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No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti,
Coimbatore, Tamil Nadu 641035, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

continued on the back inside cover

Caption: Caracal *Caracal caracal* in Ranthambore National Park, India. © Dharmendra Khandal

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EDITORIAL

Foreword to the third special issue on small wild cats

Angie Appel [1] & Shomita Mukherjee [2]

[1] Wild Cat Network, 56470 Bad Marienberg, Germany.
[2] Salim Ali Centre for Ornithology and Natural History, Anaikatty, Coimbatore, Tamil Nadu 641108, India.
[1] angie@wildkatze.org (corresponding author), [2] shomitam@gmail.com

We are delighted to present the third special issue on small wild cats in the Journal of Threatened Taxa. The authors of this special issue worked on seven small wild cats in eight countries and provide important updates on their distribution, behaviour, and their plights.

Two contributions focus on the Caracal *Caracal caracal*, one of Asia's most neglected cat. One accounts of the Caracal in India, where its range has been shrinking to just a fraction of its historical range at the turn of the 20th Century. The other reports a promising locality record, the first in the United Arab Emirates since the mid 1980s.

Asia's smallest cat, the Rusty-spotted Cat *Prionailurus rubiginosus*, motivated three author teams to share their camera trap and sighting records in northwestern India. If you ever encounter kittens in the field, make sure to read the recommendations about rescues and reunions with their mothers!

The Fishing Cat *Prionailurus viverrinus* revisited: multiple records obtained for the first time in far-western Nepal indicate that the population along the Nepal-India border is likely to be contiguous. The authors emphasize that transboundary wildlife corridors are essential to maintain the connectivity between Fishing Cat population units in this water-rich area.

Rescued from wildlife trade in Bolivia: an Andean Cat *Leopardus jacobita* provided the first opportunity to study its physiological and morphological condition while nursed in captivity. When healthy again, it was released into its natural habitat.

Caught in a cage trap: a Guigna *Leopardus guigna* showed up in an evergreen forest in far southern Argentina. This locality record will hopefully spur further surveys to increase the knowledge about the conservation needs of South America's smallest cat.

The Sunda Clouded Leopard *Neofelis diardi* in southwestern Borneo: the longest-running camera trap survey unveiled some facets of the behaviour of this cryptic cat. The authors stress on the importance of long-term monitoring to answer questions essential for planning conservation measures.

Sadly, the Clouded Leopard *Neofelis nebulosa* is the only cat, which does not make a live appearance in this issue. The authors provide crucial information on illegal trade of its skins in Nepal.

The authors of the three special issues covered work on 18 small wild cats living in 17 countries. These special issues are an ideal platform for sharing information that is crucial for planning further research and identifying conservation measures.

We thank the following people for reviewing the submitted manuscripts in this special issue: David Mallon, Andrew Spalton, Dharmendra Khandal, Jimmy Borah, Yadvendradev Jhala, André da Pinto Silva, Hem Baral,

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Meraj Anwar, Cynthia Widmer, Jane Hopper, Jayanta Kumar Bora, Prachi Thatte, Irene Sacristán, Ricardo A. Figueroa, Muhammad Kabir, Aditi Mukherjee, Nicolás Gálvez Robinson, Steven Platt, Wanlop Chutipong, Lonnie Grassman, N.V.K. Ashraf, Marcus Chua, Will Duckworth, Wyatt Peterson, Maximilian Allen, Chris Shepherd, Jayasilan Mohd-Azlan, Mariya Gritsina, Heiko Wittmer, Ugyen Penjor, Bopanna Ittira Ponnappariya, Sahil Nijhawan, Priya Singh, Jennifer McCarthy, and Sangeeta Chaudri.

We thank Dharmendra Khandal for providing the cover image of a Caracal in Ranthambhore Tiger Reserve, Rajasthan.

The enthusiasm of the authors who contributed to this issue will hopefully inspire you to share your experiences and endeavours in the world of small wild cats as well. Stay fascinated!!

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REVIEW

Historical and current extent of occurrence of the Caracal *Caracal caracal* (Schreber, 1776) (Mammalia: Carnivora: Felidae) in India

Dharmendra Khandal [1], Ishan Dhar [2] & Goddilla Viswanatha Reddy [3]

[1,2] Tiger Watch, Maa Farm, Ranthambhore Road, Sawai Madhopur 322001, Rajasthan, India.
[3] Rajasthan Forest Department, Aranya Bhavan, Jhalana Doongri, Jaipur 302004, Rajasthan, India.
[1] dharmkhandal@gmail.com, [2] dhar.ishan@gmail.com (corresponding author), [3] gvreddy.rajforests@gmail.com

Abstract: This article focuses on the historical and current extent of occurrence of the Caracal *Caracal Caracal* in India between 1616 and April 2020. We collated 134 reports during this period. Historically, the Caracal was reported in 13 Indian states in nine out of 26 biotic provinces. Since 2001, the Caracal's presence has been reported in only three states and four biotic provinces, with only two possible viable populations. Before 1947, the Caracal was reported from an area of 793,927km2. Between 1948 and 2000, the Caracal's reported extent of occurrence in India decreased by 47.99%. From 2001 to 2020, the reported extent of occurrence further decreased by 95.95%, with current presence restricted to 16,709km2, less than 5% of the Caracal's reported extent of occurrence in the 1948–2000 period.

Keywords: Camera trapping, habitat reduction, historical reports, Gujarat, Madhya Pradesh, Rajasthan, small wild cat.

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Funding: None.

Competing interests: The authors declare no competing interests.

Author details: Dharmandra Khandal, Ph.D. has served as conservation biologist with Tiger Watch since 2003. His work with Tiger Watch has involved groundbreaking initiatives in proactive anti-poaching, the monitoring of wildlife & research. He has also forged new frontiers in the world of community based conservation in the Ranthambhore Tiger Reserve. Ishan Dhar became associated with Tiger Watch when the Village Wildlife Volunteer Program commenced in 2015 and has been an active participant in Tiger Watch conservation interventions ever since. He has served on Tiger Watch's Board of Directors since 2017.He has co-authored a book on the Village Wildlife Volunteer program titled Wildlife Warriors. G.V. Reddy, Ph.D., PCCF (Retd.) retired as Head of Forest Forces in the Rajasthan Forest Department in October 2020. He has previously served as DCF, Ranthambhore National Park where his interventions saw the revival of tiger populations and he was also the only forest officer to accompany US President Bill Clinton in the National Park in 1999. He has also served on deputation to the Aceh Forest and Environmental Project in Indonesia.

Author contribution: Dharmendra Khandal—collation of reports, provision of photographs and preparation of text and maps. Ishan Dhar—collation of reports and preparation of text. G.V. Reddy—provision of reports, preparation of text and maps.

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INTRODUCTION

The Caracal *Caracal caracal* is among the most widespread of small wild cats, distributed across at least 20 million km^2 including 42 African and 18 Asian countries (Avgan et al. 2016). The oldest report of the Caracal in the Indian subcontinent is a fossil from the Indus Valley Civilization dating to 3000–2000 BCE (Ghosh 1982). In Asia, the Caracal's historical range overlaps with small ungulate species such as Blackbuck *Antilope cervicapra* in India (Sunquist & Sunquist 2002) and Chinkara *Gazella bennettii* in Iran and India (Sunquist & Sunquist 2002; Farhadinia et al. 2007; Ghoddousi et al. 2009; Moqanaki et al. 2016). The Caracal is known to inhabit the drier parts of India (Kitchener 1991; Corbett & Hill 1992; Nowell & Jackson 1996). Knowledge of its conservation status, however, is largely outdated, especially for the Asian populations (Moqanaki et al. 2016).

The Caracal has a long and unique history with humans in Asia where it was valued for its litheness and ability to catch birds in flight (Vigne 1842; Lydekker 1907; Sunquist & Sunquist 2002). The Caracal's iconic large black ears with long tufts of hair at the tips are emphasized in its name, which originates in the Turkish word 'Karakulak', meaning 'Black Ear' (Buffon 1761). In India, it is vernacularly known as 'Siya Gosh', a Persian name meaning 'Black Ear' (Harting 1883). A Sanskrit fable accounts of a small wild cat named Dirgha-karan or 'long-eared' preying on a bird's chicks (Capeller 1891; Arnold 1893). This cat might be a Caracal. The Sanskrit name 'sas-karan' meaning 'rabbit-like ears' was proposed by Vira et al. (1953) in an attempt to establish a Sanskrit nomenclature for the fauna of India, Myanmar and Sri Lanka following the Linnaean system of classification.

In India, the Caracal was used as a coursing animal during the period of the Delhi Sultanate in the late medieval period (Divyabhanusinh 1993; Verma 1994; Thapar et al. 2013). In the 14th Century, Firuz Shah Tughlaq was thought to have established a provision called 'Siyah-Goshdar Khana' solely dedicated to the maintenance of large numbers of coursing Caracal (Verma 1994). The Third Mughal Emperor Akbar furthered the reputation of the Caracal as a coursing animal and used it extensively for coursing (Blochmann 1873). It was also represented in illustrated simplified Persian adaptations of texts sourced from Sanskrit, Turkic and Arabic literature such as Anvar-i-Suhayli, Tutinama, as well as Persian poetry and epics such as Khamsa-e-Nizami and Shahnameh (Maurice 1953), which are full of wildlife fables. The Caracal's historical use as a coursing animal might have taken it far beyond its natural range in places like the Ladakh region in the Himalaya (Pocock 1939) along with Calcutta in West Bengal (Brandon-Jones 1997).

The Caracal in India has been considered rare in the wild since at least 1671 (Foster 1924, 1926), and several naturalists commented on its rarity (Hamilton 1727; Blyth 1842; Stoliczka 1872; Jerdon 1874; O'Malley 1909; Allen 1919; Sharma & Sankhala 1984a). We think that its rarity may be explained by the economic development of India. The country is primarily an agrarian economy, with 70% of the human population living in rural areas (Chand et al. 2017). In the 20th Century alone, India's human population grew six-fold, which along with economic growth resulted in the total forest area decreasing from 1,000,000–810,000 km^2 (Tian et al. 2014). Agricultural land in India increased from 1,000,000–1,200,000 km^2 between 1880 and 1950 (Tian et al. 2014). Approximately, 200,000km^2 of grassland and shrub land, along with 260,000km^2 of forests are estimated to have been converted for agricultural use from 1880 to 2010 (Vanak et al. 2017).

Landscapes in India have significantly been transformed by such anthropogenic factors. Against the backdrop of these large-scale changes, we consider it important to examine the change in the extent of occurrence of the Caracal in India. The prevalence of coursing Caracal historically along with the seemingly elusive behaviour of wild Caracal makes this a challenging endeavour.

We collated all credible reports of the Caracal in India from the beginning of recorded history until April 2020, mapped its historical range and assessed changes in its present extent of occurrence.

Study area

Historical sites with Caracal reports were spread across northwestern and central India to the states of Jharkand and Odisha in the east. This region contains four biogeographic zones with 10 biotic provinces (Table 1; Rodgers et al. 2002). The climate in this region is dominated by the south-west Asian monsoon with rain falling in the months of June to September (Prakash et al. 2015). During this season, the mean annual rainfall varies from 100–500 mm in the Thar Desert (Roy & Singhvi 2016) and increases eastwards to over 1,300mm (Prakash et al. 2015). Mean annual temperatures range from 3–10°C in the cold season to 45–50°C in the hot season (Roy & Singhvi 2016). It also must be stated that the international border between India and Pakistan passes through the states of Rajasthan, Gujarat, and Punjab. Permanent fencing began in the 1980s and has now almost been completed (Gupta 2018). Thus, while

Table 1. Biogeographic zones and biotic provinces in northern, western, and central parts of India described by Rodgers et al. (2002)

Biogeographic zone	Biotic provinces	Main characteristics
7: Gangetic Plain	7A: Upper Gangetic Plain in Uttar Pradesh and southern Uttarakhand 7B: Lower Gangetic Plain in Bihar and Bengal	River basin with alluvial barriers
4: Semi-arid	4A: Semi-arid Punjab Plains in Punjab, Haryana, Delhi, and a pocket of northeastern Rajasthan 4B: Semi-arid Gujarat Rajputana in Rajasthan, Gujarat and northwestern Madhya Pradesh	Discontinuous xerophytic vegetation cover with open areas of bare soil due to reduced ground and surface water
3: Desert	3A: Thar Desert in Rajasthan 3B: Kutch Desert in Gujarat	Sand dunes Salt marshes with flooded grasslands towards the coast of the Arabian Sea
6: Deccan Peninsula	6A: Central Highlands in Madhya Pradesh, southern Uttar Pradesh, pocket of southwestern Bihar, northwestern Chhattisgarh and pockets of northern Maharashtra 6D: Central Plateau in Maharashtra, northern Karnataka, Telangana, and a pocket of northern Andhra Pradesh 6B: Chotta Nagpur in Jharkhand, southern Bihar, northern Odisha, a pocket of West Bengal, and northeastern Chhattisgarh 6C: Eastern Highlands in Chhattisgarh, Odisha, and Andhra Pradesh	Tropical dry and moist deciduous forests

the border was not always an obstacle for the movement of wildlife, it has certainly evolved into a substantial obstacle.

Camera trapping was conducted in the peripheries of Ranthambhore Tiger Reserve and National Chambal Sanctuary, in Sawai Madhopur District and Dholpur Reserve Forest, all located in Rajasthan.

MATERIAL AND METHODS

Survey on literature, specimens in collections and interviews

We searched for literature about wild Caracal in India from the start of recorded history to 2020 including the writings of credible authors such as naturalists, zoologists, natural historians, historians, forest officers, gazetteers, chroniclers, erstwhile royalty, and army officers. Literature was sourced online and in the libraries of the India International Centre, Maharaja Fatehsinghrao Gaekwad Library at the WWF-India secretariat and at the Indira Gandhi National Centre for the Arts, all in New Delhi; and in the library of University of Rajasthan in Jaipur. Literature was also provided by Valmik Thapar, Divyabhanusinh Chavda, and Satish Sharma.

We examined Caracal specimens deposited at the Bombay Natural History Society (BNHS), Zoological Survey of India (ZSI), the Natural History Museum in London, private trophy collections in India, and other museums. We also conducted open-ended interviews with forest officers and biologists who observed the Caracal in the field and people who provided photographs.

We assessed the reliability of the information obtained and categorized reports into:

A confirmed reports based on tangible evidence like photographs, specimens including animal carcasses or body parts that can be accessed currently;

B confirmed reports based on direct sightings of live or dead individuals, specimens submitted to museums that are no longer accessible or missing, photographic reports that are no longer accessible, destroyed or missing;

C confirmed reports that indicate Caracal occurrence through species specific information which includes species description and the provision of distinct vernacular names;

D unconfirmed or questionable reports without any accompanying description, photos or erroneous description.

Reports of captive or coursing Caracal are strictly not included as their wild origins are unknown unless explicitly stated.

Camera trapping

Regular camera trapping using Cuddeback X-ChangeTM 1279 models was carried out in selected sites on the peripheries of Ranthambhore Tiger Reserve by the NGO Tiger Watch Ranthambhore and Rajasthan Forest Department under the Village Wildlife Volunteer Program since 2015 (Dhar & Dhakad 2018; Parashar

2020). Camera trapping is carried out each year by trained villagers for monitoring Tiger *Panthera tigris* and other wildlife outside the protected area. The average distance between camera traps is 2km, which we consider as one single complex. The camera traps are placed on forest paths, human trails and dry riverbeds where the opportunity to report wildlife was considered optimal. Camera traps were placed at a height of 45–47 cm above ground and were usually mounted on trees or tree stumps on one side of trails. Geo-coordinates of these locations were determined using Garmin GPS eTrex 10. Trained village wildlife volunteers checked the camera traps daily. Due to the movement of people, camera traps are deployed from 17.00h to 07.00h, making most of the detections nocturnal. In December 2015, 10 cameras were operational with 310 camera trap nights. Between 2016 and April 2020, 50 camera traps were active in various locations throughout the year, resulting in a total of 79,310 camera trap nights. Camera traps are fixed at 30 locations, while additional camera traps are deployed when required for situations like a Tiger moving out of the protected area or at the request of the Rajasthan Forest Department.

Extent of occurrence maps

To account for international boundary changes that have occurred in the region, we sorted the collated information into three categories. The first category entails all reports from undivided India until 1947. The second category excludes Pakistan and entails reports from 1948 to 2000. Both categories are considered historical reports. The third category comprises contemporary reports from 2001 to April 2020, a time period when camera trapping and photography of wildlife became more common and resulted in the availability of authentic information.

Coordinates of each report were plotted using ARC GIS 10.3 where possible. If it was not possible to determine coordinates, then the centre of the province, principality or state was plotted. We visited all locations in the third category to gather data on habitat types and water sources. The geotagged locations were used to build extent of occurrence maps in QGIS 3.12 Bucuresti version and are also shown on a map of the Biogeographic Classification of India by Rodgers et al. (2002).

The outermost geotagged locations on the map were connected to plot a minimum convex polygon. More than 50 locations in a protected area (PA) are comprised in a single polygon, so that the entire PA formed one geotagged polygon on the map and is represented by digits on both the table and the map. Multiple locations within the polygon are represented by Roman numerals in tables. Geotagged locations outside PAs in the same district were marked separately on the maps.

RESULTS

Historical reports until 2000

We found a total of 89 reports of the Caracal from 1616 to 2000 during our literature review, including 36 reports until 1947 (Table 2; Figure 1) and 53 reports from 1948 until 2000 (Table 3; Figure 2). These reports are from 13 states, viz Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, Punjab, Haryana, Delhi, Maharashtra, Jharkhand, Chhattisgarh, Odisha, Andhra Pradesh, and Telangana. In five regions, exact locations were unclear for the period before 1947 so that we used geographic centres including locations in Kutch, Gujarat (Stoliczka 1872), Chutia (Chota) Nagpur Division (Ball 1874), Kathiawar, Gujarat (Rice 1884), Northern Circars (Jerdon 1874) and South Punjab (Rose et al. 1908).

Historical reports of the Caracal from 1616 to 1947 extend over an area of 839,398km^2 (Figure 1), including an area of 45,471km^2 in Pakistan. If we subtract the area in Pakistan, the area within India's current borders extends over 793,927km^2. Reports from1948 to 2000 extend over an area of 412,877km^2 (Figure 2).

Caracal specimens in collections

We found 13 Caracal specimens in collections (Table 4). Six of these specimens are known to have originated in Rajasthan, Gujarat, Madhya Pradesh, and Uttar Pradesh. While the Bombay Natural History Society (BNHS) had eight Caracal specimens in its collection from 1888 to 1907, only two of them remain today (Curator, BNHS in. litt. 2019).

Records from 2001 onwards

We obtained authentic Caracal records between 2001 and 2020 in Rajasthan (Table 5), Gujarat (Table 6) and Madhya Pradesh (Table 7). These records are mapped in Figure 3.

a. The Caracal in Rajasthan: All districts with Caracal records in Rajasthan are located in the Aravalli Hill range or the Vindhyan Hill range, except one in Bharatpur. The eastern and southern parts of Rajasthan are bounded by the Vindhyan Hill range. The Caracal was reported in 10 districts, viz, Sawai Madhopur, Karauli, Dholpur, Bharatpur, Alwar, Chittorgarh, Pratapgarh, Udaipur, Pali, and Rajsamand (Figure 3). Photographs were obtained in the districts of Sawai Madhopur, Karauli, Dholpur,

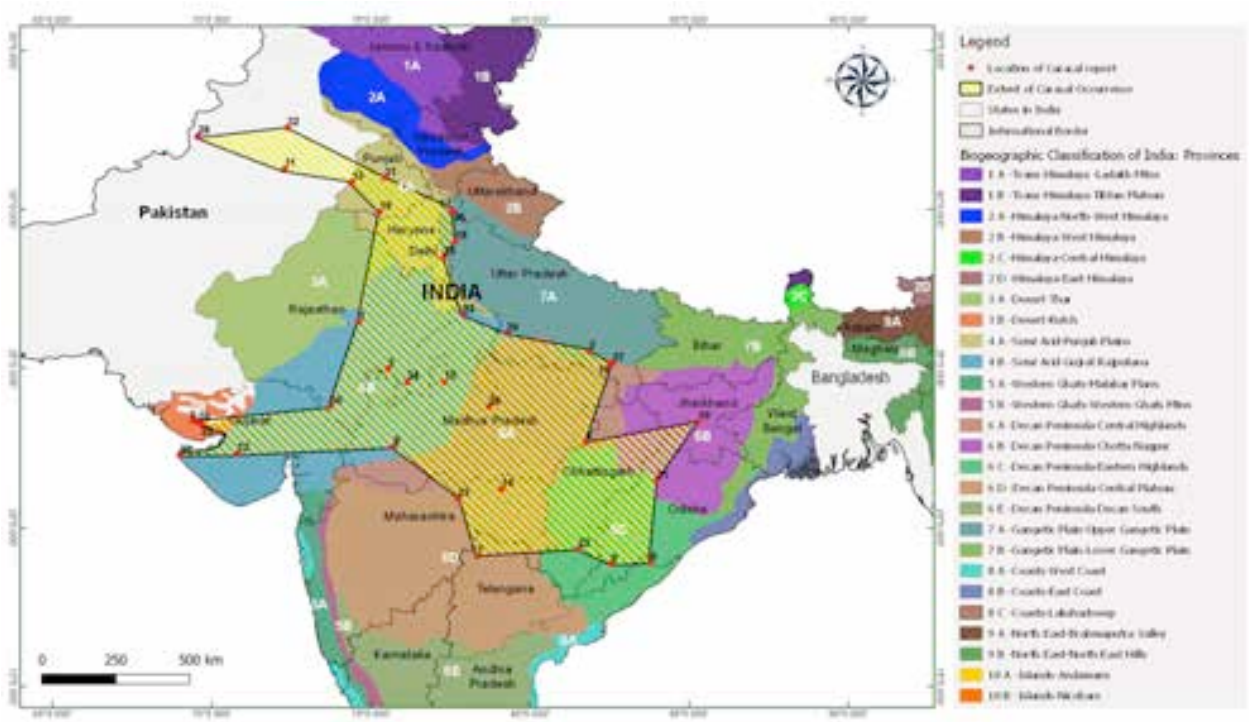

Figure 1. Caracal reports in India from 1616 to 1947.

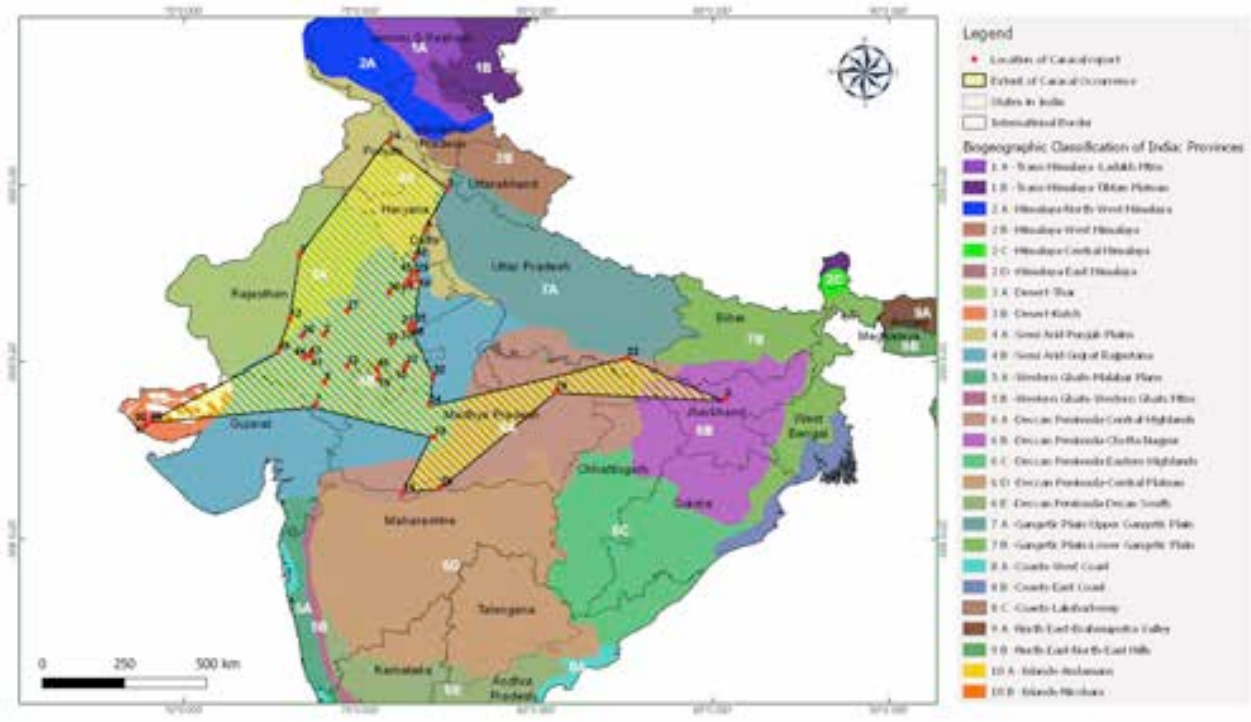

Figure 2. Caracal reports in India from 1948 to 2000.

Bharatpur, and Alwar. Outside PAs, the Caracal was reported in the districts of Sawai Madhopur, Dholpur, Udaipur, Alwar, and Pratapgarh, with most reports in Udaipur District (Figure 3).

The village wildlife volunteers obtained 176 camera trap pictures of the Caracal between 2015 and April

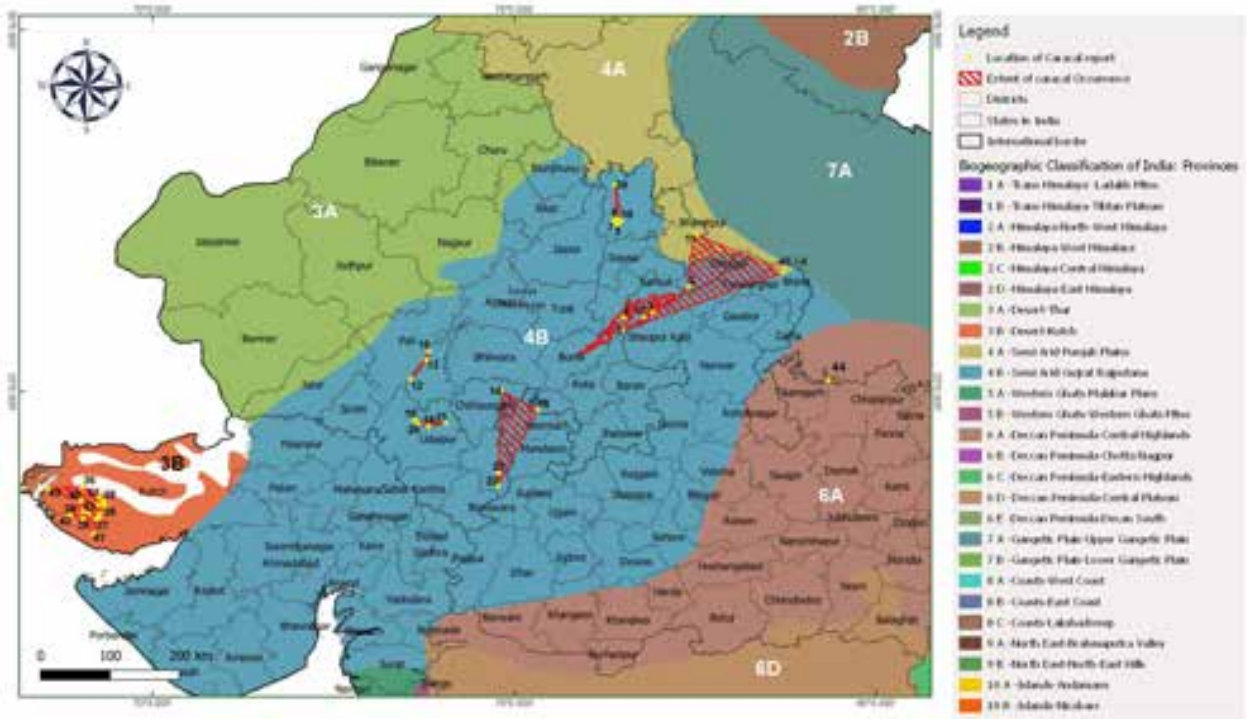

Figure 3. Caracal reports in India from 2001 to April 2020.

2020 at 23 locations, clubbed into six different areas in and around Ranthambhore Tiger Reserve (Table 5).

b. The Caracal in Gujarat: We found 19 reports of the Caracal in the state of Gujarat, all in the Kutch District. Nine of these reports are authenticated by photographs (Table 6).

c. The Caracal in Madhya Pradesh: We traced three Caracal reports in Madhya Pradesh at two locations (Table 7). Since none of these reports are supported by photographic evidence, they are category B accounts.

DISCUSSION

Our collation of literature revealed that knowledge of the Caracal's presence in India until the end of the 19th century was based on just 17 locality reports. The locations of these reports are scattered over the states of Rajasthan, Delhi, Haryana, Punjab, Gujarat, Madhya Pradesh, Uttar Pradesh, Maharashtra, Andhra Pradesh, Telangana, Odisha, Jharkhand, and Chhattisgarh. It is possible that the rarity of reports was the reason for early naturalists assuming that the Caracal is rare in India. The Caracal's historic range in India is very putative, as many reports are not supported by photographic evidence and can, therefore, neither be corroborated nor used to draw inferences. Although Jerdon (1874) reported to have obtained specimens in Odisha and northern Andhra Pradesh, Blanford (1888–91) and Lydekker (1907) assumed that its presence is limited to northwestern and central India. Examination of literature on rock painting sites in Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh revealed no clues on the Caracal, and hence there is no pre-historic report (Chakravarty & Bednarik 1997; Wakankar 2005, 2008; Saleem 2014; Sharma 2014; Gupta 2019).

Reports of the Caracal until the end of the 20th Century increased four-fold, indicating that the extent of the Caracal's occurrence putatively stretched over an area of 1,040,598km^2 in 13 states and nine biotic provinces. After 2001, its presence has been documented in just three states until April 2020.

According to Mukherjee (1998), the Caracal occurred in five biotic provinces in India, viz, 3A: Thar Desert, 3B: Kutch Desert, 4B: Semi-arid Gujarat Rajputana, 6A: Central Highlands and 6D: Central Plateau of the Deccan Peninsula. From our collation of reports starting in 1616, the Caracal was reported from four more biotic provinces in addition to those listed by Mukherjee (1998). These are 4A: Semi-arid Punjab Plains, 7A: Upper Gangetic Plain, 6B: Chotta Nagpur and 6C: Eastern Highlands in the Deccan Peninsula.

Authenticated reports supported by specimens and photographs are from 4B: Semi-arid Gujarat Rajputana,

Table 2. Chronology of Caracal reports in India until 1947.

No. on map	Date	Location	Report details	Source
1	1616	Ajmer, Rajasthan	Mughal Emperor Jahangir hunted a Caracal	B Thackston (1999); Thackston pers. comm. 2019
2	14.xi.1831	Phaphamau satellite township of Prayagraj, Uttar Pradesh	Caracal caught on the grounds of the circuit bungalow, a rest house. Parks (1850) was also acquainted with a captive Caracal owned by William Gardner.	B Parks (1850)
3	15.iv.1852	Bhainsrorgarh, Rajasthan	Saw a large Lynx (Caracal)	B Rice(1857)
4	1862–1864	Amarkantak, Madhya Pradesh	Hunted a Caracal. The Caracal was shot down from a tree at night and severely injured Forsyth's pack of hunting dogs, making it unlikely to be a case of mistaken identity with a Jungle Cat, which Forsyth (1889) separately identified.	B Forsyth (1889)
5	~1872	Kutch, Gujarat	Observed the Rao of Kutch hunting a Caracal	B Stoliczka (1872)
6	~1874	Northern Circars, Andhra Pradesh and Odisha	Caracal sighted or collected	B Jerdon (1874)
7	~1874	Neermul Jungle, Telangana	Caracal sighted or collected	B Jerdon (1874)
8	~1874	Mhow, Madhya Pradesh	Caracal sighted or collected	B Jerdon (1874)
9	~1874	Jeypore – Koraput, Odisha	Caracal collected and sent to Edward Blyth	B Jerdon (1874)
10	~1874	*Chutia* (Chota) Nagpur Division	Seen a Caracal	B Ball (1874)
11	~1883–1884	Jhang, Punjab, Pakistan	Detailed description of presence in the region. Vernacular name *bar billa* provided.	B Punjab Government (1884)
12	~1884	Kathiawar, Gujarat	Wild Caracals observed hunting hares by William Rice. Almost a century later, Dharmakumarsinhji (1978) only mentioned coursing Caracals in an article on Kathiawar. Dharmakumarsinhji's omission of wild Caracals presumably caused natural historians like Ranjitsinh (2017) to report that the Caracal in Gujarat was found only in the Kutch region.	B Rice (1884)
13	~1887	Mumdot, Firozpur, Punjab	Missed a shot on a Caracal	B Newall (1887)
14	1888	Central Province, Maharashtra	Baker(1890) hunted a Caracal	B Baker (1890)
15	vii.1891	Goona (Guna), Madhya Pradesh	Caracal skull deposited by G.E. Money, Reg. no. 6056	A Sameer Bajaru, Assistant Curator, BNHS collection in litt. 2019; Phipson (1891)
16	1892	Mirzapur, Uttar Pradesh	Caracal attacked a worker; Caracal was killed and its skeleton submitted to BNHS. First report of a Caracal attacking a human in India	B Drake-Brockman (1892); MacDonald (1893)
17	Early 20th century	Saharanpur, Uttar Pradesh	Three Caracals shot in 20–30 years by J.C. Taylor and his brother. Taylor (1961) shot a Caracal that attacked him when he was 12 years old. Second report of an attack in India after Drake-Brockman (1892)	B Taylor (1961)
18	18.ii.1905	Khadir of Meerut, Uttar Pradesh	Smith and Parsons killed a Caracal	B Wardrop (1914)
19	~1908	South Punjab	Detailed description of presence in the region.	C Rose et al. (1908)
20	ix.1908	Jalaun District, Central Province, Uttar Pradesh	Caracal skin deposited at BNHS by L.R. Clarke	B Millard (1908)
21	~1909	Sambalpur, Odisha	Dogs killed a Caracal.	B O'Malley (1909)
22	~1909	Northwest Bastar, Chhattisgarh	Detailed description of presence in the region. Tribal people include the Caracal in their diet because they do not consider it to be a cat. First report of a Caracal being a food source for humans in India.	C De Brett (1909)

No. on map	Date	Location	Report details	Source
23	~1911	Amravati, Maharashtra	Detailed description of presence in the region. Vernacular name, *jhua* or *jhuva* distinct from that of the Jungle Cat provided.	C Fitzgerald & Nelson (1911)
24	~1912	Dhondsa, Kutch, Gujarat	Male Caracal skin	B Wroughton (1912)
25	~1912	Bhuj, Kutch, Gujarat	Female Caracal skin	B Wroughton (1912)
26	Christmas 1912	Sagar, Madhya Pradesh	A Caracal is hunted	B Maxwell (1914)
27	28.xii.1912	Mirzapur, Uttar Pradesh	Hunted a Caracal	B Allen (1919)
28	8.iv.1914	Wano, Waziristan, Pakistan	Caracal skin deposited at BNHS by F.L. Hughes, Reg. no. 6054	A Sameer Bajaru, Assistant Curator, BNHS collection in litt. 2019
29	~1920	Tughlakabad, Delhi	Burke (1920) noted that he received the measurement details of a Caracal hunted by Lieut. Watson in Tughlakabad	B Burke (1920)
30	~1923	Okha, Devbhumi Dwarka, Gujarat	Detailed description of presence in the region	C Desai & Clarke (1923)
31	~1923	Punjab	A male Caracal hunted	B Ward (1923)
32	~1928	Punjab Salt range, Pakistan	Shot a Caracal	B Stockley (1928)
33	1932–1933	Dholpur, Rajasthan	Seen a Caracal	B Waddington (1933)
34	1920–1930	Lotiya Jheer Jhalawar, Rajasthan	Head mount of a subadult Caracal in Prithivi Vilas Palace, Jhalawar, Rajasthan	A Mahijit Singh pers. comm. 2019
35	1935	Nara Magra hillock, very close to Udai Vilas Palace, Dungarpur, Rajasthan	One Caracal head mount displayed in the dining hall of Udai Vilas Palace, Dungarpur, Rajasthan	A Image 3
36	1940s–1950s	Saharanpur, Uttar Pradesh	Shot three Caracals in 20 years. Holdsworth (1960) shot a Caracal in Saharanpur while hunting junglefowl *Gallus* and was not aware of the identity of the killed cat. Later, in 1962 Holdsworth shot two cats on junglefowl beats, which he identified as Caracal using the book by Brander (1923).	B Holdsworth (1960, 1962)

Image 1. A coursing Caracal with its keeper on a bedstead. A sketch depicted in an 'Essay on Sport & Natural History' by Harting (1883).

