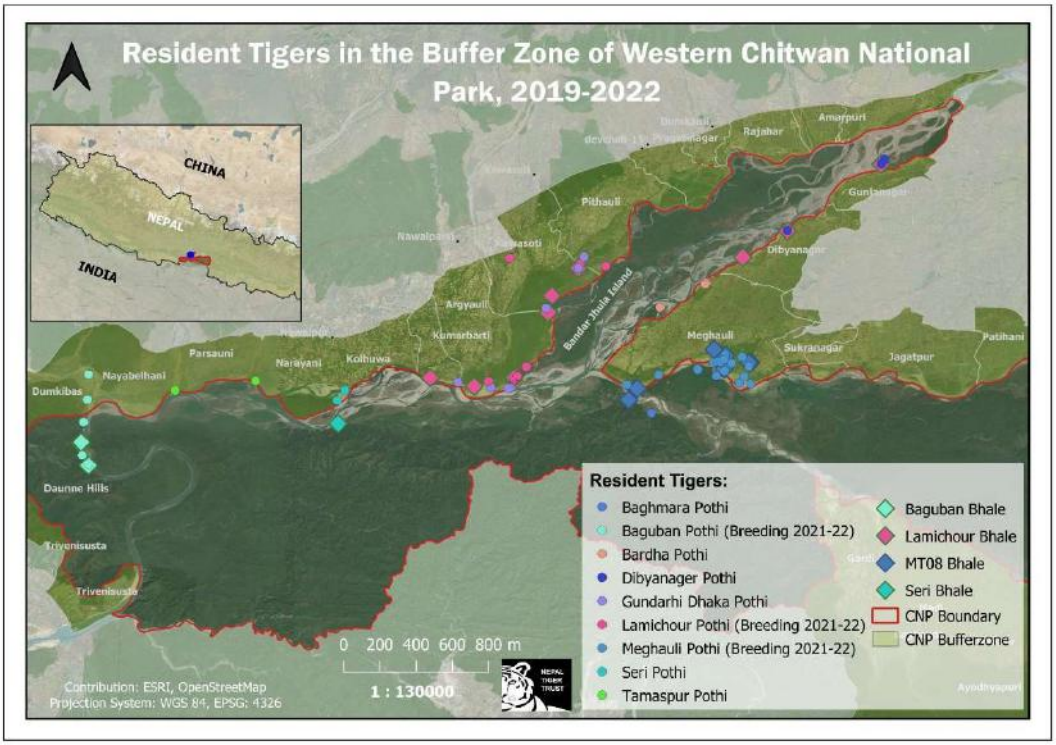
LONG TERM TIGER MONITORING BUFFER ZONE OF WESTERN

CHITWAN NATIONAL PARK, NEPAL

A Final Report 2018-2022



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SUMMARY

This is the final report on Long Term Tiger Monitoring in the Buffer Zone Community Forests (BZCFs) of Western Chitwan National Park, covering four seasons from 2018-22. The study area was divided into four blocks. The pugmark tracking was conducted three seasons in all survey blocks and camera trapping was completed four seasons and only in two survey blocks. The objectives were to understand the tiger population dynamics and long term habitat use as breeding or dispersal. We recorded 16 resident tigers of which 11 were females and 5 males. Five of the 11 females were reported with cubs during the study period indicating BZCFs supporting breeding tigers. Likewise, there were 15 transient or non-resident tigers. These tigers were recorded only once during a season and are potentially dispersers, whereas, resident or breeding tigers were reported in the same general area year after year or with cubs. These resident tigers' territory reported in the community forests is the extension from Chitwan National Park as most of these BZCFs are not large enough to support breeding tigers independently. The data shows high frequency use of BZCFs by tigers as they are breeding and rearing cubs that are supported by diverse and large number of prey species photographed at Meghauli BZCFs. Such increasing use indicates the potential of increase in human tiger conflict, but at the same time it also shows the dispersal possibilities into the larger landscape. The project was limited by Covid-19 pandemic to some extends, and it is recommended to supplement pugmark survey with camera trapping in all sites, as tigers' photos provide better and comparable long term data base.

Contents

BACKGROUND

The Chitwan National Park (CNP), a world heritage site has the longest history of tiger monitoring since its establishment in 1973 (McDougal et. al. 2016) and has the best tiger breeding habitat in the world. It was in CNP, in 1974, when the first wild tiger was ever darted and fitted with radio telemetry under the auspices of Nepal Tiger Ecology Project (Seidensticker et. al. 1974). The Tiger Ecology Project between 1974 - 1980 used radio telemetry and monitored tigers to study home range size, activity patterns, population structure and dispersal (Smith 1993; Sunquist 1981; Tamang 1982). During the same time, Dr. Charles McDougal was also studying tigers to understand the behavior, interactions and movement patterns of individual tigers in the western part of CNP. Dr. McDougal was using pugmark tracking associated with facial and body identification techniques (McDougal 1977). The tiger ecology project scientists and Dr. McDougal collaborated in their research and published many scientific articles on natural history of tiger that we know today (Seidensticker & McDougal 1993; Smith et. al. 1989).

In 1980, the Tiger Ecology Project ended and Dr. Charles McDougal established the Long-Term Tiger Monitoring (LTTM) project in partnership with Smithsonian Institution and International Trust for Nature Conservation (ITNC) to give continuity on the tiger research and specifically to understand the life histories and reproductive contribution of individual resident tigers. By that time, McDougal had already established the reliability of tiger pugmarks identification of individual tigers through meticulously investigating all four pugmarks of known radio-collared tigers. With

constant observation of pugmarks, it was possible to identify individual tiger solely by pugmarks (McDougal, 1999). Furthermore, the tracking technique relied on excellent soil substrate of CNP and experienced trackers. Therefore, LTTM covering an area from Kasara to Lendaghat, an approximately 100 km^2, used pugmark identification technique from 1980-1995 to monitor individual tiger, movement pattern, and association with other tigers. The LTTM annual report during this period was submitted to the Department of National Parks and Wildlife Conservation (DNPWC) and Smithsonian Institution where Dr. McDougal was a Smithsonian Research Associate.

However, since 1995, when game cameras were commercially available, LTTM started using camera traps to monitor individual resident tigers. The project was then supported by ITNC and The Fund for the Tiger (TFFT). The camera trap provided easier and more reliable identification of tigers than pugmarks technique.

The emphasis on monitoring breeding adult tigers were based on the population structure and territoriality of tigers (Sunquist 1981) that was supported by the 7-years of LTTM data (1995 - 2002) analyzed and published in 2009 (Barlow et. al. 2009). The authors quantified the changes in abundance of demographic group of tigers (young, transient, and breeding). The results showed high variation of these groups among years; transients were recorded low, young offspring showed high fluctuations in the number, but the number of breeding resident animals remained relatively stable. The authors recommended on counting breeding resident animals that increased the power of monitoring programs to detect change over time. Therefore, in later years LTTM focused on monitoring the individual breeding resident tigers using camera trapping, and on ad hoc basis pugmark tracking was used. Although, the camera trapping provided

the reliable identification of individual tiger but detail information on tiger movement, interactions, and communication were difficult to obtain from camera data alone.

In 2010, Nepal Tiger Trust (NTT) was established by local LTTM associates supported by CNP management to give continuity to this important project. In addition to ITNC and TFFT, McDougal Foundation and World Charity Foundation started providing additional support. In 2016, LTTM associates published forty years of LTTM data from 1974-2015, summarizing the density, territory, reproductive status and longevity of breeding females (McDougal et. al. 2016). The data showed a constant and stable density of breeding females since early 1990s that were contributing maintaining stable tiger population in the study area.

