CONSERVATION STATUS OF THE FISHING CAT IN CHITWAN NATIONAL PARK, NEPAL

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KIRTIPUR, KATHMANDU, NEPAL

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DECLARATION

I hereby declare that the work presented in this thesis entitled **"Conservation status of the Fishing Cat in Chitwan National Park, Nepal"** has been done by myself, and has not been submitted anywhere for the award of any other degree. All the sources of the information have been specifically acknowledged by references to the author(s) or institution(s).

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RECOMMENDATIONS

This is to recommend that the thesis entitled **"Conservation status of the Fishing Cat in Chitwan National Park, Nepal"** has been carried out by Ms. Rama Mishra for the partial fulfillment of the Degree of Master of Science in Zoology with special paper 'Ecology and Environment'. This is her original work and has been carried out under our supervision. To the best of our knowledge, this thesis work has not been submitted for any other degree in any institutions. We recommend that the thesis be accepted for the Degree of Master of Science in Zoology (Ecology and Environment), Tribhuvan University, Kathmandu, Nepal.

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LETTER OF APPROVAL

On the recommendation of the supervisors "Prof. Dr. Khadga Basnet and Dr. Rajan Amin", this thesis submitted by Ms. Rama Mishra entitled **"Conservation status of the Fishing Cat in Chitwan National Park, Nepal"** is approved for the examination and submitted to the Tribhuvan University in partial fulfillment of the requirements for the Degree of Master of Science in Zoology (Ecology and Environment).

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CERTIFICATE OF APPROVAL

This thesis submitted by Ms.Rama Mishra entitled **"Conservation status of the Fishing Cat in Chitwan National Park, Nepal"** has been approved as a partial fulfillment of the requirements for the Degree of Master of Science in Zoology (Ecology and Environment).

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ABSTRACT

The fishing cat is an endangered mammal on the IUCN redlist and is also listed in Appendix 2 of CITES. Its population has been decreasing from the entire range, including Nepal. Chitwan National Park (CNP) is one of the prime habitats of fishing cats in Nepal. The main objective of this study was to assess the status and threats to the fishing cat and associated small carnivores in CNP. This study reports on systematic camera trap, sign and community based survey results. From a total survey effort of 868 camera trap days across a total area of 160 km^2, 19 photographs of fishing cats were obtained in six independent events with five individuals identified from three locations. Two different methods i.e. capture recapture analysis on CAPTURE program and spatially explicit capture recapture using SPACECAP software were used for population and density estimation. Capture-recapture analysis estimated seven individuals (95% CI 6 - 23) with density 4.37 individual fishing cats per 100 km^2. The analysis from SPACECAP using spatially explicit capture recapture estimated the population of the fishing cat in CNP as 17.74 (95% CI 9 – 25) with a density estimate of 6.06 animals / 100 km^2. Sign surveys showed a patchy distribution across potential habitats from Narayani river in the west to Amrite in the northeast and Thori in the southeast. The majority of the detections were in wetlands with surrounding grassland areas of average height 1-2 m indicating the most favorable habitats of fishing cats. A total of 26 species of mammals including nine species of small carnivores (small cats, civets and mongoose) were recorded on the camera traps. Targeted community interview surveys indicate habitat loss due to shrinkage of wetlands as the main threat to the fishing cat.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

BNP	Bardia National Park
BPP	Biodiversity Profile Project
CI	Confidence Interval
CNP	Chitwan National Park
CT	Camera Trapping
DNPWC	Department of National Park and Wildlife Reserve
EN	Endangered
IUCN	International Union for Conservation of Nature
LC	Least Concern
NT	Near Threatened
NTNC	National Trust for Nature Conservation
PWR	Parsa Wildlife Reserve
SECR	Spatially Explicit Capture Recapture
SWR	Shuklaphanta Wildlife Reserve
VU	Vulnerable

1. INTRODUCTION

1.1. Background

The fishing cat, *Prionailurus viverrinus* (Bennet 1833), Local (Nepali) name: *Malaha biralo* (Jnawali et al. 2011) is a medium-sized cat native to South and Southeast Asia (Pocock 1939, Macdonald et al. 2010, Mukharjee et al. 2013). It is the close relative of rusty-spotted cat (*Prionailurus rubiginosus*), flat headed cat (*Prionailurus planiceps*) and leopard cat *(Prionailurus bengalensis)* (Sunquist and Sunquist 2002). The species ranges in their natural habitats from eastern Pakistan through portions of India, Nepal and Sri Lanka, throughout Bangladesh and mainland Southeast Asia to Sumatra and Java. However, these cats are not found all throughout this broad area because of their habitat preferences. Fishing cats are strongly associated with wetland habitat, and are typically found in swamps and marshy areas of lowlands. They are strongly tied to densely vegetated areas near water, rivers and streams (Prater 1998, Duckworth et al. 2010). In Nepal it has been recorded in Chitwan National Park (CNP), Bardia National Park (BNP), Shuklaphanta Wildlife Reserve (SWR), Parsa Wildlife Reserve (PWR) and Koshi Tappu Wildlife Reserves (KTWR) (Baral and Shah 2008, Jnawali et al. 2011).

Larger than a domestic cat, the fishing cat is a unique among all the cat species for its specialized food habits (Sunquist and Sunquist 2002, Macdonald 2010). Majority of its diet comes from the fish (Haque and Vijayan 1993) although sometimes they hunt on amphibians and terrestrial animals like mollusks, arthropods, reptiles, aves and sometimes small mammals (Myers et al. 2006, Smith pers. comm. 2013). They are well adapted to catching fish, its primary prey (ISEC 2012) with small close-set ears, deep-chested body, short tail and partially webbed front feet (Sunquist and Sunquist 2002, Macdonald et al. 2010).

However, these highly specialized medium sized nocturnal felids are under increasing threat of habitat loss and hunting for food and fur (Mukharjee et al. 2013). Their dependency on wetlands makes them even more vulnerable as most of the wetlands in Nepal and elsewhere across its range are being degraded and lost due to pollution (chemical and physical), drying and conversion. Thus its status was changed from

'vulnerable' to 'endangered' on the IUCN red list in 2008 (Mukharjee et al. 2013) and listed in Appendix 2 of CITES.

In Chitwan NP, the fishing cat occurs with three other small cats. Camera trap studies have shown the leopard cat and jungle cat to be widely distributed while the fishing cat has a highly restricted distribution having previously been recorded in three locations and the marbled cat has not been captured on camera trap for a long time (Karki 2011a). For instance, small cats are very poorly studied; in particular, the fishing cats are one of the poorest studied species. Thus, there is immediate need of understanding their status and start timely conservation measures to minimize the risk of extinction of the species.

Species and habitat management will be of little value unless the animal‟s habitat use patterns within a specific environment are understood properly. One should also consider the evolutionary history of the species along with the human disturbances influencing it (Krausman 1999). Although CNP is identified as the fishing cat habitat, its specific habitat is unknown. Three river systems (Narayani, Rapti and Reu) and many wetland sites including Bishazar lake complex (one of the Ramsar site) in and around Chitwan National Park makes it a good habitat for fishing cats but these habitats, particularly, wetland sites are also degrading very fast. Different studies (not intended for fishing cat) has recorded fishing cat in Chitwan National Park but their status, distribution with their preference habitats and their threats are unknown. Thus this project aims to assess the status of fishing cats in flood plains of three river system and wetland sites of CNP.

1.2. Objectives

The main objective of this study was to assess the status of the fishing cat in CNP. Specific objectives were to:

i. Estimate the density and occupancy of the fishing cat using camera trapping
ii. Determine the distribution and habitat of the fishing cat in floodplains of Rapti, Reu and Narayani rivers using sign surveys
iii. Determine the status of other associated small carnivores
iv. Identify the threats to the species.

1.3. Rationale

A total of 208 mammal species (Baral and Shah 2008) are found in Nepal but only relatively few species such as the Greater One-horned rhino (*Rhinoceros unicornis*), Bengal tiger (*Panthera tigris*), Asian elephant (Elephas maximus) and the leopard (*Panthera pardus*) have been studied well (Laurie 1978, Smith 1984, Smith and Mishra 1992, Thapa 2011). The small mammals are one of least studied groups (Adhikari 2001). There have been only a few studies carried out on small felid species including the fishing cat (Nowell and Jackson 1996). In Nepal, the status of small carnivores remains unknown (Adhikari 2001, Karki 2011a). The fishing cat is one of the least known species in Nepal (Sunquist and Sunquist 2002). Habitat and food specialist species like the fishing cat can be more vulnerable to extinction (Mukharjee et al. 2013). There is therefore an urgent need to assess the status of the species. CNP is one of the remaining major habitats of fishing cats. This study is designed to assess the status, distribution and threats to the fishing cat in flood plains of Rapti, Reu and Narayani rivers of CNP.

2. LITERATURE REVIEW

2.1. The fishing cat

Hodgson has a great contribution on the mammals of Nepal. He recognized the fishing cat for the first time in Nepal (Suwal and Verheugt 1995). Sunquist and Sunquist (2002) described about the fishing cat in CNP. Home range of fishing cats was calculated using a radio-collar study. It was found distinct difference in home range of male and female fishing cats. Smaller home range of many females overlaps with a single male fishing cat. Females were found to have 4 to 8 km^2 home range while a single male‟s home range was found to be 16 to 22 km^2. In addition to this fish as the most common prey species and birds as the rare prey items of the fishing cats were also reported in CNP (Nowell and Jackson 1996, Sunquist and Sunquist 2002).

The fishing cat, about twice the size of a large domestic cat (Sunquist and Sunquist 2002), has stocky powerful build, short legs, and tail which is less than half of its body length (Nowell and Jackson 1996). It has black elongated spots in parallel lines forms over its back and its cheeks consist of two darker stripes (Prater 1998, Baral and Shah 2008). Females are distinctly smaller (6-7 kg) than males (11-12 kg) (Nowell and Jackson 1996). Though fish is the primary prey of the fishing cat, a wide range of other aquatic preys probably taken as well, ranging from crustaceans and mollusks to frogs and snakes and any other animals they can catch (Adhya 2011). Even under water it swims a long distance to catch its prey species. Although fishing cats catch and eat fish their teeth are not well adapted to catch fish. Rather their teeth are suited for killing chital fawns, calves, reptiles or birds. Although fishing cats are sometimes cathermal (both nocturnal and diurnal), they are solitary and mostly nocturnal in habits (Jutzeler et al. 2010). They spend most of the time in tall and short dense grassland and are hardly seen in wild. Both male and female fishing cats scent-mark by spraying urine or rubbing cheek and head.

Females are sexually mature at the age of fifteen months and mating takes place mostly in between January to February. Following the gestation periods of 63-70 days, a litter of two to three kittens were born (Sunquist and Sunquist 2002).

2.1.1. Habitat and Distribution

The fishing cat, strongly associated with wetlands has a limited and discontinuous distribution in Asia (Sunquist and Sunquist 2002). Sanderson (2009) described the distribution of fishing cats in India, Nepal, Southern China, Ceylon, Burma, Formosa and the Malay Peninsula. Prater (1998) stated that the fishing cat occurs in the Himalayan forests up to 5000 ft. (1525 m) and the swamps at the base of these mountains. Habitat of fishing cats were described as in or near heavy jungle, or in scrub, grass swamps, reed beds about rivers and tidal creeks (Duckworth et al. 2010).

