Status of big cats and their conservation in newly declared extension areas of Bardia National Park, Nepal

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Table of Contents

Preface

This project, entitled "Status of big cats and their conservation in newly declared extension areas of Bardia National Park, Nepal, has been funded by Rufford Small Grants. The main objective has been to assess the status (proportion of area occupied by tigers) of big cats in Nepal's 10th National Park declared as "Banke National Park". I have used relatively new approach to assess the occupancy of big cats using expert opinion survey under the framework of the occupancy inferential models and crossed verified with the occupancy survey based on sign survey. I have tried to use the camera trap in the area where there are high movement of the big cats observed during the sign survey and expert opinion survey but unable to carried out the trapping due to the field limitation (which includes off season and high risk of losing the camera traps). Hence the camera trap purchased including 1- GPS has been handed over to the national park for their future monitoring.

The first chapter of this report deals with the assessment of big cat in Banke National Park using sign survey and expert opinion survey.

The second chapter of this report deals with the conservation awareness part named as "Bag Bahadur Campaign".

All the output as mentioned in the proposal has been carried out except with camera trapping in the high movement areas.

Citation

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Summary of Part I

1. Declaration of 550 sq km of area as the Nepal's 10th national park (Banke National Park) is crucial for creating the land base for tiger and other big cats in Terai Arc. This demands

the need of baseline data with respect to the status and distribution of big cats in the National Park.

2. I have assessed the habitat occupancy of big cats in 1239 sq. km of Banke National Park Landscape (core area and associated areas) employing the spatially replicate sign survey. Data were collected in the form of big cat sign from 53 grids, each 10.5 sq. km.
3. Based on sign survey, model averaging resulted in the proportion of area occupied by the tiger to be 446 sq km (S.E=4.35 sq km). With Leopard, model averaging resulted in the occupancy estimates by the leopard to be 1318 sq km (S.E= 12.36 sq km) in Banke National Park and associated areas.
4. Prey and Disturbance index was found to main factor influencing the occupancy estimates and detection probability. In case of tiger: occupancy estimates was found to be ranging from 0.28 in the area of low prey base (S.E=0.40) and high disturbance area to 1 (S.E=0.00) in the area of relatively high prey and low disturbance areas. Detection probability varies with 0.0425 (S.E=0.04) in area with low prey base to 0.4304 (S.E=0.2417) in area with high prey base.
5. Based on expert opinion survey, standard model showed that probability of occupancy (ψ) was found to be 0.40 (SE=0.06) and the probability of detection estimated (p) at 0.0368 (SE=0.0054) for tiger. For leopard, probability of occupancy (ψ) estimated at 0.4896 (SE=0.09) and the probability of detection estimate (p) at 0.280 (SE= 0.046).
6. Based on crude analysis, rough minimum population estimates of 2 tiger and 10 leopards in Banke National Park.

Conservation Implication: This study provides an opportunity for future monitoring in Banke National Park Landscape in devising the local conservation strategy. Banke National Park provides lots of opportunity in increasing the occupancy of big cats by increasing the prey and lowering disturbance factors in the Banke National Park Landscape. Present study provides the crucial base line data for future big cats monitoring in Banke National Park Landscape.

Summary of Part II

1. Bagh Bahadur Campaign was launched focusing on the eco club students at three schools across the Narti range in Banke National Park Landscape.
2. Status of Big cat was shared with government officials of Banke National Park.
3. Bagh Bahadur character was designed as ionic character focusing on the youth, who are the ardent tiger enthusiasts.
4. 1000 poster and fliers were distributed among the 40 schools, conservation organization (WWF, NTNC) and buffer zone office to spread the message of tiger conservation.
5. Bagh Bahadur Club was formed in social networking sites like FACEBOOK to create the forum for spreading the tiger conservation message among the wide audience.

Part I

Introduction

Terai Arc Landscape in Nepal is important for tiger and other big cats (2004). Tiger(*Panthera tigris* Linnaeus, 1758), leopard (*Panthera pardus* Linnaeus, 1758) are the common top carnivore found in the landscape. In many terrestrial ecosystems mammalian carnivores serve as flagship species in the conservation of biodiversity(CARO and O'DOHERTY 1999; HARIHAR *et al.* 2011)and conservation efforts aim to maintain or reestablish viable populations(Treves and Karanth 2003). At the point where global tiger population is only half of what was estimated 10 yrs ago with 3200-3600 individuals(SEIDENSTICKER 2010) and range contraction of c.93% in the past two centuries (DINERSTEIN *et al.* 2007). Increasing in the extent of protected core tiger habitat linked within larger landscape is indeed a positive step towards recovering the tiger population (DINERSTEIN *et al.* 2007; SEIDENSTICKER 2010). In 2010, The Government of Nepal decision to declare 550 sq km of the core habitat as the 10th national park of the country(DNPWC 2010) is an exemplary step in this regard. It is also the Government commitment toward doubling the tiger population in next 12 years (AMCTC 2010) through increasing the extent of the protected core habitat areas for tigers. Banke National Park (as the 5th tiger harboring protected areas in Nepal, here after referred as BNP) forms the contiguous habitat with Bardia National Park which currents hold the highest population of tiger (18(S.E 2.5)) in western part of the Terai Arc (DNPWC 2009).