Image 2. The turquoise eyed Caracal of Juna Mahal, Dungarpur, a fresco commissioned ca. 1808–1845 during the reign of Maharawal Jaswant Singh II. The Caracal is represented with accuracy with the exception of its lion-like tail. Note the tufted black ears and turquoise eyes. © Dharmendra Khandal

4A: Semi-arid Punjab Plains, 3B: Kutch Desert and 6A: Deccan Peninsula Central Highlands. As many of the historical records are without specimens or photographs, mistaken identification with the Jungle Cat is possible. Such misidentifications are common even today, with some faulty reports being perpetuated only because they are published, e.g., Gogate (1998).

Table 3. Chronology of Caracal reports from 1948 to 2000 in Indian national parks (NP), tiger reserves (TR), wildlife sanctuaries (WS) and outside protected areas (Figure 2).

No. on map	Date	Location	Report Details	Source
1	1948	Dungarpur, Rajasthan	Census carried out by Maharawal Lakshman Singh reported 38 Caracals	C Ranjitsinh (2017)
2	1–5.iii.1951	Satukhera (Satookhera) Block, Todgarh-Raoli Forest, Rajasthan	Keshav Sen Khaarwa hunted a Caracal	B Sharma (2015)
3	1954	Bikaner, Rajasthan	Saw a Caracal skin with a *Sansi* hunter who killed it in Bikaner and refused to sell the skin	B Prakash (1960)
4	1954–1958	Between Delhi and Rohtak, Harayana	Geoffrey C. Ward hunted a Caracal	B Ward & Ward (1993); Geoffrey C. Ward in litt. 2019
5	v.1955	Saharanpur, Uttar Pradesh	Caracal hunted by forest officer Srivastava.	B Srivastava (1959)
6	xii. 1956	Tamba Kan, Sariska TR, Rajasthan	Caracal cubs no older than 6-7 days captured; they died and their skins were identified by the ZSI in Calcutta	B Sharma & Sankhala (1984b)
7	xii.1956	Ajabgarh, Alwar, Rajasthan	Caracal spotted in grassy scrub land	B Sharma & Sankhala (1984a)
8	xii.1957	Hazaribagh NP, Jharkhand	Caracal seen	B Sen (1959)
9	1960	Kurabad, Udaipur	A Caracal shot by Raza Tehsin	B Satish Sharma in litt. 2020
10	30.i.1962	Amritkua Baran, Rajasthan	Caracal head mount	A Displayed in the Billiards Room of Umed Bhawan Palace Hotel, Kota, Rajasthan
11	v.1962	Sariska TR, Rajasthan	K. Rungta collected two Caracal cubs and raised them in Jaipur.	A Rungta (2017)
12	xi.1962	Jodhpur, Rajasthan	A ZSI scientist found a Caracal skin in a tanner shop in Jodhpur. The tanner told him it was killed by a *Bawri* hunter around Jodhpur in November 1962.	B Prakash (1994a)
13	1962–1963	Ajabgarh, Sariska TR, Rajasthan	Hunted a Caracal and photographed it	A Rungta pers. comm. 2019
14	1964	Burhanpur, Madhya Pradesh	Caracal sighted	B Ranjitsinh (2017)
15	1967	Sariska TR, Rajasthan	Seen a Caracal	B David (1967)
16	1967	Machedi Village, Alwar, Rajasthan	A mother Caracal with a cub seen by forest officer V.S. Saxena	B Satish Sharma in litt. 2020
17	1967	Kalighati, Sariska, Alwar, Rajasthan	A Caracal seen by forest officer V.S. Saxena	B Satish Sharma in litt. 2020
18	1970–1973	Ichhawar Range, Sehore District, Madhya Pradesh	Biologist Raghunandan S. Chundawat saw a Caracal cross the road and go into a teak forest	B Raghunandan S. Chundawat pers. comm. 2020
19	1970–1973	Gandhisagar WS, Madhya Pradesh	Biologist Raghunandan S. Chundawat saw a Caracal on foot, they flushed the Caracal from *Acacia* bushes in an overgrazed area. The Caracal ran away.	B Raghunandan S. Chundawat pers. comm. 2020
20	Unknown, before 1972	Teetarkheri Jhalawar, Rajasthan	A Caracal head mount in the possession of Vartol Jagirdar, Sabarkantha, Gujarat	A Satish Sharma pers. comm. 2019
21	1973	Ranthambhore TR, Rajasthan	A Caracal seen by forest officer V.S. Saxena	B Satish Sharma in litt. 2020
22	I.1975	Mirzapur, Uttar Pradesh	Two Caracal cubs collected and photographed by forest officer Ashok Singh. The photo of one of the cubs adorned the cover of *Cheetal*. Possibly the only photo of a Caracal from Uttar Pradesh.	A (Singh 1975)
23	~1975	Sangod Baran, Rajasthan	Caracal sighted	B Bharat Singh pers. comm. 2019
24	~1977–1979	Phagwara, Punjab	Caracal rescued from villagers who tried to beat it to death.	B Gurmit Singh pers. comm. 2019
25	v.1979	Buja, Sariska TR, Rajasthan	Caracal spotted in grassy plain in search light	B Sharma & Sankhala (1984a)
26	1980	Pali, Rajasthan	Five skins recovered thought to have been killed in Pali for skin trade	B Sharma & Sankhala (1984a)

No. on map	Date	Location	Report Details	Source
27	Unknown	Ajmer, Rajasthan	A Caracal killed by Daud Khan	B Sharma & Sankhala (1984a)
28	iii.1981	Shyamgiri Kalda Plateau, Madhya Pradesh	Skin of a Caracal poached by local people	B H.S. Pabla in litt. 2019; Shyamendra Singh pers. comm. 2019
29	ix1981	Sariska TR, Rajasthan	Caracal seen by zoologist J.H. Reichholf	B Stuart (1984)
30	~1982	Padam Talab, Ranthambhore TR, Rajasthan	Seen and photographed a Caracal	A Valmik Thapar in litt. 2020
31	xii.1982	Tehla, Sariska TR, Rajasthan	A dead Caracal collected by a forest officer	B Sharma & Sankhala (1984a)
32	Winter 1982	Chittorgarh, Rajasthan	Caracal caught and sent to Jaipur Zoo	B (Rungta 2017)
33	v.1983	Bodal Ranthambhore, Rajasthan	Caracal run over by a vehicle	B Sharma & Sankhala (1984a)
34	1982–1983	Road from Rajgarh to Narsinghgarh, 50–58 km distance, Rajgarh District, Madhya Pradesh	A Caracal road kill seen by biologist Raghunandan S. Chundawat.	B Raghunandan S. Chundawat pers. comm. 2020
35	11.iii.1984	Semli, Ranthambhore TR, Rajasthan	Caracal sighted by forest officer Fateh Singh Rathore	B Sharma & Sankhala (1984a)
36	1985	Ramsagar Talab, Nahargarh, Jaipur, Rajasthan	A Caracal poached for bushmeat (personal consumption) by a local poacher named Sultan Khan Second report of Caracals being consumed by humans in India after De Brett (1909).	B Raj Chauhan pers. comm. 2019
37	24.iv.1986	Between Sariska NP gate and Kalighati, Rajasthan	Caracal sighted	B Divyabhanusinh (1987)
38	1986	Melghat, Maharashtra	Caracal sighted	B Ranjitsinh (2017)
39	vi.1987	Luharpur Pipliya Manak Chok, Ramgarh Vishdhari WS, Bundi, Rajasthan	A Caracal sighted by forest officer P.K. Jain	B Satish Sharma in litt. 2020
40	1991	Jawda Nimdi, Chittorgarh, Rajasthan	A Caracal sighted by Shyam Singh Mahechha	B Harshvardhan Singh Mahechha pers. comm. 2020
41	1993	Modia, Kumbhalgarh WS, Rajasthan	Two adult Caracals seen by forest officer Parbat Singh	B Satish Sharma in litt. 2020
42	1994	Sirondh Kalan, Alwar, Rajasthan	A Caracal rescued from a well by forest officer B.M. Sharma	B Satish Sharma in litt. 2020
43	1994	Ghanerao, Desuri, Pali District, Rajasthan	Two adult Caracals seen by forest officer Parbat Singh	B Satish Sharma in litt. 2020
44	1994	Sadri Latada, Kumbhalgarh WS, Rajasthan	A single Caracal sighted multiple times by forest officer Parbat Singh	B Satish Sharma in litt. 2020
45	vii.1995	Sariska TR, Rajasthan	Observed a Caracal plucking feathers off a dead Peacock *Pavo cristatus*	B Shomita Mukherjee in litt. 2020
46	1996	Near Pat and Khanay Village, Naliya side, Kutch, Gujarat	A Caracal sighted by Dinesh Sharma and Bharat Jethva	B Bharat Jethva pers. comm. 2019
47	1997	Tera Village, Kutch, Gujarat	Seen a Caracal	B Bharat Jethva pers. comm. 2019
48	vi.1998	Malik Talab to Lakarda Road, Ranthambhore TR, Rajasthan	Observed a Caracal crossing the road	B G.V. Reddy pers. obs.
49	ii.1998	Takhatpura, tehsil and district Jalore, Rajasthan	Caracal sighted by Pradeep Singh	B Ranjitsinh (1999)
50	1998	Tera Village, Kutch, Gujarat	A Caracal feeding on a Cattle Egret *Bubulcus ibis*, photographed	A Dinesh Sharma in litt. 2020
51	1999	Ganeshdham, Ranthambhore TR, Sawai Madhopur, Rajasthan	Seen a Caracal crossing road at 21.00h	B Aditya Singh pers. comm. 2020
52	1999	Dhopchok, Ranthambhore TR, Sawai Madhopur, Rajasthan	Seen a Caracal	B Aditya Singh pers. comm. 2020
53	xi.1999	Guda-Lahpur road, Ranthambhore TR, Rajasthan	Caracal seen crossing road	B G.V. Reddy pers. obs.

Unconfirmed records of the Caracal

We found 33 reports that we categorised as unconfirmed.

Two originate in the Ladakh region of Jammu & Kashmir. The first is based on a drawing of a captive Caracal in Baltistan (Blyth 1842), and the second on a skin seen in a Srinagar shop by Ward (1923). Stockley (1928) and Pocock (1939) held the view that neither one is evidence for the Caracal's occurrence in the erstwhile state.

Ward (1923) also accounted of shooting a Caracal in western Dun, Uttarakhand. In a map showing the extent of occurrence of the Felidae in the western Himalaya, Sinha (1995) included the Caracal in Dehradun without providing any related information. This location matches with the account by Ward (1923). In view of Ward's earlier claim from Ladakh, we doubt the credibility of this account.

The British army officer Osborn claimed that a Caracal was sighted in the Kangra District of Himachal Pradesh in 1904 (Government of Punjab 1904; Dodsworth 1913). A purported specimen was submitted by Osborn to the museum of the BNHS in 1907 (Bell 1907). Considering that Osborn provided neither details of the sighting nor of the submitted specimen, it is possible that this could have occurred in an area either in or bordering modern day Punjab.

Two publications refer to the rarity of the Caracal in the erstwhile Madras Presidency. McMaster (1871) accounted of a Caracal presented by the Rajah of Karvetinagar to the people's park of Madras in September 1868, but did not clarify from where the Caracal originated. Thurston (1913) wrote that the Caracal or Red Lynx had become rare, but without providing information whether and where it was ever sighted or hunted in the region.

Briggs (1861) wrote about the presence of the Caracal in Surroo Nagar, currently in Telangana, but merely mentioned Lynx along with a host of other wildlife. The word 'Lynx' was at times also used for the Jungle Cat. Briggs (1861) neither provided a description nor information about a sighting.

Behura & Guru (1969) reported the occurrence of the Caracal in Mayurbhanj District on the basis of a newspaper article dating to 18 April 1962 (Acharjyo 1998). This report was further included in a ZSI publication by Das et al. (1993). Acharjyo (1998), however, conceded that no other reports of its occurrence in the state were known at the time, nor had the Nandankanan Zoo received a wild-caught individual from any part of Odisha.

Two reports of Caracals around the Ludhiana area of Punjab in 1977–79 are unconfirmed (Gurmit Singh pers. comm. 2019).

Parihar (1989) reported seeing a Caracal on the night of 16 March 1987 aided by a searchlight in the forests of Panna District in Madhya Pradesh. He acknowledged that the Jungle Cat is common there, but was certain that he saw the front and rear of a Caracal, although he "could not see the ear tuft" and described the tip of the tail being about 10cm long and darker than the rest of the tail. This description raises doubts, as Caracal tail length in India has been reported ranging from 17.5 to 29.9 cm (Blyth 1842; Jerdon 1874; Sterndale 1884; Allen 1919; Ward 1923; Prater 1948; Dharmendra Khandal pers. obs. 2019; Sonia Mondal in. litt. 2019). The tip of the tail measures approximately 1–2 cm with hair that is darker than the rest of the tail, but such hair is not present on the tails of all Caracals (Dharmendra Khandal pers. obs. 2019).

Parihar (1989) accounted of Ajit Sonakia, then

Image 3. Trophies of Indian wildlife are exhibited in the dining hall of the Udai Vilas palace in Dungarpur, including a head mount of a Caracal that was shot in 1935 on a hillock called Nara Magra very close to the palace. © Dharmendra Khandal

Director of Sanjay National Park having seen a Caracal near Raisen while driving at night from Bhopal to Sagar in Madhya Pradesh. Since this is not a first-person account and lacking specific details, it remains unconfirmed.

Desai (1974) included the Caracal in the list of animals in Gir National Park, and Singh (1998) claimed a sighting of a Caracal in tall grass in Saurashtra, Gujarat. Evidence of occurrence in both areas does not exist, despite regular camera trapping surveys today, and so we consider both reports unconfirmed. Chakraborty & Agarwal (2000) referred to 10 individual Caracals in Narayan Sarovar Chinkara Sanctuary listed in a report by Forest Department of Gujarat. This report is based on the annual waterhole census method for wild animals, which has serious limitations (Karanth & Ramaswamy 2006).

Two separate Caracal sightings were reported in the Dhakana and Gatang ranges of Melghat Tiger Reserve in Maharashtra (Gogate 1998). These were later proven to be Jungle Cats upon examination of photographic evidence (Shomita Mukherjee pers. comm. 2020).

Singh & Soni (1999) mentioned the presence of the Caracal in the salt pans of Wild Ass Sanctuary located in Little Rann of Kutch, Gujarat, based on local people's accounts. Singh & Soni (1999), however, stated to not have sighted a Caracal themselves. It must be added that the salt pans are a highly improbable habitat for the Caracal.

Kolipaka (2011) listed 11 sightings of the Caracal across India along with their purported GPS coordinates. The sources of these reports are not provided. Nine of the reports are verifiably non-specific. The errors in the locations listed and associated coordinates provided are significant, such as two different locations being presented as one, e.g., "Ranthambhore & Sariska" and "Sasaipura, Bhind". These errors make it impossible to verify the alleged sightings.

In 2015, whilst conducting a field survey in the Bagpat Reserve in the taluka of Nakhatrana in Kutch to assess the "Status and Distribution of Caracal in Gujarat", a team from the Gujarat Institute of Desert Ecology (GUIDE) claimed to have sighted a Caracal hiding 70–75 m away in a bush. The animal escaped before it could be photographed. The team, however, claimed that the animal left 'clear pugmarks for our confirmation' and provided a photograph of the pugmark with a pen placed next to it for size reference. They also surveyed the area for 10 more days but could not find the animal (Joshi et al. 2015). The length of the pen appeared to be 12–13 cm long, the average length of a pen. By comparison, the pugmark appeared to be 8–9 cm long, which is far too large for a Caracal. In an earlier update on the same survey, GUIDE provided the lengths of the right front pugmark and the right hind pugmark of a Caracal, presumably obtained in their survey, and these measured 4.7cm and 5.5cm respectively (Asrari et al. 2013-14). Skinner & Chimimba (2005) provide 5cm as the upper limit for the lengths of the right fore footprint and right hind footprint for southern African Caracals. We are, thus, of the opinion that the pugmark report is erroneous, and that the pugmark photographed was that of a Leopard.

Kazmi (2020) interpreted Sterndale (1884) to have reported "raising a young Caracal cub he had caught from the wild" in Seoni, Madhya Pradesh. In fact, Sterndale (1884) merely wrote that "They are easily tamed. I had a young one at Seonee and the natives of some parts are said to train them for sporting purposes in the manner in which the hunting leopard (read Cheetah) is trained". He did not explicitly state that this cub was 'caught from the wild' in Seoni itself. We are, therefore, of the opinion that the information by Sterndale (1884) is insufficient to draw a conclusion of the cub's origin.

Contemporary reports

Since 2001, the Caracal was reported in only four biotic provinces, namely 3B: Kutch Desert, 4B: Semi-arid Gujarat Rajputana, 4A: Semi-arid Punjab Plains, and 6A: Central Highlands in the Deccan Peninsula (Figure 3). Judging by historical and contemporary reports, 4B: Semi-arid Gujarat Rajputana seems to be the stronghold for the Caracal. The biotic province 3B: Kutch Desert has more numerous reports in the current period than in the historical period. This is likely due to greater accessibility of this biotic province today than in the past. Very few historical records are known in 3A: Thar Desert, and no contemporary reports are known despite far greater access to this region today. Prakash (1994b) considered the Caracal to have been 'very common' in the Thar Desert in the beginning of the 20th Century. He, however, does not provide any evidence to validate this statement. The report from 4A: Semi-arid Punjab Plains is very close to the border with 4B: Semi-arid Gujarat Rajputana, and the report in 6A: Central Highlands is a stand-alone report with no photographic documentation. Therefore, it appears that Caracal populations existing in 4B: Semi-arid Gujarat Rajputana and 3B: Kutch Desert could be the only viable populations in India today. Nevertheless, more targeted surveys are needed in addition to the intensive camera trapping targeting the Tiger in 4B: Semi-arid Gujarat Rajputana. It must, however, be noted that the multiple

Table 4. Caracal specimens and trophy reports in private collections and museums.

Date	Location	Specimen details	Source
In private collections			
1920–1930	Lotiya Jheer Jhalawar, Rajasthan	Head mount of a subadult Caracal in the Prithivi Palace of Jhalawar, Rajasthan	Mahijit Singh pers. comm. 2019
1935	*Nara Magra* hillock, very close to Udai Vilas Palace, Dungarpur, Rajasthan	One Caracal head mount displayed in the dining hall of the Udai Vilas Palace, Dungarpur, Rajasthan	Dharmendra Khandal pers. obs. 14 November 2019 (Image 3)
Unknown, before 1972	Teetarkheri, Jhalawar, Rajasthan	Caracal head mount in the possession of Vartol Jagirdar, Sabarkantha, Gujarat	Satish Sharma pers. comm. 2019
Unknown	Possibly from Kota Baran area, Rajasthan	Two Caracal head mounts displayed in the billiard room of Umed Bhawan Palace Hotel, Kota, Rajasthan	Ravindra Singh Tomar pers. comm. 2019
30.i.1962	Amrit Kua, Baran, Rajasthan	One Caracal head mount displayed in the billiard room of Umed Bhawan Palace Hotel, Kota, Rajasthan	Ravindra Singh Tomar pers. comm. 2019
In the museum of BNHS			
vii.1891	Goona (Guna), Madhya Pradesh	One Caracal skull deposited by G.E. Money, Reg. no. 6056	Sameer Bajaru, Assistant Curator, BNHS collection in litt. 2019; Phipson (1891)
8.iv.1914	Wano, Waziristan, Pakistan	A Caracal skin deposited by Capt. F.L. Hughes, Reg. no. 6054	Sameer Bajaru, Assistant Curator, BNHS collection in litt. 2019
In the museum of Zoological Survey of India			
20.i.1876	Unknown	Caracal skull deposited by W. Rutledge, Reg. No. 133	Chakraborty (2004)
Unknown	Unknown	Preserved body of a female Caracal given by Zoological Garden Alipore to ZSI, Catalogue no. KS 3120	Sonia Mondal, ZSI, in litt. 2019
Unknown	Unknown	Full body of a female Caracal, Catalogue no. (10) 3372	Sonia Mondal, ZSI, in litt. 2019
Unknown	Unknown	Full body of a male Caracal, Reg. no. 7140	Sonia Mondal, ZSI, in litt. 2019
Unknown	Unknown	Skin of a Caracal deposited by W. Rutledge, catalogue no. 4137	Sonia Mondal, ZSI, in litt. 2019
In the Museum of Jaipur Zoo, Rajasthan			
Unknown	Unknown	Full body mount of a Caracal	Sudarshan Sharma in litt. 2019
Deposited in the museum of the BNHS but currently not in the possession of the museum			
May–June 1888	Unknown	One live Caracal deposited by F.D. Alexander	Phipson (1888)
March–April 1889	Unknown	One Caracal skin deposited by A. Spitteler	Phipson (1889)
1892	Mirzapur, Uttar Pradesh	Caracal skeleton deposited by H.E. Drake-Brockman	MacDonald (1893)
March 1893	Unknown	One live Caracal deposited by H. Parry	MacDonald (1893)
May 1907	Kangra Hills, Himachal Pradesh	One Caracal skin and skull deposited by Gen. W. Osborn	Bell (1907)
September 1908	Jalaun District,Uttar Pradesh	Caracal skin deposited by L.R. Clarke	Millard (1908)

Table 5A. Camera trap pictures of the Caracal in Rajasthan between 2015 and 2020 by village wildlife volunteers in ravine habitat (RH), Hilly Dhonk forest (HDF), Prosopis juliflora thickets (PjT), scrubland (SL), grassland (GL), Teak forest (TF), agricultural land (A), river (R), seasonal stream (SN), seasonal pond (SP), canal (C), lake (L), perennial stream (PN), perennial waterhole (PWH).

No. on map	Habitat type	Water source	2015	2016	2017	2018	2019	2020
1	RH	R	-	-	1	-	-	-
2	HDF	SN	-	-	-	-	-	4
3	RH	SN	-	-	-	-	3	-

A

Table 5B. Records around Ranthambhore Tiger Reserve, all A, including 12 locations near Ranthambhore National Park (4 I), five locations around Sawai Mansingh Sanctuary (4 II) and three locations around Kailadevi Wildlife Sanctuary (4 III)

4 I	RH, HDF	R, L, SN, PN	6	33	41	23	33	8
4 II	HDF	R, L, SN, PN	-	-	-	1	3	2
4 III	HDF	R, L, SN, PN	-	1	5	-	9	3
	Total		6	34	47	24	48	17

A

Table 5C. Observations of the Caracal in Ranthambhore Tiger Reserve.

No.	Date	Location	Habitat type	Water source	Type of report	Source
IV	27.v.2014	Kundal	SL/HDF	SN	Seen and photographed a Caracal	A Sunil Sarkar Game watcher Manas pers. comm. 2014
V	21.i.2014	Indala tiraya	HDF	SN	A male Caracal was feeding on a Chinkara, photographed	A Balendu Singh in litt. 2019
VI	05.v.2013	Indala	HDF	SN	A Caracal observed leaping towards a flock of doves, photographed	A Dharmendra Khandal pers. obs.
VII	2.i.2010	Padam Talab	HDF	L	Seen a Caracal, photographed	A Balendu Singh pers. comm. 2019
VIII	17.i.2010	Padam Talab to Rajbagh	HDF	L	A Caracal was seen and photographed	A Balendu Singh, Gobind Sagar Bhardwaj & Subhas Sharma in litt. 2019
IX	xi.2009	Berda	HDF	SN	A Caracal on a tree, photographed	A Soonoo Taraporewala in litt. 2019
X	xi.2009	Rajbagh	HDF	L	Few glimpses of a Caracal hiding in *Justicia adhatoda* bushes near the lake	A Dharmendra Khandal pers. obs. Photographed by Rahul Rao
XI	2.xii.2009	Bhoot Khora	HDF	SN	A Caracal photographed	A Salim Ali in litt. 2019
XII	16.vi.2009	Kachida	HDF	SN	A female Caracal with two subadult cubs observed for ~ 45–50 minutes feeding on a monitor lizard, photographed	A Dharmendra Khandal pers. obs.
XIII	29.i.2009	Bhoot Khora	HDF	SN	A female Caracal with cubs photographed	A Balendu Singh pers. comm. 2019
XIV	2009	Ranthambhore TR	HDF	L	Photographed a Caracal	A Singh et al. (2011)
XV	8.iii.2008	Rajbagh – Malik Talab Road	HDF	L	Caracal seen on a tree, photographed	A Aditya Singh in litt. 2020
XVI	xii.2006–xii.2009	Various locations in Ranthambhore Division of Ranthambhore Tiger Reserve	HDF	SN	Forest Department and WII team got 37 camera trap pictures in three years	A Singh et al. (2014)
XVII	6.vii.2004	Berda	HDF	SN	A female Caracal with two sub adult cubs photographed	A Margarita Steinhardt in litt. 2019
XVIII	vi.2001	Lahpur	HDF	SN	A Caracal was observed crossing the road	B G.V. Reddy pers. obs.
Kailadevi Wildlife Sanctuary, Karauli, part of Ranthambhore Tiger Reserve						
XIX	16.x.2016	Balaji Telai, Dangda	HDF	SP	A Caracal was observed	B Dharmendra Khandal pers. obs.
XX	15.x.2016	Balaji Telai Dangda	HDF	SN	Photographed a Caracal	A Dharmendra Khandal pers. obs.

photographic reports in the Kutch Desert are not from camera trapping efforts. Regular intensive camera trapping in other parts of the Caracal's historical range such as Panna Tiger Reserve and Kuno Wildlife Sanctuary did not yield any record of the Caracal (Y.V. Jhala pers. comm. 2019). The same holds true for the forests of Mirzapur (Sinha & Chaudhary 2019).

The putative extent of occurrence of the Caracal decreased by 47.99% in the period before 1947 to the period between 1947 and 2000, and the putative extent of occurrence area of the latter period accounted for 52% of the period until 1947.

The locations with verifiable reports from 2001 onwards are within a total area of 16,709km^2, which is

Table 5D. Observations of the Caracal in other protected areas in Rajasthan

No. on map	Date	Location	Habitat type	Water source	Type of report	Source
5	2015	Kalighati to Bana Road, Sariska Tiger Reserve, Alwar	HDF	SN	Seen by forest officer Y.K Duck, no photograph	B Manoj Parashar pers. comm. 2019
6	2014	Karna Ka Bas, Sariska Tiger Reserve, Alwar	HDF	SN	Seen by Ambassador of the Czech Republic, no photograph	B Manoj Parashar pers. comm. 2019
7	2006	Sariska gate to Kankwadi, Sariska Tiger Reserve, Alwar	HDF	SN	Five Caracals seen in two different locations by forest officers Manoj Parashar and Ramkaran Khiarwa, no photograph	B Manoj Parashar pers. comm. 2019
8	2004	Near Bharthari, Sariska Tiger Reserve, Alwar	HDF	SN	Seen a Caracal vocalising as it walked 1km seen by a forest officer Udayram Chaudhary	B Satish Sharma in litt. 2020
9	2004	Karna Ka bas, Sariska Tiger Reserve, Alwar	HDF	SN	Caracal seen by forest officer Udayram Chaudhary	B Satish Sharma in litt. 2020
10	23.vii.2004	Sariska Tiger Reserve, Alwar	--	--	A Caracal photographed	A Heerden (2004)
11	18.iv.2017	Keoladeo National Park, Bharatpur	SL	L	Forest Department camera trapped a Caracal	A Bijo Joy pers. comm. 2017
12	2008	Between Areth to Thandi Beri, Kumbhalgarh Wildlife Sanctuary, Rajsamand	HDF	SN	A Caracal seen multiple times by forest officer Bhanwar Singh Chauhan	B Satish Sharma in litt. 2020
13	2003	Dhana forest Block, 2km after the main gate of Kumbhalgarh Wildlife Sanctuary	HDF	SN	A Caracal sighted by two forest officers Rahul Bhatnagar and Raghuvir Singh Shekhawat	B Rahul Bhatnagar pers. comm. 2020
14	2010	Grassland area of Bassi dam and Orai Dam. Bassi Wildlife Sanctuary, Chittorgarh	HDF	L	A Caracal seen by forest officer Manoj Parashar,no photograph	B Manoj Parashar pers. comm. 2019
15	~xii.2016–i.2017	5–6 km away from Johjawar village, Kamli Ghat, Todgarh Raoli Wildlife Sanctuary, Pali	HDF	SN	A Caracal seen by Nagendra Singh Johjawar, no photograph	B Nagendra Singh Johjawar pers. comm. 2019
16	x. 2006	Devriya Farm, Jawda Nimdi Bhainsrorgarh Wildife Sanctuary, Chittorgarh	HDF	R	Caracal seen crossing road, no photograph	B Harshwardhan Singh Mahechha pers. comm. 2020

Image 4. A female Caracal with her cub while gripping a monitor lizard. Photographed in the Kachida Valley, Ranthambhore National Park on 16 June 2009. © Dharmendra Khandal

Table 5E. Observations of the Caracal outside protected areas in Rajasthan

Sawai Madhopur District						
17	06.iv.2017	Kosra Village, Sawai Madhopur	R	R	A sub adult male Caracal fell in a well and was rescued by Forest Department staff.	A Dharmendra Khandal pers. obs. Photographed
Udaipur District						
18	30.iv.2013	Baghdarrah	SL	L	Forest officer Satish Sharma seen a Caracal crossing Badar road	B Satish Sharma in litt. 2020
19	24.ii.2010	Badi Talab adjacent to Sajjangarh Wildlife Sanctuary, Kaler Forest	OMJ	L	Caracal seen by Raza Tehsin	B Satish Sharma in litt. 2020
20	v.2009	Near Banki Forest area	HDF	SN	Seen a Caracal, no photograph	B Sharad Agarwal pers. comm. 2019
21	2004	Kheroda	SL	SN	Flying squad of Forest Department rescued a Caracal from an open well	B Satish Sharma pers. comm. 2020
Pratapgarh District						
22	22.iv.2008	Salamgarh, Arnod, Pratapgarh	OTF	SN	A subadult Caracal caught by forester Chhotulal Meena near village and later released there	B Satish Sharma in litt. 2020
23	12.xii.2006	Near Arnod, south of Pratapgarh	TF	PN	Rescued an abandoned Caracal cub and sent to Gulab Bagh Zoo, Udaipur	B Satish Sharma pers. comm. 2020
Alwar District						
24	Winter 2004	Badodh Roondh	RH	SN	A female Caracal with two cubs seen by forest officer Udayram Chaudhary	B Satish Sharma in litt. 2020

just 2.10% of the area of the Caracal's estimated historic range in India before 1947, and 4.04% of the area in the 1948–2000 period. Therefore, there has possibly been a further 95.95% decrease in the Caracal's range, which is highly fragmented today. In Rajasthan, Caracal populations are present in Ranthambhore Tiger Reserve and contiguous areas including Dholpur, the region of Kumbalgarh-Todgarh-Raoli in Udaipur, particularly at the junction of Kumbhalgarh-Todgarh-Raoli, and an isolated population in the Chittorgarh-Pratapgarh region. Outside Rajasthan, the only authentic post-2000 reports are in the Kutch region of Gujarat. There, however, have been practically no attempts to survey the Caracal in most regions of its past reported range and the much higher effort put into camera-trapping and photographing in and around Ranthambhore and Kutch could be a reason for the higher numbers reported. Physical connectivity between these four landscapes is highly fragmented with potential impact on gene flow and population connectivity for the Caracal.

This range encompasses Sariska Tiger Reserve, Ranthambhore Tiger Reserve, the districts of Udaipur and Chittorgarh in Rajasthan, the Kutch region in Gujarat and the Chambal ravine area in Madhya Pradesh.

No focused surveys for the Caracal were carried out in Maharashtra, Madhya Pradesh, Uttar Pradesh and in eastern parts of India. It may be possible that it is present there but under-reported. In that case, the putative reduction of its range needs to be verified and adjusted based on robust data.

The common feature of these areas is dry deciduous thorn forest with waterbodies. If a river is present, the ground cover is usually sparse along severely eroded riverbanks and adjacent ravine habitat, while evergreen riparian vegetation is completely absent. While both the Kutch Desert and Ranthambhore Tiger Reserve exhibit dry habitats, 97 small rivers originate in the former and the latter has many rivers and rivulets that criss-cross the landscape and meet the Chambal river (Khandal & Khandal 2017).

Our findings indicate that the Caracal is indeed present in dry open habitats with some vegetation but is absent in 'true' desert as described by Sunquist & Sunquist (2002). This habitat use is consistent with records obtained in arid and semi-arid mountains and hilly terrain in Iran (Farhadinia et al. 2007; Ghoddousi et al. 2009; Moqanaki et al. 2016) and in Uzbekistan (Gritsina 2019).

With the exception of field work carried out by Mukherjee et al. (2004) on diet and habitat use and

Table 6. Reports of the Caracal in Gujarat from 2001 onwards (Figure 3).

