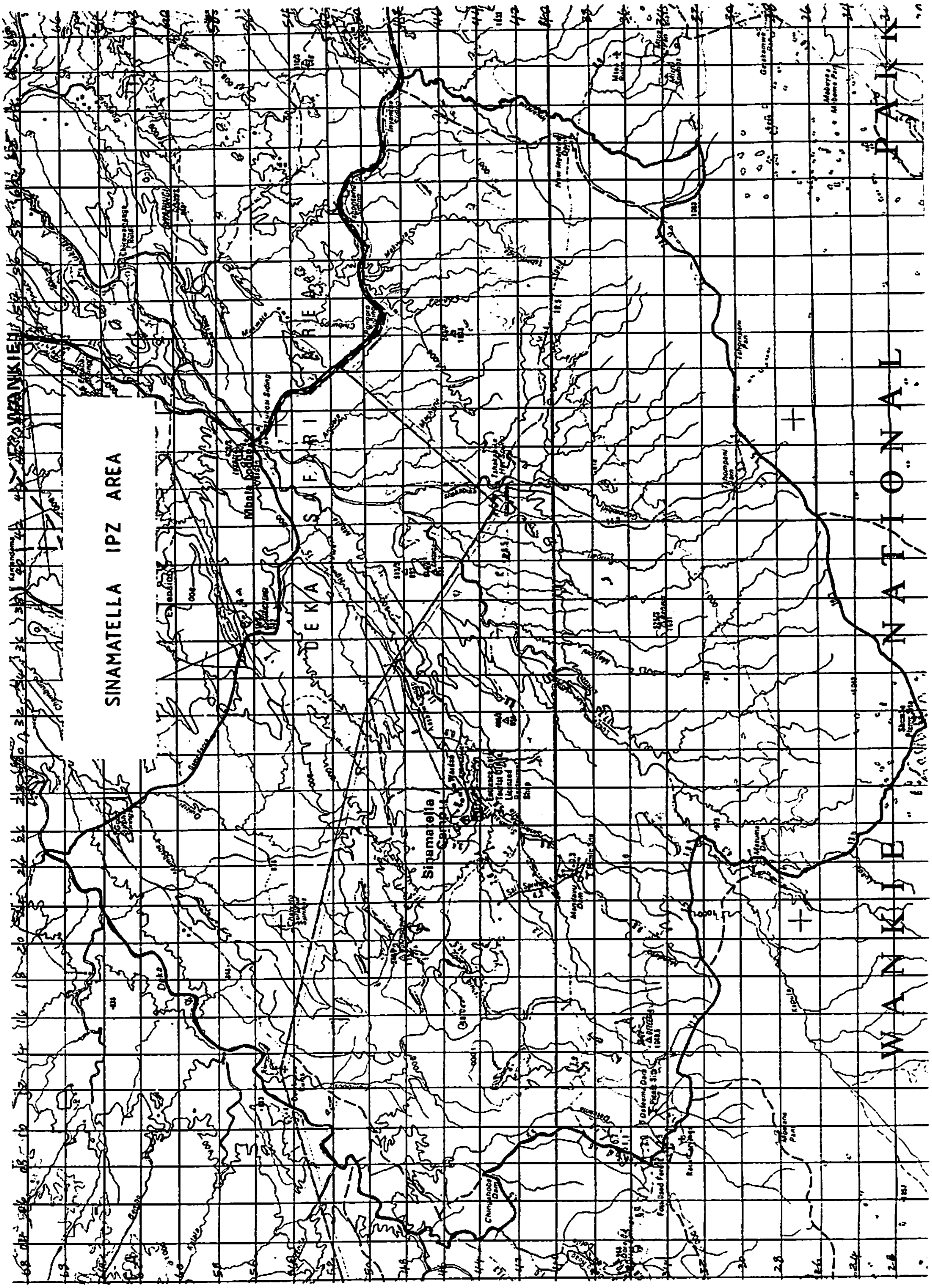


FIG. 3. TOPOGRAPHICAL MAP OF THE SINAMATELLA I.P.Z.

2 METHODS

A thorough ground survey of the black rhino was undertaken in the Sinamatella IPZ and some adjacent areas in order to acquire accurate census figures for this species.

Parallel, systematic transects were walked at 2 km intervals over the entire 1,530 km^2 Sinamatella IPZ area. Two adjacent areas to the northeast and east of the IPZ, within the Deka Safari Area and Hwange National Park respectively, were also censused in compliance with a request made by the Warden of the IPZ. These additional areas added another 295 km^2 to the study area. The total study area censused was therefore 1825 km^2. The total transect distance covered within the IPZ was 765 km and an extra 162 km was covered in the two adjacent areas. The grid lines running from west to east and north to south on the detailed 1:50,000 scale survey maps of the area were utilised as transect lines (Fig. 4). The predominant drainage lines in the study area ran south-west to north-east, thus eliminating possible bias in selection of transects. To facilitate the logistics of walking these lines, the study area was further divided into operational blocks within which sections of each transect could be located, approached and undertaken within one working day (Fig. 4). The time frame allowed for the project was approximately four months, and four teams of three observers walked all the transects in this time, a total ground distance of approximately 930 km. Sinamatella Camp was used as the operational base.

Transect line starting points were located using detailed survey maps of the area (1:50,000 series), Global Positioning Systems (GPS) and the local knowledge of experienced game scouts. Five Ensign Trimble GPS units were used. Observers were driven to the starting point of the transect each day. Transect lines were walked in west-east, east-west, north-south or south-north orientation (avoiding walking into the sun whenever possible to optimise visibility) and navigated using GPS units, compasses with sights, maps and the local knowledge of game scouts. Magnetic declination was calculated by the Ensign GPS to be 9° for the study area and compass readings adjusted accordingly. The four teams walked four parallel grid lines at 2 km intervals concurrently, and were thereby able to keep a check on directional error. Slight deviations had to be made occasionally for impassable obstacles but these were corrected immediately afterwards.

All observations were recorded onto observation sheets in the field and the results entered into a database (4D First) on an Apple MacIntosh PowerBook 540 computer. All graphical