Abundance (population size) is a state variable of primary interest to scientists and conservationists because of its decisive influence on ecological and behavioral attributes, and, thus the potential viability of any animal population (Mondol et al. 2009; Williams et al. 2002).Camera trapping has been the suitable method for monitoring these marked carnivores in the region (KARANTH 1995; KARANTH *et al.* 2004a) at such small scales. But given the logistic and resource consideration, I used two-low cost monitoring approach (BARBER-MEYER *et al.* 2010; KARANTH *et al.* 2011b) in monitoring the status of the carnivores in Banke National Park and associated areas. These two methods uses simple sign survey and expert opinion survey under the single inferential framework(MACKENZIE *et al.* 2006). The main objective of this study has been to estimate the proportion of area occupied by tiger and leopard in BNP based on the sign survey and the expert opinion survey.

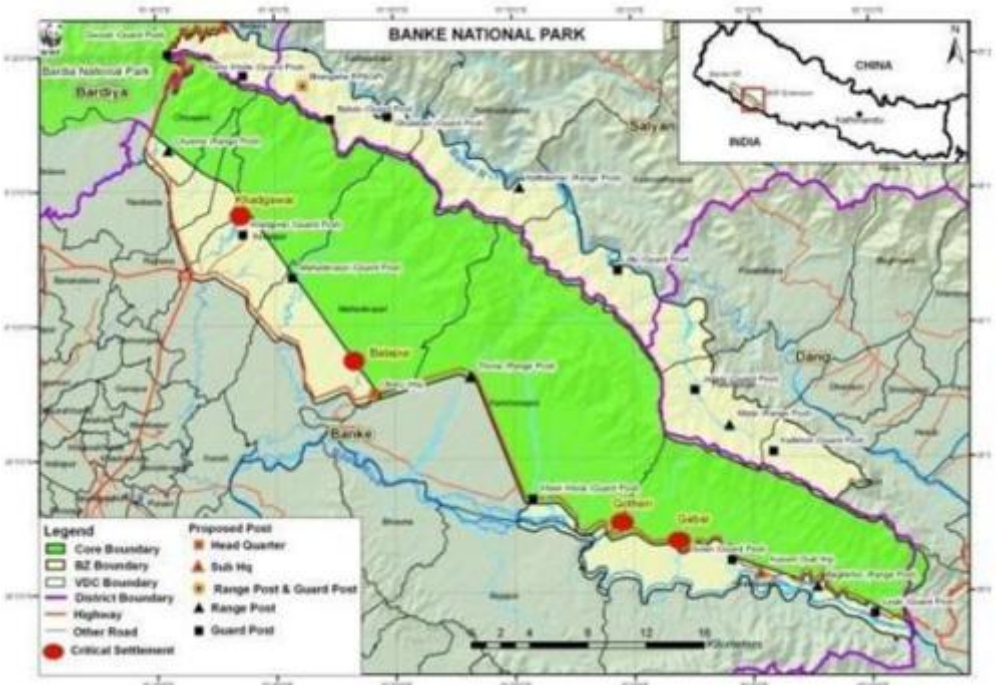
Methods and Material

STUDY AREA

Terai Arc Landscape in Nepal is important for tiger and other big cats (WICKRAMANAYAKE *et al.* 2004). This study was conducted in the Banke National Park (BNP) and associated areas (Here after referred as Banke National Park Landscape (BNPL)) located in the western part of the Terai Arc. BNPL forest connectivity is contiguous to Level 1 Tiger Conservation Landscape(DINERSTEIN *et al.* 2007) across the Bardia National Park located in the western part of the BNPL. Administratively, BNPL lies in Banke, Bardia, Dang and Salyan districts located in the mid western region of Nepal.

The land cover is the matrix of Sal forest, deciduous forest and riverine forest interspersed with agriculture areas and river banks cascading down from churia hills covering an area of1 239 sq km of which Banke National Park covers an area 893.29 sq km which includes core area of 549.13 sq km and buffer zone area of 344.13 sq km respectively (DNPWC 2010). This landscape supports the estimated 43 thousand people (CBS 2001) and daily household activities are characterized by agriculture, livestock grazing, fuel wood collection and other agri-business.

Topographically, BNPL comprises of river floodplains, river valleys and gorges and the churia hills in between Rapti River in the south and Babai River in the north (Fig. 1). The highest and lowest elevation is measured at 1247 m and 153m respectively. BNPL has the sub tropical monsoonal climate with three distinct season: summer monsoon (June to September), cold dry season (October to February) and hot dry season (March to June)(MoFSC 1998). Most rainfall occurs between June and September. Average temperature in cool season drops to 10°C while the average temperature is approximately 36°C during hot dry season (MoFSC 1998).