No. on map	Date	Location	Habitat type	Water source	Type of report	Source
Kutch District						
25	25.x.2019, 10.00h	Rampar Village, Nakhtrana	SL/A	PN	A male Caracal jumped in a shallow well to feed on Indian Bullfrog *Hoplobatrachus tigerinus*. It caught a rope in its mouth, which was hanging in the well. The rescuer put a wire mesh tree guard in the well, and it successfully climbed up and ran away. The rescue was filmed by rescuer Jagat Sinh Sodha	A Jagat Sinh Sodha, pers. comm. 2019
26	iv.2019	Guglani Rakhal, Oaran Mata – near the Lifri Lignite Mine	SL	PWH	A Caracal seen and peafowl alarm calls noted	B Jugal Tiwari pers. comm. 2019
27	Winter 2018–2019	Mosuna Village	SL	SN	A Caracal repeatedly entered a shepherd's livestock shelter and killed 18–20 lambs in a span of 15–20 days despite close vigilance	B Sujan Bhai Raibari pers. comm. 2019
28	xii.2018, 19.30h	Jalu	SL	SN	Sodha was observing animals on a water body and saw a Caracal. No photograph	B Vikram Sinh Sodha pers. comm. 2019
29	Xii.2015, 23.45h	Gatchdo Village	PjT	SN	Caracal seen and photographed	A Jugal Tiwari pers. comm. 2019
30	14.vi.2015	Nani Aral Village	PjT	SN	A sub adult Caracal killed by trained hunting dogs when it was near the charcoal maker's colony, photographed	A Shivbhadra Sinh in litt. 2019
31	2015	Devisar Village	PjT/ SL	SN	A Caracal killed eight lambs belonging to a Sodha Rajpoot pastoralist who killed the Caracal and also photographed.	A Vikram Sinh Sodha pers. comm. 2019
32	3.xi.2014	Nani Vamoti Village	SL	SN	A Caracal seen crossing the road. No photograph	B Shivbhadra Sinh in litt. 2019
33	21.i.2014	Near Khanay Village	SL/A	SN	A male Caracal came to hunt poultry and was killed by trained dogs. No photograph	B Shivbhadra Sinh in litt. 2019
34	25.xi.2013	Jatavira Village	PjT	SN	A Caracal was trapped in an iron jaw trap planted for Wild Boar *Sus scrofa*. Staff of a local NGO helped Forest Department (FD) officers to treat the injured animal. FD officers rescued a Caracal; several photographs	A Jugal Tiwari, Vikram Sinh Sodha, Shivbhadra Sinh, Ashok Chaudhary pers. comm. 2019
35	i.2014, 9.45h	Near Beru Village, Kutch , Gujarat.	SL	SN	Jugal Tiwari saw a Caracal	B Jugal Tiwari pers. comm. 2019
36	17.iii.2013	Jara-Jumra Road	SL/PjT	SN	A female Caracal killed in a road accident	B Shivbhadra Sinh in litt. 2019
37	18.ix.2012	Near Fulay Village	SL/A	SN	A local herder frequently saw a Caracal in these areas during the evening	B Shivbhadra Sinh in litt. 2019
38	24.xii.2010	Naliya forest area	SL	SN	Photographed a female Caracal with cub	A Adesh Shivkar pers. comm. 2019
39	xii.2009, 8.30h	Bitta Village, towards Abdasa Taluka on the way to Naliya	SL	SN	Female Caracal with two cubs, slipped into a thicket. No photograph	B Jugal Tiwari pers. comm. 2019
40	xi.2008	Near Mata-no-Madh of Gugliya Rakhal	SL	SN	Seen a Caracal. No photograph	B Pankaj N. Joshi in litt. 2019
41	iii.2008	Kotdi, Mandvi	SL	SN	Caracal killed in a conflict with a shepherd and his dog. Caracal seen three times before this incident. Dead Caracal photographed	A Deepak Goswami pers. comm. 2019
42	2006–2007	Naliya	SL	SN	Photographed a Caracal	A Yogendra Shah in litt. 2020
43	xi.2005	Narayan Sarovar Wildlife Sanctuary	SL	SN	A team of forest officials of Gujarat spotted a pair of Caracals, photographed	A Nair (2006)

Table 7. Reports of the Caracal in Madhya Pradesh from 2001 onwards

No. on map	Date	Location	Habitat type	Water source	Type of report	Source
Chhattarpur District						
44	2007–2008	Between the Chhattarpur and Jhansi roads The distance between the roads is 110km and the exact location was not specified	TF	SN	Caracal road kill, took a picture on his phone but apparently lost it. He shared the same image with H.S. Pabla	B Forest officer L.K. Chaudhary pers. comm. 2019
Bhind District						
45 I	11.iv.2001	Agricultural land between Bijapuri, Lavan, Chandupura, Karke Ka Pura and Goplapura	RH	SN	Spotted by Khudsar (2004) in a ravine area	B Khudsar (2014)
45 II	26.iii.2001	Agricultural land between Bijapuri, Lavan, Chandupura, Karke Ka Pura and Goplapura	RH	SN	Spotted by Khudsar (2004) in a ravine area	B Khudsar (2014)

Singh et al. (2014, 2015) on abundance and population density, no other surveys contributed to the knowledge about Caracal ecology in India in the 21st Century. The Caracal is among India's most neglected cats, although already in 2010, Ranjitsinh & Jhala (2010) considered the Caracal to be on the brink of extinction in the country. Surveys on population size, reproduction, mortality, home range sizes and prey dynamics of the Caracal are urgently needed. A review of how land policy especially the categorization of land as wasteland, impacts the Caracal as a scrub dwelling species is also necessary. Between 2008–09 and 2015–16, 2,146.11km^2 of sandy semi-stabilised, dense scrubland and open scrubland has been converted into cropland in Rajasthan for example (Government of India 2019). Equally essential are long-term studies focusing on movement patterns of Caracals to determine and establish wildlife corridors that are suitable to connect the remaining fragmented population units. We hope to inspire fellow conservationists to contribute to saving the Caracal from becoming extinct in the country.

Image 5. One of 176 village wildlife volunteer camera trap reports of Caracal in Ranthambhore Tiger Reserve, Rajasthan. © Tiger Watch Ranthambhore

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COMMUNICATION

Rediscovery of Caracal *Caracal caracal* (Schreber, 1776) (Mammalia: Carnivora: Felidae) in Abu Dhabi Emirate, UAE

Robert Gubiani [1], Rashed Al Zaabi [2], Justin Chuven [3] & Pritpal Soorae [4]

[1–4] Terrestrial & Marine Biodiversity Sector, Environment Agency Abu Dhabi, PO Box 45553, Abu Dhabi, United Arab Emirates.
[1] robert.gubiani@ead.gov.ae (corresponding author), [2] rashed.alzaabi@ead.gov.ae, [3] justin.chuven@ead.gov.ae, [4] psoorae@ead.gov.ae

Abstract: We present evidence confirming the presence of Caracal *Caracal caracal* in Abu Dhabi Emirate. Camera trap deployment into areas likely to harbour elusive species revealed the presence of at least one male individual with 37 records in 683 camera trap days over a seven-month period. These records represent the first confirmed presence of Caracal in Abu Dhabi Emirate since 1965. Both diurnal and nocturnal records highlighted varied activity patterns of this generally elusive species. Foraging activity occurred primarily during low luminosity levels associated with the new moon. The evidence obtained proves the presence of Arabian Caracal in a location long suspected of providing suitable habitat for this species.

Keywords: Camera trap, Jabal Hafit, moon phase, small wild cat, United Arab Emirates.

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Author details: Robert Gubiani currently works within the mammals section of the Wildlife Assessment & Monitoring unit at Environment Agency – Abu Dhabi contributing to multiple threatened species management programs. Robert has worked in academia, the private sector as well as multiple government entities throughout his 15 year career. As well as holding an MSc Robert is a member of the IUCN Small Mammal and Rodent Species; Cormorant; and Cat Species Specialist Groups and is a Scientific and Research Grant Reviewer for the National Geographic Society. Rashed Alzaabi is heading the Mammals section within the Wildlife Assessment and Monitoring Unit. He has been working in the Environment Agency – Abu Dhabi for the past 9 years and doing different mammals projects, from capturing small mammals to camera trap programs, with education in Wildlife Management, Msc. Justin Chuven is currently the Unit-head of the Ex-situ Conservation program for the Environment Agency Abu Dhabi where he manages multiple endangered species conservation breeding and reintroduction programs, the most ambitious being the reintroduction of Scimitar-horned Oryx and Addax into their native habitat. After obtaining his MSc. in Biology at California State University he has gone on to hold positions at several AZA and international zoological institutions. Pritpal Soorae is currently Unit Head of the Wildlife Assessment & Monitoring unit of the Environment Agency-Abu Dhabi, UAE. This unit is responsible for biodiversity monitoring activities in Abu Dhabi emirate. Other areas of work include working with alien species of the UAE, herpetology and coordinating the activities of the UAE CITES Scientific Authority. He is also program Officer of the IUCN Conservation Translocation Specialist Group for over 25 years.

Author contribution: Robert Gubiani—field sampling and camera deployment, data collection, data analysis, image preparation, manuscript drafting. Rashed Al Zaabi—supervision, manuscript drafting. Justin Chuven—field sampling, data collection, image preparation, manuscript drafting. Pritpal Soorae—supervision, manuscript drafting.

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INTRODUCTION

Globally, the Caracal *Caracal caracal* is classified as Least Concern (Avgan et al. 2016). Given the lack of recent records in the United Arab Emirates (UAE), however, it is considered 'Extinct in the Wild' in the recent Abu Dhabi Red List Assessment (unpublished 2020) and Critically Endangered in the UAE (Mallon et al. 2019). While the Caracal is listed as Least Concern in the Arabian Peninsula (Mallon 2011; Mallon & Budd 2011), it is listed as Endangered in Jordan (Amr 2000) and Oman (Fisher 1999), and as Critically Endangered in Pakistan (Sheikh & Molur 2004), and Morocco (Cuzin 2003). It already vanished in Kuwait (Cowan 2013), parts of Turkmenistan (Lukarevsky 2001) and is thought to be on the verge of extinction in many parts of northern Africa (Cuzin 2003); however, while the Caracal shows signs of population declines and range loss in parts of Asia and northern Africa, it is common and stable in central and southern Africa (Thorn et al. 2011). Although its global range is extensive, the population within the Arabian peninsula is difficult to determine and thought to be declining (Cunningham 2008; Mallon & Budd 2011). Available information about its distribution in the Arabian peninsula is based on opportunistic sightings (Thalen 1975; Gasperetti et al. 1985; Harrison & Bates 1991). It is considered rare in the UAE (Gasperetti et al. 1985; Harrison & Bates 1991; Mallon & Budd 2011). Oman may be an exception as some population expansion was observed in areas devoid of Leopard *Panthera pardus* (Spalton et al. 2014). This is concerning as the local population is considered to be a distinct subspecies, *Caracal caracal schmitzi* (Kitchener et al. 2017).

In Arabia, the Caracal has an average body length of 1–1.2 m and a weight of 8–15 kg (Harrison & Bates 1991). Some aspects of its ecology were studied in Israel (Weisbein & Mendelssohn 1990), southern Africa (Avenant & Nel 1998; Avenant & Nel 2002a; Bothma et al. 2004; Marker & Dickman 2005), Turkey (Giannatos et al. 2006; Ilemin & Gürkan 2010), and India (Mukherjee et al. 2004; Singh et al. 2014). It is predominantly nocturnal, solitary and extremely secretive making field observations rare (Van Heezik & Seddon 1998). The paucity of information on this species limits active conservation measures until surveys are conducted to find out where it is present and in which density (Schaller 1976).

In the 1990s, the diet of a radio-collared individual was studied in Saudi Arabia that was observed while scavenging on ungulate and raptor carcasses (Van Heezik & Seddon 1998). Scat analysis showed a high density of rodent bones consisting mainly of Libyan Jird *Meriones libycus* (Van Heezik & Seddon 1998). Stuart & Stuart (2002) reported Caracal scat found in northern Oman and adjacent parts of the UAE that contained remains of ungulates, bird feathers and a spider (Stuart & Stuart 2002). It is considered to be diverse in its selection of prey that is up to 2 to 2.5 times its own size (Van Heezik & Seddon 1998; Avenant & Nel 1998; Sunquist & Sunquist 2002; Avenant & Nel 2002a; Livingston 2009). It preys on small domestic livestock to varying degrees (Stuart 1982; Stuart & Hickman 1991; Bothma et al. 2004; Melville & Bothma 2006), but this has yet to be reported as a major occurrence in the middle-east region.

Historically, the Caracal has not been reported to occur far into the hyper-arid regions such as those present in the Empty Quarter; instead, it prefers mountain ranges and hilly steppe (Van Heezik & Seddon 1998). Within the UAE, most sightings have historically occurred in the mountainous northern emirates (Gasperetti et al. 1985; Mallon & Budd 2011), although sightings were infrequently reported in sandy desert areas between Dubai and Al Ain (Harrison & Bates 1991; Stuart & Stuart 2007). The last known individual in the United Arab Emirates was photographed in September 1983 in Al Rams located in the north (Gasperetti et al. 1985). Previous surveys on Jabal Hafit failed to identify the presence of any individuals, however, it was suspected that the Caracal might have occurred in the area, albeit in very low numbers (Harrison & Bates 1991). As with most carnivore species in the region, persecution by farmers (Harrison & Bates 1991) and the general public continues to put additional pressure on existing populations that are likely to be naturally already low in density (Melville & Bothma 2006).

STUDY AREA

Our study area of 27km^2 was located in Jabal Hafit National Park. This protected area in eastern UAE was established in 2017 to conserve the biodiversity of Jabal Hafit (Mubarak 2018) (Figure 1). Jabal Hafit is a 25km long and 5km wide foothill of the Al Hajar Mountains that stretch from the eastern UAE through northern Oman (Hansman & Ring 2018). The city of Al Ain is located northeast of Jabal Hafit; in the east, the 30km wide Al Jawwa plain separates it from Al Hajar Mountains; in the south, it terminates in Oman (Zaineldeen & Fowler 2014). The permanently fenced border between the UAE and Oman divides Jabal Hafit into two portions, the smaller of which is located within UAE (S. Tubati

Figure 1. Map of the study area in Abu Dhabi Emirate.

pers. comm. 01 October 2020). Jabal Hafit National Park is surrounded by residential and industrial areas in the west and north and farmland in the east, which transitions into a residential and mixed used landscape (R. Gubiani pers. obs. 2020). The main thoroughfare to the top of Jabal Hafit National Park is a sealed road providing access to a hotel, viewing area and private residences all extending off this main road.

Home range of this individual is extremely difficult to presume. Elsewhere in Caracal range countries, home ranges varied from 418km^2 (Norton & Lawson 1985) to 15.2km^2 (Bothma et al. 1997), 26.9km^2 (Avenant & Nel 1998), and 308.4 km^2 in the southern Kalahari (Bothma & LeRiche 1994) to 1,116km^2 in northern Saudi Arabia (Van Heezik & Seddon 1998). Giannatos et al. (2006) estimated Caracal density to be 1.73 individuals per 100km^2 in southwestern Turkey, assumingly a result of limited prey and development activities in the surroundings of the survey area. The limited size of suitable habitat in Jabal Hafit National Park increases the likelihood that the Caracal may be traversing the border fence and utilising the rest of the mountain within Oman, which is significantly larger and relatively undeveloped in comparison.

The climate in the region is classified as bi-seasonal Mediterranean type characterised by limited rainfall and high temperatures (Aspinall & Hellyer 2004). Winter temperatures drop to 4°C at night and soar to 49°C by day in the peak summer season in July (National Center of Meteorology 2020). Precipitation varies on an annual basis with heavy downpours during the peak winter season with a mean of 10.7mm in January and close to no rainfall in summer with a mean of 0.6mm (National Center of Meteorology 2020).

Due to Jabal Hafit's elevation of 1,240m and unique climatic conditions, it hosts about 160 of the roughly 390 floral species currently known to occur within Abu Dhabi Emirate (Aspinall & Hellyer 2004). Predatory species recorded historically on Jabal Hafit include Blanford's Fox *Vulpes cana*, African Wildcat *Felis lybica* (Harrison & Bates 1991), Striped Hyaena *Hyaena hyaena*, Arabian Wolf *Canis lupus arabs* (Aspinall & Hellyer 2004) and Leopard (Edmonds et al. 2006). Industrial development and urban expansion has caused large tracts of natural

habitat to be lost or modified that is deemed no longer suitable for a number of endemic species (Al Dhaheri et al. 2018).

MATERIAL AND METHODS

We used five Bushnell Trophycam HD camera traps that were active for 24 hours per day. We mounted them either on camera tripods, metal stakes or on trees in a north or south orientation to eliminate misfires due to direct exposure to sunlight. We placed them in funnel points or areas with high resource density. In areas lacking obvious funnel points, we placed them in patches of vegetation or on elevated points. Such locations have in the past shown to be more likely to carry scent from baiting products, and to be used for scent marking by carnivores. Camera traps were placed in five locations. The distance between locations varied from 600m to 1.26km.

Batteries were changed every three months, however misfires due to wind or non-target species such as humans resulted in some periods of camera inaction. Only periods when photographs were recorded were included in this analysis.

In order to increase the likelihood of recording wildlife, bait was placed approximately one metre directly in front of the deployed camera trap and replenished every three months. Although many types of artificial lures are available internationally, very few dedicated lure products are available locally. Therefore, we used cat food with chicken flavour as it had proven successful with similar trapping programmes aimed at Sand Cat *Felis margarita* and Rüppell's Fox *Vulpes rueppellii*. Additionally, bait was used in areas that were exposed to increase the visual stimulus as well as enhancing scent dispersal into lower lying areas within the survey area.

Activity of recorded wildlife was determined by the time stamp on each obtained photograph. The influence of moon phase on foraging activity was determined by the division of lunar cycle into ten moon exposure increments namely phase 1 (0%–10%), phase 2 (10.1%–20%), phase 3 (20.1%–30%), phase 4 (40.1%–50%) and so forth. The percentage of lunar presence was determined using the time stamp recorded by the camera trap and then determined by using the database of the Moonpage (2020) website. It should be noted that moon phase does not take cloud cover into consideration as no dedicated weather station currently exists on Jabal Hafit.

RESULTS

During our study, we obtained 37 photographs of Caracal after a survey effort of 683 camera trap days, or one photograph of a Caracal per 18.45 camera trap days. Of the five camera traps deployed, four recorded a Caracal. Diurnal records were also obtained by camera traps located 300m south and 250m north from the initial location. Our camera traps also recorded Nubian Ibex *Capra nubiana*, Arabian Tahr *Arabitragus jayakari*, Red Fox *Vulpes vulpes*, feral Domestic Cat *Felis catus*, feral Domestic Goat *Capra hircus*, Rock Hyrax *Procavia capensis*, Egyptian Spiny Mouse *Acomys cahirinus* and *Rattus*. Avifauna species recorded included Eurasian Collared Dove *Steptopelia decaocto*, Rock Dove *Columba livia*, Laughing Dove *Spilopelia senegalensis*, Grey Francolin *Francolinus pondicerianus*, Eurasian Hoopoe *Upupa epops*, and Arabian Partridge *Alectoris melanocephala*.

A preference for early moon phases was clearly evident with 62% (n=23) of records during phase 1 and 11% (n=4) occurring in phase 2, constituting 63% of all records obtained (Figure 3). Record totals of 3, 2, and 2 were obtained in phases 5, 3, and 6 whereas only single records occurred in phases 7, 9, and 10. No records were obtained during moon exposure phase 30.1%–40% and 70.1%–80 %. Regression analysis indicated that these results were not statistically significant.

DISCUSSION

Our record of a Caracal in Jabal Hafit National Park represents the first confirmed record of this species in the United Arab Emirate since 1983. Gasperetti et al. (1985) reported a photograph taken in the vicinity of Al Rams in the Emirate of Ras Al Khaimah in September 1983, but we did not find any other authenticated record in the country. Stuart & Stuart (2007) reported one scat sample found between the cities of Ras Al Khaimah and Dibbah in June 1995, which they attributed to Caracal, but without indicating their method of identifying scat to a species.

We obtained the first record on 7 July 2018 (Image 1). A short video confirmed its presence on 3 January and 9 January 2019 (Image 2). A footprint (Image 3) was also identified as well as additional diurnal photographs (Image 4) with a final record on 25 February 2019. Our repeated records of a Caracal over nine months indicate that it may be resident in Jabal Hafit National

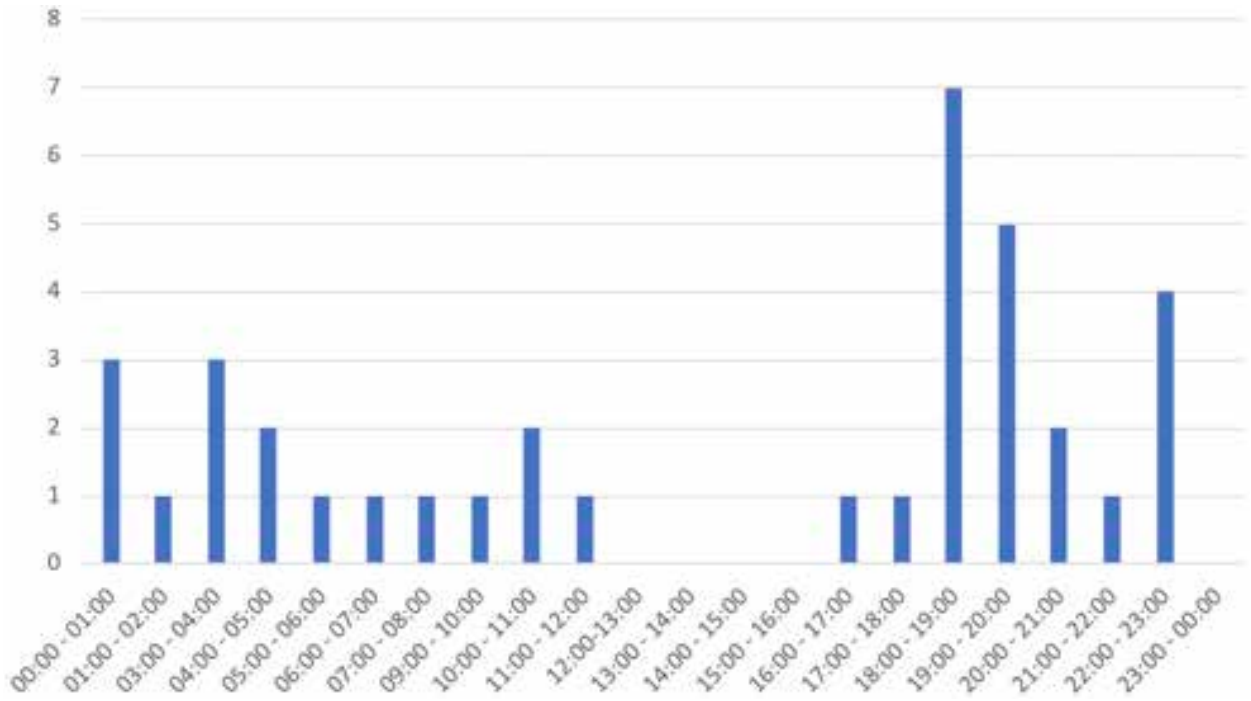

Figure 2. Hourly activity of the Caracal.

Park. All our camera trap photographs show a solitary individual of the same size. We, therefore, assume that the same individual was repeatedly recorded. Definitive identification of the number of individuals is difficult as we did not identify any scars, marks or deformities.

Activity of the recorded individual/s showed a preference for nocturnal activity with 29 of 37 records (78%) obtained between 18.01 and 06.00 h (Figure 2). The remaining records were obtained during the day at 06.01–12.00 h (n=6) and in the afternoon at 12.01–18.00 h (n=2). Further analysis of activity in hourly time slots demonstrated that the highest activity periods occurred at 18.00–23.00 h with peak record acquisition between 18.00–19.00 h (n=7) (Figure 2). No record was obtained in the midday to early evening period.

Peak activity records occurred between 18.00 and 23.00 h, which differs greatly from results of studies conducted by Singh et al. (2014) who noted peak activity at 01.00–04.00 h with early night activity only constituting less than 5%. Similarly, camera trapping surveys in Turkey showed that Caracal were active foremost between 06.00 and 08.00 h (Ilemin & Gürkan 2010) with a slight increase at dusk. Temperature is known to influence Caracal foraging behaviour, which was seen to align with increased activity from primary food sources (Hassan-Beigi 2015). Activity records during our study do not appear to show any influence by temperature or activity of prey species. The majority of activity periods differs from peak activity of Arabian Partridge and Rock Hyrax. Primary activity of these species decreases during the increased hunting period of the Caracal.

Moon phase and lunar activity of carnivores is well-studied and documented (Harmsen et al. 2011; Penteriani et al. 2011, 2013; Huck et al. 2016; Pratas-Santiago et al. 2017). Previous studies highlighted that Caracal activity pattern can be influenced greatly by the activity pattern of its prey (Nowell & Jackson 1996; Sunquist & Sunquist 2002; Singh et al. 2014; Hassan-Beigi 2015). This appears not to be the case with this individual/s as our records indicate little overlap with prey activity during the same periods. All records of Blanford's Fox (n=4) and Egyptian Spiny Mouse (n=10) in our study area occurred from moon phase 3 onwards. Caracal are known to prey on smaller carnivores (Livingston 2009), which could provide some explanation as to why Blanford's Fox avoided peak Caracal hunting periods. Further data, however, will be needed to assess activity patterns and temporal avoidance between the two predators. Rodents constitute large parts of the Caracal's diet (Ghoddousi et al. 2009; Livingston 2009), but the moon phase behaviour of Egyptian Spiny Mouse cannot be definitively linked to the arrival of a new meso-predator in the landscape. Although this limited data

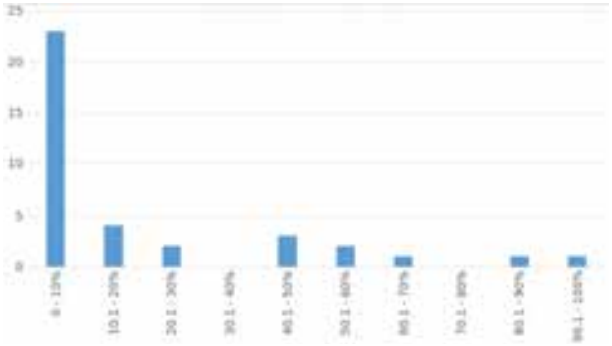

Figure 3. Moon phase activity of the Caracal.

Image 1. First nocturnal record of the Caracal in Jabal Hafit National Park on 7 July 2018. © Environment Agency Abu Dhabi.

Image 2. First diurnal record of the Caracal on 3 January 2019 in Jabal Hafit National Park. © Environment Agency Abu Dhabi.

does not definitively prove increased foraging activities as a result of the presence of the Caracal, it does provide some insight into preferred activity periods of smaller mammals present on Jabal Hafit based on moon phase and warrants further investigation.

Currently, the information about dietary needs of many species of small wild cats is scarce, especially Caracal (Livingston 2009). The Caracal is considered to be a generalist predator often taking advantage of localised resources (Van Heezik & Seddon 1998; Avenant & Nel 2002a; Moqanaki et al. 2016). The Caracal is able to kill prey weighing 2–3 times its own size such as gazelles *Gazella* (Moqanaki et al. 2016). The reduction of these ungulates as a result of hunting and land degradation may be the reason for the Caracal to prey occasionally on small domestic livestock and poultry (Stuart & Stuart 2007; Zafar-ul et al. 2018). Predation on escaped livestock was recorded in South Africa, but is considered to be seasonal in nature and limited in extent (Avenant & Nel 2002a). Remains of domestic goat and sheep were also found in Caracal scat in Oman and northern UAE (Stuart & Stuart 2007). On Jabal Hafit, Arabian Tahr is present in small numbers, estimated at less than 15 individuals (J. Chuven pers. comm. 12 December 2019). Whether they constitute prey for the Caracal in Jabal Hafit remains unknown. We observed four feral goats, which escaped from local farms, but we did not come across any incidence that the Caracal preyed on livestock.

The Caracal in Jabal Hafit was recorded in areas where Rock Hyrax and Egyptian Spiny Mouse were observed. Rodents such as Libyan Jird and Egyptian Spiny Mouse were found in Caracal scat in Iran (Ghoddousi et al. 2009). Van Heezik & Seddon (1998) noted that a collared individual selected areas with high rodent abundance during the day. Rodents are deemed to be an important part of the Caracal diet particularly in arid environments (Avenant & Nel 2002b; Mukherjee et al. 2004; Seddon et al. 2007; Farhadinia et al. 2007; Ghoddousi et al. 2009; Livingston 2009). Although Arabian Jird *Meriones arimalius* and Cheesman's Gerbil *Gerbillus cheesmani* were recorded in the vicinity of Jabal Hafit, only Egyptian Spiny Mouse and *Rattus* are confirmed to occur on the mountain (Cunningham 2008). The recent release of approximately 10,000 Arabian Partridge is likely to be a more easily accessible food source for the recorded Caracal. Furthermore, the high level of development around and on Jabal Hafit will likely result in increased levels of House Mouse *Mus musculus* and *Rattus*, which could constitute a prey base for the Caracal. Given the dramatic increase in prey sources within the Abu Dhabi portion of Jabal Hafit, this raises the possibility

Image 3. Caracal footprint in Jabal Hafit National Park. © Environment Agency Abu Dhabi.

Image 4. Second diurnal record of the Caracal in Jabal Hafit National Park on 8 February 2019. © Environment Agency Abu Dhabi.

of predators moving back and forth across the border with Oman to take advantage of this increase in prey abundance. Van Heezik & Seddon (1998) proposed that the Caracal might have a broader diet and larger home range than expected due to low prey abundance. Home range size of the Caracal in Saudi Arabia reduced significantly during periods of increased biomass (Van Heezik & Seddon 1998).

The use of camera trapping rates as an index for abundance has been widely debated (Rovero & Marshall 2009; De Bonde et al. 2010; Hobbs & Brehme 2017), however, the probability of encounters between camera traps and individuals would increase if abundance of target individuals increases (Rovero & Marshall 2009). Limited access to protected areas and the scarcity of confirmed records make it difficult to identify further potential areas harbouring this species. In view of the limited knowledge and precarious state of the Caracal within parts of the Arabian Peninsula, it is important that any new information, particularly sightings and observed behaviour is reported. The identification of the Caracal in Abu Dhabi Emirate is important in terms of species abundance as it highlights the possibility of elusive and rare species occurring in protected areas within the Emirate. The preservation of Jabal Hafit National Park and its natural habitat is of paramount importance. Continued monitoring of the behaviour and movement of the Caracal in this area is essential to devise conservation measures and determine corridors that connect Jabal Hafit National Park with other areas suitable for the Caracal in the UAE.

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COMMUNICATION

The Fishing Cat *Prionailurus viverrinus* (Bennett, 1833) (Mammalia: Carnivora: Felidae) in Shuklaphanta National Park, Nepal

Bhupendra Prasad Yadav [1], Angie Appel [2], Bishnu Prasad Shrestha [3], Bhagawan Raj Dahal [4] & Maheshwar Dhakal [5]

[1,3] Department of National Parks and Wildlife Conservation, PO Box 860, Babar Mahal, Kathmandu, Nepal.
[2] Wild Cat Network, Auf dem Dörnchen 14, 56470 Bad Marienberg, Germany.
[4] Zoological Society of London Nepal, Bishal Nagar Marg, Kathmandu, Nepal.
[5] Ministry of Forests and Environment, Singha Durbar, Kathmandu, Nepal.
[1] bhupendra.dnpwc@gmail.com, [2] angie@wild-katze.org (corresponding author), [3] bishnu_stha@yahoo.com,
[4] bhagawanraj.dahal@zsl.org, [5] maheshwar.dhakal@gmail.com

Abstract: The Fishing Cat *Prionailurus viverrinus* is known to occur in the Terai region since at least the late 1920s. Contemporary locality records of the Fishing Cat in this region are widely spaced, and the knowledge about the connectivity between these localities is still deficient. We present the first photographic evidence for the presence of the Fishing Cat in far western Nepal. In spring and winter 2016, we obtained 30 notionally independent events of the Fishing Cat in the floodplain of Shuklaphanta National Park at elevations of 181–221 m. This population unit may be connected to units in Indian protected areas. Further targeted surveys in adjacent wetlands and wildlife corridors are warranted to clarify its range in the Indian and Nepal Terai.

Keywords: Camera trapping, small wild cat, Terai, wetland, wildlife corridor.

सारांश: सन् १९२० दशक पछि मलाह बिरालो *Prionailurus viverrinus* तराई क्षेत्रमा देखा परेको हो। हाल यस क्षेत्रमा मलाह बिरालोको रेकर्ड व्यापक रूपमा राखिएको छ र पनि यी स्थानहरू बीचको कनेक्टिभिटीको बारेमा ज्ञानको अझै कमी छ। सुदूर पश्चिम नेपालमा मलाह बिरालोको उपस्थितिको रुपमा यो पहिलो फोटोग्राफिक प्रमाणको रुपमा प्रस्तुत गरिएको हो। सन् २०१६ को बसन्त र जाडो याममा शुक्लाफाँटा राष्ट्रिय निकुञ्जको बाढीग्रषित मैदानमा १८०-२२१ मीटर को उचाइमा मलाह बिरालोको स्वतन्त्र क्रियाकलापहरु गरेको देखियो। यो मलाह बिरालोको संख्या भारतीय संरक्षित क्षेत्रहरुमा भएको संख्या संग पनि जोडिएको हुन् सक्छ । यो पाइने क्षेत्रहरुको बारेमा थप जान्नको लागि नेपाल र भारतको तराई क्षेत्रमा बन्यजन्तु प्रयोग गर्ने बाटो तथा सिमसार क्षेत्रहरुलाई लक्षित गरी थप अध्यन गर्नु आवश्यक देखिन्छ।

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INTRODUCTION

The Fishing Cat *Prionailurus viverrinus* has an extensive but discontinuous geographic range in subtropical and tropical Asia, as it is strongly associated with inland and coastal wetlands (Mukherjee et al. 2016). These ecosystems have been imperilled since the early 20th Century due to large-scale conversions for agriculture, aquaculture, industry, hydropower plants (Gopal 2013; Davidson 2014; Dixon et al. 2016) and construction of brick kilns (Chakraborty et al. 2020a). The Fishing Cat is negatively impacted by this loss of natural wetlands and is consequently listed as Vulnerable on the IUCN Red List of Threatened Species, since populations are thought to have declined in all range countries (Mukherjee et al. 2016). Outside protected areas, Fishing Cats have been killed for consumption, in retaliation for preying on livestock and for damaging fishing nets (Miththapala 2006; Mukherjee et al. 2012; Chowdhury et al. 2015; Cutter 2015). At several sites, Fishing Cats have been victims of road collisions (Miththapala 2006; Thudugala 2016; Prerna et al. 2016; Palei et al. 2018). Fishing Cat populations are detrimentally affected by increased anthropogenic disturbances and destruction of mudflats and crop fields (Chakraborty et al. 2020a).

Little is known about the contemporary status of the Fishing Cat in Pakistan, where it was photographed in just one locality in the Indus River basin (Islam et al. 2015). In India, the Fishing Cat is present in and around several albeit widely scattered protected areas (Singh 1982; Mukherjee et al. 2012; Nair 2012; Sadhu & Reddy 2013; Naidu et al. 2015; Malla 2016; Prerna et al. 2016; Talegaonkar et al. 2018). The Ganges-Brahmaputra River delta and Sri Lanka are presently considered Fishing Cat strongholds because of multiple locality records both inside and outside protected areas (Miththapala 2006; Mukherjee et al. 2012; Chowdhury et al. 2015; Das et al. 2017; Mukherjee et al. 2016; Kolipaka et al. 2019; Chakraborty et al. 2020a, b). Records of the Fishing Cat in Thailand, Myanmar, and Cambodia are, however, highly localised (Cutter & Cutter 2009; Rainey & Kong 2010; Thaung et al. 2018; Chutipong et al. 2019; Naing Lin & Platt 2019).

In Nepal, the Fishing Cat was listed as nationally Endangered in 2011, as the population was thought to comprise no more than 200 mature individuals (Jnawali et al. 2011). Since then, the Fishing Cat was recorded at several sites in the lowland Terai region (Fig. 1): in the Babai River valley in Bardia National Park (Yadav et al. 2018), in the surroundings of Jagdishpur Reservoir (Dahal 2016), in Chitwan and Parsa National Parks (Karki 2011; Mishra et al. 2018; Poudel et al. 2019) and in and around Koshi Tappu Wildlife Reserve (Pandey & Kaspal 2011; Taylor et al. 2016).

Here we report the first photographic evidence for the presence of a Fishing Cat population in Shuklaphanta National Park obtained during two monitoring surveys targeting the Tiger *Panthera tigris*.

STUDY AREA

Shuklaphanta National Park (ShNP) is a 305km^2 large protected area in the Terai of southwestern Nepal (Fig. 2), ranging in elevation from 174m in the south to 1,386m in the north-east (Bhuju et al. 2007). ShNP is bordered by farmland and settlements in the north, the Syali River in the east, and the Mahakali River in the south and west (Bharal & Inskipp 2009). In the south, ShNP is connected to Pilibhit Tiger Reserve in India through the Laggabagga corridor (Talukdar & Sinha 2013). The Kilpura–Khatima–Surai corridor to the west of the Mahakali River also connects ShNP to Pilibhit Tiger Reserve (Anwar & Borah 2020). The climate in this area is tropical savannah (Karki et al. 2016a) with temperatures ranging from 7–21 °C in January to a maximum of 37°C in May and 25°C in July (Timilsina & Heinen 2008). The area receives an annual rainfall of 1,055–2,843 mm, with more than 90% falling during the monsoon season between July and August (Pokheral & Wegge 2019).