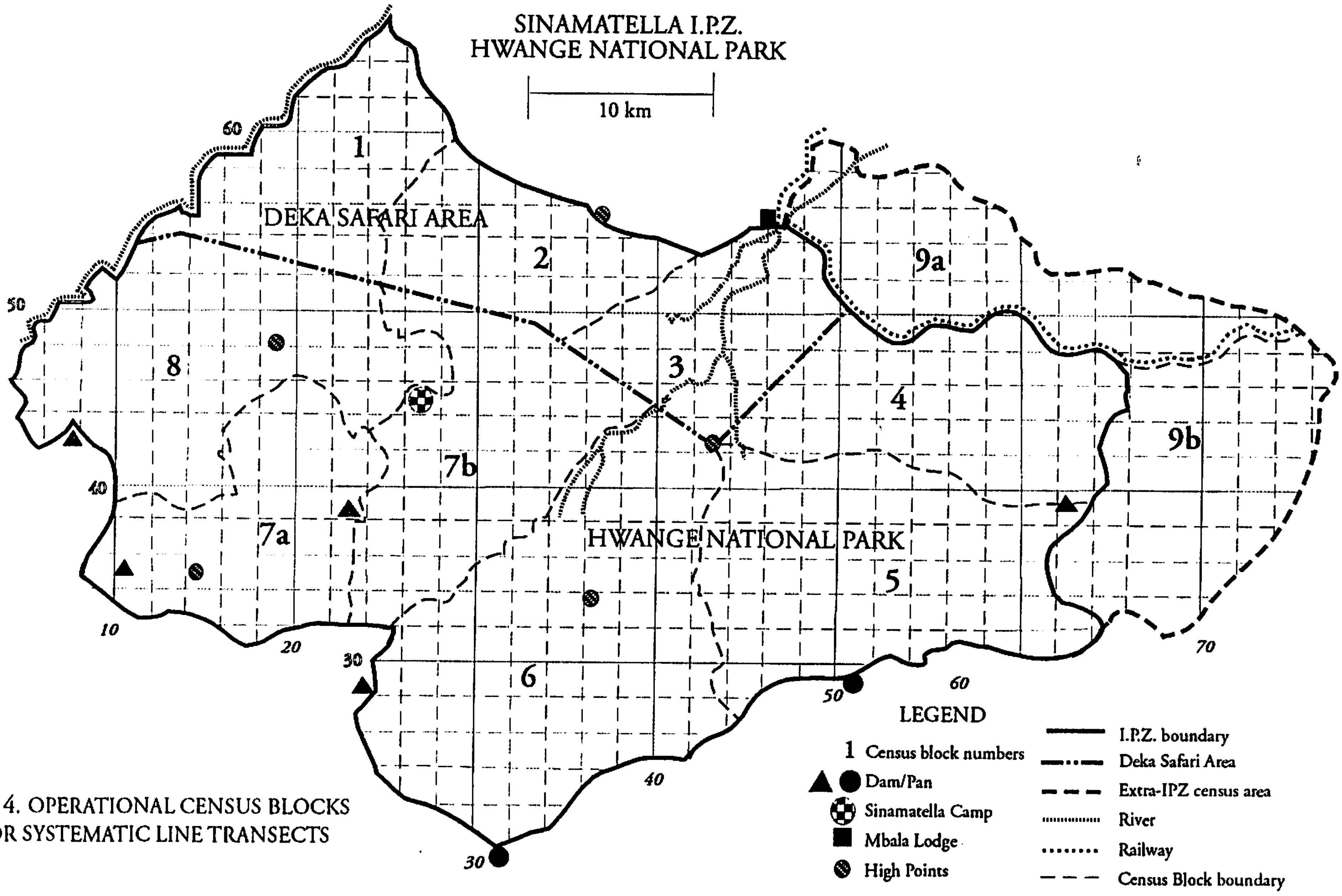


FIG. 4. OPERATIONAL CENSUS BLOCKS FOR SYSTEMATIC LINE TRANSECTS

presentations were carried out using Aldus Freehand and Deltagraph Pro. Statistical analysis was carried out using Unistat and Hayne's Estimator of density using software developed by Krebs (1989).

In September 1994 the Veterinary Unit of the DNPWLM began a dehorning and collaring operation of rhino at Sinamatella (Veterinary Unit report, 1995) which complemented, and fully cooperated with, the Rhinowatch census.

2.1 RHINO SIGHTINGS

Rhino sightings were recorded for the purposes of the census if individuals were observed within 100m perpendicular distance of the transect line. The distance was calculated using a portable rangefinder and the angle from the perpendicular was measured using the compass. Where possible, photographs were taken of rhinos to help with the identification of individuals using ear tears, horn shape etc.(Towindo, 1990).

Rhino density was calculated using two methods:

2.1.1 THE HAYNE METHOD (Hayne, 1949; Burnham & Anderson, 1976)

$$D_H = \frac{n}{2L} \frac{1}{n} \sum \frac{1}{r_i}$$

Where:

D_H = Hayne's estimator of density

n = No. of animals seen

L = Length of transect

r_i = Sighting distance to each animal i

The Hayne Method assumes that the sines of the angles Ø of the observed sightings are a sample from a uniform random variable ranging from 0 to 1. This assumption implies that the average sighting angle is 32.7°. In cases where the Hayne model is not applicable, because the average sighting angle is not 32.7°, the modified model (Burnham & Anderson, 1976) can be applied.

2.1.2 DIRECT EXTRAPOLATION (From numbers seen on transect)

Transects were 2000m (2 km) apart, and rhino sightings were recorded if an animal was seen within 100m on either side of the transect. The observation area therefore covered 10% of the total study area. Therefore, when the figure for the number of black rhino seen on transect was multiplied by 10, this gave an estimate of total population by direct extrapolation from numbers seen on transect.

2.2 SPOOR, DUNG AND BROWSE OBSERVATIONS

Spoor, dung and browse sites were observed on transect and sign densities were calculated per km of transect.

2.2.1 SPOOR OBSERVATIONS

Observations of rhino spoor were made, and recorded if within 5m perpendicular distance of the transect line. Age categories were allocated to spoor observations as follows (Towindo, 1990):

Category a - Fresh, < 24 hours old. Sharp edges and clear outline. Surface detail clear.

Category b - Not fresh, 2-3 days old. Less sharp outline, often partially obscured by other animal tracks. Surface detail less clear.

Category c - Old, > 3 days old. Often very unclear outline and surface detail almost totally lost.

Each rhino track was counted as one unit. The ease of observation of spoor was dependent on the age of the spoor and the substrate on which the spoor had been made.

2.2.2 DUNG OBSERVATIONS

Observations of individual rhino dung piles (middens and scrapes) were recorded if within 10m perpendicular distance of the transect line. The observations were allocated age categories as follows (Towindo, 1990):

Category a - Fresh, not > 1 day old. Dung wet and yellow/green inside

Category b - Not fresh, 2-3 days old. Dung less wet and brown inside.

Category c - Old, > 3 days old. Dung completely dry and may have termite infiltration.

2.2.2 BROWSE OBSERVATIONS

Black rhinos, as browsers, leave characteristic, blunt edges on the browse plants. Observations of rhino browse were made and recorded if within 5m perpendicular distance of the transect line. Each individual plant browsed was taken to be one unit. Age categories for browse were divided as follows (Towindo, 1990):

Category a - Fresh cut, 1-3 days old. Wet cut edge with green edges and white pulpy interior.

Category b - Not fresh, 4-90 days old. Dry cut edge, but still fairly sharp. Brown edges.

Category c - Old, > 90 days old. Cut edge less identifiable and greyish in colour.

2.3 IDENTIFICATION OF INDIVIDUAL RHINO BY SPOOR

du Toit (1989) described the identification of individual rhino by analysis of spoor, it having been shown that each animal had a unique spoor print. Provided the same foot was used to compare prints, it was shown to be possible to identify animals in the field by means of comparing their spoor prints.

Spoor seen were recorded in one of the three designated age categories, but only the fresh and more detailed spoor, predominantly category A , were traced (Towindo 1990).

On finding spoor of sufficiently good detail to take an accurate tracing, a 0.9mm thick, 26cm square acetate sheet was placed very carefully and with minimum pressure on top of the spoor. Tracings of spoor prints of the left hind foot of each individual track seen were made using permanent marker pens. Special care was paid to individual markings on the base of the foot, toe notches and to the general outline of the spoor. To minimise parallax error and subsequent distortion, the spoor tracing was done with the observer directly over the footprint. To minimise error due to variations in substrate and animal gait, one overhead tracing was made of each of three different left hind spoor prints in a particular track where possible. In some cases, the spoor tracks were followed for a short distance off the transect to acquire a good tracing although the original sighting was only recorded for the purpose of the census if it was within 5m perpendicular distance of the transect line.

The exact location of the spoor was recorded using the GPS, and acetate sheets marked with the date, locstat, transect number and drawing number.

Spoor tracings of the left hind foot were compared both using superficial similarity as judged by eye and more objectively using a series of critical measurements of each left hind spoor tracing which were drawn up (Fig. 5) and compared using hierarchical cluster analysis.