Also, in 2010, Nepal, along with other 12 tiger range countries had adopted a challenging goal of doubling the tiger population by 2022 (DNPWC, 2016). Nepal has taken positive conservation actions in this direction by establishing 550 km² of Banke National Park in 2010, extension of 127 km² area of Parsa Wildlife Reserves in 2015, and prioritizing conservation activities in the buffer zone community forests and establishing corridor habitats between populations. By this time camera trapping became the standardized method for monitoring tigers in Nepal and around the globe. In Nepal, the tiger population were estimated every four years to monitor the progress towards this massive goal and Nepal became the first country to double its tiger population. Table 1 shows the tiger population estimated during this period 2009 to 2022 (DNPWC 2023). Nepal adopted the baseline tiger population estimated in 2009 where study area only covered the lowland areas of all the parks and had excluded hilly regions (Karki et. al. 2009). However, in 2010, camera trapping including the hilly

region of CNP was conducted and the results was published (Table 1; Karki et. al. 2015). In all the later years of tiger estimations, Nepal has been covering the lowlands and hilly areas of all the parks and even beyond park boundaries.

The estimated tiger population in CNP from 2010 to 2022 shows fluctuations over the four estimated years (Table 1), however, it has been showing the steady increasing trend in the captured tigers' photos.

Table 1 The tiger population estimated between 2009 and 2022 in the National Parks of Nepal (DNPWC 2023; *Karki et. al. 2015).

National Park	YEAR ESTIMATED									
	2009		*2010		2013		2018		2022	
	Captured	Estimated	Captured	Estimated	Captured	Estimated	Captured	Estimated	Captured	Estimated
Chitwan National Park	59	91	68	125	77	120	85	93	113	128
Parsa National Park	4	4	4	4	4	7	15	18	35	41
Suklaphanta National Park	7	8	7	8	13	17	15	16	28	36
Bardia National Park	16	18	16	18	44	50	77	87	117	125
Banke National Park					4	4	17	21	23	25
Total	86	121	95	155	142	198	209	235	316	355

Given the degree of stability concluded by the LTTM in the western part and population estimations of CNP, one could not expect dramatic increase in tiger number, where it seems tiger and prey base are in sync with the habitat (DNPWC 2020; Dahal et. al. 2023). However, CNP and buffer zone user committee (BZUC) efforts have been successful in re-establishing additional tiger habitats in the buffer zone or forestlands

adjacent to CNP. The tigers have established or extended their territory in the buffer zone community forests. Additionally, the adjoining forest also serves as a corridor habitat for tigers to disperse beyond Chitwan to other tiger populations in Nepal and India. Documenting the breeding tigers, understanding the abundance of tiger, prey and habitat sync in the buffer zone forests become even more critical. All these conservation efforts beyond the CNP boundaries, certainly contributed increase in the overall Chitwan tiger's population.

Therefore, from 2018-2022, LTTM focused on tigers living in the western buffer zone community forests of CNP. Tiger monitoring in the main LTTM area inside the CNP was carried out during the national tiger survey in 2018 and 2022 and also was done on ad-hoc basis. In the buffer zone, we adopted pugmark tracking technique to monitor individual tiger as it provides additional detail information on tiger movement patterns and associations. Also, we want to keep the pugmark tracking technique alive by integrating with technologies such as Footprint Identification Technique (FIT) and other improved data collection techniques and tools. Camera trapping was also done in part of the study area, the Meghauli buffer zone community forests (BZCFs).

The objectives of this project are to:

1. Understand the long-term population dynamics and interaction of tigers living in the buffer zone.
2. Build capacity and train next generation of tiger trackers.
3. Assist and mitigate human-tiger conflict situation.
4. Promote tiger conservation through participations.

METHODOLOGY

Study Area

The study area is situated in the northern part of CNP covering BZCFs from Sukhivar in the east to Daunne Hills in the west. The area is divided into four survey blocks, and are:

Block I. Meghauli/Kerunga (Camera Trapping and Pugmark Tracking): BZCFs along Rapti River from Sukhivar to Rapti-Narayani confluence.

Block II. Kalabanjar/Sisuwa (Camera Trapping and Pugmark Tracking): BZCFs along eastern channel of Narayani River from Rapti-Narayani confluence to Ganjapur post.

Block III. Lamichour/Amaltari (Pugmark Tracking): BZCFs along western channel of Narayani River from Amaltari to Kujauli.

Block IV. Daunne Devi/Nanda Bhauju (Pugmark Tracking): BZCFs west of Seri along Narayani River to Daunne Hills.

Training And Participation

Several trainings were conducted for tiger monitoring team that included Footprint Identification Technique (FIT), ArcGIS Survey123, Global Positioning System (GPS) unit and TrailGuard AI camera. The first training on FIT was conducted by DPhil scholar, Amy Fitzmaurice, WILDCRU, University of Oxford, on 3 November 2018. The training focused on skill development regarding footprint/pugmark measurement, footprint photography using measurement scales, and identification of different pugmarks. In 2019, the second training was held on ESRI ArcGIS Survey123 app. The monitoring team was trained on how to record the tiger data in the field when

tiger tracks or other tiger signs were encountered. It included measurements of tracks, taking track photographs, entering other tiger information and saving the data. It also included uploading the data online. The third training was conducted by Rupesh Maharjan, graduate students on the use GPS unit. It was held on 9 Feb 2021. The monitoring team was trained on how to mark and collect GPS points of tiger locations along the tiger travelling route. The monitoring team were also trained on how to load the collected GPS points into the computers. Last but not least, the LTTM tiger monitoring team also participated in TrailGuard AI camera technology training organized by National Trust for Nature Conservation, on 7 December 2022. The participants were trained on how the TrailGuard AI cameras can detect wildlife species or humans and transmits associated text alerts with photos to rapid response teams instantly. The training also included setting up the AI cameras in the field and test the notification alert. The tiger monitoring team included tiger technicians from NTT, accompanied by park game scouts, forest guards from respective community forests, and CBAPU youth from the same survey blocks.

Camera Tapping Meghauli BZCFs (2018-2022)

We conducted camera trapping in the Meghauli buffer zone community forests during 2018-2022 covering four seasons (Figure 1). It covered the study block I and block II. Each study block was further divided into two camera trapping blocks. And within each block we established 5 to 7 camera locations and in each location, two camera traps were placed for 24 hours (trap night) and was monitored regularly for tiger tracks, camera photos, batteries and SD card. Furthermore, GPS coordinate of all camera

locations were recorded. The camera trapping efforts, tiger's photos obtained during the study period are shown in Table 2.

Table 2 Season wise camera trapping effort and success rate in the Meghauli Buffer Zone Community Forest, Chitwan National Park during the 2018-22.

Season	Locations	Trap/Nights	Photos	TN/Photos	Individuals	TN/Individual
2018-19	17	615	146	4.2	12	51.3
2019-20	12	228	74	3.1	5	45.6
2020-21	18	478	92	5.2	5	95.6
2021-22	10	227	16	14.2	5	45.4
Total	NA	1548	328	4.7	27	57.3

We identified individual tiger from the photos using their unique stripe and facial markings. We also linked the tiger tracks obtained at trap site with that of photographed tigers. We then mapped the individually identified tigers based on the locations of photographs to understand its distribution (Figure 2). We also verified different species of animals photographed in the trap sites. Finally, we counted the associated prey species, domestic animals and human photographed in each site to understand their habitat use and sharing (Appendix 1 (h)) .

Tiger Pugmark Survey (2019-2022)

The tiger pugmark survey was conducted in three seasons. However, survey was impacted due to Covid-19 pandemic. In season 2019-20, the tiger pugmark tracking was conducted between the period of 15 October 2019 to 8 June 2020. Survey of all four blocks were completed by 12 March 2020. After March, tiger survey was impacted due to Covid-19 pandemic, when country-wide lockdown was implemented in Nepal from 24 March 2020 to 21 July 2020. Likewise, in 2020-21, tiger tracking was conducted in all four blocks but in different time period from 22 November 2020 to 17 April 2021.