The protected area consists of about 35% mixed deciduous forest, 30% Sal *Shorea robusta* forest and 35% open grasslands interspersed with wetlands (Pokheral & Wegge 2019). Grasslands called *phantas* occur mainly in the south-central part and are dominated by tall grasses such as *Imperata cylindrica* and *Heteropogon contortus; Phragmites karka* and *Saccharum spontaneum* grow around marshes and seven small lakes (Bharal & Inskipp 2009; Image 1). The national park hosts a diverse fauna including 28 fish species (Bhuju et al. 2007), 423 bird species (Bharal & Inskipp 2009), and Mugger *Crocodylus palustris* (Bhatt et al. 2012; Image 1). Nine turtle, 15 amphibian, 16 lizard, and 30 snake species have been documented to date (Rawat et al. 2020). Mammals are represented by Asiatic Elephant *Elephas maximus*, Greater One-horned Rhinoceros *Rhinoceros unicornis* (Talukdar & Sinha 2013), Hispid Hare *Caprolagus hispidus* (Yadav et al. 2008), Rhesus Macaque *Macaca mulatta*, Terai Gray Langur *Semnopithecus hector*, Chital *Axis axis*, Hog Deer *A. porcinus*, Indian Muntjac *Muntiacus muntjak*, Nilgai *Boselaphus tragocamelus*, and Wild Boar *Sus scrofa* (Pokheral & Wegge 2019). The phantas

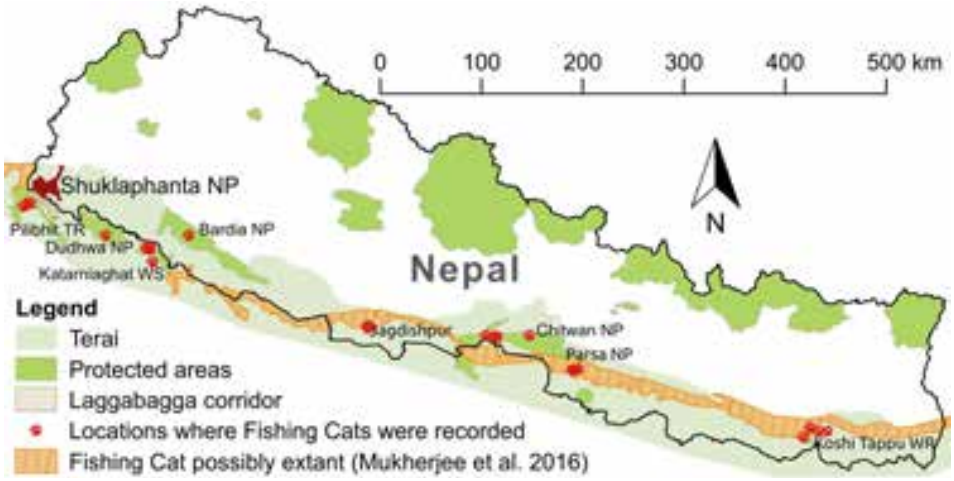

Figure 1. Terai with localities where the Fishing Cat has been recorded since 2010

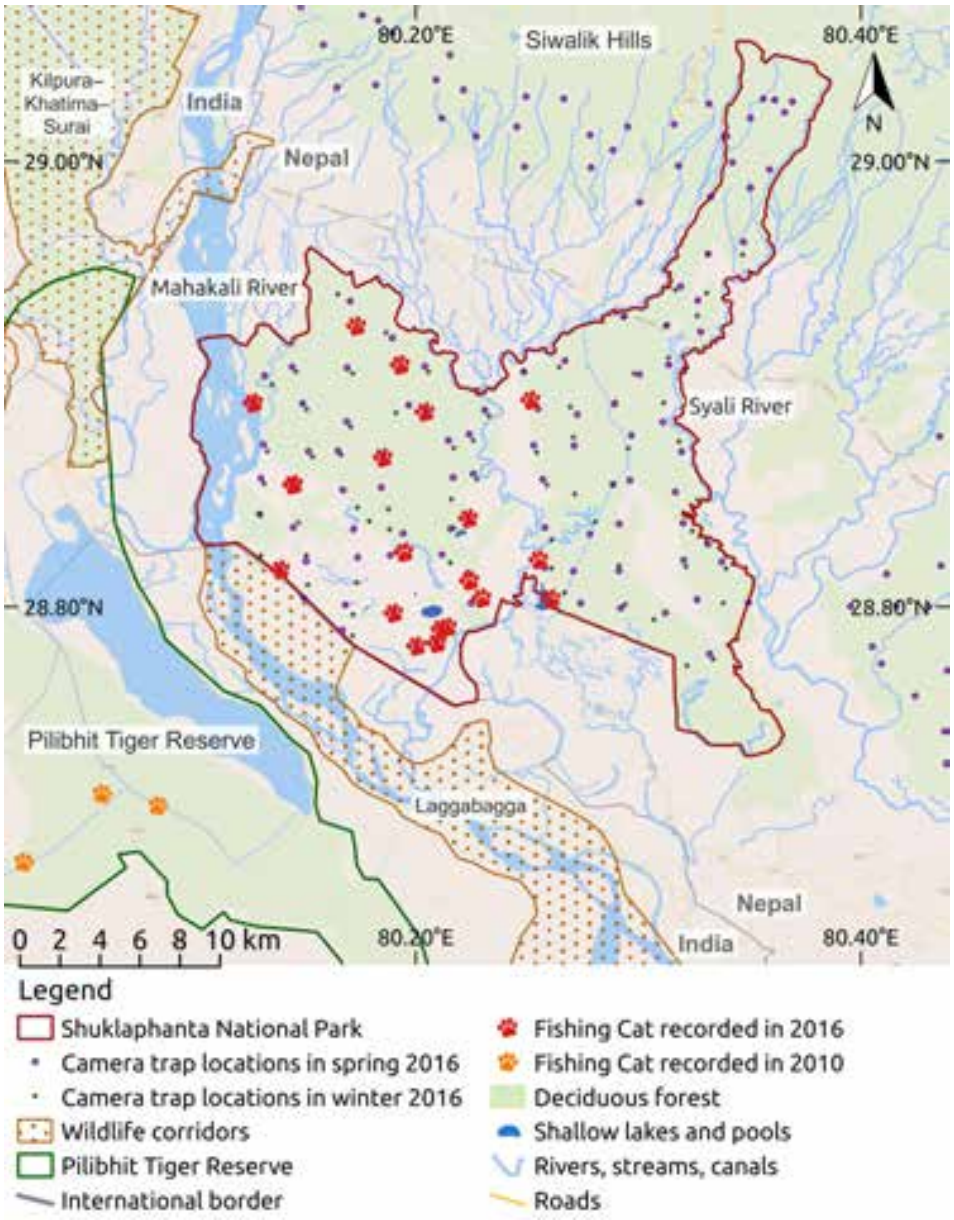

Figure 2. Shuklaphanta National Park and surroundings in the southwestern Terai

Image 1. Rani Tal, one of the shallow lakes in Shuklaphanta National Park. © Angie Appel

provide prime habitat for Nepal's last remaining Swamp Deer *Rucervus duvaucelii* herds (Pokheral & Wegge 2019). Since December 2008, cats recorded during camera trap surveys include Tiger, Leopard *Panthera pardus* (Pokheral & Wegge 2019), and Rusty-spotted Cat *Prionailurus rubiginosus* (Lamichhane et al. 2016).

MATERIALS AND METHODS

Three camera trap models were used during surveys: Reconyx 550, Bushnell Trophy Cam and Panthera V4. Each camera trap had a unique identification number for data recording and maintenance purposes. ShNP and adjacent forest corridors were superimposed with a grid of 2x2 km^2 cells that were searched for Tiger signs to determine suitable camera trap locations. Two camera traps were deployed as pairs facing each other at a distance of 6–12 m, henceforth termed station. The camera traps were mounted 45–60 cm above ground without any attractant. They were active for 24 hours and set to take between three and 12 photographs within an interval of one second followed by a video. Stations were placed between 1.5km and 2.9km apart from each other. The coordinates of locations were determined using a Garmin eTrex 64s device set to WGS 84 datum, and their elevations using the digital elevation model generated by the Space Shuttle Radar Topography Mission version 3 dataset that provides a 90-meter resolution (NASA JPL 2013). Inside ShNP, the stations were kept at locations for at least 15 days and were then moved to new locations. In the forest corridors outside of ShNP, they were kept at locations for six to seven days as local people collected firewood during the survey period. Habitat type and site parameters were collected at each location. Records of the Fishing Cat within an interval of 30 minutes between consecutive photographs are considered a notionally independent event.

RESULTS

The first survey session was carried out from 27 January to 26 April 2016 in 95 cells within the national park and in 67 cells in two forest corridors located to the northwest and east of the national park. The second survey session covered 85 cells from 23 November 2016 to 11 December 2016 inside the national park. The total survey effort during both sessions amounted to 3,404 camera trap days (Table 1).

The Fishing Cat was recorded at nine locations in 12 notionally independent events (NIE) during the first survey session (5.55% of locations), and at 15 locations in 18 NIE during the second survey session (17.65% of locations) (Table 2). These 24 locations range in elevation from 181m to 211m and encompass an area of about 144km^2 in the southwestern part of Shuklaphanta National Park. Seven locations were in proximity of less than 10m to a waterbody; 10 were between ~40m and 250m away from a waterbody; and the distance of seven locations to a waterbody was between ~500m and 2km. All photographs show solitary individuals that were recorded between early evening at 18.44h and early morning at 06.30h in 28 NIE. Two NIE were recorded in mid-morning, both at the same location in a grassland.

Table 1. Survey sessions and survey blocks in Shuklaphanta National Park and adjacent forest corridors, Nepal. The term 'camera trap day' refers to a 24-hour period.

Survey session	Survey block	Elevation range	Camera trap days
27 January–26 April 2016	Inside ShNP	174–917 m	1,503
	Brahmadev forest corridor	245–809 m	465
	Laljhadi forest corridor	179–361 m	465
23 November–11 December 2016	Inside ShNP	174–244 m	1,436

Table 2. Details of notionally independent events of Fishing Cat obtained in Shuklaphanta National Park between January and December 2016.

Date and time	Coordinates	Elevation and habitat
30.i.2016, 02.57h; 8.ii.2016, 06.19h	28.790°N & 80.211°E	182m; open riverine forest, resting on a wooden bridge over a creek (Image 2)
31.i.2016, 21.20h; 9.ii.2016, 19.33h	28.817°N & 80.139°E	185m; open grassland, <140m to a marsh
2.ii.2016, 19.03h	28.867°N & 80.185°E	202m; Sal forest, <140m to a creek
2.ii.2016, 21.09h	28.797°N & 80.190°E	189m; open riverine forest, <200m to a marsh
4.ii.2016, 05.37h	28.892°N & 80.127°E	198m; riverine forest, <4m to bank of Mahakali River
4.ii.2016, 10.02h; 7.ii.2016, 09.22h	28.784°N & 80.209°E	182m; open grassland, on a stream bank (Image 3)
5.ii.2016, 06.30h	28.840°N & 80.224°E	192m; dense Sal forest, <50m to a stream bank (Image 4)
6.ii.2016, 03.12h	28.855°N & 80.145°E	188m; forest road passing through a grassland interspersed with forest patches, <2km to Mahakali River
9.ii.2016, 18.44h	28.782°N & 80.200°E	181m; riverine forest interspersed with grasses, ~185m to a creek
25.xi.2016, 05.33h	28.891°N & 80.126°E	198m; mixed deciduous forest on bank of Mahakali River
26.xi.2016, 18.58h	28.812°N & 80.224°E	184m; forest patch in grassland, <1.5km to a marsh
26.xi.2016, 19.21h	28.909°N & 80.193°E	213m; Sal forest, <1km to a creek
26.xi.2016, 21.16h	28.804°N & 80.229°E	191m; riverine forest, <1.2km to a marsh
28.xi.2016, 06.17h; 29.xi.2016, 05.25h; 6.xii.2016, 23.13h	28.824°N & 80.195°E	186m; mixed deciduous forest patch, <500m to a marsh (Image 5)
29.xi.2016, 05.25h; 9.xii.2016, 23.19h	28.855°N & 80.145°E	189m; Sal forest patch in grassland, ~250m to a creek
30.xi.2016, 02.50h	28.784°N & 80.209°E	182m; riverine forest on bank of Mahakali River
1.xii.2016, 20.49h	28.893°N & 80.252°E	210m; Sal forest, ~250m to a creek
2.xii.2016, 20.10h	28.812°N & 80.224°E	184m; riverine forest on bank of Mahakali River
5.xii.2016, 02.40h	28.821°N & 80.255°E	190m; Sal forest, <40m to Syali River
6.xii.2016, 02.59h	28.909°N & 80.193°E	213m; Sal forest, ~40m to a stream
6.xii.2016, 04.07h	28.888°N & 80.204°E	206m; Sal forest, ~890m to a marsh
7.xii.2016, 03.19h	28.926°N & 80.173°E	221m; Sal forest, ~800m to a marsh
10.xii.2016, 21.29h	28.804°N & 80.261°E	193m; Sal forest on bank of lake
11.xii.2016, 04.47h	28.791°N & 80.214°E	185m; riverine forest, ~80m to a marsh (Image 6)

DISCUSSION

The survey sessions in 2016 yielded the first photographic evidence for the presence of a Fishing Cat population in ShNP. Solitary Fishing Cats were recorded at 24 locations in the south of the national park. These records contribute to reducing the information gap about the cat's distribution in the Terai.

In 2011, the Fishing Cat was not yet suspected to inhabit this protected area (Jnawali et al. 2011). As documented by the opportunistic records obtained in spring and winter 2016, the floodplain below the elevation of 250m provides suitable habitat for the cat. It was photographed foraging in the vicinity of stream banks, but also while wandering between shallow waterbodies in grassland and forest patches. These records are consistent in the Fishing Cat's habitat use with those in the similarly water-rich Dudhwa and Chitwan National Parks (Nair 2012; Mishra et al. 2018). Elsewhere in its range, it was also observed in a matrix of grass cover and shallow edges of waterbodies (Mukherjee 1989; Cutter 2015; Islam et al. 2015; Taylor et al. 2016; Angie Appel pers. obs. 04 February 2016; Malla et al. 2018; Naing Lin & Platt 2019).

The survey effort inside ShNP was concentrated on the floodplain in the south. We, therefore, emphasize that the absence of records of the Fishing Cat in the hilly landscape in the north does not indicate its absence there. For comparison, Bardia National Park extends over an area of 968km² in the Nepal Terai; since 2008,

Image 2. Fishing Cat resting on a wooden bridge over a creek in Shuklaphanta National Park on 30 January 2016. © Department of National Parks and Wildlife Conservation (DNPWC), National Trust for Nature Conservation (NTNC) and Zoological Society of London, Nepal (ZSL)

Image 3. Fishing Cat in a grassland in Shuklaphanta National Park on 4 February 2016. © DNPWC, NTNC and ZSL

camera trapping surveys have been conducted annually to bi-yearly for a duration of 2–3 months in 197–295 locations spread across the entire national park (Thapa & Khanal 2014; Thapa et al. 2015; Thapa & Sherchan 2016; Karki et al. 2016b; Bajracharya et al. 2017). Despite these extensive surveys, the Fishing Cat was recorded only in late 2016 in just one location in the vicinity of a riverbank (Yadav et al. 2018). The survey effort in the two forest corridors adjacent to ShNP was very likely too short to record the Fishing Cat. Furthermore, local people collected firewood in both corridors, which is why camera trapping was discontinued after a few days.

A Fishing Cat targeted survey in Koshi Tappu Wildlife Reserve yielded 5.94 notionally independent events per 100 camera trap nights with cameras set up only at night (Taylor et al. 2016). The rather low encounter rate of 0.88 notionally independent events per 100 camera trap days in ShNP during the two survey sessions is possibly due to the camera trapping design that was employed. A spacing between camera traps of 1.5–2 km placed

Table 3. Notable records of the Fishing Cat obtained during surveys targeting the Tiger in national parks (NP), wildlife sanctuaries (WS), and tiger reserves (TR) in the Indian and Nepal Terai.

Site and date of record	Source	Distance to next closest site where the Fishing Cat was recorded
Lansdowne Forest Division, Uttarakhand, India; 14.iii.2012	Abishek Harihar in litt. 25.x.2012	~175km north-west of Shuklaphanta–Pilibhit protected area complex
Dudhwa NP, Uttar Pradesh, India; 21.ii.–4.iv.2012	Nair (2012)	~60km south-east of Shuklaphanta–Pilibhit protected area complex
Katarniaghat WS, Uttar Pradesh, India; 8–27.iii.2011	Meraj Anwar in litt. 27.v.2011	~40km east of Dudhwa NP
Bardia NP, Nepal; 31.xii.2016 and 5.i.2017	Yadav et al. (2018)	~35km north-east of Katarniaghat WS
Parsa NP, Nepal; 8.iii.2016	Poudel et al. (2019)	~50km south-east of Chitwan NP

Image 4. Fishing Cat in a Sal forest patch in Shuklaphanta National Park on 5 February 2016. © DNPWC, NTNC and ZSL

along roads and wildlife trails is the usual design for documenting large carnivores (Pokheral & Wegge 2019). Apparently, the Fishing Cat does not frequent these beaten tracks and is therefore less readily recorded at such locations. The encounter rate of the Fishing Cat will probably increase by adjusting the survey design to focus on waterbodies, an experience also shared by Chakraborty et al. (2020b). Nair (2012) recommended a spacing of less than 1km between camera traps with increased emphasis near water for a Fishing Cat targeted survey. Mohd-Azlan & Thaqifah (2020) also advised to place camera traps closer to potential hunting grounds of a cat that exhibits a preference for waterbodies as well, the Flat-headed Cat *Prionailurus planiceps*. On the other hand, we recognise that such a survey design is more challenging to implement, especially in tall grasslands and marshy grounds. Placing camera traps in the many pools, puddles and lakes in ShNP is a rather adventurous endeavour due to Muggers and Greater One-horned Rhinoceroses hiding in these habitats.

In June 2010, the Fishing Cat was recorded in three locations in the adjacent Pilibhit Tiger Reserve in India (in Fig. 1; Meraj Anwar in litt. 27 May 2011). We, therefore, consider it likely that the Laggabagga corridor provides connectivity for this population unit across the Mahakali River. Colour-marked Greater One-horned Rhinoceroses were repeatedly recorded in this corridor moving between ShNP, Pilibhit Tiger Reserve and up to Kishanpur Wildlife Sanctuary and Dudhwa National Park, latter two located about 60km farther southeast

Image 5. Fishing Cat in a mixed deciduous forest patch on 28 November 2016. © DNPWC, NTNC and ZSL

Image 6. Fishing Cat in riverine forest on 11 December 2016. © DNPWC, NTNC and ZSL

(Talukdar & Sinha 2013; Thapa et al. 2013). Two male Tigers were also identified in both ShNP and this corridor (Chanchani et al. 2014). To the west of ShNP, the Fishing Cat is potentially present in the Kilpura–Khatima–Surai corridor (Mukherjee et al. 2016). Both Rusty-spotted Cat and Jungle Cat *Felis chaus* were recorded in this corridor in the late autumn seasons of 2012 and 2014 (Anwar & Borah 2020). In light of these circumstances, we would like to encourage surveyors to watch out for the Fishing Cat when working in these corridors.

In the late 1920s, Champion (1933) obtained one of the earliest camera trap records of the Fishing Cat in the Indian Terai, specifically in the area where the Ganges River leaves the Siwalik Hills and meanders into the Gangetic plains. Since then, several contemporary camera trap records of the Fishing Cat were obtained as by-catch during surveys targeting the Tiger in the Indian and Nepal Terai (Table 3).

To date, camera trap surveys targeting the Fishing Cat in the Terai were carried out only in the vicinity of Jagdishpur Reservoir (Dahal 2016), in Chitwan National Park (Mishra 2016; Mishra et al. 2018) and in Koshi Tappu Wildlife Reserve (Taylor et al. 2016). All these records shed important light on the Fishing Cat's distribution and habitat use. Some of them (Talegaonkar et al. 2018; Yadav et al. 2018) indicate that its range is wider than estimated by Mukherjee et al. (2016). Yet, little is known about its ecology and conservation needs in these sites and beyond the borders of protected areas.

The Terai is a water-rich region with innumerable small seasonal streams and perennial rivers passing through; most of the streams originate in the Siwalik Hills north of the Terai (Champion 1933; Bhuju et al. 2007; Anwar & Borah 2020). The Nepal Terai alone harbours 163 wetlands (Bhuju et al. 2007). Mukherjee et al. (2016) collated unsurveyed areas across the Terai that are potentially suitable for the Fishing Cat (Fig. 1). In one of these areas, its presence was corroborated by Poudel et al. (2019) in the very south of Parsa National Park.

Still, large wetland areas and waterbodies remain to be surveyed in the region to determine the population size, survival rate and conservation needs of the Fishing Cat. As a large part of these areas is situated in human-influenced and -dominated landscapes, we strongly recommend to also assess the quality of wetland habitats and use by local people, especially in the vicinity of aquaculture sites. As documented by Haque & Vijayan (1993) inside a protected area, the Fishing Cat preys mainly on fish, but also on birds, small mammals, amphibians and reptiles. Fundamental aspects of the Fishing Cat's diet and trophic relations in human-dominated landscapes are still lacking and urgently need to be updated through in-depth investigations in future survey sites.

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COMMUNICATION

The Rusty-spotted Cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hillaire, 1831) (Mammalia: Carnivora: Felidae) in Rajasthan, India – a compilation of two decades

Satish Kumar Sharma [1] & **Meenu Dhakad** [2]

[1] Chakariya Amba, Rampura Choraha, Jhadol Road, Udaipur, Rajasthan 313004, India.
[2] Tiger Watch, Maa Farm, Ranthambhore Road, Post Khilchipur, Rajasthan 322001, India.
[1] sksharma56@gmail.com, [2] dhakad13@gmail.com (corresponding author)

Abstract: In Rajasthan, the presence of the Rusty-spotted Cat *Prionailurus rubiginosus* was first reported in 1994 in Udaipur District, the southernmost district of Rajasthan. Since then, it was also recorded in four more districts scattered over an area of about 86,205km^2. We compiled information about the occurrence of the Rusty-spotted Cat in Rajasthan based on direct sightings, road kills, rescued kittens, and camera trap images. Our data set shows that the Rusty-spotted Cat is also present in eight more districts of Rajasthan that form part of the Aravalli Hills and Vindhyan Hills in the semi-arid zone of eastern Rajasthan. The area encompassed by these records amounts to 71,586km^2. Kittens were rescued in six instances. Adult cats were recorded in 45 instances including 41 live cats and four roadkills. Ten adult live Rusty-spotted Cats were sighted in the mornings, and 31 were recorded after dark between late evenings and early mornings. They were recorded in eight habitat types including foremost thorny and dry deciduous forests, but also ravines and agricultural fields adjacent to forests, and in forest patches in the vicinity of human settlements. The preservation of forests is of utmost importance for the long-term viability of the Rusty-spotted Cat. We strongly recommend surveys outside protected areas to determine the connectivity between Rusty-spotted Cat population units in Rajasthan.

Keywords: Aravalli Hills, camera trapping, distribution, sightings, small wild cat, Vindhyan Hills.

सारांश: राजस्थान के दक्षिणी चोर पर स्थित उदयपुर जिले में 1994 में रस्टी-स्पॉटिड कैट (*Prionailurus rubiginosus*) की प्रथम उपस्थिति दर्ज की गयी थी। इसके बाद 86,205 वर्ग किमी क्षेत्र में फैले चार और जिलों में इसकी उपस्थिति दर्ज हुई। तत्पश्चात हमने राजस्थान में इसकी उपस्थिति जानने हेतु प्रत्यक्ष अवलोकन, सड़क पर दुर्घटना में मार गए, विपदा में फसे बचाये बिलौटे तथा कैमरा ट्रैप में दर्ज हुए प्राणियों के चित्र इकट्ठे किये गए। हमारे द्वारा संगृहीत तथ्यों से यह स्पष्ट हुआ है की रस्टी-स्पॉटिड कैट राजस्थान के आठ और जिलों में भी उपस्थित है, जो अरावली एवं विंध्यन पर्वतमाला तथा पूर्वी राजस्थान के अर्ध-शुष्क क्षेत्र हैं। जिन क्षेत्रों में इस बिल्ली की उपस्थिति दर्ज हुई है उनका फैलाव 71,586 वर्ग किमी क्षेत्र तक है। अध्यन्न के दौरान छह बार बिलौटे बचाये गए। वयस्क बिल्लियां 45 बार दर्ज की गयी जिनमे 41 जीवित तथा चार सड़क दुर्घटना में मृत पायी गई। दस व्यस्क जीवित बिल्लिंयाँ सुबह देखि गयी एवं 31 अँधेरे के समय देर शाम और शुरुआती सुबह में देखि गई। ये बिल्लियां आठ प्रकार के आवासों में देखी गई, जिनमें कांटेदार और शुष्क पर्णपाती वन सबसे प्रमुख हैं, लेकिन ये कंदरा क्षेत्र, वनों के निकट स्थित कृषि क्षेत्र एवं मानव आबादियों के पास स्थित वन कुंजों में भी देखी गई। रस्टी-स्पॉटिड कैट के दीर्घकालीन बचाव हेतु वन संरक्षण सबसे जरूरी है। हम राजस्थान में रस्टी-स्पॉटिड कैट की संख्या इकाइयों के सम्बन्ध को निर्धारित करने हेतु संरक्षित क्षेत्रों के बाहर इसके सर्वेक्षण की पुरजोर अनुशंषा करते हैं।

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INTRODUCTION

The Rusty-spotted Cat *Prionailurus rubiginosus* is native to India, Sri Lanka, and southern Nepal (Pocock 1939; Nowell & Jackson 1996; Prater 1998; Kittle & Watson 2004; Appel 2016; Lamichhane et al. 2016). Across its range, it is closely associated with forest habitats (Nowell & Jackson 1996; Mukherjee 1998; Patel 2006; Appel 2016; Lamichhane et al. 2016; Nimalrathna et al. 2019; Bora et al. 2020; Chatterjee et al. 2020). Since 2016, it is listed as Near Threatened on the IUCN Red List of Threatened Species (Mukherjee et al. 2016). For decades, the knowledge about its distribution was based on anecdotal sightings in Jammu & Kashmir (Chakraborty 1978), Madhya Pradesh (Digveerendrasingh 1995), Odisha (Acharjyo et al. 1997), Maharashtra (Dubey 1999; Athreya 2010), Gujarat (Digveerendrasingh 1987; Pathak 1990; Singh 1998; Chavan et al. 1999), Rajasthan (Tehsin 1994; Sharma 2007), Karnataka (Kumara & Singh 2007), Tamil Nadu (Pillay 2008), and Andhra Pradesh (Manakadan & Sivakumar 2006; Behera 2008). Since camera traps are widely used in wildlife surveys, it was photographed in multiple locations in Uttar Pradesh (Anwar et al. 2010, 2012), Haryana (Ghaskabdi et al. 2016), Chhattisgarh (Basak et al. 2018), and Punjab (Kanwar & Lomis 2020).

In Rajasthan, the Rusty-spotted Cat was first reported in the outskirts of Udaipur City, where an individual was killed on a road passing through a forest patch (Tehsin 1994; Sharma 1999). Several sightings in subsequent years confirmed its presence in the vicinity of Udaipur (Bhatnagar et al. 2000; Sharma et al. 2006; Sharma 2007). Rusty-spotted Cats were also sighted in two tiger reserves of the state, namely Sariska (Sharma 1998; Mukherjee 1998, 2013) and Ranthambhore (Reddy 2002; Verma 2008; Khandal & Khandal 2015) in Alwar and Sawai Madhopur Districts, respectively. A road kill was reported in Bundi District (Nayak et al. 2017), and sightings in Bharatpur District (Singh et al. 2017).

Large forest tracts in India lie outside protected areas and are subject to conversion for other land uses, a development that negatively impacts the Rusty-spotted Cat population in the country (Mukherjee et al. 2016). To conserve vital forest habitat in Rajasthan, it is important to understand how well the Rusty-spotted Cat is established throughout the state; however, nothing is known to date about its presence in other districts of the state. We address this knowledge gap by providing new information about the occurrence of Rusty-spotted Cat across Rajasthan. Our collation consists of direct sightings, road kills, rescues and camera trap records obtained between August 2000 and March 2020.

STUDY AREA

Rajasthan is the largest state in India, with an area of 342,239km^2 in the north-western part of the country (Roy & Jakhar 2002). In the north-west, Rajasthan is bordered by Pakistan, in the north and north-east by the Indian states of Punjab, Haryana and Uttar Pradesh, in the east by Madhya Pradesh and in the south by Gujarat (Roy & Jakhar 2002). The most striking geological feature of Rajasthan is the Aravalli Hills, spanning at least 2,500 million years of the Earth's history (Roy & Purohit 2015). The Aravalli Hills intersect Rajasthan from north-west to south-east over about 800km and are bounded by the Thar Desert in the west and the Vindhyan Plateau in the east (Roy & Jakhar 2002). The average elevation of the Aravalli Hills is 550–670 m, with the highest peak rising to 1,722m (Roy & Jakhar 2002). The main forest types in Rajasthan are dry deciduous forest covering 12,850km^2, thorn forest in 2,536.5km^2, dry savannah in 593.5km^2 and broad-leaved hill forest in 153.8km^2 (Krishna & Reddy 2012). Forests are classified into three categories, viz., reserve forest, protected forest, and un-classed forest as per provisions of Rajasthan Forest Act, 1953 (Government of Rajasthan 1953). Sariska, Ranthambhore, and Mukundara Hills National Parks are managed under Project Tiger (Bhardwaj & Sharma 2013; Singh & Reddy 2016). Except Desert National Park and Tal Chhapar, all the other protected areas of the state are either confined to the Aravalli Hills or east of this hill range (Sharma 2006).

While pursuing the study, a particular focus was given to Udaipur's surrounding districts, where the Rusty-spotted Cat was first observed, namely Rajasmand, Banswara, Dungarpur, Pratapgarh, Pali, Sirohi, Chittorgarh, and Bhilwara.

The northern and central Aravalli Hills from Alwar to Ajmer Districts have *Anogeissus pendula*, *Acacia senegal*, and *Acacia catechu* forests on hilly slopes, while *Boswellia serrata* forests are confined towards upper reaches (Champion & Seth 1968; Mathur 1996; Sharma & Koli 2014). Patches of thorny forest and *Euphorbia caducifolia* bushes are present in drier areas (Champion & Seth 1968; Mathur 1996; Bhandari 1990; Sharma 2011). The southern Aravalli Hills support mostly mixed forests, Teak *Tectona grandis* forests, *Anogeissus latifolia* forests and dry bamboo breaks (Champion & Seth 1968; Mathur 1996; Sharma 2011). *Butea monosperma* forests are confined to foothills (Champion & Seth 1968; Mathur 1996; Sharma 2011). *Anogeissus pendula* and *Acacia catechu* forests are also present in the Vindhyan Hills (Champion & Seth 1968; Mathur 1996).

The climate in the Thar Desert of western Rajasthan is characterized by extreme temperatures and drought with cold winters and freezing temperatures (Bhandari 1990). January is the coldest month with average mean temperatures ranging from 12°C to 17°C (Sharma & Tiagi 1979). Mean monthly temperatures in April to June vary from 34–40°C in the west of the Aravalli Hills to 28–32°C in the south (Sharma & Tiagi 1979; Shetty & Singh 1987). Diurnal temperatures rise to 32°–47°C in May and June, which are the hottest months (Sharma & Tiagi 1979). The south-east Asian monsoon brings rain during the months of June to September (Prakash et al. 2015), varying from 100–400mm in the west (Bhandari 1990; Sharma 2011) to over 1,300mm in the east (Prakash et al. 2015). Mount Abu in the southwestern part of the Aravalli Hills is the only hill station of the state, and receives a maximum rainfall of 700–1,250 mm per year (Bhandari 1990; Shetty & Singh1987; Sharma 2002).

MATERIAL AND METHODS

Opportunistic and sometimes planned surveys were conducted across Rajasthan from 2000 to 2020: to collect the data related to occurrence of the species, the following methods were adopted; direct sightings, rescue, road kill, and camera trap records. The first author was an officer of the Rajasthan Forest Department and worked in various districts. Whenever a Rusty-spotted Cat was encountered during patrolling and routine duties, notes were made about the date and time, location, surrounding habitat, sex of the individual, and its activity at the time of sighting. Camera trap records include those obtained by the Rajasthan Forest Department and by Tiger Watch, an organisation that has been working in Ranthambhore Tiger Reserve since 1997. Tiger Watch runs a program called Village Wildlife Volunteers (VWV) in collaboration with the Rajasthan Forest Department. VWV have been installing Cuddeback Attack camera traps in the peripheral areas of the reserve since 2015. The camera traps are mounted at 45–50 cm above ground on trees or poles along mud roads, animal trails and dry stream beds at a distance of 1–1.5 km between locations. All locations are situated in forest, grassland and ravine habitats. They are active only by night for 12 hours and are set to trigger images with a minimum delay of five seconds. VWV check them daily to download data, ensure proper functioning and replace drained batteries. The coordinates of locations are determined using a Garmin eTrex device. Until April 2020, camera traps were deployed at 200 locations in an area of 2,000km^2 amounting to 79,310 camera trap nights.

We defined three age groups, namely kittens with closed eyes (I1), kitten with eyes opened (I2), and adults (A). When possible, we measured body length from snout to vent (BL), tail length from anus to tip of the tail (TL) and weight (Wt) of rescued cats, and determined their sex as female (F) or male (M) by close observation of their external sex organs. The sex identification of directly sighted and photographed animals remained unknown (UN).

RESULTS

We report 51 records of the Rusty-spotted Cat in 30 locations across 13 districts of Rajasthan (Fig 1; Table 1). These records comprise 21 direct sightings (41.18% of all records), 20 camera trap images (39.22%), six rescues (11.76%) and four road kills (7.84%). The cats were recorded in thorny and dry deciduous forest at 17 locations (56.67% of all), and in the outskirts of human settlements at five locations (16.67%). Two locations (6.67%) were in ravines and two (6.67%) in agricultural fields adjoining forest areas. One each was in Teak forest, broad-leaved semi-evergreen hill forest, a fruit orchard and a public park in a densely populated human habitation (3.33% respectively). The area encompassed by the 30 locations of these records amounts to 71,586km^2.

Kittens were rescued in six instances (11.8% of all records), all of them in the mornings. Adult cats were recorded in 45 instances (88.2%), including 41 live cats (80.4%) and four found killed on roads (7.8%). The live adult cats were recorded by day between 06.09h and 11.56h in 10 instances (24.4% of all live cats) and after dark between 19.00h and 05.29h in 31 instances (75.6%).