Eleven measurements were taken of each spoor tracing using a ruler and protractor. In some cases the tracings were less clear than optimally clear or incomplete and a visual estimate was made of the best fit line. The measurements were as follows:

2.3.1 The length of the spoor across the longest point between the front of digit 3 and the lowest point of the heel.

2.3.2 The width of the spoor between the bottom of two lines which divide digits 2 and 4 along their maximum length.

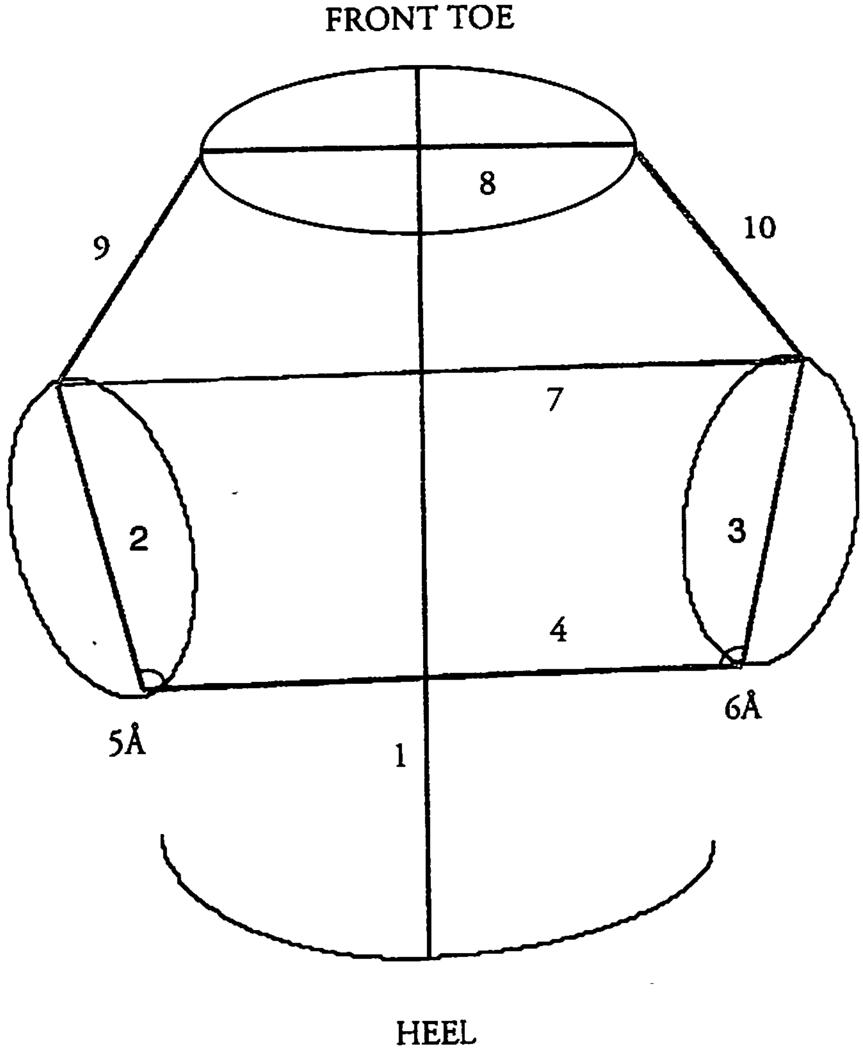
2.3.3 The width of the spoor between the top of two lines which divide digits 2 and 4 along their maximum length.

2.3.4 The longest width of digit 3

2.3.5 The maximum length of digit 4.

2.3.6 The maximum length of digit 2.

2.3.7 The angle made by the intersection of lines 6 and 2.



KEY

1-11	11 chosen lines and angles of foot
11	Circumference
————	Lines of measurement
(ellipse)	Simplified Rhino spoor outline

FIG. 5. REPRESENTATIONAL SPOOR TRACING SHOWING MEASUREMENTS TAKEN

2.3.8 The angle made by the intersection of lines 5 and 2.

2.3.9 The distance between the top of digit 2 and the intersection with line 4

2.3.10 The distance between the top of digit 4 and the intersection with line 4.

2.3.11 The circumference of the spoor.

Using the hierarchical cluster analysis complete linkage method, an analysis was performed to distinguish between spoor of different individuals. Cluster analysis requires complex computation. An MS-DOS statistical package, UNISTAT, was used to analyse the data on a 486 IBM-compatible PC. This method was used successfully to estimate black rhino density in the Chirisa Safari Area and Sengwa Wildlife Research Area in 1992 (Alibhai & Jewell, 1993).

Photographs of the spoor were also taken for future development of a photographic spoor analysis technique.

2.4 RHINO CARCASSES

Observations of rhino carcasses were recorded if found within 100m perpendicular distance from the transect line. The exact locstat of the carcass was provided by the GPS. Carcass observations can be a useful indicator of poaching activity. Carcasses were collected and taken to the National Parks office at Sinamatella for identification and labelling to provide information about absolute poaching levels in years before the IPZ was established.

3 RESULTS

3.1 RHINO SIGHTINGS

Eleven black rhino were sighted on transect and identified as being different animals by spoor print. Sighting points are identified (Fig. 6). Since there was no statistically significant difference between the observed mean sighting angle and 32.7°, the Hayne method was used rather than the modified Hayne to calculate rhino density (Table 1).

3.1.1 THE HAYNE METHOD

The black rhino density for the Sinamatella IPZ (1530 km^2) was calculated as
0.035 ± 0.01 (SE) animals per km^2

The total number of black rhino in the IPZ was therefore estimated to be 53.55.

3.1.2 DIRECT EXTRAPOLATION FROM NUMBERS SEEN ON TRANSECT

Eleven animals were seen from transect. The area sampled by transect represented 10% of the total survey area.

Therefore, estimate by direct extrapolation = 11 x 100/10 = 110 animals

3.2 SPOOR, DUNG AND BROWSE OBSERVATIONS

Figs. 7,8 & 9 show respectively the distribution of rhino spoor, dung and browse observations in the study area. Spoor were seen throughout the study area but particularly in the western and northern areas. Distribution patterns of dung and browse were, not surprisingly, similarly distributed.

Fig. 10 shows the frequency of observations of spoor from transects in the study area. This frequency distribution again shows a predominance of activity in the north and western parts of the study area.

Tables 2,3 and 4 show the frequency of observation of spoor dung and browse per km of transect walked in the IPZ for different age categories of sign. Censuses in forthcoming years will be able to use these tables for comparison, with the aim of developing an index of sign frequency per unit area to rhino abundance.

Fig. 11 shows the distribution of observations of spoor from white rhino. Because observations were of very low frequency those made off transect are shown in addition to those on transect. Only one white rhino was located within the study area by the Veterinary Unit during the dehorning and collaring operation and too few spoor observations were made in this study for a viable population estimate.

3.3 SPOOR TRACINGS

3.3.1 DIRECT VISUAL ASSESSMENT

All but a very few black rhino spoor tracings were taken from category A spoor seen on transect. The quality of the tracings varied according to individual interpretations of spoor outlines, the weathering of the spoor and the type of substrate. Although it was impossible to control the latter two, the former variable was minimised by the tracing of spoor by experienced assessors. Direct visual assessments and comparisons of spoor were made independently three times by two assessors. It was estimated that there were between 45 and 55 distinct black rhino spoor patterns which could be attributed to different individuals.

