



PROJECT SUNDARBANS TIGER: Tiger Density and Tiger-human Conflict

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**PROJECT SUNDARBANS TIGER:
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Summary

A research-cum-conservation project was implemented from 01 August 2005 to 01 February 2007 that focussed on the estimation of tiger *Panthera tigris* density and reduction of tiger-human conflict in the Sundarbans of Bangladesh. This project was under the umbrella of the Carnivores and People Conservation Programme of the Zoological Society of London, and was funded by the Save The Tiger Fund of the National Fish and Wildlife Foundation, USA.

The tiger density was estimated by camera-trap survey (for 90 days) and tiger track counts in riverbanks (for 16 months). The absolute density of tiger (adult and subadult) in the Sundarbans East Wildlife Sanctuary was estimated at 4.8 tigers/100 km². The average density of fresh (maximum five days old) tiger tracks in the Sundarbans was estimated at 0.44/km of riverbank surveyed. Using the relative density estimates (tiger track densities) in six different plots in six parts of the Sundarbans (three in the three sanctuaries and other three outside the sanctuaries) and using the correlation between the absolute and relative densities in the Sundarbans East Wildlife Sanctuary, the absolute densities of tiger for the other five plots were estimated, which gives the average absolute density for the entire Sundarbans at 3.7 tigers/100 km². Since the total area of the Bangladesh Sundarbans is 5,770 km², it is inferred that, to a rounded figure, the tiger population size in the Bangladesh Sundarbans is about 200. The absolute densities of tiger and the relative densities of tiger prey showed strong correlation across six plots [Pearson correlation = 0.951, significance (2-tailed) = 0.004, N = 6], which supports the correctness of tiger density estimates.

A number of attempts were taken to reduce tiger-human conflict in and around the Sundarbans. Keeping one pet dog (chained) with each group of people (and one big stick with each person) was found very effective in saving humans from man-eating tigers, because the dogs warned people about the presence of the tiger around them. The dogs were particularly useful for honey gatherers, because when they smoke the honeycomb their visibilities become very poor, and they become very vulnerable to tiger-attack. The responses of the 40 dogs were recorded and verified in the field and was found that the dogs could successfully detect the presence of any sizable wild animal around them (success rate: 92.4 ± 4.8 %), but they could not always distinguish tiger from wild boar *Sus scrofa* or spotted deer *Axis axis* (success rate: 61.6 ± 17.5 %).

The effect of tourism was studied and was found that only 5% of the tourists, mainly the foreign tourists, behave as ecotourists. Others make a lot of disturbance and pollution during their stay in the Sundarbans. The most disturbing groups were the teenagers. In order to avoid the disturbance of tourists tigers either become more nocturnal during the tourist season or temporarily move from the area. In the dry season one in every five motorboats illegally used the sound system. The tourists leave both degradable (35% of the volume) and non-degradable (65% of the volume) pollutants. The rate of leaving non-degradable pollutants in the dry season was 0.3 (no.) pollutant/person/day. Tourism, however, plays the key role in the Government's revenue earning and the economic development of the areas of entry to the Sundarbans. Every tourist directly or indirectly spent Tk 400 (US \$ 5.7)/day in the market at Mongla.

A total of 38 awareness programs were conducted and 33 'Friends of the Tiger' groups were formed during the project period, so that the local support for tiger conservation is increased, and tiger-human conflict and poaching of tigers and their prey are reduced. School children and young people were the main target groups for these programs. The awareness programs included open discussion, quiz contests on tigers, writing articles on tigers, drawing pictures of tiger, etc. Attractive prizes were given to the best performers.

The network of Friends of the Tiger groups played significant role in reducing the poaching pressure in their localities. They helped saving one stray tiger and gathered much important information, including information of a freshly poached skin of the tiger.

We interviewed 126 local people in order to know their views on tiger-human conflict. According to most of the interviewees (63%), tigers kill people mainly to eat human flesh to satisfy hunger. Most of the interviewees (47%) thought that human casualties by tigers can be reduced by taking only the spiritual protection measures, but most of them (54%) thought that improved patrolling and implementation of laws can reduce the killing of tigers.

As a part of the awareness-raising for tiger conservation a colorful poster (3,000 copies) has been produced and distributed mainly in the buffer areas of the Sundarbans. The activities of this project have got good coverage in both print and electronic media. Moreover, a book will be published by 2007, which will further disseminate the findings of this project.

The findings of this project will be useful in temporally monitoring the tiger population trend and in reducing the tiger-human conflict. However, there are still a lot of things to do to further reduce the conflict, since tiger-human conflict is the main challenge for tiger conservation in the Sundarbans.

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1. Introduction

The tiger *Panthera tigris* is the flagship species to save the wilderness and biodiversity throughout its range. A hundred years ago the tiger roamed across the vast land of the Asian continent, but today it is restricted only to some fragmented habitats. It is a globally Endangered (IUCN 2003) and nationally Critically Endangered species (IUCN Bangladesh 2000). Therefore, the remaining tiger populations, particularly the relatively larger populations, are in serious need of scientific management.

The Sundarbans of Bangladesh and India harbours one of the two biggest unfragmented tiger populations on earth comparing only to the tiger population in the Russian Far East (WWF 1999; Khan 2002, 2004a). This mangrove habitat is unfragmented and naturally inaccessible, which offers excellent potential for long-term conservation of the tiger. Other than the Sundarbans, vagrant tigers are occasionally seen in the mixed-evergreen forests in the far southeast of the country (Sangu-Matamuhuri and Kassalong-Sajek valleys) (Khan 2004b).

The tiger is legally protected under the Bangladesh Wildlife Act 1974 and, as such, it should not be killed or captured. The use and export of the tiger or its parts is banned under the provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Bangladesh joined CITES in 1982. The habitat of the tiger is legally protected under the Forest Act 1927. Although the tiger is the national animal of Bangladesh, and it is legally protected, practical conservation still remains at the preliminary level (Akonda *et al.* 2000). The inaccessibility of the tidal mangroves, lack of local capacity and resources, and the existence of some notorious man-eating tigers make any research or management activity difficult in the Sundarbans. The scientific information on the tiger in the Bangladesh Sundarbans is still limited (Hendrichs 1975, Seidensticker and Hai 1978; Seidensticker 1986, 1987; Tamang 1993, Reza 2000, Khan 2004c).

Understanding the urgent need to gather scientific knowledge, initiate science-based conservation activities and build up the local capacity, the Project Sundarbans Tiger (PST) was started. The first phase was a PhD project (of Dr Monirul Khan), from 2000 to 2004, focussing on the ecology and conservation aspects, and was funded mainly by WWF – World Wide Fund For Nature and Cambridge Commonwealth Trust.

During the first phase (Khan 2004c), it was identified that tiger density (absolute and relative) and tiger-human interactions (addressing the reduction of tiger-human conflict and poaching, effect of tourism, etc.) are the two highest priorities for further research, if we are to conserve tigers in the Sundarbans. Therefore, the second phase of the PST was developed to address these issues. This was started on 01 August 2005 and continued until 01 February 2007, and was funded by the Save The Tiger Fund of the National Fish and Wildlife Foundation, USA. This phase was under the umbrella of the Carnivores and People Conservation Programme of the Zoological Society of London.

The second phase of PST, i.e., the subject matter of this report, was needed particularly for the partial fulfillment of some of the major clauses of the draft Tiger Action Plan of Bangladesh (Bangladesh Forest Department 2000). These are as follows –

‘Clause 13(a). Population – There is no authentic knowledge on the population of the tiger in the Sundarbans. It is not known whether the population is increasing or decreasing and what is the actual number of tigers in the Sundarbans. There is also no knowledge on the nature of breeding or

breeding habitat of the tiger in the Sundarbans, so a continuous research initiative will have to be kept in place for five years initially to gain knowledge on the ecology and biology of the tiger, including its other problems in the Sundarbans. Project cost of this component for five years is US \$ 100,000.'

This project scientifically estimated the absolute and relative densities of tigers, and based on these the total population of tigers in the Bangladesh Sundarbans has been inferred. The results will be useful in temporal monitoring of tiger population trend.

'Clause 13(g). Capacity Building – Basic knowledge on wildlife management is given to forest officials during their training at the forest schools in Rajshahi and Sylhet, and in Bangladesh Forest Academy, Chittagong, but there is a need for further and advanced training on wildlife management among the forest officials. Presently Bangladesh Forest Department is facing acute problems due to shortage of officers and employees. The capacity building component may require US \$ 500,000 within a period of three years.'

This project helped in improving the local capacity for research, monitoring and conservation activities. The principal investigator has trained two students of a local University and many local people who were involved with this project. Now they are expert human resources who can be useful to the Government and Non-Governmental Organizations in implementing any tiger and prey management program in the Sundarbans.

'Clause 13(h). Motivation and Public Awareness Campaign – People living in and around the Sundarbans are not aware of the tiger and its contribution to the maintenance of the environmental balance. An awareness programme on tiger conservation may be undertaken in a massive scale. Total cost of this component for five years is US \$ 500,000.'

A medium-scale motivation and awareness campaign was conducted under this project. Participatory talks were organized in local schools and other public gatherings. Moreover, an informative book will be published by 2007, focusing mainly on the findings of this project, which will strengthen the awareness about the tiger in the Sundarbans.

The specific objectives of this project were as follows –

1. Estimate the absolute and relative densities of tigers.
2. Test the effectiveness of some possible techniques in saving human lives from man-eating tigers (e.g., keeping big sticks with each individual and one pet dog with each group), record public views on tiger-human conflict, and reduce the poaching of tigers and their prey.
3. Assess the effect of tourism in the Sundarbans.
4. Conduct motivation and awareness programs, mainly for the people living in the buffer zone.