General major forest types that has been identified in BNPL(SHRESTHA 2004) includes: High density Sal forest, Low density Sal forest, tall and short grasslands and degraded forest (Table 1). Basnet *et al.*1998 recorded 88 species of trees &climbers and 36 shrub species. *Shorea robusta*, *Terminalia tomentosa, Buchanania latifolia, Anogeisus latifolia, Dalbergia sisso, Acacia catechu, Ficus glomerata, Mallotus philippinensis,* and*Sugenia jambolana* are the dominant species recorded across BNPL.

Table 1: General forest classification in BNPL.

Areas	High Density (ha)	Low density (ha)	Degraded (ha)	Short grass (ha)	Tall grass (ha)
BNPL	63694.9	68468.7	10637.8	3697.0	751.3

In terms of faunal diversity; 50 species were recorded as an endangered (HMG 1996) among 34 mammals, 300 birds, 24 reptiles and 3 amphibians as listed by Basnet *et al.* 1998. Tiger *Panthera tigris* Linnaeus, 1758, leopard *Panthera pardus* Linnaeus, 1758 are the principal top carnivores. Sambar *Rusa unicolor* Kerr, 1792; spotted deer *Axis axis* Erxleben, 1777,wild boar *Sus scorfa* Linnaeus, 1758, barking deer *Muntiacus muntjak* Zimmermann, 1780 are the commonly recorded prey species.

FIELD SURVEY PROTOCOLS

Survey design for Occupancy Survey

The proportion of habitat in BNPL occupied by tigers and leopard, occupancy, was a key parameter of interest. BNPL was divided into the grid size measuring 10.5 sq. km. The total of 118 grids was generated and randomly selected 53 grids (45%) for field survey. Within each surveyed cells, route measuring 500 m-14 km of transect walk was carried out. Data was collected in every 100 m segment and final detection data was generated in every 1km spatial replicates. Survey was focused on high probability location for tiger sign detections (e.g., trails, ridgelines, roads, and river and stream beds) within each grid cell(KARANTH *et al.* 2011a). Data was recorded on big cat and its prey species occurrence and human disturbance at every 100 m segment of 1km spatial replicate. The total survey effort invested in the survey was 228 man hrs covering 266 km of transect route walk detecting 43 signs of big cats. Survey was carried out in the month of the July-October 2011 with each surveyed unit (grid) being completed between 12-36 hrs. and reasonably met the closure assumption (MACKENZIE *et al.* 2006).

Occupancy Survey Using the expert Opinion Survey

The proportion of area covered by big cats was also carried out using expert opinion survey (KARANTH *et al.* 2009).This is first time approach being used to measure the big cat

occurrence in Nepal. To deal with problem of the false absence, replication based survey was carried. This situation creates the scenario where species was present but not always detected by the observer. Grid based sampling approach was used and divided the BNPL into 118 grids (each measuring 10.5 sq.km).Experts used in our sampling approach were the local people living in the buffer zone areas of the national park, local wildlife experts and government employee of Banke National Park and District Forest Office. Interviews were carried out with more than 101 experts independently thus representing the entire coverage of the BNPL. Thus it was feasible to collect the expert information on big cat presence or absence across the BNPL.

At each interview, respondent were selected and information was asked about occurrence of the big cats from their surrounding grids. Respondent might have knowledge about the big cat occurrence at particular grid surrounding him/her but not grid far away. Respondent were first asked about the wildlife presence in general across the BNPL. Then respondent were double checked about the occurrence of big cats. Confusion over the identity of big cat was solved through photographs. Once they were aware of the species in investigation, they were asked about their occurrence in BNPL and pinpoint on the grid map about their tentative locations. Confirmation of the big cat occurrence was made based on basis of their personnel observation of the species and/or their sign in the field at any particular grid. Any discrepancy/ confusion on the conformity of the species at any particular grid were not regarded presence of the species. The average number of respondent ranged from 2 to 6 per grid. These multiple independent respondents replicated the presence and absence data to estimate the occurrence of the species across BNPL.

Occupancy Data Analysis

Single season occupancy model was used to estimate the occupancy (MACKENZIE *et al.* 2006) of big cats using the method of maximum likelihood (Karanth et al 2010). The models were ranked and model weights calculated using Akaike's information criterion (AIC)(BURNHAM and ANDERSON 2002). In a model set, the AIC weights represent measures of the appropriateness of a given model relative to other models in the model set. We used model averaging to estimate parameters in situations where there were multiple models that were supported by the data.

In case of expert opinion survey, detection probabilities are estimated via 'replication' in the form of multiple expert opinions obtained per cell. Basic idea is that for cells in which a species is detected, one can ask how many other experts also detected the species. This information permits inference about detection probability. The formal analytic methods are described in detail in MacKenzie *et al.*(2006). All the analysis was performed in the program PRESENCE v.3 (HINES 2010).