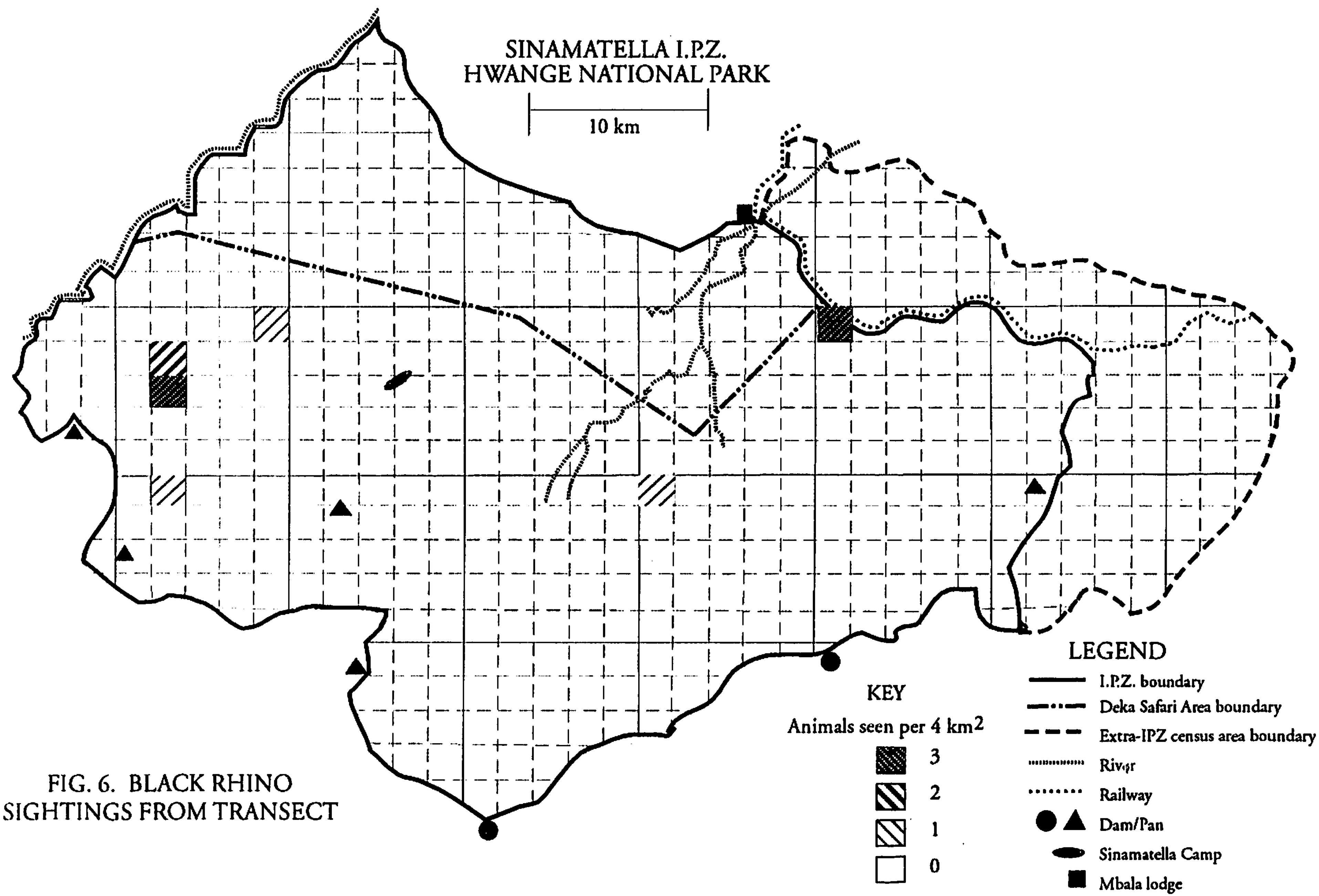


FIG. 6. BLACK RHINO SIGHTINGS FROM TRANSECT

BLACK RHINO (*Diceros bicornis*)

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LINE TRANSECT ESTIMATION OF BLACK RHINO POPULATION DENSITY
IN THE SINAMATELLA 1PZ: JULY - OCTOBER 1994
(PROGRAMME HAYNE, VERSION 3.0)

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** HAYNE/MODIFIED HAYNE ESTIMATE **

ESTIMATE OF POPULATION DENSITY =	0.03516 indiv./unit area
VARIANCE OF DENSITY =	0.00011241
STANDARD ERROR OF DENSITY ESTIMATE =	0.01060
95% CL =	0.0233

POPULATION ESTIMATE FOR SINAMATELLA IPZ (AREA = 1530 Km^2)

54 BLACK RHINO

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TABLE 1. LINE TRANSECT ESTIMATION OF BLACK RHINO POPULATION DENSITY IN THE SINAMATELLA IPZ