2. Study Area

The project was implemented in and around the Sundarbans of Bangladesh – the only area in Bangladesh where there is a stable population of wild tigers. The Sundarbans is the world's largest tidal mangrove forest (Chaudhuri and Choudhury 1994), which is about 6% of all mangroves on earth (Khan 2002). The word 'mangrove' (a combination of the Portuguese 'mangue' and English 'grove') can refer to an ecological group of holophytic plant communities belonging to 12 genera in 8 families, or a complex of plant communities fringing sheltered tropical shores, or more specifically by some authors, the vegetation formation below the high tide mark (Seidensticker and Hai 1978). The Sundarbans is an essential and high quality wildlife conservation area of regional and international importance (Seidensticker 2004). It has been identified as a Level I Tiger Conservation Unit (TCU), because the habitat offers the highest probability of persistence of tiger population in the long-term (Wikramanayake *et al.* 1999).

The Sundarbans mangrove swamp is of recent origin, formed by the eroded soil from the Himalayas carried downstream by the Ganges, Brahmaputra, Meghna and many other river systems. These deposited the sediments at the apex of the Bay of Bengal that gave rise to the Sundarbans. The most striking adaptations of the mangrove plants are various forms of aerial roots to meet the oxygen requirement for respiration (Hogarth 1999). The holophytic tree species mainly form the natural vegetation. The forest is more or less open and canopy height is commonly within 10 m from the ground. The forest floor is normally 0.9-2.1 m above the sea level (Tamang 1993). Three ecological zones, i.e. freshwater zone, moderately saline water zone, and saline water zone, can be distinguished according to salinity and species composition.

The mean maximum and minimum temperature in the Bangladesh Sundarbans are 31.2°C (April-May) and 21.5°C (December-January), respectively. The mean annual relative humidity varies between 70 and 80%. The mean annual rainfall varies from about 2,600 mm in the east to 1,600 mm in the west. There are about 120 rainy days in a year in the Bangladesh Sundarbans. The pH in river water varies from 6.5 to 8. Tides are twice daily and the average tidal time difference is about 12 hours and 25 minutes.

The entire Sundarbans is about 10,000 km², of which roughly 60% lies in the southwest of Bangladesh (between 21°30'-22°30' N latitudes and 89°00'-89°55' E longitudes) and the other 40% in the southeast of the Indian state of West Bengal (between 21°32'-22°40' N latitudes and 88°05'-89°00' E longitudes) (Hussain and Acharya 1994, Chaudhuri and Choudhury 1994). The Bangladesh Sundarbans covers an area of 5,770 km², of which 1,750 km² is under water as rivers and creeks (Hussain and Acharya 1994).

A total of 1,397 km² of the three Wildlife Sanctuaries (Sundarbans East, Sundarbans South and Sundarbans West) of the Bangladesh Sundarbans form a UNESCO World Heritage Site (declared in December 1997). The surveys of tiger density of this project, however, were conducted in six plots: three in three different Sanctuaries and other three outside Sanctuaries, but roughly the plots were of equal sizes, and each had an area of about 170 km² (Table 2.1 and Figure 2.1)

Table 2.1 Six plots in the Sundarbans where the surveys of tiger density were conducted

Sl. No.	Name of the plot	Legal status	Geographic location
1	Katka-Kochikhali	Wildlife Sanctuary	21°49'-21°57' N, 89°43'-89°51' E
2	Hironpoint	Wildlife Sanctuary	21°45'-21°52' N, 89°21'-89°29' E
3	Mandarbaria	Wildlife Sanctuary	21°38'-21°47' N, 89°12'-89°18' E
4	Harintana	Reserve Forest	22°04'-22°11' N, 89°42'-89°49' E
5	Chandpai	Reserve Forest	22°18'-22°25' N, 89°38'-89°47' E
6	Burigoalini	Reserve Forest	22°07'-22°15' N, 89°07'-89°15' E

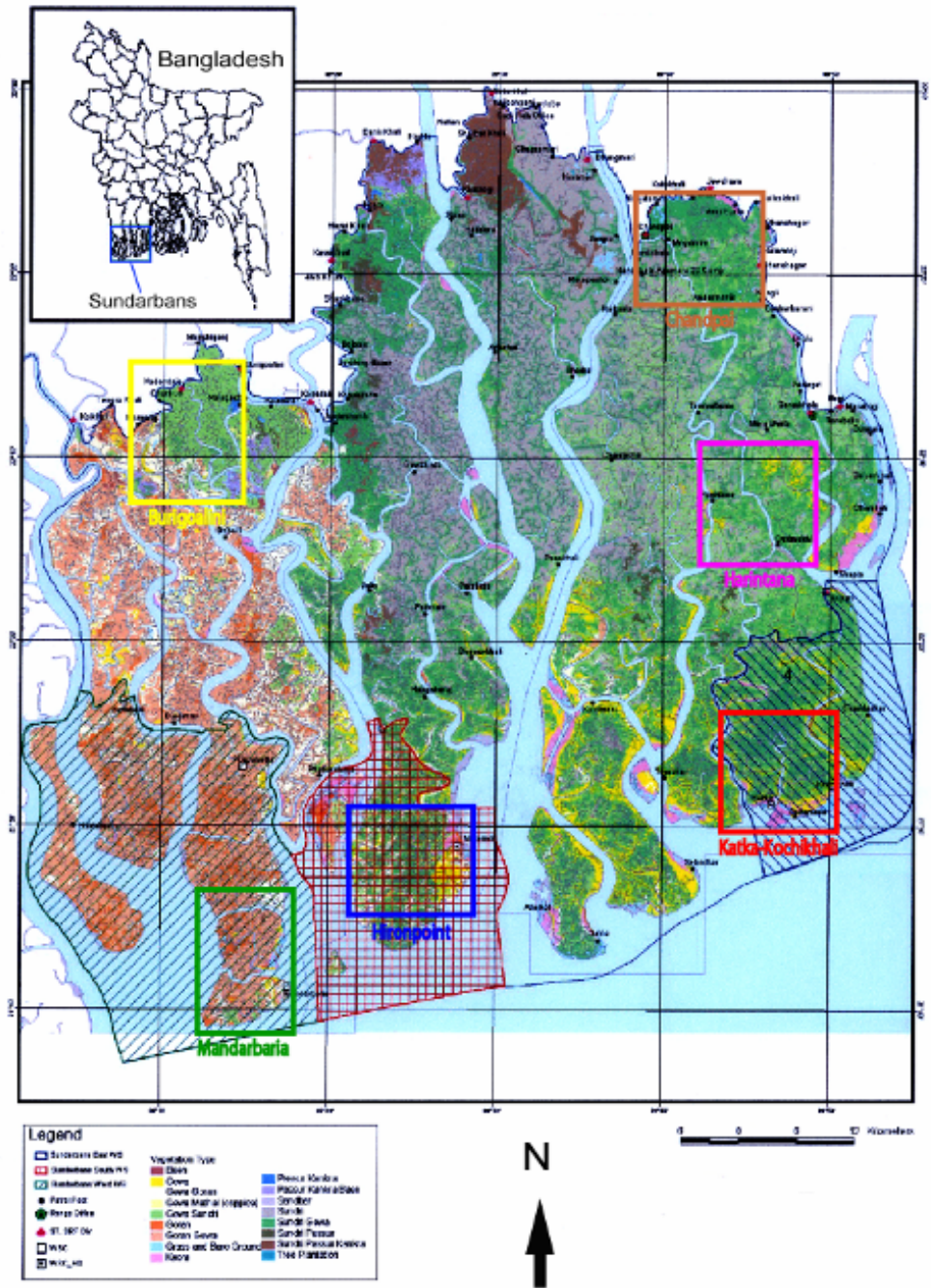


Figure 2.1 The Sundarbans of Bangladesh showing the three Wildlife Sanctuaries (line shades) and six plots for tiger density survey.



Typical view of the Sundarbans: a) from the air, and b) from the ground.

3. Tiger Density

3.1 Introduction

Perhaps the most commonly asked question about tigers in the Sundarbans is 'how many tigers are there?', and different 'estimates' of the total number of tigers in the Sundarbans of Bangladesh mainly based on 'pugmark census' (Panwar 1979) or interviewing, which are not scientific and does not fit to any of the conceptual framework of population sampling methods. The pugmark census assumes that tigers are individually identifiable from their pugmarks, which is not the case (Karanth 1987, 1988, 1993a, 1993b; Khan 2004a), so these 'estimates' cannot even be considered as indices of relative abundance.

Based on the fact that tigers are individually identifiable from their stripe patterns (Schaller 1967, McDougal 1977), Karanth (1995) (elaborated by Karanth and Nichols 1998) pioneered the use of camera-trap photographs as a substitute of actual capture-recapture of the tiger, and used the data in formal capture-recapture sampling (Seber 1982, Nichols 1992). The availability of suitable computer software like CAPTURE (Otis *et al.* 1978, White *et al.* 1982, Rexstad and Burnham 1991) can be used to analyze the capture history data. Since the tiger is a large carnivore, it occurs at relatively low population densities (Eisenberg 1981, Karanth and Nichols 1998), distributed over extensive range, and it is secretive. Therefore, it is natural that estimation of wild tiger density will be difficult. Camera-trapping, however, appears to be more suitable compared to other scientific methods based on radiotelemetry (Smith *et al.* 1987a,b; Quigley 1993) or on habitat quality with arbitrarily assumed tiger densities (Rabinowitz 1993). Despite the fact that radiotelemetry-derived data can be used in estimating tiger density (Smith *et al.* 1987a,b; Quigley 1993), the small number of tagged animals, the presence of untagged animals in the population, and the excessive effort involved in capture and radiotracking operations limit the usefulness of this method in tiger density estimation (Karanth 1995). Moreover, this method is invasive and, to some extent, endangers the life of the study animal. Because of its low density and shy nature, other methods of animal population estimation like transect or quadrat sampling (Buckland *et al.* 1993, 2004) are of no use for tigers.