Finally, in season 2021-22, tiger tracking was completed between 8 November 2021 to 12 March 2022. In block I and block II tiger tracking also were conducted during camera trapping.

The pugmark identification method used was the same that was developed by LTTM project. The tiger tracks were identified by differentiating features of their all four pugmarks. The technique relies on finding the clear impressions made by all four of the tiger's feet. This is critical, because the distinguishable features facilitating identifications may occur on any of the four feet. Additionally, it is also important to note that the technique is to a large extent site specific. In Block I, II and III, there is extensive hard sand substrate along river and stream courses where it is relatively easy to encounter clearly-defined pugmarks. However, in Western area, on the Daunne Hills (Block IV), finding tiger tracks becomes increasingly difficult. There is less suitable substrate to find clear pugmarks. Therefore, tracks were surveyed along river banks, streams, dust path and dirt roads, where possibilities of suitable substrate for the recording tiger tracks are high. Finally, the pugmark identification technique depends on a few highly skilled, experienced individual over a long period of time. The survey team included senior wildlife technicians Baburam Mahato, Raju Kumal, and Bir Bdr Kumal, each with over 20 years of tiger monitoring experiences. They were accompanied by park game scouts and/or community forest guards, or CBAPU youth, from the corresponding survey sites.

The track of tiger, when encountered, data form was filled with date, time, GPS locations, and foot ID. The photograph of good tracks was taken with foot ID and measurement ruler placed next to the track. Such data of all four feet were documented.

The tiger pugmark data was also collected using ArcGIS Suvery123 apps with same tracks information and photographs. Individual tiger track when encountered were identified using identification techniques, and was provided names. In Block I and II, Meghauli area, where camera traps were also used to monitor tiger, photographed tigers and its associated pugmarks was used to cross check pugmark identification technique. In this way tiger tracks and photographs were analyzed, and identified. We than mapped the track and photographed tiger locations over the study area to understand their distribution and territory (Figure 4).

The pugmark photographs collected with measurement ruler could be used for FIT software analyses. However, it requires only a left hind footprint image. In this report we used the pugmark identification techniques using all four feet of the tiger tracks.

RESULTS

Camera Trapped Tigers in Meghauli BZCFs (2018-22)

We were successful in obtaining photographs of 18 different tigers during the four seasons (2018-2022) of camera trapping in the Meghauli BZCFs (Figure 2 & 3). Of those 7 were resident tigers: 5 females (including one philopatric sub-adult female (PSAF), and 2 males (Appendix 1 (a-g)). PSAF is a sub-adult female that subsequently settled in the area. Seven were transients' tigers and 4 were juveniles / cubs. The transient tigers included are adults and sub-adults. The juveniles and cubs are still associated with mother where juvenile is categorized above one year and cub below one year of estimated age. The breakdown of photographed tigers by category in each season of camera trapping is summarized in Table 3.

Table 3 Breakdown of Tigers by Categories during 2018-22 camera trapping seasons at Meghauli BZCFs, CNP. (PSAF=Philopatric sub-adult female), J=Juvenile, SC=Small Cub)

Season	Resident Female	Resident Male	PSAF	Transient	J+SC	Total
2018-19	4	2		3	4	13
2019-20	2	1	1	1		5
2020-21	2	1		2		5
2021-22	2	1		1	1	5
Total	10	5	1	7	5	28

Photos identified and named resident female, male and PSAF tigers by seasons are shown in Table 4. PSAF in season 2019-20 is MPD Pothi, a daughter of Meghauli Pothi.

Table 4 Camera Trapped Resident Tigers by seasons (2018-22) at Meghauli BZCFs, CNP.

SEASON	RESIDENT FEMALE	RESIDENT MALE
2018-19	Baghmara Pothi w/cubs Meghauli Pothi w/cubs Bardha Pothi Jamuna Pothi w/cubs	Kamal Bhale MT08 Bhale
2019-20	Baghmara Pothi Meghauli Pothi MPD Pothi	MT08 Bhale
2020-21	MPD Pothi Bardha Pothi	MT08 Bhale
2021-22	Meghauli Pothi w/cubs MPD Pothi	MT08 Bhale

Tiger Distribution by Pugmark

We documented 22 different residents and non-resident tiger during three seasons (2019-22) of pugmark tracking. Of those 13 were resident tigers (9 females and 4 males) and 9 were transients that included sub-adults (Figure 4 & 5). Table 5 summarize the number of tigers in each category. PSAF is included in the resident category as it subsequently become resident in their natal area.

Table 5 Breakdown of Tigers by Category during 2019-22 pugmark tracking in the Western BZCFs, CNP. (PSAF=Philopatric sub-adult female), J=Juvenile, SC=Small Cub)

Season	Resident Female	Resident Male	PSAF	Transient	J+SC	Total
2019-20	6	3	1	4		14
2020-21	4	3		2		9
2021-22	4	3		3	2	12
Total	15	9		9	2	35

Pugmark identified and named resident tigers are recorded by season is shown in Table 6. PSAF recorded is 2019-20 is Gundharhi Dhaka Pothi, a daughter of

Lamichour Pothi.

Table 6 Pugmark Tracked Resident Tigers by seasons (2019-22) Western BZCFs, CNP.

SEASON	RESIDENT FEMALE	RESIDENT MALE
2019-20	Baghmara Pothi Meghauli Pothi Lamichour Pothi Baguban Pothi Dibyanagar Pothi Tamaspur Pothi Gundharhi Dhaka Pothi	MT08 Bhale Lamichour Bhale Baguban Bhale
2020-21	Meghauli Pothi Bardha Pothi Lamichour Pothi Baguban Pothi	MT08 Bhale Lamichour Bhale Baguban Bhale
2021-22	Meghauli Pothi w/cubs Baguban Pothi w/cubs Lamichour Pothi w/cubs Seri Pothi	MT08 Bhale Baguban Bhale Seri Bhale

All together 16 resident tigers (11 females and 5 males) were documented during the study period. Table 7 shows the block wise distribution of all the male and female resident tigers identified by pugmark and camera trapping.

Table 7 Distribution of Camera Trapped and Pugmark Tracked Resident Tigers by Survey Blocks (2018-2022) in the Western BZCFs, CNP.

BLOCK	RESIDENT FEMALE	RESIDENT MALE
I (Meghauli/Kerunga)	Baghmara Pothi Meghauli Pothi Jamuna Pothi (MPD Pothi)	MT08 Bhale Kamal Bhale
II (Kalabanjar/Sisuwa)	Bardha Pothi Dibyanagar Pothi	
III (Lamichour/Amaltari)	Lamichour Pothi (Gundharhi Dhaka Pothi)	Lamichour Bhale
IV (Daunne Devi/Nanda Bhauju)	Baguban Pothi Seri Pothi Tamaspur Pothi	Baguban Bhale Seri Bhale

ASSOCIATED SPECIES AND DOMESTIC ANIMALS

Total numbers of tiger prey species photographed and counted in the four camera trapping season (2018-2022) are summarized by season in Table 8.

Table 8 Number of prey species photographed during 2018-22 camera trapping seasons at Meghauli BZCFs, CNP.

Season	Rhino	Samber	Cheetal	Hog Deer	Wild Boar	Rhesus Macaque	Indian Hare
2018-19	388	6	2202	695	217	92	0
2019-20	57	0	880	63	16	37	0
2020-21	441	12	1465	1084	93	204	3
2021-22	108	0	1130	98	22	172	5

Likewise, Table 9 shows the number of other associated species photographed in each of the four seasons.

Table 9 Number of other associated animals photographed during 2018-22 camera trapping seasons at Meghauli BZCFs, CNP.