Covariates

Occupancy and detection probabilities are influenced by the site characteristics. Human disturbance and prey abundance were two covariates found to influence the distribution of tigers and other big cats. Forest fire, evidence of poaching, physical disturbances, resource collection etc. which were collectively recorded and expressed in terms of human disturbance index (Table 1). Human disturbance index (Barber et al in preparation) was expressed as continuous variable for each grid cell as follows: H = (L*0.2) + (V*0.25) + (E*0.35) + (F*0.2). In this expression poaching (E) were given the highest weight, followed by the factors influencing the habitat (V) while physical disturbance (L) and other factors (F) have equal contribution.

Sambar, spotted deer, barking deer, wild pig were the main prey recorded in the survey. Here the livestock were also pooled as the prey for the big cats. Prey Index were expressed as number of prey sign encounter per 10 km of transect walk. The global model was defined as ψ(HP+LD),θ_0,θ_1,p(HP+LD) the probability of occupancy (ψ) and detection probability is influenced by the prey index (HP), the human disturbance index (HD) and the probability of detection (p) is influenced by spatial correlation (with the initial θ_0 not equal to other θ_0's). While, I have used proportion of habitat available as a covariate influencing the occupancy and detection probability in the expert opinion based occupancy estimation.

Results

Occupancy Survey based on Route Transect Walk

Subsets of 53 sub grids (556.5 sq. km) were surveyed in the 228 man hrs covering 45% of the total area of Banke National Park Landscape (1239 sq. km). Continuous transect walk was carried after walking 1-2 km from the settlement areas in all the grids. Total of 80 indirect signs of tiger and leopard were detected in 266 km transect walk (Table 2). The naïve occupancy estimate were 0.05(3/53) for tiger and leopard 0.33(17/53) respectively. For tiger, 5 % of the potential tiger habitat (forest and grassland: 74.09 sq km) was occupied based on tiger sign detected in the 3 sub grid cells (31.5 sq. km). For leopard, 33 % of the potential leopard habitat (forest and grassland: 494 sq km) was occupied based on leopard sign detected in the 18 sub grid cells (189 sq. km).

Table 2 : Big cat sign type of sign detected in BNPL

S.No	Type of Observation	Leopard	Tiger
1	Direct Observation	-	-
2	Indirect Observation	73	7
2.1	Tracks	68	7
2.2	Scats	3	-
2.3	Scrapes	2	-

Occupancy Analysis for Big Cats

No correlation was observed between the prey and disturbance index (r=0.137, p=0.327) in Banke National Park Landscape. Hence there were further used in the occupancy analysis as the covariates for assessing their influence on occupancy estimates and detection probability.

Tiger

We compared the five plausible alternative models to describe the influence from combination of the covariates on the occupancy as well the detection probabilities at the 1 km replicates as well as the grid level. High prey was found to be influencing to the detection probability of tigers the as expressed in the top model with lowest AIC value (Table 3).

Table 3. Model selection results; role of covariates in determining probability of detecting tiger sign pt on 1-km-long replicates, based on covariates for probability of tiger occupancy from the global model. Number of sites = 53. Covariates considered high prey (HP) and low disturbance (LD)

Model	AIC	ΔAIC	AIC wgt	Model Likelihood	Number of Parameter	Deviance
psi(HP+LD),thta0,thta1,p(HP)	48.13	0	0.4148	1	7	34.13
psi(HP+LD),thta0,thta1,p(.)	49.46	1.33	0.2133	0.5143	6	37.46
psi(HP+LD),thta0,thta1,p(HP+LD)	49.87	1.74	0.1738	0.419	8	33.87
psi(HP+LD),thta0,thta1,p(LD)	50.27	2.14	0.1423	0.343	7	36.27
psi(HP+LD),thta0,thta1,p(HD)	52.14	4.01	0.0559	0.1347	7	38.14

In the next steps, we have retained the high prey (HP) index as the main covariates influencing the detection probability, while varying the occupancy. Our best model explains that high prey and low disturbance support the best structure for the replicate level occupancy estimates (41%). The result showed that all the data fit to the model quite well with ΔAIC< 1.45 (Table 4). Hence we used the model average techniques (BURNHAM and ANDERSON 2002) for deriving the cell level estimates for tiger occupancy and detection probability.

Table 4. Model selection results; role of covariates in determining probability of tiger occupancy in Banke National Park Landscape based on modeling probability of detecting tiger sign on 1-km-long replicates. Covariates for probability of detecting tiger sign was obtained table 3. Number of sites = 53. Covariates considered high prey (HP) and low disturbance (LD)

Model	AIC	ΔAIC	AIC wgt	Model Likelihood	Number of Parameter	Deviance
psi(HP+LD),thta0,thta1,p(HP)	49.13	0.00	0.4132	1.000	7	34.13
psi(LD),thta0,thta1,p(HP)	49.20	1.07	0.2420	0.5857	6	37.20
psi(HP),thta0,thta1,p(HP)	49.58	1.45	0.2001	0.4843	6	37.58
psi,thta0,thta1,p(HP)	50.23	2.10	0.1446	0.3499	5	40.23