A scientific estimate of tiger population in the Sundarbans was very much needed in order to understand, and pay required attention to, the prospect of long-term management of the population. The estimate of absolute and relative densities of tigers was needed so that any demographic change can be monitored. However, from management or conservation point of view, exactly how many tigers are in the Sundarbans is not very important to know, so long as we have sufficiently large population that can withstand ecological changes of its habitat in the long-term, and there is no genetic drift due to inbreeding. The most important for the Sundarbans tiger population is to know the population trend, i.e., whether the number of tigers is decreasing, remaining stable, or increasing with time.

3.2 Material and methods

Camera-trap survey was conducted to know the absolute density of tigers in a high density area of the Sundarbans. A total of 105 km² area in the southern part of the Sundarbans East Wildlife Sanctuary was effectively covered in the survey. The entire survey area was crisscrossed extensively in order to find good trap-points, i.e., the spots where there is a good chance of getting the tiger in the camera-trap photo. The trap-points were about two km apart from each other, so there was no 'gap' area large enough to contain a tiger's movements during the sampling period and within which any tiger had a zero capture probability. The effectively sampled area was calculated by adding up to two

km boundary strip width (since the two recaptured tigers crossed trap-points of about two km distance; see Karanth and Nichols 1998) with the outer boundary of the trap-polygon (straight lines connecting the outermost trap-points). Since the survey area was covered by estuary and large rivers in three sides, the boundary strip was added up to the land, but on the fourth (northern) side the boundary strip of two km was added (Figure 3.1).

Tigers regularly travel along forest roads and trails, communicating with conspecifics through scent markings (Sunquist 1981, Smith *et al.* 1987b), but in the Sundarbans there is no such forest road and tigers do not follow the same route very often (Khan 2004c). The camera-traps were set on the basis of tiger cues, such as the presence of earlier tiger signs (tracks, scats, scrapes, scent deposits, etc.), intersections of trails (Karanth and Nichols 1998), and near the kills. All points were marked on a map using a GPS unit (eTrex Vista C).

We have used ten commercially made Wildlife Pro (made by Forestry Suppliers, Inc. <www.forestry-suppliers.com>) camera-trap units in the survey area. These camera-traps have protective housing (with colouration suitable for camouflaging), which were required in the Sundarbans to save the equipment from the frequent rain. Inside the housing there is a Canon Super Shot fully-automatic 35 mm autofocus camera and a motion sensor for triggering the camera. In the camera we have used Fuji 100 ASA film rolls. The camera-traps were mounted on wooden posts, or in tree trunks if available, about 350 cm away from the trail, set at a height of 45 cm (Karanth and Nichols 1998).

During the sampling period the camera-traps were systematically shifted in three trapping sub-plots in order to cover all the potential trap-points by limited number of camera-trap units. Out of the 90-day (here 'day' means day-night of 24-hours) sampling period (06 September to 04 December 2006), the first 45 days were treated as Occasion 1 (when the photographed individual tigers were 'marked') and the second 45 days were Occasion 2 (when the photographed individual tigers had two individuals that was 'marked' in Occasion 1). In each Occasion the camera-traps were deployed in three sub-plots (Kochikhali, Katka and Chita Katka sub-plots), one after another, for 15 days in each sub-plot. In order to get photos of both sides of a tiger, two cameras were placed in each trap point (since the stripe pattern is different in two sides of the same tiger), one almost facing another (not face-to-face so that the flash light of one camera does not distract the photo of the opposite camera). Therefore, we could cover five trap-points at a time to cover each sub-plot.

A maximum of two months is suggested as the survey period (Karanth *et al.* 2002), but we had to spend more time for our sampling because of the limited number of camera-traps and the difficulty of 'capturing' a tiger in a photo. Since the tiger is relatively a long-living and slow-breeding animal (Nowell and Jackson 1996), it can be assumed that there was no significant change in the dynamics of tiger population during the 90-day sampling period. The camera-traps were checked once every day in order to record the date and location of each photographic 'capture'. Individual tigers can be identified from photographs by comparing the stripe patterns (Schaller 1967, McDougal 1977, Karanth and Nichols 1998).

The capture history data were analysed by using CAPTURE2 software program (<www.mbr-pwrc.usgs.gov>, downloaded in February 2007). This software was developed to implement closed-population capture-recapture models. This program calculates tiger density (D) and its associated variance [$\text{var}(D)$] from the values of tiger capture abundance (N), and estimated area sampled by the camera-trapping [$A(W)$], by following the equations –

$$D = \frac{N}{A(W)}$$

$$\text{var}(D) = D^2 \left[\frac{\text{var}[A(W)]}{[A(W)]^2} + \frac{\text{var}(N)}{N^2} \right]$$

Since we could cover only a small part of the Sundarbans in our camera-trap survey, we also surveyed tiger tracks, for 16 months (October 2005 to January 2007) in riverbanks in order to estimate the relative density of tigers. The relative density of tigers between localities or years can be estimated using suitably designed indices like number of tracks/scats/sightings per km of roads traversed (Joslin 1973).

In our survey we first selected six plots, three in three sanctuaries and other three outside sanctuaries, so that the average estimate represents that of the entire Bangladesh Sundarbans. Since the tiger tracks are visually identifiable (Palomares *et al.* 1996, Van Sickle and Linzey 1991), especially in the muddy riverbanks, all the fresh tracks (maximum five days old) were counted from the riverbanks. Very wide rivers and very narrow creeks present a problem with observation and navigation, so they were discarded. In the Sundarbans, tigers frequently cross the rivers, especially those that are not too wide. The survey took place from a dinghy, which was driven slowly at a relatively constant speed while the observers searched for fresh tracks on both banks of the river. However, the same track, i.e., the same crossing, on two sides of the river was treated as one observation. The geographic locations of the surveyed rivers and the salinity of each of the rivers were recorded by using a GPS unit and a salinity refractometer (VEE GEE, model A366ATC, range = 0-100 ppt, accuracy = ± 1.0 ppt). Binoculars (Tasco and Nikon Travelite V) were used whenever necessary for searching tracks and for general observations. Since the rivers were not straight, the speed of the boat (by using a GPS unit) and the total time of observation were recorded in order to convert the travelling distance into equivalent straight distance. According to Nichols and Karanth (2002), an index of relative abundance is a count statistic that is thought to convey information about abundance. Where n is the total length at which the tracks are counted, the index of relative abundance (\bar{C}) and its standard error [$SE(\bar{C})$] can be computed as –

$$\bar{C} = \frac{\sum C}{n}$$

$$SE(\bar{C}) = \sqrt{\frac{\sum (C - \bar{C})^2}{n(n-1)}}$$

In order to calculate the correlation between the relative density and absolute density of tigers, track survey in riverbanks in the Sundarbans East Wildlife Sanctuary was conducted in the same plot covered by camera-trapping. Based on this correlation the absolute densities have been estimated for the other five plots. The average of the absolute densities of the six different plots in six parts of the Sundarbans represents the average density of tiger population in the Bangladesh Sundarbans.

3.3 Results

A total of seven photographs of tigers were achieved from Katka-Kochikhali plot during the survey period (three in Occasion 1 and four in Occasion 2, with two 'recaptures' in Occasion 2), of which there were five different tigers. Using the 'capture' history data in CAPTURE2 software program it was estimated that the absolute density of tiger population (adult and subadult) in the 105 km² survey area in the southeastern end of the Bangladesh Sundarbans is 5 (standard error = 0.96, capture probability or p-hat = 0.70).

This means that the tiger density in the area covered by camera-trap survey is 4.8 tigers/100 km². Due to the complexity and lack of correctness of estimating the variance of estimated area sampled by camera-trapping, the standard error for this density estimate was not calculated. However, due to the fact that the sampled area (105 km²) was very close to 100 km², it is assumed that the standard error for the density estimate is very close to 0.96. This is the first scientific estimate of the tiger population density in any part of the Bangladesh Sundarbans.

Other than the tiger there were many photos of two common prey species of the tiger, i.e., spotted deer *Axis axis* and wild boar *Sus scrofa*, and a few photos of humans, red junglefowl *Gallus gallus*, ring lizard *Varanus salvator*, rhesus macaque *Macaca mulatta*, lesser adjutant *Leptoptilos javanicus*, greater coucal *Centropus sinensis* and jungle myna *Acridotheres fuscus* (Table 3.1).

Based on tiger track counts, the relative density of tigers in six different plots was estimated (Table 3.2). These six different plots were selected from six different areas and the average result of these six plots represents the average for the entire Bangladesh Sundarbans, which is 0.44 tracks/km of riverbank surveyed. The three plots in three sanctuaries clearly had higher densities of tiger tracks than the three blocks outside the sanctuaries (Table 3.2).

In Katka-Kochikhali, the relative density of tigers was estimated from the same plot that was covered by camera-trap survey to estimate the absolute density. Based on the correlation of absolute and relative densities of tigers in this plot, the absolute densities in other five sites were calculated (Table 3.2).

The relative densities of tiger prey (excluding humans) in six plots were estimated by counting them along the two banks of rivers while the observers were on dinghy, counting tiger tracks along riverbanks. The estimated relative densities of tiger prey (Table 3.3) and the absolute densities of tiger in six plots show strong correlation [Pearson correlation = 0.951, significance (2-tailed) = 0.004, N = 6] (Figure 3.2). This strong correlation supports the correctness of the calculations of absolute densities of tigers in six different plots. Notably, it is well-accepted fact that carnivores and their prey numbers show strong positive correlation in any undisturbed area.

The average of the absolute density of tigers in six plots, which represents the average density in the entire Bangladesh Sundarbans, is 3.7 tigers/100 km². Since the Bangladesh Sundarbans is an area of 5,770 km², it is inferred that, to a rounded figure, the tiger population size in the entire Bangladesh Sundarbans is about 200.

Table 3.1 Species captured in camera-trap photos in the Sundarbans East Wildlife Sanctuary.

