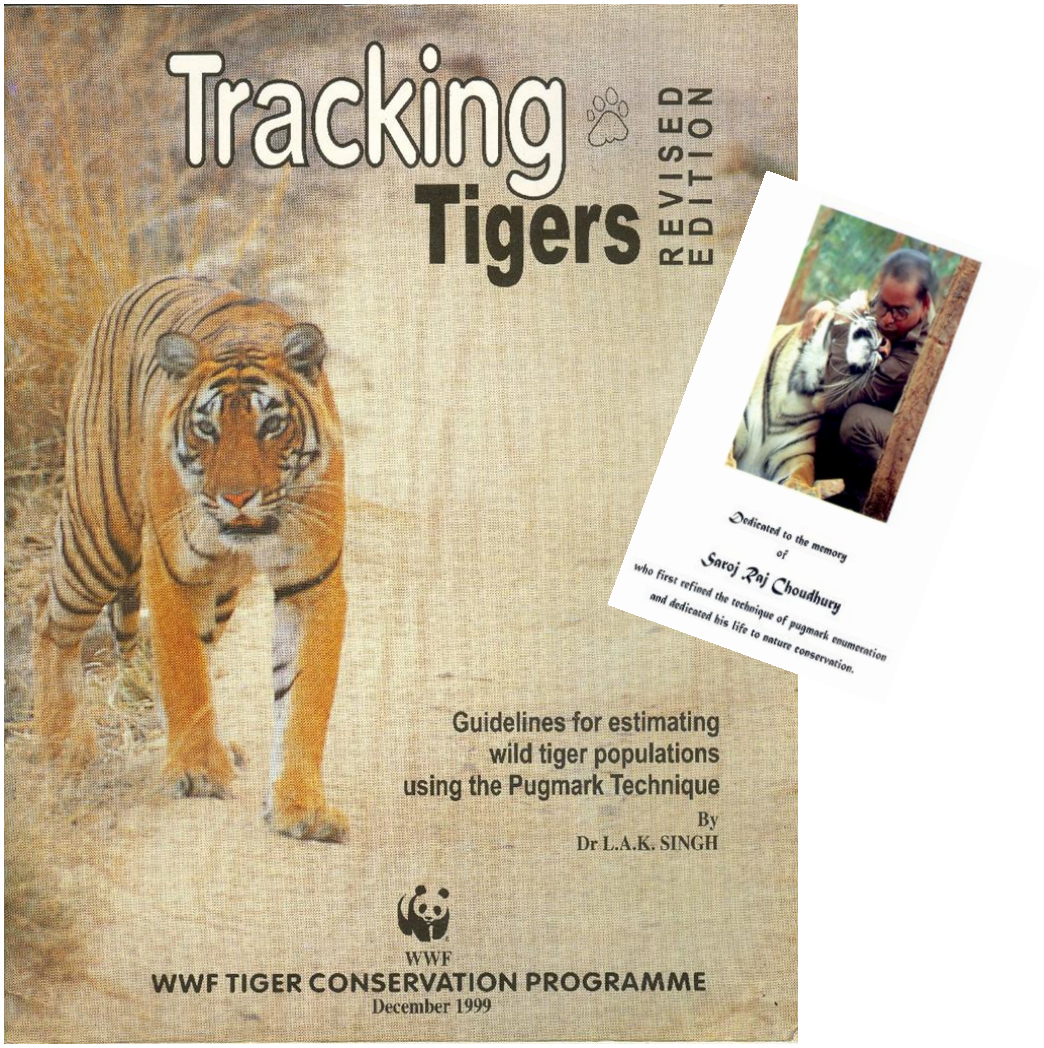
Tracking Tigers
REVISED EDITION
Dedicated to the memory
of
Saroj Raj Choudhury
who first refined the technique of pugmark enumeration
and dedicated his life to nature conservation.
Guidelines for estimating
wild tiger populations
using the Pugmark Technique
By
Dr L.A.K. SINGH
WWF
WWF TIGER CONSERVATION PROGRAMME
December 1999

सत्यमेव जयते

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Foreword

The tiger is our national animal and symbol of our biodiversity. The status of tiger reflects not only the health of the habitat and the prey species, but also the effectiveness or otherwise of our conservation efforts. The Central and the State governments must, therefore, regularly monitor the fluctuations in the tiger populations.

The assessment of tiger numbers through the identification of footprints, for which this volume provides the guidelines, is a traditional method which has the widest application in the country. It is also the most cost effective and readily used by the forest guards and other field staff. There is a great need for refinement and standardization of this method, which this volume attempts to do. Its application will provide greater reliability to the population estimates of the tiger, lion and leopard.

I am aware that the present methodology has some weaknesses and the scientific community is engaged in evolving more effective methods for estimation of tiger population. These efforts need to be encouraged and appropriate changes made in the tiger population estimation methodology from time to time to keep pace with technical advancements in this field.

(SURESH P. PRABHU)

PREFACE

It is unfortunate that the status of the tiger has become a "number's game", undermining to that extent the original objective of Project Tiger which was to save not only the tiger and its preybase, but also the best surviving samples of the diverse ecosystems in which tigers exist in India. The number of tigers, or rather the increase or decrease in a given population, has become almost the sole measure to assess the success or failure of an officer in charge of a protected area holding tigers. The one question he is invariably asked concerns the number of tigers in his reserve.

This narrow mind-frame has had a negative impact denigrating the importance of the other more important dimensions of tiger conservation on the one hand, and on the other, automatic annual "increase" in the number of tigers. It has also led to a situation where nobody really believes the figures, not even the "counters" themselves. Yet, it cannot be denied that we need to estimate our tiger numbers periodically. The purpose of such an exercise in the management process is self evident.

Various methods for estimating tiger numbers have been fielded and they all have their justifications and applicability. One method which has the widest application, which the forest guard who will do the actual counting in the field is already familiar with or can easily be taught, and which is also the most cost effective. This is the counting from footprints, the "pugmark" technique. Other methodologies need to be refined and tried out, and if found to be practical, acceptable and definite, they should also be considered for estimation of tiger populations. In future there could be a combination of methods and *modus operandi* to assess tiger numbers.

Though identification of tigers from the pugmark has been in operation for ages, and the countrywide enumeration every four years since 1972 has been done by this method, there is lack of uniformity in application, even in understanding of the procedure. There is also an almost universal lack of training. Sometimes the left footprint and sometimes the right, sometimes the front and sometimes the hind footmark are measured. The technique of measurement is also

inadequately known. There is as yet no guideline which would be widely, if not universally followed, nor one with which to train the actual enumerators in the field. These factors have significantly contributed to the improper application of the method.

It is fully realised that the subject is controversial and emotive, and there will never ever be total consensus on the methodology and application. It is also understood that if the bonafides of the enumerator are dubious and a deliberate attempt is made to increase the count by sending in false data, there is no foolproof system of proving the contrary. Besides, no counting method can give 100 percent accuracy, and that is why one prefers to use the words "enumeration" or "estimation" instead of the word "census". Notwithstanding all this, there is no denying the fact that the pugmark method is being used, has a countrywide application, is simple, inexpensive, and one which can be easily deployed by the field staff and, if properly used, can identify individual tigers. Therefore, as long as it is being used, there is a crucial need to finetune and standardise the method, from which endeavour it is hoped that inputs received would make it more practical, precise and user-friendly. We regard this document as a capacity building exercise.

As was mentioned in the first edition of this guideline, the inputs and suggestions received after its usage would help in bringing out a revised version. We are very grateful for the suggestions received, amongst them from P.K. Mishra and R.L. Singh, based upon all of which a revised and more rationalized text has been prepared by Dr. LAK Singh. Its Hindi translation, prepared by Dr. Suresh Mishra, is ready and would be simultaneously released. A shorter and simpler version for the forest guard is also being got ready.

But the footprint method is not the only one and others could and should be developed and applied where feasible and practical. A special *modus operandi* would also be required for the mangrove forests of the Sunderban.

We are very grateful to Dr. L.A.K. Singh whose knowledge and commitment to the cause of nature conservation is second to none. I would like to acknowledge the contributions of my colleagues Brig. Ranjit Talwar and Tariq Aziz, and for helping to put together this document in its present form. We also thank the Wildlife Institute of India for analysing the document and giving very valuable inputs, Mr HS Panwar, former Director of Project Tiger and WII, and Mr PK Sen, present Director, Project Tiger, for going through this document and making very significant improvements. We are also grateful for the inputs received from authorities in Nepal and Bhutan.

Lastly, I wish to pay tribute to my colleague, friend and comrade-in-arms, the late Saroj Raj Choudhury, who amongst his many contributions to conservation, developed and refined the pugmark counting methodology which this document seeks to further improve. He was a stalwart amongst stalwarts.

Dr MK Ranjitsinh

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INTRODUCTION

Dr. L.A.K. Singh's guideline is fundamentally firmly based on Chaudhary's cooperation census method published in Cheetal, 1970. It is apparent that what ever debate has been raised over the past several years on the validity of the methodology, people concerned have failed to read the original methodology established by Shri Saroj Raj Choudhury. Dr. Singh has further added some useful explanations and details for easy understanding and thus are excellent effort and contribution towards estimation of tiger population has been made.

The document has been scrutinised and also presented before the expert group mainly to explain that methodology has several procedural steps in it which attract attention of field personnel at different levels. The pug mark technique for estimation of tiger population is not contentious but has been made so unfortunately by some poor practice. And therefore it is reiterated that on "cooperation" basis the estimation of tiger population this technique is the simplest of all and at the same time most robust of all the techniques that are used for estimation of population of various wild animal species in India. Following this guideline what is needed is a clear understanding of the tenets, and responsibilities at different levels of participation.

The technique is simple however it is demanding in that it works on certain levels of skills which are acquired through constant practice. The supervisory level of staff has a major role to play in developing that kind of expertise. This guideline is very timely and hopefully will bring the refinement in the field performance of the personnel involved in estimation of tiger population.