In Southeast Asia, the distribution range of the fishing cat is the second smallest among the species of small cats (Cutter and Cutter 2009). They are usually found in swamps and marshy areas, tidal creeks, reed beds, oxbow lakes, and mangrove areas. They prefer dense vegetation near rivers and streams and their occurrences is highly localized (Nowell and Jackson 1996). Suwal and Verheugt (1995) indicated the species primarily occurring in CNP, Bardia National Park (BNP), Shuklaphanta Wildlife Reserve (SWR) and Koshi Tappu Wildlife Reserve (KTWR) in Nepal. Water-sides are the habitats of fishing cats with the habit of hunting fishes by swimming after them. They also kill wildfowl on land. Existing information shows that the distribution of fishing cat is mainly restricted in the flood plains of the Karnali, Babai, Rapti, Narayani, Reu and Koshi rivers and Ghodaghodi tal of the tarai region. It is also believed that because of increasing threats, fishing cats are mostly confined to protected areas of tarai (Jnawali et al. 2011). Karki (2011) recorded the fishing cat from three locations (Ghatgain, Icherny and Amrite) of CNP around Sauraha at the range of 156-171 m altitude.

2.1.2. Population Status

Like other small carnivores, there have been very few studies on the status of the fishing cat (Lynda 2001). In Nepal, the tarai region along the foot of the Himalaya consisting of major wetlands and water system potentially supports large numbers of fishing cats (Lynda 2001).The population is assumed to be approximately 150-200 mature individuals of fishing cats in tarai of Nepal (Jnawali et al. 2011). However, the tarai has been significantly impacted by human activities. It is believed that population of the fishing cat in Southeast Asia is decreasing (Mukherjee et al. 2010). In Java, fishing cats appear only in isolated coastal wetlands in small numbers and absence of records during surveys

further inland beyond 15 km shows that it must be considered critically endangered (Nowell and Jackson 1996). Currently, it seems that the fishing cat no longer occurs in large parts of its range from India and possibly is extinct from Pakistan (Mukherjee et al. 2010).

Conservation Status: The fishing cat is listed in 'Endangered' category in IUCN redlist and Appendix 2 of CITES. Its hunting is prohibited in Bangladesh, China, India, Indonesia, Myanmar, Nepal, Pakistan, Sri Lanka, and Thailand. But there is no legal protection of this species in some Asian countries like Laos, Bhutan, Malaysia and Vietnam (Nowell and Jackson 1996, ISEC 2012). It is not listed as protected animal in Nepal (Jnawali et al. 2011).

2.1.3. Conservation Threats

As fishing cats are locally common around wetlands, loss of wetland habitats is the primary threat to their survival in wild. The habitat is susceptible to human encroachment for irrigation for agriculture and aquaculture, and contamination by pesticides. In spite of these, direct killing of fishing cats by human for fur and meat, and poisoning and poaching by farmers for the taking of livestock is also the great threat for the fishing cat (Lynda 2001). Survey shows that over 50 percent of Asian wetlands were facing moderate to high degrees of threat, which includes human settlement, drainage for agriculture, effluence, and excessive hunting, wood-cutting (Nowell and Jackson 1996) and excessive fishing (Nowell and Jackson 1996, Dahal and Dahal 2011). In Nepal, already a high level of exploitation of wetlands is increasing in the whole tarai region with the increase in human population growth rate. In the late 1950s, human settlements rapidly increased throughout the region. Because of intensive farming distinct blocks of wildlife habitat interspersed leading to the habitat fragmentation (Smith 1984), a major threat to the wild fauna. Although there is no permanent human settlement within CNP, there is heavy pressure from adjoining villages for resource use (BPP 1995a). Through the semi-structured questionnaire survey carried out in the local community, Pandey and Kaspal (2011) clearly showed that illegal hunting and clearing of forest in the adjoining of KTWR were the major threats to all mammals.

2.1.4. Habitat overlapping between the Fishing cat and other small carnivores

Although small mammal weight ranges from less than two gram to five kilograms (Bourliere 1975), small cats and small carnivores are considered as small mammals (Dahal and Dahal 2011). Most of the small mammals are nocturnal (Adhikari 2001). With fishing cats other two species of small felid leopard cats *Prionailurus bengalensis* and jungle cats *Felis chaus* are also present within the study area (Karki 2011a). Other small carnivores reported from the study area are small Indian civet *Viverricula indica* , large Indian civet *Viverra zibetha*, Indian grey mongoose *Herpestes edwardsii,* small Asian mongoose *Herpestes javanicus* (Dahal and Dahal 2011, Dahal 2012b). During a survey of small mammal at the Tiger tops tented camp area of CNP, Dahal (2012b) had captured two different individuals of the fishing cat along with other four species as associated small carnivores: small Indian civet, large Indian civet, small Asian mongoose and Indian grey mongoose. Similarly, crab-eating mongoose *Herpestes urva* and common palm civet *Paradoxurus hermaphroditus* were also recorded within the overlapping altitudinal range (Karki 2011a). Pandey and Kaspal (2011) recorded the fishing cat along with other small carnivores like jungle cat and small Indian civet as their associate animals from Koshi Tappu Wildlife Reserve while studying the density of small mammals through camera trapping.

Among small felidae, the jungle cat is found especially in reed swamps, marshy area and riparian forests. It is found near cultivated landscape and human settlements with a high chance of harboring a large number of rodents as it primarily feeds on rodents. Leopard cat occurs in a wide range of habitat from tropical rainforest to temperate broadleaf. Like fishing cats, leopard cats are also excellent swimmers. Like fishing cats, diets of leopard cats and jungle cats include birds, young swines, chital fawn, hares, fish, etc. (Baral and Shah 2008, Jnawali et al. 2011).

Amongst viverridae, large Indian civet, small Indian civet and palm civet prefer scrub and brushes, found in grasslands, thick shrubs and trees of riverine and sal forest. Also found near settlements, they are omnivorous and feed on birds and their eggs, termites, poultry and on fruits as well. Unlike other civets palm civets are mostly vegetarian in feeding habits where they feed primarily on fruits (Baral and Shah 2008, Jnawali et al. 2011).

Herpestidae in the study area includes Indian grey mongoose, small Asian mongoose and Crab-eating mongoose. Indian grey mongoose is found in dry forests, thorn forests, near human settlements and agricultural lands. Different from Indian grey mongoose, small Asian mongoose prefers area where there is sufficient water. Crab-eating mongooses are found in tropical and subtropical forests. They feed on insects, birds, small rodents, poultry, snakes and crabs (Baral and Shah 2008, Jnawali et al. 2011).

Table 1.Status of small cats, civets and mongooses in Chitwan National Park.

Family	**Scientific name**	**Common name**	**IUCN redlist (Global)**	**IUCN redlist (National)**
FELIDAE	*Prionailurus viverrinus*	Fishing Cat	EN	EN
	Prionailurus bengalensis	Leopard Cat	LC	VU
	Felis chaus	Jungle cat	LC	LC
VIVERRIDAE	*Viverra zibetha*	Large Indian Civet	NT	NT
	Viverricula indica	Small Indian Civet	LC	LC
	Paradoxurus hermaphrodites	Common Palm Civet	LC	LC
	Paguma larvata	Masked Palm Civet	LC	LC
HERPESTIDAE	*Herpestes edwardsii*	Indian Grey Mongoose	LC	LC
	Herpestes javanicus	Small Asian Mongoose	LC	LC
	Herpestes urva	Crab-eating Mongoose	LC	VU
Where, EN - Endangered, VU - Vulnerable, NT - Near Threatened and LC - Least Concern				

2.2. Review on camera trapping methods

Camera trap was pioneered by Griffith and Van Schaik (1993). It is the best method for the study of cryptic species like small and large carnivores (Karanth 1995, Rebecca and Bart 2011). During camera trapping fixed cameras which are automatically triggered by

active infra-red sensors, passive thermal or motion sensors for trapping the images of passing animals are used. This technique is the best among all other in case of elusive animals because of minimal environmental disturbance (Rowcliffe et al. 2008). Photographs taken by camera traps are helpful to recognize different individuals of large felids such as tigers (DNPWC 2009, Karki et al. 2009) as they have unique pelt pattern between the individuals (Karanth 1995, Rebecca and Bart 2011). Moreover camera traps provide good opportunity to gather different information on species like their distribution, habitat use (Rowcliffe et al. 2008), population structure and behavior (Wegge et al. 2004). Though camera trapping is used to estimate the density and abundance of felids, different factors like reduced spacing between the cameras, small survey area and lack of information on true home-range size (Dillon and Kelly 2008) can lead to overestimation of density. Over estimation of density may lead to under estimation of the menace faced by the threatened felid species. This may result a slow rate of implementation of conservation strategies.

3. STUDY AREA

Chitwan National Park (CNP) lies in the Southern central lowlands or Inner tarai region in Chitwan , Nawalparasi, Parsa and Makwanpur district of Nepal (27°16.56‟- 27°42.14‟ N latitudes and 83°50.23‟- 84°46.25‟ E longitudes) (CNP 2013). In the north of the Park lies Mahabharat range (3000m) and India lies to the south (Smith1984). The park covers 932 km^2 of subtropical lowland with an altitude ranging from 150 to 815 m (UNEP-Wo 2009). The Churia hills (61%), sloping benches (25%), and flood plain (14%) are three different ecological zones of the park (Smith 1984). Different characteristic features of the parks comprise of Someshwor hills, Churia hills, ox-bow lakes and alluvial flood plain of the Rapti, Reu and Narayani river (Bhuju et al. 2007). At least 20 large ox-bow lakes lie in CNP (BPP 1995a). Besides, it has created a unique ecosystem with the combination of tall grassland, riverine forest and sal forest (Bhuju et al. 2007).

3.1. Park boundary

The park is bounded by the Narayani and Rapti rivers to the north (Smith 1984) and by the Panchnad and Reu rivers and a forest road to the south. Parsa Wildlife Reserve is bordering to the eastern boundary of the park (UNEP-Wo 2009).

3.2. Climate

The climate of this area is sub-tropical. Most of the rainfall occurs from mid-May to late-September. In the total annual rainfall, about 90% occurs during this period. The heavy rainfall in monsoon causes floods which alter the river course. The maximum temperature is 38^oC during this season and drop to a minimum of 5^oC in winter (UNEP-Wo 2009).

3.3. Vegetation

The floodplain of Rapti, Narayani and Reu rivers composed of a dynamic interspersion of riverine forests, tall grasses and broad, sandy riverbanks. There is high chance of vegetational interspersion in the alluvial region of the park which may account for the

high density and diversity of animals (Smith 1984). Park is rich in flora where 919 species of flora had been estimated including endangered species such as the Tree fern (*Cyathea spinosa*), Cycas (*Cycas pectinata*), Screw pine (*Pandanus nepalensis*), andseveral other orchids (BPP 1995b, Bhuju et al. 2007). The Park consists of three basic vegetation; sal forest (70%), riverine forest (7%) and grassland (20%) while the remaining (3%) is primarily the open river bank (Sunquist 1981).

Sal forest: Sal (*Shorea robusta*) is supported by upland area of the park which attains the heights of 20-25 m. In the Sal forest shrub layer is usually absent giving the appearance of open woodland. But in some areas, beneath the Sal forest some grasses like *Narenga porphyrocoma* and *Thyrsia zea* grows above the height of one meter. In the absence of dense understory, Palms grows on the upper and drier ridges of the Churia and Someswor hills. Sometimes sal interspersed with pine in the eastern ridges of the park (Sunquist 1981).

Riverine forest: Riverine forest is found along the lakes, streams and rivers in the park. Khair (*Acacia catechu*) and Sisso (*Dalbergia sisso*) are the most dominant species found in the bank of Rapti and Narayani rivers. There is usually a dense shrub understory of Rudilo (*Pogostemon benghalensis)* with a variety of shade-tolerant herbs and grasses. *Saccharum* species is the most dominant grass along the forest-flood plain interface (Sunquist 1981). The riverine forest can be further divided into six diverse types as Khair-Sissoo Forest, Tropical Evergreen Forest, Simal-Velar Forest, Listea-Bombax Forest, Machilus Forest and Eugenia Woodland (Dahal et al. 2011).