DISCUSSION

Our compilation of records shows that the Rusty-spotted Cat inhabits thorny and dry deciduous forest tracts in the Aravalli and Vindhyan Hills from the districts of Jaipur in the north to Banswara in the very south. We did not learn of any sightings in Thar Desert to the west of the Aravalli Hills, although the first author used to work there. It is neither included in the faunal list of the Thar Desert (Prakash 1963, 1964). We therefore assume that it is absent in this part of Rajasthan due to

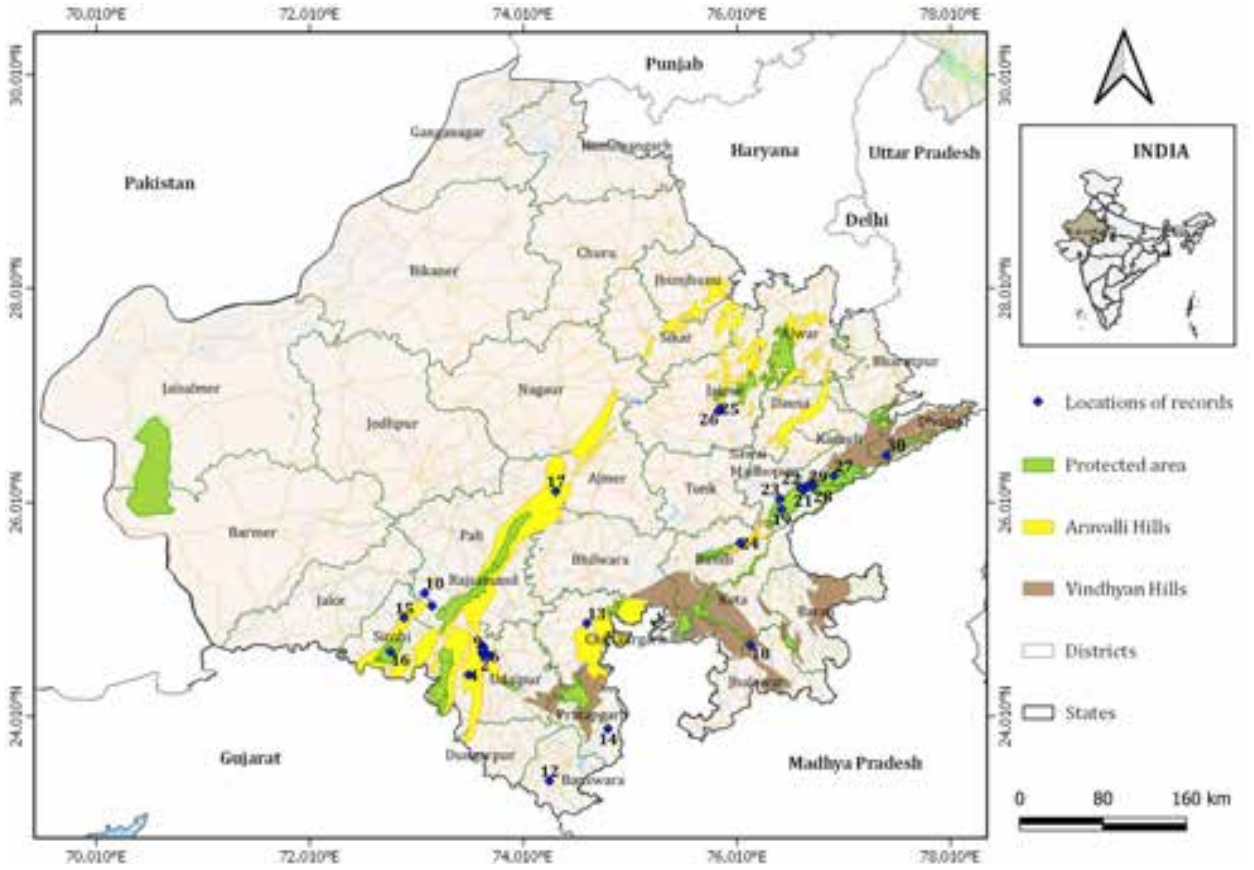

Figure 1. Records of the Rusty-spotted Cat in Rajasthan.

Image 1. Rusty-spotted Cat recorded on 14 October 2018 in Jaipur District, Rajasthan. © Jaipur Forest Department

Image 2. Rusty-spotted Cat found dead beside road on 27 October 2019 in Jaipur District, Rajasthan. © Nirav Bhatt

the arid climate with sand dunes and sparse vegetation. However, we think it possible that it may be recorded in future in this area as the habitat is expected to change from xeric to mesic due to the construction of the Indira Gandhi Canal (Prakash 1986; Chandrakasan et al. 2010).

We did not learn of any records in the districts of Dausa, Tonk, Rajsamand, Bhilwara, Baran, and Jhalawar in the east of the Aravalli Hills, despite the presence of dry deciduous forest. Rajsamand, Baran, and Jhalawar

Table 1. Records of the Rusty-spotted Cat based on direct sighting (D), camera trap image (C), rescue (R), road kill (K) in Rajasthan. Numbers in the table correspond to numbers in Figure 1.

No. on map	Date and time	Type of record	Age and sex	Location	Habitat at location	Activity of the cat at the time of observation
Udaipur District						
1	19.viii.2000, 15.00h	D	A, M	Foothills of Thur Magra forest block, Udaipur East Forest Range near Fateh Sagar Lake	Thorny and dry deciduous forest dominated by *Acacia senegal*, *A. leucophloea* and *Boswellia serrata*	It was injured and sick. It was captured, kept in Gulab Bagh Zoo, treated and released on 25.viii.2000 in the same habitat.
2	10.xi.2007, 08.30h	R	I2, F BL 21cm, TL 9cm	Gorella village near Udaipur City	Fruit orchard amidst a hilly forest	The kitten was wailing continuously
3	16.iii.2008, 20.00h	D	A, UN	Foothills of Sajjangarh Wildlife Sanctuary	Thorny and dry deciduous forest	A single individual sitting on a 0.60m high boundary parapet wall of the sanctuary
	1.vii.2008, 19.00h	D	A, UN			A single individual crossed the road
	2.viii.2008, 22.00h	D	A, UN			A single individual was sitting on a 0.60m high boundary parapet wall
	22.viii.2008, 21.00h	D	A, UN			A single individual walked on the road near the sanctuary
	5.xii.2008, 23.00h	D	A, UN			A single individual at a carcass dump in outskirts of Sajjangarh Wildlife Sanctuary
	7.vi.2009, 20.00h	D	A, UN			A single individual fed on a trampled *Calotes versicolor* on the road near sanctuary
	30.viii.2011, 20.30h	D	A, UN			A single individual and a Leopard *P. pardus* were sitting on the same boundary wall of the forest at a distance of only 50m from each other
	13.iii.2014, 21.00h	D	A, F			A single individual was sitting on a 0.60m high boundary parapet wall of the sanctuary
4	18.iv.2008, 16.00h	K	A, F	Near village Surana on Ubheshwar – Jhadol road	Agriculture fields adjacent to forest areas	Roadkill
5	14.x.2008, 19.35h	D	A, UN	Eastern part of Sajjangarh Wildlife Sanctuary	Thorny and dry deciduous forest dominated by *Boswellia serreta*	A single individual sitting on the boundary wall of the sanctuary
	7.i.2009, 20.00h					
	17.iii.2009, 21.45h					
	16.vi.2009, 21.45h					
6	11.ii.2009, 19.45h	D	A, UN	Gulab Bagh, Udaipur	Public park inside densely populated human habitation	A single individual crossed the road and climbed a *Cassia fistula* tree. Several sightings in the zoo premises
7	13.ix.2009, 08.00h	K	A, F	Chunaveri Kaler Forest Block, near village Gorela	Thorny and dry deciduous forest dominated by *Acacia senegal*, *A. leucophloea*, *A. catechu*, *Ziziphus nummularia* and *Boswellia serrata*	A road kill on Ubeshwar road. During post mortem, a full developed female embryo was found in the uterus
8	5.v.2010, 20.00h	D	A, UN	Tirol Village near Dhol-Kamol, Tehsil Gogunda	Outskirts of human habitation	A single individual in a fallow agricultural field
9	3.iii.2014, 08.00h	D	A, F	Foothills of Thur Magra forest block, Udaipur Forest Range near Fateh Sagar Lake	Thorny and dry deciduous forest dominated by *Acacia senegal*, *A. leucophloea* and *Boswellia serrata*	A single individual crossed the road. The stretch of road is generally busy with sharp curves, often prone to accidents
Pali District						
10	19.viii.2012, 08.30h	K	A, UN	Sumerpur	Outskirts of human habitation	Roadkill observed by Parbat Singh Champawat, Forest Range Officer, pers. comm. 19.viii.2012
11	19.iv.2016, 20.30h	D	A, UN	Dudni village, near Jawai Dam	Thorny and dry deciduous forest dominated by *Prosopis juliflora*	An individual crossed the road, photographed by Deputy Conservator of Forests Balaji Kari

No. on map	Date and time	Type of record	Age and sex	Location	Habitat at location	Activity of the cat at the time of observation
Banswara District						
12	19.xi.2010, 08.30h	R	I2, M, F	Bhagtol Forest Block, Range Ghatol	Teak forest	Two wailing kittens in the forest without mother in sight. After waiting the whole day for their mother to return, the forest staff eventually rescued and fostered the kittens. One died on 21.xi.2010 and another on 25.xi.2010
Chittaurgarh District						
13	15.ix.2013, 09.00h	R	I1, F BL 14.5cm, TL 5.5cm, Wt. 96g	Chittaurgarh	Outskirts of human habitation	One abandoned wailing kitten was found in the outskirts of the city
Pratapgarh District						
14	22.x.2014, 10.00h	R	I2, UN	Arnod	Agriculture fields adjoining forest	Two abandoned wailing kittens sighted by Forest Department staff
Sirohi District						
15	31.vii.2015, 10.00h	R	I2, UN	Sirohi	Thorny and dry deciduous forest dominated by *Acacia senagal* and *Anogeissus pendula*	An abandoned kitten brought to Udaipur zoo
16	1.xii.2018, 21.00h	C	A, UN	Mount Abu	Broad-leaved semi-evergreen hill forest	10 camera trap photos
Ajmer District						
17	30.vii.2016, 11.00h	R	I2, UN	Beawar	Thorny and dry deciduous forest dominated by *Acacia senegal*	Two abandoned wailing kitten sighted by the forest staff
Kota District						
18	11.x.2019, 06.19h	C	A, UN	Mashalpur forest block, Mukundara Hills National Park	Thorny and dry-deciduous forest	An individual recorded (T. Mohanraj pers. comm. 15.iii.2020)
Sawai Madhopur District						
19	8.v.2013, 20.30h	D	A, UN	Near Bodal Village	Outskirts of human habitation	An individual crossed the road and climbed an *Acacia leucophloea* tree (Dharmendra Khandal pers. comm. 15.iii.2020)
20	16.xii.2014, 20.30h	D	A, UN	On the periphery of Ranthambore National Park near helipad	Thorny and dry deciduous forest dominated by *Anogeissus pendula*	An individual appeared to be searching for food, climbed a tree after being noticed (Dharmendra Khandal pers. comm. 15.iii.2020)
21	24.v.2015, 11.18h	C	A, UN	Amalideh near Banas River	Ravines	An individual recorded by camera trap
22	21.xi.2019, 05.10h	C	A, UN	Talda Village	Ravines	An individual recorded by camera trap
23	11.i.2020, 20.30h	D	A, UN	Ranthambhore National Park near helipad	Thorny and dry deciduous forest dominated by *Anogeissus pendula*	A single individual was sitting on boundary wall of the park (Dharmendra Khandal pers. comm. 15.iii.2020)
Bundi District						
24	20.ii.2019, 04.52h	C	A, UN	Near a perennial water source in Sakhawada area	Thorny and dry deciduous forest dominated by *Anogeissus pendula*, *Acacia*, *Grewia tenax*	An individual recorded by camera trap
Jaipur District						
25	14.x.2018, 05.29h	C	A, UN	Jhalana Leopard Safari Park	Thorny and dry deciduous forest dominated by *A. pendula*	An individual recorded by camera trap (Shri Sudarshan Sharma, Deputy Forest Officer, Wildlife, Jaipur, pers. comm. 15.iii.2020) (Image 1)
26	27.x.2019, 15.00h	K	A, UN	Jhalana	Outskirts of human habitation	Roadkill observed by Nirav Bhatt pers. comm. 15.iii.2020 (Image 2)

No. on map	Date and time	Type of record	Age and sex	Location	Habitat at location	Activity of the cat at the time of observation
Karauli District						
27	6.iii.2016, 20.30h	D	A, UN	Near Marmda ghati, Kailadevi Wildlife Sanctuary (KWS)	Thorny and dry deciduous forest with sparse *A. pendula*	An individual crossed the road and climbed a tree
28	28.xi.2017, 11.56h	C	A, UN	Khaadka Ughena, KWS	Thorny and dry deciduous forest ~ 200m away from a seasonal stream	An individual recorded by camera trap (Image 3)
	15.xi.2018, 06.09h	C	A, UN			
	29.iii.2019, 11.00h	C	A, UN			
	3.iv.2019, 01.33h	C	A, UN			
	11.v.2019, 11.43h	C	A, UN			
	3.vi.2019, 03.32h	C	A, UN			
	7.x.2019, 04.57h	C	A, UN			
	28.x.2019, 02.00h	C	A, UN			
	1.xi.2019, 08.53h	C	A, UN			
	7.xii.2019, 02.50h	C	A, UN			
	23.iii.2020, 09.32h	C	A, UN			
29	4.i.2020, 01.52h	C	A, UN	Tipkan ghati in KWS	Thorny and dry deciduous forest dominated by *A. pendula*	An individual recorded by camera trap
	5.i.2020, 02.21h	C	A, UN			
Dholpur District						
30	20.ii.2020, 03.55h	C	A, UN	Dhamoh Khoh, near Sarmathura	Thorny and dry deciduous forest with *Capparis decidua*, *Boswellia serrata*, *Butea monosperma*, ~ 100m away from a stream	An individual recorded by camera trap

Image 3. Rusty-spotted Cat recorded on 3 April 2019 in Karauli District, Rajasthan. © Tiger Watch

have protected forests, whereas forests in Dausa, Tonk, and Bhilwara are not protected. To date, no camera trapping survey was carried out in these forests. In view of our records of the Rusty-spotted Cat in thorny and dry deciduous forests in other parts of the Aravalli and Vindhyan Hills, we consider it likely that it will be recorded there as well in future surveys.

Most of the adult cats were recorded after dark, confirming the foremost nocturnal activity of the Rusty-spotted Cat observed in other study areas (Mukherjee 1998; Chavan et al. 1999; Kittle & Watson 2004; Kumara & Singh 2007; Patel 2006; Anwar et al. 2010, 2012; Vyas & Upadhyay 2014; Aditya & Ganesh 2016; Ghaskadbi et al. 2016; Lamichhane et al. 2016; Basak et al. 2018). Cats sighted at night in Sajjangarh Wildlife Sanctuary, Jhalana Leopard Safari Park and Ranthambhore National Park, however, were resting, either sitting or walking on boundary and parapet walls. On one occasion, both Rusty-spotted Cat and Leopard were observed sitting on the same parapet wall at a distance of only 50m from each other. This observation was made in the rainy season when the ground was covered with thick and tall grasses, which may hinder the cat's vision on the ground. On one occasion, the cat was observed on Ronjh trees *Acacia leucophloea* and other thorny tree species. Ronjh is a thorny 6–8 m high tree with sharp stipular spines up to 3.5cm long (Shetty & Singh 1987). Despite the presence of spines on stem and branches, the cat was observed comfortably perched on a branch. These observations were in concurrence with the cat's semi-arboreal behaviour (Nowell & Jackson 1996; Kumara & Singh 2007; Vasava et al. 2012; Mukherjee & Koparde 2014), and preference for dense forest cover (Bora et al. 2020; Chatterjee et al. 2020).

We found nine kittens between July and November, indicating that females give birth in the warm season. Females under captive conditions also gave birth in January, April, and July to October (Dmoch 1997).

We found four Rusty-spotted Cats killed on roads in

20 years. Increased road networks and vehicular traffic may pose a threat, as road kills were also observed in other areas (Digveerendrasingh 1995; Dubey 1999; Behera 2008; Vyas & Upadhyay 2014; Adhikari et al. 2019). Especially at night, the cat was observed to venture on roads to scavenge on roadkills, which increases the risk of getting hit by vehicles. Significant preventive measures are required to prevent the Rusty-spotted Cat from falling victim to road accidents. Patrolling staff should be trained to check incidents of roadkills and dumped cattle carcasses and remove them from roads passing through forests. Other measures like proper waste disposal system from roadside hotels and small roadside food restaurants, provisions of culverts and underpasses at intervals on highways, water hole facilities away from the roads, and speed signs for drivers, may prevent roadkills of not just Rusty-spotted Cat but also of many other species crossing roads.

The Forest Department should initiate training for staff to identify the Rusty-spotted Cat correctly, so that sighting data can be compiled and reported in future. Intensive camera trap studies are needed in other districts and forests of the state to determine the connectivity between population units in Rajasthan. In view of loss and fragmentation of habitat being the most serious threat to the Rusty-spotted Cat (Mukherjee et al. 2016), it is imperative to preserve forest tracts. To date, little is known about the Rusty-spotted Cat's movement pattern, reproduction and diet in the wild. In-depth studies on these aspects of the Rusty-spotted Cat's ecology are essential to promote adequate conservation measures.

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Author details: Satish Kumar Sharma, an expert on Rajasthan biodiversity, he retired as Assistant Conservator of Forests, with Doctorate on "Weaver birds and Plant relationship" and another on "Biodiversity of Phulwari Sanctuary". He has authored more then 600 research and popular articles and 10 books. Meenu Dhakad is working with Tiger Watch as a conservation biologist after completing her Master's degree in the conservation of biodiversity. She is passionately involved with conservation education, research, and community in the Ranthambhore to conserve wildlife. She has been part of various research projects of Rajasthan Forest Department.

Author contribution: Satish Kumar Sharma—data collection and paper writing. Meenu Dhakad—data collection, paper writing and Map making.

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COMMUNICATION

Male residency of Sunda Clouded Leopard *Neofelis diardi* (Cuvier, 1823) (Mammalia: Carnivora: Felidae) in a peat swamp forest, Indonesian Borneo

Lynn Pallemaerts [1], Adul [2], Ici P. Kulu [3], Karen Anne Jeffers [4], David W. Macdonald [5] & Susan Mary Cheyne [6]

[1] Department of Biology, Lund University, Sölvegaten 37, 22362 Lund, Sweden.
[2, 4, 6] Borneo Nature Foundation, Jalan Bukit Raya 82, Bukit Raya, Palangka Raya 73112, Central Kalimantan, Indonesia.
[3] Deceased, UPT LLG-CIMTROP, Jl. Yos Sudarso, Kampus UNPAR Tunjung Nyahu, Palangka Raya, Central Kalimantan, Indonesia.
[5] WildCRU, Department of Zoology, University of Oxford, The Recanati-Kaplan Centre, Tubney House, Tubney, OX13 5QL UK.
[6] Gibbs Building G2.23, Department of Social Sciences, Oxford Brookes University, Headington, Oxford, OX3 0BP, United Kingdom.
[1] lynn.pallemaerts@gmail.com (corresponding author), [2] adul@borneonature.org, [4] k.jeffers@exeter.ac.uk.,
[5] david.macdonald@zoo.ox.ac.uk, [6] s.cheyne@borneonature.org

Abstract: The Sunda Clouded Leopard *Neofelis diardi* is the apex predator on the island of Borneo, yet little is known of its ecology. We document the length of residency of male Sunda Clouded Leopards in Central Kalimantan, Indonesian Borneo. Over 10 years, camera trap data have been obtained in the Sebangau peat swamp forest in a study area of ~ 105km^2. We identified 11 individuals (eight males, one female, and two with unknown sex), from 152 notionally independent photographs. On average, males remained in the study area for 39.3 months (SE 8.3), or 3.3 years (SE 0.7), ranging from less than a month of residency up to 71 months. Females were infrequently recorded, possibly as a result of human disturbance and/or high male densities. Our results reveal that even a 10-year dataset is inadequate to answer some basic ecological questions, emphasising the importance of long-term monitoring of this species.

Keywords: Camera trap, Kalimantan, male sex-bias, social organisation.

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INTRODUCTION

The rainforests of Sumatra and Borneo harbour one of the least known cat species (Allen et al. 2016): the Sunda Clouded Leopard *Neofelis diardi* (Wilting et al. 2006). This medium-sized cat weighs 11–25 kg and is thought to be adept to climbing because of its broad paws and long tail (Wilting et al. 2006). On Borneo, it occupies the role of the apex predator, being the largest of five cat species on the island (Cheyne & Macdonald 2011).

The Sunda Clouded Leopard inhabits primary and selectively logged dipterocarp forest, peat swamp forest, and mangroves (Hearn et al. 2016). Borneo's forests have been heavily affected by logging, conversion to plantations and fire since the early 1970s (Gaveau et al. 2014). This habitat loss coupled with illegal hunting of wild prey is considered a serious threat to the Sunda Clouded Leopard (Wilting et al. 2006), resulting in a decreasing population (Hearn et al. 2015). Since 2015, the Sunda Clouded Leopard is listed as Vulnerable on the IUCN Red List (Hearn et al. 2015), and rapid and efficient conservation measures are necessary.

Research effort has already increased, but studying the Sunda Clouded Leopard remains a challenge (Hearn et al. 2013). It is rare, elusive, and predominantly nocturnal (Adul et al. 2015). The increase in camera trapping for ecological studies, however, has somewhat alleviated this problem.

The Sunda Clouded Leopard is solitary, and assumed to be territorial (Allen et al. 2016), however, this assumption is based on little empirical evidence, and results of recent research indicate that home ranges of males overlap (Allen et al. 2016; Pallemaerts et al. 2019). A similar social organisation was identified in some other felid species such as Leopard Cat *Prionailurus bengalensis* (Grassman et al. 2005), Leopard *Panthera pardus* (Odden & Wegge 2005), Jaguar *P. onca* (Harmsen et al. 2009; Guilder et al. 2015), and Tiger *P. tigris* (Goodrich et al. 2010). This spatial organisation involves a combination of temporal avoidance and tolerance towards conspecifics (Grassman et al. 2005; Harmsen et al. 2009; Núñez-Pérez 2011).

We describe the residency of male Sunda Clouded Leopards that were recorded on camera trap between 2008 and 2018 in a peat swamp forest in Kalimantan, Indonesia.

STUDY AREA

We conducted this study in a portion of the 550km^2 Natural Laboratory for Peat Swamp Forest (NLPSF), nested within the tropical peat swamp forest of Sebangau in Central Kalimantan, Indonesia (Fig. 1). This area of approx. 5,600km^2 is the largest area of contiguous forest remaining in Kalimantan (Cheyne et al. 2013). The NLPSF is seasonally flooded from October to June, and is one of the deepest peat swamp forests in the world with a peat depth of 3–26 m (Page et al. 1999). The forest has a history of logging concessions, illegal logging, drainage and wildfire (Cheyne 2010; Cheyne & Macdonald 2011), but has been protected as a national park since 2004 (Cheyne 2010). Due to past exploitation and disturbance, it is a patchwork of pristine and recovering forest (Page et al. 1999).

MATERIAL AND METHODS

In May 2008, an extensive and continuous camera trap survey was started within the NLPSF. It is still running and is, therefore, the longest-running camera trap survey on Borneo. Over the years, we used six camera trap models including Cuddeback Expert, Cuddeback IR, Cuddeback Ambush IR, Maginon WK 3 HD, Crenova RD100, and Bushnell NatureView HD.

For this study, only data between May 2008 and February 2018 were used. At the start of the survey, we planned to place camera traps in a systematic grid in the study area, and this was achieved in the forest immediately surrounding the base camp (Fig. 1). Due to the difficult terrain, however, such a grid was not practical in the areas further away from base camp, and so, over the years, short expeditions were undertaken to set up several camera trap stations in areas of interest within the NLPSF, resulting in a clumped trapping grid (Fig. 1). As a result, we placed camera traps at 94 different locations between 2008 and 2018 and sampled an area of 104.8km^2 (i.e. 19.1%) of the NLPSF, as determined by the polygon formed by the outermost locations (Fig. 1). Most locations were sampled for two or three months, but sometimes 1–2 years, within this 10-year period, while other locations have been sampled almost continuously since 2008, with an average sampling duration of approximately 21 months for a single location. On average, the cameras were located at a distance of 2.7 ± 0.6 km from each other. Because of the close proximity between stations, the clumped array of cameras, and uneven distribution of sampling across our

study area, we checked the independent photographs for spatial autocorrelation using Moran's index I (Sokal & Oden 1978) in ArcMap 10.3 with weights for pairs of neighbouring stations computed using the inverse distance between the respective camera trap stations. Camera trap photographs were spatially independent at all stations, with Moran's index over the entire survey period (2008–2018) being non-significant (I = 0.043, p = 0.87).

Where possible, we placed the camera traps in pairs at a distance of 7–10 m from each other, henceforth termed station, to allow for simultaneous photographs of both sides of Sunda Clouded Leopards. We installed the stations along transects, animal trails, boardwalks, natural bridges, or watering holes to maximize photographic rates. If insufficient cameras were available, they were placed singly. We deployed each camera at about 50cm above ground and protected them with a simple plastic box from rainfall and potential destruction by wildlife. In the early years of the camera trap survey, the stations were checked every two weeks to change batteries and retrieve memory cards; later, due to improvements in battery life, they were checked every 40 days.

We identified individual Sunda Clouded Leopards based on their unique coat patterns and, when possible, sexed them based on secondary sexual traits. For each individual, a capture history was made based on the number of notionally independent photographs each year (Fig. 2), where a photograph was considered notionally independent if it was taken at a different station than the previous one, or if there was at least a 10-minute interval between two photographs at the same station. We defined the residency of individual Sunda Clouded Leopards as the number of continuous months and years each individual was recorded during the entire study period and estimated it using the dates of first and last detection within the study area. We categorised an individual as resident if it was recorded for at least six continuous months, a length of time that was judged to reflect site attachment by Hemker et al. (1984) and Zimmermann et al. (2005). We categorised individuals present in the area for less than this period as transient individuals.

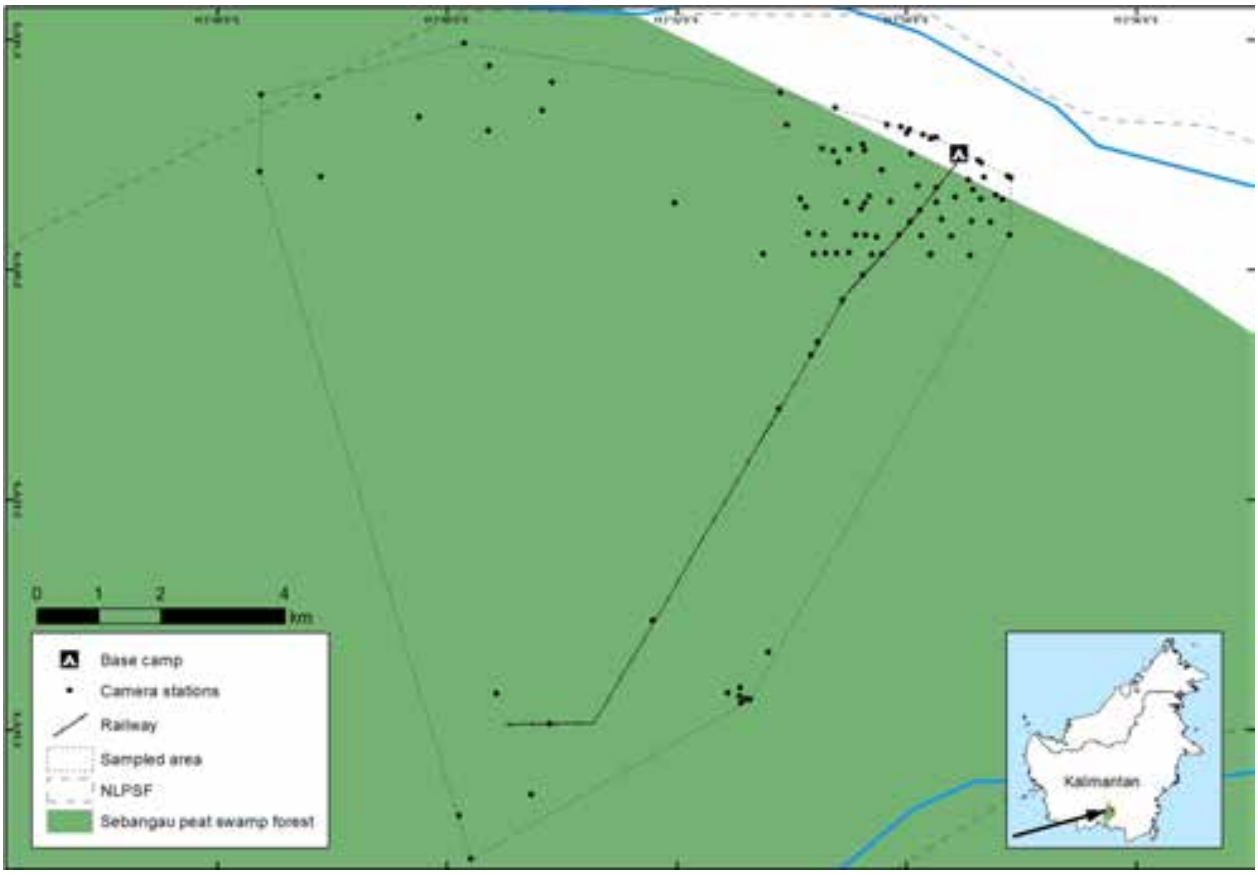

Figure 1. Study area within the NLPSF in Central Kalimantan, Indonesian Borneo.

RESULTS

During the entire study period, we obtained 152 notionally independent photographs of Sunda Clouded Leopards in more than 55,075 traps nights. Eight of these photographs were not clear enough to be attributed to any known individual, and were excluded from further analyses. From the remaining 144 independent photographs, we were able to identify 11 individuals (Table 1). Eight were male, one was female, and two could not be sexed. The number of individual photographs for individuals ranged from one to 32, with a mean at 13.1 (SE 3.7) records per individual.

Time spent living in the study area ranged from less than a month up to 71 months. We identified eight individuals that were present for at least six months in the study area, and three transient individuals. The mean residency of the eight resident individuals was 39.3 months (SE 8.3 months) or 3.3 years (SE 0.7 years) with a range of nine to 71 months. All but one residents were males.

The number of individuals present within the study area each year varied from one to five, and averaged 2.8 (SE 0.5). During one year, individuals were recorded between once and 19 times across the study area (Fig. 2). Several camera traps were visited by different males, with an average of 1.5 (SE 0.1) males visiting the same location in a six-month period.

DISCUSSION

On average, resident males seem to remain in our study area for approximately three years, before ceasing to be detected by camera traps. Short gaps in an individual's detection record may indicate that it evaded camera traps (M1 and M4), whereas longer gaps (M3 and M5) could indicate genuine periods of absence (Fig. 2). The reason for these absences are unknown. As our study area is located close to a hard border of the overall habitat, the Sebangau River, it may be possible that our camera traps were positioned at the edge of the individuals' home ranges, and short gaps in detection could indicate that the individuals spent some time in their core range.

In our study area, four males appeared to overlap (M2, M3, M4, and M5 all overlap amongst themselves; Pallemaerts et al. 2019). This suggests some combination of temporal partitioning and tolerance, as also reported for the Leopard Cat (Grassman et al. 2005) and Jaguar (Harmsen et al. 2009; Guilder et al. 2015). We did not record any instance of wounds that indicate fighting. Several photographs revealed instances of olfactory communication like urine spraying, cheek rubbing and tree scratching, all of which have been interpreted as territorial behaviour by Allen et al. (2016). They could equally function in the maintenance of temporal avoidance.

Another, more striking, result of our camera trap survey was the low detection rate of female Sunda Clouded Leopards. Over the course of 10 years, we

Table 1. Summary of all adult Sunda Clouded Leopard detections within the study area from May 2008 until February 2018. Individuals were classified as residents if they were recorded in the study area for longer than six months. One captive-born individual released in the study area was excluded from this analysis.

ID	Sex	No. of notionally independent photographs	First detection	Last detection	Residence (months)	Status
M1	M	9	3.vii.2008	28.vii.2011	36	Resident
M2	M	29	14.viii.2008	25.xii.2011	40	Resident
M3	M	20	4.xi.2009	29.x.2015	71	Resident
M4	M	32	3.xi.2009	20.viii.2015	69	Resident
M5	M	29	26.x.2013	25.i.2018	51	Resident
M6	M	3	14.ii.2014	14.ii.2014	0	Transient
M8	M	11	6.xi.2014	5.xi.2016	24	Resident
M9	M	3	9.x.2016	8.xii.2017	14	Resident
F1	F	2	8.x.2009	9.x.2009	0	Transient
ID1	?	1	5.x.2014	5.x.2014	0	Transient
ID2	?	5	25.xii.2013	8.ix.2014	9	Resident

M—male | F—female | ?—unknown sex.

Image 1. Cumulus (M3), the longest resident male Sunda Clouded Leopard in our study area. He stayed in the NLPSF for 71 months. © Susan M. Cheyne

Image 2. Nimbus (F1), the only female photographed by camera traps in the NLPSF between 2008 and 2018. © Susan M. Cheyne

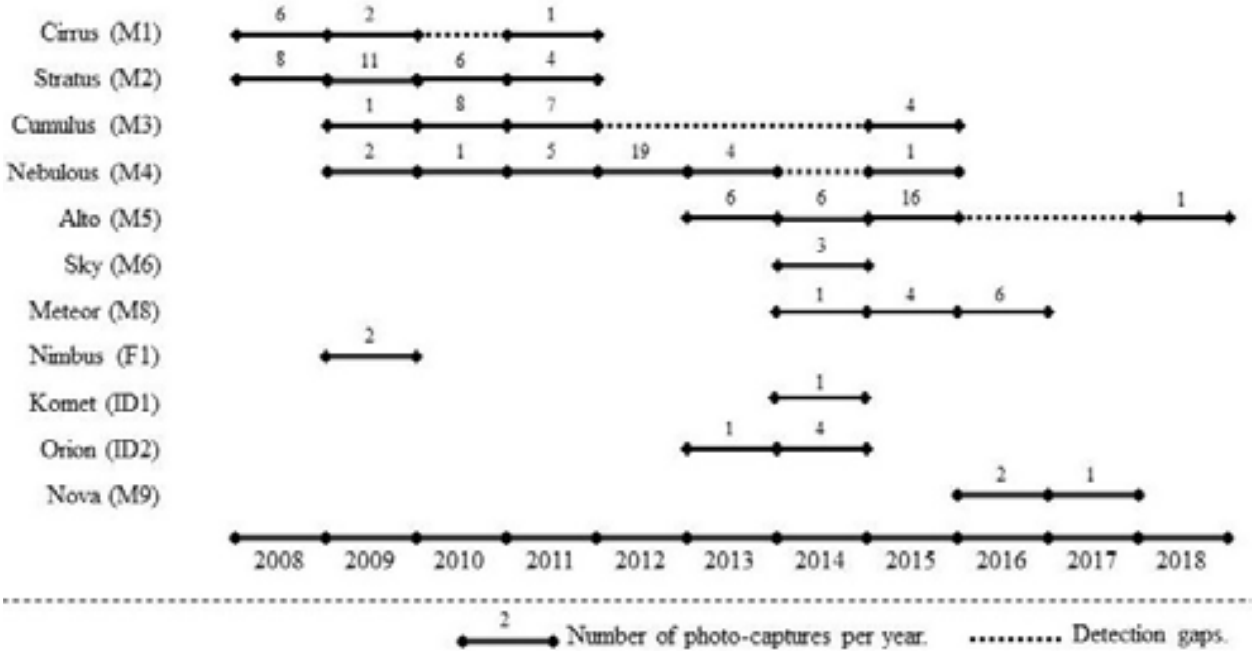

Figure 2. Residency of all Sunda Clouded Leopards identified within the NLPSF. The numbers above each line indicate the number of independent captures during the respective year. Dotted lines indicate gaps in the captures of individuals.

were able to identify only one female, namely F1 (Image 2). This male-biased detection is recurrent in studies on both Sunda Clouded Leopard and mainland Clouded Leopard *Neofelis nebulosa* (Cheyne & Macdonald 2011; Wilting et al. 2012; Cheyne et al. 2013; Sollmann et al. 2014; Mohamad et al. 2015; Hearn et al. 2017), and has been noted for the Jaguar (Harmsen et al. 2009) and the Leopard (Gray & Prum 2012) as well. To date, only Borah et al. (2014) reported a more balanced detection of both Leopard and mainland Clouded Leopard females and males, based on a camera trapping design that covered the 300km^2 large study area homogeneously. The lack of photographs of females may be due to their spending more time in trees (Wilting et al. 2012) and avoiding trails and forest edges, which may affect their detectability (Cheyne et al. 2013). Adult female Sunda Clouded Leopards weigh only half as much as adult males (Nájera et al. 2017), adding to the likelihood of niche separation (Quentin Phillipps pers. comm. 10 September 2018). While there is no evidence to date

that Sunda Clouded Leopards move in the canopy, there have been reports of them hunting in trees (Matsuda et al. 2008; Wilcox et al. 2016). We recommend to place camera traps in a systematic grid to enhance the chances for a more balanced representation of both sexes of the Sunda Clouded Leopard in future studies. The possibility of spatial segregation between females and males, and their different exposure and reactions to disturbance, are all factors relevant for planning adequate conservation measures, and thus merit further investigation.