(S.K. Mukherjee)

CONTENTS

A. BIOLOGICAL BACKGROUND

Introduction

Estimating the population size of the tiger in a given natural habitat must inevitably depend upon indirect evidence because of the difficulty in the actual sighting of individuals inhabiting that area. The technique described here for arriving at a reasonably reliable estimate (minimum number) of tiger population in a given area employs the recording of tiger pugmarks as the basis for identifying individuals. The technique is widely known as the 'Pugmark Census Technique'. It is based on specific postulates, the dependability of which has been established by testing through field applications on an extensive and intensive scale. The method is indeed an extension of the ethnic methods used by tribals and *shikaris* in different parts of the country. At the outset, credit for scientifically establishing these postulates must be given to the late Shri Saroj Raj Choudhury, a forester from Orissa who devoted much of his life to natural history, conservation, and on studying the tiger. A number of practising wildlifers have further refined the technique. This presentation borrows from their research and from the author's own experience.

Territoriality of Tigers and Basic Postulations

The tiger is a territorial animal. Each territory is fairly well demarcated and the occupant of a territory is subjected to change when ousted by a stronger rival or by death. While male occupants of territories change more often, females tend to hold a territory for longer periods. It is also widely accepted that the territory of a male overlaps the territories of one or more females. The cubs are reared exclusively by the mother and remain attached to them for up to two and a half years, the female cubs often occupying territories or home ranges adjacent to their mother's. Thus, within the short period of field operations for

estimation of tiger populations by the pugmark method, the occupants of different territories remain unchanged. This helps in eliminating duplication and arriving at a reasonably accurate minimum figure of the tiger population in the area.

2.1. POSTULATION ONE

In good habitats adult male and female tigers have well defined territories.

In good habitats with adequate food and cover, adult tigers have a definite territorial pattern of social spacing among individuals. The usual pattern is the larger well defended individual male territories, within each of which occur reasonably well defined female sub-territories. These rich habitats are also prime breeding areas. Occasional transient individuals may also be recorded even in prime habitats, but they do not stay for more than a few days.

2.2. POSTULATION TWO

In medium level habitats there are overlapping territorial patterns.

In habitats with a medium level availability of food and cover, the territorial patterns exist but tend to do so with overlaps over adjacent territories. The number of transients here may be more because such areas are the usual abode of the pre-prime or past-prime individuals, e.g., the one attempting to get hold of a territory in the prime habitat area, or the one just ejected from a territory in the prime area.

2.3. POSTULATION THREE

In poor habitats and low populations territorial patterns may be absent.

In poor habitats the territorial pattern may be absent. However, the population density of the tiger in such an area is more likely to be low and ascertaining just the presence of identified individuals can give the number of the residents in the area.

3. The Pugmark

3.1. PUGMARK: *Evidence of Tiger's Presence*

Tigers like to walk along motorable or other dirt tracks, fire-lines, footpaths, animal trails, open, clear stream banks, beds of dry streams (*nullahs*), saddles and passes on the ridges. Such routes offer better visibility and an increased possibility of quietly detecting the movement of prey species. While doing so, they leave pugmarks on sandy, dusty, moist or even gravelly substratum. Soil moisture greatly enhances the definition of the pugmark, though too much of it (wet sand or slush) would render the substratum unsuitable. In dry areas with little or no vegetative undergrowth, it is often easy to locate tiger tracks close to water- holes.If the recording of the pugmarks is carried out over a period of one or two weeks, it is possible to pick up the pugmarks of all the tigers in the area, provided the search is conducted systematically and thoroughly.

3.2. PUGMARK: *Design*

The tiger's paw is a supple organ which adjusts itself to the ground on which it rests. The paw consists of a pad and four toes. A fifth toe, which corresponds to the human thumb, is held higher on the limb and does not make an impression on the ground. The front paw of a tiger is always larger than the hind paw. The toes are numbered 1, 2, 3 and 4. The print that the paw leaves on the ground, therefore, consists of four toes arranged in a semi-circle over a large pad. The pad itself is tri-lobed at the rear and has a flattened front-edge.

3.3. PUGMARK: *Its Identity*

Studies have shown that several distinguishable morphological features of tiger footprints can be used to describe individual tigers. The shape, size and various other parameters not only help identify different tigers, but also help determine the sex and sometimes even the age of the animals.

It is however not easy to isolate individual tigers from a set of pugmark plaster-casts or tracings as variations in the soil conditions can produce considerable differences in the size and at times even the shape of the print of the pugmark. Hence, considerable experience in the selection and recording of pugmarks is called for. Besides, a variety of supporting field data can help in enhancing the quality of the analysis through a better interpretation of the different recorded pugmarks. Detailed knowledge of the terrain plays an important role in arriving at logical conclusions and avoiding duplicity. The need to identify individual tigers arises only when pugmarks are found in two adjoining areas.

3.4. PUGMARK: *Effect of Soil*

Depending on the ground conditions, the impression of the paw may appear splayed or compact. Such differences, which can alter the pugmark size of the same individual, can be interpreted in the context of the differences in the texture and moisture content of the soil. In thick slush or coarse sand the splayed impression will show a wider gap between the pad and the toes, and generally, a seemingly larger pad. While on firm substratum overlaid with dust or fine sand, the impression will be well knit and representative of the pad. However, a pebble underneath can displace a toe or change the outline of the pad. Care is therefore essential in proper selection of the pugmark, giving preference to a longer trail of tracks on an amenable substratum, particularly in areas of high tiger density.

The tracer must meticulously note down the ground condition, age of the track and other relevant information, along with a plaster cast. In such a situation, the person who finally analyses the field data uses his experience and judgement, taking care to retrace the pugmark from a plaster cast often considering all other field information. If not satisfied, the data may be rejected with a simple statement about the 'occurrence of a tiger'. If the problem is detected early and the PIPs are still available, or ground conditions are favourable, an attempt can be made to obtain interpretable evidence.

3.5. PUGMARK: *Measurements*

The Pugmark Length (PML) and Pugmark Breadth (PMB) are outer measurements. PML is the measurement from the tip of the farthest toe to the base of the pad along the line of walk, while PMB is the measurement between extreme ends of the first and the last toe. These are measured by drawing a box (all corners at 90 degrees) touching the extreme ends of the pugmark. Figures 1 & 2 illustrate how these are measured. Toe to Toe Breadth (TTB) and Pad to Toe Length (PTL) measurements are taken from the centre of the pad/ toes, and are taken into consideration when comparing pugmarks made on varying soil conditions.The centres in these measurements are the eye-estimated cross-points of the long and broad axes of the corresponding part.

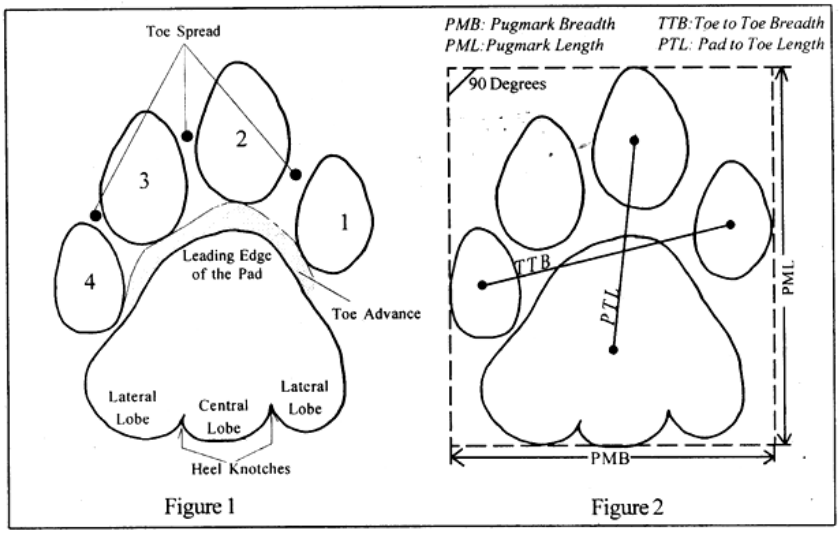


Figure 1 Figure 2

4. The Tiger's Walk

Pugmarks left on the ground by a tiger walking at a normal pace are made in such a way that very frequently only the impressions made by the hind paws are clear . This is because normally the hind foot comes to rest wholly or partly upon the corresponding front foot, left upon left and right upon the right. Therefore, very often, due to partial or complete superimposition of the front pugmarks, only the hind pugmarks are available for recording in an intact form (Fig. 3).

During a slow gait the hind pug falls behind the impression of the corresponding front pug (Fig. 4). On the other hand, during a fast walk the hind pug goes ahead and falls in front of the impression of the front pug (Fig. 5). During a slow or fast walk, provided the ground conditions are favourable, all the impressions of left, right, front and hind pugs are available in the field. However, of all four, it is the hind pugmarks that almost always remain undisturbed by the tiger's walk.

4.1. THE STRIDE AND THE STEP

A stride is the distance between two successive prints of either the left or the right hind foot as a result of a single complete movement of the particular leg (Fig. 3).

A step is the distance between the successive left and right hind foot prints measured vertically between parallel lines drawn at 90 degrees to the direction of the walk (Fig. 3).

It is recommended that the stride/step measurements be taken between the leading points on the pads of the successive pugmark. The stride/step measurements are helpful in distinguishing between individual tigers, as also tiger cubs, and leopard tracks (See p.8).

A ***step*** measures half as much as a ***stride***. The measurements are best taken on level surfaces (*avoid measuring these distances on slopes*). In case either the step or the stride is missing, the other can be calculated by applying the formula :

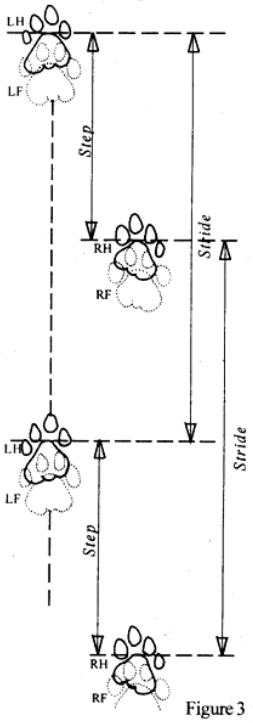
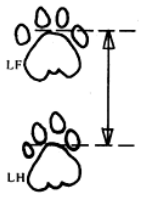


Figure 3
NORMAL WALK



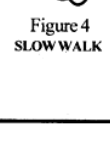


Figure 4
SLOW WALK

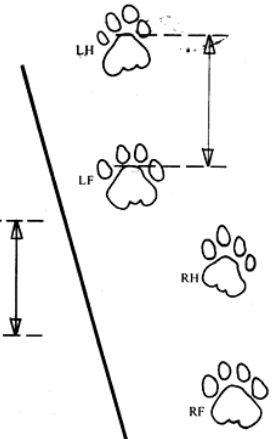


Figure 5
FAST WALK

stride = two steps

When the tiger has walked at a normal pace leaving impressions of two hind pugs, irrespective of left or right, the stride is measured from these. If only one hind left and one hind right impression are visible, the distance between the two pads is measured and doubled to get the stride.