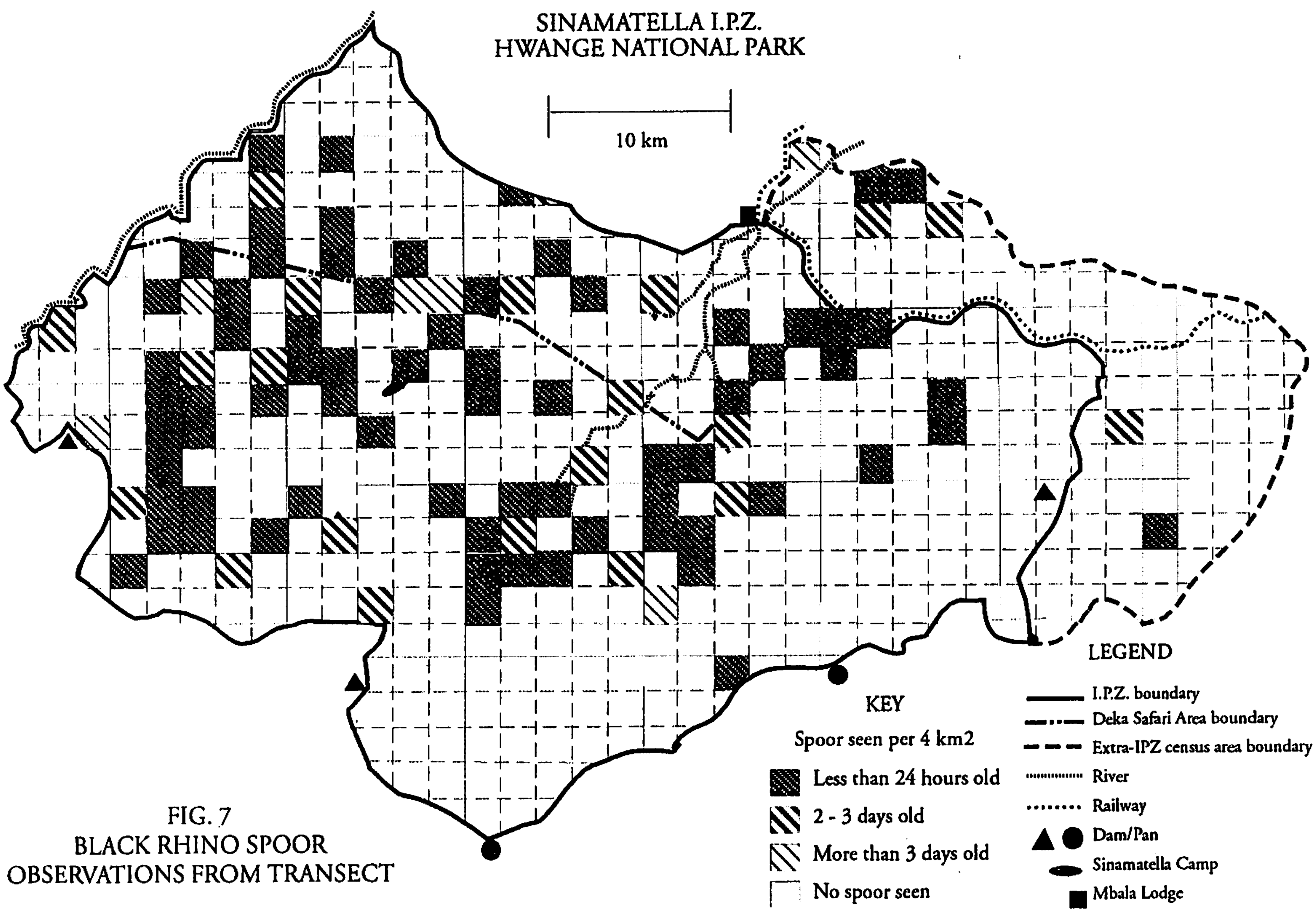

FIG. 7
BLACK RHINO SPOOR
OBSERVATIONS FROM TRANSECT

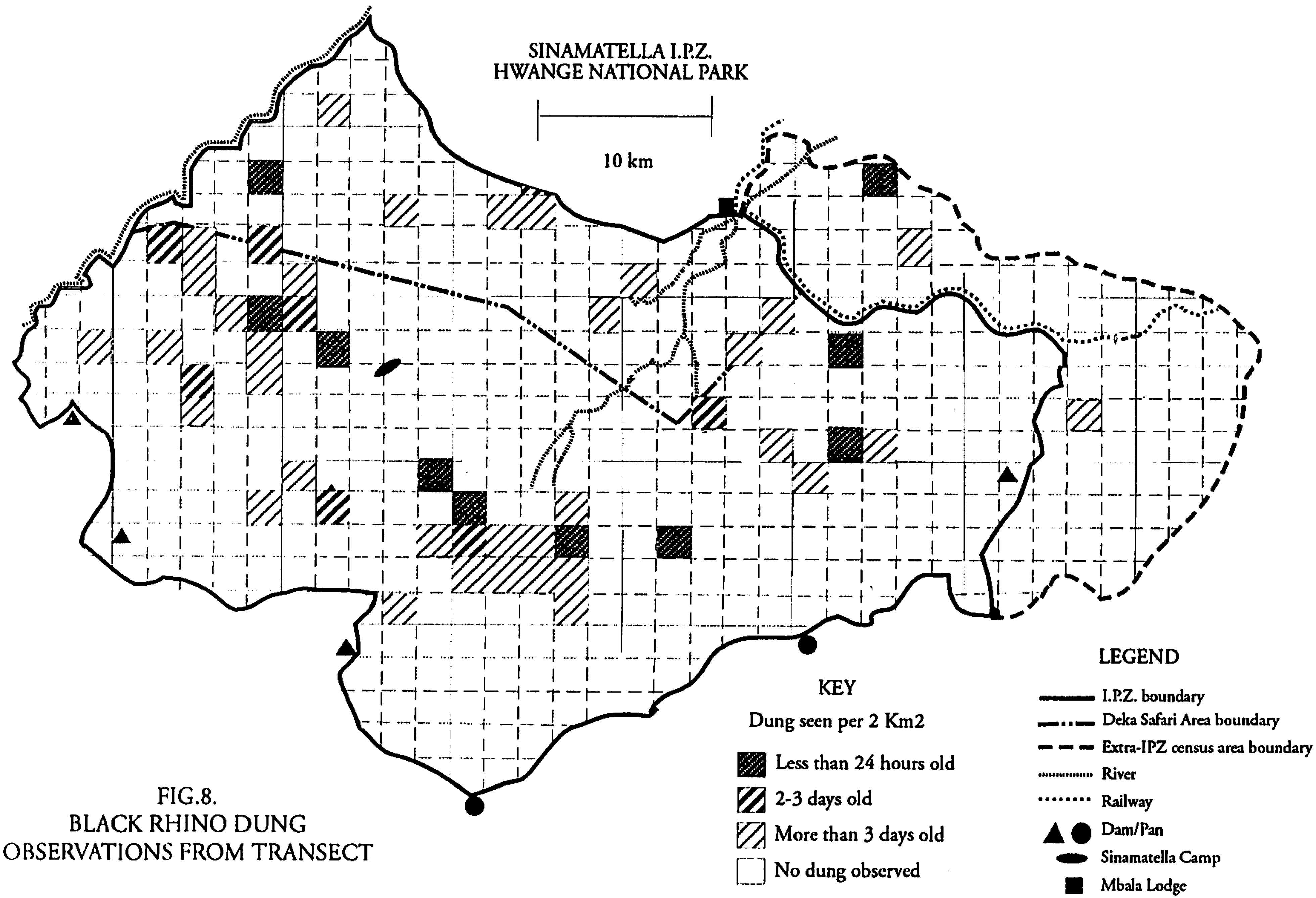

FIG.8.
BLACK RHINO DUNG
OBSERVATIONS FROM TRANSECT

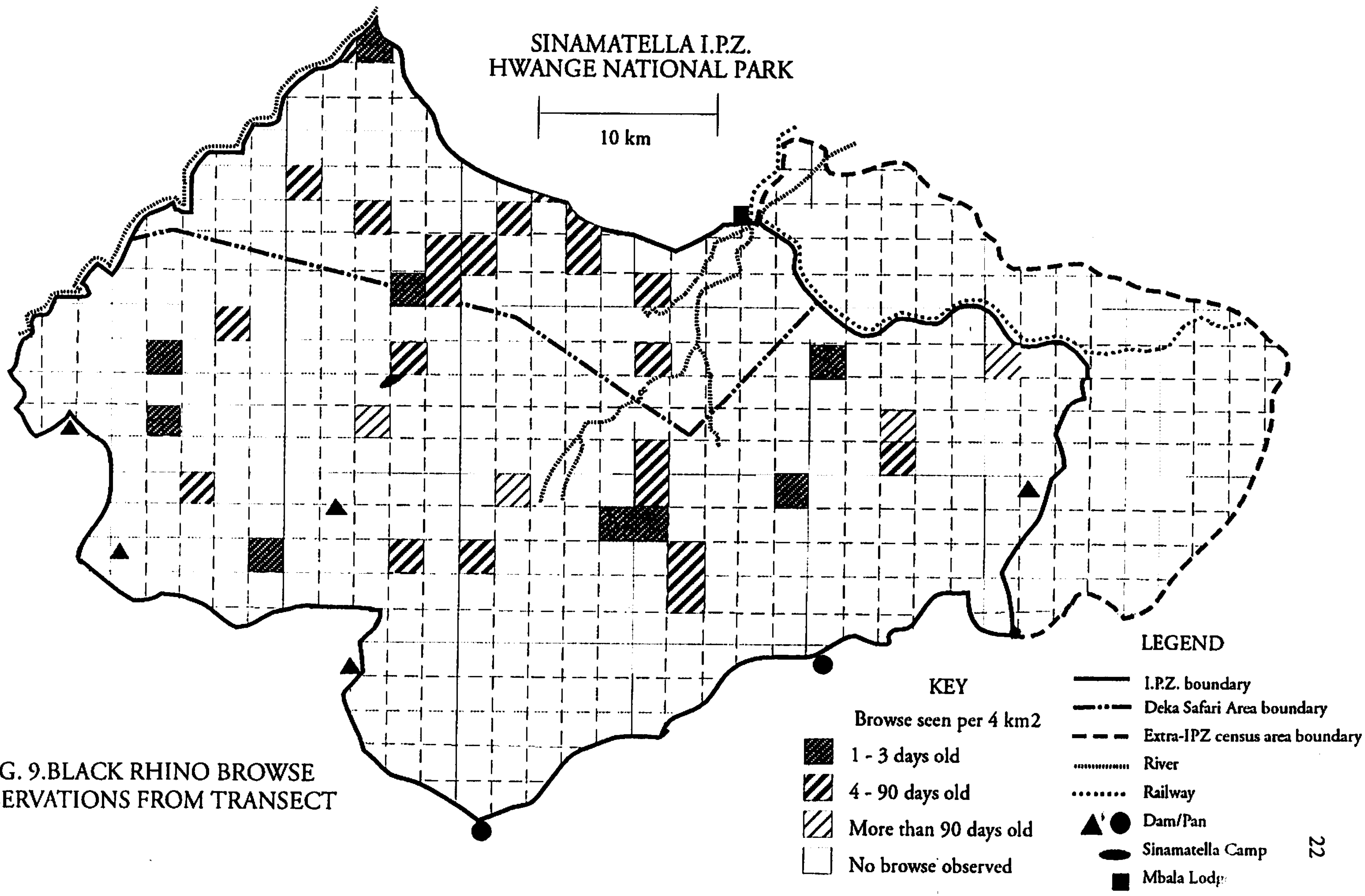

FIG. 9.BLACK RHINO BROWSE OBSERVATIONS FROM TRANSECT

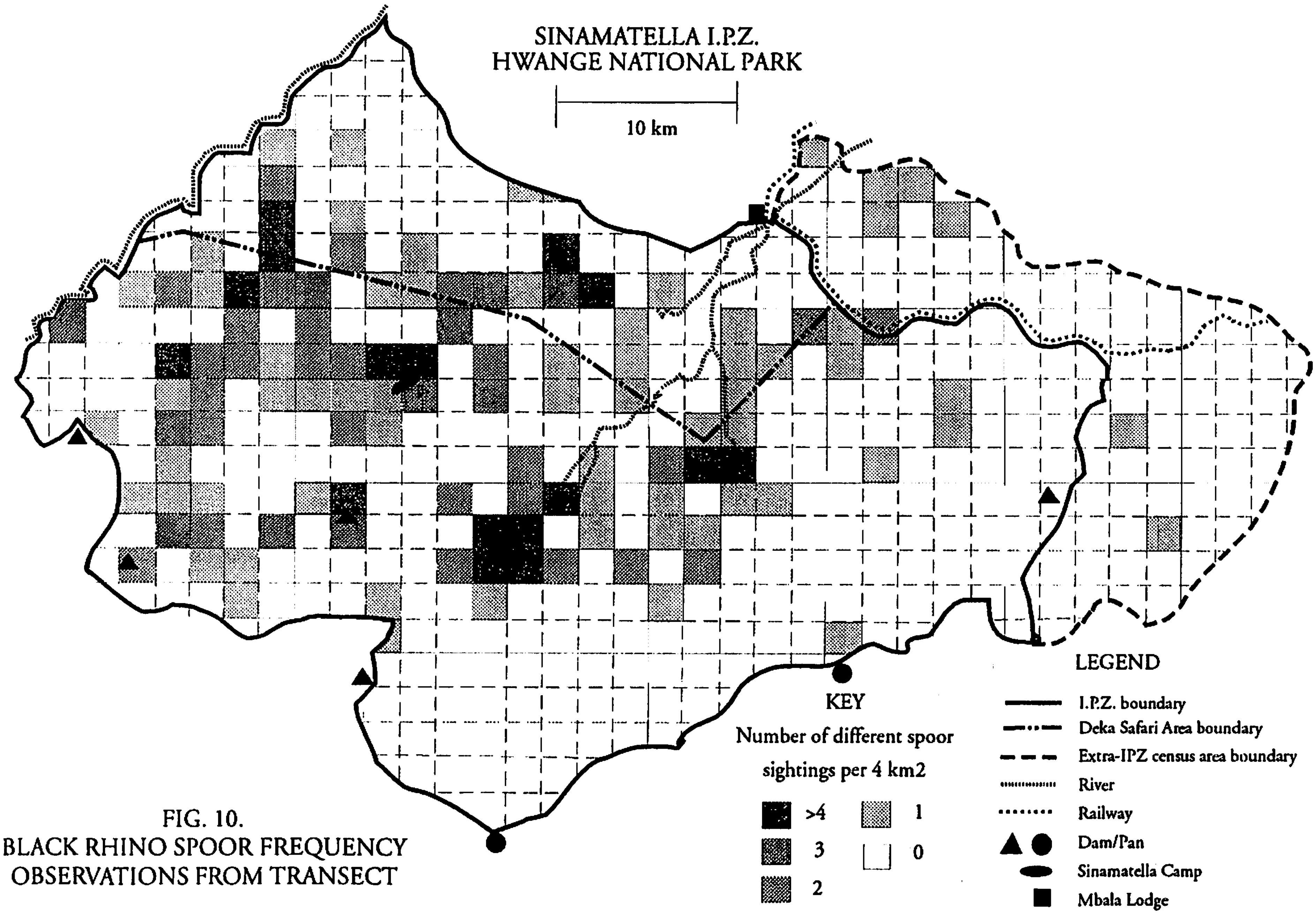

FIG. 10.
BLACK RHINO SPOOR FREQUENCY
OBSERVATIONS FROM TRANSECT

SPOOR CATEGORY	NO. OF SPOOR	SPOOR/KM OF TRANSECT
A	141	0.1843
B	48	0.0627
C	21	0.0275

TABLE 2. Number of spoor and spoor/km of transect for different spoor categories (A <24hrs, B=2-3 days, C >3 days) in the Sinamatella IPZ.

DUNG CATEGORY	NO. OF DUNG SITES	DUNG SITES/KM OF TRANSECT
A	12	0.0157
B	8	0.0105
C	47	0.0614

TABLE 3. Number of dung sites and dung sites/km of transect for different dung categories (A <24hrs, B=2-3 days, C >3 days) in the Sinamatella IPZ.

BROWSE CATEGORY	NO. OF BROWSE SITES	BROWSE SITES/KM OF TRANSECT
A	11	0.0144
B	27	0.0353
C	5	0.0065

