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FISHING CAT *PRIONAILURUS VIVERRINUS* BENNETT, 1833 (CARNIVORA: FELIDAE) DISTRIBUTION AND HABITAT CHARACTERISTICS IN CHITWAN NATIONAL PARK, NEPAL

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Abstract: The Fishing Cat is a highly specialized and threatened felid, and its status is poorly known in the Terai region of Nepal. Systematic camera-trap surveys, comprising 868 camera-trap days in four survey blocks of 40km² in Rapti, Reu and Narayani river floodplains of Chitwan National Park, were used to determine the distribution and habitat characteristics of this species. A total of 19 photographs of five individual cats were recorded at three locations in six independent events. Eleven camera-trap records obtained during surveys in 2010, 2012 and 2013 were used to map the species distribution inside Chitwan National Park and its buffer zone. Habitat characteristics were described at six locations where cats were photographed. The majority of records were obtained in tall grassland surrounding oxbow lakes and riverbanks. Wetland shrinkage, prey (fish) depletion in natural wetlands and persecution threaten species persistence. Wetland restoration, reducing human pressure and increasing fish densities in the wetlands, provision of compensation for loss from Fishing Cats and awareness programs should be conducted to ensure their survival. We also recommend studying genetic diversity of sub-populations, as well as habitat use by radio-tagging.

Keywords: Camera trapping, Chitwan National Park, Fishing Cat, distribution, habitat characteristics, status.

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Author Details: RAMA MISHRA is young conservationist with interest in small carnivores. She is working in Fishing Cat research in Nepal. She is also conducting conservation awareness project on human-elephant co-existence. BABU RAM LAMICHHANE has interest in application of geo-informatics in wildlife conservation and research. He is now studying human-wildlife interactions in Chitwan National Park, Nepal. PROF. KHAGDA BASNET is experienced professor in ecology in Nepal. RAJAN AMIN is conservation biologist with long experience from Asia and Africa.

Author Contribution: RM & BRL designed and conducted the survey; RM, BRL & RA analyzed the data and RM, BRL, KB and RA wrote the paper.

For **Nepali abstract** see end of this article.

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INTRODUCTION

The Fishing Cat *Prionailurus viverrinus* (Bennet, 1833), is a medium-sized cat endemic to South and Southeast Asia. The species is classified as Vulnerable by the IUCN Red List of Threatened Species (Mukherjee et al. 2016) and is threatened by habitat loss and persecution throughout its range. Fishing Cats are strongly associated with water bodies, marshlands and swamps (Pocock 1939; Nowell & Jackson 1996; Mukherjee et al. 2016; Macdonald et al. 2010). Fish are their primary prey, although they also consume mollusks, arthropods, amphibians, reptiles, birds, small mammals (Haque & Vijayan 1993; Sunquist & Sunquist 2002; Macdonald et al. 2010) and deer fawns (James L. David Smith pers. comm. 2013). Cats are largely nocturnal (Mukherjee 1989; Sunquist & Sunquist 2002; Lynam et al. 2013) and shelter mostly in densely vegetated areas near water, rivers and streams during daytime (Prater 1980; Duckworth et al. 2010).

Fishing Cats have been recorded in five protected areas of the Nepal Terai: Shuklaphanta National Park, Bardia National Park, Chitwan National Park, Parsa National Park, and Koshi Tappu Wildlife Reserve (Jnawali et al. 2011; Karki 2011; Mishra 2016; Tylor et al. 2016; Yadav et al. 2018; DNPWC unpublished data). They have also been recently recorded outside protected areas

in Gagdishpur reservoir, a Ramsar site in southwestern Nepal (Dahal 2016); however, few studies have been carried out to understand the ecology, distribution and conservation status of this species in Nepal (Karki 2011; Dahal & Dahal 2012; Taylor et al. 2016). A radio-collared study of four Fishing Cats (three females and a male) in Chitwan showed that they spent most of their time in thick vegetation of short or tall grasslands, sometimes well away from water (Sunquist & Sunquist 2002). A better understanding of habitat characteristics and use patterns is essential for the conservation of this highly specialized species (Krausman 1999). Although Fishing Cat is known to occur in Chitwan National Park, its actual distribution and habitat characteristic remain unexplained. This paper presents the findings of our camera trap surveys conducted specifically for the species in 2012, and also from data obtained during systematic camera trap surveys carried out for Bengal Tiger *Panthera tigris* in 2010 and 2013.