Grassland: A complex and varied assemblage of grasses are found in the Park. Along streams and around lakes, tall (3-5m), dense stands of coarse grasses, such as *Themeda villosa, Saccharum vavennae,* and *Arundo donax* are commonly found. Other grass growing densly on moist areas are *Saccharum procerum*, *Arundinella nepalensis*, *Phragmiteskarka*, and *Themeda arundinacea* which attain the height of more than four meter (Sunquist 1981).

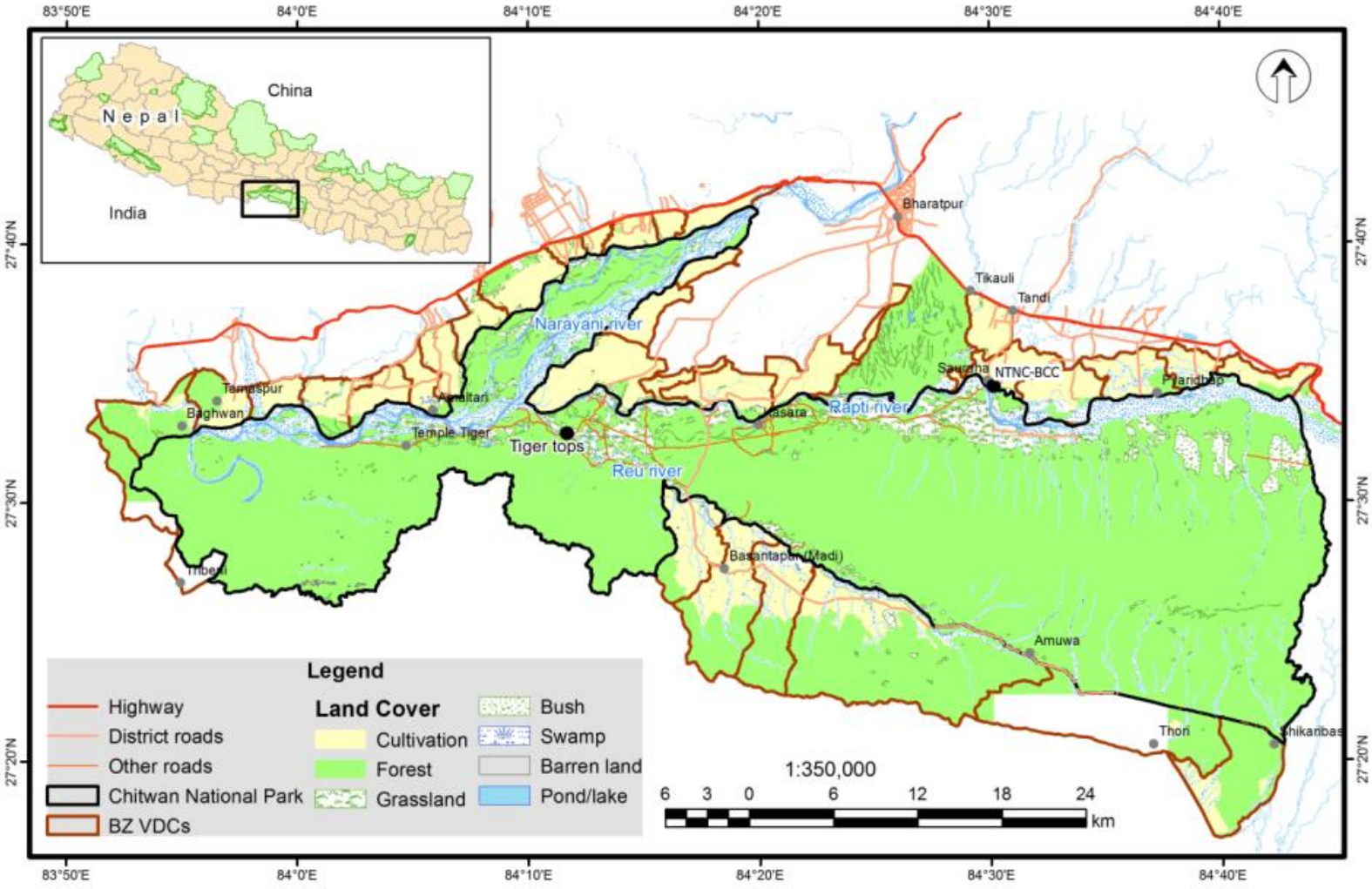

Figure 1. A GIS map of Chitwan National Park and the surrounding buffer zone area.

3.4. Fauna

Chitwan National Park is rich in faunal diversity and contains array of nationally important fauna. The park is home to nearly 70 mammal species (CNP 2013), over 525 birds, and 55 amphibians and reptiles (DNPWC 2012). Greater one-horned rhinoceros (*Rhinoceros unicornis),* Royal Bengal tiger (*Panthera tigris*), and Asiatic elephant (*Elephas maximus*) are the symbolic mammal species of the Park. Likewise, maskey frog (*Tomopterna maskey*) is the species endemic to the park (DNPWC 2012). Similarly black-necked stork (*Ephippiorhynchus asiaticus*), lesser-adjutant stork (*Leptoptilos javanicus*), grey-headed fishing eagle (*Ichthyophaga ichthyaetus*) and the brahmini duck (*Tadorna ferruginea*) are the bird species symbolic to the park (Bhuju et al. 2007). Other mammals include rhesus macaque (*Macaca mulatta*), tarai grey langur (*Semnopithecus hector*), smooth-coated otter (*Lutrogale perspicillata*), large Indian civet (*Viverra zibeth*), small Indian civet (*Viverricula indica*), mongoose (*Herpestes* spp.), fishing cat (*Felis viverrina*), leopard cat (*Felis bengalensis*), jungle cat (*Felis chaus*), golden jackal (*Canis aureus*), striped hyaena (*Hyaena hyaena*), sambar (*Rusa unicolor*), hog deer (*Axis porcinus*), spotted deer (*Axis axis*), wild boar (*Sus scrofa*), Indian crested porcupine (*Hystrix indica*), etc.

3.5. Conservation history of Chitwan National Park

The habitat of the Park had been well protected as a royal hunting reserve before 1951 during the Rana regime (DNPWC 2012). Tharu were the indigenous people surrounding the park having high resistance to malaria. After eradication of malaria around 1960s, high mass of people migrating from middle hills to tarai results tripling the population between 1961 and 1971 leading rapidly conversion of alluvial grassland and forests to cultivation lands (Smith 1984). His Majesty‟s Government of Nepal, at the proposal of the Fauna Preservation Society, formed Mahendra Mriga Kunja (1961-1962) north of the Rapti river and a rhino sanctuary south of the river (DNPWC 2012, Sunquist1981) for the protection of wildlife habitat. Organization of government committee (1963) to examine the legal status of settlers in Chitwan is followed by the foundation of a Land Settlement Commission in 1964.

In 1970, King Mahendra approved the establishment of a national park south of the Rapti river including the area of the rhino sanctuary leading to the preliminary development (1971) and finally the area was gazetted as the country‟s first national park, Royal Chitwan National Park (RCNP) in 1973 with an area of 544 km^2. The Park was enlarged to its present area in 1977. UNESCO declared RCNP as a World Heritage Site in 1984, recognizing its unique ecosystem of international significance (BPP 1995a). In 1996, an area of 750 km^2 surrounding the park was declared its buffer zone, which consists of forests and private lands together with cultivated lands (Bhuju et al. 2007, DNPWC 2012).

3.6. Sampling Sites

A reconnaissance survey was carried out in different parts of CNP and its adjoining forests in February 2012 before selecting the specific study sites. During the reconnaissance survey, an informal interview was carried out with fisherman, local tribes, nature guides, wildlife technicians and park personnel in order to gather general information about the occurrence of fishing cats, their prey species and other wildlife species. Following the preliminary survey and interview, four different study sites (Figure 2) were chosen for the survey of fishing cats in CNP.

3.6.1. Sauraha

Sauraha, the center of attraction for every traveler lies in the eastern sector of the Park. Most of the locations of this area have lots of human interactions. People collecting fodder and firewood are found here. Also visitors are allowed to visit this site either by elephant riding or by trekking. Riverine forest and grassland are the dominant vegetation of this area. Simal (*Bombax cebia*) and velar (*Trewia nudiflora*) are the dominant plant of this area. Invasive species *Mikania* has been destroying the main vegetation. This area consists of different wetlands. Rapti River, Budhi rapti, Dudhaura nala, Iccharni khola, Khorsor tal and Patna tal are the reasonable wetlands where the survey was done.

3.6.2. Kasara

Park headquarters also lies in this area with lots of human interactions. Park staff quarters and army camp are situated here. Besides, Gharial Breeding Centre and Vulture Breeding Centre are also located here. Tourists visit the area regularly as jungle safari by jeep. Vegetation of the area is dominated by sal forest, riverine forest and grassland. Rapti river, Ghatgain ghol, Kasara khola, Bhalu khola, Seri nala, Tamor tal, Thapaliya tal and Lami tal are the major wetland habitats, which were surveyed for the fishing cat.

3.6.3. Tiger tops

It is 18 km west from the park headquarters. Riverine forest, sal forest, mixed-sal forest and tall grassland are the main vegetation types in this area. Along the flood plain of Reu river *Saccharum* species was the most dominant grass. The Chure range just begins at this site. Surung khola and Rheu river flow through this site. Other wetlands of this area include Kamal tal, Sukibar lake, Devi tal, Tentent Camp ghol, Lamo tal and Munna tal. All these wetland habitats were surveyed for the fishing cat.

3.6.4. Island

It is the western sector of the Park. A tropical deciduous type of vegetation dominated by khair (*Acacia catechu*) or sissoo (*Dalbergia sissoo*) is found here along the bank of the Narayani river. Khair and sissoo trees are seen either mixed or in pure stands in the flood plain of the Narayani river. *Saccharum* species is the most dominant grass along the forest-flood plain interface of this site. Beside Narayani river beds, Bhumari ghol, Mardi ghol, Gaida ghol, Jugeshwor khola and Divyapun khola are the potential wetland habitats where the fishing cat survey was carried out.

4. MATERIALS AND METHODS

4.1. Field sampling methods

4.1.1. Camera trapping

Two types of camera traps were used for trapping. Reconyx RM45 was programmed to take picture in every 10 seconds when any object crossed the beam and Moultire D-40 was programmed to interval of one minute. All the camera traps were set to take three photo frames at a time. Alkaline batteries „C" were used in Reconyx RM45 and alkaline batteries „D" were used in Moultire D-40 cameras. Reconyx RM45 has a wide area of sensitivity to detect the presence of animals. It is a digital camera with night time infrared illuminator and Passive InfraRed (PIR) motion detector and all are enclosed within a secure, rugged, and weather-resistant case. It gives 1.3 megapixel monochrome images during day and night time and has the capacity of 15,000 images with 2 GB card (www.reconyx.com). While Moultire D-40 gives the color pictures.

Cameras were deployed from 25 March to 11 June 2012. Grids of 2x2 sq km were overlaid on the trapping area and two camera trapping stations were deployed within each grid. A pairs of camera were deployed in each station except for Sauraha block where single camera was placed due to insufficient number of cameras. Best possible locations within the grid was searched through sign surveys to put camera traps while maintaining distance of 0.5 km to 1.5 km between the camera stations within the grid. There were 22 stations (n=22) in Sauraha block, 19 stations (n=19) in Kasara block, 17 stations (n=17) in Tiger tops block and 20 stations (n=20) in Island block within 10 grids in each block.

Cameras were placed for 14 days in the Sauraha block and for 10 days in each of the three successive blocks logging 868 camera trap-nights at four sites. Cameras were fixed 2-3 meters from the center of the trail in each station and both cameras were focused on the center of the trail roughly 30 cm above the ground surface to cover the whole body of the animal in photographs. High sensitivity Garmin etrex was used to record the GPS location of all camera stations**.** GPS coordinates of all trap locations were plotted on map. Stations were frequently visited to check the cameras.