The final parameter estimates was derived for tiger habitat occupancy and sign detection probabilities from model averaging. The Presence-generated probability of occupancy (ψ) estimate from model with no covariates was 0.1166 (SE=0.07) and the probability of detection estimate (p) was 0.144 (SE= 0.08). This explains was 106% increase from the naïve estimates of 5%. This explains that traditional presence and absence approach underestimates the true occupancy by more than 101%. The model average probability of the site level occupancy estimate for tiger was found to be 0.36 (S.E=0.09). Of the total potential habitat of 1239 sq km in Banke National Park landscape, 446 sq km (S.E= 4.35 sq km) habitat was actually occupied by tigers. The grid site specific tiger occupancy was found to be ranging from 0.28 in the area of low prey base (S.E=0.40) and high disturbance area to 1 (S.E=0.00) in the area of relatively high prey to low density areas. Whereas across the grids, detection probability varies with 0.0425 (S.E=0.04) in area with low prey base to 0.4304 (S.E=0.2417) in area with high prey base.

Leopard

The probability of occupancy (ψ) estimate from model with no covariates was 0.4896 (SE=0.09, 44% increase from the naïve estimate) and the probability of detection estimate (p) was 0.280 (SE= 0.046). This explains that traditional presence and absence approach underestimates the true occupancy by more than 44%. Based on lowest AIC value, Model 1 was found to be most parsimony with high prey abundance affecting the occupancy and low disturbance affecting the detectability of leopard sign in Banke National Park Landscape (Table 5:).

Table 5. Model selection results; role of covariates in determining probability of leopard occupancy in Banke National Park Landscape based on modeling probability of detecting tiger sign on 1-km-long replicates. Disturbance factor was used as covariates for probability of detecting tiger sign. Number of sites = 53. Covariates considered high prey (HP) and low disturbance (LD)

Model	AIC	ΔAIC	AIC wgt	Model Likelihood	Number of Parameter	Deviance
psi(HP),thta0,thta1,p(LD)	192.06	0.00	0.5766	1.0000	6	180.06
psi(LD+HP),thta0,thta1,p(LD)	193.50	1.44	0.2807	0.4868	7	179.50
psi(LD),thta0,thta1,p(LD)	196.21	4.15	0.0724	0.1256	6	184.21
psi,thta0,thta1,p(LD)	196.27	4.21	0.0703	0.1218	5	188.27

The model average probability of the site level occupancy estimate for tiger was found to be 0.88 (S.E=0.09). Of the total potential habitat of 1239 sq km in Banke National Park landscape, 1318 sq km (S.E= 12.36 sq km) habitat was actually occupied by leopards.

Based on similar analysis as cited above, the final parameter estimates derived for leopard habitat occupancy and sign detection probabilities from model averaging techniques(BURNHAM and ANDERSON 2002). The grid site specific leopard occupancy was found to be ranging from 0.32 in the area of low prey base (S.E=0.40) to 0.89 (S.E=0.00) in the area of relatively high prey base. Whereas across the grids, detection probability varies with 0.41 (S.E=0.04) in area with high disturbance to 1 (S.E=0.2417) in area with low disturbance.

Occupancy Survey Based on Expert Opinion Survey

I conducted the expert opinion survey across the buffer zone and associate areas of BNPL. The survey resulted in 101 respondents with the total of 202 man hrs time effort spread over 2 month survey period. The age of the respondent ranged from 78 yrs old to as young as 21 yrs old. The mean age of the interviewees was recorded at 42 yrs old.

Tiger

Tiger was detected 91 times in 34 grids out of 101 grids based on expert opinion survey. Maximum of 6 detections were recorded at each sampling unit and covers the total potential area of 478 sq km by tigers with naïve estimates of occupancy 0.33 (34/101).

I used "the proportion of habitat available" as a potential covariate affecting the occupancy and detectability of tiger. All models showing AIC weight including the habitat covariates is shown in the table below. Model 1 showed the AIC weight of 0.65 (lowest AIC), while the model 2 received the AIC weight of 0.233 with ΔAIC of 2.06 (Table 6). The Presence-

generated probability of occupancy (ψ) estimate from model 2 (i.e., no covariates) was 0.40 (SE=0.06, 95% CI=0.29-0.52, a 21% increase from the naïve estimate) and the probability of detection estimate (p) was 0.0368 (SE=0.0054, 95% CI=0.0276-0.0490).

Table 6. Model selection results; role of covariates in determining probability of tiger occupancy and detection probability of tiger in Banke National Park Landscape based on expert opinion survey. Number of sites = 101. Only covariate considered was proportion of habitat available.