Season	Leopard	Sloth Bear	Large Indian Civet	Small Indian Civet	Indian Palm Civet	Golden Jackal	Jungle Cat	Indian Grey Mongoose
2018-19	2	0	1	4	0	232	62	2
2019-20	0	2	0	0	2	5	1	0
2020-21	0	2	0	5	0	118	49	1
2021-22	0	5	0	5	0	6	3	3

The number of domestic animals and humans photographed are in Table 10.

Table 10 Number of people and domestic animals photographed during 2018-22 camera trapping seasons at Meghauli BZCFs, CNP.

Season	Cow	Buffalo	Goat	Dog	Human
2018-19	0	0	97	10	2167
2019-20	3	0	4	35	1927
2020-21	0	6	0	47	663
2021-22	35	0	0	0	1848

The associated species total numbers should not be considered as absolute number as same individual may have been counted multiple times.

DISCUSSION

We documented 16 different breeding resident tigers in the BZCFs of western CNP between 2018-2022 monitoring seasons. These included 7 resident tigers photographed in Block I and part of Block II, and 9 resident tigers identified by pugmark surveys from other blocks. Of the 7 photographed resident tigers, two tigers Jamuna Pothi and Kamal Bhale were not reported during pugmark tracking because they were photographed only in the season 2018-19 and pugmark tracking was initiated a year later. The territory or home range of all these resident tigers reported in the BZCFs is the extended home range from the CNP as these community forests size are not large enough to support resident tigers independently, except block III, i.e., Lamichour area may support resident tigers. Few resident females were documented with juvenile and cubs, indicating their breeding status.

Likewise, there were 15 different non-resident / transient tigers recorded that included adults and sub-adults. These tigers were recorded only in one season. However, two sub-adult females MPD Pothi and Gundharhi Dhaka Pothi became resident in subsequent year. They both were placed in PSAF category.

Such high number of tigers found in the western BZCFs suggests that the buffer zone area is extensively used by the tigers and are also breeding and rearing cubs. The number of prey species photographed in the Meghauli BZCF also indicates the improved habitat quality for tiger. Below we discuss these tigers distributed by blocks representing three areas of the CNP: a. LTTM area - Block I - Meghauli BZCFs; b. BandarJhula Island - Block II and III – eastern and western channel Narayani River; and c. Daunne Hills - Block IV - along lower portion of Narayani River.

Tiger in Meghauli BZCFs Block I (2018-22): LTTM area

Camera trapped tigers reported in Meghauli BZCFs can be divided into two separate forest blocks: Block I and Block II. Block I along Rapti River represents tigers in LTTM area and Block II along Narayani River indicating tiger territories in BandarJhula Island. This is because Meghauli is situated by the confluence of Narayani and Rapti Rivers. Both these Rivers form the boundary of the CNP mainland and BandarJhula Island. Rapti River, flowing east-west along southern border on Meghauli BZCFs represented in block I provides additional habitats for tigers living in the main LTTM area. Likewise, Narayani River, flowing north-west, along northern part of Meghauli BZCFs representing part of block II, provides additional habitats for tigers living in the BandarJhula Island. Here we discuss camera trapped and pugmark surveyed tigers in Block I.

During the study period from 2018-22, 6 resident tigers has been recorded in block I, along Rapti River community forests. Of these four were females and 2 males. Likewise, there were 5 transient tigers documented during the same period. All these 11 are representatives of tigers in the LTTM area inside of CNP. Such high increase in tiger use of BZCF is supported by the presence of diverse and large number of prey species photographed in the Meghauli BZCFs (Appendix 1 (h).

Three resident females were photographed in 2018-19: Baghmara Pothi, Meghauli Pothi, and Jamuna Pothi and all these 3 females were photographed with cubs and so the total number of tigers photographed in this season was 13, compared to 5 in each of the following 3 seasons (Table 3). The fewer number of tigers photographed in later seasons was also due to Covid-19 limitations, where complete coverage of the area

was not possible. The 4rth resident female is PSAF, MPD Pothi, who became resident in the area.

Baghmara Pothi, Meghauli Pothi and MPD Pothi are related. Baghmara Pothi a resident female in the LTTM area since 2007-08 (McDougal et al 2016) has been breeding and was recorded with 2 juvenile cubs in 2018-19 season. She was also photographed during 2018 national camera trapping (DNPWC 2018). On 29 July 2020, she attacked an army man while patrolling inside the CNP. After that incident, Baghmara Pothi were not photographed in Meghauli BZCFs nor during national camera trapping in 2022 (DNPWC 2022).

The Meghauli Pothi, daughter of Baghmara Pothi established territory in her natal LTTM area along the Rapti River and Sukhivar area since 2016-17. Even within Meghauli BZCFs Baghmara Pothi and Meghauli Pothi territory was separated. Meghauli Pothi covered habitat near airport and towards east, whereas Baghmara Pothi was documented towards west and inside the CNP until her disappearance in 2020. The Meghauli Pothi, now has moved towards vacated Baghmara Pothi territory. Meghauli Pothi has been photographed during the last two national camera trapping in 2018 and 2022 and has delivered two litters. MPD Pothi from her 1st litter, has now established her territory at the Meghauli BZCF covering the community forest near the airport and inside the CNP. She also has been documented in 2022, national camera trapping.

In 2018-19, Jamuna Pothi with cub was photographed at Meghauli BZCF. She was not photographed in later seasons as her territory was inside the CNP towards Sukhivar. In 2016-17 camera trapping she was recorded as unknown sub-adult female and now has established her territory. She was photographed in both 2018 and 2022

national camera trapping season.

The MT08 Bhale established its territory in the Meghauli BZCF and inside the CNP since 2017-18 season. The vacant territory had occurred when long-time resident male Gaida Khawa Bhale (Carter et. al. 2023) was removed from the Meghauli BZCF in 2018. MT08 Bhale has been documented in Meghauli BZCF in all seasons, including 2018 and 2022 national camera trapping. Another, longtime resident male, Kamal Bhale was only photographed in 2018-19 season at Meghauli. His territory was in the eastern part around Kamal Tal area inside the CNP. It is difficult to understand the activities of all the tigers that are photographed at Meghauli BZCFs as they all have territories inside the park.

Additionally, in Block I, Meghauli BZCF, 8 different transients tigers were recorded during the study period. Of those 6 were males and 2 were females. We tried to document or monitor these transient tigers but these tigers were dispersing or looking for vacated area to establish territory and so were documented only in one season. Those that were documented in following seasons were added into resident category. Furthermore, there is no further dispersal habitat from Meghauli BZCFs and so these transients have to move through the CNP.

Tigers in BZCFs adjacent to BandarJhula Island Block II & III (2018-22):

BandarJhula Island, formed by the bifurcation of the Narayani River, is one of the best riverine forest habitats of the CNP. The BZCFs around this Island are separated by the two channels of Narayani River that flows from northeast to southwest. The BZCFs along the outer bank of eastern channel up to Rapti-Narayani confluence is

categorized as block II. In part of this block belonging to Meghauli BZCFs were camera trapped and remaining areas were pugmark surveyed for tigers. This block is managed by the central sector of CNP management unit. Likewise, BZCFs along the western channel of Narayani River are categorized into block III. These areas are managed by the western sector of CNP management unit. Although, each block II and III is managed separately, tigers reported in both blocks is discussed as one representing BandarJhula Island. Both these forests blocks are the enlargement of Island that extends up to the human settlements.