Sl. No.	Species captured in camera-trap photos	No. of photos got	Total no. of individuals in photos*	Average no. of individuals/photo
1	Tiger	7	7	1
2	Human	39	134	3.44
3	Spotted deer	606	1,063	1.75
4	Wild boar	128	175	1.37
5	Rhesus macaque	10	10	1
6	Lesser adjutant	8	8	1

7	Red junglefowl	6	7	1.17
8	Greater coucal	5	5	1
9	House crow	7	9	1.29
10	Jungle myna	1	1	1
11	Ring lizard	12	12	1
Total/Overall		829	1,431	1.73

It often happened, particularly in case of social animals, that more than one individual was in the photo, but it was not considered whether different or same individuals repeatedly captured in different photos.

Table 3.2 Relative density of tiger population in the Bangladesh Sundarbans

Sl. No.	Area surveyed	Location in the Bangladesh Sundarbans	Status of the area	Water salinity (ppt)		Relative density of tiger [average no. of tracks/km riverbank (\pm SE)]	Absolute density of tiger (no. of individuals/100 km ²)*
				Dry season	Wet season		
1	Katka-Kochikhali	Southeast	Wildlife Sanctuary	5-10	0-5	0.58 (\pm 0.12)	4.8
2	Hironpoint	South	Wildlife Sanctuary	20-25	15-20	0.51 (\pm 0.14)	4.2
3	Mandarbaria	Southwest	Wildlife Sanctuary	25-30	20-25	0.54 (\pm 0.15)	4.5
4	Harintana	East-Central	Reserve Forest	5-10	0-5	0.42 (\pm 0.17)	3.5
5	Chandpai	Northeast	Reserve Forest	0-5	0-5	0.29 (\pm 0.19)	2.4
6	Burigoalini	Northwest	Reserve Forest	20-25	5-10	0.32 (\pm 0.16)	2.6
Ave- rage	Bangladesh Sundarbans					0.44	3.7

* In Katka-Kochikhali the tiger density was estimated by camera-trap survey in the same plot where the relative density of tiger was estimated on the basis of track counts. Based on the correlation between the relative density and absolute density in this plot, the absolute density has been calculated for other five plots.

Table 3.3 Relative density of potential tiger prey in the Bangladesh Sundarbans

Sl. No.	Area surveyed	Location in the Bangladesh Sundarbans	Status of the area	Relative density of potential tiger prey (average no./km observation from river)					
				Spotted deer	Wild boar	Rhesus macaque	Lesser adjutant	Human	Total (excluding human)
1	Katka-Kochikhali	Southeast	Wildlife Sanctuary	3.97	0.17	2.42	0.09	0.85	6.7
2	Hironpoint	South	Wildlife Sanctuary	3.66	0.15	2.36	0.09	0.87	6.3
3	Mandarbaria	Southwest	Wildlife Sanctuary	3.62	0.15	2.40	0.07	0.00	6.2
4	Harintana	East-Central	Reserve Forest	1.18	0.13	1.18	0.05	1.09	2.5
5	Chandpai	Northeast	Reserve Forest	0.76	0.11	0.83	0.03	4.83	1.7
6	Burigoalini	Northwest	Reserve Forest	0.96	0.12	0.85	0.05	4.98	2.0
Ave- rage	Bangladesh Sundarbans			2.36	0.14	1.67	0.06	2.10	4.2

3.4 Discussion

It is always difficult to estimate the population density of a shy and secretive animal like the tiger, which is thinly distributed throughout a large area. It is even more difficult in the impenetrable swamp of the Sundarbans where tigers are rarely seen by people. Therefore, most of the previous 'estimates' used pugmarks, which are easily available, and ended up overestimating tiger population (Table 3.4).

Based on the prey density, and following Karanth and Stith (1999), and Karanth *et al.* (2004), there is a previous estimate of tiger density in the Sundarbans East Wildlife Sanctuary (Katka-Kochikhali area is the major part of this Sanctuary) (Khan 2004c), conducted during the previous phase of this project, and the estimated figure (4.3 tigers/100 km²) is similar to that estimated in that area during this study (4.8 tigers/100 km²). This again supports the correctness of tiger density estimate of this study.

Table 3.4 Estimates of tiger population in the Bangladesh Sundarbans

Estimated population	Estimated density (no./100 km ²)	Method	Reference
350	-	Interviewing	Hendrichs 1975
450	-	Pugmark study	Bangladesh Forest Dept. & Dept. of Zoology, Univ. of Dhaka 1982
(150 adults) [original result: 250 adults in the entire Sundarbans]	-	Arbitrary estimate based on Chitwan (Nepal) density	Seidensticker 1987a
359	-	Interviewing	Bangladesh Forest Department 1992
362	-	Pugmark study	Tamang 1993
-	20 in high density area	Pugmark study and year-round monitoring	Reza 2000
440	-	Pugmark study	Bangladesh Forest Department 2004
200	4.3 in high density area	Inferred on the basis of prey density	Khan 2004c
200	3.7	Camera-trap survey and track counts	This study

Although there is no previous estimate of tiger density in the Bangladesh Sundarbans based on camera-trap survey, Karanth and Nichols (2000) reported tiger density in the Indian Sundarbans, which was based on camera-trapping. The result (0.84 tigers/100 km²), however, might be an underestimate, because of the relatively low number of photo 'captures' in relation to the survey area and the number of trap points covered. Unlike other tiger ranges in India, it is much more difficult to capture tiger photos by camera-traps in the Sundarbans, because there is no forest road in the Sundarbans (tigers prefer to walk along the forest roads) and it is difficult to locate commonly-used trails of the tiger.

The initial results of radio-collaring two female tigers in Katka-Kochikhali area suggest that their normal home range (in a period of about five months) was approximately 12-20 km² (Sundarbans Tiger Project Update, December 2005; A. Barlow pers. comm. 2006). This estimate of home range size indicates a population density close to what has found in the same area in this study, which was based on camera-trap survey.

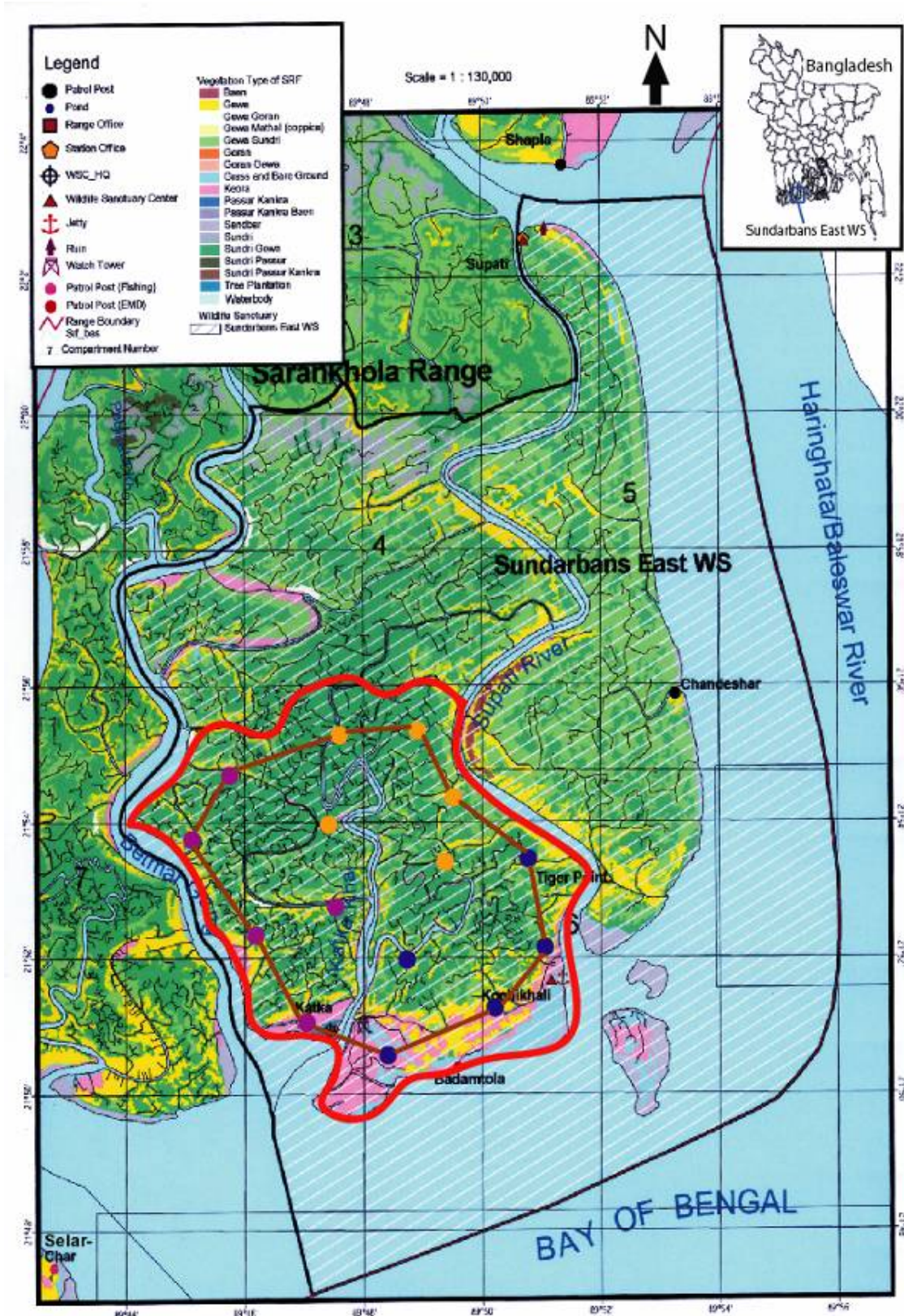


Figure 3.1 Sundarbans East Wildlife Sanctuary showing 15 trap-points (three colour dots indicating three shifts of camera-traps), trap-point polygon (brown line) and effectively sampled area (red line).