Model No.	Model	AIC	ΔAIC	AIC Weight	Model Likelihood	No. of Parameter	Deviance
1	Psi(habitat),p(habitat)	701.59	0.00	0.6544	1.0000	4	693.59
2	Psi(.),p(.)	703.65	2.06	0.2336	0.3570	2	699.65
3	Psi(habitat),p(.)	705.12	3.53	0.1120	0.1712	3	699.12
4	Psi(.), p(habitat)	742.77	41.18	0.0000	0.0000	3	736.77
5	1 group, Survey-specific P	825.56	123.97	0.0000	0.0000	88	649.56

Estimates of ψ and p from the models 1 varied depending on covariates (habitat: proportion of habitat available) and received the AIC weight of 65%. The tiger occupancy estimates ranged from 0.20 (SE=0.02) in areas with low availability of habitat to 0.97 (SE=0) in areas with higher availability of habitat. There was significant +ve correlation found between the site specific occupancy estimates and site specific proportion of the available habitat (r=0.667, p=0.00).

Leopard

Leopard was detected 93 times in 45 grid out of 118 grid based on expert opinion. Data from 19 grids were not used in the analysis due to lack of consistent response from the expert opinion survey. Maximum of 6 detections were recorded at each sampling unit (grid) and covers the total potential area of 632 sq. km by leopard with naïve estimates of occupancy 0.38 (45/101).

I used "the proportion of habitat available" as a potential covariate affecting the occupancy and detectability of leopard. All models showing AIC weight including the habitat covariates is shown in the table below. Model 1 showed the AIC weight of 640.77 (lowest AIC), while the model 2 received the AIC weight of 642.79 with ΔAIC of 2.02 (Table 7). The Presence-

generated probability of occupancy (ψ) estimate from model 1 (i.e., no covariates) was 0.47 (SE=0.07, 95% CI=0.3305-0.6215, a 36% increase from the naïve estimate) and the probability of detection estimate (p) was 0.0288 (SE= 0.0050, 95% CI= 0.0204 - 0.0405).The model 1 showed that covariates have no weighted influence upon the estimates of ψ and p. The model 2 has the influence upon the estimates of psi and p by 26 % only.

Table 7. Model selection results; role of covariates in determining probability of leopard occupancy and detection probability of leopard in Banke National Park Landscape based on expert opinion survey. Number of sites = 118. Only covariate considered was proportion of habitat available.

Model No.	Model	AIC	Δ AIC	AIC Weight	Model Likelihood	No. of Parameter	Deviance
1	Psi(.),p(.)	640.77	0	0.732	1	2	636.77
2	Psi(habitat),p(habitat)	642.79	2.02	0.267	0.3642	4	634.79
3	Psi(habitat),p(.)	659.19	18.42	0.0001	0.0001	3	653.19
4	Psi(.), p(habitat)	661.56	20.79	0	0	3	655.56

Discussion

Status of Leopard and Tigers

Status (proportion of habitat occupied) of the leopard was found to be higher than tiger using both the standard and covariates based models. Similar result was also found in Chilla range in western most section of Terai Arc, India (HARIHAR *et al.* 2011). Harihar et al 2011 found high density of leopard in chilla range at western part of Terai Arc, while low density of tigers during the time of the relocation of village from Chilla range. With increase in the prey base, tiger population recovered sharply while decline in the leopard population. The inter-specific competition between these two sympatric carnivores could play important role in shaping the recovery of tiger population in newly established BNPL.

Factor Influencing the Big Cats

Tiger occupancy was found to be influenced both by prey and disturbance factors, but not in case of leopard, only prey was found to be influencing the occupancy. Disturbance was not found to be deciding factor in estimating occupancy but the detection probability was found to be influence by the disturbance factors. This relates that leopard was found in area with

high human disturbance. In both cases, it is evident that prey depletion is the crucial for decline in the big cats(KARANTH *et al.* 2004b; KARANTH and STITH 1999). For the big cats, only 36 percent of area is occupied by tigers, where as the 88 percent of area is occupied by leopards. Hence, there are lots of potential areas unoccupied with tiger hence high prey factor and low disturbance would help to increase land base for big cats in BNPL.

Sign based survey Vs Expert Opinion Survey

Leopard occupancy estimates were found to be consistent in both of the independent survey approach based on comparison of the standard occupancy model. Tiger occupancy estimates were found to vary significantly between two survey approaches. Many respondents had no direct sighting of the tiger but had the experience based on the signs only. Discrepancy in detecting the tiger from leopard sign by local experts (farmers) may have overestimated the tiger occupancy. Covariates using the expertise level in the future such survey could be vital for solving overestimation problem. Karanth et al 2010 used the expert mainly biologist who had a prior knowledge about the biology of the species. Hence more care should be taken care regarding the false detection in such types of survey when utilizing the opinion based survey.

Future monitoring of Tiger and Leopard

In the larger grid cells (15 km x 15 km: occupying the subset of 16- 14.06 sq. km size cells), tiger sign was detected only 2 grids thus yielding the rough minimum population estimate of 2 tigers in BNPL. Comparing with home range size of 47 sq km (home range size of leopard male in Nepalese protected areas)(ODDEN and WEGGE 2009), rough minimum crude population estimates of 10 leopards yielded in BNPL. Hence in the near future, more formal population estimation using CMR (Capture-Mark and Recapture) framework should be conducted(KARANTH and NICHOLS 2002). Present status and distribution provides reference for future monitoring in the Banke National Park.

