International Journal of Ecology and Environmental Sciences 48: 747-753, 2022
ISSN: 2320-5199 (Online); https://doi.org/10.55863/ijees.2022.6747

Status, Activity Pattern and Habitat Use of Rusty-Spotted Cat (*Prionailurus rubiginosus*) in Gir Protected Area, Gujarat, India

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ABSTRACT

Lack of ecological information apart from anthropogenic causes like habitat fragmentation is among the major hindrances in proper conservation planning of endemic rusty-spotted cat (*Prionailurus rubiginosus*). The present study assessed the status, fine scale habitat use, and activity pattern of the rusty-spotted cat using camera traps at 50 sites in Gir protected area, Gujarat, India. Camera traps were placed in a systematic grid of 4 km^2 and resulted in a total 2003 trap night effort. The rusty-spotted cat status was assessed using relative abundance indices, while the activity pattern was assessed using circular statistics. Generalized linear model with binomial distribution and logit link was used to assess the variables affecting habitat use of rusty-spotted cat. A total of 30 captures of the rusty-spotted cat were obtained, resulting in a RAI of 1.49 captures/100 trap nights. Activity pattern of rusty-spotted cat was nocturnal (mean activity =01:06 hours (S.E. = 00:29)) and non-uniform ($Z=17.84$, $p<0.05$). Habitat use of rusty-spotted cat was found to be positively related to the rodent abundance and shrub height and negatively related to the tree abundance. Rusty-spotted cat used mixed habitat most followed by moist mixed, teak acacia ziziphus and thorn woodland habitat types. The present study can serve as a baseline for future studies on rusty-spotted cat in the Gir landscape.

Key words: Rusty-spotted cat, *Prionailurus rubiginosus,* camera trap, Gir, activity.

INTRODUCTION

The rusty-spotted cat (*Prionailurus rubiginosus)*) is the world's smallest wild felid endemic to the Indian subcontinent and Sri Lanka (Langle et al. 2019). Belonging to the leopard cat lineage (O'Brien and Johnson 2006), three subspecies of have been identified i.e., *P. r. rubiginosus*, *P. r. phillipsi* and *P. r. koladivius* (Kitchener et al. 2017). Originally believed to have been distributed in pockets, its presence has been found throughout India by recent studies (Anwar et al. 2010, Patel et al. 2010, Athreya et al. 2010, Aditya and Ganesh 2016, Lamichhane et al. 2016, Nayak et al. 2017, Vimalraj et al. 2019). The rusty-spotted cat is legally protected in Schedule I of the Wildlife Protection Act (1927) of India and listed as Near Threatened in IUCN red list (Mukherjee et al. 2016). Rusty-spotted cat has a broad distribution and its habitat requirements range from grassland to tropical forest and low scrubland to mountain tops (Langle 2019). Significant threats to rusty-spotted cat are habitat fragmentation, change in land-use patterns, and hybridization with domestic cats (Mukherjee et al. 2016).

Despite being endemic and facing habitat degradation, there is a paucity of ecological information on the rusty-spotted cat (Mukherjee et al. 2016) in India. Recently only two studies (Bora et al. 2020, Chaterjee et al. 2020) have mentioned about broad habitat requirements and population of the rusty-spotted cat; otherwise, much of the information is available in the form of observations or anecdotal records (Langle 2019). This paucity of ecological information may hinder the proper conservation planning for this small endemic felid.

Gir protected area (hereafter Gir) is situated in the semi-arid biogeographic zone of India (Jhala et al. 2019) and is known for having a sole surviving population of the Asiatic lion (*Panthera leo leo*). Past research efforts in the Gir protected area have been purely focused on large mammalian prey-predator (Joslin 1973, Khan 1993, Chellam 1993, Meena 2008, Zehra 2014, Jhala et al. 2019, Chaudhary et al. 2020a,b), and no information exists on small

carnivores like the rusty-spotted cat in Gir, except its first documentation for three decades ago (Pathak 1990). The present study was carried out in Gir with the objectives to assess the status, habitat use, and activity pattern of the rusty-spotted cat.