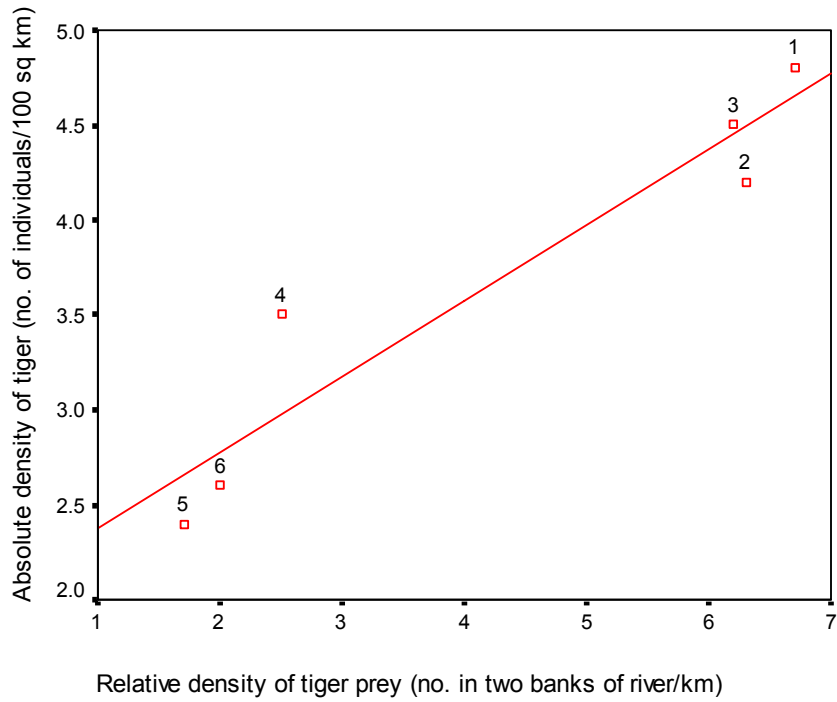
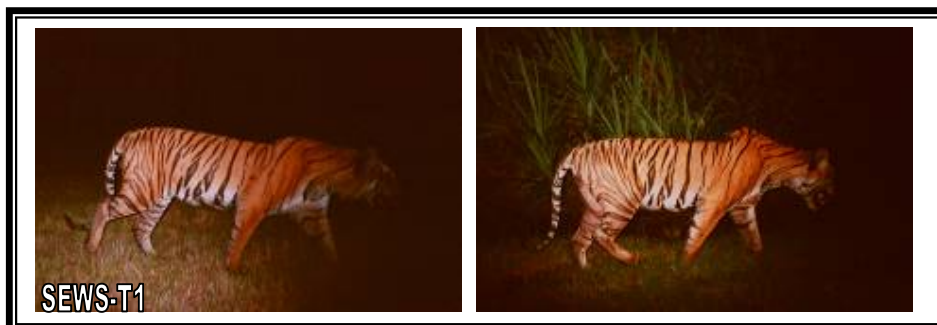


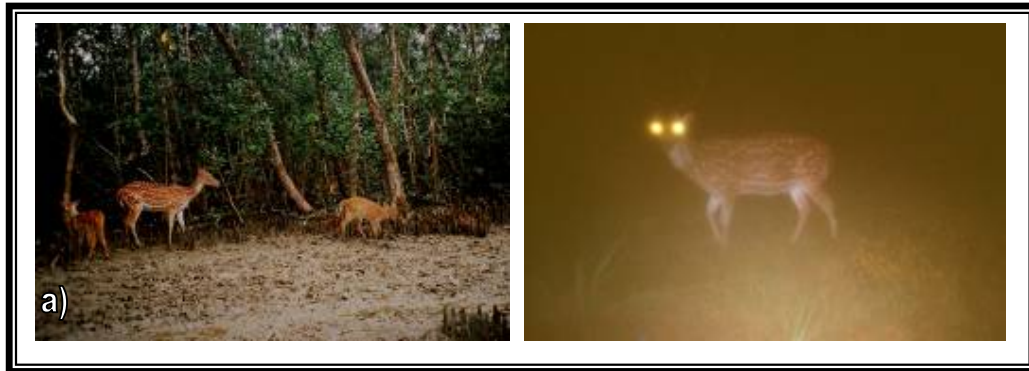
Figure 3.2 Correlation between the absolute density of tiger and relative density of tiger prey in six plots (1. Katka-Kochikhali, 2. Hironpoint, 3. Mandarbaria, 4. Harintana, 5. Chandpai, and 6. Burigoalini) in the Sundarbans of Bangladesh.



Tiger density estimation in the Sundarbans: a) setting remote camera-traps on a trail, b) tiger track on a riverbank, c) surveying for tiger tracks along the riverbank. and d) testing water salinity.



Five different tigers (two 'recaptures') 'captured' in remote camera-trap photos in 105 km² sample area in the southeastern end of the Sundarbans of Bangladesh.



Some of the creatures, other than the tiger, 'captured' in remote camera-trap photos in the Sundarbans: a) spotted deer, b) wild boar, c) rhesus macaque, d) human, e) red junglefowl, and f) lesser adjutant.

4. Tiger-human Conflict

4.1 Introduction

People living at the fringes of the Sundarbans either partially or completely depend on the natural resources of the Sundarbans. These people have little choice but to go to the Sundarbans, either legally (with necessary permit from the Forest Department) or illegally. It is difficult to check the entry of a large number of people in this huge tract. When people and tigers roam in the same area, some conflicts take place. The level of tiger-human conflict in the Sundarbans, however, is the highest in the world because here many of the tigers are man-eaters. People are either deliberately or accidentally killed by tigers, whereas some tigers are killed by people either because those tigers started attacking humans and cattle or just to poach it for economic gain.

The Sundarbans is not only a great stock of natural resources, but also the main tourist attraction in Bangladesh for both domestic and international tourists. The National Tourism Policy (NTP) 1992 proposed that because of its unique and diverse attractions of international renown, the Sundarbans should be developed as a springboard for the tourism industry for the country as a whole (UNDP and FAO 1998). The Sundarbans East Wildlife Sanctuary (more specifically Katka and Kochikhali) is a popular place for tourists. Despite the fact that the Sundarbans has huge prospect for developing tourism, and increasing the Government's revenue income, uncontrolled tourism is a threat to the tiger and other wildlife of the Sundarbans, mainly through disturbance and pollution.

The tiger plays the key role in attracting the tourists in the Sundarbans. Tiger-human conflict, however, makes many people (especially those who are living around the Sundarbans) hostile towards the tiger. Therefore, motivation and awareness campaigns are very much needed in strengthening the local support for the conservation of the tiger. Moreover, people are completely unaware of the need of conserving wild tigers for the well-being and potential economic benefits of the local communities. This type of campaign is needed also to reduce human casualties from man-eating tigers and to reduce poaching of the tiger and its prey. Every year a significant number of people are killed by tigers, because most of the people believe in taking only the spiritual protection measures when they work in the Sundarbans.

4.2 Methods

4.2.1 *Saving Humans from Man-eating Tigers*

The effectiveness of keeping one pet dog with each group of people and carrying a big stick by each individual of the group, in order to reduce the risk of being attacked by man-eating tigers, was tested in 50 groups of local people of different professions ('Bawalis' or plant-product harvesters, honey gatherers, fishermen, etc).

The dogs that were used were of local breeds, available in the villages along the edge of the Sundarbans. The 40 dogs were selected on the basis of tests. A total of 67 dogs went through the test. Each of these dogs was taken to the Sundarbans in an exploratory visit when the performance of the dog in detecting wild animals was observed. Based on the performance, 40 dogs were finally selected. After the selection, informal training was given to these 40 dogs by forcing them to smell the tiger trails and drawing their attention to any wild animal in the forest. Dry food was given immediately after any successful performance.

In the Sundarbans the people do not work continuously for a long time (people have to come out of the Sundarbans for taking rest and taking supplies for the next trip), so 40 pet dogs were sufficient enough to serve the purpose of 50 groups of people, since all the groups did not work the Sundarbans at the same time. This reduced the cost of maintaining the dogs. The dogs fed mainly on the residual food of humans, which is the normal practice in Bangladesh. Hence, the cost of keeping a dog like this was very negligible, which was about Tk 60 (US \$ 0.9)/dog/month. Many people keep these dogs in the fringes of the Sundarbans, not just as a pet, but also to ensure safety from any intruder at night.

During the 18-month study period (August 2005 to January 2007) a total of about 30 days were spent in observing each of the 40 dogs in the field. All the 40 dogs could not be sent to the Sundarbans and observed at the same time due to our limited manpower, but the observation took place in different seasons in different parts of the Sundarbans (except the three sanctuaries, because people are not normally allowed to work there).

In the field the signals of the dogs were recorded. The signals were classified into two groups: i) signal for any wild animal, including the tiger, characterised by sudden excitement, and ii) signal (apparently) for the tiger, characterised by fear and low noise. The signals were verified either immediately, by observing the animals or their signs around, or in the next day (in order to avoid the risk of meeting the tiger face-to-face), by observing the signs (pugmarks in case of tigers).

4.2.2 Effect of Tourism

The major activities of the tourists, with particular reference to those affecting the tiger and its prey, were observed and recorded in the Sundarbans. The main disturbing groups were identified. The quantifiable pollutants (e.g. disposables) were estimated to know the rate of pollution. The revenue earning of the Government and the benefits to the local communities was recorded in order to compare the loss and gain due to tourism.

4.2.3 Awareness Campaign and Creation of 'Friends of the Tiger' Groups

A medium-scale motivation and awareness campaign was conducted in the schools and other public gatherings in the buffer zone of the Sundarbans. The main target group was the school children and young people, but people of all levels were involved.

An informal network named 'Bagher Bandhu' or 'Friends of the Tiger' was formed mainly by organising the young and enthusiastic local people who are interested in conservation. They have provided information on poaching and acted against it. They were not paid, but token prizes were given in order to encourage them. The information was immediately passed to the officials concerned, so that they can take immediate action.