The pugmarks of an adult leopard appear similar in size to that of a tiger cub of about four months age. But the stride of a leopard is longer than the stride of a tiger cub. In the case of the tiger, the stride is about ten times the length of the hind pug, while in leopards it is about 12-14 times the length. For a minimum pugmark length of about 9.0 cm, for a tiger cub the stride is about 80-90 cm, whereas for the leopard, it is above 100 cm. For the same pad size the toes of the tiger are larger than the toes of the leopard, and this striking structural variation helps in distinguishing between the two. The spread (PMB) of a tiger cub's pugmark is also greater than that of an adult leopard with equal PML.

5. Pugmark Distinctions

5.1. DISTINCTION : *The cat's pugmark*

5.1.1. HOW TO SEGREGATE CAT PUGMARK FROM OTHER TRACKS

Various types of tracks made by other animals in the field can be categorised into four classes for quick distinction.

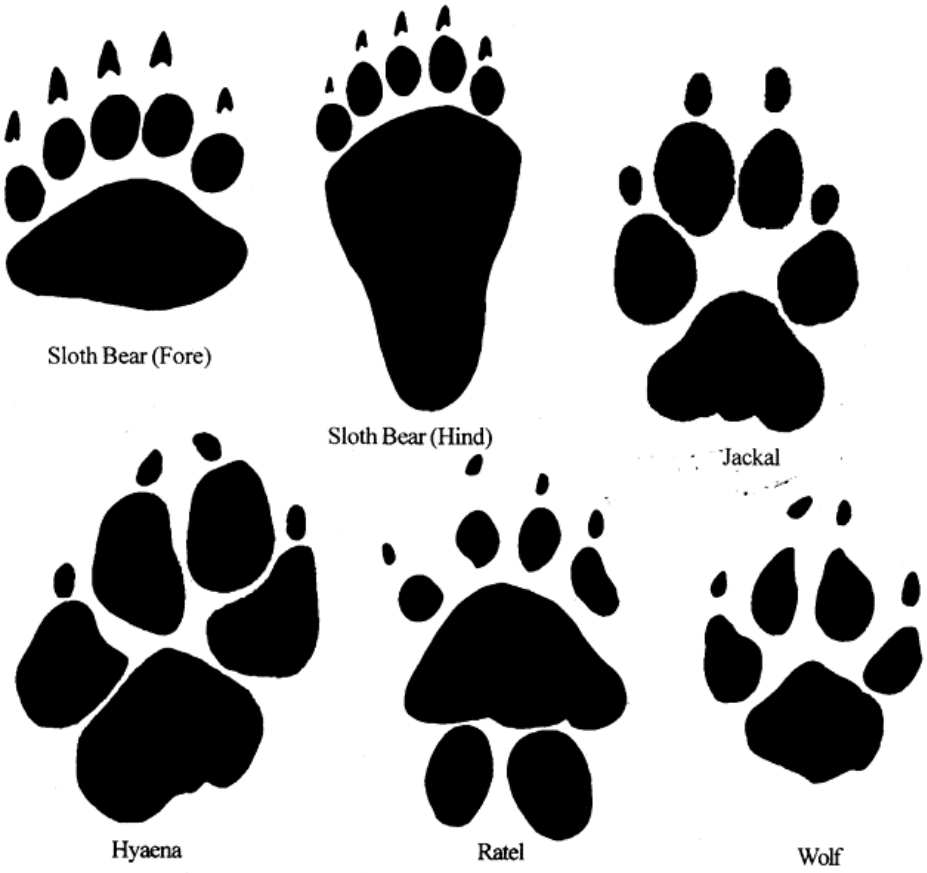
1. The elephant and rhino foot prints are easy to separate.
2. The tracks of hooved animals are also easy to separate, and these include animals like gaur, sambar, chital, barking deer, etc.
3. Animals with soft paws but extruded claws which leave clawmarks on the ground. Such animals are the wild dog, jackal, hyaena, wolf, bear and ratel. Among these the ratels may sometimes confuse beginners with tracks of a leopard or tiger cub. The two lobes at the back of the main paw separate the ratel from others (see p. 25)
4. The cats have a characteristic tri-lobed paw with four distinct toes and are without claw marks (Figs. 1 & 2).

5.1.2. LARGE CAT AND SMALL CAT

Large cats include the tiger, lion, leopard, clouded leopard, snow leopard and the cheetah, while the small cats include 10 other species found in different parts of the country (Annexure 1). Cat pugmarks (hind foot) with lengths between 4 cm to 9.5 cm are of leopards, and pugmarks above 7.0 cm of length may be of the tiger. Pugmarks smaller than these ranges are difficult to identify because these include the pugmarks of lesser cats.

5.2. DISTINCTION : *The Tiger's Front and Hind Pugmark*

Corresponding to the heavier front part of the tiger's body, the supporting fore legs and paws have a sturdier and large build as compared to that of the corresponding rear limbs.



As a result, the front pugmark is distinctly bigger, and this feature alone distinguishes it from the rear pugmark.

Additionally, if the protrusion of the second digit over the third digit is compared between the front and the rear pugmarks, it would be seen that there is more of a protrusion in the rear pugmark (Figs. 6a & 6b). This is another feature that distinguishes the fornt from the rear pugmark.

It is important to remember that in pugmark based enumeration only the hind pugmarks are taken into account because, as mentioned before, these are the ones most likely to occur intact in the field. The front pugmark often get partially or wholly superimposed by the hind pugmark by dint of the very nature of the gait of the tiger. However, where intact, the front pugmark can be recorded as additional evidence. A front pugmark must invariably be recorded in a case where it displays a typical mark/feature of the animal, e.g. a scar mark on the pad, or a foot twist. These would, of course, get recorded only where a single clear impression of the front pugmark is available on the ground.

5.3. DISTINCTION : *The Tiger's Left and Right Pugmark*

The leading toe in a pugmark is a ready means of finding whether it is an imprint of the right or the left foot. Reversed palms of both the human hands with the thumbs folded in can be visualised to simulate a pair of fore or rear feet of the tiger (Fig 7). The middle fingers of the two palms would then simulate the leading toes in a pair of tiger feet. If the leading digit

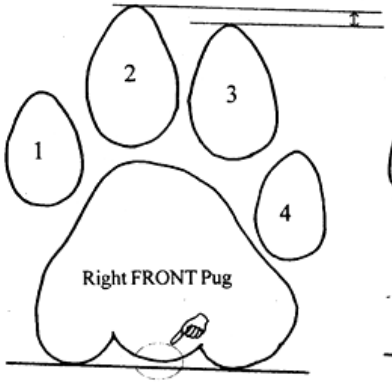


Figure 6a

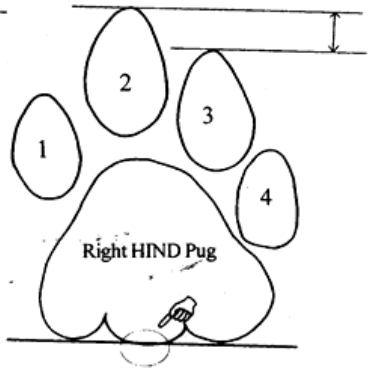


Figure 6b

is second from right, it would be the right pugmark, and if the leading digit is second from left, it would denote the left pugmark.

It is better to select and assign in advance either the left or the right pugmark as the standard one to be traced out all through the course of enumeration. Like human hands and feet, the left and right paws of the tiger are mirror images of one another. No additional information is gained by recording both, except in cases where one carries a typical identifying feature for the individual, e.g. a scar mark or a paw twist. In such instances, it will be essential to record both the assigned and the other pugmark. The WII, in its published manual on census techniques, suggests that the left pugmark be adopted as the standard. Since this manual is being used all over the country, prior selection of the left rear pugmark is prescribed here too. However, where no clear impression of the left hind pugmark is available, then the right hind pugmark may have to be taken into account.

5.4. DISTINCTION : *Identification of Male and Female Tigers from Their Pugmark*

As mentioned before, the hind pugmarks are taken into account to distinguish between male and female. On the prepared pugmark tracing draw a right-angled quadrangle touching the outermost extremities of the whole impression, including the toes. Care should be taken that the left and the right side arms of the quadrangle are along the direction of the walk, which should have been recorded on the tracing in the field itself. If the shape of such a quadrangle is close to the square, the animal is a male. On the other hand, if it is promi-

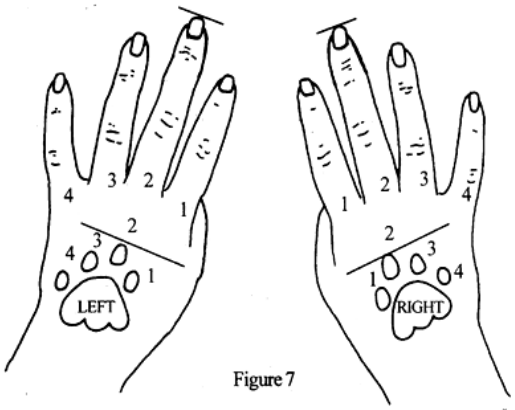


Figure 7

nently rectangular, it would be a female. It is important that both the pugmarks compared are representative, and do not suffer from any defect induced by substrate variation. For example, pugmarks recorded on deep slush or on deep dry sand would be given to splay and cannot be taken to truly represent the shape of the animal paw.

The shape of the toe prints of hind pugmarks also helps in determining the sex of the animal. Toe prints of males tend to be roundish or oval, while those of the female are more elongated. This distinction may not apply to the front pugmark.