STUDY AREA

Present study was carried out in Gir protected area (Fig. 1) (20°57' to 21°20' N latitude and 70°27' to 71°13' E longitude). It consists of a wildlife sanctuary with an area of 1412 km^2 and a national park with an area of 259 km^2. The forest type is very dry deciduous, and teak dominated (Champion and Seth 1968). There is a cool, dry winter in Gir from December to March (average minimum 9°C) followed by a hot, dry season (average maximum 42°C), which lasts until mid-June. For more details, see Khan (1993).

METHODOLOGY

The rusty-spotted cat is a nocturnal and elusive felid (Bora et al. 2020), making data collection difficult through direct observations. Camera traps have been proven to be useful in studying felids due to camera's functionality for 24 hours (Karanth 2004). Therefore, achieving the objectives of the present study, camera traps were used. An intensive study area (ISA) of 200 km^2 was selected in the western part of Gir, representing major habitat types (Fig. 1). ISA was further divided into a grid system of 4 km^2, and in each grid, a camera trap was placed with inter trap distance ranges from 1.8-2.0 kms. Grid of this size is far larger than the home range of rusty-spotted cat (Chatterjee et al. 2020) and hence maintained the assumption of spatial independence in capture while assessing the habitat use of rusty-spotted cat. Camera traps were placed from March 2017 to June 2017 and November 2017 to January 2018. Camera traps were tied with a wooden block at the height of 35 cm and functioned for 24 hours with a capture time of 5 seconds between two consecutive photographs.

ANALYSIS

Captured pictures of the rusty-spotted cat were identified and segregated using a field guide (Menon 2014). Status of rusty-spotted cat was assessed using relative abundance index (RAI) (Carbon et al. 2001).