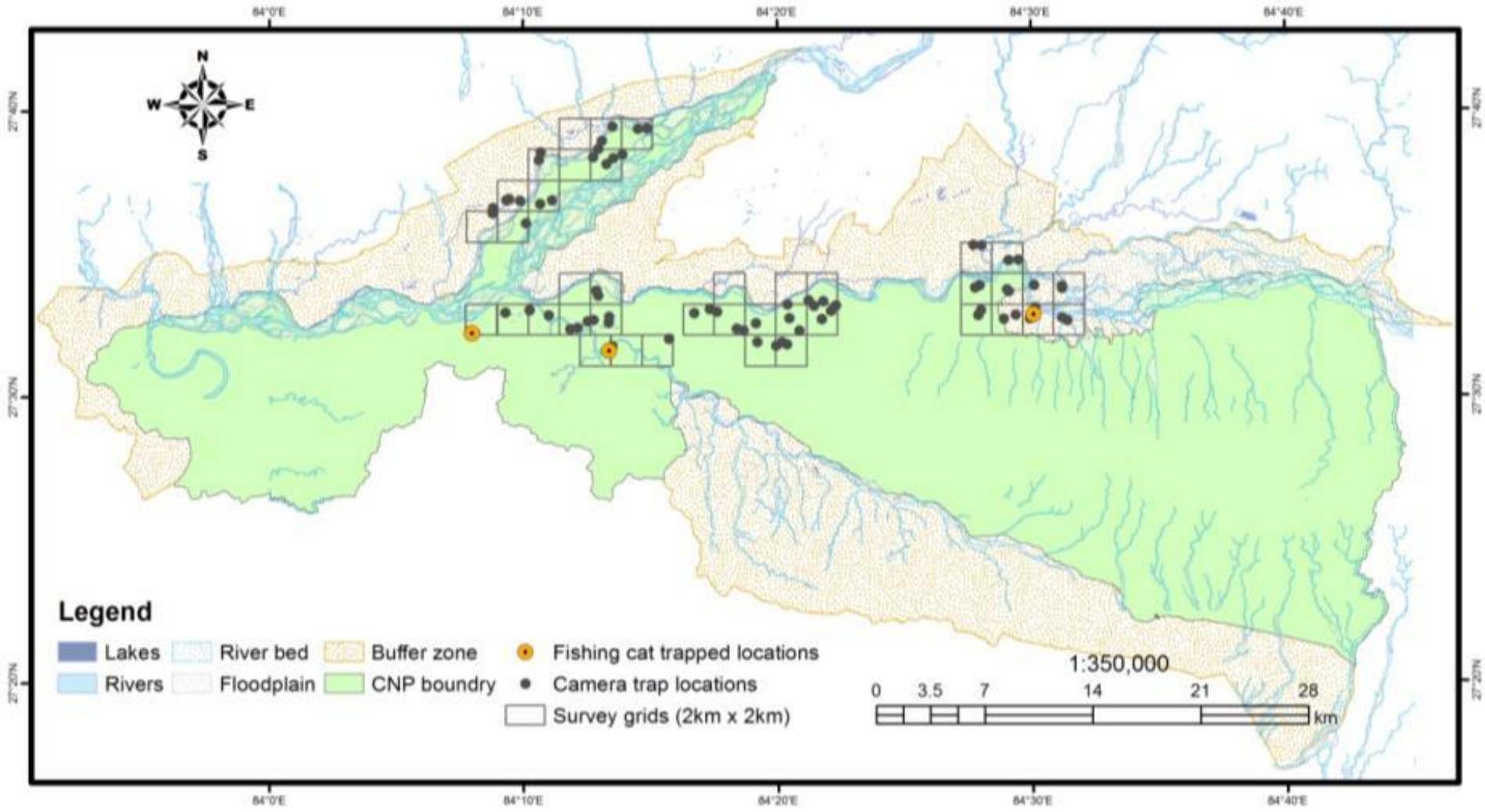

Figure 2. Camera trapping grids, camera locations and the fishing cat trapped locations in Chitwan National Park, Nepal.

4.1.2. Sign surveys

Sampling was done in four blocks. Each block was divided into systematic grids of 2 km x 2 km. On each grid signs of the fishing cats were searched on 1.5 km long transects. Search paths (transects) were aligned with rivers, lakes and other wetland areas as they are the most potential habitats. Fishing cat signs along with the signs of other species encountered from an occupancy survey was recorded with GPS location. Based on the encountered signs, distribution of the fishing cats was also produced. This survey was done just before camera trapping. Based on the survey, the best suitable location for the camera trapping was selected. Special focus was given to the presence of animal trails, signs of carnivores and confirmation of the fishing cat pugmarks.

4.1.3. Habitat preference

Habitat preference of the fishing cat was assessed based on the locations where they were camera trapped. The fishing cat camera trapped locations during the camera trapping in 2010 (Karki 2011a) and this study (2012) as well as live trap locations (Dahal and Dahal 2011) were used for the analysis. At the time of camera deployment, different habitat parameters like vegetation types, ground coverage, canopy coverage, etc. including wetland types and their variables were recorded. At the same time variables relating to human activities around the stations were also recorded.

4.1.4. Key informant's survey

A semi-structured questionnaire was prepared (Annex II) for a key informant interview survey. Survey was carried out with 35 respondents in order to identify the threats of the fishing cat. It was carried out with the persons who had spent considerable amount of time in and around the Park. The respondents included 8 park staff (including five game scouts, wildlife veterinarians, park officer), 11 Nature guides, 15 NGO staff (including five wildlife technicians and ten elephants mahuts) and one boat man (majhi).

4.2. Analysis methods

4.2.1. Camera trap data

Data of camera trapping were collected from 78 camera trapping stations of the study area of approximate size of 160 Sq. km (4*40 Sq. km). All the data of camera trapping including small carnivores were entered systematically into Microsoft Office Excel 2007 along with the time and dates of images taken. Filtering images of species was followed to ensure independent events. Each photo was considered as an independent event if it met certain criteria; consecutive images of different individuals of alike or unlike species, alternate photos of individuals of the same species (Negroes et al. 2010) and consecutive photographs of individuals of the same species taken in the gap of more than an hour (Bowkett et al. 2007, Negroes et al. 2010). Finally, data of all small carnivores with fishing cats were separated from the whole records for analysis.

To calculate the abundance of individually identifiable species two methods were widely used, i) capture recapture analysis on program CAPTURE (Otis et al. 1978) and ii) Spatially explicit capture-recapture analysis using program SPACECAP (Royle et al. 2009, Gopalaswamy et al . 2012). It was found that parallel rows of black spots on the olive grey pelt background of the fishing cat are distinctive features for the identification of different individuals (Cutter 2009). Capture history matrix for individual fishing cats was prepared on the standard format of CAPTURE program, i.e. 0, 1 matrix for total camera trapping days where 1 is animal captured and 0 is no capture. Conventional capture recapture analysis was carried out using the input file prepared and best fit model was selected.

The other program SPACECAP is a user-friendly software package for estimating animal densities using closed model capture-recapture sampling based on photographic captures using Bayesian spatially-explicit capture-recapture models. This approach offers advantage such as: substantially dealing with problems posed by individual heterogeneity in capture probabilities in conventional capture-recapture analyses. It also offers non-asymptotic inferences which are more appropriate for small samples of capture data typical of photo-capture studies. Thus, it gives a robust estimate compared to traditional capture recapture based analysis.

Three different data input files i.e. Animal capture detail, trap deployment and habitat index were prepared following the guidelines of the program. Animal capture detail file includes location ID, animal ID and sampling occasion (day of capture) for SPACECAP. Trap deployment file was prepared with active camera day as 1 and inactive day as 0 whereas animal ID file was prepared with animal ID, location ID and day of the capture. The third input file i.e. habitat index was prepared with the grids of 580 m x 580 m where suitable fishing cat habitat was given 1 and unsuitable habitat as 0. The habitat suitability layer should be sufficiently large to ensure the geographic closure (Gopalaswamy 2012). Thus a buffer of 2.5 km, approximate radius of the home range of male fishing cats i.e. 16 to 22 km^2 (Sunquist and Sunquist 2002) was used to cover the habitat of fishing cats adjoining to the survey area.

Event rates can be used as an index of relative abundance whether through transect line methods (Jones and Coman 1982) or through camera trap method and track count methods (Silveira et al. 2003). In camera-trapping study for the unidentified carnivore species, trap success (capture events/trap nights) can be calculated to measure the relative abundance of species (Gerber et al. 2010). Also camera trap event rates ((the number of independent events per station/sampling effort per station)*100)) are used as an index of relative abundance where individual recognition is not possible (Yasuda 2004, Bowkett et al. 2007) to give a standardized value per 100 days.

4.2.2. Habitat preference

General description of the trapped sites was summarized for qualitative information about the specific habitat. To assess the general habitat quantitatively, a 1.5 km buffer was created around the fishing cats trapped locations. Buffer of 1.5 km (area 7.068 sq km) was created based on the home range of fishing cats which is 4-8 sq km for female (Sunquest and Sunquest 2002) and habitat type within the buffer was quantified using ARCGIS 10.0. Habitat layer from the topographic map from Department of survey was used.

5. RESULTS

5.1. Status

Out of 78 camera trapping stations during 857.73 active trap nights, the fishing cat was recorded only from three stations (Table 1). Altogether there were six independent events of the fishing cat. The maximum event rate for the fishing cat was 40 independent events/100 camera trap days. Most of the images of fishing cats were captured in the Tiger tops (block C) with five independent events. It was followed by Sauraha (block A) with just one event. But during the study period cameras did not capture any images of the fishing cat in Kasara (block B) and Island (block D).

Table 2. Event rates for the fishing cat (number of independent events/100 days).

Block ID	No. of camera locations	No. of stations with fishing cat image captured	Site ID	Fishing cat Event Rates/100 nights
A	22	1	A03A	7.14
B	19	0	-	-
C	17	2	C05A/B/C	40
			C11A/B	10
D	20	0	-	-

Altogether 19 photographs of fishing cats were captured from three camera stations in six independent events. After a rigorous analysis of body stripe patterns of the fishing cat photographs, five individuals were positively identified. Only one (20 %) fishing cat was recaptured. Four individuals were captured only once. Three individuals were captured on a station i.e. grid no C05A/B/C (Tiger tops tented camp ghol). One individual was captured on each of A03A (Patna tal) and C11A/B grids (Devi tal).

A capture history of individual fishing cats (n = 5) was prepared. Total sampling occasions were 10 and total independent events were 6. Capture-recapture analysis was carried out on the CAPTURE software (Otis et al. 1978, Karanth et al. 1995). Null model M_o was selected as best model by the software. Although model M_o is the best fitted it is sensitive to violation of the assumption of homogeneous capture probabilities (Otis et al. 1978) thus, the next best fit model M_h jackknife was selected for population estimation.

Table 3. Results obtained from CAPTURE.

Model Selection Criterion				M_h Goodness of fit			Closure test	
M_o	M_h	M_b	M_t	Chi-square	Df	p	z	P
1	0.89	0.57	0.0	7.61	9	0.57	0.60	0.72

Where, M_0 = Null model; M_h = Heterogeneity effects model; M_b = Behavior effects model; M_t = Time effects model

The population estimate based on the M (h) Jacknife was 7 (+/- 3.3) and 95 % confidence interval was 6 to 23. The density of fishing cat of the survey area was estimated to be 4.37 individuals/100 km^2.

Analysis on the SPACECAP on SECR framework resulted the estimated population of fishing cat in CNP as 17.74 (+/- 5.09) with 95% confidence interval of 9 - 25. The density of fishing cats was estimated to be 6.06 individuals/100 km^2 (Table 4).

Table 4. Results obtained from SPACECAP.