In adult male tigers the PMB of the front pug is often greater than the PML. Therefore, in instances where no other clue is available to determine the sex of the tiger, such front pug dimensions, if available, can be used to conclude that they belong to males.

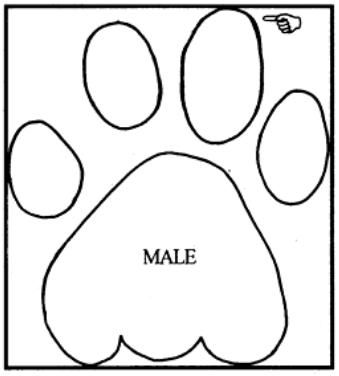


Figure 8

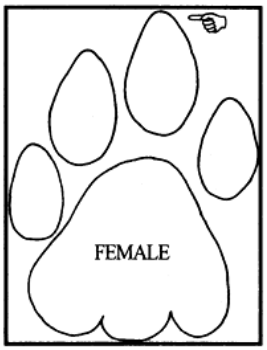


Figure 9

TABLE 1

SEX IDENTIFICATION OF TIGER*

A READY RECKONER BASED ON HIND PUGMARK LENGTHS (PML) AND CORRESPONDING BREADTHS (PMB)

All measurements are in cm.

A			B		
Standard PML	PMB		Standard PM_B	PM_L	
	Male	Female		Male	Female
9.0	8.3	8.0	8.0	9.5	10.4
9.2	8.5	8.1	8.2	9.6	10.6
9.5	8.6	8.3	8.5	9.9	10.9
9.7	9.0	8.5	8.7	10.0	11.0
10.0	9.3	8.7	9.0	10.3	11.3
10.2	9.5	8.9	9.2	10.5	11.5
10.5	9.7	9.1	9.5	10.7	11.7
10.7	9.9	9.2	9.7	10.9	11.9
11.0	10.2	9.4	10.0	11.1	12.2
11.2	10.4	9.6	10.2	11.3	12.3
11.5	10.7	9.8	10.5	11.6	12.6
11.7	10.9	9.9	10.7	11.7	12.8
12.0	11.1	10.2	11.0	12.0	13.0
12.2	11.3	10.3	11.2	12.1	13.2
12.5	11.6	10.5	11.5	12.4	13.5
12.7	11.8	10.7	11.7	12.6	13.7
13.0	12.1	10.9	12.0	12.8	14.0
13.2	12.3	11.0	12.2	13.0	14.1
13.5	12.6	11.2	12.5	13.2	14.4
13.7	12.7	11.4	12.7	13.4	14.5
14.0	13.0	11.6	13.0	13.7	14.8
14.2	13.2	11.7	13.2	13.8	15.0
14.5	13.5	13.4	13.5	14.1	15.2
14.7	13.7	12.1	13.7	14.2	15.4
15.0	14.0	12.3	14.0	14.5	15.7
15.2	14.2	12.5	14.2	14.7	15.9
15.5	14.4	12.7	14.5	14.9	-
15.7	14.6	12.8	14.7	15.1	-
16.0	14.9	13.1	15.0	15.3	-
16.2	15.1	13.2	15.2	15.5	-
16.5	15.4	13.4	15.5	15.7	-
16.7	15.6	13.6	15.7	16.0	-
17.0	15.8	13.8	16.0	16.2	-

* *In order to use this table follow the example below:*

Let the field measurment of hind pug PML x PMB = 13.1 x 11.0 cm. First take PML as base. In column (1) 13.1 is between 13.0 and 13.2. The corresponding PMB for these two are 10.9 and 11.0 for females, and is close to our field data. Therefore, the tiger is a female. Alternatively, take PMB valued at 11.0 cm as the base. The observed PML value of 13.1 cm is closer to 13.0 cm. PML table value for female, but is away from the table value for male i.e. 12.0 cm. Therefore, the pugmark is that of a female.

This ready reckoner has been developed by the author from field data collected at Simlipal Tiger Reserve. The equation presented in the table should be further tested in other locations. This will help in fine tuning the equations presented in the table.

Occasionally, it is difficult to ascertain the sex of a tiger/leopard from the type of tracing or plaster cast received for analysis. Yet, because of other field information, there may not be any dispute about the occurrence of a distinctly separate animal. In such cases a tiger or leopard, as the case may be, should be recorded in the report as "unknown sex". If , however, there is any doubt about the separate identity of the animal, it should not be counted at all.

5.5. DISTINCTION : *Similar Pugmarks in the Same or Adjacent Counting Areas*

Only in the rarest cases would one encounter pugmarks strikingly similar in shape and size in the same and in adjacent counting units. The first possibility is that they are tracks of sub-adult siblings of the same litter staying together after parting from the mother. The second is that the female siblings of the same litter occupy adjacent territories. In such cases it would be essential to prolong the exercise of locating and tracing pugmarks for identification until fresh pugmarks, similar in size and shape, are recorded at such a distance that would rule out the possibility of the same animal's simultaneous presence at another location. Even then, other recorded features at the two locations should be compared before accepting the fact of there being separate individuals. These features could be the relative lengths of strides, injury/pug-twist, and biometrical measurements PTL and TTB (Fig. 2). Even after such examination, if unequivocal distinction does not emerge, the two should be taken as belonging to the same animal.

5.6. DISTINCTION : *Age of Pugmark*

A fresh pugmark bears very sharp and distinct edges of its pad and toes. But due to wind and dew, the pugmarks lose their sharp features even by th end of one day. In simple terms, when fresh, the impression has sharp edges, and when it is old, edges become defused. With this clue and on the basis of the gap between visits to the area, the age of a pugmark can be calculated.

Pugmarks made near water have a longer life and may retain their features even after a week or more. Some of these pugmarks can be related to rains in the past. Such information is to appear in Form 'A' for later correlation.

During the estimation week when a pugmark is seen for the first time, its age is ascertained as explained above and the pugmark is obliterated after collecting the necessary data. During this period each area is searched at least twice. Therefore, when a pugmark is seen during the second search, its age could be upto three days old. At this stage, in order to determine how fresh the pugmark is, it has to be seen whether there are any dust particles on it, and if the sharp edges have eroded. Accordingly, the age can be fixed as fresh (one day old, previous night) or two to three days old. Heavy dew, especially in the winter, leaves marks on the soil similar to those of a light drizzle. If the pugmarks have been imposed upon such dewy soil or sand, they would have been made in the early morning as that is when the dew is the heaviest.

The process of judging the age of a pugmark falls in the realm of 'fine art' and is best left to those who can use it. Since it requires a high degree of skill and experience it may not be suitable as a mainstream parameter of this population estimation technique.

5.6. DISTINCTION : *The Tiger Cub and the Adult Leopard*

The maximum length of the pugmark (PML) of a leopard (about 9-10 cm) is smaller than the pugmark length of even a 3-4 month old tiger cub. At this age a tiger cub would have just started accompanying the mother. Besides size, there are other features that distinguish the two. The most important and, in itself adequate, is that a tiger cub having a pugmark size equal to or smaller than the biggest size leopard pugmark, would not move except in the company of its mother. So, if adult female pugmarks are absent, they should be taken as belonging to a leopard. A further corroborative feature is that proportionately, the toe-size in relation to the pad-size in the case of tigers is distinctly larger than the proportionate size difference between the toes and the pad in the case of leopards. This feature is so marked that even in the pugmarks of a 3-4 month old tiger cub the proportionate size of toes is larger than in the case of an adult leopard. This means that for the same size of pad as an adult leopard, the toes of the youngest tiger cub whose tracks would be seen, are larger.

TABLE 1

SEGREGATING TIGERS FROM LEOPARDS
The Males, Females and Cubs

LEOPARD	PML cms	TIGER
Leopard cub	*5*	*Lesser cats*
	5.5	
	6.0	
	6.5	
Adult male PML ; PMB < or = 1 cm	*7.0*	
	7.5	
	8.0	
	8.5	*Tiger cub*
	9.0	
	9.5	
	10.0	
	10.5	
	11.0	*Adult male PMB ; PML < or = 1.5 cms Follow ready reckoner Table 1*
	11.5	
	12.0	
	12.5	
	13.0	
	13.5	
	14.0	
	14.5	
	15.0	
	15.5	
	16.0	
	16.5	
	17.0	

B. COLLECTION OF FIELD DATA

6. Schedules and Procedures

6.1. SYSTEMATIC APPROACH

The fundamental approach in pugmark-based estimation of tiger populations is to shift pugmark evidences from the field to the analysis room. This data is in the shape of pugmark tracings, plaster casts and associated information. During analysis this data is subjected to a rigorous process of elimination to **arrive at an estimated minimum size of tiger and leopard populations**. In this kind of population estimation, efforts must be made to compensate for the varying ground conditions. The technique definetely requires experience.

6.2. SEASONS FOR SEARCHING PUGMARK

The best period for searching tiger pugmarks is during the dry season (December-March) when a soft substrata exists in the sandy riverbeds, and on roads and trails with enough sand for a desired imprint. The second best period is the early dry season (September-November).

6.3. ON THE FIELD

The field days for conducting the exercise have to be a minimum of seven consecutive days. Large predators are always on the move irrespective of the period of the exercise However, the movement of large predators could be more prominent around new moon and full moon nights essentially because of increased sighting success.

6.4. PREPARATIONS

Preparations before the actual collection of field data should include the following:

1. Filling up of FORM-A and FORM-B
2. Identification of localities and routes where tiger movement is known
3. Allotment of routes/areas to specific personnel
4. Selection of NGOs for participation, if deemed appropriate.
5. Procurement and distribution of field kits.
6. Determinaton if the ground condition is good enough to register marks
7. Training
8. Creation of PIPs (Pug Impression Pads) if necessary along appropriate routes and places.
9. Movement of NGOs (if being co-opted) and staff to the camps of respective field units so as to reach there a day before the commencement of operations.

6.5. FIELD ROUTE / PERSONNEL IDENTIFICATION

The grassroots person in the field operations is the "Participant" or Forest Guard. If a Forest Guard is newly posted or a Forester is holding the charge of the area, at least one of the three persons comprising the field unit must have a good knowledge of the area where field work is to be carried out.