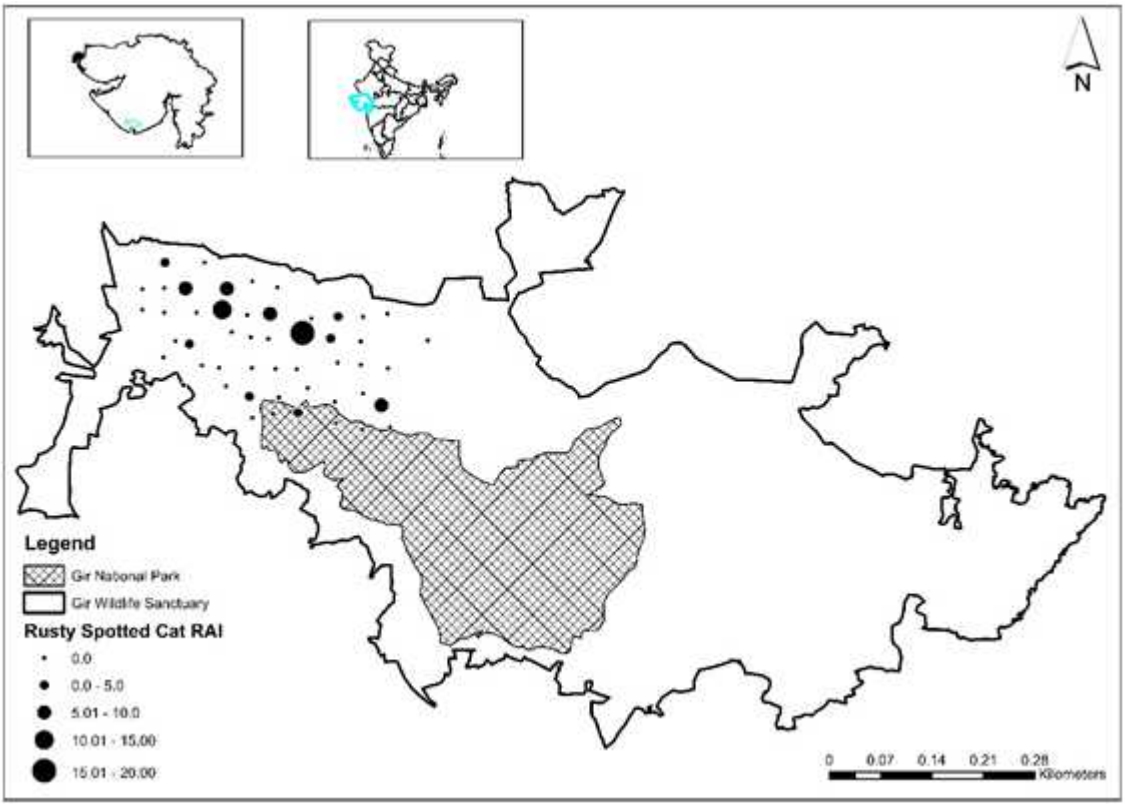

Figure 1. Map of the study area along with RAI of rusty-spotted cat at camera trap location

RAI is defined as the number of independent pictures (two consecutive capture with 30 minutes difference) divided by trap night (24 hours equal to one trap night) and have been used in some earlier studies (Jenks et al. 2011, Atherya et al. 2013, Palei et al. 2018). Camera traps pictures also have time stamps on them, used to assess the activity pattern in carnivores (Kämmerle et al. 2020, Chaudhary et al. 2020a). Therefore, time data from camera traps pictures was used to assess the rusty-spotted cat's activity pattern. To assess uniformity in activity pattern, Rayleigh's test was used (Zar 2006) while descriptive circular statistics was used to define the activity pattern using Programme Oriana 4.0 (Kovach 2011).

To assess habitat association potential habitat variables includes tree abundance, shrub height, rodent abundance, hare abundance, lion and leopard abundance were collected from field-based sampling and camera trap data. Tree abundance was considered due to the arboreal habitat of the rusty-spotted cat (Bora et al. 2020) and quantified by counting trees in a camera trap-centred plot of 20-meter radius. Shrub height was considered as a proxy for cover to capture prey as well as to avoid competitors. Shrub height was quantified by placing a one-meter straight rod (marked at 5 cm intervals) in four directions and recording the height of shrub at each point which further average for analysis. Rodent and hare abundance were considered since they are potential food items of the rusty-spotted cat (Mukherjee et al. 2016). Ramesh et al. (2013) during their research on rodents found that the number of rodent burrows can act as an index of rodent abundance; therefore, to assess rodent abundance number of rodent burrows was counted in the camera trap-centred plot of a 20-meter radius. While to assess the abundance of Indian hare, camera trap-based RAI was used.

Large predators have the potential to affect space us of sympatric small carnivores through intraguild predation (Palomares and Caro 1999, Chutipong et al. 2017). Asiatic lion and leopard are two intraguild predators in Gir, which could affect habitat use of rusty-spotted cat. Therefore, camera trap-based RAI of leopard and lion were considered as habitat variables.

To assess the habitat use of rusty-spotted cat we used generalized linear model (GLM). Since our data consist of presence absence location of rusty-spotted cat, therefore, we used binomial distribution with logit link. We used rusty-spotted cat presence absence as a response variable while potential variables defined earlier were used as predictor variable. A list of all possible models was created using dredge' function of package MuMIn in program R and model with $\Delta AIC < 2$ was considered as the final model (Chaudhary et al. 2020b). To assess relative importance of the model we used ΔAIC and AIC weight (Burnham and Anderson 2002). Model averaging was done for the models with $\Delta AICc < 2$ following Burnham and Anderson (2002). All analysis was carried out in program R ver. 4.0.2 (<www.r-project.org>). Broad level habitat use of rusty-spotted cat was assessed by segregating data on camera traps concerning four habitat types following Qureshi et al. (2004), i.e., Mixed (M), Moist mixed (MM), Teak *Acacia Ziziphus* (TAZ), and Thorn woodland (TW). A Chi-square test was used to assess the significant difference in habitat use of rusty-spotted cat (Zar 2006).