Part 2: Conservation Awareness

Banke National Park is newly formed national park in Nepal. People living in the buffer zone and surrounding area of Banke National Park Landscape (BNPL) has been living in harmony with wildlife. However after the promulgation of the national park by the Government of

Nepal in 2009, there is need to foster the conservation message to the people living in BNPL. This study aims to spread the big cat conservation message in the BNPL in particular and conservation in general to wider audience in Nepal as well. What really make the people excited toward the conservation? Lots of the brainstorming has been done taking help of the conservation experts, conservation education experts and my friends. I wanted to draw the people attention on conservation education message. So I have focused toward the youths, school children for purpose of imparting the tiger conservation message.

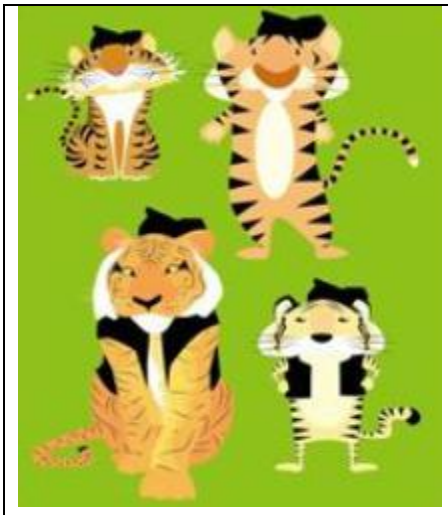
Our premise for the conservation message was based on following premise:
"In the Nepalese context and elsewhere, Tiger is a mighty beast in this planet yet holds a unique position. Tiger is an icon: a mascot, a Chinese zodiac, Buddhist beliefs and a macho figure. In Hindu mythology, tiger has been symbolic as a vehicle or carrier of Goddess, Durga. Tigers are enshrined and venerated in our cultures and faiths. This magnificent and mysterious beast enthralls and captivates the attention of every mankind. Especially young generations show more curiosity and keen interest in tigers. They are always eager and enthusiastic to learn more about their icon. There are lots of question a young generation asks and it is our obligation to answer their curiosity. Enlightening these young minds with the facts and figures about the tigers will help us gain their support in conservation actions. We, as a scientist and a tiger biologist, are putting our best efforts, through the use of innovative techniques and hard hitting mathematical formulas to make an educated guess about tiger population size, their food habit, dispersal pattern, behaviors etc. But there always remains a gap between what we, biologists do and what the people perceive about what we do."

I have reviewed all the conservation education activities in Nepal. Poster, fliers, book marks were key relevant material for the spreading the conservation related message to the wider audience in Nepal. I have formed same approach to fulfill my purpose to have education campaign with the help of the posters and fliers. In addition, I wanted to have young people aware of tiger conservation in Banke National Park. I had additional information on big cats that roam around their national park.

I wanted to have an icon figure of tiger in my campaign from where I wanted to grab the young people attention. So, instead of real life portrait of the tiger itself, I have designed the character named as " Bagh Bahadur" in the form of cartoon character. The reason for the development of the character was to grab a young people including children attention on it. Bagh Bahadur meaning "Male Tiger" in local Nepali dialect. I have named the campaign as the "Bagh Bahadur".

Design of the character Named as " Bagh Bahadur".

I have taken help of the cartoon illustrator (Promina Shrestha) for the design of the character for the campaign. After the series of discussion on the character and purpose and target audience, we have designed the sets of the characters (Please see below the sets of the character designed) and final character was chosen with help of friends and school children.

	**List of the character design for the part of the campaign.**
	**Fig: Character "Bagh Bahadur" finalized for our Bagh Bahadur Campaign.**

Design of the Poster for the Bagh Bahadur Campaign

Our purpose of the campaign was to spread the tiger conservation message focusing on the youth. So we designed the poster with help of our character "Bagh Bahadur". Message we want to depict to the local youth was to save the tiger, their prey and habitat. Here in the poster: we have character that is doing "Namaste" to the people in the village. The village is a typical Tharu village along with Tharu people. Tharu are the ethnic community of terai who have been living in harmony with nature. Bagh Bahadur is carrying the *doko* (canned basket) with lots of goodies on it (poster, books etc). He is walking across the village and spreading the tiger conservation message carried in his *dokos*. This is common scenario which we can observe in our village life. Bagh Bahadur carrying dokos is exclusive to our campaign. So character will be used in future campaign as well. So poster was designed combining the bagh bahadur character and conservation message texts.