The assistants have an additional role during tiger population estimation exercise. Two members of the field unit should keep a watch while the third one is stooping down to prepare a pugmark tracing or plaster cast. The assistants also help in maintaining the camp as well as in taking measurements and maintaining PIPs, and obliterating pugmarks after recording data.

6.6. PRE-COUNTING DATA COMPILATION

There are some aspects which can be completed before actual tracking operation starts. These informations are also required for better planning for tracking of tigers in a new area and reduce work dueing the counting-operation in a known area.

6.6.1 FILLING UP OF FORM-A

This Form (Annexure-II) can be filled in about 60 days before actual counting. This is about the habitat condition of a field condition of a field unit and about the past and recent records of tiger and leopard movement in the unit and its adjacent.

6.6.2 FILLING UP OF FORM-B

This Form (Annexure-II) can be filled in about 45 days before actual counting. This is about the common herbivore and other species found in the area.

6.7. DISTRIBUTION OF KITS

The field kits should be distributed to the field unit leaders on the day of Division-level training. Ideally the kit should contain the following material.

Tier tracer, Sketch pen, Ball-point pen, Two meter long measuring tape, FORM D, Water bottle (2 liters), Mug (500ml), Plaster of paris (medical grade), Aluminium strip (3 cm wide) Census bag.

6.8. TRAINING

The main objective of the training should be to discuss the method, time schedule, funds provision and development of a sense of participation at all levels. Each participant from the level of Conservator of Forests downwards should be able to attend or conduct at least two sessions of training. While the first may be to develop a better insight, the second is to clarify doubts of other participants. A gross schedule for training can be drawn up as shown in the chart overleaf. Those involved in day-to-day field supervision must be trained to cover each counting unit in the area and must be available for verifying and correcting data recorded in the field .

SCHEDULE FOR TRAINING

Level	Participant	Date/Time
State	CWLW, State Coordinator All Conservators of Forests All Regional Coordinators	60 days in advance
Region or Circle	State Coordinator Conservator of Forests Regional Coordinator, DFOs, ACFs	45 days in advance
Division	DFO, ACFs, Range Officers, Foresters, Forest Guards	30 days in advance
Range	ACF, Range Officer, Forester, Forester Guard	10 days in advance

6.9. RESTRICTION ON VEHICLES

Where forest areas are used for tourism, bamboo working or other such operations, it is better that all such activity be stopped or restricted. Preventing the movement of vehicles in the field units will increase the probability of recording pugmarks.

It is also advisable to restrict all necessary vehicular movement to after 9 am, before which data collection in each unit must be completed. Where PIPs are laid along roads on which vehicles ply, all the drivers have to be instructed to drive slowly and avoid PIPs, at least along the main wheel tracks (Fig. 10). That is, before they come across a wheel track, they should slow down and proceed in such a manner that wheels on one side remain out of the main wheel tracks, and wheels of the other side remain between the wheel tracks (Fig. 10).

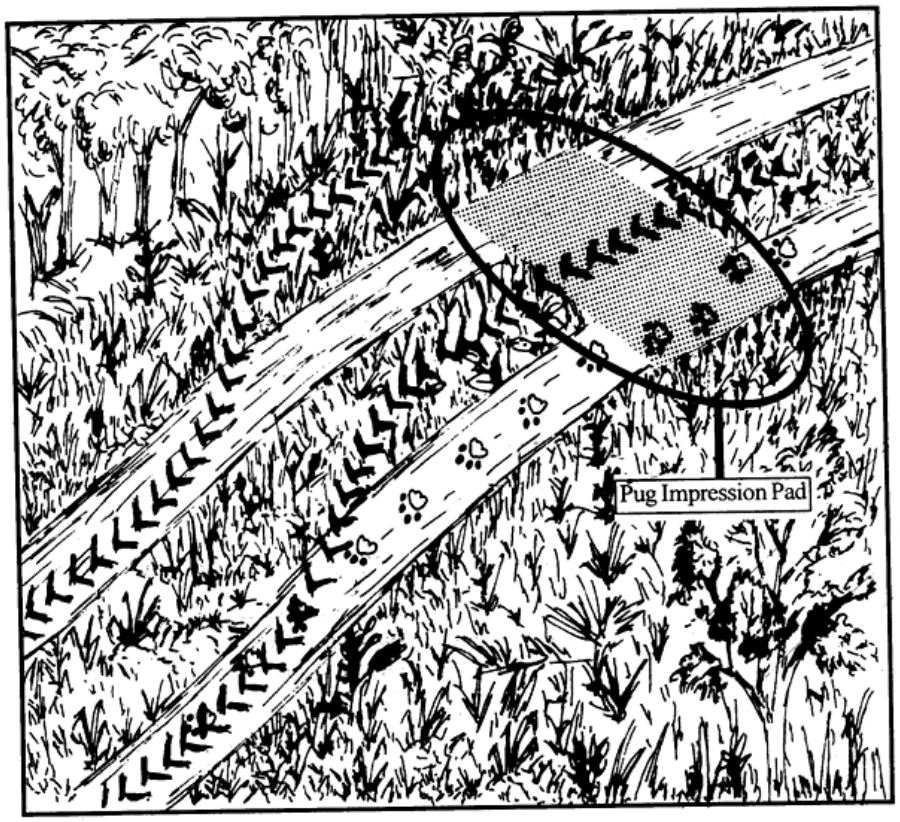


Figure 10

When vehicles approach Pug Impression Pads or pugmarks of a tiger on any track, they should slow down and proceed in such a manner that wheels remain out of the main wheel tracks leaving the pugmarks intact.

7. Pug Impression Pad

7.1. PREPARATION AND MAINTENANCE

Each PIP extends along the entire width of the road/route and stretches at least two metres along the length of the road. Where the route is narrow, PIP can be of an appropriate size in length and in width. The soil is removed to a depth of at least two to three centimetres. The area is then filled up with well powdered fine earth sieved through a fine wiremesh.

It is best to clear the PIP with a brush and remove small pebbles. In certain cases the entire width of the road is dug by 10-15cm, and the soil thus extracted is beaten to dust and then sieved through the fine mesh before relaying it on the PIP.

PIPs can also be laid down across routes leading to water holes. In such cases it has to be ensured that the PIP contains a fine dust of earth and is suitable for registering the edges and features of the pugmark. Sometimes a thin layer of ash on a hard ground serves the purpose but it is not encouraged because it may lead to the burning of dry leaves to prepare ash.

Each PIP must be numbered showing the census unit serial number, the name of the route and the PIP serial number. For example, ***7/CH-TLB/21*** means the PIP is in field unit number 7 along Chahala-Talabandh route and bears the serial number 21.

All laying of PIPs must be completed at least seven days before the commencement of the field operations and freshened 2-3 days before the start..Each PIP should be checked at least twice in the seven day period of field work.

After recording of observations, each PIP is cleared of old tracks and litter like dry leaves. One easy way to do this is by brooming the PIP with a green leafy branch.

7.2. DISTRIBUTION OF PIPs

PIPs are to be layed out in such a manner that at least one of them registers the pugmarks of a tiger that walked along the route. The PIP is laid out at such points that a walking animal cannot avoid it. If there are boulders, trees or bushes on the sides, then the animal is almost compelled to keep to the middle of the path, and thus leave its pugmarks on the PIP.

On jeepable tracks , when there are two treadways, the animal normally keeps to any one of these treads. At crossroads and at the beginning of other roads, 3-4 PIPs are laid 50-100 metres apart. After about 500-1000 metres, again a cluster of 3-4 PIPs can be laid with 50-100 metres spacing between two PIPs. Keeping in mind the importance of a route, the above number or pattern of PIPs can be increased or decreased.

8. Procedure in the Field during Census

8.1. WHERE TO LOOK FOR THE PUGMARK

The tiger's pugmarks are searched for along roads, tracks, river banks, beds of dry streams, firelines, animal trails and near water holes.

It is not easy to see pugmarks in certain habitats where the ground is grassy or is composed of hard soil and may even be rocky. Also, leaf litter during autumn prevents the formation of pug impressions. In such areas, artificial impression pads are created. These pads have loose soil spread over a small area suitable for registering pugmark impressions along known routes of tigers. Such Pug Impression Pads (PIPs) are made by physically clearing the leaf litter, loosening up the soil or, if need be, spreading loose soil over a hard substratum.

8.2. DATA COLLECTION

All seven days have to be devoted to collection of data on the tiger. During the first three days all the routes and locations within the jurisdiction of each unit have to be searched. During the fourth to sixth days, the same areas are to be searched in the same chronological sequence. On the seventh day, certain areas can be rechecked if necessary.

8.3. FILLING UP OF THE DATA SHEET

All the information required must be filled in the data sheet. Before tracing the pugmark, stride measurements have to be taken carefully without obliterating any signs on the pugmark on the ground. Plaster casts have to be prepared last, after the tracing.

8.4. SELECTION OF PUGMARK FOR TRACING

Normally there will be a number of pugmarks along a route or on a PIP. It is recommended that the best hind pugmark available for the right or the left side be selected. **For any particular year the left or right pugmark has to be kept constant and must be assigned by the CWLW for the entire state.**

Suppose, for example, for 1997 it is decided to trace the right hind pugmarks, but at some place only the left pugmarks are clear, then we may record the left pugmarks. After all, left or right will be necessary only for individual identification. Similarly, if no hind pugmark is available we can record the front pugmark. But this may not indicate details like the sex of the tiger.

In Nepal, however, pugmarks of all four paws are recorded. This is based on the fact that distinguishing features (like deformities) may be on any of the four feet.

8.5. PUGMARK TRACING

After measuring the stride, select a pugmark for tracing, place the Tiger Tracer on it so that the glass surface remains as close to the pugmark impression as possible, but without actually touching the mark and distorting it.

For accurate tracing, the person who is doing it has to rest on the ground on his knees and position, his eyes vertically above the Tiger Tracer. This will eliminate reflections and parallax in viewing the pugmark.

In case the pugmark is deep with a distinct wall on the edges because of loose dry earth, a judicious decision has to be made about where exactly the original edges of the pug would have been. Where no decision can be taken easily, it is best to follow a middle line between the upper and the lower edges of the deep pugmark.

Trace the outline of the pugmark along the pad, its notches and toes. Sometimes, one or two toes may not be distinct. In such cases draw the portions which are clear and give a dotted outline for the portions which are considered appropriate to complete the outline.