Study Area

The study was carried out in alluvial floodplain of the Rapti, Reu and Narayani rivers of Chitwan National Park (CNP) and Buffer Zone (BZ) located at 27.230–27.630 °N and 83.810–84.710 °E (Fig. 1). CNP was established in 1973 as the first national park of Nepal and it was designated a world heritage site in 1984. A

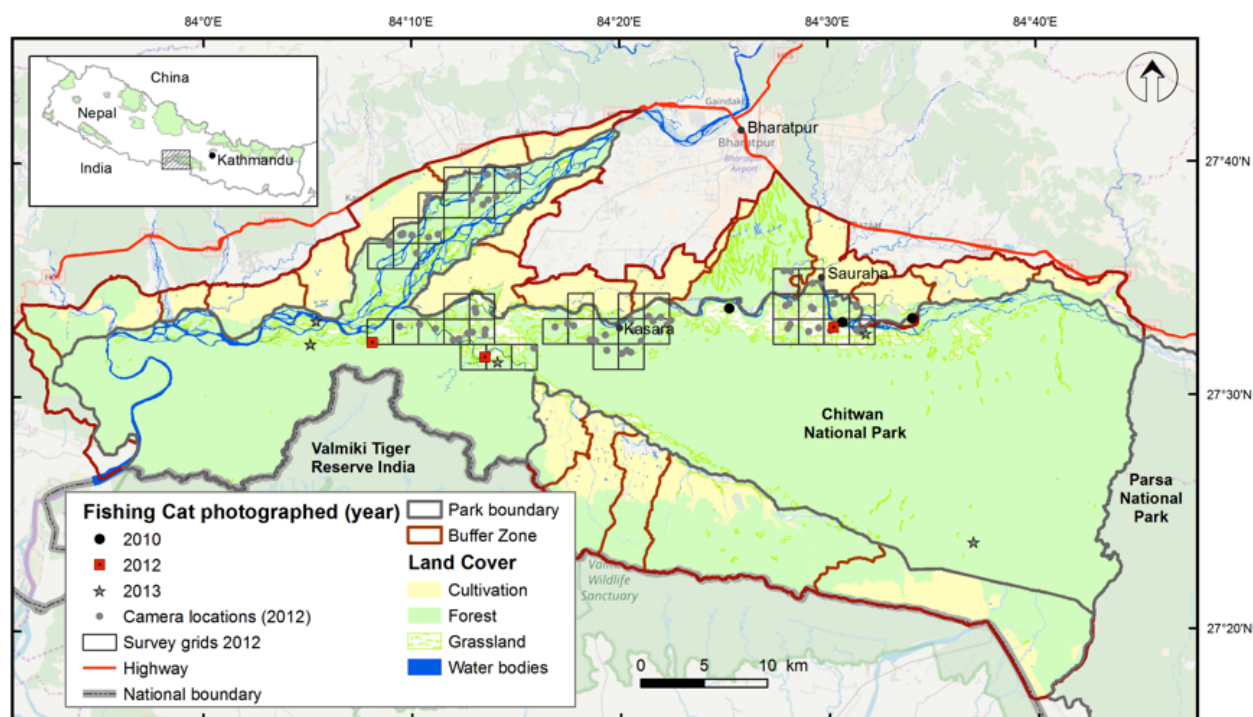


Figure 1. Fishing Cat distribution in Chitwan National Park, Nepal based on camera trapped locations. Survey in 2012 was done only in the areas within the grid cells.

larger portion (73%) of the 953 km² park is covered by Sal *Shorea robusta* dominated forest followed by grasslands (12%), riverine forest (7%), wetlands (3%), and exposed surfaces (5%) (Thapa 2011). An additional 750km² (29km² of which was included into CNP in 2016) of the area around the park was designated a BZ in 1996. CNP has three ecological zones—Churia hills (350–735 m altitude, 566km²), Bhawar (200–350 m altitude, 233km²), and alluvial floodplain (120–200 m altitude, 154km²) (Smith 1984). CNP includes three large river systems (Narayani, Rapti and Reu rivers) and more than 50 oxbow lakes (Khadka et al. 2015). The Park has sub-tropical climate with three distinct seasons i.e. monsoon (mid-June to mid-September), cool dry (mid-September to mid-March) and hot dry (mid-March to mid-June) (Subedi et al. 2013). Average annual rainfall is ~2,250mm (2000–2010), 80% of which occurs during the monsoon season. Average monthly maximum and minimum temperature ranges range 24–38 °C and 11–26 °C respectively (Sudedi et al. 2013).