RESULTS

Camera trapping results in the total effort of 2003 trap nights (42±3.5; mean ± SE sampling effort per trap site). The rusty-spotted cat was captured at 13 sites out of 50 camera trap sites resulted in naïve occupancy of 26%. A total of 30 captures of the rusty-spotted cat were obtained, resulting in a RAI of 1.49 captures/100 trap nights. The rusty-spotted cat showed a strict nocturnal activity pattern, ranging from 20:00 h to 06:00 h, with high activity from 23:00 h to 00:00 h (Fig. 2). The mean activity pattern of the rusty-spotted cat was 01:06 hours (SE; 00:29 minutes) with non-uniform activity around the clock (means activity was not equally distributed around the clock) ($Z=17.84$, $p<0.05$).

Three model perform best consist of three habitat variables i.e., rodent abundance, shrub height and tree abundance. Rodent abundance ($b=2.01 \pm 0.74$) and shrub height ($b=0.13 \pm 0.28$) were positively associated with the habitat use rusty-spotted cat, while tree abundance ($b= -0.04 \pm 0.20$) was negatively associated with the habitat use of rusty-spotted cat (Table 1). Rusty-spotted cat used mixed habitat most followed by moist mixed, teak *Acacia*

Table 1. Summary of Generalized linear model (GLM) use to assess habitat use of Rusty-spotted cat. Only parameters for the set of models with ΔAICc < 2 are reported. Int. = intersection; *d.f.* = degrees of freedom; Log Lik = log likelihood function; ΔAICc = difference in value of Akaike's information criterion between the focal model and the top-ranked model; Est. = estimator for the GLM average model; Variables are described in materials and methods.

Model	Int	RA	SC	TA	*df*	Log	ΔAICc	Weight
1	-1.17	1.94	-	-	2	-21.24	0.00	0.50
2	-1.20	2.19	0.42	-	3	-20.79	0.98	0.30
3	-1.19	1.88	-	-0.24	3	-21.26	1.91	0.19
Est	-1.18	2.01	0.42	-0.24	-	-	-	-
SE	0.39	0.74	0.36	0.42	-	-	-	-