In these blocks, representing BandarJhula Island, 5 resident tigers, (4 females and 1 male) were documented by pugmark and camera trapping. Of those three tigers: Lamichour Bhale, Lamichour Pothi, Gundharhi Dhaka Pothi, offspring of Lamichour Pothi were found in block III, and Bardha Pothi and Dibyanager Pothi, were documented in block II. Finding the presence of Lamichour Pothi in a Lamichour forest block for several seasons, and successfully rearing cubs that is becoming PSAF and eventually resident in the area is a good indication of long-term territory occupancy that support the population stability. In terms of resident male tiger in the Island, Lamichour Bhale, seems to be covering the entire Island, however, few new transient's male has been reported during the study period.

In addition to these identified resident tigers, 7 transients (4 males and 3 females) have been documented. Most of these tigers reported were in the northern part of the BandarJhula Island. Community forests along the Narayani River, provide corridor habitat for these tigers for dispersal into the northern national forests. Further research in the northern part of BandarJhula Island and beyond is recommended.

Long term monitoring tigers around the BZCFs of BandarJhula Island, provide the understanding of tiger living in the Island. However, we recommend monitoring tigers using both camera trapping and pugmark tracking. Photographed tigers each season can have a good long term data base for tiger identification in the future, whereas pugmark data in a longer term may not be feasible for identification and it requires trackers working in the area for long time.

Tigers in Daunne Hills and BZCF Block IV (2019-22)

This area covered BZCFs along Narayani River west of Amaltari to Daunne Hills. Five tigers (3 females and 2 males) were documented during pugmark surveys (2019-22) in this Block IV. Three resident tigers; a male (Baguban Bhale) and two females (Baguban Pothi and Tamaspur Pothi represented tigers sharing CNP and Daunne Hills. The Baguban Bhale and Baguban Pothi with cub tracks were found at the base of the Danne Hills around Baguban post, suggesting these tigers use Danne Hills. Another female, Tamaspur Pothi was found in the Nanda Bhauju BZCF east of Tamaspur village. Seri Bhale and Seri Pothi just outside of LTTM area was also reported. All these tigers have territory inside the CNP and have been using BZCFs as an extended territory.

Daunne Hill is a critical corridor habitat for tigers to connect Chitwan tigers to the other tiger populations in the west Nepal. In the hilly terrain tiger monitoring is challenging. Previously, as part of LTTM, camera trapping was used in Daunne Hill forest block for two consecutive seasons. In 2016, 262 trap nights and in 2017, 332 trap nights were invested. Despite of such efforts no tigers were photographed. However,

tiger tracks were reported during both camera trapping seasons. Likewise, Gurung et al (2006) also has reported tiger using the Daunne Hills, where tiger tracks were found near the top of the Hill and beyond towards Butwal.

The major critical dispersal gap for Chitwan tiger's connectivity to western Bardia population was identified at Dovan above Butwal city (Gurung et al. 2006). However, in recent publication by Subedi et. al. (2021), tigers were photographed in Rupandehi and Palpa districts, north west of Butwal city in 2018. This is very promising suggesting possibilities of linkage between Chitwan and Bardia populations.

East West Highway, traverse through Daunne Hills corridor, impeding animal movement. As part of the South Asia Subregional Economic Cooperation (SASEC) road connectivity project, Government of Nepal is widening this highway from two lanes to four lanes, that further disrupt movement of wildlife. In 2018-19 season, as part of the environmental assessment, wildlife sign survey and camera trapping assisted by NTT technicians Raju Kumal, Bir Bdr Kumal, and Rupesh Maharjan were conducted both side of the highway from Narayanghat to Daunne Hills (Karki, 2019). The tiger signs were observed in Daunne – Dumkibas and a male tiger was photographed north and south side of the highway in Arun khola – Binaya khola forest block, indicating tiger use of corridor. The report recommended to build 25 suitable underpass (bridge) and 2 box culverts for wildlife movement under the highway between Narayanghat and Daunne Hills.

Likewise, PhD scholar, Samantha Helle, is studying tigers in this larger corridor from CNP to Banke National Park using camera trapping to determine tiger use of these areas as dispersal or breeding habitats (Pers. communication).

NTT Technicians Assisting Human Tiger Conflict Resolutions

Since the beginning, NTT has been supporting CNP management in anti-poaching efforts, national camera trapping surveys in Chitwan-Parsa complex and human-tiger conflict resolutions. There have been several occasions when NTT technicians assisted in human-tiger conflict scenarios in the western part of CNP. They assist in identification of problem animals using their pugmark identification skills and other signs, and also assist in problem resolutions. Below, we describe three such incidents that took place during the project period (inside CNP, in the BZCF, and national forest beyond BZ) in the western part of CNP.

A. **Incident I: inside CNP Season 2019-20**: On 29 July 2020, a tiger attacked one of the three army men patrolling on foot inside CNP along the motorable road near Dhakre Khola. It was approximately around 4 pm. The tiger appeared from the side and attacked a man in the middle. The tiger bit man's left arm, that made three, one-inch-deep canine holes. Instantly, the last man behind picked up a big stone and threw it at the tiger. The stone hit the tiger, tiger left the man and walked away into the forest. The victim was a 22 years old army man and sustain no other serious injuries. On the request from Meghauli ranger CNP management, NTT technicians, Baburam Mahato and Raju Kumal, went to the attack site. After investigating the tiger tracks near the attack site was determined to be Baghmara Pothi. To understand the physical condition of the problem tigress, five sets of camera traps were established at different locations, in the vicinity of incident site from 4 July 2020 to 2 August 2020. Total camera trapping effort was 150 trap nights. Despite of such efforts, neither photo nor track of Baghmara Pothi was obtained. However, four

different male tigers were photographed, which included sub-adult male (Baghmara Pothi's offspring), 2 new male and a resident male tiger MT08 Bhale. Baghmara Pothi, a resident tigress in the area since 2007-08 was not reported after that incident.

B. **Incident II: BZCF Season 2021-22:** On 24 September 2021, a sub-adult male tiger killed a dog in the compound of Sarang Hotel at Meghauli. The next two days, same tiger tracks were found in and around the Meghauli village near some of the houses. On the request of Meghauli BZUC, the permission was obtained from CNP management to determine the physical condition of the tiger. Baburam and Raju, placed seven sets of cameras in the Meghauli village and the BZCF. On the morning of 27 September, same tiger killed another dog and attacked a young water buffalo (which died later) in Dharampur village, close proximity of NTT office building. The animal killed was not eaten. The tiger remained in the vicinity near the edge of BZCF. The incidents were happening in human settlement; therefore, the tiger darting operation was conducted by the rapid response team and tiger was darted and taken away from the area by the night time. The tiger was a 2-3 years old young male that was very weak and starving, seemed unable to kill natural prey.

C. **Incident III: National Forest Season 2021-22:** Three incidents happened within two months in the national forests (Arun khola- Binaya khola-Dumkibas) that serves part of Daunne corridor beyond CNP and BZ. On 27 November 2021, a 60 years old man, CF guard, Jeet Bdr BK, of Dumkibas, Nawalpur was killed in the forest south east of Binaya Khola bridge around 4 pm, when patrolling in the CF. Baburam and Raju, visited the incident site two days later and determined from pugmarks that it was a male tiger. A month later, on 30 December 2021, a 38 years old woman,