CNP provides shelter to 70 mammal and >600 bird species. Bengal Tiger and Leopard *Panthera pardus* are large carnivores of the park (Karki et al. 2015). Along with Fishing Cat, a range of small-to-medium sized carnivores including Clouded Leopard *Neofelis nebulosa*, Dhole *Cuon alpinus*, Striped Hyena *Hyaena hyaena*, Golden Jackal *Canis aureus*, Jungle Cat *Felis chaus*, Leopard Cat *Prionailurus bengalensis*, Bengal Fox *Vulpes bengalensis*, Honey Badger *Mellivora capensis*, and Indian Crested Porcupine *Hystrix indica* are found in CNP. In addition to the terrestrial carnivores, more than 100 endangered Gharial *Gavialis gangeticus* are found in Rapti and Narayani rivers along with ca. 350 Marsh Mugger crocodiles in the rivers and lakes of CNP (Khadka et al. 2015). A total of 126 fish species are found in CNP (CNP 2017), including Sahar *Tor putitora*, Katle *Neolissocheilus hexagonolepis*, Catfish *Wallago attu*, *Mystus seenghala*, and *Mystus aor* (Dhital & Jha 2002).

MATERIALS AND METHODS

Field survey

During February 2012, a preliminary pugmark sign survey was conducted and informal interviews were carried out with local fishermen, nature guides, wildlife technicians and park personnel to identify sites of Fishing Cat occurrence. Based on these surveys and interviews, four blocks (Sauraha, Kasara, Tiger Tops, and Island) of ca. 40km² each were chosen in the alluvial floodplains of CNP and BZ for a camera trap survey (Mishra 2016). The

survey was subsequently carried out between 25 March and 11 June 2012. Each 40km² block was divided into 2x2 km² cells and ten cells were identified in each block and within each cell, two camera trap stations were selected based on likely Fishing Cat presence. A pair of camera traps was placed 4–7 m apart facing each other at 30–45 cm above the ground at each station. Reconyx RM 45 Rapidfire and Moultrie Game Camera were used. Cameras operated throughout 24hr for 10–15 days and were programmed to take three photographs per trigger with no delay between triggers. Camera's detection range was 25+ m. Moultrie game cameras used a white flash to obtain color images whereas Reconyx RM 45 cameras had infrared flash giving black and white pictures.

All pictures of cats obtained from camera traps were stored in a folder and individual identification was done based on body spot patterns (Cutter 2009). A sequence of photographs of Fishing Cat occurring after an interval of >60 minutes from the previous photograph was considered as an independent event.

Fishing Cat distribution

In addition to the data from our targeted survey, we used Fishing Cat records from the 2010 and 2013 camera trap surveys targeted for Bengal Tigers, which covered CNP and BZ forests with a total of 310 and 362 CT stations respectively. Detailed methodology of these surveys can be found in Karki et al. (2015) and in Dhakal et al. (2014).

We recorded habitat characteristics, i.e., habitat type (grassland, sal forest, riverbank, riverine forest, lake/marsh, wooded grassland), tree canopy cover, distance to wetland, wetland type and wetland state (area, depth and disturbance) of each camera trap station during camera deployment. We visually quantified the tree canopy cover within a circular area 50m radius from the centre of the camera into 0, 1–10 %, 11–50 %, >50% tree canopy cover. A buffer of 7.065km² (1.5km radius) was created around the camera trap stations of fishing cat capture. The buffer was based on the assumption that a female Fishing Cat home range is 4–8 km² (Sunquist & Sunquist 2002). Animals do not use the habitat uniformly and their home ranges are not exactly circular but we used circular buffer around the camera trap station as the best possible way to represent home range. Habitat type within the buffer area was quantified as forest, grassland, water bodies and sand/gravel using land cover layers of topographic map of 1:25000 scale produced by Survey Department of Nepal Government (<https://ngiip.gov.np/index.php>) in 1998. Spatial analysis

was undertaken in ArcGIS 10.0 (ESRI 2010).