TABLE 4 Number of browse sites and browse sites/km of transect for different browse categories (A=1-3 days, B=4-90 days, C>90 days) in the Sinamatella IPZ.

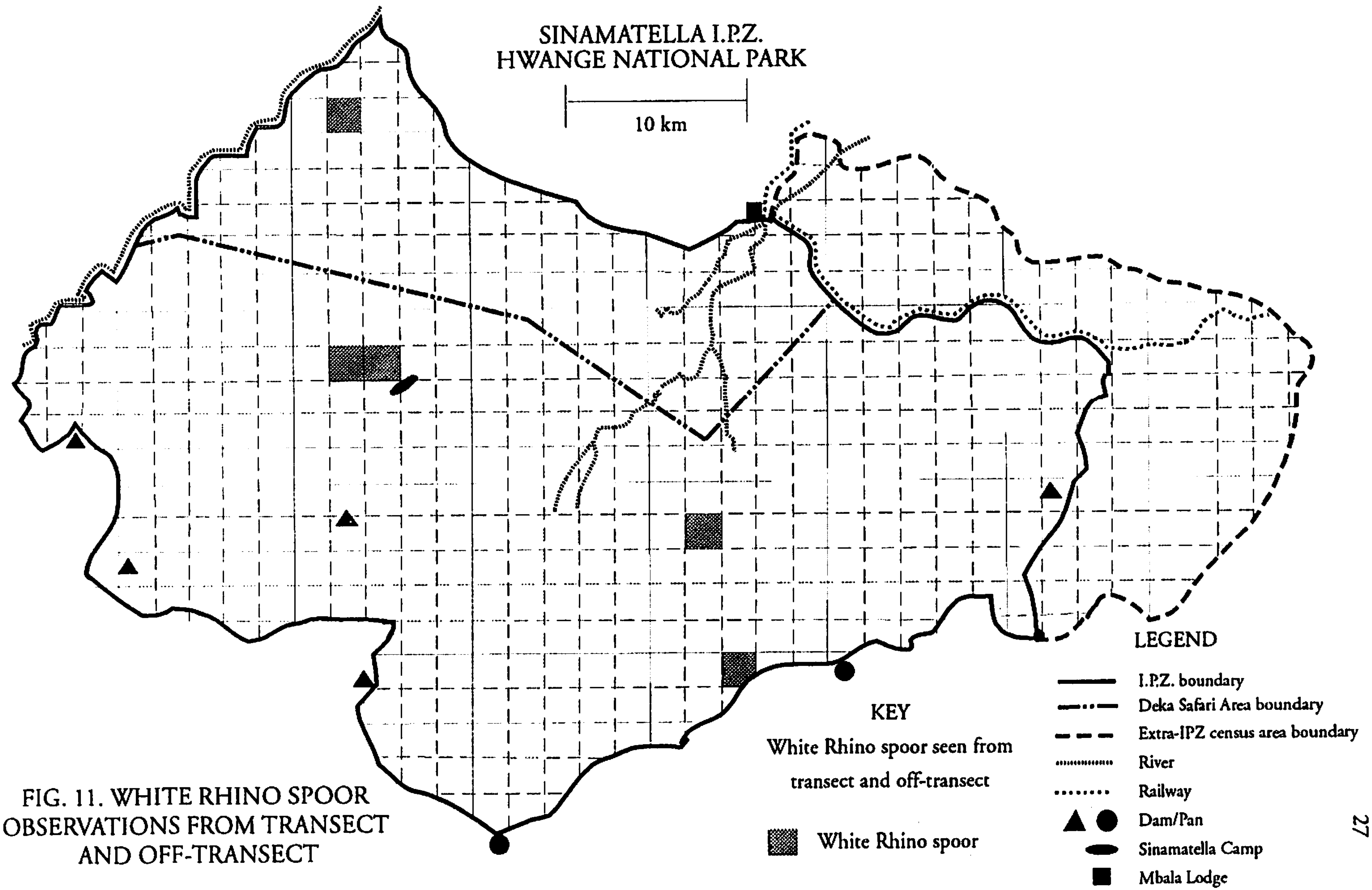

FIG. 11. WHITE RHINO SPOOR OBSERVATIONS FROM TRANSECT AND OFF-TRANSECT

3.3.2 CLUSTER ANALYSIS OF SPOOR MEASUREMENTS

The 1992 black rhino census in Chirisa indicated a useful model of hierarchical cluster analysis to be the complete linkage method using a cut-off point of 10 (Alibhai and Jewell 1993). This method was repeated for the Sinamatella census and gave an estimated population of 54 animals.

Fig 12 shows the complete linkage hi-res dendrogram for this cluster analysis.

3.4 RHINO CARCASSES

Only one skull was found on transect, (fig. 13) and this was estimated to be three years old. The sample size was too small to analyse using the Hayne method or by direct extrapolation. Seven skulls were observed off transect, and therefore not included in the census figures. All seven were estimated to be more than two years old, and from animals poached before the inception of the IPZ.