Moreover, the experienced local people were interviewed (inside or along the edge of the Sundarbans) in order to know their views on different aspects of tiger-human conflict. Standard interviewing sheets and a portable tape recorder were used for this.

4.3 Results

4.3.1 Saving Humans from Man-eating Tigers

Keeping one pet dog (chained) with each group of people, and one big stick with each person, was found very effective in saving humans from man-eating tigers. The result shows that the use of pet dogs significantly reduced the risk of being attacked by a tiger,

because the dogs warned people about the presence of the tiger around them. The pet dogs were most useful for honey gatherers, because when they smoke the honeycomb their visibilities become very poor and they become very vulnerable to tiger-attack.

Dogs have much better hearing and smelling abilities than that of humans, so they could successfully detect the presence of any sizable wild animal (success rate: 92.4 ± 4.8 %). However, they could not always distinguish the tiger from wild boar or spotted deer (success rate: 61.6 ± 17.5 %) (Table 4.1). It was noticed that the performance of the dogs in serving the purpose improved gradually, which was probably due to the accumulation of the dogs' experience in the Sundarbans. Moreover, dry food was given to the dogs after every time it signalled for tigers, which perhaps helped in improving the dogs' performance.

In most of the cases the dogs' response against the presence of any sizable wild animal was in the form of sudden excitement, together with quick and haphazard movements, and often with barks or grunts. The dogs, however, showed the symptoms of fear, like making short and low noises, and coming close to the owner, when it thought that the tiger is around. This was treated as the specific signal of the presence of tiger, but sometimes there were something else than the tiger. Notably, the dogs never barked when they were afraid due to the apparent presence of the tiger.

In the Sundarbans the dogs were almost always excited and overwhelmed than they were at villages. Therefore, the dogs were roped or chained at all times in the Sundarbans, so that they couldn't get lost in the forest and couldn't attack any wild animal, particularly the deer fawns and red Junglefowl.

Table 4.1 Effectiveness of pet dogs in signalling people about the presence of tigers and other wild animals in the Sundarbans

ID no. of dog	Success in signalling presence of any animal (including tiger)			Success in specifically signalling presence of tiger		
	No. of dog's response	No. of times presence of any animal confirmed	Level of success (%)	No. of dog's specific response of fear (for tiger)	No. of times presence of tiger confirmed	Level of success (%)
1	92	89	97	13	9	69
2	117	109	93	19	11	58
3	43	40	93	5	4	80
4	84	77	92	10	6	60
5	55	51	93	8	6	75
6	111	103	93	18	12	67
7	106	95	90	14	10	71
8	71	66	93	9	6	67
9	76	72	95	12	8	67
10	102	94	92	17	12	71
11	83	80	97	16	12	75
12	59	54	92	8	5	63
13	74	69	93	15	11	73
14	89	83	93	14	10	71
15	37	35	95	5	2	40
16	108	101	94	18	13	72
17	116	109	94	24	14	58
18	51	37	73	11	4	36
19	122	113	93	27	18	67
20	49	45	92	8	5	63
21	61	57	93	11	9	81
22	33	28	85	2	0	0
23	97	92	95	15	7	47
24	77	73	95	12	8	67
25	106	100	94	16	11	69

26	113	108	96	18	13	72
27	48	39	81	6	3	50
28	62	58	94	9	6	67
29	118	111	94	21	14	67
30	41	33	80	5	0	0
31	94	90	96	13	9	69
32	71	66	93	8	5	63
33	115	111	97	14	9	64
34	114	109	96	15	8	53
35	102	96	94	13	8	62
36	88	80	91	11	6	55
37	76	73	96	10	7	70
38	58	53	91	6	3	50
39	51	47	92	5	4	80
40	107	101	94	16	12	75
Mean ± SD	81.9 ± 26.7	76.2 ± 26.3	92.4 ± 4.8	12.4 ± 5.5	8.0 ± 4.0	61.6 ± 17.5

4.3.2 Effect of Tourism

It was observed in the field that only 5% of the tourists who visit the Sundarbans behave as ecotourists, and this 5% is composed mainly of the foreign tourists. Others cause a lot of disturbance and pollution during their stay. The most disturbing groups were the teenage tourists. Since there is no one to motivate the tourists, we had talked to many groups of tourists and tried to convince them.

The problem is becoming more and more critical because there is no control over the number of tourists and there is neither any area in the Sundarbans nor any season is officially restricted for tourists. Therefore, tourism in general is producing adverse effect to the Sundarbans, together with its habitants like the tiger and its prey.

The presence of excessive number of people, together with increased noise pollution, particularly in Hironpoint, Dubla Island, Katka, Kochikhali and Karamjal in dry season (November to March) scares the tiger away (in many cases, together with the prey) from the area and the tiger's natural behaviour is affected. In order to avoid the disturbance of tourists tigers become more nocturnal during the tourist season. These were evident by our repeated observations of tiger pugmarks in different seasons. The rate of sound systems used illegally in different houseboats in the two dry seasons during this study (November 2005 to March 2006, and November 2006 to January 2007) were one sound system in every five houseboats.

The pollution in the Sundarbans is increasing alarmingly as a result of increasing number of tourists. The pollutants on the land were divided into tow groups: degradable (forms 35% of the volume of pollutants) and non-degradable (forms 65% of the volume of pollutants). The major threat, however, is the non-degradable pollutants like polythene bags, polythene packets, plastic bottles, etc. The rate of leaving non-degradable pollutants in the two dry seasons during this study was 0.3 pollutant/person/day. Sometimes the tourists throw away half-eaten lunch or dinner, including meat and other food, wrapped in polythene bags. While feeding on the food wrapped in polythene bag, or just from curiosity, wild animals sometimes ingest the polythene bag, which sometimes jam on the intestine and causes death of the animal. In the last five years at least two tigers were died after ingesting polythene bags (post-mortem reports confirmed this).

Tourism, however, is playing some strong positive roles through huge amount of revenue earning for the Government and directly or indirectly providing the scope for business for the local communities. The Sundarbans alone contributes more than 50% of the revenue in the forestry sector. The average annual revenue income from the Sundarbans in the

recent three fiscal years (2002-2003 up to 2004-2005) was Tk 62,543,554 (US \$ 953,699). Other than the entry fee for houseboat, the entry fee for each Bangladeshi tourist is Tk 50 (US \$ 0.76)/day and for each foreign tourist it is Tk 700 (US \$ 10.67)/day. This huge revenue income is indeed the principal stimulator in driving the Government's attention towards the conservation and management of the biodiversity of the Sundarbans, but it must be controlled.

The local communities, particularly those who live around the entry routes, are significantly benefited from the tourism. The houseboat business in Mongla and Khulna and the raw food market conduct their main business with the tourist parties. The houseboats, together with the package tour operating organisations, provide employment of many people. Our sampling in Mongla revealed that on average every tourist directly or indirectly spent at the rate of Tk 400 (US \$ 5.7)/day in the market at Mongla during the tourist season.

4.3.3 Awareness Campaign and Creation of 'Friends of the Tiger' Groups

Conducting awareness campaigns and forming some groups of young people called 'Friends of the Tiger' were our major step in strengthening local support for tiger conservation and reduce poaching of the tiger and its prey. A total of 38 awareness programs were conducted and 33 Friends of the Tiger groups were formed during the study period. All these were done in the villages along the edge of the Sundarbans. Perhaps a few thousand people attended the 38 awareness programs.

People of both sexes and all ages were invited in the awareness campaigns, to discuss with them about the need of tiger conservation and how to avoid confrontation with tigers. The heads of local schools, representatives of Local Government, staffs of the local forest offices and other influential people were always invited to participate. People were motivated to keep pet dogs and big sticks when they work in the Sundarbans. We informed people about the real facts and real life of the tiger so that they can get themselves free from superstition.

We also interviewed 126 adult people in the Sundarbans (when they were working), and in localities of the Sundarbans, to gather their views on different aspects of tiger-human conflict. According to most of the interviewees (63%), tigers kill people mainly because the tiger deliberately eat human flesh to satisfy hunger, which indicates that people get killed mainly by man-eating tigers (Figure 4.1). People living around the Sundarbans are so superstitious that most of the interviewees (47%) thought that human casualties by tigers can be reduced by taking only the spiritual protection measures (Figure 4.2), i.e., keeping a sacred bead, a sacred rope or a sacred handkerchief, or sacrificing domestic chicken or goat in the Sundarbans (by releasing them in the name of a spiritual man called 'Gazi'), or praying to Banbibí or Gazi-Kalu. Moreover, there are some sacred verses to 'deter' the tiger. Most of the interviewees (54%) thought that improved patrolling and implementation of laws by the Forest Department can reduce killing of tigers in the Sundarbans (Figure 4.3).

From our interviews with public it was clear that raising their awareness is crucial. Not only that people have many superstitions about the tiger, but their knowledge on tigers is very limited or wrong. When we organised programs in schools we used to ask the students about the advantage of having tigers in the Sundarbans. The students replied that if they have tigers in the Sundarbans they will be able to make shoes and bags from tiger skins, soaps from fats, medicines from different body parts, and skins as wall-hangings! This indicates the level of knowledge of the local children about the tiger, and emphasizes how badly the awareness programs were needed for them.

Our awareness campaign included open discussion, presentation of actual facts about the tiger by us, quiz contest on tigers (questions included different aspects of the tiger, i.e., what is the colour of tiger's eye, how many toes are on a tiger's foot, other than Bangladesh tiger is the national animal of which country, etc.), writing articles on tigers (for school students only), drawing pictures of tigers (for school students only), etc. All the necessary materials for different events, together with snacks, were supplied for free, and prizes were given to those who stood first, second or third.

Most of the awareness programs were followed by the creation of local Friends of the Tiger groups. The groups were formed to continue strengthening the conservation of tiger and its prey and use this network of groups to gather information and fight against poaching. We continuously keep contact with these groups, and are convinced that due to the existence of these groups the poaching pressure has been reduced significantly.