Parameters	Mean	SD	95% Lower CI	95% Lower CI
Sigma	0.4731	0.372	0.0684	1.2312
lam0	0.8991	0.9136	0.0103	2.9274
Beta	-1.9083	1.7955	-4.8797	1.6781
Psi	0.6948	0.2045	0.3282	1
Nsuper	**17.7442**	**5.0916**	**9**	**25**
Density	**6.0699**	**1.7417**	**3.0787**	**8.5519**
p1	0.4547	0.3287	0.0102	0.9465
p2	-19.8336	30.8654	-81.3834	0.9561

Results from SPACECAP (range 9 – 25) and CAPTURE (range 7 – 23) with 95% Confidence Interval (CI) were close although the estimated mean value of SPACECAP was higher than that of CAPTURE.

5.2. Habitat and Distribution

5.2.1. Distribution

Fishing cats were found in CNP from the Narayani river in the west to Amrite area in the east. The highest encounter of the signs and maximum camera trapping records were found from the Tiger tops area. During the National Tiger and Prey base survey in Nepal 2013, fishing cats were camera trapped from Narayani floodplain north of Temple tiger area and northeast of Thori in addition to the previously recorded areas. They were recorded from Temple tiger, Devi tal, Tiger tops, Tiger tops tentent camp, Sukibar, Ghatgain, Icharni, Patna tal, Amrite and Thori (Figure 3). No sign of the fishing cat was recorded from block B (Kasara) and block C (Narayani Island) during the survey. The fishing cat could not be camera trapped from these areas.

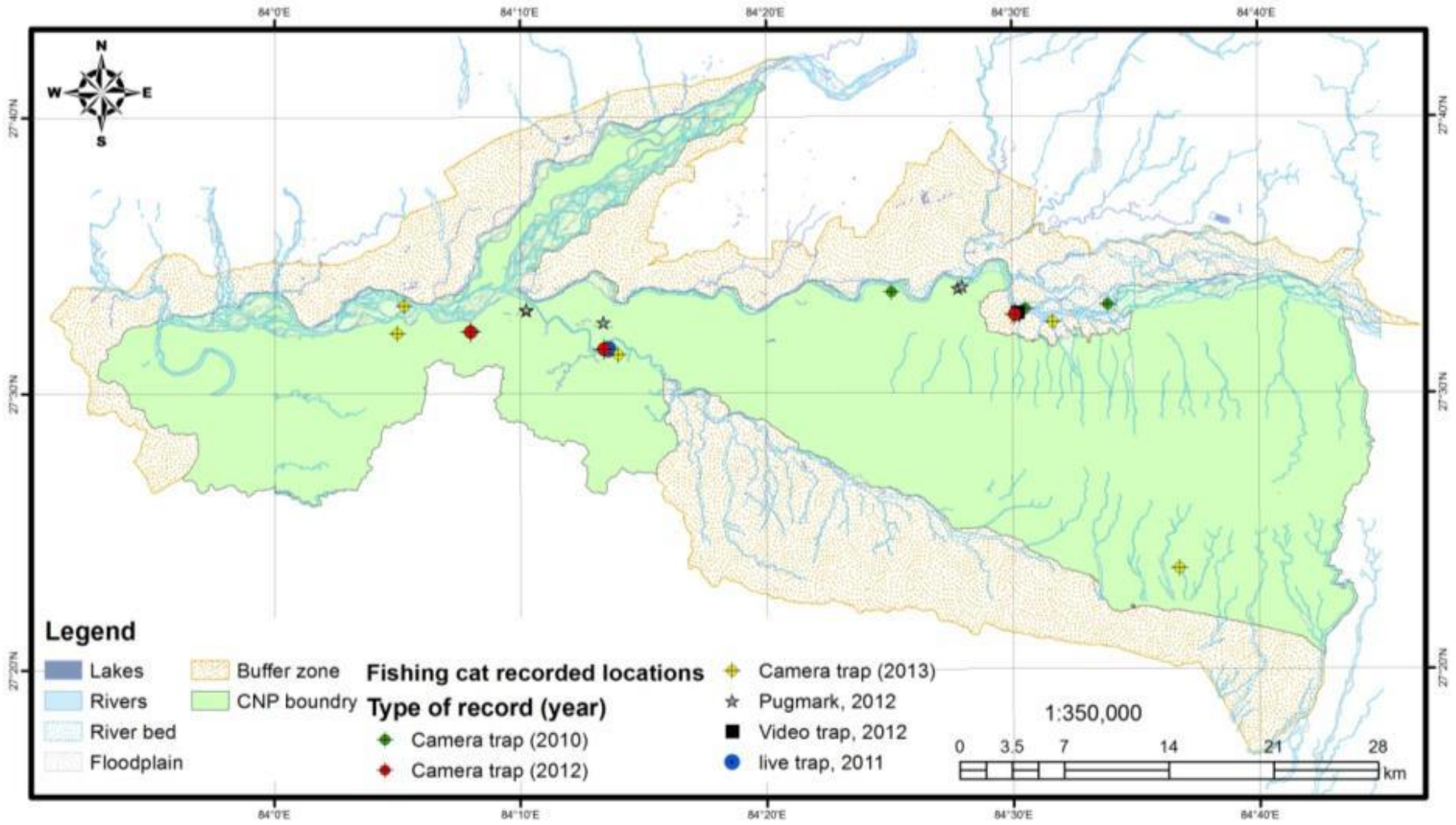

Figure 3. Distribution of fishing cats in CNP.

5.2.2. Habitat preference

In total of 78 Camera Trapping (CT) stations of study area, pugmark signs of fishing cats have been recorded only from nine locations that include the photo capture from three locations namely Patna tal, Tentent Camp ghol and Devi tal area. Most of the locations where the pugmark signs of fishing cats and the entire photo captured locations are adjoining to the water bodies such as lakes or streams with the surrounding area having high density of tall grass layer with an average height of 1-2 m. There were just three records of fishing cat signs from the river bank in open and semi-coverage vicinity of short grass below one meter (Table 5).

Table 5. Sign encountered and camera trapped locations of the fishing cat in Chitwan National Park, Nepal (2012).

S.N.	Location	Habitat types					Human disturbances	Remarks
		Type of water point	Habitat type	Dominant grass	Grass layer	Average height of grass layer		
1	Patna Tal	Lake	Tall grass	Narkat, Kans, Siru, Niuro	Dense	Above 2m	Absence	Pugmark sign presence
2	Patna Tal	Lake	Tall grass	Narkat, Siru	Dense	Above 2m	Absence	CT-photo capture
3	Shankar Ghat (Rapti river)	River	River bank	-	Open	0-1m	Presence	Pugmark sign presence
4	Rapti river (near to Shankar	River	River bank	Kans	Open	0-1m	Presence	Pugmark sign presence

	Ghat)							
5	Sukibar Lake	Lake	Tall grass	Kans	Dense	Above 2m	Absence	Pugmark sign presence
6	Tentent Camp Ghol	Marsh (small lake)	Tall grass	Sim ghans, Narkat	Dense	Above 2m	Absence	CT-photo capture
7	Reu River	River	River Bank	Kans	Semi-cover	0-1m	Absence	Pugmark sign presence
8	Munda Tal	Lake	Patch of tall grass within mixed forest	Kans	Dense	Above 2m	Absence	Pugmark sign presence
9	Devi Tal	Lake	Tall grass	Baruwa, Kans, Bader	Dense	1-2m	Absence	CT-photo capture

The major habitat within the buffer area of the camera trap was found to be grassland with some scattered trees followed by forest, sand and gravel and water-bodies (Figure 4). Grassland with scattered trees was the most preferred habitat as shown by detail descriptions of habitat types around each camera trap location (Table 6). Of the total locations, 45% was grassland, 27% Forest, 15.95% sand and gravel, and 10.59% water-bodies which formed a mosaic of habitats dominated by grasslands with sufficient water around.

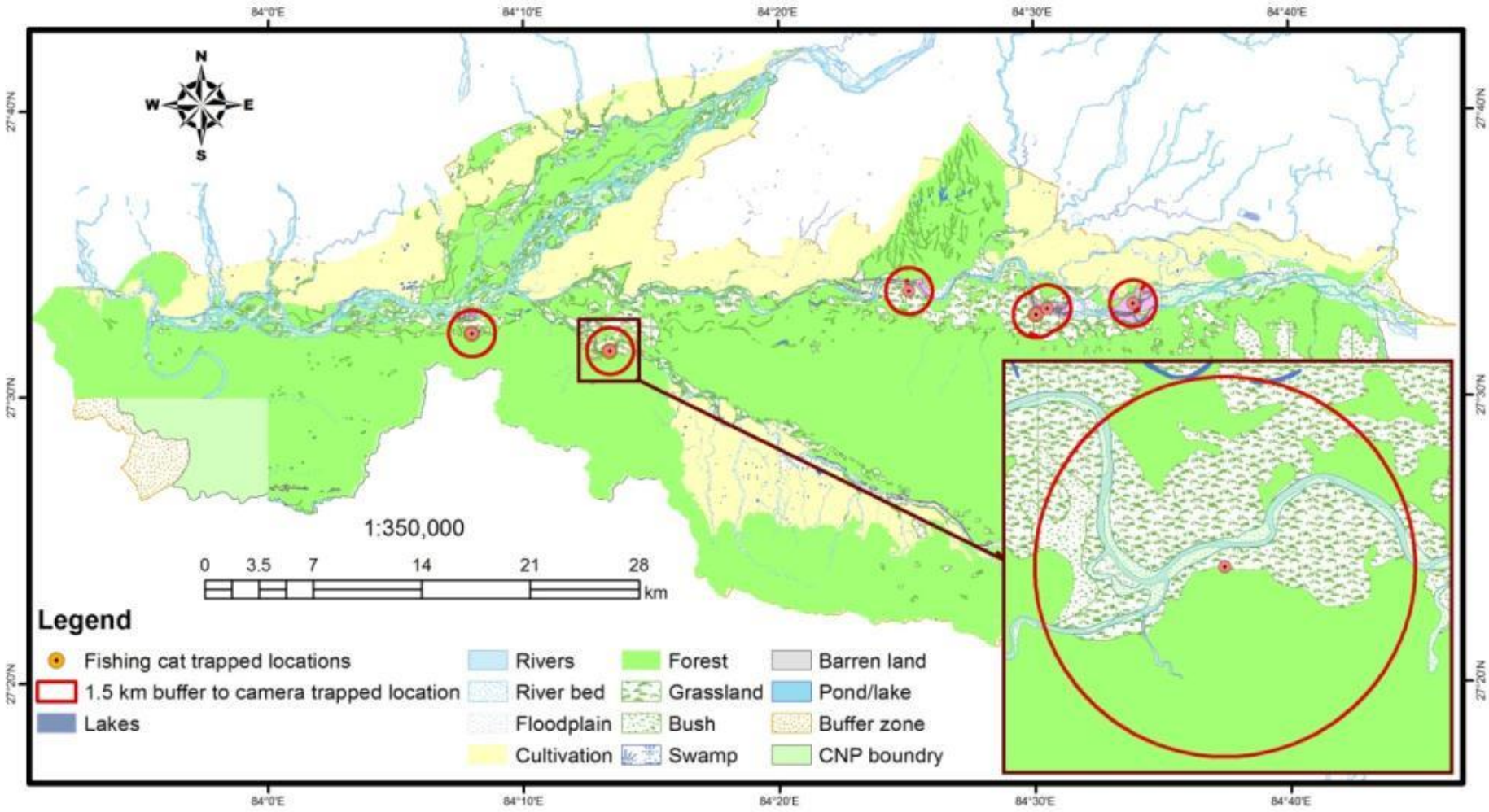

Figure 4. Habitat preference of the fishing cat based on camera trapped locations of 2010 and 2012.