RESULTS

Survey effort and cat detections

A total of 868 camera trap-days in 78 camera trap stations in CNP and BZ resulted in 640 photographs of 13 carnivore species including Fishing Cat (Table 1). Survey effort varied among the habitats with highest effort in grasslands (30.2%). About half (46%) of the camera traps stations were placed in vicinity of the wetlands (lakes, marshes or river bank). Only 11 camera trap stations (14%) were in riverine and Sal forests (Table 1). A total of 19 photographs (11 right and eight left flank) of Fishing Cat were recorded at three camera trap stations, one in grassland surrounding a lake and the other two at the edge of an oxbow lake. Three individuals were captured at one station i.e., grid no C05 (Tiger Tops tented camp area) (Image 1). One individual was captured in A03 (Patna Lake) and C11 grids (Devi Lake) (Fig. 2). Individual identification was based on pelage patterns. None of the camera stations in the BZ ($n = 4$) detected Fishing Cat.

Fishing Cat distribution

Overall, Fishing Cat was recorded at 11 camera-trap stations in CNP (Table 2, Fig. 1) from the three different camera trap survey years: 2010 (three), 2012 (three) and 2013 (five). The elevation range of camera stations was



Image 1. Camera trap photograph of a Fishing Cat in Chitwan National Park, April 2012.

97–628 m and Fishing Cats were captured between 117 and 307 m. Most of the stations ($n=8$) recorded single individuals once only. Two and three individuals were photographed in two and one locations, respectively. Majority of the stations with Fishing Cat detections ($n=7$) were in alluvial floodplain grassland or grassland-wetland edge habitat (Fig. 2, Table 2).

Habitat characteristics

Fishing Cats were detected near lakes and swamps surrounded by dense tall grass (average height of 1–2 m) dominated by *Phragmites karka* and *Saccharum* sp. The animals were detected on animal trails at the edge (within 10m) of lakes and swamps (Table 3).

Table 1. Survey effort and detection of Fishing Cat and other carnivore species during March–June 2012 in different habitats of Chitwan National Park, Nepal.

Habitat type	No. of stations	No. of trap nights	Carnivore species recorded in camera traps	No. of Fishing Cat detections (No. of photographs)	No. of Fishing Cat individuals
Grassland	23	262	Tiger, Fishing Cat, Golden Jackal, Himalayan Crestless Porcupine <i>Hystrix brachyura</i> , Common Palm Civet <i>Paradoxurus hermaphroditus</i> , Large Indian Civet <i>Viverra zibetha</i> , Small Indian Civet <i>Viverricula indica</i> , Sloth Bear <i>Melursus ursinus</i>	1 (3)	1
Sal forest	5	54	Himalayan Crestless Porcupine, Asian Palm Civet, Tiger, Small Indian Civet, Sloth Bear	-	-
River bank	17	190	Golden Jackal, Jungle Cat, Indian Grey Mongoose <i>Herpestes edwardsii</i> , Himalayan Crestless Porcupine, Common Palm Civet, Tiger, Large Indian Civet, Small Indian Civet, Sloth Bear	-	-
Riverine forest	6	80	Golden Jackal, Leopard Cat, Indian Grey Mongoose, Himalayan Crestless Porcupine, Asian Palm Civet, Large Indian Civet, Small Indian Civet, Sloth Bear	-	-
Lake/Marsh	19	198	Fishing Cat, Jungle Cat, Indian Grey Mongoose, Tiger, Large Indian Civet, Sloth Bear	5 (16)	4
Wooded grassland	8	84	Jungle Cat, Small Asian Mongoose, Indian Grey Mongoose, Himalayan Crestless Porcupine, Common Leopard, Large Indian Civet, Small Indian Civet, Sloth Bear	-	-
Total	78	868		6 (19)	5