Final Design of the Poster

Texts (message in the poster) were finalized with help of the people in the conservation field. I have consulted with few experts namely: Mr. Santosh Mani Nepal (Director, Policy and Support, WWF Nepal), Mr. Diwakar Chapagain (Coordinator, Wildlife Trade Monitoring, WWF Nepal), Mr. Gokarna Jung Thapa (Senior GIS Officer, WWF Nepal), Mr. Pradeep Khanal (Field Officer, WWF Nepal), Mr. Prem Poudel (TAL-Monitoring Field Assistant), Mr Babu ram Lamichanne (Conservation Officer, BCC/ NTNC) and Dr Amrita Thapa (Tiger Enthusiasts and Dentist). The final text read as follows:

In Nepali	In English
d, af3 axfb'/ Û oxfF+x? ;dIf clGtd uh{g ;lxtsf] cg'/f]w lnP/ cfPsf] 5' . k|fs[lts jf;:yfgsf] ;+/If0f u/L :j:y kof{j/0fLo cj:yfdf /dfpg] xfdL b'n{e k|f0fLx?sf]] ;+/If0f ub} efjL k':tfnfO{ ;s'zn x:tfGt/0f ug'{xf];\ . xfdL / xfd|f] cfxf/fsf] lzsf/ gu/L k|s[ltdf afFRg lbg'xf];\ . xfdLnfO{ :jtGq ?kn] lhpFg lbg'xf];\ . **k[YjL ;a}sf] ;femf 3/ xf], ;x–cl:tTjdf afFRg l;sf}F .**	**"Me Bagh Bahadur, would like to make one last roaring request to you all"** "We are endangered animals who love to roam in healthy ecosystem, would request to hand over the well conserved natural habitat to the future generation." "Please do not hunt us and our food so that we could like live naturally. We would like live in complete freedom". "**Earth is common home to everyone; let's try to live in co-existence"**
3/ d]/f] t/fO{ k¥of] gfd t af3 axfb'/ Xfd|f] cj:yf af/] eGg d 5' cft'/========	"My name is Bagh Bahadur and my home is terai" "I am eager in telling you our current state"

The final design of the poster approved for the printing has been as follows:

Design of the Fliers for the Bagh Bahadur Campaign

I have designed the fliers in the form of bookmark. I have used the character " bagh bahadur" and few facts sheets on tigers. Many times fliers are design just for making it fliers and people often forget it. So making it form of book mark would make a dual purpose. I also wanted to make the Bagh Bahadur character a hit, so front side of the fliers depicts the character of Bagh Bahadur with name on it. Nepali dialect for Bagh Bahadur was written by school children. Back side of the fliers has a fact sheets about tigers and do you know section. Do you know section highlights presents happening in the tiger conservation which people may not be aware of. Many of my friends ask me about the general information about tigers so I have tried to fulfill that in this book mark.

Front Side	Back Side
	
Final Design of Fliers (In the form of Bookmark)	

Bagh Bahadur Campaign at Schools

I have done the kick of start of the campaign focusing of the eco-club students at five schools located at Narti Range Post across buffer zone of Banke National Park. Firstly, teach the

students about the tigers and aware them how they can help in the tiger conservation with help of our campaign material. Secondly, I have also distributed our campaign material to eco clubs at 40 schools located in and around five national parks where we find the tigers in Nepal namely Chitwan National Park, Bardia National Park, Suklaphanta Wildlife Reserve and Parsa Wildlife Reserve. Since objective was also focus toward the youth, I have distributed the campaign material to the schools in the capital city which has the highest student enrollment. The total of 1000 copies of the posters and fliers were used during the campaign.

Campaign at the Wider Conservation Arena with formation of "Bagh Bahadur Club"

Our iconic character was further used with the formation of Bagh Bahadur Club (BBC). We used the social networking site Facebook for the purpose of spreading the tiger conservation message. The bagh bahadur club was made public on the eve of 2nd November 2011. Any-one can be the member of the Bagh Bahadur Club and members will receive the recent happening in the field of tiger conservation. I would also request all (the viewers and reader) to become member of the club and spread around the tiger conservation message. The bagh bahadur club page can be assessed at following link: http://www.facebook.com/pages/Bagh-Bahadur-Club/220803864656142. The final page of the BBC looks like as follows:

Page as displayed in the Facebook with our " Bagh Bahadur Club

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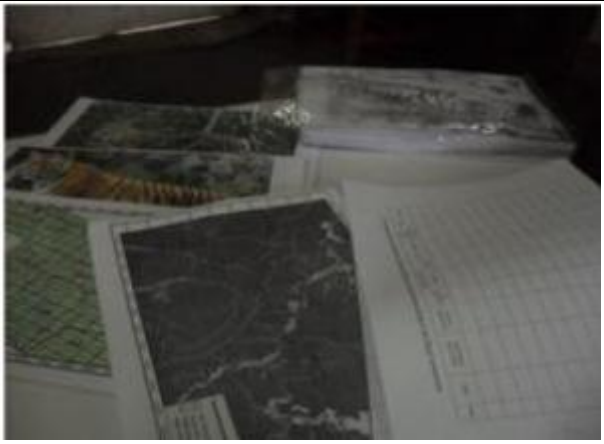
Appendix: Photo Section

Grazing is severe problem, however livestock presence is also major prey for big cats



Data sheet and photographs ready for expert opinion survey

Field Assistant collecting a big cat information from female respondent