Besahara Magar, of Belahani, Madyabindu Municipality-10, Nawalpur was also killed around 12 noon when collecting Sal leaves in the forest between Arun Khola and Siseni village. During that time, Baburam and Raju were participating in the national tiger camera trapping survey in Chitwan and Parsa complex. Assistant warden Mr. Shant Magar, called them and requested them to go to the incident site and investigate. They reached the incident site on 1 Jan 2022, and determined from pugmark that it was the same male tiger that had killed a man a month earlier. Both these incidents had occurred south of the east-west highway, and no further actions were taken except Baburam and Raju placed a camera trap near the 1st victim kill site, where male tiger photo was captured. After reporting their finding to the assistant warden, they returned to their respective camera trapping field stations. However, on 23 January 2022, Baburam was called again by the rapid response team to join them to investigate tiger that had killed 2 oxen, near village called Gauri Jhok, quite far away from the CNP in the national forest, north of Dumkibas, along Binaya khola. The rapid response team included CNP park staff, armed forest guards from Nawalpur district, and 3 CNP elephants. On 24 January, Baburam and team started investigating tiger tracks and other sign in the vicinity of the oxen carcass. They were tracking from three elephants. The track found was of male tiger but different than previously found at two human killed sites. When they reached near the oxen carcasses, a male tiger was still feeding. The 1st ox was completely eaten and the tiger was feeding on 2nd carcass. The team saw the tiger and tiger attacked the elephants, further tracking was risky as the terrain was not suitable for elephants and so the team returned back to the village. Next day, fresh tiger tracks confirmed

the tiger presence in the area. The park ranger invited forest officer who came with 6 armed guards. On 26 January DFO (District Forest Officer) also came and meeting was held. It was decided to dart and take away the tiger from the area. On 27 January 2022, Tirtha Lama, technician from NTNC arrived with immunization equipment. Tirtha and Baburam climbed the tree near the oxen carcass with dart gun. Between 3:30 -5:30pm tiger was still in the area but it did not come close to dart range. It was a winter month, due to cold weather, Tirtha and Baburam returned back to village on elephant after placing a camera trap near the carcass. Early morning at 4am, on 28 January, Tirtha and Baburam went and climbed on the same tree and stayed until 7am but tiger did not come. They checked the camera trap and a male tiger was photographed around 7:45pm at night and was different then the male tiger photographed at human killed site. The tiger had completely gorged the 2nd ox remains. The team after lunch returned back to the same tree and around 5:45pm the tiger came in the vicinity but not close enough to dart. The team stayed on the tree until 11pm and returned to village for the night. On 29th January the team took the young water buffalo as bait for the tiger and tied it in the nearby tree and stayed on the same tree for tiger to come. The tiger came around 5:25pm but did not come close and did not kill the bait. The team waited until 11:30pm and returned back with water buffalo. Next day the response team including assistant CNP warden, ranger, NTT and NTNC technicians held the meeting. Baburam had already identified the male tiger, and he was needed in the camera trapping survey. So, Baburam and ranger returned back to CNP camera trapping site and resumed their responsibilities. The NTNC technicians Tirtha Lama and his team tried three more

days to dart the tiger but was not successful and they also returned back.

These incidents in national forests, camera trapping surveys along east-west highway, and LTTM monitoring of tigers in the BZCF shows an increase use of tigers in the Daunne Hills and surrounding areas. Although, these areas are providing the dispersal corridor for tigers, it is not without challenges.

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FIGURES

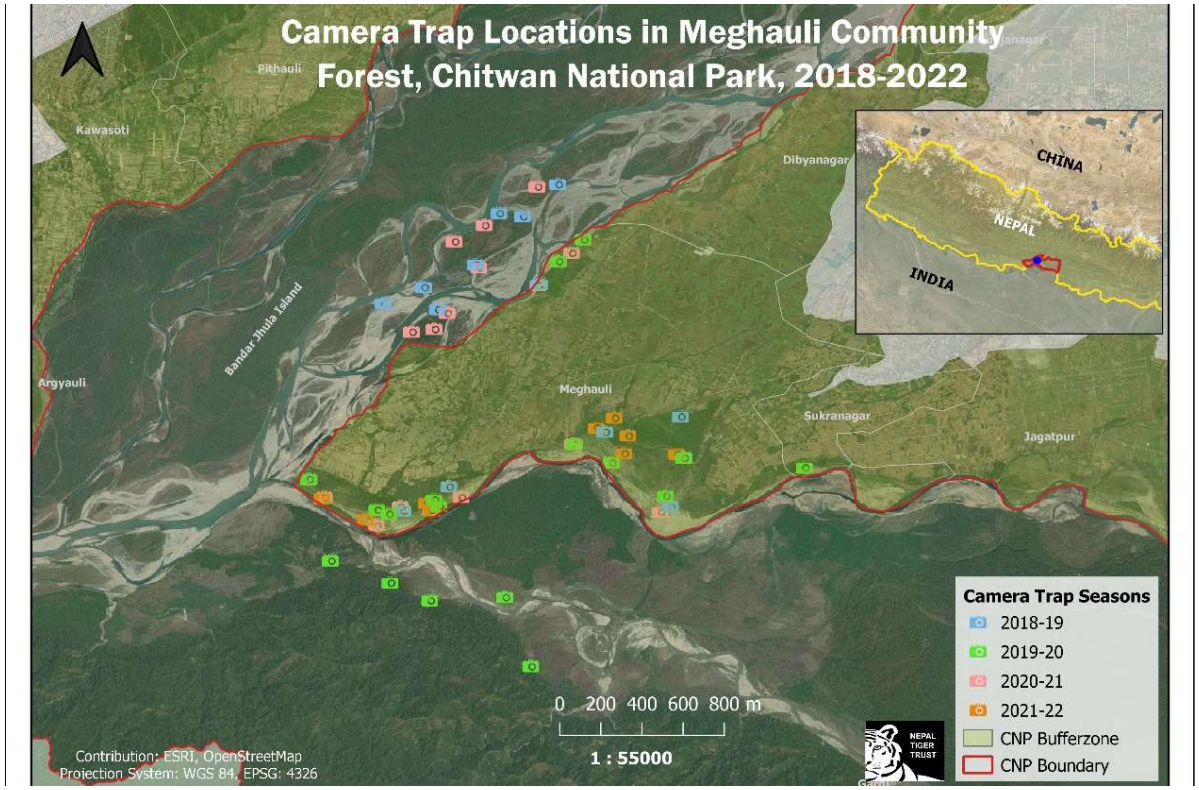

Figure 1: Season wise camera trap locations in Meghauli Buffer Zone Community Forests, CNP, 2018-22.