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COMMUNICATION

Clouded Leopard *Neofelis nebulosa* (Griffith, 1821) (Mammalia: Carnivora: Felidae) in illegal wildlife trade in Nepal

Yadav Ghimirey [1] & **Raju Acharya** [2]

[1, 2] Friends of Nature, PO Box 23491, Sundhara, Kathmandu, Nepal.
[1] mustela.altaica@yahoo.com (corresponding author), [2] rajuhugu_13@yahoo.com

Abstract: We document trade of the Clouded Leopard *Neofelis nebulosa* in Nepal based on pelt seizure reports published in wildlife trade reports and in newspapers. Just 27 cases in three decades seem little to suggest targeted illegal trade of the species, the seizure information in recent years indicate that illegal trade of Clouded Leopard body parts is still taking place. Hence an in-depth assessment is necessary to understand properly the intensity and magnitude of illegal trade on Clouded Leopard in the country.

Keywords: Kathmandu, pelts, seizures, skin trade.

हामीले नेपालमा वन्यजन्तु व्यापारसँग सम्बन्धित प्रतिवेदनहरू साथै पत्र पत्रिकामा आएका ध्वाँसे चितुवाको छाला जफत गरिएका घटनाहरूको आधारमा नेपालभित्र यस प्रजातिको अवैध व्यापारको अध्ययन गरेका छौं । तिन दशकमा जम्मा २७ वटा मात्र व्यापारका घटनाले यस प्रजातिलाइ नै तोकेर व्यापार हुने निर्क्यौल गर्न गार्हो भएपनि हालसम्म पनि यस्ता व्यापारका घटनाहरू भएकाले यसको व्यापार भने चलिरहेको देखाएको छ । त्यसकारण यस प्रजातिको नेपालमा हुने व्यापारको विविध आयामहरुको बारेमा अध्ययन हुन जरूरी देखिएको छ ।

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Author contribution: YG and RA collected the data and wrote the article.

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INTRODUCTION

The Clouded Leopard *Neofelis nebulosa* is a medium-sized felid native to southern and southeastern Asia from the Himalayan foothills in Nepal to China in the east and the Malay Peninsula in the south (Grassman et al. 2016). It inhabits primary forests (Ghose 2002; Grassman et al. 2005; Borah et al. 2010; Gray & Phan 2011; Shafi et al. 2019), but was also recorded in secondary and logged forests (Azlan & Sharma 2006; Mohamad et al. 2015; Grassman et al. 2016). In the Himalaya, the Clouded Leopard has been recorded up to an elevation of 3,720m (Sathyakumar et al. 2011; Than Zaw et al. 2014; Penjor et al. 2018; Can et al. 2019; Letro & Duba 2019).

In Nepal, the Clouded Leopard was photographed for the first time in Chitwan; the individual was radio collared and monitored for a few days before it was lost (Dinerstein & Mehta 1990). The first camera trap photographs were obtained in Shivapuri Nagarjun National Park in 2010 (Pandey 2012). It was also photographed in Annapurna Conservation Area (Ghimirey et al. 2013, 2019), Chitwan National Park (Lamichhane et al. 2014), Parsa National Park (Poudel et al. 2019), and Langtang National Park (Can et al. 2019).

The Clouded Leopard is listed as Vulnerable in the IUCN Red List (Grassman et al. 2016). In Nepal, it is protected under the National Parks and Wildlife Conservation Act 1973 and Forest Act 1993 (Aryal 2004) and listed as Endangered in the National Red List of Nepal (Jnawali et al. 2011). Until at least 2006, a person found guilty of killing protected wildlife in Nepal was punishable with imprisonment from five to 15 years, a fine of 50,000–100,000 Nepali Rupees, or both (Aryal 2004; Banks et al. 2006). The fine was increased to 500,000–1,000,000 Nepali Rupees in 2017 (Government of Nepal 2017).

Body parts of *Panthera* species felids detected in the illegal wildlife trade between 1996 and 2008 constituted about 26% of mammal product seizures during this period (Rosen & Smith 2010). China was identified as one of the major destinations for the illegal trade in body parts of Tiger *Panthera tigris* and Leopard *P. pardus* (Banks et al. 2006; Oswell 2010; Nijman & Shepherd 2015; Nijman et al. 2019). Body parts of Clouded Leopards were also found in wildlife markets in Myanmar (Oswell 2010; Nijman & Shepherd 2015). In Nepal, occasional seizures of Clouded Leopard skins and other body parts were reported indicating the presence of an illegal trade (Shakya et al. 1999; Shrestha 2012). China is considered to be the possible destination for body parts of many other species (Shakya et al. 1999).

Here we present a compilation of cases of Clouded Leopard pelts found in Nepal.

MATERIALS AND METHODS

We carried out a search of both published and grey literature on illegal wildlife trade in Nepal. Newspapers and digital portals were also searched for relevant information on illegal trade of Clouded Leopards. Photographic evidence was sought to confirm the seizure of the target species. Publications on illegal wildlife trade like Wildlife Conservation Nepal (WCN)'s newsletters and South Asian Wildlife Enforcement Network (SAWEN) Bulletin were also searched. Any information available was cross-checked with available photographs and also by contacting relevant people related with the cases. We also contacted experienced field biologists regarding any possible Clouded Leopard related trade incidents. We were not able to contact the convicted poachers and relevant law enforcement personnel for individual cases due to the logistical difficulty at the time of COVID-19 pandemic.

RESULTS

We found a total of 27 cases of Clouded Leopard traded between November 1988 and March 2020 (Table 1; Figure 1). Eight of these were reported in newspapers and digital news portals, four in trade survey reports and five in trade related newsletters. Two records involved trade of six live cubs, and the remaining cases involved the trade of Clouded Leopard pelts.

Clouded Leopard pelts were seized in a total of nine districts in Nepal, including Dang, Kanchanpur, Kathmandu, Kavrepalanchowk, Lamjung, Sankhuwasabha, Siraha, Tanahu, and Taplejung districts (Figure 2). In two cases (8% of all), Clouded Leopard body parts were offered for sale, and three pelts (12% of all) found in rural houses were not explicitly offered for sale. In 21 cases (80%), body parts were seized, and poachers and traders arrested.

DISCUSSION

Our search yielded 27 cases of body parts encountered in Nepal in 32 years. Assuming that at least three skins were needed to make one coat, we reason that these 27 cases comprised at least 51 individual Clouded Leopards.

Table 1. Details of Clouded Leopard trade documented between 1988 and 2020

Year	Parts	Circumstance and location of case	Source of information
1988	Four coats and one hat	Shop catering to tourists in Thamel, Kathmandu	Barnes (1989)
1991	One pelt	Discovered with a hunter in Sunumla, Sankhuwasabha District	Ghimirey & Acharya (2017)
1992	Two coats	Shop catering to tourists in Thamel, Kathmandu	Van Gruisen et al. (1992)
1994	Three live cubs	Confiscated at Tribhuvan International Airport, Kathmandu; trader was arrested.	Shakya et al. (1999)
03.iii.1996	Three live cubs	Confiscated at Bagbazar, Kathmandu; offender was sentenced to five years prison and a fine of 100,000 Nepali Rupees.	Shakya (2004)
2006	One pelt	Killed in retaliation at Zhongim, Taplejung District; skin was kept in private house.	Badri Vinod Dahal in litt. 04 February 2010
2007	One pelt	Kathmandu	Wildlife Conservation Nepal Seizure Database (2017)
13.vi.2008	One pelt	Seized in Malekhu on the highway to Kathmandu; three people were arrested.	WCN (2008)
2009	One pelt	Kathmandu	WCN (2017)
xii.2009	One pelt	Found in a local house in Chyamtang, Sankhuwasabha District	Ghimirey et al. (2012)
xii.2009	One pelt	Found in a local house in Hatiya Village, Sankhuwasabha District (Image 1)	Ghimirey et al. (2012)
2011	One pelt	Confiscated in Shuklaphanta, Kanchanpur District; four traders were arrested.	DNPWC (2011)
2011	One pelt	Seized in Kathmandu; one person was arrested.	Shrestha (2012)
2012	One pelt	Seized in Manamaiju, Kathmandu; one person was arrested.	WCN (2017)
2013	One pelt	Seized in Khadbari, Sankhuwasabha District; one person was arrested.	Prabhat Pal in litt. 13 February 2014
10.vi.2014	One pelt	Seized in Bhakundebesi, Kavrepalanchowk District; two poachers were arrested.	Adhikari (2014)
2014	One pelt	Kathmandu	WCN (2017)
06.i.2015	One pelt	Confiscated in Gongabu, Kathmandu; poacher was arrested.	Baral (2015)
19.x.2016	One pelt	Seized in Kirtipur, Kathmandu; one person was arrested.	Baral (2016)
2017	One pelt	Seized in Besisahar, Lamjung District; one person was arrested.	Mahesh Paudel pers. comm. 28 July 2020
18.i.2018	Three pelts and bones	Seized in Aabukhaireni, Tanahu District; two people were arrested	Paudyal (2018)
iii.2018	One pelt	Found in a local house in Topke Gola, Taplejung District	Sandesh Lamichhane pers. comm. 27 October 2020
21.ix.2018	One pelt	Seized in Boudha, Kathmandu; three people were arrested	Baral (2018)
23.ix.2018	One pelt	Seized in Mhepi, Kathmandu; trader was arrested.	Koirala (2018)
26.ix.2019	Two pelts	Seized from poacher in Lahan, Siraha District; one person was arrested.	Yadav, S. (2019)
12.v.2019	One pelt	Seized in Bhalubang, Dang District; three people were arrested.	Sharma (2019)
09.iii.2020	Two pelts	Seized in Phaktanglung, Taplejung District; one man was arrested.	Koirala (2020)

This result indicates that the Clouded Leopard may be threatened in the country by illegal hunting. The figure is not extremely high, however, it is thought that seizures happen only in less than 9% of total cases in wildlife trade (Niraj 2009), which points to the fact that the actual number in the trade might be much higher than the cases presented. While our collation of data seems to be a small sample size, the true number of Clouded Leopards poached in Nepal is possibly grossly under-estimated. Furthermore, it is difficult to assess the temporal trend of this trade as the seizure data is dominantly consistent across most years. In view of three pelts detected in rural houses, we surmise a lack of awareness among rural people about the Clouded Leopard's legal status as protected species and the penalties in place against poachers and traders.

The low frequency of observations of Clouded Leopard body parts might be due to our opportunistic survey or to actual low intensity of trade in Clouded Leopard in Nepal. Nepal Police only recently established a special wing that exclusively deals with illegal wildlife trade. The non-existence of an enforcement agency in the past decades might explain the low frequency of Clouded Leopard seizures in the past. In contrast, open sales of Clouded

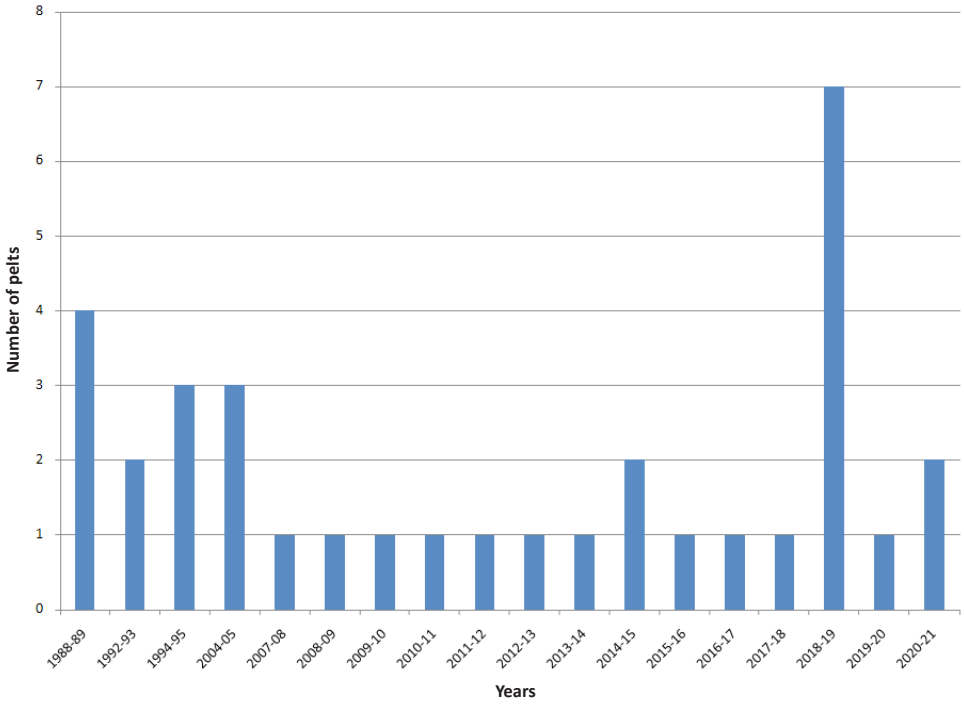

Figure 1. Clouded Leopard body parts encountered in Nepal between 1988 and 2020.

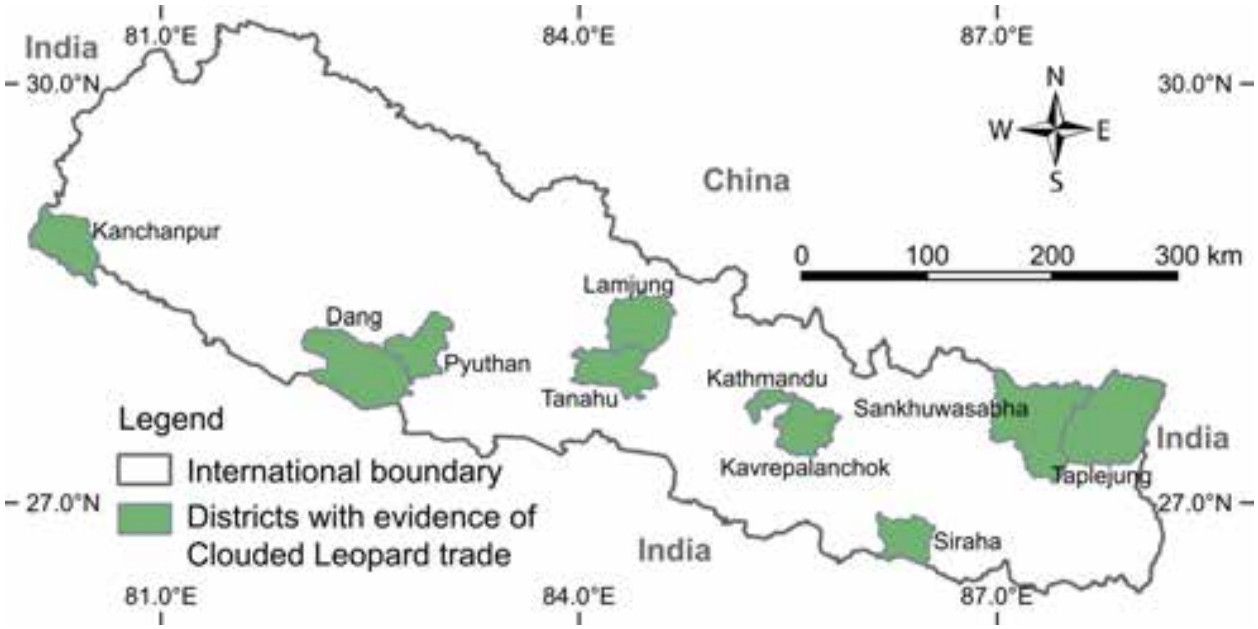

Figure 2. Districts where Clouded Leopard body parts were traded.

Leopards and pelts in wildlife markets of Myanmar and Laos are fairly common (Shepherd & Nijmann 2008; Oswell 2010). During surveys in 1991 to 2006, Shepherd & Nijman (2008) observed 301 Clouded Leopard parts in wildlife markets in Myanmar. Oswell (2010) observed 149 Clouded Leopard pelts at Mong La and Tachilek markets in Myanmar between 2001 and 2010.

We did not find any report of a Clouded Leopard pelt and body part openly displayed for sale in a market or in the vicinity of an international border. Banks et al. (2006) neither reported a case of Clouded Leopard parts confiscated in India, Nepal and Tibet. We, however, stress that the lack of evidence for cross-border smuggling of Clouded Leopard parts between Nepal and Tibet is not

a proof for the absence of such a trade. As described by Li et al. (2000), illegal trade of body parts of mammals and birds continued in China's Himalayan region across the borders with Pakistan, India, Nepal, and Myanmar at least until the late 1990s.

The detection of Clouded Leopard cubs apparently brought from India seems to be an exceptional case. However, with only two incidences of live trade and no live seizures after 1996, we assume that the trade in live Clouded Leopard is opportunistic. Understanding the origin of pelts will be an important step forward in understanding the spatial pattern of the trade in the country. The origin of most pelts, however, is difficult to trace due to the logistical difficulty to track down convicted poachers. One pelt seized in Dang District in 2019 was supposedly brought from Pyuthan District based on the statement provided by the person arrested with the pelt. Provided this statement is true, the westernmost occurrence of the Clouded Leopard in Nepal would be around 100km farther west of Annapurna Conservation Area. This protected area is currently the northwesternmost known area with photographic records of the species in Nepal (Ghimirey et al. 2018). In 2011, one pelt was confiscated in Kanchanpur District, the southwesternmost district in Nepal, but the origin of the pelt could not be determined. One pelt observed in Sankhuwasabha District was presumably bought in a village of the same district, which indicates a possible trade within Nepal. We do not have any information regarding price dynamics of Clouded Leopard pelts and body parts.

Illegal trade on Clouded Leopard and its body parts is not a well-researched topic in Nepal. In 2017, all seized wildlife trophies were destroyed including two Clouded Leopard pelts, 4.5kg decayed pelts and 0.19kg of bones (Dhakal et al. 2018). This action was supposed to ensure that these products do not enter the market in any way and served as a message to wildlife traders that wildlife derivatives have no value (Dhakal et al. 2018).

Other aspects of this trade like origin, price range of pelts and body parts and people involved in the trade are equally important to understand the dynamics of this trade. Hence, we strongly recommend to keep track of trade related records of Clouded Leopard to understand the trend of this trade, possible trade routes and destinations in order to guide strategic enforcement efforts on the species in the future. Further concerted effort on status survey of the species is also essential.

Image 1. Clouded Leopard skin found in December 2009 in Sankhuwasabha District. © Binod Ghimire

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COMMUNICATION

Anaesthetic, clinical, morphometric, haematological, and serum chemistry evaluations of an Andean Cat *Leopardus jacobita* (Cornalia, 1865) (Mammalia: Carnivora: Felidae) before release in Bolivia

L. Fabián Beltrán-Saavedra [1], Rolando Limachi Quiñajo [2], Grace Ledezma [3], Daniela Morales-Moreno [4] & M. Lilian Villalba [5]

[1] Wildlife Conservation Society, Programa de Conservación del Gran Paisaje Madidi, Tambopata, La Paz Casilla 3-35181, Bolivia.
[2,3,4] Vesty Pakos Municipal Zoo, Wildlife Conservation and Management Area, La Paz Av. La Florida s/n, Bolivia.
[1,5] Andean Cat Alliance, Bolivia.
[1] fbeltran@wcs.org (corresponding author), [2] limachirolando@gmail.com, [3] amzeled@gmail.com, [4] da.moralesmoreno@gmail.com, [5] lilianvi@gmail.com

Abstract: The Andean Cat *Leopardus jacobita*, one of the most rare and endangered feline species in the world, is distributed from central Peru to central Argentina. The aim of this study was to evaluate the health and morphometry of a subadult male Andean Cat that was rescued from wildlife trade in Bolivia and held captive for 165 days before being released back into its natural habitat. Physical immobilizations followed by anaesthesia using ketamine hydrochloride (KH) and xylazine hydrochloride (XH) were performed to obtain clinical, morphometric, haematological and serum chemical parameters. Physical immobilizations were efficient using capture nets. The combination of KH + XH had an average initial sedation effect within 12min with a range of 10–16 min after intramuscular application. Anaesthetic average plane lasted 41.7min with a range of 40–45 min and was extended to 64.5min (63–66 min range) with an addition of KH. The individual was underweight on arrival and gradually reached an ideal condition and was overweight before its release. Morphometry parameters showed that it grew during the captive period. It was released back into the wild when it was considered healthy. This is the first report of a protocol of physical and chemical immobilization, physiological values, and biometric variation of an Andean Cat under captive conditions.

Keywords: Anaesthesia, biometry, immobilization, health evaluation, physiology, small wild cat, South America.

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For **Author details, Author contribution** and **Spanish abstract** see end of this article.

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INTRODUCTION

The Andean Cat *Leopardus jacobita* is one of the rarest feline species in the world and the most threatened in America (Andean Cat Alliance 2011). The species is classified as Endangered and is threatened by loss and degradation of habitat, opportunistic or palliative hunting and extremely low genetic diversity (Cossíos et al. 2012; Villalba et al. 2016). In Bolivia's Red List Species Book, it is listed as Critically Endangered, as it is threatened by hunting, fragmentation and alteration of habitat and by declining prey populations (Villalba et al. 2009).

The species is distributed from central Peru to central Argentina (Sorli et al. 2006; Cossíos et al. 2007; Novaro et al. 2010). In Bolivia, its presence was confirmed in the high Andean region of the departments of Potosí in southwestern Bolivia, of Oruro and Cochabamba in the central Andes of Bolivia and of La Paz in western Bolivia (Villalba et al. 2012; Huaranca et al. 2013).

To our knowledge, there is no published information on haematology, serum chemistry and clinical values of the Andean Cat. According to phylogenetic studies, the closest related species to the Andean Cat is the Pampas Cat *Leopardus colocola* (Johnson et al. 2006), for which only isolated data on chemical immobilization, clinical parameters and haematology in one free-ranging individual are available (Beltrán-Saavedra et al. 2009). To date, morphometric information on Andean Cats is scarce, because most of the data correspond to measurements of museum skins, and just a few live individuals were measured (Pine et al. 1979; Yensen & Seymour 2000; García-Perea 2002; Noss et al. 2010; Tellaeche et al. 2018).

The aim of this study was to evaluate an anaesthetic protocol and determine clinical, morphometric, haematological and serum chemistry parameters, and their variations in an Andean Cat rescued from wildlife trade. The animal was kept in captivity at the Vesty Pakos Zoo in La Paz, Bolivia, prior to being relocated to its natural habitat.

STUDY AREA

The Vesty Pakos Zoo in the Municipal Autonomous Government of La Paz is a wildlife custody centre legally established and recognized by the National Environmental Authority, through administrative Resolution VMABCC # 34/15. It is located in La Paz city (-16.572°S & -68.083°W) at an elevation of 3,265m, with an extension of 201,522.15m^2. On 15 March 2016, a subadult male Andean Cat was handed over by the La Paz Department Authority to the Vesty Pakos Zoo, which maintained the feline in temporary quarantine for 165 days. The animal was visually isolated from humans, and environmental enrichment was applied until it was considered healthy for release. This study was carried out on the basis of five evaluations, the details and dates of each are presented in Table 2.

MATERIAL AND METHODS

On arrival of the individual, Ixodidae ticks were removed from the edges of the ears, and through the coproparasitological enrichment technique faeces analyses were performed, finding eggs of nematodes of the order Strongylida (parasitic load 2 eggs/g faeces). The Andean Cat was dewormed with a broad-spectrum anthelmintic (Oralmec Gold, ivermectin 1mg/g, pyrantel pamoate 80mg/g, praziquantel 35mg/g, Biomont S.A. Peru; ivermectin 0.2 mg/kg, pyrantel pamoate 16mg/kg, praziquantel 7mg/kg oral route). Subsequent coproparasitological faeces analyses remained negative for endoparasites. Every day, the animal was observed using a remote camera (GoPro Hero 4, GoPro Inc., USA) and a digital camera (Nikon D5200, 300 mm lens, Nikon Corp. Japan). Various postures adopted by the animal were photographed to evaluate its attitude, bilateral symmetry, appearance, conformation, body condition, tail movements, motor activity, breathing, among others, that indicate possible abnormalities compatible with pathological signs. Inspections of fluids, urine or secretions were carried out during cleaning and environmental enrichment events.

During the captive period, the Andean Cat was fed every day for the first four weeks with a diet composed of live Guinea Pigs *Cavia porcellus* (595g average; diet proportion: 95.1%) and mice (30.7g average; diet proportion 4.9%), providing the mice once a week. Thereafter, to simulate natural conditions of feeding and because of its low activity inside the enclosure, the cat was fed every other day with a diet of red meat (600g average; diet proportion: 25.5%), heart (550g average; diet proportion: 23.4%) and live Guinea Pigs (800g average; diet proportion: 51.1%); this last item was provided once a week.

Physical and chemical immobilization

The Andean Cat was captured on two occasions with a 106.7 x 38.1 x 50.8 cm folding cage trap (Tomahawk Live Trap Co., USA) following free-ranging capture

methodologies (Beltrán-Saavedra et al. 2009). On the following three occasions, the individual was captured with a capture net and immediately covered with cloth to minimize stress.

Chemical immobilization was performed with a combination of dissociative anaesthesia ketamine hydrochloride (KH) (Ketamine 10%, 100mg/ml, Alfasan International B.V., The Netherlands; 10mg/kg intra-muscular [i/m] route) and the muscle sedative-relaxant xylazine hydrochloride (XH) (Xilazine 2%, 20mg/ml, Alfasan International B.V., The Netherlands; 1–2 mg/kg i/m). This combination was administered with a hand syringe in the posterior extremity musculature, with the animal covered with cloth until the pharmacological effect was achieved. The veterinary staff remained silent during this time. If drug supplementation was necessary, only KH was used. We did not use any antagonist, as the individual was kept in all occasions in a Kennel cage of 55.9 x 35.6 x 35.6 cm covered with cloth during the recovery phase. After it woke up and was able to stand, its pupillary response to light and motor coordination was evaluated before it was released into the enclosure and after the last evaluation, into the wild.

Clinical and morphometric evaluations

Clinical evaluations of the Andean Cat's body condition and physical state were performed using the 9 points-Body Condition Score, according to which 1–3 points are considered "underweight", 4–5 "ideal", 6–7 "overweight" and 8–9 "obese" (Laflamme 1997 in Santarossa et al. 2017). Temperature, heart and respiratory rates were also determined (MedArks register: ISIS, 12101 Johnny Cake Rd., Apple Valley, MN 55124, USA).

Morphometric parameters were obtained according to previous publications (Emmons 1999; García-Perea 2002; Yensen & Seymour 2000; Noss et al. 2010; Tellaeche et al. 2018) and our own elaborated guide (Table 1; Figure 1). On the first four evaluations, measurements and body weight were recorded, and on the fifth evaluation only body weight was obtained as the individual was on the way to being released.

The individual was weighed with a digital scale (Inmobiliaria y Constructora TOR S.A. de C.V., San Nicolas MR 66480 México) to the nearest 0,001kg. Body measurements were obtained using a digital vernier caliper (Truper S.A. de C.V., Jilotepec MX 54240 México) to the nearest 0.1mm; and a measure tape and a ruler to the nearest 0.1cm. The increase in body size was calculated from the difference of the last measurement made for each parameter in relation to the first one; and considering that the tail is one of the most relevant characteristics for the identification of the species (Cossíos et al. 2007), the proportion of tail length in relation to body length was calculated.

Following García-Perea (2002) criteria regarding age, the parameters of head and body length (HBL) and tail length (TL), were also used to verify the initial determination of the individual's age as a subadult, which was based on its size and overall appearance.

Biometric data were compared to all available bibliographic data on the species (Table 1).

Blood collection, haematological and serum chemistry evaluations

Before haematological and serum chemistry evaluations, the individual had a 12-hour fasting period. On the first three chemical immobilizations, blood samples of the cephalic vein were collected, keeping 4ml in tubes with ethylenediaminetetraacetic acid (EDTA) for haematology studies, and 3ml in tubes without additives for serum chemistry. Haematological and serum chemistry parameters were determined in a commercial laboratory (Laboratorio Clínico Científico, La Paz, Bolivia) two hours after blood sampling.

RESULTS

Protocol of physical and chemical immobilization

The first two physical immobilizations with folding cage traps allowed the capture of the Andean Cat individual. On the third occasion, it avoided entering the cage, so that a capture net was used, allowing to reduce the time between the capture and the application of the anaesthetic drug.

The combination of KH + XH had an average effect within 12min (range of 10–16 min), after intramuscular (i/m) application to the start of sedation; the average duration of the anaesthetic plane was 41.7 min (range of 40–45 min); and when HK had to be added, it lasted on average 64.5min (range of 63–66 min) (Table 2; Images 1 and 2).

Clinical and morphometric evaluations

Clinical evaluations showed that the individual arrived with underweight (first weight= 4.100kg). Between the evaluation II and IV, it was judged to have an ideal body weight, reaching 5.946kg at the evaluation V, when it was considered overweight. The Andean Cat increased 1.846kg during the captive period before it was released back into the wild (Table 2).

Table 1. Morphometry guidelines and tools used to measure a subadult male Andean Cat *Leopardus jacobita* in captivity at Vesty Pakos Zoo, La Paz, Bolivia.

Parameter	Description	Tool
Total body length (TBL)	Distance from the tip of the snout to the tip of the tail (excluding the fur at the tip) along the spine	Measure tape
Head length (HL)	Distance from the tip of the nose to the junction of the skull with the spine, along the middle part of the head	Measure tape
Tail length (TL)	Distance from the anus to the tip of the tail (excluding the fur at the tip), measured by the ventral side of the tail	Measure tape
Head and body length (HBL)	Difference between TBL and TL	
Neck circumference (NC)	Neck contour perimeter	Measure tape
Front foot length (FFL)	Distance from the elbow to the tip of the longest finger. Measurement taken from the front right foot	Ruler
Back foot length (BFL)	Distance from the heel to the tip of the longest toe, measured on the back-right foot	Ruler
Front pad length (FPL)	Distance from the base of the palm to the tip of the longest finger, measured on the right front leg	Ruler
Front pad width (FPW)	Widest part of the pad, measured on the right front leg	Ruler
Back pad length (BPL)	Distance from the base of the palm to the tip of the longest finger, measured on the right back leg	Ruler
Back pad width (BPW)	Widest part of the pad, measured on the right back leg	Ruler
Ear length (EL)	Distance from the base of the notch to the tip of the ear, excluding the hairs, on the inner side of the ear	Ruler
Testicles length (T)	Distance from the tip to the base of one of the testicles, measured on the right testicle	Digital caliper
Upper canine height (UCH)	Canine tooth height from the tip to the gum, measured on the upper and lower right canine throughout the center of each	Digital caliper
Lower canine height (LCH)		
Dental formula (DF)	Number of incisors, canines, premolars and molars of the upper and lower jaw counted from the center of the dentition in the right jaw	Visual
Weight	Total body weight in kg after a 12-hour fasting period	Digital scale

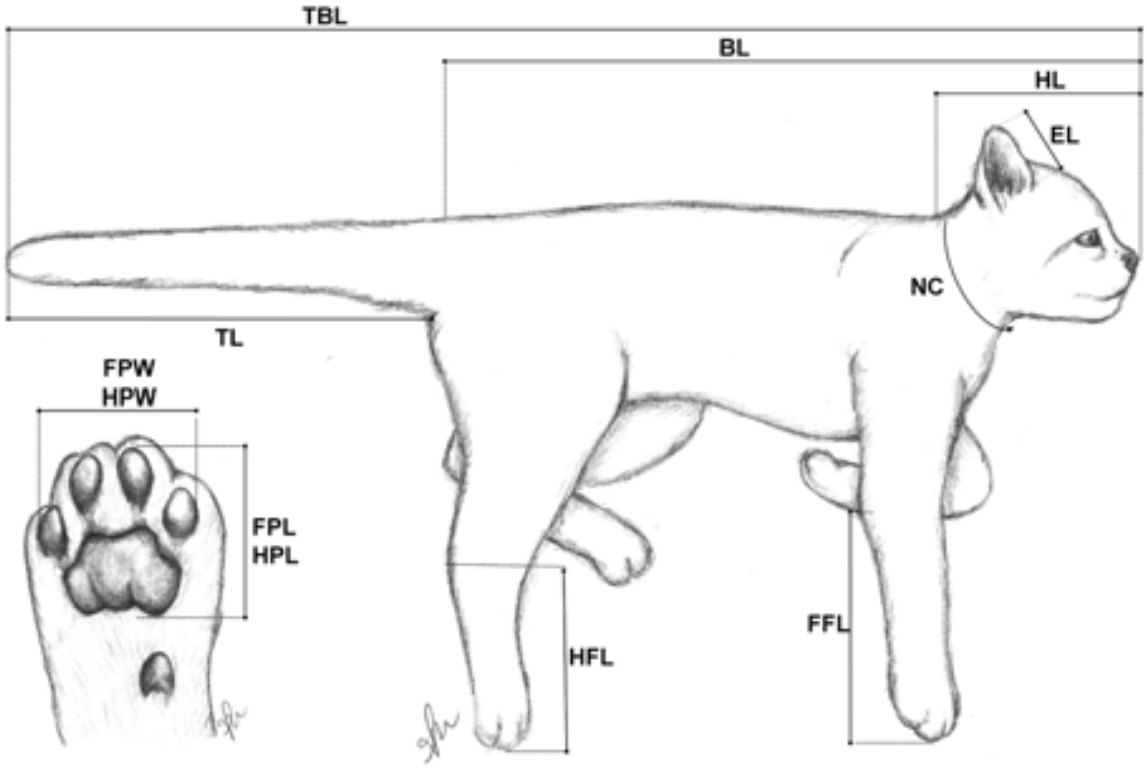

Figure 1. Schematic drawing of biometrics obtained from a male subadult Andean Cat *Leopardus jacobita* at the Vesty Pakos Zoo, La Paz, Bolivia. © Daniela Ticona Nacho

Table 2. Protocol of chemical immobilization used in a male subadult Andean Cat *Leopardus jacobita* in captivity, Vesty Pakos Zoo, La Paz, Bolivia. The evaluations I to IV were done for health studies and the last one prior to its release. Doses of KH and XH are listed in mg/kg of body weight.

Date	Evaluations	Intended dose HK:HX	Weight	KH initial dose	KH additional dose*	KH total dose	No. of additional doses	XH initial dose	Application-sedation effect (min)	Duration of sedation (min)
17.iii.2016	I	10:1	4.100	10	0	10	0	1	16	45
04.iv.2016	II	10:2	4.720	8.68	0	8.68	0	1.74	11	40
12.v.2016	III	10:2	5.328	8.91	1.00	9.91	1	1.79	10	66
14.vi.2016	IV	10:2	5.602	8.50	1.68	10.18	1	1.69	13	63
27.viii.2016	V	10:2	5.946	9.40	0	9.40	0	1.88	10	40

*Additional doses of ketamine were used after ~40–45 min to extend the duration of sedation, when more handling had to be done with the individual.
The data recorded for body temperature (˚C), heart rate (min) and respiratory rate (min) are presented in the Table 3.

Table 3. Body condition and physiological parameters of a subadult male Andean Cat *Leopardus jacobita* in captivity at Vesty Pakos Zoo, La Paz, Bolivia.

Evaluations	Body condition**	Temperature (˚C)*		Heart rate (min)*		Respiratory rate (min)*	
		Mean	Ranges	Mean	Ranges	Mean	Ranges
I	Underweight	38.4	38.0–38.8	169	132–220	44	-
II	Ideal	37.6	37.2–38.4	104	88–112	24	-
III	Ideal	36.9	-	111.5	110–113	29	22–35
IV	Ideal	38.7	-	116	-	56	-
V	Overweight	36.4	-	121.2	108–135	28	20–36

*For averages not accompanied by ranges, the values recorded were unique | ** Body condition and fitness according to 9 points-Body Condition Score (Laflamme 1997 in Santarossa et al. 2017).

Image 1. The male subadult Andean Cat *Leopardus jacobita* in Vesty Pakos Zoo, La Paz, Bolivia. © Omar Torrico

Table 4. Morphometric measurements and body size increase of a subadult male Andean Cat *Leopardus jacobita* in captivity at Vesty Pakos Zoo, La Paz, Bolivia. Biometric values are expressed in millimeters (mm) and are compared with values obtained in other studies.