RA=Rodent Abundance; SC=Shrub cover; TA=Tree abundance

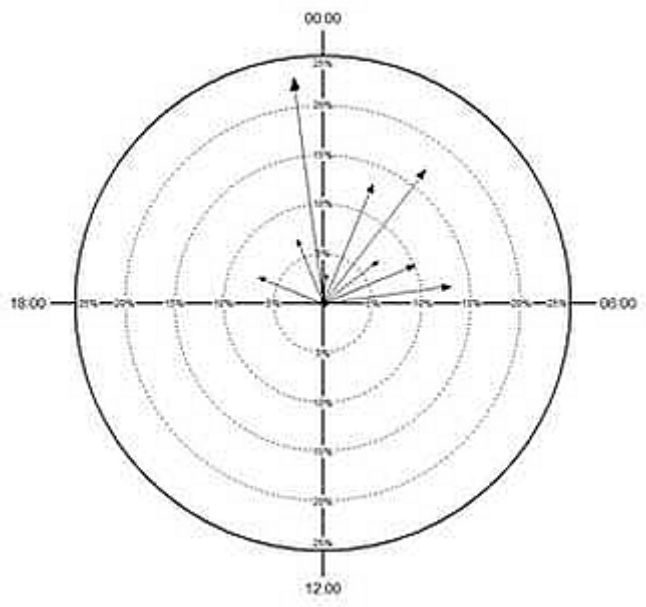

Figure 2. Activity pattern of rusty-spotted cat in Gir

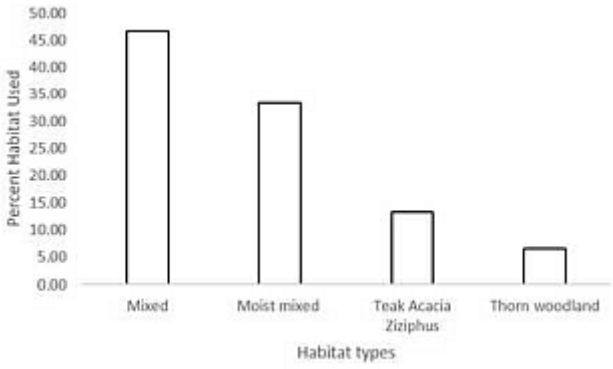

Figure 3. Habitat use by rusty-spotted cat

ziziphus, and thorn woodland habitat (χ^2=12.06; p<0.05) (Fig. 3).

DISCUSSION

The present study results are based on camera trapping of rusty-spotted cat. We found five such studies out of which three were from India (Bora et al.2019, RAI=0.09); (Chaterjee et al. 2020, RAI=0.63); (Atherya et al. 2013, RAI=0.90), one was from Nepal (Lamichante et al. 2016, RAI=0.46) and one from Sri Lanka (Nimalrathna et al. 2019, RAI=0.27). However, RAI across these studies cannot be compared since it is affected by a number of factors. For instance, dense camera trap array and placement for longer duration can increase the chance of species capture (Sollmann et al. 2013). Other important factor is season of camera trap deployment, since in different seasons resource distribution in an area can change which could further affect the movement pattern of a species, consequence of which is differential encounter in front of camera traps in different seasons.

The nocturnal activity of the rusty-spotted cat is in accordance with the recent study of Bora et al. (2020) that has also found similar activity pattern of the rusty-spotted cat in Kanha Tiger Reserve of India. Rodents are among the key prey species of rusty-spotted cat and they also have nocturnal activity patterns (Mukherjee et al. 2016). Being nocturnal in habit, rusty-spotted cat possibly synchronizes its activity with rodents, and hence having more hunting success. Rodent abundance along with shrub height and tree abundance were the habitat variables that showed association with RAI of the rusty-spotted cat at different trap sites. Optimal foraging theory predicts that predators will synchronize their space use with prey to increase their hunting success (Macarthur and Pianka 1966). Possibly by using sites having high abundance of rodents, the rusty-spotted

cat might increase their hunting success. Further, use of area with high shrub height may possibly be related to the vegetative cover required to ambush prey (Moseby and McGregor 2022).

Studies have found that small cats use sit and wait hunting strategy which requires availability of cover to conceal themselves. A recent study on free ranging cats using radio-telemetry has also found high use of area with dense shrub cover during foraging by free ranging cats (Moseby and McGregor 2022). The negative relationship of rusty-spotted cat space use with tree abundance is unusual since it is arboreal in nature. There are two possible reasons of negative relationship of rusty-spotted cat with tree abundance. First is availability of food, since rusty-spotted cat has strong dependency on small prey, primarily rodents. Also, studies have found that rodents have high abundance and diversity in open areas such as grasslands (Misher et al. 2022). It is thus quite possible that the rusty-spotted cat uses such area while foraging and hence has negative relationship with tree abundance.

Second, habitat use among animals is scale dependent which may vary from presence location of animal (fine scale) to large area use such as home range or use of large habitat patches (broad scale) (Rather et al. 2021). In the present study we assessed habitat use of rusty-spotted cat at fine scale i.e., at their presence location in front of camera traps. It is possible that at broad scale rusty-spotted cat use habitat with high tree abundance. Later statement is also supported by results of broad scale habitat use by rusty-spotted cat where it uses mostly mixed habitat, followed by moist mixed, teak acacia woodland and thorn habitat. Both mixed and moist mixed habitat types have high tree and understory cover than Teak-Acacia-Ziziphus and thorn habitat (Khan 1993). Bora et al. (2020) and Chatterjee et al. (2020) have also found that vegetation cover affects the space use of rusty-spotted cat positively. Possibly use of habitat patches with high tree and understory cover fulfils arboreal requirement of rusty-spotted cat as well as suitable area to ambush prey and predator avoidance.