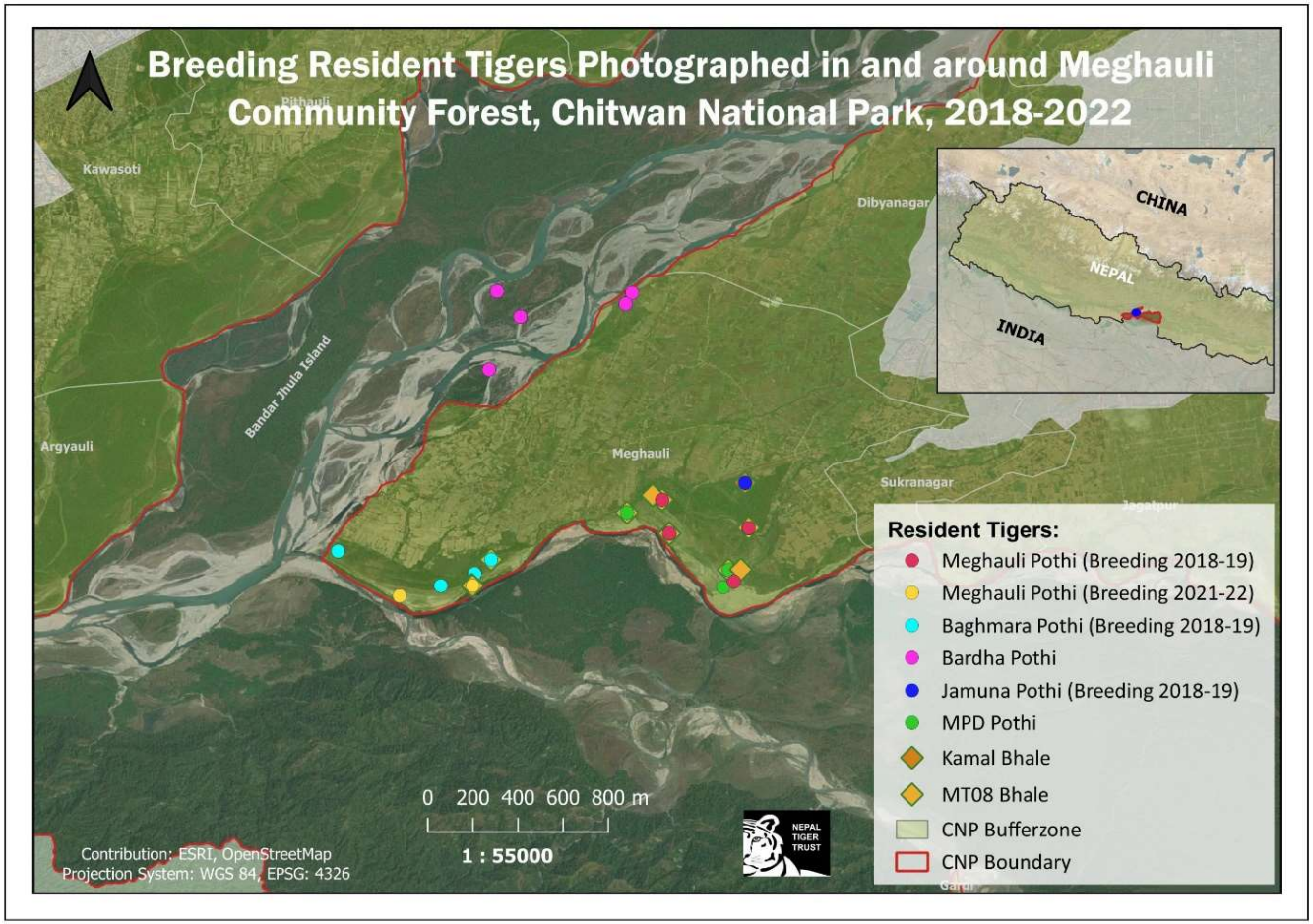

Figure 2: Breeding resident tigers photographed during 2018-2022 camera trapping season in Meghauli Buffer Zone Community Forests, Chitwan National Park, Nepal.

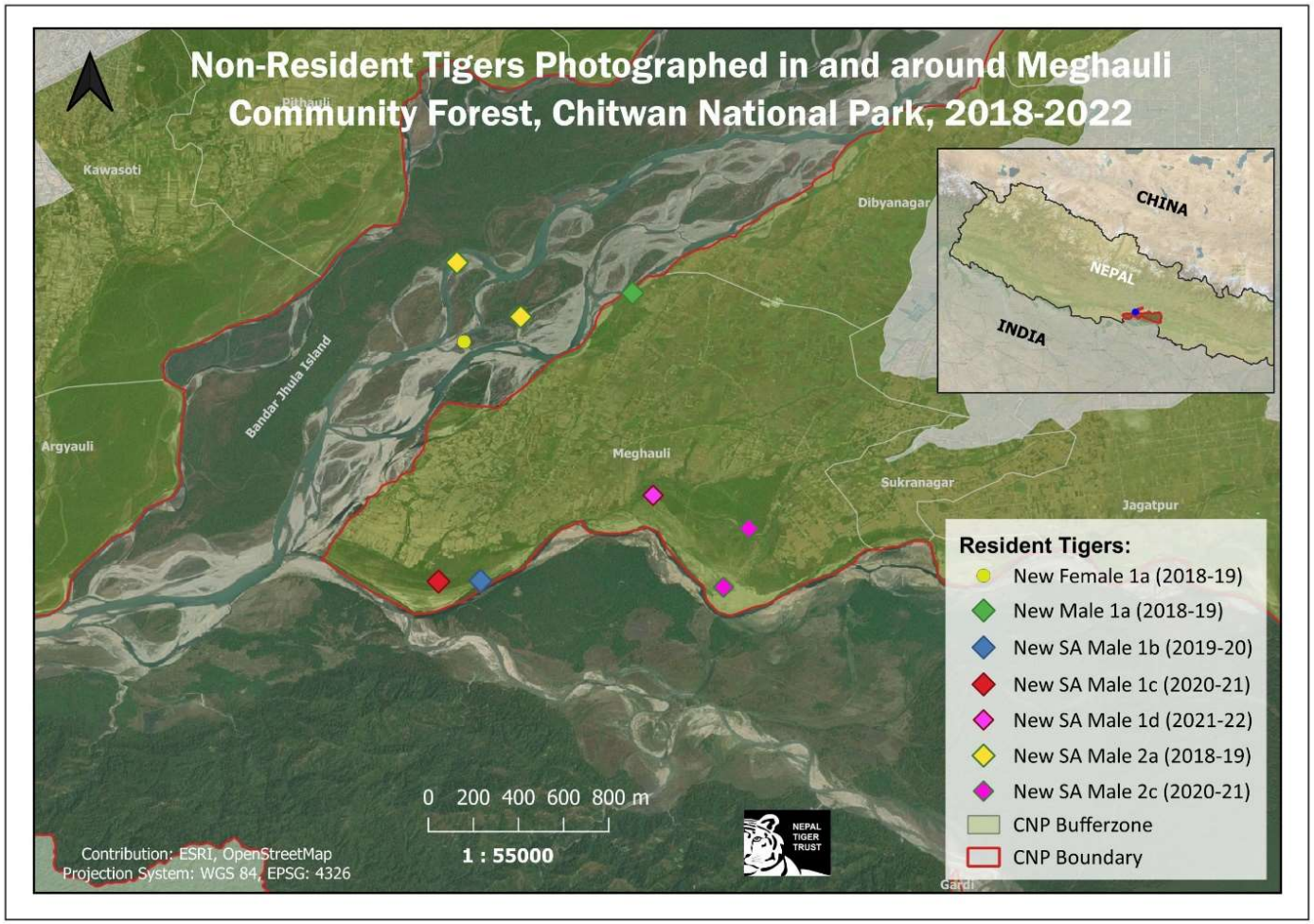

Figure 3: Non-resident tigers photographed during 2018-2022 camera trapping season in Meghauli Buffer Zone Community Forests, Chitwan National Park, Nepal.