Parameter	Evaluations of this study					Other studies	References
	I	II	III	IV	Increase		
TBL	1015	-	1017	1020	5	-	-
HBL	645	-	644	645	0	577–850	Yensen & Seymour (2000)
						640–660** 740–850	García-Perea (2002)
						570–920	Noss et al. (2010)
						620–750	Tellaeche et al. (2018)
HL	130	135	139	140	10	120–150	Tellaeche et al. (2018)
TL	370	373	373	375	5	480	Pine et al. (1979)
						410–480	Yensen & Seymour (2000)
						330–420**	García-Perea (2002)
						350–480	Noss et al. (2010)
						420–460	Tellaeche et al. (2018)
NC	202	206	219	219	17	190–230	Tellaeche et al. (2018)
FFL	209	209	216	216	7	-	-
BFL	120	125	129	129	9	110	Pine et al. (1979)
						133	Yensen & Seymour (2000)
						110–133**	García-Perea (2002)
						110–130	Noss et al. (2010)
FPL	44	46	46	46	2	42–48	Tellaeche et al. (2018)
FPW	-	39	39	42	3*	34–40	Tellaeche et al. (2018)
BPL	45	46	47	47	2	45–48	Tellaeche et al. (2018)
BPW	-	29	31	31	2*	38–40	Tellaeche et al. (2018)
EL	60	60	61	61	1	53**	Pine et al. (1979)
						63**	Yensen & Seymour (2000)
						53–63**	García-Perea (2002)
						30–70	Noss et al. (2010)
						47–56	Tellaeche et al. (2018)
T	18,4	18,4	22	24	5,6	-	-
UCH	11.8	-	-	11	-0.8	5.6–7.58	Tellaeche et al. (2018)
LCH	10	-	-	10.1	0.1	5.32–7.82	Tellaeche et al. (2018)

*Data taken from the evaluation II | **Measurement of subadult individuals

The individual had the following dental formula: incisors= 3/3; canines= 1/1; pre-molars= 2/2; and molars= 1/1. Also, between the evaluations I and IV, a small dental wear was observed in the UCL.

Morphometric parameters obtained from the individual in the first four evaluations are presented in Table 4, establishing changes in some parameters; these are compared with those reported by other authors. In the measurement of HBL and TL, the tail represented 57.4% of the total body length upon arrival and gradually increased to 58.1%.

The measurements of HBL and TL taken in the evaluations I to IV were within the range of measurements taken for subadults (Table 4). Therefore, when the Andean Cat was released into the wild, it was still considered to have been in this age category.

Table 5. Haematological and serum chemistry parameters in a male subadult Andean Cat *Leopardus jacobita* kept in captivity at Vesty Pakos Zoo, La Paz, Bolivia. Values of free-ranging Ocelot *L. pardalis* (Widmer et al. 2016) and captive Ocelot (International Species Information System 2002), and reference ranges of Domestic Cats *Felis catus* (Aiello & Moses 2015) are included for comparison.

Parameters	Units	Evaluation of Andean Cat			Free-ranging Ocelot	Captive Ocelot	Domestic Cat
		I	II	III	Range	Range	Range
Haematology							
Red blood cells	10^9 /L	5.2	4.6	5.2	5.5–7.1	5.10–10.8	5.0–10.0
Haemoglobin	g/L	155	129	154	95–131	94–171	100–150
Haematocrit	L/L	0.46	0.39	0.46	0.30–0.40	0.27–0.53	0.30–0.45
MCV*	fl	89.6	85.2	88.6	42.25–60.0	42.9–62.8	39–55
MCH*	pg/cell	29.8	28.0	29.6	13.4–22.4	12.7–21.8	13–17
MCHC*	g/L	332.0	330.0	334	311.8–363.9	238.0–396.0	300–360
Platelet count	10^9 /L	180	190	260	280–694	88.0–581.0	300–800
Eritrosedimentation	mm/h	1	4	1	-	-	-
White blood cells	10^9 /L	10.0	9.9	10.0	12.1–19.8	4.62–23.30	5.5–19.5
Bands	10^9 /L	0.20	0.0	0.20	0.18–0.57	0.0–0.50	0.0–0.30
Neutrophils	10^9 /L	7.2	6.6	5.2	7.4–15.9	0.105–20.7	2.5–12.5
Eosinophils	10^9 /L	0.1	0.1	0.3	0–0.9	0.0–3.63	0.0–0.8
Basophils	10^9 u/L	0.0	0.0	0.0	0.0	0.0–0.37	0.0–0.2
Lymphocytes	10^9 /L	2.3	2.9	4.2	1.5–8.7	0.46–7.61	1.5–7.0
Monocytes	10^9 /L	0.2	0.3	0.1	0.5–1.6	0.05–2.62	0.0–0.9
Serum chemistry							
Creatinine	umol/L	100	120	120	61.9–114.9	71.0–283.0	80–194
Blood urea nitrogen	mmol/L	13.6	17.6	16.6	-	-	6.8–12.1
Potassium	mmol/L	3.2	-	-	4.5–5.2	2.8–5.8	3.7–6.1
Total protein	g/L	68.0	64.0	62.0	74.0–113.0	56.0–100.0	60.0–79.0
Albumin	g/L	36.0	36.0	-	22.1–28.2	22.0–46.0	28.0–39.0
Globulin	g/L	31.0	-	-	50.0–90.9	24.0–67.0	26.0–51.0
Albumin/globulin proportion		1.16	-	-	0.24–0.48	-	-
AST*	IU/L	47.7	53.8	28.9	38.0–193.0	9.0–111.0	7.0–38.0
ALT*	IU/L	49.0	52.7	39.8	33.0–117.0	19.0–269.0	25.0–97.0
ALP*	IU/L	11.3	20.0	6.83	13.0–35.0	4.0–243.0	0.0–45.0

*MCV—Mean cell volume | MCH—Mean cell haemoglobin | MCHC—Mean cell haemoglobin concentration | AST—Aspartate aminotransferase | ALT—Alanine aminotransferase | ALP—Alkaline phosphatase.

Haematological and serum chemical evaluations

Haematological and serum chemistry parameters obtained from the first three immobilizations are reported in Table 5.

DISCUSSION

The present work reports for the first time a protocol of chemical immobilization, haematological and serum chemistry parameters of a healthy Andean Cat individual; and contributes to the morphometry of the species.

Protocol of physical and chemical immobilization

In this study, the individual "learned" not to enter the cage trap, and the use of capture nets proved to be a more appropriate method of physical immobilization in a closed environment.

Chemical immobilization of other feline species such as Bobcat *Lynx rufus*, Guigna *Leopardus guigna*, Ocelot *L. pardalis*, and Pampas Cat suggest the use of ketamine and xylazine on doses ranging from 7.65–14.7 mg/kg KH and 0.74–1.4 mg/kg XH (Beltrán & Tewes 1995; Acosta et al. 2007; Tellaeche et al. 2020). For this individual Andean Cat under captive conditions, however, we had

Image 2. Obtaining blood and biometrics samples in an anesthetized male subadult Andean Cat *Leopardus jacobita* at the Vesty Pakos Zoo, La Paz, Bolivia. © Omar Torrico

a good and safe 40 minutes sedation period using a dose of 8.68mg/kg KH and 1.74mg/kg XH.

Clinical and morphometric evaluations

The Andean Cat was considered underweight on the evaluation I of its body condition, which may be related to its natural condition of being a wild subadult individual (García-Perea 2002), and a presumable four-day fasting period prior to its arrival at the Vesty Pakos Zoo. Subsequently, its body condition was judged ideal and within ranges of 4.0–5.8 kg recorded for the species by García-Perea (2002), Villalba et al. (2004), and Tellaeche et al. (2018). At the evaluation V, it was judged overweight, which was probably the effect of a low energy expenditure, and also by medical and nutritional care given during captive conditions.

Although hypothermia and hyperthermia are considered common adverse effects of chemical immobilizations of wild felids (e.g., Tellaeche et al. 2020), the Andean Cat showed none, probably because it was not too stressed prior to anaesthetic injection and because it was kept warm using hot-water bottles wrapped in cloth during procedures.

During sedation, heart and respiratory rates higher than the averages were initially recorded (129.7/min y 36.2/min respectively), possibly due to capture stress, which stabilized during the course of the sedations. Similar records were observed in a free-ranging wild Pampas Cat (Beltrán-Saavedra et al. 2009).

The cat's tail length ratio to the body length (58.1%) was slightly lower (60–75%) than those obtained of free-ranging adult Andean Cats (Yensen & Seymour 2000; García-Perea 2002), and from skins (66–75%) of this species (Cossíos et al. 2007). Its body measurements, however, were similar or within the ranges reported for the species (Yensen & Seymour 2000; García-Perea 2002; Tellaeche et al. 2018). We report measurements of testis length of an Andean Cat for the first time. For further morphological measurements, we suggest to evaluate both left and right size of canines and testicles to identify the existence of possible asymmetries.

Haematological and serum chemical evaluations

In the evaluation I, the haematological values of red blood cells, mean cell haemoglobin concentration (MCHC), eosinophils, basophils and lymphocytes obtained were all within the reference ranges of Domestic Cats, free-ranging and captive Ocelots (International Species Information System 2002; Aiello & Moses 2016; Widmer et al. 2016), and similar to those reported in a free-ranging Pampas Cat (Beltran-Saavedra et al. 2009). On the other hand, haemoglobin values obtained by Beltran-Saavedra et al. (2009) presented slightly superior variations in relation to the reference ranges of Domestic Cats and free-ranging Ocelots, but they were within the ranges of those of captive Ocelots. In the evaluation II, the values obtained of MCHC, eosinophils, basophils and lymphocytes and haemoglobin were all within the reference ranges of Domestic Cats, free-ranging and captive Ocelots (International Species Information System 2002; Aiello & Moses 2016; Widmer et al. 2016), and similar to those reported in a free-ranging Pampas Cat (Beltran-Saavedra et al. 2009). The value of red blood cells, however, was lower than those reported in Domestic Cats, free-ranging and captive Ocelots and a free-ranging Pampas Cat (Beltran-Saavedra et al. 2009), but not related to physiological and morphological abnormalities of the red series. In the evaluation III, the values obtained of red blood cells, MCHC, eosinophils, basophils and lymphocytes were all within the reference ranges of Domestic Cats, free ranging and captive Ocelots (International Species Information System 2002; Aiello & Moses 2016; Widmer et al. 2016), and in a free-ranging Pampas Cat (Beltran-Saavedra et al. 2009). On the other hand, haemoglobin values showed slightly superior variations in relation to the reference ranges of Domestic Cats and free-ranging Ocelots, but they were within the ranges of captive Ocelots.

The values of white blood cells, bands, neutrophils and monocytes obtained in evaluations I to III were within the ranges of Domestic Cats and captive Ocelots (International Species Information System 2002; Aiello & Moses 2016). All these values were similar to those reported in a free-ranging Pampas Cat and in free-ranging Ocelots (Beltrán-Saavedra et al. 2009; Widmer

et al. 2016). In contrast, haematocrit values in all three evaluations were within the reference ranges of Domestic Cats, but showed little variations with respect to those of free-ranging and captive Ocelots, and those of a free-ranging Pampas Cat.

On the other hand, the values of mean cell volume (MCV) (89.6, 85.2 y 88.6 fl) and mean cell haemoglobin (MCH) (29.8, 28.0 y 29.6 pg/cell) obtained in the evaluations I to III were superior to the reference ranges of Domestic Cats and, to those of free-ranging and captive Ocelots (International Species Information System 2002; Aiello & Moses 2016; Widmer et al. 2016). These differences, however, were not associated with pathological signs and abnormal haematological morphologies such as reticulocytosis, anisocytosis or polychromasia, which are compatible with anaemia or haemolysis (Aguiló 2001; Cowell 2004).

Also, in the evaluations I to III, the platelet counts (180, 190, and 260 10^9/L) were lower than the reference ranges of Domestic Cats, free-ranging and captive Ocelots (International Species Information System 2002; Aiello & Moses 2016; Widmer et al. 2016). Ectoparasite ticks on the ears and a low parasite load of one type of nematode that were detected at the individual's arrival could be the cause for initial lower platelet count, which increased after removal of ticks and the deworming treatment. The low platelet count, however, was not associated with pathological signs such as bleeding, haemorrhagic diathesis or petechiae described by Nuñez-Ochoa (2007).

All the values of serum chemistry obtained in the evaluations I to III were within the reference ranges of Domestic Cats and free-ranging and captive Ocelots (International Species Information System 2002; Aiello & Moses 2016; Widmer et al. 2016), with little variation of creatinine, globulin and total protein values in free-ranging Ocelots. In addition, total protein was similar to the values reported in a free-ranging Pampas Cat (Beltrán-Saavedra et al. 2009).

The only potassium value obtained in the evaluation I was a little lower than the reference ranges of Domestic Cats, whereas blood urea nitrogen and aspartate aminotransferase values were higher than the same reference ranges (Aiello & Moses 2016). There were, however, no clinical abnormalities, and these serum values are among those reported for free-ranging and captive Ocelots (International Species Information System 2002; Widmer et al. 2016).

The value of albumin/globulin proportion obtained in the evaluation I was higher than the ranges reported for free-ranging Ocelots (Widmer et al. 2016). The parameters of erythrosedimentation were not comparable, since previous authors did not report these data.

Using capture nets was more suitable than cage traps for the containment of this individual. The procedures using KH+XH with an intended dose of 10:2mg/kg proved to be safe and efficient for 40 minutes of procedure for this subadult male Andean Cat under captive conditions. Clinical parameters indicated that the individual remained in good body condition during captivity, showed a constant increase in size and weight, and was considered healthy following haematological and serum chemistry evaluations. This study contributed to the knowledge of physiological and morphological parameters of the Andean Cat, and together with other health and biological parameters allowed to determine the timing of release of this individual into its natural habitat. We strongly recommend to conduct more research on the Andean Cat to obtain additional data relevant for both in situ and ex situ conservation and management of this little-known cat.

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Resumen: El Gato Andino *Leopardus jacobita*, una de las especies de felinos más raras y amenazadas del mundo, se distribuye desde el centro de Perú hasta el centro de Argentina. El objetivo de este estudio fue evaluar la salud y la morfometría de un Gato Andino macho subadulto que fue rescatado del tráfico de fauna silvestre en Bolivia y mantenido en cautiverio durante 165 días antes de ser liberado de nuevo en su hábitat natural. Se realizaron inmovilizaciones físicas seguidas de anestesia utilizando clorhidrato de ketamina (HK) y clorhidrato de xilacina (HX) para obtener parámetros clínicos, morfométricos, hematológicos y químicos séricos. Las inmovilizaciones físicas fueron eficientes utilizando redes de captura. La combinación de HK + HX tuvo un efecto sedante inicial promedio dentro de 12min con un rango de 10–16 min después de la aplicación intramuscular. El promedio del plano anestésico duró 41.7 min con un rango de 40–45 min y se extendió a 64.5 min (rango de 63–66 min) con una adición de HK. El individuo llegó con una condición corporal de bajo peso, gradualmente alcanzó una condición ideal y sobrepeso antes de su liberación. Los parámetros de morfometría mostraron que creció durante el período de cautiverio. Se liberó de nuevo al medio silvestre cuando fue considerado saludable. Este es el primer informe de un protocolo de inmovilización física y química, valores fisiológicos y variación biométrica de un Gato Andino en condiciones de cautiverio.

Palabras clave: América del sur, anestesia, biometría, evaluación de salud, felinos silvestres pequeños, fisiología, inmovilización.

Author details: L. Fabián Beltrán-Saavedra is a wildlife health researcher and his areas of interest are health evaluations and parasitic ecology in mammals and birds, combining veterinary and biological sciences, focused to conservation of wildlife. Rolando Limachi Quiñajo works as a Veterinary Doctor supporting wildlife rescue centers and his areas of interest are clinical, clinical pathology, surgery and epidemiology of wildlife diseases.Grace Ledezma Encinas is a biologist and her main areas of interest are research on wildlife trafficking, rehabilitation and conservation of threatened species. Daniela Morales Moreno is a biologist and her main areas of interest are animal welfare and animal behavior. M. Lilian Villalba has been a member of the Andean Cat Alliance, a multinational network devoted to Andean cat conservation over the four range countries, since its creation in 1999. She has been developing, participating and collaborating in research projects, training and education aimed to contribute to the knowledge and conservation of the Andean cat and its habitat in Bolivia.

Author contributions: LFBS performed study design and chemical immobilizations, analyzed clinical, physiological and chemical immobilization data, and prepared the manuscript. RLQ performed the study design, physical and chemical immobilizations, obtained samples and clinical data, supplemented the manuscript. GL performed the study design, obtained biometric data, supplemented the manuscript. DM obtained and analyzed biometric data, supplemented the manuscript. MLV analyzed biometric data, supplemented the manuscript

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COMMUNICATION

Reunion with the mother: a successful rehabilitation strategy for displaced wild Rusty-spotted Cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire, 1831) (Mammalia: Carnivora: Felidae) kittens

Ajay Deshmukh [1], Yaduraj Khadpekar [2], Mahendra Dhore [3] & M.V. Baijuraj [4]

[1–4] Wildlife SOS, D-210, Defence Colony, New Delhi 110024, India.
[1] drajaydeshmukh@gmail.com, [2] yaduraj.k24@gmail.com (corresponding author), [3] mahendra@wildlifesos.org, [4] baiju@wildlifesos.org

Abstract: One of the common challenges for wildlife rehabilitators and conservationists is dealing with displaced young animals, needing intervention and help. Most commonly, such displaced animals are moved to zoos or rescue centers where they are hand-raised. In some cases, the hand-raised animals are rehabilitated back in the wild following suitable protocols. For young animals that are not injured or ill, however, reuniting them with their mothers in the wild might be the best option. There are few reports on such reunion efforts. We report successful reunions of 26 Rusty-spotted Cat *Prionailurus rubiginosus* kittens with their mothers in the period of six years in the Junnar Forest Division, Maharashtra, India. The kittens found by the villagers were examined for injuries or signs of sickness, and physiological parameters were recorded. If found healthy, they were placed in a plastic basket at the same location in the evening of the same day for a reunion with their mothers. In all cases, the mother cat was in the vicinity and took the kittens away after a brief period. The success of reunion effort was confirmed by direct observation or vocalization of the kittens combined with the presence of pugmarks of an adult cat at the site, or just by the presence and appearance of pugmarks. The results of our efforts show that displaced kittens of small wild cats can be successfully reunited with their mothers, provided that the time gap between separation and reunion effort is minimized.

Keywords: Displaced wildlife, human-wildlife interaction, small wild cat, wildlife rehabilitation, wildlife rescue.

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Ethics statement: All suitable protocols for animal safety, welfare and ethics were followed during this work.

Author details: Dr. Ajay Deshmukh is a wildlife veterinarian with an extensive experience in Leopard handling, captive management, and managing and mitigating the negative interactions between Leopards and people. Dr. Yaduraj Khadpekar is a wildlife veterinarian working in the field of wildlife medicine and conservation for 15 years. Mr. Mahendra Dhore has been working in the study area for more than a decade for the mitigation of Leopard-human negative interactions and for conservation awareness. Mr. Baijuraj MV is a wildlife biologist with two decades of experience in wildlife conservation, rescues, conflict mitigation and conservation awareness.

Author contribution: Ajay Deshmukh—the work described in this paper was carried out by Dr. Deshmukh and his team. Yaduraj Khadpekar—the data analysis and the manuscript writing has been done by Dr. Khadpekar for this article. Mahendra Dhore—has been involved in all the field work described in this paper along with Dr. Deshmukh. Baijuraj MV—has contributed in the writing of this manuscript.

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INTRODUCTION

Displacement and separation of young animals from their mothers is not an uncommon occurrence in the wild. Conservationists and wildlife rehabilitators around the world frequently come across young wild animals without their mother, needing help. There are a number of reasons why the young animals may get separated from their mothers, such as natural calamities (Barman et al. 2014), human activities (McTurk & Spelman 2005), death of the mother due to hunting (Pajetnov & Pajetnov 1998) or natural causes (Singh et al. 2011). The common strategies followed for such rescued young animals are hand-raising them to rehabilitate to the wild, or taking them permanently to a captive facility such as a zoo or a lifetime care facility and hand-raise them there. Hand-raised animals have been successfully rehabilitated in the wild such as in case of Asian Elephants *Elephas maximus* (Perera et al. 2018), Greater One-horned Rhinoceros *Rhinoceros unicornis* (Barman et al. 2014), Common Wombat *Vombatus ursinus* (Saran et al. 2011), and Giant Otter *Pteronura brasiliensis* (McTurk & Spelman 2005).

Another option that is less frequently followed, is the immediate or soonest possible reunion of the displaced young animal with its mother. For the young animals that are temporarily separated from their mothers and are not injured or ill, this might be the best suitable option (Sparks & Casey 1998). Indeed, such reunions have been successfully accomplished for infants of wildlife as diverse as the Western Chimpanzee *Pan troglodytes verus* (Pruetz & Kante 2010) and the Giant Otter (Lima & Marmontel 2011). In our knowledge, however, organised efforts for the reunion of cubs or kittens of wild cats with their mothers have not been reported so far.

The Rusty-spotted Cat *Prionailurus rubiginosus* is the smallest cat species in Asia (Menon 2014; Nayak et al. 2017). It is resident in India, Nepal, and Sri Lanka (Mukherjee et al. 2016). The population in India is thought to be fragmented as intensive irrigated agriculture negatively impacted its prime habitat; dry and moist deciduous forests (Mukherjee et al. 2016). Although the data on the current population trend are scarce, the species is currently categorised as Near Threatened on the IUCN Red List (Mukherjee et al. 2016). The authors have come across many displaced Rusty-spotted Cat kittens that were in a situation where they could be reunited with their mothers. Except for one report on the possible natural reunion of a kitten with its mother (Sharma 2007), there is no other record of reuniting Rusty-spotted Cat kittens with their mothers in situ. Therefore, this may be the first report on successfully reuniting multiple Rusty-spotted Cat kittens with their mothers in the wild.

STUDY AREA

All the reunions occurred within the Junnar Forest Division in Pune District in the state of Maharashtra, India (Fig. 1). The terrain of the area is made up of the northern part of Western Ghats with hills and valleys. The hills do not have many large trees but are mostly grassy with boulders. The most common occupation in the area is farming, and the crops of sugarcane, grapes, and onion dominate the cultivated parts of the valleys (Athreya et al. 2011). Due to the large areas of sugarcane cultivation (Image 1), which provide suitable habitat and cover for the Leopard *Panthera pardus*, the division is known for high Leopard density and a close co-existence of Leopards and humans (Jhamvar-Shingote & Schuett 2013). Although there are no published records of Rusty-spotted Cat in the division before this report, the species has been recorded during camera trap surveys in adjoining areas (Athreya et al. 2016).

A wildlife rescue team lead by Ajay Deshmukh and Mahendra Dhore had been working in the study area since 2009 for the mitigation of human-Leopard conflict, and thus are well-known to the local villagers and the forest department officials.

MATERIALS AND METHODS

When the kittens were handed over to the rescue team, they were first placed in a plastic basket and moved away from the location. They were transported to either the nearest forest department office or to the rescue team office. There they were checked for any visible injuries. Their ages were estimated based on their body size and locomotor abilities described by Dmoch (1997). Physiological parameters such as rectal temperature, heart rate (HR; heart beats/minute), and respiration rate (RR; respirations/minute) were recorded. Once the kittens were found to be healthy through this examination, they were left undisturbed in the basket in a quiet area. No attempts were made to feed them before reunion. For the reunion attempt with the mother, they were taken in the evening to the exact spot where they were found. The basket with the kittens was left on the ground at the location. This procedure was always carried out after 18.00h to minimise the possibility of

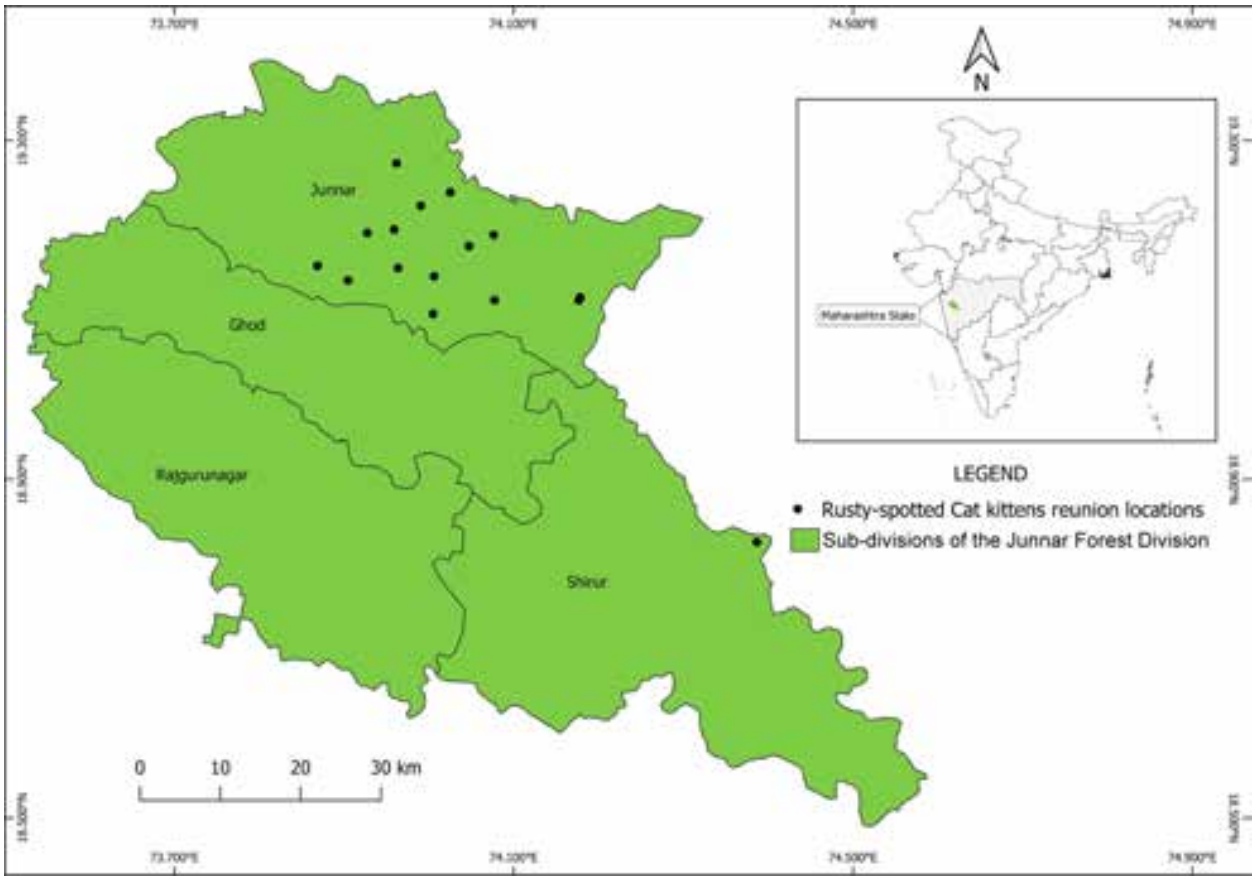

Figure 1. Junnar Forest Division in the state of Maharashtra, India, where all the reunions of Rusty-spotted Cat kittens with their mothers were carried out. The sections inside the main map indicate the sub-divisions within the Junnar Forest Division. The green portion in the small inset map shows the location of the Junnar Forest Division in India.

disturbance by human activities, and considering the crepuscular and nocturnal activity pattern of Rusty-spotted Cat (Nimalrathna et al. 2019; Bora et al. 2020). When possible, the rescue team of two to three members observed the kittens with the help of spot lights from a distance of 200–300 m until the mother came and picked them up. At other times, the rescue team moved 500–1,000 m away and went back periodically to check if the kittens were safe. If the kittens were not in the basket any more, the area was examined for pugmarks and signs of predation, to make sure that the kittens had been picked up by the mother. The reunion was confirmed by the direct observation of an adult female picking up and carrying the kittens away, or by the mewing sounds of the kittens combined with the presence of pugmarks of an adult Rusty-spotted Cat at the location, or just by the presence and appearance of pugmarks. For all the reunion events, we recorded the approximate time when the kittens were first spotted, the time when they were kept at the location for the reunion, and the estimated time when the mother took them.

RESULTS

A total of 26 kittens were reunited with their mothers in 18 reunion events between 2014 and 2019 (Table 1). Eight of these reunions involved a litter of two kittens. Out of these, four litters included a male and a female kitten. Their estimated ages ranged between 30 and 60 days.

The presence of kittens was reported to the rescue team by either the villagers or the forest department staff. In all the cases, the kittens were first spotted by the villagers and reported to either the forest department or to the rescue team. All kittens were found in sugarcane fields (Image 2). In instances when the rescue team was directly informed by villagers, the team conveyed the information to the relevant forest department officials for further actions and coordination. It is important to mention here that in about 80% of instances, the kittens were picked up and handled by the villagers before the rescue team could reach the location. At other times, even though the kittens were not picked up by the

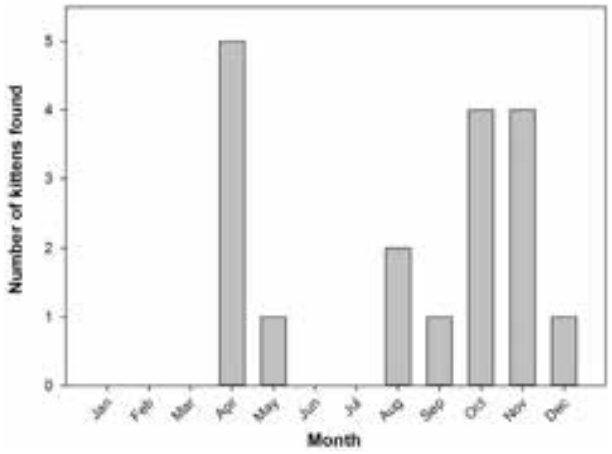

Figure 2. The highest number of displaced Rusty-spotted Cat kittens were found in early summer (April), followed by early winter (October and November).

villagers, they had to be removed from the location to avoid stress from human activities, crowding, noise, and possibility of handling by the villagers.

During the assessment of physiological parameters, the minimum rectal temperature recorded was 37.8°C while the maximum was 38.9°C. The mean rectal temperature among all kittens was 38.4°C (n=26). RR ranged between 16–40, and the HR was within the range of 126–180. It was not possible to measure the body weights of all the kittens, however, the body weights of the kittens that were weighed (n=10) ranged from 100g to 300g.

Table 1. Temporal details of reunion events with approximate time when kittens were spotted by the villagers (Rescue time), time when the kittens were taken to the location for reunion (Return time), and estimated time when the kittens were picked up by the mother cat (Reunion time).

Reunion event	Month and year	Rescue time	Return time	Reunion time
1	iv.2014	14.30h	18.45h	22.30h
2	x.2014	13.15h	18.20h	21.20h
3	xi.2014	13.20h	18.20h	21.20h
4	iv.2015	14.45h	18.35h	21.35h
5	x.2015	14.40h	18.30h	21.30h
6	xi.2015	14.45h	18.35h	21.35h
7	v.2016	14.05h	18.10h	22.30h
8	ix.2016	14.20h	18.20h	22.40h
9	xii.2016	14.10h	18.35h	20.35h
10	iv.2017	13.20h	18.20h	22.00h
11	x.2017	12.25h	18.00h	20.00h
12	xi.2017	13.30h	18.10h	19.15h
13	iv.2018	13.25h	18.35h	21.35h
14	x.2018	13.35h	18.40h	21.40h
15	xi.2018	13.25h	18.35h	21.35h
16	iv.2019	15.20h	19.10h	21.10h
17	viii.2019	11.30h	18.15h	22.15h
18	viii.2019	13.10h	18.05h	22.05h

Image 1. Habitat with sugarcane fields in the study area. © Akash Dolas, Wildlife SOS.

Image 2. A Rusty-spotted Cat kitten that was found in a sugarcane field © Akash Dolas, Wildlife SOS.

The highest number of kittens were found in the early summer or early winter during the sugarcane harvesting season (Fig. 2). No kittens were reported in late winter or late summer. The villagers spotted the kittens during mid-day between 11.00 and 15.30 h. All the reunions of the rescued kittens occurred at late evening or night on the same day they were found. Among all the reunion efforts, the maximum time gap between finding a kitten and taking it back for the reunion, was >6h 45min. After the kittens were brought to the location for the reunion, the minimum time recorded for a successful reunion was 1h 5 min, while the maximum was 4h 20min.

During the reunions that the rescue team members were able to observe directly, the mother cats were noticed to approach the baskets with the kittens very slowly and cautiously. During approach, they stopped and looked around frequently before continuing the approach. Many times, the mother sat 3–6 m away from the basket for 20 to 30 minutes and kept looking around, before she approached the basket. In some instances, after such pause, the mother walked around the basket keeping some distance and sat down again for some period before approaching the basket. The kittens were noticed to become very active and vocal with lot of mewing, once they noticed the mother approaching. They kept looking in the direction of the mother until she reached the basket. After reaching the basket, the mothers licked the kittens for some time before picking and carrying them away. When there were more than one kitten, the mother carried away one kitten first, kept it inside the crop cover, and came back for the second kitten with the same cautious approach.

DISCUSSION

All of the 18 reunion attempts were considered to be successful, as the female Rusty-spotted Cats came to pick up the kittens within > 4h 20min. No kitten was lost to predation. We observed that the females remained in the vicinity of the locations where the kittens were found. Under favourable conditions such as same location, late evening hours, and no disturbance from people, they accepted the kittens back and carried them

away. The key to successfully reuniting the mother and kittens is to provide this opportunity to them as quickly as possible after separation.

All the kittens were found during the sugarcane harvesting season, indicating that sugarcane fields provide cover for females with kittens and access to prey. Arthreya (2010) also reported two kittens found during the cutting of sugarcane in October and December 2008 in Ahmednagar District, Maharashtra. Leopard and Sunda Leopard Cats *Prionailurus javanensis* were also found in sugarcane fields, apparently attracted by a wide variety of prey (Jhamvar-Shingote & Schuett 2013; Lorica & Heaney 2013).

The Rusty-spotted Cat exhibits some tolerance for human-modified habitats and the vicinity of human settlements (Nowell & Jackson 1996; Athreya 2010). In one occasional instance, a Rusty-spotted Cat even gave birth in a farmhouse (Nowell & Jackson 1996).

In captivity, the Rusty-spotted Cat gives birth at any time of the year (Dmoch 1997). We came across approximately one to two months old kittens, mostly in April, also in October and November (Fig. 2). This might be due to the seasonality of crop harvesting in the region. The sugarcane harvest in the region generally begins in October with the opening of sugar factories. While in April, the speed of harvest in the last remaining sugarcane fields is increased by farmers as the sugar factories are about to close. This possibly results in an increased sighting of Rusty-spotted Cat kittens by villagers in sugarcane fields. Many times, the kittens were picked up and moved by the farmers as they wanted to urgently continue the sugarcane harvest. In a few cases, the kittens were mistaken by the villagers as Leopard cubs and were, therefore, moved away from the field for their own safety. In captivity, Rusty-spotted Cat kittens start moving about at the age of one month but frequently get tired and fall asleep (Dmoch 1997). Weaning begins at the age of 35 to 40 days, but suckling is continued in some cases until two months of age (Dmoch 1997). Information on the maternal care and development of kittens of the Rusty-spotted Cat in the wild is lacking. We speculate that the kittens were spotted by the people when the mother had left them for a brief period for hunting and feeding. In each of these events, the rescue team members made efforts to communicate with the villagers and farmers involved, and give them information about Rusty-spotted Cat and Leopards. The members also requested the villagers not to handle and remove the kittens they come across, and inform forest department officials about their presence.

Although there is no information available on normal physiological parameters in Rusty-spotted Cat, the parameters recorded in the rescued kittens were considered to be healthy as compared to the Domestic Cat *Felis catus* (Eldredge et al. 2011). None of the kittens exhibited any sign of sickness and were considered to be healthy and fit for the reunion.