Although it was thought that one of the old skulls might have been from a natural death, the other 7 carcasses had been poached. In some cases it was possible to confirm this by finding a skull on which the horns had been removed or on which a bullet hole could be seen. However, caution must be used in interpretation, because intact skulls might have resulted from poached animals which had been wounded, evaded the poachers, and died later. Data is held by the Area Ecologist for the Sinamatella IPZ.

3.5 SUMMARY OF RESULTS

Combining the results given by the several different methods above, and discounting the result given by direct extrapolation of numbers seen on transect, the black rhino population in Sinamatella IPZ was estimated to be 55 ± 5 animals (Table 5).

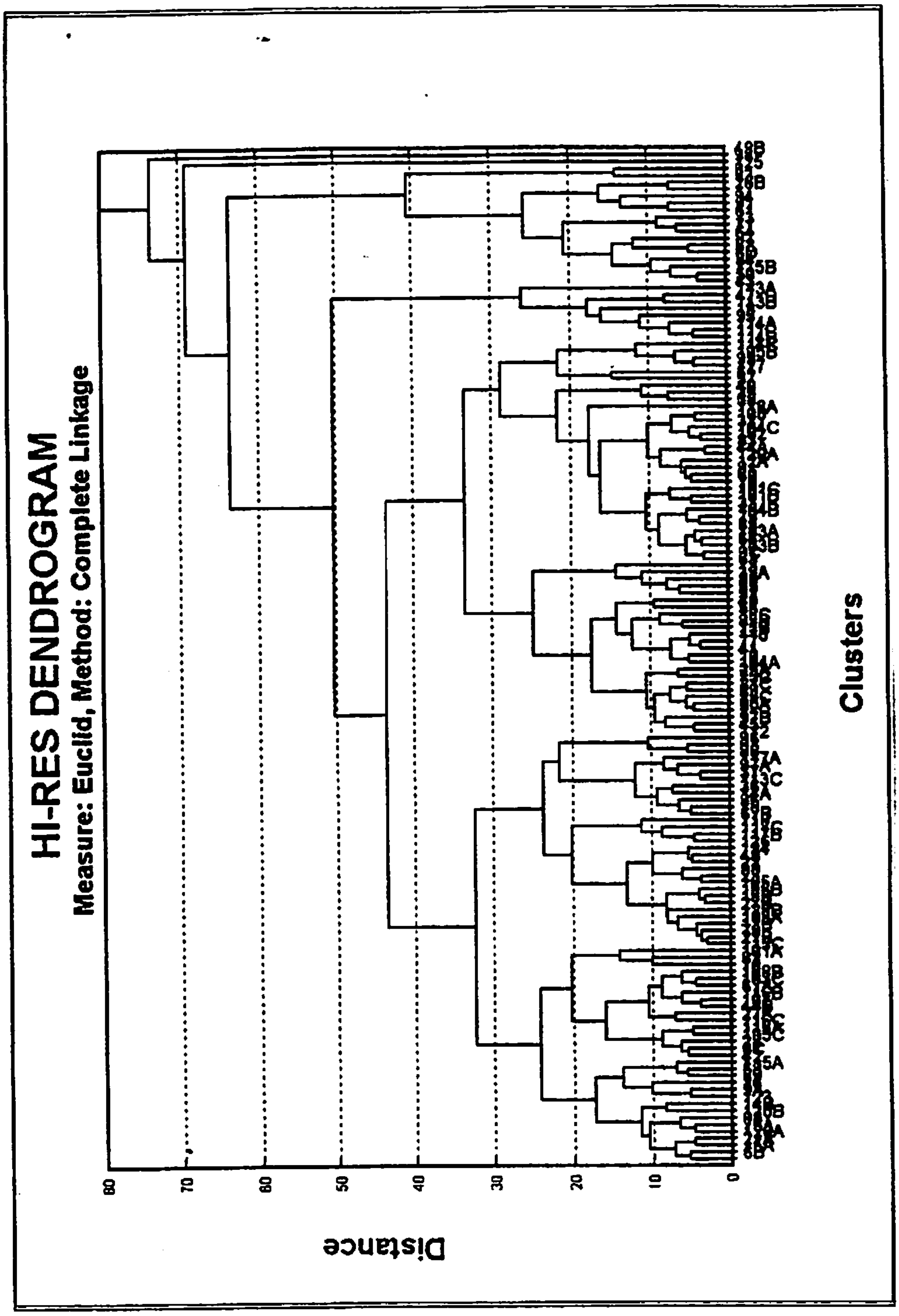

FIG. 12. CLUSTER ANALYSIS HI-RESOLUTION DENDROGRAM USING COMPLETE LINKAGE

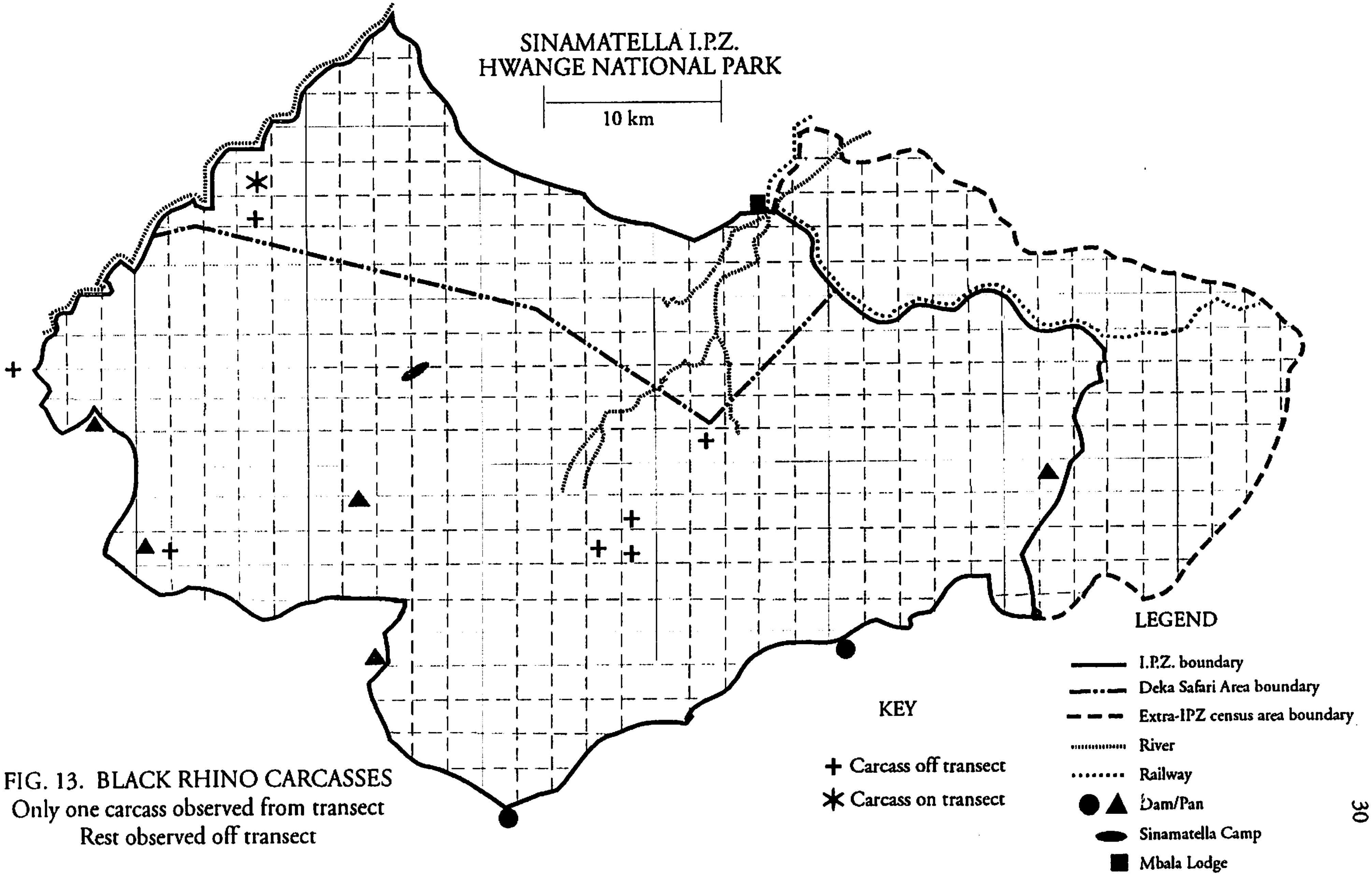

FIG. 13. BLACK RHINO CARCASSES
Only one carcass observed from transect
Rest observed off transect

METHOD	BLACK RHINO NUMBERS IN SINAMATELLA IPZ
1. RHINO SIGHTINGS	
1.1 The Hayne Method	54
1.2 Direct Extrapolation	110
2. SPOOR ANALYSIS	
2.1 Direct Visual Assessment	50
2.2 Cluster Analysis	54
3. VET TEAM CAPTURE	45
4. FINAL ESTIMATE	55±5

TABLE 5. METHODS USED TO ESTIMATE BLACK RHINO POPULATION IN THE SINAMATELLA IPZ, HWANGE AND THE RESULTS OBTAINED.