All tracings on the Tiger Tracer have to be done distinctly with a sketch pen. Now place Form 'D' with the plain side on the top of the tracing on the Tiger Tracer. At the space provided for the pugmark retrace the drawing from the glass with a sketch pen.

8.6. PLASTER CAST PREPARATION

After drawing all pugmark tracings, select where possible, a good hind pugmark of which a plastercast can be made. Such a pugmark should preferably be on fine earth and be at least 2-3 millimetres deep.

Spread a uniform thin layer of French chalk powder or the Plaster of Paris itself on the pugmark. Provide a boundary at least two centimetres high around the pugmark. The boundary should preferably be of thick cardboard or tin plate.

To prepare the plaster casts of an adult tiger's pugmark take about 350ml water in a mug and add Plaster of Paris powder gradually but quickly with constant stirring. When the mixture assumes a thick consistency gently pour it on the pugmark along the stirring stick from one side. Allow the cast to dry up and harden. Before it dries up completely, write down the following information with a fine stick:

(a) Unit name	(b) Unit number
(c) Date	(d) Plaster cast serial no and the date
(e) Location	(f) Initials of unit leader
(g)Length of stride and step	(h) Reference number of tracing

After the plaster cast hardens lift it from one side and with support from the bottom place it on some leaves and carry it carefully to the camp. At the camp the plaster cast may be cleaned by pouring water over it gently. Do not try to clean with a stick or by rubbing with finger. This will deface the sharp features of the pugmark.

9. Deposition of Field Data

At the first opportunity transfer field data from the Participant (Forest Guard) to the Organiser (Range Officer) taking utmost care of the plaster casts, tiger tracings and other papers.

Outside Tiger Reserves, estimation work is often an additional assignment fitted into the routine work. Besides, the entire process of analysis and compilation at various levels is a chain of events dependent on feeding of information from the field level to the Government of India. Therefore, it is urged that deposition of field data and subsequent reports must follow a definite time schedule.

9.1. DATA TYPES

At the end of the estimation week, the types of data available for interpretation are the records of sighting or kill evidence in the recent past in the beat or its neighbouring beat; records on direct sighting during estimation; tracings of pugmarks along with relevant field information; and the plaster casts of the pugmarks. In addition, information on the terrain cover and man-tiger conflict should also now be available.

C. ANALYSIS

10. Analysis : Scope and Modalities

10.1. HABITAT CONDITIONS

The most critical post-field component of the technique is the comparative analysis of the pugmark tracings in the light of other information returned by the enumerators and supervisors. The main objective of this analysis is to identify as accurately as possible the individual animals in a given area from the pugmark tracings, concurrently using the other information submitted by the field personnel. Ascertaining age and sex structure of the population, determining an area- wise profile of the ranging patterns (broad land tenure patterns), and obtaining crude information on habitat quality, can be the other objectives of the analysis.

It must be recognised that being carried out over large areas by a large assemblage of field staff whose acquisition of skills through training can be but limited, the method can only give broadly reliable estimates of the population. This is what should be expected, and should also be considered adequate when the exercise is carried out on a large scale in a limited field period of a week or two. This technique is also the most cost effective and least demanding of equipment, for any scale of operation. This is not to berate the other methods, but rather to emphasize the field-friendly features of this technique. As stated earlier, the technique itself, when consistently applied by skilled and experienced managers or researchers over long periods in a given area, is capable of yielding fairly accurate results on all the above determinants. The sequencing and processes of the different steps of the analysis are described on the following pages.

Independent studies are in progress at many places to assess habitat conditions. Yet, the information asked in Form 'A' is a ready assessment of ground realities from the experience of field staff. This will remain as a record with the Range Officer for future compilation and reference but will be of immediate use during analysis of pugmark data.

10.2. LARGE CAT OCCURANCE

Form 'A' will enable one to conclude if tigers and leopards are there in the enumeration beat and its neighbourhood. This data will help during analysis of pugmark data.

10.3. POPULATION STRCUTURE

The foremost objective of analysis will be to ascertain range-wise male female cub composition of tiger and leopard populations, along with their movement areas. Knowledge about the movement areas will be of help to the management.

10.4. DISTRIBUTION MAP

Division maps are prepared and are based on data from each Field Unit. These maps show the distribution of tiger and leopard males, females and cubs.

Distribution maps for the state show the total number of tiger and leopard males, females and their cubs at division level compilations.

10.5. OTHER ANIMALS

Specific studies may be in progress in certain areas to ascertain the status of other animals. However, information provided in Form 'B', on compilation, can be useful for a state-level appraisal. The information will be about the presence or absence of species and provide a broad picture on population status.

11. Analysis : Procedure

11.1. DATA SHEETS

Based on information in Form 'A' the following data is to be compiled at the Range level (this compilation is done before actual census) :

(1) Past record of presence of tigers and leopards in the field unit based on cattle killed.

(2) Past record of presence of tigers and leopards in the neighbouring field unit based on cattle killed.

11.2. SCREENING

At the first instance, the tracings of footprints of animals other than the tiger and leopard are to be separated. Check and reject all tracings and plaster casts of animals like ratel, hynea, wolf, bear, jackal, fox, etc. At a later stage when the pugmark lengths are measured the lesser cats will also get excluded.

11.3. CODIFY AND CORRELATE

For better reference, each tracing and plaster cast should be given a coded number. For example, CH/94 on a tracing will indicate the 94th pugmark tracing received from Chahala Range. If the same pugmark has also been obtained as a plaster cast, the plaster cast serial number, say PL/CH/38, shall be written on the corresponding tracing named CH/94. Thus, each plaster cast will be correlated to its corresponding tracing.

11.4. REDRAWING A PUGMARK FROM A PLASTER CAST

When the pugmark tracing received from the field appears deficient and the plaster cast received for the same animal is of good quality, the cast can be used to prepare a tracing suitable for use in the analysis. A good cast is a true replica of the pad and therefore it is easy to recreate the pugmark impression on a suitable substratum. Put lightly moistened fine sand in a shallow cardboard box and level its top surface. Press the plaster cast on sand in order to get the pugmark impression. Trace the pugmark as in the field in order to obtain a proper tracing, and mention this on the plate, citing the plaster cast from where it has been obtained.

11.5. DIRECTION OF WALK

It is important to record by an arrow mark the direction of walk on the tracing, in the field itself. The direction of walk is to be ascertained from a trail of pugmarks and not from any single pugmark. The direction is given by a line passing through the middle of the two trails marked by the left and right feet in the course of movement (Figures 3 & 4). After visually ascertaining this line on the ground, it should be recorded as a line with an arrow mark on the tracer plate itself before it is removed from the pugmark on the ground. This is transferred to the tracing sheet along with the pugmark itself.

11.6. BOX PLOTTING

A box in the form of a right-angled quadrangle is to be drawn around the pugmark. The quadrangle is drawn in the manner described under 'Identification of sex of animals from pugmarks' on page 7. The base of the rectangle gives the PMB, and its vertical side the PML.

11.7. MEASUREMENTS

Record PML and PMB as well as the stride on the tracing sheet beside the pugmark as PMLxPMBxS.

11.8. ASSORTEMENTS (Tables 1 & 2)

(a) Select only the hind pug measurements. Retain front pug tracings for possible reference at a later stage. The various distinguishing procedures described earlier should be applied to separate the pugmarks of an adult leopard and tiger cub, and the male and female of the two species. Such sorting is required to be done initially by the basic counting unit, and is then to be carried out in successive steps for each Supervisor's area, for the forest range, and for the forest division/PA. In fact, the sorting as above and the comparative analysis

ought to be carried out concurrently. Special care will need to be exercised when examining the tracings and the information from adjacent areas, particularly if habitat contiguity is present.

(b) For additional information and to reconfirm the foregoing separations, proceed with the hind pugmark measurements as listed in the following page.

Leopard:	(i) PML = 5 - 9.5cm (ii) Stride more than 10 times PML, and /or (iii) Pugmark features (see text)
Tiger:	Other pugmarks
Leopard cub:	PML equal to or less than 7.0 cm
Leopard male:	PML - PMB difference less than 1 cm
Leopard female:	PML - PMB difference more than 1 cm
Tiger cub:	PML - less than 10 cm
Tiger male/female:	Follow the ready reckoner (Table 1)

Total reliance on the ready reckoner for sex distinction is not advised. In case of doubt it is advisable to enter 'sex unknown' instead.

11.9. PROCESS OF COMPARATIVE ANALYSIS FOR IDENTIFICATION OF INDIVIDUALS

1. Postulations 1 to 3 indicate what patterns to expect in the light of habitat quality of a given area. The identification of individuals must, however, proceed along the tenets of pugmark details.

2. Start with grouping together identical and similar looking pugmarks of the same sex in the broad age catergories (adult and cub) for any basic counting unit / census route.

3. Establish correlative groupings of mother-cub associations and, in relatively rare cases, the associations of courting male-female and sub-adult siblings. These pugmarks ought to have been encountered at the same site and at the same time. Further, in the case of the mother-cub association, more than one such recording of simultaneous evidence is to be expected. But even if there is at least one such irrefutable evidence obtained in the form of collective trails signifying simultaneous movement of individuals constituting the mother-cub association, it should be taken as firm. In case of other associations, at least one replication even during the short enumeration period should have been seen in order to accept and record as an association. Such associations are more likely to be encountered in the better quality habitats, but may be noticed even in poorer habitats.

4. Identical and similar looking pugmark tracings should be compared by laying them over each other and holding the overlay against light. Based on such comparison, separate the groups belonging to individual animals. Some of the salient features to be looked for while distinguishing between individuals are as follows:

(a) The shape, length and the inclination (to the direction of walk) of the top edge of the pad.
(b) The shape and sag (with respect to the direction of walk) of the two larger side lobes of the pad.
(c) The shape and size of the smaller middle bottom lobe of the pad.
(d) The pointing-direction (with respect to the direction of walk) of the tips formed by the junctions of the two sidelobes with the bottom middle lobe of the pad. The pointing-direction is given by a line bisecting the angles formed by the above mentioned lobe junctions at the bottom of the pad.
(e) The repetitive feature of the constant distance between the top edge of the pad and the leading digit in pugmarks of the same individual recorded on firm substrata in different locations.
(f) Any typical repetitive feature of the injury mark(s) on the pad or a toe, or a consistent paw-twist (with respect to the direction of walk) as an unequivocal feature of individual identity.