LIMITATION

The present study was designed to study large carnivores therefore have sampling design limitations for assessing the status of the rusty-spotted cat. The camera traps were placed along roads and trails to maximize the leopard captures, which might affect the capture probability of the rusty-spotted cat. Also, large camera trap spacing may reduce the encounter rates in front of camera traps. Despite this, the present study is the first systematic information on the rusty-spotted cat in Gir and among the few from its range and may serve as a baseline for future studies.

ACKNOWLEDGEMENTS

Authors are thankful to the Chief Wildlife Warden of Gujarat state to provide permission for field work and Chief Conservator of Forest (Junagadh Circle) for facilitating the work. Authors are also thankful to deputy conservator of forest, Wildlife Division Sasan and Gir West for providing necessary support in field work. We are also thankful to our field assistants Usmaan and Fatteh Mohamad who helped us during our field work.

Authors' contribution: All authors contributed equally

Conflict of interest: Authors declare no conflict of interest

REFERENCES

Aditya, V. and Ganesh, T. 2016. Camera trap records of Rusty-spotted Cat *Prionailurus rubiginosus* and Leopard Cat *Prionailurus bengalensis* (Mammalia: Carnivora: Felidae) from Papikonda national park, northern eastern Ghats, India. Journal of Threatened Taxa, 8, 8818-8819.

Anwar, M., Kumar, H. and Vattakavan, J. 2010. Range extension of rusty-spotted cat to the Indian Terai. Cat News, 53, 25–27.

Athreya, V. 2010. Rusty-spotted cat more common than we think? Cat News, 53, 27.

Athreya, V., Odden, M., Linnell, J.D.C., Krishnaswamy, J. and Karanth, U. 2013. Big cats in our backyards: Persistence of large carnivores in a human dominated landscape in India. PLoS one, 8(3), e57872. doi:10.1371/journal.pone.0057872.

Bora, J.K., Awasthi, N., Kumar, U., Goswami, S., Pradhan, A., Prasad, A., Laha, D.R., Shukla, R., Shukla, S.K., Qureshi, Q. and Jhala, Y.V. 2020. Assessing the habitat use, suitability and activity pattern of rusty-spotted cat *Prionailurus rubiginosus* in Kanha Tiger Reserve, India. Mammalia, 85, 459-468.

Burnham, K.P. and Anderson, D.R. (Eds.). 2002. Model

Selection and Multimodal Inference: A Practical Information-Theoretic Approach. Springer, New York. xxvi +488 pages.

Carbone, C., Christie, S., Conforti, K., Coulson, T., Franklin N., Ginsberg, J.R., Griffiths, M., Holden, J., Kawanishi, K., Kinnaird, M., Laidlaw, R., Lynam, A., Macdonald, D.W., Martyr, D., McDougal, C., Nath, L., O'Brien, S., Seidensticker, J., Smith, J.L.D., Sunquist, M., Tilson, R. and Shahruddin, W.NW. 2001. The use of photographic rates to estimate densities of tigers and other cryptic mammals. Animal Conservation, 4, 75-79.

Champion, H.G. and Seth, S.K (Eds.). 1968. A Revised Survey of the Forest Types of India. Government of India Press, Nasik. xi+389 pages.

Chatterjee, N., Nigam, P. and Habib, B. 2020. Population density and habitat use of two sympatric small cats in a central Indian reserve. PLoS one, 15(6), 1-13.

Chaudhary, R., Zehra, N., Musavi, A. and Khan, J.A. 2020b. Evaluating the effect of ecological and anthropogenic variables on site use by sympatric large carnivores in Gir protected area, Gujarat, India. Wildlife Biology, 4, 1-7.