In early January 2006 the Friends of the Tiger group members in Joymoni, near Chandpai Range of the Sundarbans, were succeeded to convince the villagers not to kill a stray tiger that entered the village. They, together with the villagers, finally chased the tiger back to the forest. Another group of the Friends of the Tiger in the northeastern end of the Sundarbans recorded a freshly poached skin of the tiger in November 2006. Later on, the skin was seized by the Forest Department officials.

A total of seven people (five from the local villages) and two research students (from a local University) were always involved with the implementation of this project, and through this process they have made themselves resources for the future works on the monitoring and conservation of the tiger in the Sundarbans. Moreover, many local people were partially involved with this project who has gained basic knowledge about the tiger and the importance of conserving it in the wild.

As a part of the awareness raising for tiger conservation a colourful poster (3,000 copies) on the tiger, with the slogan 'Save the Last Tigers of Bangladesh', was produced and distributed to many people, mainly to those living around the Sundarbans (Appendix I). Moreover, a Bengali TV channel named NTV telecasted (nationally and internationally) a program on 22 January 2007, and four feature stories have been published in different newspapers and magazines, focusing on and admiring the work of this project on tigers (Appendices II, III, IV and V). Moreover, a book will be published by 2007, which will further disseminate the findings of this project.

4.4 Discussion

4.4.1 Saving Humans From Man-eating Tigers

Based on the official records (those recorded by the Forest Department), an average of 15.8 people and 2.6 tigers were killed per year in the last five years (Table 4.2). Notably, the human casualties were significantly low in the year 2006 and our project played a significant role in making this difference. The actual number of human casualties, however, is always higher than these (Montgomery 1995, Helalsiddiqui 1998; Ahmed 2002a, 2002b; Khan 2004c), but usually proportional to the official numbers. When an illegal intruder is killed by a tiger, the death is not recorded officially. Even the news of death of valid permit holders sometimes does not reach to the Forest Offices, because the Sundarbans is a huge area. Because of the presence of more man-eaters in the western part of the Sundarbans, the rate of human casualty is higher in the Sundarbans West Forest Division than the East.

Table 4.2 People killed by tigers and tigers killed by people in the Bangladesh Sundarbans in the last five years.

Year	Sundarbans East Forest Division		Sundarbans West Forest Division		Total for the Bangladesh Sundarbans	
	No. of people killed	No. of tigers killed	No. of people killed	No. of tigers killed	No. of people killed	No. of tigers killed
2006	2	1	2	0	4	1
2005	2	1	11	0	13	1
2004	1	2	14	2	15	4
2003	1	2	18	1	19	3
2002	1	2	27	2	28	4

The idea of using pet dogs to save humans from man-eating tigers is innovative. It is well-known, however, that dogs can successfully serve many similar purposes like finding the hunt, criminal or drugs. In early 20th Century, Jim Corbett – the legendary hunter in Northwest India – often used his pet dog named Robin to track man-eating tiger or leopard (Corbett 1944, 1948, 1954, 1957). In the Russian Far East the pet dogs are being used to locate individual tigers from their scents (L.L. Kerley pers. comm. 2007). Taking into account the urgency of reducing human casualties in the Sundarbans, where people are not able to cope with any sophisticated or expensive solution, keeping pet dogs and big sticks is probably the best option for them.

Using pet dogs to save humans from man-eating tigers does not mean that human lives will be saved by endangering the lives of dogs. Since each of the dogs must be chained, a person will always accompany the dog. It is well-known that in the Sundarbans a man-eating tiger will prefer a human (easy to hunt, get more meat) more than any other animal. Compared to a pet dog, a human is easy to hunt and it is more gainful in terms of the amount of meat, so if a man-eating tiger decides to attack it will probably go for a human instead of a dog when both options are there.

Another aspect to discuss is whether the tiger can rather be attracted by the dog and can increase the risk of confrontation. If we assume that noise is the main factor that drives the tiger's attention, which is more likely to happen, then the dog's noise is negligible in comparison to that of people. In the Sundarbans people almost always work in groups and they intentionally make a lot of noise to deter the tiger. If there is any tiger that is not a man-eater, it is unlikely that the tiger will dare approaching the dog that is in close association of people. On the other hand, if the tiger is a man-eater, people themselves will be a greater attraction instead of the dog, which has already been mentioned earlier.

4.4.2 Effect of Tourism

The growing tourism in the Sundarbans has tremendous economic prospect, but if it is not properly managed it can be disastrous for the Sundarbans, together with tigers and other species. Based on our observation of the ongoing trend of tourism, we strongly recommend that i) tourists must be allowed only in some designated areas, ii) there must be some control over the number of tourists entering the Sundarbans so that a large number of tourists cannot enter at the same time, and iii) either the Forest Department officials or the motorboat people must be assigned to motivate and instruct the tourists, particularly the teenage tourists, at the entry to the Sundarbans, on how to behave and how to treat the pollutants while in the Sundarbans.

4.4.3 Awareness Campaign and Creation of 'Friends of the Tiger' Groups

The awareness campaign and the network of Friends of the Tiger groups that we organised played very effective role, but these require continuation and expansion. Currently there is no sustained way of continuing these, so a long-term program is needed to optimize the support for conservation.

From the feedbacks of the attendants it was clear that the awareness campaign significantly improved public knowledge and interest on tigers, and provided them some key information that will be useful in saving their lives from man-eating tigers. From the programs people were encouraged to use pet dogs and big sticks when they work in the Sundarbans.

The network of Friends of the Tiger has proven to be very effective in reducing the poaching. The young people were found to be the most effective, because they are more curious and they have more time to spend for this kind of work.

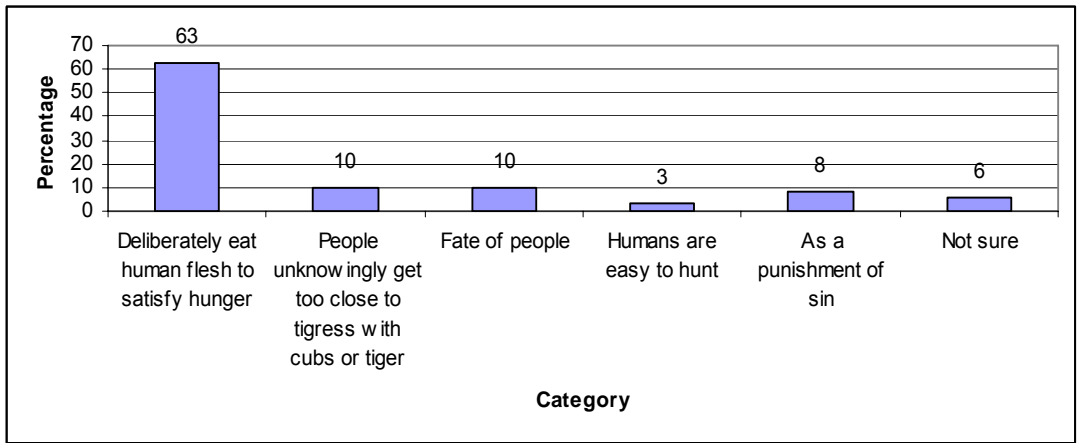


Figure 4.1 Comments of the local communities on why people get killed by tigers.

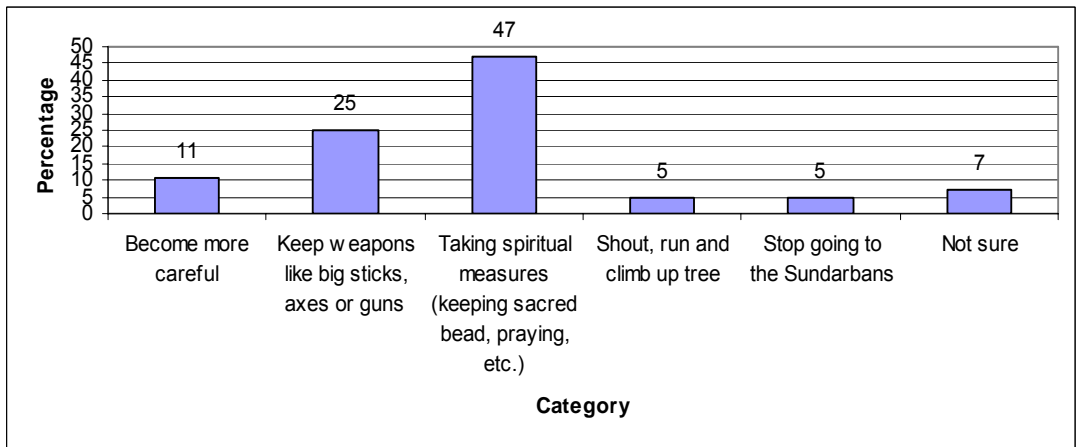


Figure 4.2 Comments of the local communities on how the human casualties by tigers can be reduced.