5. When individual identity is established for a particular animal, only one or two of the most representative pugmark tracings may be retained for record and reference and the rest rejected. The accepted tracing will be marked, as TM15/accept, and the rejected ones will be marked as TM15/reject.

6. Proceed with similar examination of the tracings from the adjacent unit(s), and after the segregation as above of the tracings from within the unit, undertake inter-unit comparison among adjacent units. Such comparison is required to be taken up successively for the larger counting areas, e.g., a forest range, or a forest-division, or a national park, each of which may be comprised of many basic forest-beat level counting units.

11.10. MOVEMENT AREA

From all tracings and plaster casts for the same animal, list out all places where it has been recorded. While preparing this list, also refer to the front pug tracings now given the same code number, say, TM15/X.

The list will indicate the movement area. Write down the movement area on the accepted tracing as shown in the following example :

TM15/Accept/13.5x12.9x132cm/Devasthali-Mahabirsal-Ganapati

12. Reporting

12.1. RANGE REPORT

The Range Report is to be furnished in Form 'E'. The information for this is compiled from analysis statements recorded on the "accepted" pugmark tracing for each tiger.

12.2. OTHER REPORTS

Other reports are primarily compilations of data received in the data sheets. However, at the time of compilation of division level data (Form 'F'), elimination of overlappings be-

tween ranges has to be carried out. Information on data sheets and discussions with the Range officers will facilitate this work.

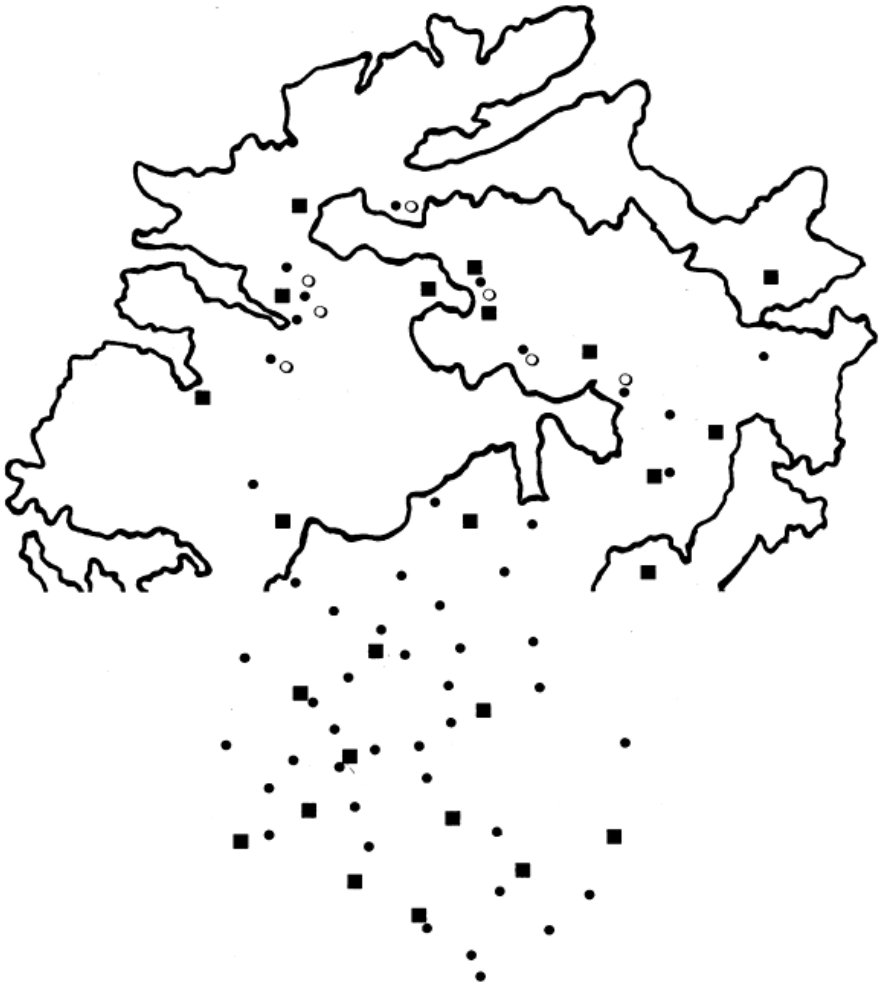
Similarly, inter-Division overlappings are to be eliminated at the time of circle-level compilation (Form 'G'). Compilation in Form 'H' for the state is a simple addition of the figures from all division level data.

12.3. THE FINAL REPORT

The final report will contain the same type of information as that described for low density areas, That is, it will indicate the species, sex, serial number and movement area of the tigers and leopards separately. Other reports in Form 'F' and Form 'G' have been discussed earlier.

12.4. DISTRIBUTION MAP

Based on the information in Forms 'E', 'F' and 'G', the distribution maps for tigers and leopards are to be prepared separately. The maps for, Division, PA and Tiger Reserves have to be more detailed showing the composition as male, female and cub for the two species (Fig. 16)



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E. ANNEXURES

Annexure - I

Large Cats	THE CAT FAUNA OF INDIA			
		Wildlife (P) Act Schedule	CITES Appendix	Red-data Book
1 Tiger	*Panthera tigris*	I	I	Endangered
2 Leopard	*Panthera pardus*	I	I	Threatened
3 Asiatic lion	*Panthera leo*	I	I	Endangered
4 Clouded leopard	*Neofelis nebulosa*	I	I	-
5 Snow leopard	*Panthera uncia*	I	I	Endangered
6 Asiatic cheetah	*Acinonyx jubatus*	I	I	Endangered (extinct ?)
Lesser Cats				
7 Leopard cat	*Felis bengalensis*	I	I	-
8 Finishing cat	*Felis viverrina*	I	II	-
9 Jungle cat	*Felis chaus*	II	II	-
10 Desert cat	*Felis libyca*	I	II	-
11 Pallas cat	*Felis manul*	I	II	-
12 Golden cat	*Felis timmincki*	I	I	Indefinite
13 The lynx	*Felis lynx isabellina*	I	II	-
14 Rusty spotted cat	*Felis rubiginosa*	I	I	Insufficiently known
15 Marbled cat	*Felis marmorata*	I	I	Indefinite
16 Caracal	*Felis caracal*	I	I	-

Annexure - II

ESTIMATION OF WILD TIGER POPULATIONS IN INDIA

Let us count our Tigers and Leopards (JAN 2001)

FORM 'A'
Parts One,Two and Three **A** 1,2,3

To be filled up by: ***Range Officer*** *in consultation with the* ***Forester*** *and* ***Forest Guard***

A0.1 Field Unit Number: ***A0.2*** Species: Tiger ☐ Leopard ☐

A.0.3 Date of filling up of forms

Part One : Locations

A1.1	Division	***A1.5*** Name of participant
A1.2	Range	***A1.6*** Address (Field Unit)
A1.3	Section	***A1.7*** Co-ordinator
A1.4	Beat	***A1.8*** NGO

Part Two : Description of the area of the Field Unit

A2.1 Overall location of the area you intend to cover during census

A2.2 Terrain *Give percentage of:* Hill (%); Hill-plain (%); Plain (%) Ravines(%); Broken (%); Unbroken (%)

A2.3 Cover *Give percentage of:* Dense tree (%); Open trees (%); Bush (%); Open grass (%); Barren land (%)

A2.4 Concern Encircle appropriate choice

a) - Natural preys- abundant/moderate/bare subsistence/none left
b) - Human competition - heavy/moderate/negligible
c) - Cattle competition - heavy/moderate/negligible
d) - Nature of protection - good/fair/inadequate/nil
e) - Local co-operation - good/fair/inadequate/nil

Part Three : Past Record

A3.1 When was the last man-eating/ cattle-lifting in your area ?

A3.2 When was the last tiger seen in your area ? Seen by whom ?

A3.3 Where has the tiger gone now ?

A3.4 Where does it normally remain ?

ESTIMATION OF WILD TIGER POPULATIONS IN INDIA

Let us count our Tigers and Leopards (JAN 2001)

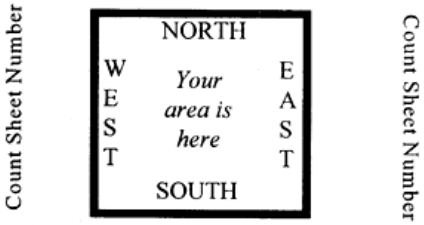
FORM 'A'
Parts Four and Five

A 4.5

*To be filled up by: **Range Officer** in consultation with the **Forester** and **Forest Guard***

Part Four : Neighbourhood

Count Sheet Number



Count Sheet Number

A4.1 Do you reliably know of any tiger in the following layout around your Field Unit ? Give details for the above layout as below :

A4.2 How far is the tiger from your area ?

N) E) S) W)

A4.3 What sex ?

N) E) S) W)

A4.4 Has the tiger ever come to your area of count ? If so when, and how often ?

N) E) S) W)

Part Five : Remarks

A5.1 Forester

A5.2 Range Officer

Beat.....
Section.....
Range .....
Division .....

Name of Field Unit Leader

Signature of Field Unit Leader.

Date

ESTIMATION OF WILD TIGER POPULATIONS IN INDIA

Information on other animals
(JAN 2001)

FORM 'B' **B**

To be filled up by: ***Forester*** *in consultation with the* ***Field Unit Leader***

Beat..... Section..... Range..... Division.....

(Please tick (Ö) and answer)

	Name	Unavailable	Available	If available then,			Numbers ?
				Rare	Common	Plenty	
1	*Wolves*						
2	*Wild dog*						
3	*Bear*						
4	*Wild boar*						
5	*Elephant*						
6	*Bison*						
7	*Wild Buffalo*						
8	*Sambar*						
9	*Spotted deer*						
10	*Mouse Deer*						
11	*Barking Deer*						
12	*Chowsingha*						
13	*Nilgai*						
14	*Black-buck*						
15	*H. Langur*						
16	*Rh. Macaque*						
17	*Porcupine*						
18	*Pangoline*						
19	*Mangoose*						
20	*Otter*						
21	*G. Squirrel*						
22	*F. Squirrel*						
23	*G. Hornbill*						
24	*P. Hornbill*						
25	*Pea fowl*						
26							
27							
28							
29							
30							

Name of the Beat Officer.....