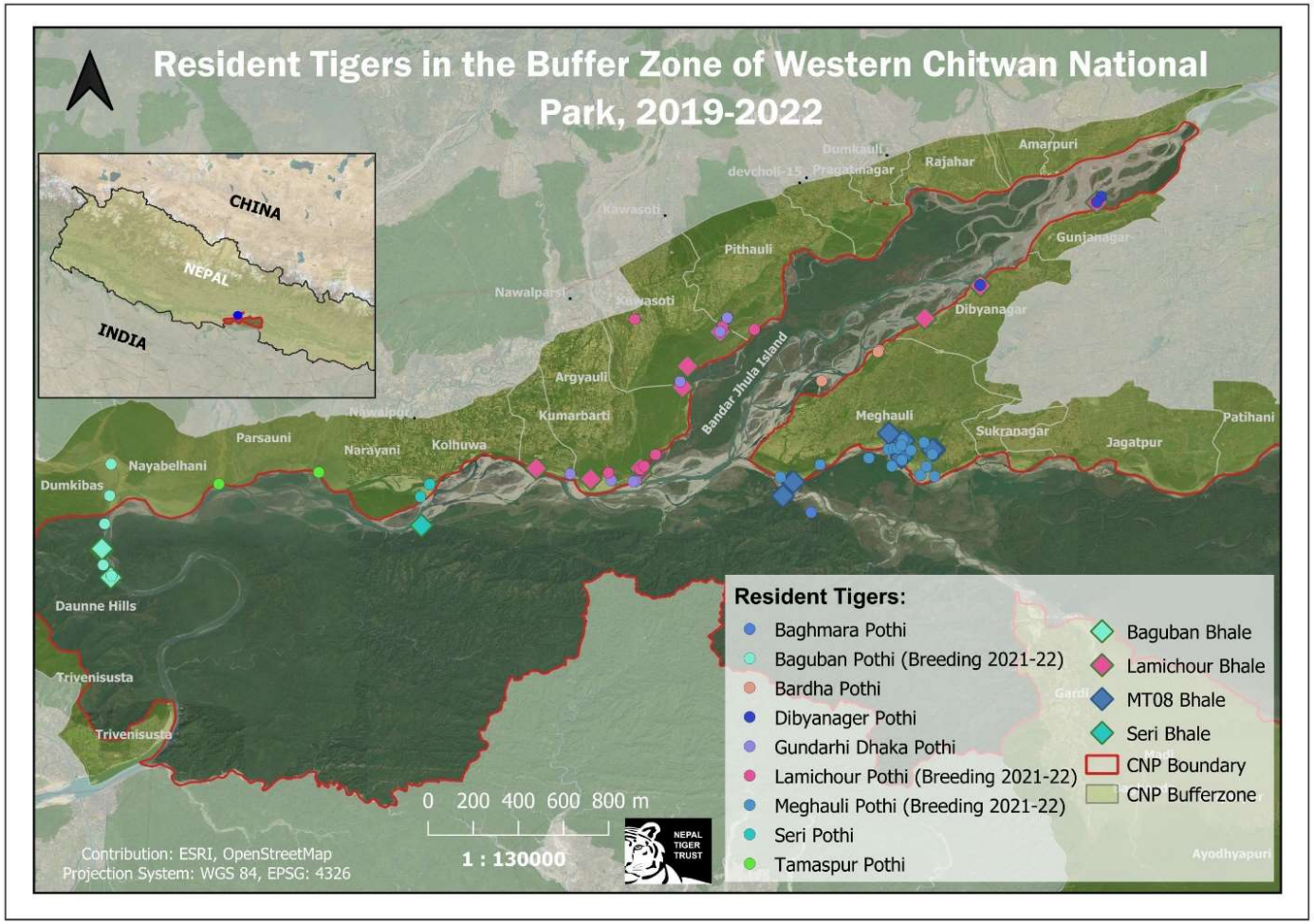

Figure 4: Breeding resident tigers pugmark surveyed during 2019-2022 season in the buffer zone of western Chitwan National Park, Nepal.

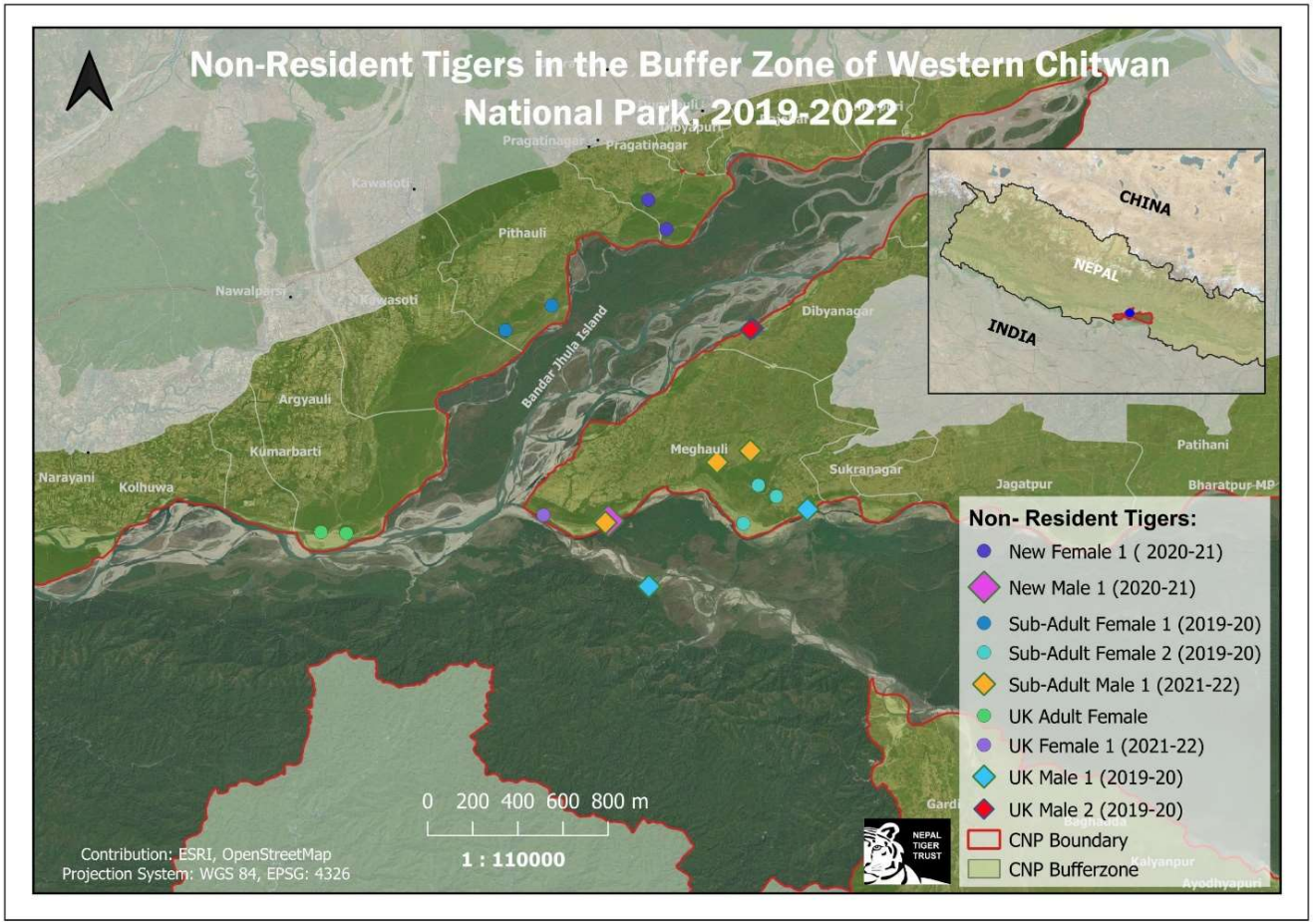

Figure 5: Non-resident tigers pugmark surveyed during 2019-2022 season in the buffer zone of western Chitwan National Park, Nepal.

APPENDIX - Photos

RESIDENT TIGERS PHOTOGRAPHED AT MEGHAULI BUFFER ZONE COMMUNITY FORESTS DURING 2018-22.

Appendix 1 (a): Baghmara Pothi photographed during 2018-19 & 19-20 seasons

Appendix 1 (b): Meghauli Pothi photographed during 2018-19 and all seasons

Appendix 1 (c): Jamuna Pothi photographed during 2018-19 season

Appendix 1 (d): Bardha Pothi photographed during 2018-19 & 20-21 seasons

Appendix 1 (e): MDP Pothi photographed during 2019-20 and all seasons

Appendix 1 (f): MT08 Bhale photographed during 2020-21 and all seasons

Appendix 1 (g): Kamal Bhale photographed during 2018-19 season

PREY AND OTHER ASSOCIATED SPECIES PHOTOGRAPHED IN MEGHAULI BUFFER ZONE COMMUNITY FORESTS DURING 2018-22.

Appendix 1 (h): prey and other associated species photographed during 2018-22


STEALTH CAM
00:11 29/05/20 95F KK G 6B


STEALTH CAM
08:02 02/01/21 46F G G 4A


STEALTH CAM
11:30 29/09/21 91F P G 2 B


65F 12/26/2020 05:06PM SBG 5B


STEALTH CAM
21:51 30/09/21 78F P G 2 B