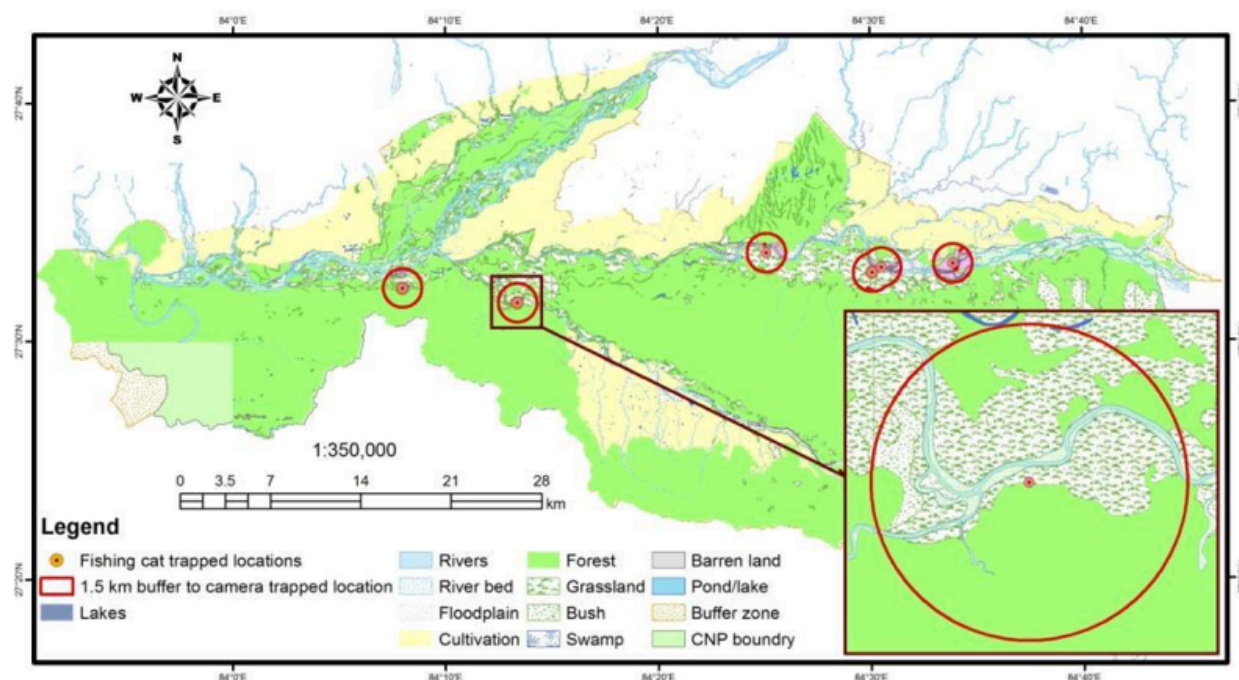


Figure 2. Fishing Cat habitat within 1.5km of camera trap locations in Chitwan National Park, Nepal

Table 2. Fishing Cat camera trapped locations in Chitwan National Park, Nepal in different camera trap sessions (2010, 2012, and 2013).

	Location	Coordinates	Date	Time	Elevation (m)	Habitat type
1	Ghatgain	27.56239°N & 84.41631°E	16.ii.2010	00:02	156	Riverine forest
2	Amrite	27.55470°N & 84.56258°E	04.iii.2010	20:12	174	Grassland
			20.iii.2010	03:42		
3	Icharny	27.55208°N & 84.50666°E	16.iii.2010	02:42	171	Grassland
4	Patnatal	27.54815°N & 84.49961°E	28.iii.2012	22:34	187	Grassland
5	Tiger tops tented camp	27.52784°N & 84.22099°E	23.iv.2012	19:25	177	Wetland
			27.iv.2012	22:39		
			28.iv.2012	00:06		
			02.v.2012	03:41		
6	Devital	27.53825°N & 84.13084°E	24.iv.2012	16:28	145	Wetland
7	Temple tiger	27.55386°N & 84.08595°E	21.ii.2013	02:28	119	Grassland
8	Temple tiger	27.5373°N & 84.08124°E	22.ii.2013	02:19	117	Wetland
			24.ii.2013	20:12		
			26.ii.2013	19:21		
9	Tented camp east	27.52457°N & 84.23104°E	21.iii.2013	01:37	145	Grassland / Riverine forest
10	Amrite	27.54395°N & 84.52535°E	12.iv.2013	22:44	171	Grassland
11	Thori	27.39494°N & 84.6107°E	04.v.2013	01:18	307	Mixed forest

The major habitat within 1.5km radius buffer area around the camera trap stations where Fishing Cat were detected (Fig. 2) was grassland (45%) followed by forest (27.8%), sand and gravel (16.6%) and water-bodies

(10.6%) (Table 4). All six camera trapped locations were in grassland but they were close to forests (within 1km) in the core area of CNP.