Table 6. Types of habitat around each camera trap locations

Habitat type	Area (ha)						Total Area (ha)	Total % habitat
	Tented camp (2012)	Devi Tal (2012)	Patna Tal (2012)	Ghatgain (2010)	Amrite (2010)	Icherny (2010)		
Forest	369.76	439.31	27.84	177.44	71.73	93.78	1,179.85	27.82
Grassland & scattered trees	286.31	165.39	540.94	389.96	135.35	391.72	1,909.67	45.03
Sand/gravel	24.89	36.36	64.29	66.27	381.65	102.76	676.22	15.95
River/lakes/waterbodies	25.83	65.75	73.73	73.13	92.08	118.53	449.05	10.59
Other	-	-	-	-	25.98	-	25.98	0.61
Total	**706.80**	**706.80**	**706.80**	**706.80**	**706.80**	**706.80**	**4,240.77**	**100**

5.3. Associated small carnivores of fishing cats

In total, nine species of three different families (felidae, viverridae and herpestidae) of small carnivores were recorded during camera trapping. Small felids like leopard cat and jungle cat along with fishing cat were recorded. Among the viverridae, images of large Indian civet, small Indian civet, masked palm civet and common palm civet were also trapped. Similarly, small Asian mongoose and Indian grey mongoose of herpestidae were also recorded.

Table 7. Total number of CT stations taking images of small carnivores along with total number of independent images.

Name of the Species	No. of camera trapped stations					No. of Independent events				
	Block A	Block B	Block C	Block D	**Total**	Block A	Block B	Block C	Block D	**Total**
Fishing Cat	1	0	2	0	**3**	1	0	5	0	**6**
Leopard Cat	1	0	0	0	**1**	1	0	0	0	**1**
Jungle Cat	1	1	1	0	**3**	1	1	2	0	**4**
Large Indian civet	8	6	4	0	**18**	16	9	6	0	**31**
Small Indian	8	3	1	1	**13**	20	3	1	1	**25**

Civet										
Common Palm civet	5	1	0	0	**6**	9	1	0	0	**10**
Masked Palm civet	5	0	0	0	**5**	5	0	0	0	**5**
Small Asian Mongoose	0	1	0	0	**1**	0	1	0	0	**1**
Indian Grey Mongoose	5	1	2	3	**11**	9	2	2	4	**17**
Total	34	13	10	4	**61**	62	17	16	5	**100**

Out of 78 CT stations, small cats were recorded at only six stations (fishing cats and jungle cats at three stations each; leopard cats at one station), civets were recorded from 31 stations (large Indian civets from 18, small Indian civets from 13, common palm civets from six, and masked palm civets from five stations) and herpestidae were recorded from 12 stations (small Asian mongoose from one station; Indian grey mongoose from 11 stations) (Table 7). The maximum event rate among small carnivores was of small Indian civets with 42.86 independent events/100 days followed by the fishing cat with 40 independent events/100 days and common palm civets with 35.71 independent events/100 days (Annex III). But the most images among small carnivores were taken of large Indian civets (Table 6; 31 independent events in total). Among nine species of small carnivores recorded from the sampling area, only two species, small Indian civets and Indian grey mongoose were recorded from all four sampling sites (Table 7). However there was no record of image taken of all small carnivores from a single station.

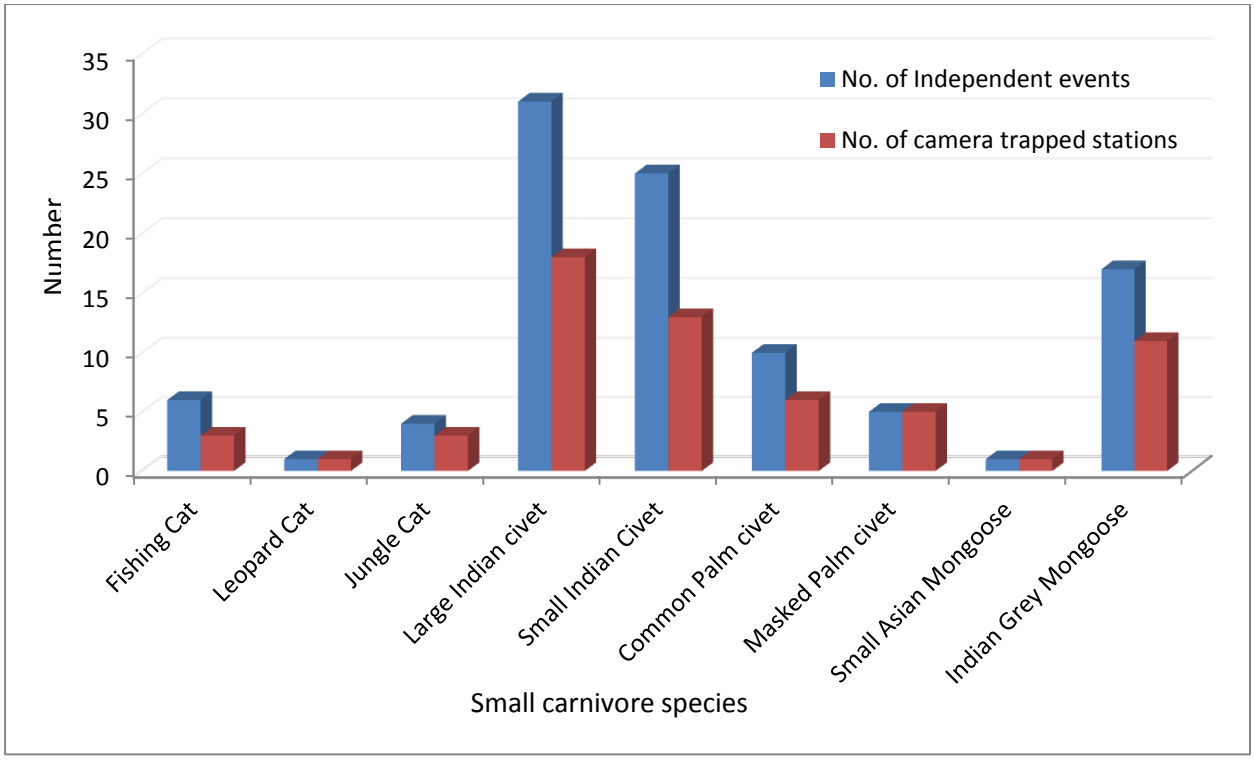

Figure 5. Capture stations and independent events for different small carnivores.

Among nine different species of small carnivores, fishing cats occurred only in six out of 100 independent events. Remaining eight species accounted for 94 % (with total of 94 independent events) of the photographs of the target species.

Abundance of small carnivores was relatively high with 62 independent events out of 100 in Sauraha area (block A) in comparison to the whole study sites (Table 7). Abundance of small carnivores was the least in Island area (block D) where there were only five independent events. Kasara area and Tiger tops area (block B and block C respectively) were similar in abundance of small carnivores with independent events of 17 and 16 respectively.

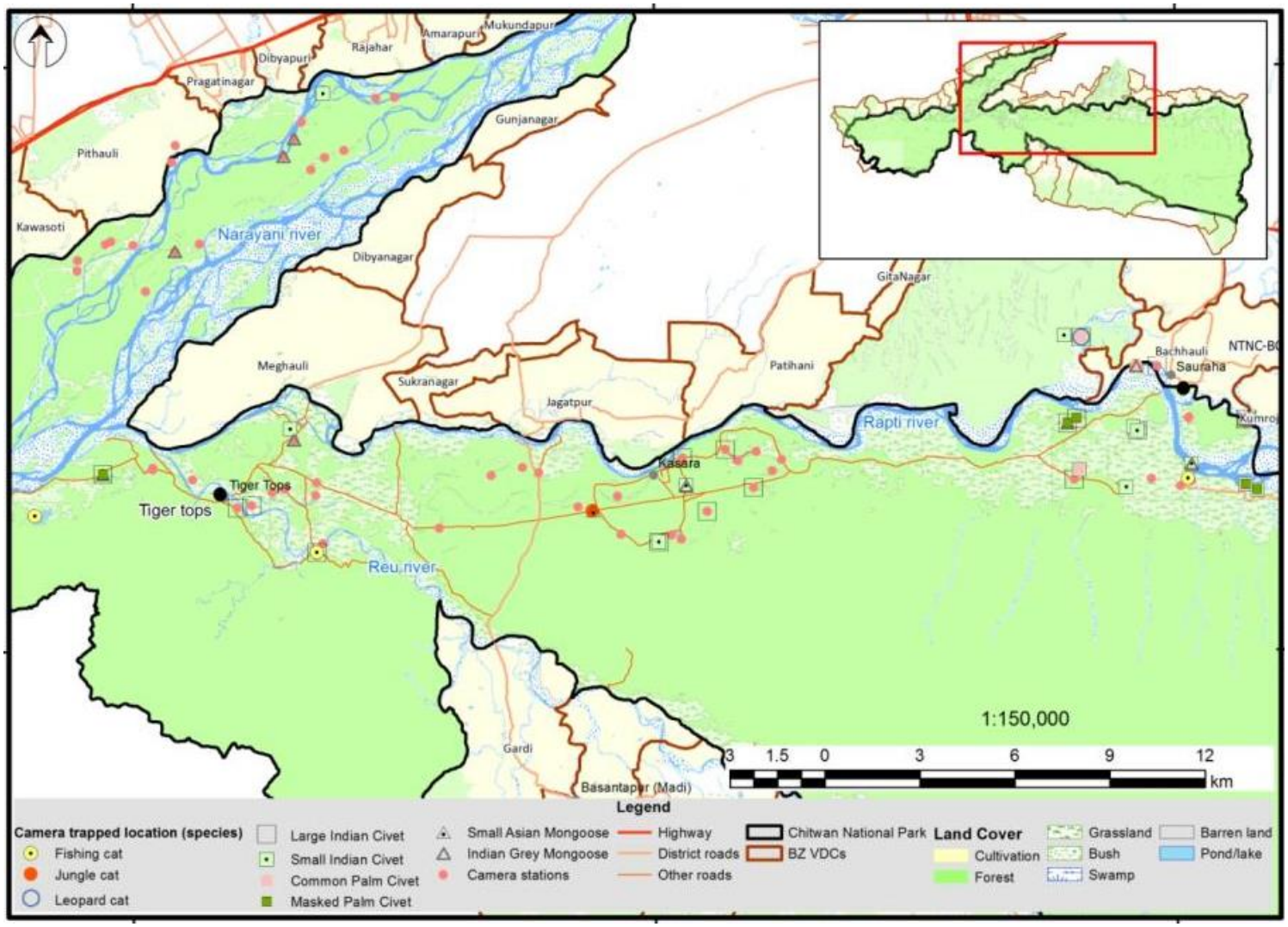

Figure 6. Camera trapped locations of small carnivores.

5.4. Threats

Almost 63% of the total respondents participated in the questionnaire survey, described degradation of habitats due to wetland shrinkage as the main threat to fishing cats. Some of them suggested that competition among the small carnivores with similar feeding habits led to threats to the species like the fishing cat. Remaining had described the environmental factors including disturbance to habitats, water pollution and poaching as threats to the fishing cat. Poaching of fishing cat was due to its preying on chicken, ducks, and fish and also for its meat and pelt (Figure 7).