Signature..... Date.....

ESTIMATION OF WILD TIGER POPULATIONS IN INDIA

The Week's Log Book
(JAN 2001)

FORM 'C'
Tiger

C TIGER

To be filled up by: ***Field Unit Leader*** *at the end of each period*

Beat.................... Section..................... Range..................... Division...........................

	Area/Route visited	Date/Time	Tiger seen				Pugmark seen				Remarks/ serial number of plaster cast, tracing.
			M	F	C	U	M	F	C	U	
		Mor									
		Aft									
		Evn									
		Mor									
		Aft									
		Evn									
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		Evn									
		Mor									
		Aft									
		Evn									

M - Male; F - Female; C - Cub; U - Sex unknown
Mor - Morning; Aft - Afternoon; Evn - Evening

ESTIMATION OF WILD TIGER POPULATIONS IN INDIA

The Week's Log Book
(JAN 2001)

FORM 'C'
Leopard

C LEOPARD

To be filled up by: ***Field Unit Leader*** *at the end of each period*

Beat.................... Section..................... Range..................... Division...........................

	Area/Route visited	Date/Time	Tiger seen				Pugmark seen				Remarks/ serial number of plaster cast, tracing.
			M	F	C	U	M	F	C	U	
		Mor									
		Aft									
		Evn									
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		Evn									

M - Male; F - Female; C - Cub; U - Sex unknown
Mor - Morning; Aft - Afternoon; Evn - Evening

ESTIMATION OF WILD TIGER POPULATIONS IN INDIA : 2001

Pugmark Tracing

FORM 'D' **D**

To be filled up by: ***Field Unit Leader*** *or the* ***Tracer.***

Sheet No.....

Name of the Beat Officer .....
Beat..... Section..... Range..... Division.....Date.....
Location of Pugmark: *dusty road/moist earth/sand/mud/PIP*.....
Name of the route/river bank..... Age of Pugmark.....(days)
Time of Tracing.....Direction of walk.....(according to route)

HIND PUGMARK			
Normal Stride		Normal Step	Slow/Fast Stride
Distance between two hind pugs irrespective of whether the pugs overlap or remain separated but gap between two adjacent pug < 30 cm.		Left to right or right to left	Distance between two adjacent pugmarks if gap is more than 30 cms
Left to left	Right to right		

Tip of paw

Stride Length

Tip of paw

Note: Space for pugmark tracing should be at least 17cm x 17cm
The form should be on thin or transparent paper.

Signature/Address of Non Official Participant

Full Name of Tracer.....Signature of Tracer.....

ESTIMATION OF WILD TIGER POPULATIONS IN INDIA

Proforma for Collecting Range Data (JAN 2001)

FORM 'E'

E

*To be filled up by: **Range Officer** after compilation.*

No. of Beats..... No. of Sections..... Range..... Division.....

Species /Sex/Age Group	Pugmark (cms) Length x Breadth x stride	Movement Area (names of places)
Tiger Male		
1		
2		
3		
Tiger Female		
1		
2		
3		
4		
Tiger Sex Unknown		
1		
2		
3		
4		
Tiger Cub		
1		
2		
3		
4		
Leopard Male		
1		
2		
3		
4		
Leopard Female		
1		
2		
3		
4		
Leopard sex unknown		
1		
2		
3		
4		
Leopard Cub		
1		
2		
3		
4		

Total Number of Sections.....Total Number of Beats.....

Name of Range Officer..... Signature of Range Officer..... Date.....

ESTIMATION OF WILD TIGER POPULATIONS IN INDIA

Abstract of Estimation for the Division (JAN 2001)

FORM 'F'

F

*To be filled up by: **Head of the Forest Division** and sent to the circle level coordinator.*

Name of the Division/ Protected Area/ Tiger Reserve.....

Name of the Range	TIGER					LEOPARD				
	Male	Female	Unsexed	Cubs	Total	Male	Female	Unsexed	Cubs	Total
1										
2										
3										
4										
5.										
6										
7										

Total Number of Ranges ..... Sections..... Beats.....

Name and Signature of Head of the Division/ PA/TR.....

Date .....

Note :- This should be accompanied by a map of each division showing the ranges and, if possible, the beats. The location of each tiger found should be placed approximately at the centre of territory/ home range of tiger in question.

ESTIMATION OF WILD TIGER POPULATIONS IN INDIA

Abstract of Estimation for the Circle (JAN 2001)

FORM 'G'

G

*To be filled up by: **Head of the Forest Circle** and sent to the Chief Wildlife Warden.*

Name of the Circle.....

Name of the Divisions/PAs/TRs	TIGER					LEOPARD				
	Male	Female	Unsexed	Cubs	Total	Male	Female	Unsexed	Cubs	Total
1										
2										
3										
4										
5										
6										
7										

Total Number of Divisions/PAs/TRs .....

Total Number of Ranges ..... Sections..... Beats.....

Name and Signature of Head of the Circle .....

Date .....

Dr. Lala Aswini Kumar Singh has been in the field of wildife research since the early 1970s and is the longest serving Tiger Reserve Research Officer in the country. He has played an important role in the Forest Department's estimation of tiger populations at Similipal Tiger Reserve and other tiger areas of Orissa. Over the years, he has refined the pugmark technique and has made it reliable by adding his innovative supplementary techniques. These include distinguishing between tracks of tiger cubs and adult leopards. He has also brought clarity to the methods available for determining the sex of a tiger from its hind pugmark. He was involved with the eminently successful crocodile conservation programme at its inception and has made pioneering contribution to the conservation of wildlife in wetlands adjoining Satkosia Gorge Wildlife Sanctuary, Orissa. Dr Singh has also published a large number of papers on wildlife ecology and management.

Published by WWF Tiger Conservation Programme,
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Picture Captions
Front Cover:
A Tiger in Ranthambhore Tiger Reserve by Ranjit Talwar
Front Cover Inside:
Late Saroj Raj Choudhury with Kheri, the tigress, Simlipal Tiger Reserve by SR Choudhury
Back Cover Inset :
Pugmarks of a tigress and cub in Dudhwa Tiger Reserve by Ranjit Talwar

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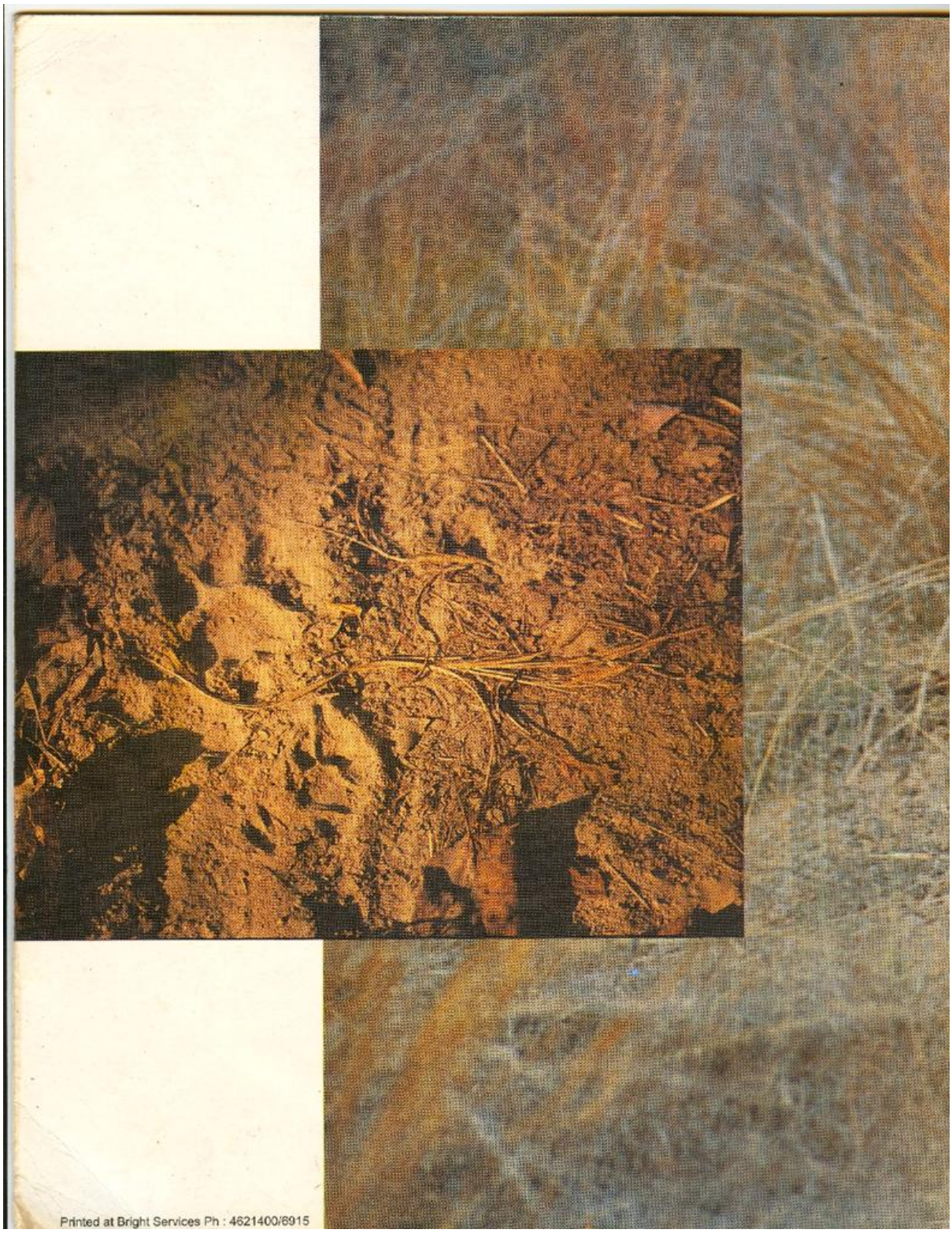

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