Chaudhary, R., Zehra, N., Musavi, A. and Khan, J.A. 2020a. Spatio-temporal partitioning and coexistence between leopard (*Panthera pardus fusca*) and Asiatic lion (*Panthera leo persica*) in Gir protected area, Gujarat, India. PLoS one, 15(3), e0229045. 1-14.

Chellam, R. 1993. Ecology of the Asiatic Lion (*Panthera leo persica*). Ph.D Thesis, Department of Biosciences, Saurashtra University, Gujarat, India. 170 pages.

Chutipong, W., Steinmetz, R., Savini, T. and Gale, G.A. 2017. Assessing resource and predator effects on habitat use of tropical small carnivores. Mammal Research, 62, 21-26.

Jenks, K.E., Chanteap, P., Damrongchainarong, K., Cutter, P., Cutter, P., Redford, T., Lynam, A.J., Howard, J. and Leimgruber, P. 2011. Using relative abundance indices from camera-trapping to test wildlife conservation hypotheses – an example from Khao Yai National Park, Thailand. Tropical Conservation Science, 4, 113-131.

Jhala, Y.V., Banerjee, K., Chakarbarti, S., Basu, P., Singh, K., Dave, C. and Gogoi, K. 2019. Asiatic Lion: Ecology, Economics, and Politics of Conservation. Frontiers Ecology Evolution, 7, 1-21.

Joslin, P. 1973. The Asiatic Lion: A Study of Ecology and Behaviour. Ph.D. Thesis, University of Edinburgh, UK. 249 pages.

Kammerle, J.L., Rondeaux, S. and Storch, I. 2020. Circadian activity patterns of red foxes (*Vulpes vulpes*) in montane forests under different culling regimes. Mammal Research, 65, 615-619.

Khan, J.A. 1993. Ungulate Habitat Relationship in Gir and its Management Implications. Ph.D Thesis, Aligarh Muslim University, Aligarh, India. 185 pages.

Khan, J.A., Musavi, A., Zehra, N., Chaudhary, R., Sharma, P. and Hussain, K. 2020. Monitoring structure, functioning and ecosystem services of dry tropical forest ecosystem of Gir for conservation and management of ecosystem, prey populations and predators. Final Technical Report submitted to MOEF&CC. Department of Wildlife Sciences, Aligarh Muslim University, Aligarh, India. 491 pages.

Kitchener, A.C., Wursten, B., Eizirik, C., Gentry, E., Werdelin, A., Wildting, L., Yamaguchi, A., Abramov, N., Christiansen, A.V., Driscoll, P., Duckworth, C., Johnson, J.W., Luo, W.E., Meijaard, J., O'Donoghue, E., Sanderson, P., Seymour, J., Bruford, K., Groves, M., Hoffman, C., Nowell, M., Timmons, Z. and Tobe, S. 2017. A revised taxonomy of the Felidae. The final report of the Cat Classification Task Force of the IUCN/SSC Cat Specialist Group. Cat News Special Issue, 11, 1-80.

Lamichhane, B.R., Kedariya, R., Subedi, N., Dhakal, B.K., Thapa, M. and Acharya, K.P. 2016. Rusty-spotted cat: 12th cat species discovered in Western Terai of Nepal. Cat News, 64, 31-33.

Langle, P.R. 2019. *Prionailurus rubiginosus*. Mammalian Species, 51, 155-162.

Linnell, J.D.C. and Strand, O. 2000. Interference interactions, co-existence and conservation of mammalian carnivores. Diversity and Distribution, 6, 169-176.

MacArthur, R.W. and Pianka, E.R. 1966. On optimal use of a patchy environment. American Naturalist, 100, 603-609.

Meena, V. 2008. Reproductive strategy and behaviour of male Asiatic lions. Ph.D. Thesis, Forest Research Institute, Dehradun, India. 179 pages.

Menon, V. 2014. Indian Mammals: A field guide. Hachette, UK. 528 pages.