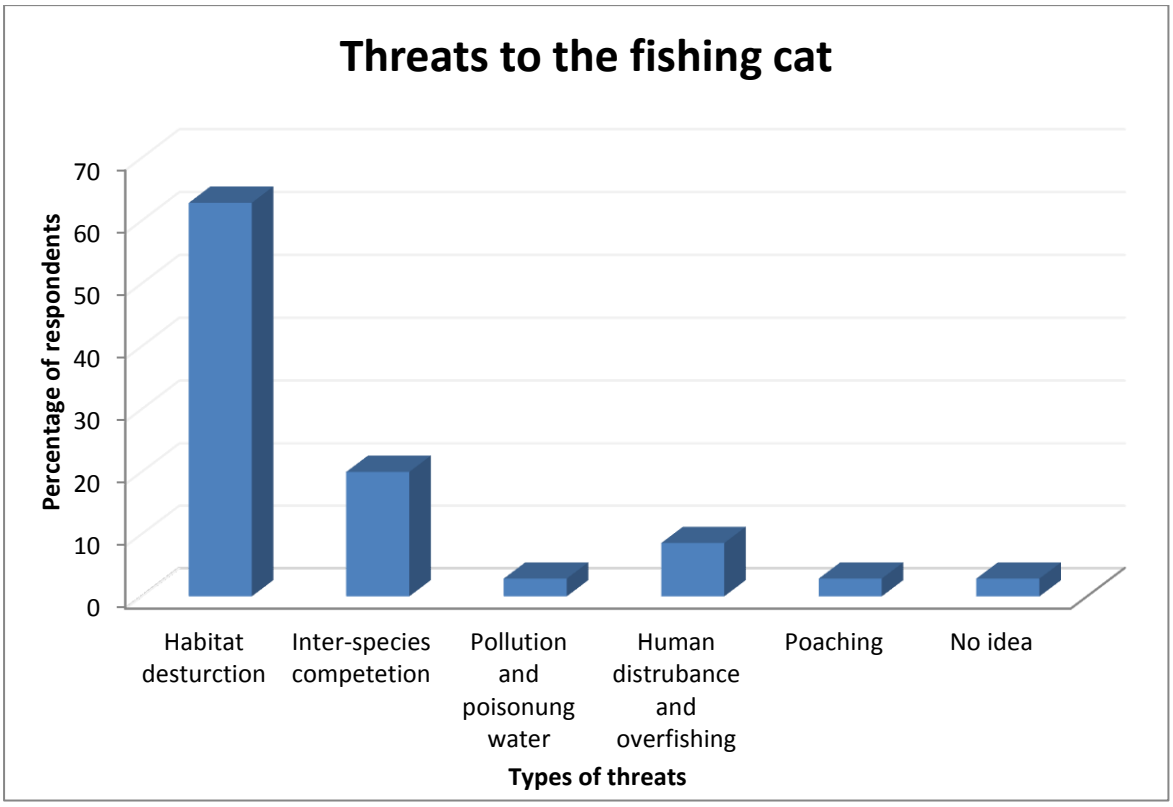

Figure 7. Perception about threats to the fishing cat in Chitwan National Park.

6. DISCUSSION

6.1. Status

The fishing cat was camera trapped from three locations in 2010 during the camera trapping survey done for tigers in CNP (Karki 2011a, Karki 2011b). Similarly two individuals of fishing cats were live trapped at the Tiger tops tented camp area in 2011 (Dahal and Dahal 2011). Recently six different individuals of fishing cats have been recorded from five camera trapping locations from the National tiger and prey base monitoring 2013 (DNPWC 2013 unpublished), suggesting the presence of at least six fishing cats in CNP.

This study used 857.73 active trap nights, which were less than the initial target of 868 because of the inactiveness of some cameras during the survey. Some cameras malfunctioned, batteries and memory cards of some cameras were stolen, and some other were disturbed by one-horned rhinoceros and sometimes by primates. After the analyses of body stripe patterns of fishing cat photographs, five individuals of the fishing cats were identified in six independent events from three locations. There was only one recapture which suggested the trap shyness of the animal. It also suggests that fewer individuals were captured than they exist. The reason for the higher mean number estimates obtained from SPACECAP (6.06 individuals/100 km^2) than CAPTURE (4.37 individuals/100 km^2) may be due to the additional habitat suitability component that SPACECAP accounts which CAPTURE program does not use. The estimated density of 6.06 individuals/100 km^2 was only for the fishing cat habitats not for all the park area.

6.2. Distribution

Fishing cats were recorded in CNP since the establishment of the park in 1973. The only radio collar study was carried out in Chitwan (Sunquist and Sunquits 2002) but their distribution throughout the park was not well documented. Karki (2011) described the locations of the fishing cat captured during camera trapping for tigers in 2010. Based on primary data (camera trap and sign survey data) and secondary information (published

documents), the species appears to occur in the Narayani, Rapti and Reu floodplains, major lakes like Devi tal, Tamor tal and Patna tal. During the camera trapping study (2013) of tigers, fishing cats were recorded from a new area i.e. northeast of Thori area. Tiger tops tented camp area and South of Sauraha were the places where fishing cats were recorded in most of the recent studies (Karki 2011a, Dahal 2012a). Pugmarks of the fishing cat were recorded from some places such as Kasara and Sukivar areas although they could not be camera trapped.

Most of the locations with signs of fishing cats are near water bodies with dense and tall grass layer of average height above one meter. It shows that patches of tall grass predominantly of kans and narkat as the most appropriate habitat for the fishing cat.

6.3. Associated small carnivores of fishing cats

It is found that fishing cats coexist with other two small cats - leopard cat and jungle cat in CNP (Karki 2011a). Four species of civets i.e. large Indian, small Indian (Dahal and Dahal 2011), common palm (Karki 2011a) and masked palm civets are also common and frequently recorded in camera traps from the study area of CNP. Moreover, crab-eating mongoose (Karki 2011a), Indian grey mongoose, small Asian mongoose (Dahal and Dahal 2011) were also been recorded within the overlapping altitudinal range. Likewise Pandey and Kaspal (2011) recorded the fishing cat along with other small carnivores like jungle cat and small Indian civet as their associate animals from Koshi Tappu Wildlife Reserve. Like fishing cats, jungle cats and leopard cats also feed on rodents, birds, young swines, chital fawn, hares, fish, etc. Large Indian civet, small Indian civet and palm civet along with fishing cats feed on birds, poultry and termites. Indian grey mongoose, small Asian mongoose and crab-eating mongoose together with fishing cats prefer insects, birds, small rodents, poultry and crabs as their diets (Jnawali et al. 2011). These observations and results show that other small cats, civets and mongoose are associated with each other because of their feeding habits.

Independent events of fishing cats were higher than that of masked palm civet, small Asian mongoose, jungle cat and leopard cat (Table 6). This was probably due to the biased setting of cameras inside the grids by selecting the potential fishing cat habitats which may not be suitable for other small carnivores. On the other hand lower

independent events of the fishing cat in its preference habitats was less than that of large Indian civet, small Indian civet, Indian grey mongoose and common palm civet which showed that number of the fishing cat was very low compared to other associated small carnivores in CNP.

6.4. Threats

Majority of the respondents described habitat loss and degradation due to wetland shrinkage, wetland conversion and flooding were the main threats to the fishing cat. Sunquist and Sunquist (2002), Cutter (2009), Adhya (2011), and Dahal and Dahal (2011) have also described destruction of habitats due to wetland shrinkage as the main threats to fishing cats. Moreover they have also explained trade of its pelt, human exploitation of marshes and grasslands as the threats to fishing cats which were described in this study as well.

Smith (pers. comm. 2013) described wetland conversion as a major threat to it. Radio collared study of five fishing cat done by Smith (1987) at Jayamangala ghol near Sauraha in CNP suggested extensive use of the area by the species at that time. Jayamangala area was a wetland with high fish stocks. During this survey, the wetland of Jayamangala has disappeared completely and the area is converted now into the tall grassland with scattered *Bombax* trees. No sign of fishing cats was found from the Jayamangala area. The conversion of wetlands to grassland was probably the major threat to fishing cats.

Based on key informant‟s survey in this study to find the threats to the fishing cats, some of the respondents has suggested that competition among the small carnivores with similar feeding habits led to threats to the species like the fishing cat which has not reported by other studies.

Human disturbance and over fishing were also major threats to the species also highlighted by Sunquist and Sunquist (2002), Cutter (2009), Adhya (2011), and Dahal and Dahal (2011) in different places at different time.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusions

I drew following conclusions from the study on the fishing cat conducted during March to June 2012 in CNP.

- Very small population of fishing cats less than 25 individuals exist in Chitwan although density was estimated to be 4.37 to 6.06 individuals/100 km^2 for suitable habitat.
- Fishing cats were limited in distribution found around wetland habitat in the form of patch. They were recorded from just three locations Patna tal, Tiger Tops tentent camp ghol and Devi tal.
- Many other small carnivores like small cats (jungle cat, leopard cat), civets (large Indian, small Indian, common palm and masked palm civets) and mongoose (Indian grey, small Asian and crab eating mongoose) overlapped within the fishing cats range.
- Occurrence of fishing cats in marsh and swamp areas made them more vulnerable to extinction due to a rapid rate of shrinkage and conversion of wetlands. Other threats included poisoning of wetlands, human disturbance, overfishing and poaching for their pelt and meat.

7.2. Recommendations

On the basis of my study, following recommendations have been suggested

- To draw the attention of wildlife scientists, Government of Nepal and conservation authorities, the fishing cat should be include in the list of protected animals of Nepal.
- Degradation and destruction of the wetlands should be stopped and wetland restoration should be prioritized.
- As population is very small, periodic monitoring of the species should be continued.

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9. ANNEXES

Annex I. Checklist of species captured on camera traps.

Animals photographed from camera trapping during the study of fishing cat in Chitwan National Park.

S. N.	Common Name	Scientific Name
Mammals		
1.	Indian Hare	*Lepus nigricollis*
2.	Black Rat	*Rattus rattus*
3.	Malayan Porcupine	*Hystrix brachyura*
4.	Indian Crested Porcupine	*Hystrix indica*
5.	Large Indian Civet	*Viverra zibetha*
6.	Small Indian Civet	*Viverricula indica*
7.	Masked Palm Civet	*Paguma larvata*
8.	Common Palm Civet	*Paradoxurus hermaphroditus*
9.	Jungle Cat	*Felis chaus*
10.	Leopard Cat	*Felis bengalensis*
11.	Fishing Cat	*Prionailurus viverrinus*
12.	Common Leopard	*Panthera pardus*
13.	Bengal Tiger	*Panthera tigris*
14.	Small Asian Mongoose	*Herpestes javanicus*
15.	Indian Grey Mongoose	*Herpestes edwardsi*
16.	Golden Jackal	*Canis aureus*
17.	Sloth Bear	*Melursus ursinus*
18.	Tarai Grey Langur	*Semnopithecus hector*
19.	Rhesus Macaque	*Macaca mulatta*
20.	Wild Boar	*Sus scrofa*
21.	Barking Deer	*Muntiacus muntjak*
22.	Sambar	*Rusa unicolor*
23.	Chital	*Axis axis*
24.	Hog Deer	*Axis porcinus*

25. Gaur	*Bos gaurus*
26. One-horned Rhinoceros	*Rhinoceros unicornis*

Reptiles

1. Golden Monitor Lizard	*Varanus flavescens*
2. Marsh Mugger Crocodile	*Crocodylus palustris*

Aves

1. Barn Owl	*Tyto alba*
2. Brown Fish Owl	*Ketupa zeylonensis*
3. Chestnut-tailed Starling	*Sturnus malabaricus*
4. Common Greenshank	*Tringa nebularia*
5. Crested Serpent Eagle	*Spilornis cheela*
6. Emerald Dove	*Chalcophaps indica*
7. Great Egret	*Casmerodius albus*
8. Greater Coucal	*Centropus sinensis*
9. Indian Peafowl	*Pavo cristatus*
10. Indian Pond Heron	*Ardeola grayii*
11. Jungle Myna	*Acridotheres fuscus*
12. Large-billed Crow	*Corvus macrorhynchos*
13. Lesser Adjutant	*Leptoptilos javanicus*
14. Large-tailed Nightjar	*Caprimulgus macrurus*
15. Lesser Coucal	*Centropus bengalensis*
16. Oriental Honey-buzzard	*Pernis ptilorhyncus*
17. Purple Heron	*Ardea purpurea*
18. Oriental Magpie Robin	*Copsychus saularis*
19. Red-wattled Lapwing	*Vanellus indicus*
20. River Lapwing	*Vanellus duvaucelii*
21. Rufous Treepie	*Dendrocitta Vagabunda*
22. Red Junglefowl	*Gallus gallus*
23. Spotted Dove	*Streptopelia chinensis*
24. Streak-throated Woodpecker	*Picus xanthopygaeus*
25. White-breasted Waterhen	*Amaurornis phoenicurus*
26. White-browed Wagtail	*Motacilla maderaspatensis*
27. Woolly-necked Stork	*Ciconia episcopus*

Annex II. Questionnaire for key informant survey.