4 DISCUSSION

In contrast to the devastating population decline shown in the Chirisa census of 1992, this Sinamatella IPZ census revealed a substantial population of black rhino, with no evidence of recent decline. No fresh carcasses were found and there were no contacts with poachers during the census period. The DNPWLM had implemented a policy of increased anti-poaching effort and the de-horning of all rhino in the IPZ and there had been no rhino poaching incursions since the inception of the IPZ. Although it would be premature to imply a causal relationship between the former and the latter, it would nevertheless be fair to say that there is justification for optimism about the future of the IPZ.

This census was the second to be conducted by Rhinowatch and enabled a thorough revision of the suitability of the methods undertaken for the purpose of a black rhino census in the habitat concerned. A major improvement to the accuracy of the census was provided by the GPS units, which enabled locstats for observations to be recorded with an accuracy of ±60m.

In addition to censusing the Sinamatella IPZ, two adjacent blocks were covered. Black rhino spoor and dung observations were made in these adjacent blocks, illustrating clearly that animals range outside the IPZ. Scout patrol reports suggest that rhino range outside the IPZ across all borders with Hwange National Park, the Deka Safari Area and Matetsi Safari Area As the IPZ is not fenced it is impossible to prevent these animals from ranging freely, and as long as anti-poaching patrols take this into account and the animal still has part of its range inside the IPZ this should not present future problems. Animals which have a range entirely outside the IPZ might be expected to suffer from increased vulnerability to poachers.

As in the Chirisa survey (Alibhai and Jewell, 1993), it was found that the ideal of using transects of random length, position and direction to minimise inadvertent design bias was difficult to implement due to thickly wooded terrain. Furthermore the difficulty in locating and navigating such transects would be enormous and greatly prolong the time required to complete the work, as well as increasing error due to inaccurate navigation. In addition, the random transect approach is often used as compensation where the censused area is a much smaller fraction of the total area than is the case here.

Because initial observations and scout patrol reports suggested that the population was much larger than it had been in the previous census, transects were walked at 2 km intervals rather than 1 km without compromising data analysis. This had the additional benefit of allowing more time for follow-up spoor analysis. Using systematic ground transects at intervals of 2 km, Rhinowatch was able to survey 10% of the total 1530 km^2 IPZ area.

Eleven rhino were observed from transect. The dangers of estimating population by direct extrapolation from censused to total area are obvious. This method produced a population estimate of 110 black rhino for the Sinamatella IPZ. This figure was more than twice the estimate for all other methods. This form of disparity is likely to occur when the population of species being sampled is generally low and small changes in the numbers of animals observed can produce wide fluctuations in density estimates. However, the Hayne estimator produced a figure of 54 animals, and this was consistent with results produced by direct visual assessment and hierarchichal cluster analysis of spoor. A dehorning and radio-collaring operation was carried out by the Veterinary Unit in September/October 1994 in the Sinamatella IPZ. (Vet. Unit report, 1995). A total of 46 animals were identified by the Veterinary team. This figure is slightly lower than the other estimates. However, the Veterinary team only operated for five weeks in the Sinamatella IPZ, and, if their operations had been extended, it is highly likely that their figure would have increased and compared favourably with the Rhinowatch estimate of 55± 5 animals. Since the direct extrapolation estimate was completely inconsistent with the other estimates, it was excluded when the final estimate was made for the black rhino population in the Sinamatella IPZ.

Attempts were made to build a photographic identification library of rhino encountered on transect. However, this proved to be very difficult in practice as many observations were of brief duration and vegetation cover often heavy.

The tracing of spoor prints for individual identification presented several challenges. Firstly, the tracings were made by different individuals and from different substrates, and were consequently variable quality and detail. It became clear that the tracing of spoor prints had to be tightly standardised, and two improvements were implemented over the technique used in 1992. Firstly, the acetate sheet was placed directly on the spoor, and this greatly improved accuracy. Secondly, a minimum number of experienced tracers were used to make the tracings. Also, preliminary work was done on a new and very promising photographic technique for spoor analysis, and results are expected to be available within the next 12 months, depending on the acquisition of the necessary computer equipment.

Three independent attempts were made by two of the authors at judging the differences in the tracings by eye, with reasonable consistency. However, it became clear that a more standardised and less subjective method would be more valuable in terms of reliability. More confidence was therefore placed in the hierarchical cluster analysis method.

The hierarchical cluster analysis of spoor measurement data was dependent on the selection of an arbitrary cut-off point to determine the estimated number of individuals. In this census a cut-off level of 10 units was used with the complete linkage method, as used in the Chirisa census (Alibhai & Jewell, 1993). This method gave results in close agreement with the Hayne method and direct visual assessment and, with the benefit of previous experience, was used with confidence. In the present study, all 11 variables were included to carry out Cluster Analysis. It is possible that not all these variables contribute equally to variability between individuals and it is hoped that principal component multi-variate analysis will be used to ascertain the significance of these variables once the new photo-analysis technique has been fully developed.

Spoor, dung and browse densities were calculated per km of transect. Given suitable follow-up census work in forthcoming years it will be possible to use these figures to calculate an index of population density by sign observation, such as those calculated by Towindo (1990) in the Sengwa Wildlife Research Area.

Carcass observations were not used as a means of estimating current population because no previous census figures were available for this area. However, should poaching recur in this area, future censuses in this area will be able to make use of carcass observations in re-assessing population status.

No attempt was made in this census to correlate rhino distribution with vegetation type, but this will be done in forthcoming work and its potential importance to the understanding of the ecology and behaviour of this species can not be overlooked. However, because the primary aim of the census was to establish baseline data on distribution and abundance in this newly-established IPZ, there was insufficient time for a thorough vegetation survey. A geographic information system (GIS) would be of enormous benefit in correlating vegetation type, altitude, water sources and other topographical strata with rhino distribution and ranging behaviour. It is extremely important that the opportunity to study the ecology and behaviour of this unique population is taken whilst the population is apparently secure. Rhinowatch has offered to provide much-needed support to the DNPWLM over the next few years so that this can be achieved.

Rhinowatch aims to provide essential baseline data from censusing and monitoring rhino and other large mammals, to assist the appropriate authorities to plan effective conservation strategies. As such it is important that the results of a thorough census can be generated fairly quickly and interpreted with confidence. The preliminary results of this survey were submitted to the DNPWLM immediately after the census had been completed (Alibhai, Jewell & Towindo 1994b & c).

At the end of the last census in Chirisa in 1992 it was noted that the black rhino population in Zimbabwe has undergone a dramatic decline. At that time Rhinowatch (Alibhai and Jewell 1993) wrote:

"In view of this, Rhinowatch thoroughly endorses the adoption of the latest Zimbabwean rhino conservation policy which involves the protection of these animals in Intensive Protection Zones throughout the country, thus optimising the distribution of limited resources whilst at the same time protecting the animal *in situ* and thereby placing value on the protection of all the flora and other fauna found within their natural habitat".

This census shows that the population in the Sinamatella IPZ is the highest on any Parks Estate area in Zimbabwe, and that there has been no evidence of poaching since the inception of the IPZ. The Rhinowatch survey together with information provided by anti-poaching patrols and the Veterinary Unit, indicated that several new calves were born in 1994 and preliminary indications are that the population is increasing.

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