DISCUSSION

A survey effort of 868 trap nights in 78 camera trap locations in CNP in 2012 resulted in capture of five individuals in six events from three locations, for a capture rate of 0.73/100 trap nights. Survey effort was highest (46.2%) in wetlands (lake, marsh and riverbanks) followed by grasslands (39.7%) and forests (12.8%). Fishing cats were recorded only in wetlands (5 of six events) and grassland (one event) with highest probability of capture (1.3 events/100 trap nights) in wetlands followed by grasslands (0.3 events/100 trap nights). Fishing Cats were only recorded in close proximity to water edge. During 2012 survey we did not record Fishing Cat from forests, but during 2010 and 2013 Fishing Cats were photographed from locations in riverine forest and mixed forest respectively. In 2013, an additional location of Fishing Cat camera trap was at the edge of grassland and forest (Table 1).

Fishing Cat distribution in CNP is strongly associated with rivers, oxbow lakes and floodplain grasslands.

Cats were recorded within 125km² of Reu, Rapti and Narayani floodplains in CNP (Fig. 1). During our study we photographed Fishing Cat in the location where Dahal & Dahal (2012) and Karki (2011) had also found Fishing Cat during their survey between 2010 and 2011. Recently (in 2016 December), a wildlife photographer photographed a Fishing Cat walking on a forest road in Sal forest 200m from a lake (GPS 27.535°N & 84.337°E) close (1.5km) to the park headquarters where we failed to record the species during our survey (Kasara block). In Nepal, Fishing Cat is distributed from east (Koshi Tappu Wildlife Reserve) to west (Shuklaphanta National Park); however, they have patchy distribution within the range and we lack information whether the Fishing Cat sub-populations found (both in and outside of the protected areas) are connected to each-other.

Sunquist & Sunquist (2002) reported the radio-tagging of Fishing Cats in CNP during 1980s. With the help of wildlife technicians (Mr. Bishnu Bahadur Lama and Mr. Harkaman Lama; National Trust for Nature Conservation) who were involved in the radio-tagging,

Table 3. Fishing Cat habitat characteristics of camera trapped locations during field survey in March–April 2012 in Chitwan National Park, Nepal.

	Location	Coordinates	Type of wetland	Distance to water edge	Distance to forest edge	Surrounding Hab. type	Dominant grass	Ht. of grass	Other carnivores
1	Patna	27.54815°N & 84.49961°E	Lake	10m	1.1km	Tall grass	<i>Phragmites karka</i> and <i>Imperata cylindrica</i>	>2m	None
2	Tented Camp	27.52763°N & 84.22112°E	Swamp	2m	0.1km	Tall grass	Simghans, <i>Phragmites karka</i>	> 2m	Sloth Bear, jungle Cat & large Indian Civet
3	Devi Tal	27.53804°N & 84.13097°E	Lake	5m	0.1km	Tall grass	<i>Saccharum Bangalensis</i> and <i>S. spontaneum</i>	1-2m	None

Table 4. Habitat within 1.5km radius of Fishing Cat camera trap locations in Chitwan National Park, Nepal.

Year	Location	Coordinates	Habitat area in hectares within 1.5km radius of CT location (% coverage)			
			Forest	Grassland	Sand/gravel	Wetland
2012	Tented camp	27.52763°N & 84.22112°E	369.76 (52.3)	286.31 (40.5)	24.89 (3.5)	25.83 (3.7)
2012	Devi Tal	27.53804°N & 84.13097°E	439.31 (62.2)	165.39 (23.4)	36.36 (5.1)	65.75 (9.3)
2012	Patna Tal	27.54815°N & 84.49961°E	27.84 (3.9)	540.94 (76.5)	64.29 (9.1)	73.73 (10.4)
2010	Ghatgain	27.55208°N & 84.50666°E	177.44 (25.1)	389.96 (55.2)	66.27 (9.4)	73.13 (10.3)
2010	Amrite	27.55470°N & 84.56258°E	71.73 (10.1)	135.35 (19.1)	407.63 (57.7)	92.08 (13)
2010	Icherny	27.55208°N & 84.50666°E	93.78 (13.3)	391.72 (55.4)	102.76 (14.5)	118.53 (16.8)
	Total		1179.85 (27.8%)	1909.67 (45%)	702.2 (16.6%)	449.05 (10.6%)

we placed camera traps at the locations of the live captures (Jayamangala ghol, 27.561°N & 84.480°E). We failed to photograph Fishing Cat at the location but obtained a camera trap photograph of a Fishing Cat about two kilometers south-east of this location (i.e., Patna Tal, Table 2). Smith (James L.D. Smith pers. comm. 2013) described the Jayamangala ghol as a wetland during 1980s which is now converted to grassland (Khadka et al. 2015). This is an example of the rapid change in habitat of Fishing Cat in just 30 years. Such habitation alteration and drying of wetland areas can severely affect the distribution and abundance of the species. In addition to the shrinkage, reduced fish abundance and high human pressure (both in terms of pollution and fishing) in the remaining wetlands makes Fishing Cats more vulnerable.