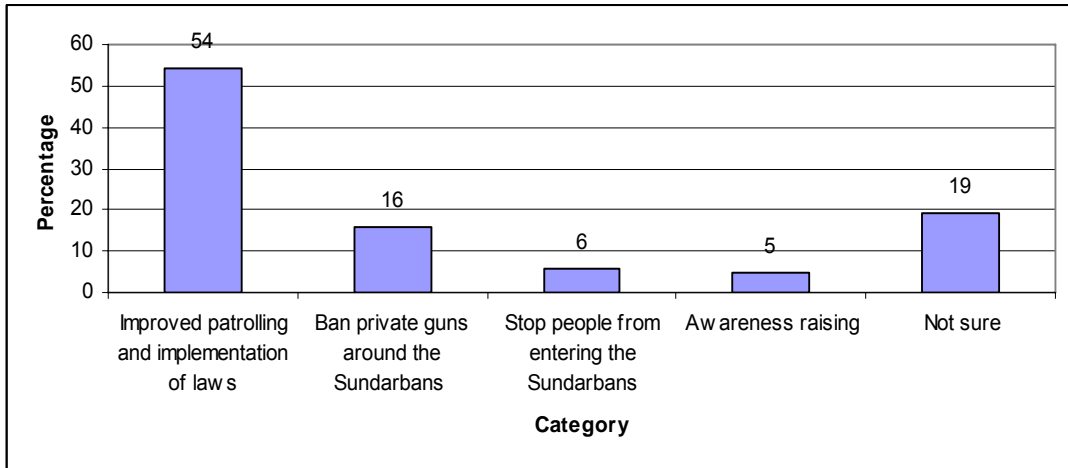


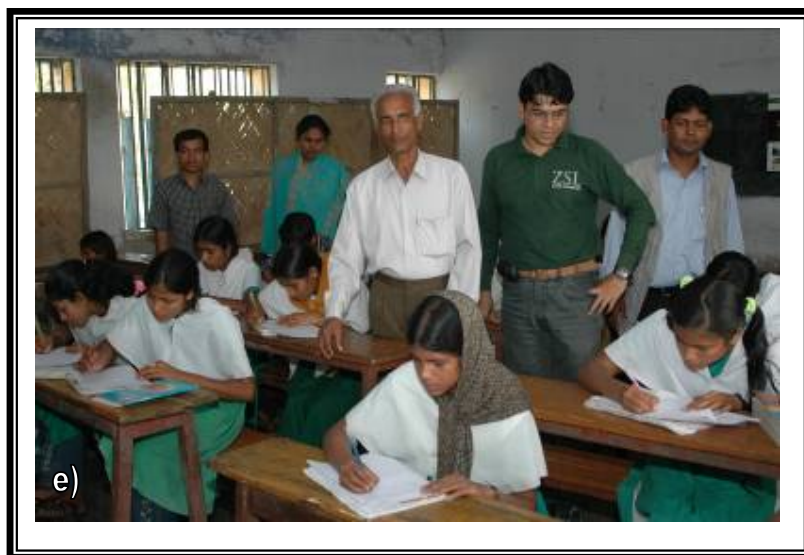
Figure 4.3 Comments of the local communities on how the killing of tigers by people can be reduced.



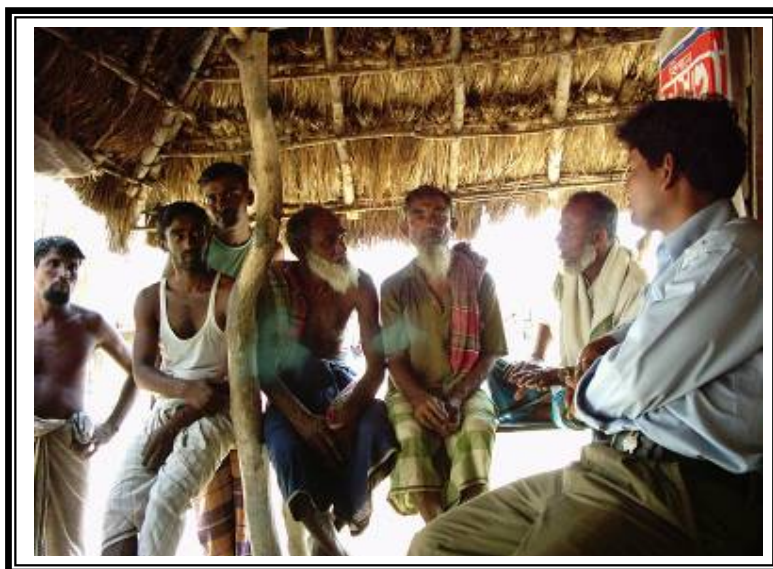
Use of pet dogs by honey gatherers and firewood collectors in order to reduce the risk of being attacked by man-eating tigers.



Awareness campaign to strengthen tiger conservation: a-b) discussion program in a school to organize a 'Friends of the Tiger' group, c-d) discussion program with villagers, and e) demonstration of the use of remote camera-trap that is used to photograph wild tigers.



Awareness campaign in the schools often involved contests of tiger picture drawing (a-b; sample pictures c-d), writing articles (e) and answering quizzes on tigers.



The experienced local people were interviewed in and around the Sundarbans to record their views on different aspects of tiger-human conflict.

5. Management Implications

The scientific estimate of tiger population in the Sundarbans will be the key factor in convincing different national and international organisations and communities about the potential of the Sundarbans tiger population for long-term conservation. This will also bring an end of the wide controversy on the tiger population size in the Sundarbans. The estimates of absolute and relative densities will also be useful in temporal monitoring of the tiger population trends in the Sundarbans inside and outside the sanctuaries. The information presented in this report will serve as the baseline for future monitoring. The Project Sundarbans Tiger intends to continue periodical monitoring of the tiger population by repeating the same work in the same plots in different times.

Since the use of pet dogs has proven to be effective in reducing the risk of being attacked by man-eating tigers, this can be imposed to every group of people going to work in the Sundarbans, i.e., introducing pet dogs in a large-scale. This not only will reduce human casualties, but in the long-term this will change the hostile attitude of many people towards the tiger and will improve local support for tiger conservation.

The adverse effect of uncontrolled tourism, which is still overlooked in the Sundarbans, should now come to the limelight. Hopefully, necessary attempts will be taken so that tourism is restricted to certain areas and in certain levels, and there will be some people to motivate the tourists entering the Sundarbans.

Both the awareness campaign and the network of Friends of the Tiger groups have significantly improved the local knowledge and support for tiger conservation in the Sundarbans. The presence of Friends of the Tiger network is a strong challenge against poaching, and is a good source of information about the poachers and poaching routes, for the Forest Department and all other conservation-supporting bodies. If this network can be sustained this will eventually abolish the poaching of tigers and their prey.

The Project Sundarbans Tiger has done this 18-month work as the second phase. Now we are planning for the third phase that will focus mainly on the mitigation of tiger-human conflict by introducing pet dogs and sticks on a large scale, restoring buffer zones (so that people don't need to go to the Sundarbans for firewood), monitoring tiger movements between the forest and the nearby villages and conducting awareness programs. Moreover, the monitoring of tiger population trend will continue.

A survey of the status and distribution of wild tigers in the Chittagong Hill Tracts, in the southeast of Bangladesh, bordering with India (Mizoram State) and Myanmar, is also under active consideration. Wild tigers are rarely seen in this area, but there is yet any survey. The political disturbance, inaccessibility and the threat of malaria makes any survey work difficult in the Chittagong Hill Tracts.

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Appendices


Appendix I. Sample of the poster that was produced and distributed for free, mainly among the people living around the Sundarbans.


SAVE THE LAST **TIGERS**
OF BANGLADESH
বাংলাদেশের বিপন্ন বাঘ রক্ষা করুন



PROJECT SUNDARBANS TIGER Research and Conservation Activities
প্রজেক্ট সুন্দরবন টাইগার : গবেষণা ও সংরক্ষণ কার্যক্রম



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Appendix V. Article on the use of pet dogs to save humans from man-eating tigers, published in the Cat News of IUCN/SSC Cat Specialist Group (Bern, No. 45, Autumn 2006, p. 20).

Pet Dogs Can Save Humans From Man-Eating Tigers

M. Monirul H. Khan¹

Pet dogs are the best animal-friends of human beings from the very beginning of human civilization. They are used for various purposes; from a companion to tracking hunts, criminals or drugs. Recently, it has found that the pet dogs can be used to save human lives from man-eating tigers by warning people about the presence of a tiger.

In the Ganges-Brahmaputra delta of Bangladesh and India lies the largest mangrove forest in the world – the Sundarbans, a tract of about 10,000 km². This huge tract is believed to harbour one of the two largest single populations of the tiger on earth, compared only to the tiger population in the Russian Far East. These tigers, however, have a reputation as man-eaters. As many as 50 people are killed every year by tigers in the entire Sundarbans. As a consequence, the local communities are becoming more and more hostile toward the tiger. Reducing human casualties from man-eating tigers is crucial for the welfare of both people and tigers, but it is not an easy job and a number of techniques have been applied and failed.

The idea of introducing pet dogs is innovative. Jim Corbett, who had hunted man-eating tigers and leopards in India in the early last century, often used his dog, Robin, to locate the tiger. Since the tiger kills its prey (including humans) by surprise, it is very practical for a group of people to keep a pet dog with them because the dog will detect the presence of the tiger and warn. This will give them some time to get together and shout, climb up a tree or get back to the boat. The dog, however, must be chained so that it is not lost in the forest and cannot attack smaller wildlife.

In order to test the effectiveness, pet dogs have been introduced in 50 local groups of woodcutters, honey gatherers (Fig. 1, 2) and fishermen. Either I or a member of my team accompanied each of these groups in the Sundarbans and recorded all the warning signals or reactions of the dog in response to the presence of a tiger or any large animal (spot-



Fig. 1. A group of honey gatherers going to the Sundarbans with a pet dog on board (Photo: M. M. H. Khan).



Fig. 2. Accompanied by a pet dog, a group of honey gatherers smoking a honey-comb in the Sundarbans (Photo: M. M. H. Khan).

ted deer, wild boar or rhesus macaque). The animal was identified immediately, either by direct observation of the animal or its footprints/pugmarks, or by its footprints/pugmarks in the next day (in order to avoid risk).

Although the research is still going on, based on the initial data I am confident to say that, although the pet dogs cannot always distinguish the tiger from other large animals in the forest, the warning signal is very useful in reducing the risk of a tiger. The dog is particularly useful to honey gatherers, because when they smoke the honey-comb the visibility becomes very poor

and they become very vulnerable to the tiger.

This work is being done under a research-cum-conservation project called 'Project Sundarbans Tiger', which is under the umbrella of the Conservation and People Conservation Programme of the Zoological Society of London, and is funded by the Save the Tiger Fund. The Project wishes to introduce pet dogs on a large scale should there be sufficient support to do that.

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