Format of key information interviewed to the nature guides, wildlife technicians, fisherman, ranger and other park personnel during fishing cat survey in Chitwan National Park.

Date : ……..

Name of Respondent : …… **Address : ……..**

Sex : …. **Age : ……** **Profession : …….**

1. Have you seen fishing Cat in wild? (Yes/No)
2. How many times did you see it? (1/2/3/4/more)
3. When did you see? (within the last six months / within last 1 year)
4. Where did you see? (location, season and habitat)
5. What is the number of individuals? (In group /single)
6. At what time did you see it?
7. Are fishing cat increasing in this area?
8. Why do you think so?
9. What are the main threats to fishing cat?
10. Do people kill fishing cat?
11. Why are they poached?

Annex III. Event rates for small carnivores (number of independent events/100 days).

Site ID	Event rates of								
	Fishing Cat	**Leopard Cat**	**Jungle Cat**	**Large Indian Civet**	**Small Indian Civet**	**Common Palm Civet**	**Masked Palm Civet**	**Small Asian Mongoose**	**Indian Grey Mongoose**
A01A	0	0	0	14.29	0	0	0	0	0
A01B	0	0	0	0	7.14	7.14	0	0	0
A02B	0	0	0	0	21.43	0	0	0	0
A03B	7.14	0	0	0	0	0	0	0	0
A03C	0	0	0	0	14.29	0	0	0	7.14
A03D	0	0	0	0	14.29	0	**7.14**	0	0
A04A	0	0	0	0	0	7.14	**7.14**	0	0
A04B	0	0	0	**28.57**	0	**35.71**	**7.14**	0	7.14
A05A	0	0	0	7.14	0	7.14	**7.14**	0	0
A05B	0	0	0	0	**42.86**	0	0	0	0
A06A	0	0	0	7.14	21.43	0	0	0	0
A06B	0	0	0	7.14	14.29	0	0	0	14.29
A08A	0	0	0	7.14	0	0	0	0	**28.57**
A08B	0	0	0	0	7.14	0	0	0	0
A09A	0	0	0	**28.57**	0	7.14	0	0	0

A09B	0	**7.14**	0	0	0	0	**7.14**	0	7.14
A10A	0	0	7.14	14.29	0	0	0	0	0
A10B	0	0	0	14.29	0	0	0	0	0
B01C/D	0	0	0	0	10	0	0	0	0
B02A/B	0	0	0	20	0	0	0	0	0
B02C/D	0	0	0	20	0	0	0	0	0
B03C/D	0	0	0	20	0	0	0	0	0
B04A/B	0	0	0	10	0	0	0	0	0
B04C/D	0	0	0	0	10	0	0	0	20
B06C/D	0	0	0	10	0	0	0	0	0
B07A/B	0	0	0	0	10	0	0	0	0
B09A/B	0	0	10	0	0	10	0	**10**	0
B10A/B	0	0	0	10	0	0	0	0	0
C03A/B	0	0	0	0	10	0	0	0	0
C03C/D	0	0	0	0	0	0	0	0	10
C05A/B/C	**40**	0	**20**	20	0	0	0	0	0
C07A/B	0	0	0	20	0	0	0	0	0
C07C/D	0	0	0	10	0	0	0	0	0
C10A/B	0	0	0	10	0	0	0	0	10
C11A/B	10	0	0	0	0	0	0	0	0
D02A/B	0	0	0	0	10	0	0	0	0
D05A/B	0	0	0	0	0	0	0	0	10
D05C/D	0	0	0	0	0	0	0	0	20
D09C/D	0	0	0	0	0	0	0	0	10

Annex IV. Photo plate1: Camera trap photographs of fishing cat and associated small carnivores.

(a)

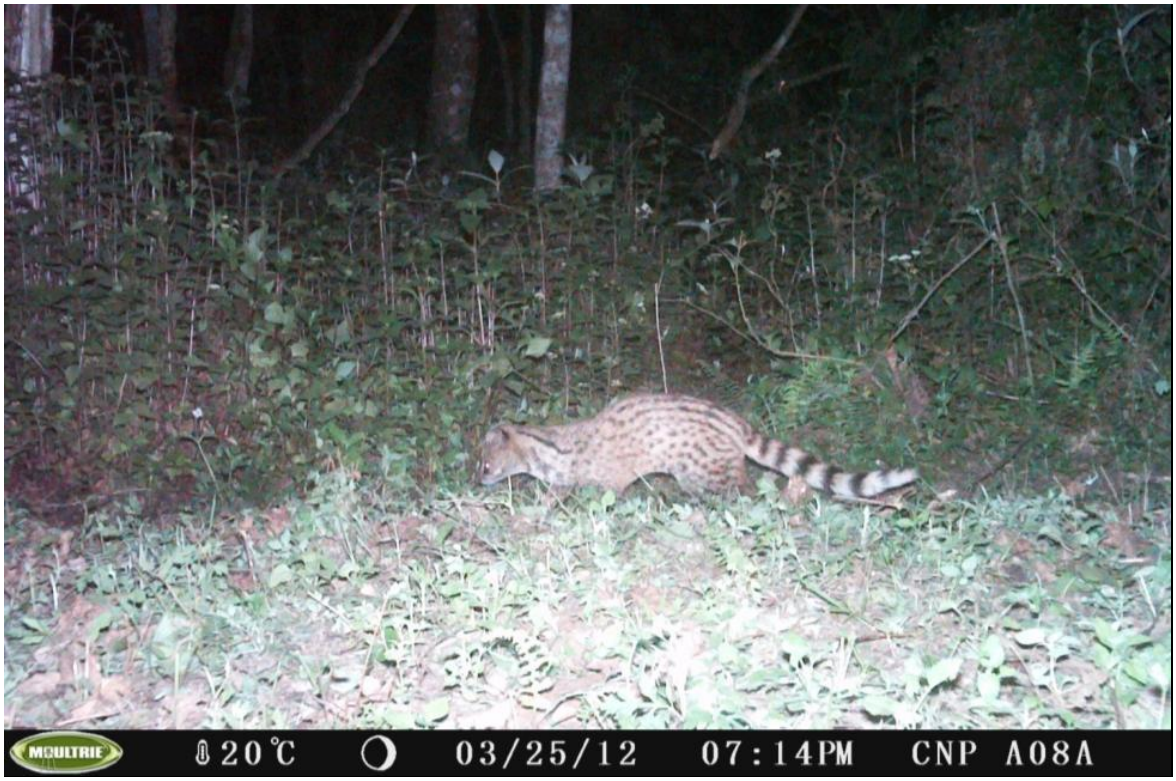
(b)

Photo plate 1: (a) Fishing Cat - *Prionailurus viverrinus*; (b) Jungle Cat - *Felis chaus*

(c)

(d)

Photo plate 1: (c) Leopard Cat - *Prionailurus bengalensis*; (d) Large Indian Civet - *Viverra zibetha*



(e)

(f)

Photo plate 1: (e) Small Indian Civet - *Viverricula indica*); (f) Masked Palm Civet - *Paguma Larvata*

(g)

(h)

Photo plate 1: (g) Common Palm Civet - *Paradoxurus hermaphroditus; (h)* Indian Grey Mongoose - *Herpestes edwardsii*

Annex V. Photo plate 2: Field photographs.

(a)

(b)

Photo plate 2: (a) Researcher carrying cameras traps to set-up in the field; (b) Researcher setting the camera trap and recording the site details with the technicians of NTNC.

(c)

(d)

Photo plate 2: (c) Observing for the suitable location for camera locaiton at Devital (one of the fishing cat trapped locations); (d) Team on the move - searching for the fishing cat sings and camera trap locations.

(e)

(f)

Photo plate 2: (e) Fishing cat pugmark; (f) Typical fishing cat habitat - Tiger tops tented camp ghol

(g)

(h)

Photo plate 2: (g) Fishig cat habitat degradation due to invasive species water hyacinth (*Eichhornia crassipes*); (h) Drying of wetlands and *Mikania micrantha* invasion.

Annex VI. Photo plate 3: Camera trap photos of other key species.

(a)

(b)

Photo plate 3: (a) Bengal Tiger - *Panthera tigris; (b)* Greater one-horned rhinoceros - *Rhinoceros unicornis*

(c)

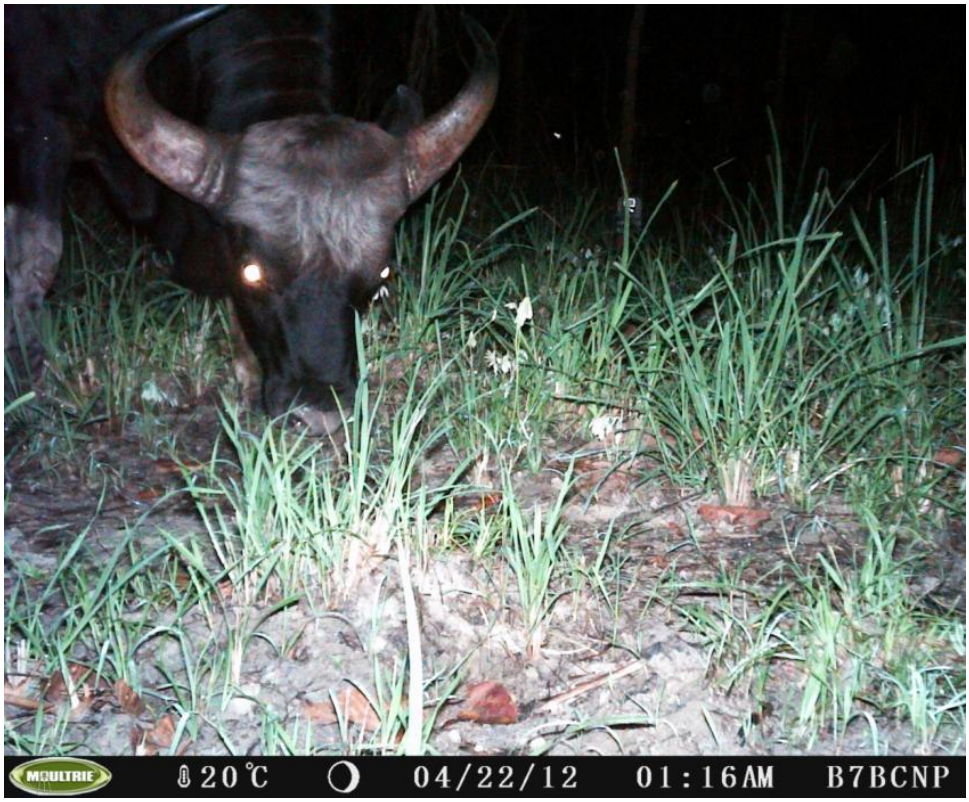
(d)

Photo plate 3: (c) Sloth bear - *Melursus ursinus*; (d) Spotted deer - *Axis axis* and Rhesus macaque - *Macaca mulatta*

(e)

(f)

Photo plate 3: (e) Terai grey langur -*Semnopithecus hector*; (f) Barking deer -*Muntiacus muntjak*



(g)

(h)

Photo plate 3: (g) Gaur - *Bos gaurus*; (h) Golden jackal – *Canis aureus*

(i)

(j)

Photo plate 3: (i) Hog deer - *Axis porcinus*; (j) Sambar - *Rusa unicolar*

(k)

Photo plate 3: (k) Wild boar - *Sus scrofa*