Grasslands, river banks (sand/gravel) and wetlands altogether make about three fourth of the 7.065km² (1.5km radius) of Fishing Cat captured location. It indicates the preference of Fishing Cats for the areas with mosaics of habitats abundant with water as found by Nair (2012) in Western Terai Arc Landscape in India. In contrast to our record of Fishing Cat in the core area of CNP, Taylor et al. (2016) reported Fishing Cat from private fish ponds along the eastern border of Koshi Tappu Wildlife Reserve in Eastern Nepal. Similar report of Fishing Cats intensively using aquaculture and rice fields was reported by Cutter (2015) in Thailand. But they also face a threat of persecution by the aquaculture farmers in such areas (Taylor et al. 2016).

We recommend to focus fishing cat conservation actions on wetland restoration, reduce human pressure in identified pocket areas of Fishing Cat, increase fish density in the wetlands, provision of compensation for loss from Fishing Cat and awareness programs for the local communities living close to Fishing Cats. We also recommend examining the genetic diversity and relatedness among Fishing Cat sub-populations in Nepal through non-invasive genetic study. A detailed understanding of habitat use by Fishing Cat can also be obtained through radio-tagging of few Fishing Cat individuals (Nair 2012; Cutter 2015), both in natural conditions like CNP and in close proximity of settlements (like Koshi Tappu eastern buffer zone).

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शारांश

मलाहा बिरालो वासस्थान विशेषमा मात्र पाईने संकटापन्न बिरालो प्रजाति हो। नेपालको तराई क्षेत्रमा यसको अवस्थाबारे थोरैमात्र थाहा छ। चितवन राष्ट्रिय निकुञ्जको राप्ती, रिउ र नारायणी नदीको नदी तटीय क्षेत्रमा क्रमबद्ध रूपमा करीब ४० वर्ग कि.मी.का चारवटा सर्भे ब्लकमा ६८६ क्यामेरा ट्राप दिनको प्रयत्नबाट यस प्रजातिको वितरण क्षेत्र र वासस्थानको प्रकार/विषेशता अध्ययन गरियो। तीनवटा स्थानमा छ पटकमा गरी पाँचवटा मलाहा बिरालोको १९ वटा फोटोहरू प्राप्त भयो। तीन वर्ष (२०१०, २०१२ र २०१३) को क्यामेरा-ट्राप सर्भेमा मलाहा बिरालोको फोटो खिचिएका ११ वटा स्थानहरू प्रयोग गरी मलाहा बिरालोको वितरण क्षेत्र नक्शांकन गरियो। मलाहा बिरालो क्यामेरा ट्रापले फोटो खिचेको ६ वटा स्थानको वरिपरि रहेको वासस्थानको प्रकार/विषेशता व्याख्या गरियो। मलाहा बिरालो भेटिएको धेरैजसो स्थान अग्लो घाँसे मैदानले घेरिएको सिमसार (ताल) र नदीकिनारा छन्। खुम्चेंदै गएको सिमसार क्षेत्र, प्राकृतिक सिमसारमा आहारा (माछा) घटिरहेको तथा मान्छेले प्रतिशोधले मार्ने आदि यीनिहरूको दिगो संरक्षणमा खतराको रूपमा रहेका छन्। यीनिहरूलाई बचाईराख्न सिमसार क्षेत्रको पुनर्स्थापना, प्राकृतिक सिमसारमा मानवीय चाप कम गरी माछाको घनत्व बढाउने, मलाहा बिरालोबाट हुने क्षतिको राहतको व्यवस्था तथा जनचेतनाका कार्यक्रमहरू संचालन गरिनुपर्छ। नेपालका विभिन्न क्षेत्रका मलाहा बिरालाहरूको वंशाणुगत विविधता साथै रेडियो ट्यागको सहयोगबाट बासस्थान प्रयोगको बारेमा विस्तृत अध्ययन गर्न हामी सिफारिस गर्दछौं।





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