Minimizing the time of separation between kittens and mothers appears to be an important contributing factor for a successful reunion. Leopard females in the wild are known to accept their cubs after a separation period as long as six days (Ajay Deshmukh unpub.). During such long periods, however, attempts were made on each night for the reunion. Our experiences from similar reunion attempts for displaced Leopard cubs indicate that the frequency of the mother returning to the location to look for cubs reduces with the increasing time gap between the separation and the reunion attempt. In case of the reunited Rusty-spotted Cat kittens, all the reunions happened on the evening of the same day. The mother cats were in the vicinity of the location where the kittens were found and returned on presumably hearing the kittens' vocalizations. None of the reunion events needed deployment of any artificial means to attract the mother to the kittens. We conclude that displaced Rusty-spotted Cat kittens can be successfully reunited with their mothers, provided that the time gap between the finding of kittens and reunion attempt is minimized.

We do not have any evidence that a delay of more than 24 hours would reduce the chance for a successful reunion. We, however, recommend that any reunion attempt should be made in the evening to minimize the disturbance from human activities, and that the handling of kittens before the reunion should be kept minimum. If the reunion does not happen on the same day, attempts should be made on the following nights until the absence of the mother in the vicinity is confirmed. Based on our experience with Rusty-spotted Cats and Leopards, such reunion protocols can be replicated for the kittens or cubs of other wild cat species.

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SHORT COMMUNICATION

Updating records of a threatened felid species of the Argentinian Patagonia: the Guigna *Leopardus guigna* (Molina, 1782) (Mammalia: Carnivora: Felidae) in Los Alerces National Park

Maria de las Mercedes Guerisoli [1], Mauro Ignacio Schiaffini [2] & Gabriel Bauer [3]

[1] Grupo de Genética y Ecología en Conservación y Biodiversidad, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Av. Angel Gallardo 490, CABA, Buenos Aires, Argentina.
[2] Centro de Investigación Esquel de Montaña y Estepa Patagónica, Universidad Nacional de la Patagonia San Juan Bosco, Consejo Nacional de Investigaciones Científicas y Técnicas, Laboratorio de Investigaciones en Evolución y Biodiversidad, Roca 780, Esquel, Chubut, Argentina.
[3] Departamento de Conservación y Educación Ambiental, División Conservación y Manejo, Parque Nacional Los Alerces, Parques Nacionales. Primeros Pobladores S/N, Villa Futalaufquen, Parque Nacional Los Alerces, Chubut, Argentina.
[1] mariadelasmercedesguerisoli@gmail.com (corresponding author), [2] mschiaffini@hotmail.com, [3] gbauer@apn.gob.ar

Abstract: The Guigna *Leopardus guigna* is an endemic felid of the Valdivian Temperate Forests in Argentina and Chile, and of the Chilean Matorral ecoregion. It is a small-sized felid (1.6–2.5 kg), one of the least known wild felids, and categorized as Vulnerable to extinction. Here, we present two new reliable records in Los Alerces National Park, Chubut Province, Argentina, the southernmost protected area, in which the species is present. The first record is an individual found dead on 6 June 2019 on the bank of Frey River near Amutui Quimei Lake. The second record was an individual casually captured in an American Mink *Neovison vison* cage on 7 December 2019 near Menéndez Lake. Both records were in forested *Nothofagus* sites very nearby to watercourses. In order to maintain viable long-term Guigna populations, corridors between protected areas should be established, particularly in habitat dominated by human presence and activities. We strongly recommend further fieldwork in protected areas and between them to increase the knowledge about the distribution, habitat use, and ecology of the Guigna.

Keywords: *Abrothrix*, American Mink, Argentinian protected area, cage trap, Kodkod, Valdivian Temperate Forests.

Resumen: El Guigna *Leopardus guigna* es un félido endémico de los Bosques Templados Valdivianos, en Argentina y Chile, y de la ecoregión Matorral Chileno en Chile. Este felino de pequeño tamaño (1.6-2.5 kg) es uno de los miembros menos conocidos de la Familia, y categorizado como Vulnerable a la extinción. En este trabajo, presentamos nuevos registros indudables en el Parque Nacional Los Alerces, provincia del Chubut, Argentina, el área Protegida más austral con registros fehacientes de la especie. El primero corresponde a un individuo encontrado muerto el 6 de junio de 2019 en la costa del río Frey, cerca del embalse Amutui Quimei. El segundo fue un individuo capturado casualmente en una trampa para visón *Neovison vison* el 7 de diciembre de 2019 en el lago Menéndez. Ambos registros ocurrieron en bosques de *Nothofagus* muy cerca de cursos de agua. Para mantener una población viable de Guigna a largo plazo, se deben establecer corredores entre las áreas protegidas, particularmente en hábitats dominados por la presencia y actividades humanas. Creemos que es necesario un mayor trabajo de campo en las áreas protegidas y entre ellas, para contribuir al conocimiento ecológico de esta especie.

Palabras clave: *Abrothrix,* Áreas protegida de Argentina, Bosques Templados Valdivianos, Kodkod, Trampa para visones.

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The Guigna *Leopardus guigna*, also called Kodkod or "Gato Huiña", is an elusive and cryptic species endemic to Chilean and Argentinian Valdivian Temperate Forests and Chilean Matorral (Nowell & Jackson 1996; Sunquist & Sunquist 2002, 2009; Tecklin et al. 2011; Fig. 1). Apart from being very small and rare, the Guigna is a wild felid with a restricted geographical distribution in approximately 300,000km^2 (Napolitano et al. 2015; Fig. 1). Categorized on the IUCN Red List as Vulnerable, its area of occupancy is fragmented due to loss and degradation of native forests (Napolitano et al. 2015). Due to changes in human use of land, the Guigna has lost 5.5% of its range since 1923 (Cuyckens et al. 2015). Moreover, Cuyckens et al. (2015) estimated that climate change together with human land use will negatively affect 40% of the Guigna's present potential distribution by the year 2050. Additionally, retaliatory killing for poultry depredation, road kills and attacks by dogs are also threats to this species, particularly in fragmented landscapes (Napolitano et al. 2015). In this scenario, contact with Domestic Cat *Felis catus* can be common, thus increasing transmission of common domestic species' pathogens such as Feline Immunodeficiency Virus and Feline Leukemia Virus (Mora et al. 2015). Still, in human-dominated landscapes, the Guigna can tolerate habitat fragmentation as long as an appropriate network of forest patches exists (Gálvez et al. 2018).

Protected areas are pivotal for the preservation of the Guigna, given that a great portion of the species' present range is contained in 19 protected areas of Chile and Argentina, covering a total of 133,882km^2 (Napolitano et al. 2014; Cuyckens et al. 2015). In Argentina, the Guigna is also categorized as Vulnerable (Monteverde et al. 2019), and its geographic distribution covers the Andean Mountains of Neuquén, Rio Negro and Chubut provinces with an area of less than 20,000km^2 (Monteverde et al. 2019; Figure 1). In this portion of its global range, the Guigna occurs only in four national parks of the Argentinian Patagonia, namely in Lanín, Nahuel Huapi, Lago Puelo, and Los Alerces national parks (Fig. 1), which together cover a total area of 13,837km^2 (SIB 2020a). In these protected areas, the Guigna is a "species with special value", a protection category that includes all species that: i) are highly threatened, ii) are distributed in at least 10% of the Argentinian national parks, and iii) represent a societal and spiritual value for local people (Monteverde et al. 2019).

In Argentina, the southernmost protected area where the Guigna is known to occur is Los Alerces National Park. In this protected area, only eight sighting records of Guigna exist during the last four decades 1978–2018 (SIB 2020a). These sightings consisted of nine individuals: four adults, three sub-adults, and two of uncertain age. Most of the individuals were sighted in summer (n = 6, SIB 2020a). Considering that this national park receives approximately 130,000 visitors per year (SIB 2020b) with about 15 active rangers in the field (GB, pers. obs.), the sighting frequency of this felid is quite low. New records for this rare and threatened species are of high value. Here, we report two additional records of the Guigna in Los Alerces National Park in 2019.

Study area

Los Alerces National Park covers 2,595.7km^2 in the Andean region of northwestern Chubut Province, Argentina (Fig. 1) and includes two main management categories: national reserve and national park (Martin & Chehébar 2001). The first is a buffer zone of 722.9km^2 where human activities are permitted, but regulated for livestock raising and tourism, while the second preserves the core area of this conservation unit extending over 1,872.8km^2 (Martin & Chehébar 2001). This protected area is part of the Valdivian Temperate Forests (Dinerstein et al. 2017), an ecoregion that spans across 346,000km^2 between 36 and 47°S latitude and is dominated by complex and open forests with endemic broadleaf evergreen tree species (Tecklin et al. 2011).

The climate is temperate cold, with a mean annual temperature of 8°C (APN 1997). The mean maximum temperature in summer is 14.7°C, and mean minimum in winter is 1.8°C. Mean annual precipitation decreases abruptly from west to east, from more than 3,000mm/year on the western side of the national park, including Valdivian evergreen rainforest, to 800mm/year at the eastern forest-steppe ecotone (APN 2019). Variable conditions of elevation and sun exposure affect the water balance and creates warm microclimates (APN 2019). Precipitation occurs mainly from April to October, with snowfall concentrated during autumn to spring, i.e. June to September (APN 2019).

Material and Methods

We recorded two Guignas opportunistically while conducting wildlife studies inside Los Alerces National Park in 2019. For controlling American Mink *Neovison vison*, we installed cage traps of 46cm in length with an entrance of 10 cm x 10 cm. Capture was authorized through a permit no. DI-2018-255-APN-DRPN#APNAC. Traps were installed at 2–3 m from the water edge and baited with Rainbow Trout *Oncorhynchus mykiss*. Guigna's faeces was analysed macroscopically by eye and microscopically using a microscope with 10x and

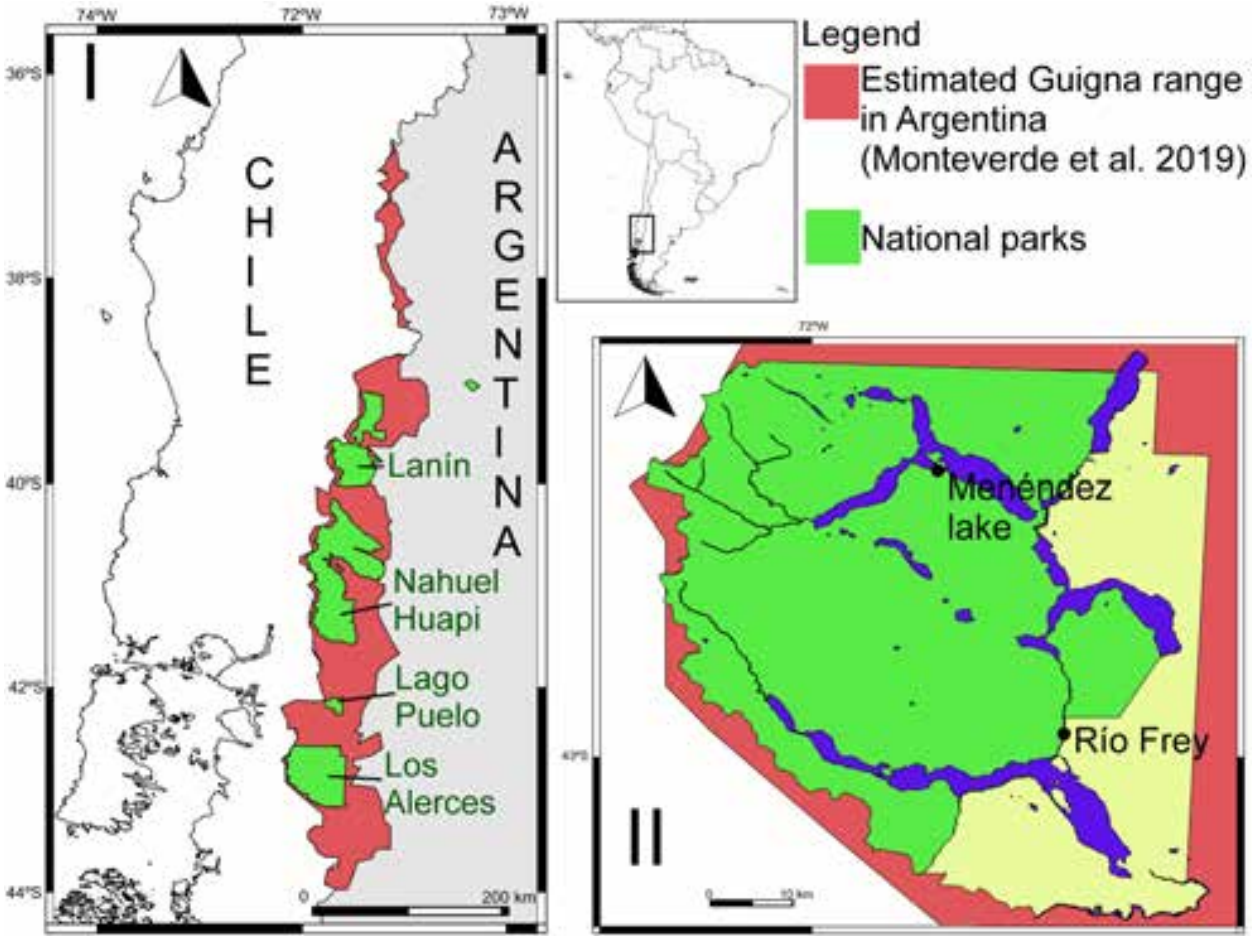

Figure 1. Map showing study area and distribution of the Guigna in Argentina.

40x lenses. Coordinates were determined using a GPS Garmin Etrex Legend-H.

Results

On 6 June 2019 at 11.00h, a subadult female was found dead on the bank of Frey River (Image 1) near Amutui Quimei Lake (-42.9741^{0}S & -71.7241^{0}W; Fig. 1). The cause of death was unknown. It was severely malnourished and estimated to have died a maximum of 48 hours ago. Its mass and total length were 940g and 65cm, respectively. It was not possible to remove the stomach and intestinal contents due to the decomposition status. The habitat of the finding location is characterized by typical Andean Forest, mainly composed of Coihue *Nothofagus dombeyi* (Fagaceae), Ciprés de la Cordillera *Austrocedrus chilensis* (Cupressaceae), Maitén *Maytenus boaria* (Celastraceae) and Radal *Lomatia hirsuta* (Proteaceae) trees, interspersed with Chilean Bamboo *Chusquea culeou*.

This Guigna specimen is now housed at the mammal's collection of Laboratorio de Investigaciones en Evolución y Biodiversidad (LIEB-M-1630), Esquel, Argentina.

On 7 December 2019 at 10:00h, one of us (MIS) found a live adult Guigna in a cage trap (Image 2) at Menéndez Lake (-42.6869^{0}S & -71.8622^{0}W; Fig. 1). This location was 35km in straight line from the first record location. We were unable to determine the sex of this individual because of its body position and scared condition. We estimated that the Guigna was captured between approximately 19.00h of 6 December 2019 and the next morning at approximately 09.00h. When found, the Guigna exhibited a nervous behaviour and was released shortly afterwards. Inside the cage, we found faeces composed entirely of dark grey hairs with a cuticular and medullary pattern that were identified as belonging to *Abrothrix* species. The capture site in the Andean Forest was characterized by a dense understorey with several fallen trunks that had a diameter ranging from approximately 5 to 50 cm. The nearby forest was dominated by adult more than 5m high trees of Coihue, Ciprés, Tepa *Laureliopsis philippiana* (Monimiaceae), Tineo *Weinmannia trichosperma* (Cunoniaceae) and

Image 1. Guigna found dead on 6 June 2019 in Río Frey near Amutui Quimei Lake, Los Alerces National Park, Argentina. © R. Sauval

Image 2. Guigna captured in a cage trap on 7 December 2019 near Menéndez Lake, Los Alerces National Park, Argentina. © M. Schiaffini

shrubs of Maqui *Aristotelia chilensis* (Elaeocarpaceae), and Espino Azul *Rhaphithamnus spinosus* (Verbenaceae).

Discussion

Los Alerces National Park is one of four national parks in Argentina where Guignas were sighted apart from Nahuel Huapi, Lago Puelo and Lanín National Parks (SIB 2020a). The last known sighting of a Guigna in Los Alerces National Park was in January 2018, but without photographic evidence. This Guigna was close to a stream and a water intake of the park where the habitat is characterized by the presence of low Ñire *Nothofagus antarctica* (Fagaceae) and Ciprés forests (SIB 2020a). According to Napolitano et al. (2015), the distribution of the Guigna extends to Santa Cruz province in Argentina near Perito Moreno National Park. In the latest published map for the species by Monteverde et al. (2019), however, Los Alerces National Park is the southernmost protected area in Argentina with confirmed presence of the species. We think that it is probably present in more southerly regions of Argentina, but lack of records and research efforts make it difficult to confirm this. Napolitano et al. (2014) affirmed that the Andes mountain range was neither a historical nor a current effective barrier to gene flow for the Guigna, but the southern Guigna group identified in Chile, the San Rafael Lake group between -46.5^{0}S and -47.5^{0}S, is geographically isolated. The potential Guigna population in the Argentinian side between -46.5^{0}S and -48^{0}S is demographically isolated or received dispersing individuals from the "Argentinian group", a population approximately 160km to the north (Napolitano et al. 2014). The closest cluster in Chile is the Lake District group (Napolitano et al. 2014) at a distance of about 600km. Still, dispersal of Guignas between regions in Argentina may not be easy, since they are likely exposed to competition from its more abundant and larger-sized sister species, the Geoffroy's Cat *Leopardus geoffroyi* (Lucherini et al. 2008; Napolitano et al. 2014).

At present, two Guigna subspecies are recognized: *L. g. tigrillo* inhabiting the Chilean Matorral, woodlands and forests in northern and central Chile; and *L. g. guigna* inhabiting the denser Valdivian temperate rainforest and Andean Patagonian forest in southern Chile and southwestern Argentina (Napolitano et al. 2014). The two records in Los Alerces National Park can possibly be referred to *L. g. guigna*, but based only on geographic distribution. These new records were found near closed vegetation habitat, with dense understorey and near waterbodies. Vegetation cover is an important ecological requirement for this species (Napolitano et al. 2015). The main vegetation around the two records were *Nothofagus* and Ciprés trees, with dense understorey. The presence of many carnivore species is associated with dense understorey, since the abundance of prey such as small mammals and birds is correlated with the presence of understorey shrub cover (Saavedra & Simonetti 2005; Estades et al. 2012). Dense understorey has been an important characteristic to enhance Guigna presence in forest plantations in Chile (Simonetti et al. 2013) and in other areas of Chile where Guignas were recorded (Sanderson et al. 2002; Acosta-Jamett & Simonetti 2004; Delibes-Mateos et al. 2014). Gálvez et al. (2013) found that in a fragmented Andean piedmont landscape, Guignas inhabited sites preferentially with forest cover such as old and secondary forest and scrubland. Although this species is thought to be strongly dependent on forests and sensitive to degradation and fragmentation (Sunquist & Sunquist 2002; Acosta-Jamett & Simonetti 2004; Acosta & Lucherini 2008), Gálvez et al. (2018) emphasized that it can tolerate habitat loss if networks of forest patches are present in agricultural areas.

In the faecal sample of the Guigna captured we found remains of *Abrothrix* species. This rodent was identified as a common prey of the Guigna in southern Chile, where faecal samples contained mainly *A. olivacea* and *A. hirta*, representing between 5.8% and 33.3% of the Guigna's diet (Dunstone et al. 2002; Freer 2004; Correa & Roa 2005; Moreira-Arce et al. 2015; Figueroa et al. 2018).

According to Cuyckens et al. (2015), the border between Argentina and Los Lagos Region in Chile is highly suitable for Guigna conservation. Two groups of Guigna haplotypes, i.e. Lake District and Argentinian, occur in this region with low migration rates between them (Napolitano et al. 2014). This area was proposed as a "Management Unit for Guigna Conservation" that facilitates various degrees of gene flow between Guigna populations (Napolitano et al. 2014). In order to maintain viable long-term populations, corridors between protected areas need to be established, particularly in habitat dominated by human presence and activities. We strongly recommend further fieldwork in protected areas and between them to increase the knowledge about the ecology and conservation needs of the Guigna, especially in Argentina.

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SHORT COMMUNICATION

Records of Rusty-Spotted Cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire, 1831) (Mammalia: Carnivora: Felidae) in Mount Abu Wildlife Sanctuary, Rajasthan, India

Hemant Singh [1] & **Aditya Kariyappa** [2]

[1] Rajasthan Forest Department, Divisional Forest Office Jhalawar, Near ITI, Jhalawar, Rajasthan 326001, India.
[2] Rajasthan Forest Department, Ward No. 16, Vidya Nagar, Belagavi, Karnataka 591307, India.
[1] hemant.shekhawat6@gmail.com (corresponding author), [2] adityak2025@gmail.com

Abstract: The Rusty-spotted Cat *Prionailurus rubiginosus* is the smallest cat in the world and restricted to the Indian subcontinent. Although it has been recorded across India, its ecology is poorly understood. In the northwestern state of Rajasthan, it has been recorded in the dry deciduous forest landscapes of Udaipur, Sariska, and Ranthambore. We report camera trap records of the Rusty-Spotted Cat in semi evergreen and dry deciduous forests in Mount Abu Wildlife Sanctuary, Rajasthan. In the current study from September 2017 to April 2018, out of 1,800 camera trapping nights the species was recorded on ten occasions, at four different locations in Mount Abu Wildlife Sanctuary.

Keywords: Camera trapping, small wild cat, threatened species.

The Rusty-spotted Cat *Prionailurus rubiginosus* is the world's smallest cat, endemic to the Indian subcontinent. It was thought to be found only in India and Sri Lanka until its presence was also documented in Nepal (Lamichhane et al. 2016). It is a protected species included in the Schedule I of the Wildlife (Protection) Act 1972 of India (Acharjyo 1998) and listed as Near Threatened on the IUCN Red List of Threatened Species (Mukherjee et al. 2016). The Rusty-spotted Cat population might have declined in the recent past possibly due to habitat changes, hybridization with domestic cats, poaching for trade of skins and predation by feral dogs (Van Gruisen et al. 1992; Menon 2003; Miththapala 2006; Vyas et al. 2018). Several Rusty-spotted Cats were killed in traffic accidents (Tehsin 1994; Digveerendrasinh 1995; Karanth et al. 2008; Behera & Borah 2010; Nayak et al. 2017; Adhikari et al. 2019). Very little is known about the home range and population dynamics of this elusive cat (Miththapala 2006; Nayak et al. 2017; Adhikari et al. 2019; Bora et al. 2020).

The Rusted-spotted Cat has been reported in various regions, spanning a wide range of habitats in the country. These include the foothills of the Himalaya in Jammu & Kashmir, the Terai region, Deccan Plateau, Eastern Ghats, Western Ghats, and the semi-arid landscape of Gujarat & Rajasthan (Chakraborty 1978; Digveerendrasinh 1995; Mukherjee 1998; Dubey 1999; Manakadan & Sivakumar 2006; Patel 2006; Pillay 2008; Anwar et al. 2010; Aditya & Ganesh 2016). Its presence has also been documented near human habitations and agricultural fields (Nowell & Jackson 1996; Mukherjee 1998; Dubey 1999; Athreya 2010).

Two-third of the state of Rajasthan is under desert cover; in arid and semi-arid parts the main forest type is thorn forest, and tropical dry deciduous forest occurs in

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hilly terrain (Sharma et al. 2013). In this state, the Rusty-spotted Cat has been reported near Udaipur (Tehsin 1994; Bhatnagar et al. 2000), in Sariska Tiger Reserve (Mukherjee 1998) and in Ranthambhore Tiger Reserve (Dharmendra Khandal in litt. 2013). One Rusty-spotted Cat carcass was found on a highway near Ramgarh-Vishdhari Wildlife Sanctuary in 2014 (Nayak et al. 2017).

Study Area

Mount Abu Wildlife Sanctuary covering an area of 326.14km^2 is situated in Rajasthan's Sirohi District bordering Gujarat (Fig. 1) in the southern part of the Aravalli Hills (Verma 2011). Elevation ranges from 300m at the foothills to 1,722m at Guru Shikhar, the highest peak of the Aravalli Hills. The dominant forest type is semi-evergreen on higher elevations and dry deciduous forest in the foothills (Champion & Seth 1968). Mount Abu is the only hill station in Rajasthan and harbours a unique biodiversity including few endemic species (Sharma et al. 2013). The flora of Mount Abu consists of 112 plant families, comprising 449 genera and 820 species (Mehta 1979). The Sloth Bear *Melursus ursinus* is abundant in the sanctuary while Leopard *Panthera pardus* is the apex predator (Verma 2011). Due to its geographical features and elevation, the climate is cool with a high average annual precipitation above 1,500mm in contrast to 470mm average annual rainfall in Rajasthan (Sharma et al. 2013; Verma 2011). The temperature ranges from -5°C in winter to 35°C in summer in higher elevations and from 7°C to 42°C in the foothills (Verma 2011).

Material and Methods

In order to establish a scientific management practice in Mount Abu Wildlife Sanctuary, camera trapping surveys were implemented to determine the diversity of species and their distribution pattern across the landscape. Cuddeback 1279 20 mega-pixel trail cameras were deployed across different elevation zones and habitat types in the sanctuary. They were installed

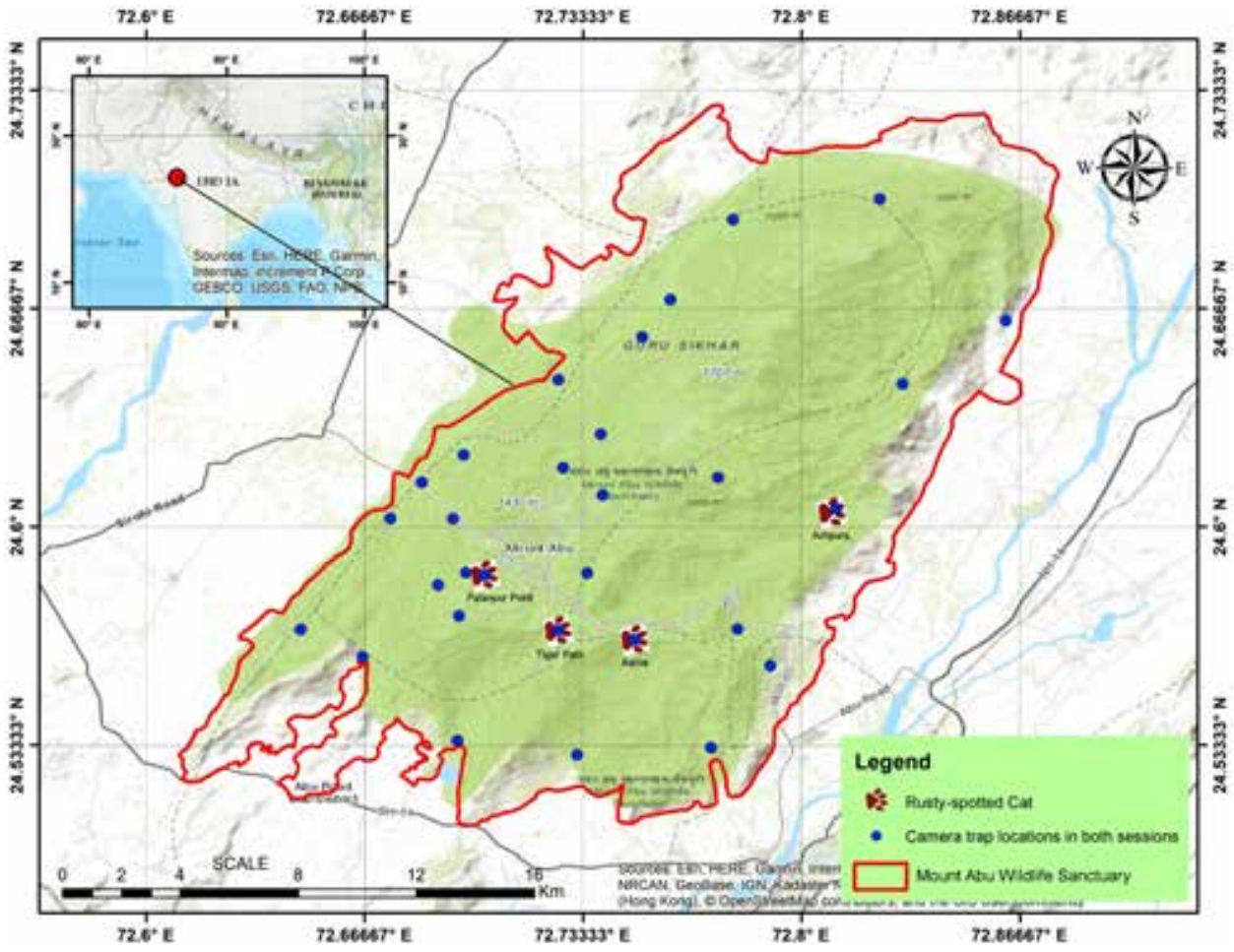

Figure 1. Study area in Mount Abu Wildlife Sanctuary with camera trapping locations

40–50 cm above ground and at a distance of 2–3 m away from the trails used by wild animals to record both large and small animals. The time interval between two consecutive photos was set to 10 seconds and were active for 24 hours. They were monitored routinely to retrieve data and check batteries.

We determined grids with cells of 2x2 km^2 and deployed one camera trap per cell. The cells were selected based on criteria such as accessibility of terrain, presence of animal signs and representative 'Beats', i.e., the smallest management units for different habitat types. Coordinates were determined using a handheld GPS (Garmin eTrex 20x) device set to datum WGS 84.

In the first session, sampling was carried out in elevation zones above 800m from September 2017 to December 2017 using 10 camera traps. In the second session from January 2018 to April 2018, the survey was extended to elevations below 800m (Table 1).

We define an occasion as a single image recorded in a particular location in the study area.

Results

The total survey effort during the study was 1,800 camera trap days. The Rusty-spotted Cat was recorded on ten different occasions at four camera locations (Table 2). Out of these, it was recorded in nine occasions at elevations above 800m in semi evergreen forest patches, and once in dry deciduous forest in lower elevations. It was recorded in an open forest area in a small valley at Palanpur Point trail located at 1,211m (Image 1). On Tiger Path track, it was recorded on five occasions (Image 2). The surrounding area was open undulating landscape with moderately dense undisturbed forest on both sides, dominated by *Mangifera indica*, *Erythrina suberosa*, and *Ficus glomerata* with undergrowth mainly consisting of *Lantana camara*. The area is situated in close proximity to a small hamlet named Sitavan. It was recorded on three occasions near Aarna Village on a wildlife track that is often used by humans (Image 3). This terrain and forest area is similar to the previous location, except the anthropogenic disturbance was higher due to the proximity of the village. Also, it is noteworthy that four different Leopards were recorded in this area. The fourth locality record in Achpura, situated in the lower foothills is a dry deciduous forest with *Anogeissus pendula* as dominant tree species. Apart from the Rusty-spotted Cat, the Leopard was commonly recorded, and the Jungle Cat *Felis chaus* on a couple of occasions. The details of the camera trap records are provided in Table 2. In addition, one adult female Rusty-spotted Cat (Image 4) was found injured, probably hit by a vehicle on 14 April 2018 near human habitation in Sunset area at an elevation of 1,159m. It was treated by the local veterinarian in Mount Abu but eventually succumbed to injuries.

Table 1. Details of camera trapping survey design used in the study.

Survey session	Extent of study area and elevation range	Survey effort
September to December 2017	10 cells from 800–1,722 m	600 camera trap days
January to April 2018	30 cells from 300–1,722 m	1,200 camera trap days

Image 1. Rusty-spotted Cat at Palanpur Point trail on 10 September 2017. © Rajasthan Forest Department. Note the time format was incorrectly set to PM instead of AM.

Image 2. Rusty-spotted Cat at Tiger Path on 10 January 2018. © Rajasthan Forest Department.

Table 2. Details of camera trap records of the Rusty-spotted Cat in Mount Abu Wildlife Sanctuary.

Date and time	Camera location	Other wildlife recorded at these locations
09.x.2017, 10.53h	24.585°N & 72.703°E; 1,211m at Palanpur Point Trail	Indian Grey Mongoose *Herpestes edwardsi,* Indian Hare *Lepus nigricollis*, Asian Palm Civet *Paradoxurus hermaphroditus*
10.i.2018, 20.32h; 21.i.2018, 02.11h; 30.i.2018, 03.38h; 01.ii.2018, 22.06h	24.568°N & 72.725°E; 1,178m at Tiger Path	Leopard, Sloth Bear, Sambar *Rusa unicolor*, Indian Grey Mongoose, Ruddy Mongoose *H. smithii*, Asian Palm Civet, Small Indian Civet *Viverricula indica*, Indian Crested Porcupine *Hystrix indica*, Indian Hare, Grey Junglefowl G*allus sonneratii*
28.i.2018, 20.33h; 31.i.2018, 04.56 h; 1.ii.2018, 19.27h	24.565°N & 72.749°E; 1,143m in Aarna Beat	Leopard, Sloth Bear, Sambar, Striped Hyaena *Hyaena hyaena*, Asian Palm Civet, Small Indian Civet, Indian Crested Porcupine, Indian Grey Mongoose, Ruddy Mongoose, Indian Hare, Grey Junglefowl
15.iv.2018, 02.22h	24.605°N & 72.810°E; 370m in Achpura Beat	Sloth Bear, Asian Palm Civet, Indian Grey Mongoose, Indian Hare

Image 3. Rusty-spotted Cat at Aarna on 28 January 2018. © Rajasthan Forest Department.

Image 4. Rusty-spotted Cat found injured near Sunset Point on 14 April 2018. © Hemant Singh.

Discussion

Our records of the Rusty-spotted Cat in Mount Abu Wildlife Sanctuary are among the highest elevation records in India to date. In Udanti-Sitanadi Tiger Reserve located in Chhattisgarh, Central India, it was recorded up to elevations of 924m in dry deciduous mixed forests (Basak et al. 2018). Nimalrathna et al. (2019) reported records in Horton Plains National Park in Sri Lanka at an elevation range of 2,084–2,162 m in a mosaic of grasslands and forest patches. To date, Mount Abu Wildlife Sanctuary is the southwestern most protected area in Rajasthan, where the Rusty-spotted Cat was recorded. About 85km aerial distance farther east, a Rusty-spotted Cat kitten was sighted in Sajjangarh Wildlife Sanctuary in 2006 (Sharma 2007). Farther south, Vyas et al. (2007) reported sightings of Rusty-spotted Cats in dry deciduous forest patches outside protected areas in northeastern Gujarat. Our records corroborate findings in other study areas that the Rusty-spotted Cat preferably inhabits forested areas and is foremost nocturnal in nature (Patel 2011; Basak et al. 2018; Nimalrathna et al. 2019; Bora et al. 2020). In Mount Abu Wildlife Sanctuary, multiple records in the areas around Tiger Path and Aarna imply the importance to sustainably manage these undisturbed forest habitats for the long-term viability of the Rusty-spotted Cat population. The detection of the species on only 10 occasions may be due to the wide spacing of camera traps and the limitation in survey effort. A more extensive camera trapping survey over a longer period and using smaller cells may shed more light on the Rusty-spotted Cat population in the sanctuary.

Dry and moist deciduous forests seem to provide prime habitat for the Rusty-spotted Cat (Mukherjee et al. 2016). Its presence in Mount Abu Wildlife Sanctuary warrants surveys in neighbouring protected areas of the Aravalli Hills such as Jessore Sloth Bear Sanctuary, Balaram Ambaji Wildlife Sanctuary, and Phulwari Ki Nal Wildlife Sanctuary to determine connectivity to population units in Gujarat. A comprehensive survey across the landscape using camera trapping in combination with radio telemetry and scat analysis is important to improve understanding of the Rusty-spotted Cat's ecology, in particular regarding its

movement and space use pattern, diet, reproduction, response to anthropogenic factors and identification of threats to its survival. This baseline information will form the basis for developing a robust strategy for its conservation.

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