Misher, C.; Vats, G. and Vanak, A.T. 2022. Differential responses of small mammals to woody encroachment in a semi-arid grassland. Frontiers Ecology Evolution, 10, 1-13.

Moseby, K.E. and McGregor, H.M. 2022. Feral cats use fine scale prey cues and microhabitat patches of dense vegetation when hunting prey in arid Australia. Global Ecology and Conservation, 35, 1-13.

Mukherjee, S., Duckworth, J.W., Silva, A., Appel, A. and Kittle, A. 2016. *Prionailurus rubiginosus*. The IUCN Red List of Threatened Species. www.iucnredlist.org .

Nayak, S., Shah, S. and Borah, J. 2017. First record of Rusty-spotted Cat *Prionailurus rubiginosus* (Mammalia: Carnfvora: Felidae) from Ramgarh-Vishdhari Wildlife Sanctuary in semi-arid landscape of Rajasfhan, India. Journal of Threatened Taxa, 9, 9761-9763.

Nimalrathna, T.S., Choo, Y.U., Kudavidanage, E.P., Amarasinghe, T.R., Bandara U.G.S.I., Wanninayaka, W.A.C.L., Ravindrakumar, P., Chua, M.A.H. and Webb E.L. 2019. First photographic record of the Rusty-spotted Cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire, 1831) (Mammalia: Carnivora: Felidae) in Horton Plains National Park, Sri Lanka. Journal of Threatened Taxa, 11, 13506-13510.

O'Brien, S.J. and Johnson, W.E. 2006. The evolution of cats. Scientific American, 297, 68-75.

O'Conell, A.F., Nichols, J.D. and Karanth, K.U (Eds.). 2011. Camera Trap in Animal Ecology. Springer, Tokyo. xiv+271 pages.

Palei, H.S., Pradhan, T., Sahu, H.K. and Nayak, A.K. 2016. Estimating Mammalian Abundance Using Camera Traps in the Tropical Forest of Similipal Tiger Reserve, Odisha,

India. Proceeding Zoological Society, 69, 181-188.

Palomares, F. and Caro, T.M. 1998. Interspecific killing among mammalian carnivores. American Naturalist, 153, 492-508.

Patel, K. 2010. New distribution record data for rusty-spotted cat from Central India. Cat News, 53, 26 -27.

Pathak, B.J. 1993. Rusty-spotted cat *Felis rubiginosa* Geoffroy: a new record for Gir Wildlife Sanctuary and National Park. Journal of Bombay Natural History Society, 87, 445.

Qureshi, Q. and Shah, N. 2004. Vegetation and habitat monitoring. Pp. 8-14, In: Jhala, Y.V. (Eds.) Monitoring of Gir. A technical report submitted to the Gujarat Forest department under GEF-India ecodevelopment program. Wildlife Institute of India, Dehra Dun, India.

Ramesh, D., Home, C., Jhala, Y.V. and Qureshi, Q.Q. 2013. Calibration of a burrow count index for the Indian desert jird, *Meriones hurrianae*. Population Ecology, 55, 241-245.

Rather, A., Kumar, S. and Khan, J.A. 2020. Multi scale habitat modelling and predicting change in the distribution of tiger and leopard using random forest algorithm. Scientific Reports, 10, 1-19.

Sollmann, R., Mohamed, A., Samejima, H. and Wilting, A. 2013. Risky business or simple solution – Relative abundance indices from camera-trapping. Biological Conservation, 159, 405-412.

Zar, J. 2006. Biostatical Analysis. Pearson Publication House, UK. 623 pages.

Zehra, N. 2014. Large mammalian prey-predator of Gir with special reference to ecology of leopard (*Panthera pardus fusca*) in Gir lion sanctuary and national park. Ph.D Thesis, Aligarh Muslim University, Aligarh, India. 492 pages.

Received:22nd January 2022
Accepted:30th August 2022