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DISTRIBUTION, HABITAT USE MAPPING AND CONSERVATION THREATS OF FISHING CAT (*PRIONAILURUS VIVERRINUS*) IN SHUKLAPHANTA NATIONAL PARK, NEPAL

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Abstract

The fishing cat (*Prionailurus viverrinus* Bennett, 1833) is a medium sized globally vulnerable wild cat of South and Southeast Asia. The Government of Nepal lead the periodic monitoring of big cats and their prey species, however such monitoring program focusing on small cats including fishing cat has almost lacking in the Western part of Nepal. Considering this gap in knowledge, we used strip transect (1–2 km * 5 m) and key informant survey to understand the current distribution, habitat use and conservation threats to fishing cat in Shuklaphanta National Park (ShNP) of Sudurpaschim Province of Western Nepal. Our findings indicate that the fishing cat was distributed in and around the wetland habitats. Furthermore, the majority of sign records were found in wetland with sparse sal forest, riverine forest and grassland with marshy areas. Using relative threat ranking method, we identified over fishing, wetland depletion and lack of recognition of fishing cat habitat as crucial threats to fishing cat. Restoration of wetland habitats, enhancement of fish densities in the wetlands and conservation awareness programs focusing fishing cat distribution sites should no longer be neglected in conservation planning to ensure their survival. We also recommend the systematic camera trapping and genetic level study of sub-population in ShNP and adjacent areas, as well as habitat use by radio-collaring.

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Introduction

The fishing cat (*Prionailurus viverrinus*) is a medium sized small cat species with stocky, powerful build, short legs and has webbed paws and a short tail to be used as rudder in water for swimming (TIMILSINA et al. 2021). It has elongated face, small ears that are poisoned far back on their head, short legs and a short tail. It is one of those small felines characterized by noticeable strips and spots patterns on the head, face and body (THUDUGALA and RANAWANA 2015). A fully grown fishing cat weights about 5–16 kg (DUGAN 1993). This elusive and moderately distributed aggressive animal is locally known as Malaha biralo (JNAWALI et al. 2011) The fishing cat is a globally threatened small cat species enlisted as "Vulnerable" in the IUCN Red List with a decreasing population range in South and Southeast Asia (MUKHERJEE et al. 2016) and appended in the Appendix II of *Cites* for enhancing conservation initiatives (*Cites*. 2020). Fishing cats have a wide range of patchy distribution throughout their range, primarily in low lands of South and Southeast Asia (MUKHERJEE et al. 2016, MISHRA et al. 2018, SILVA et al. 2020) with strongholds in Sri Lanka, Bangladesh, India and Nepal (MUKHERJEE et al. 2016). Their distribution range is shrinking globally with loss and degradation of wetlands, land degradation due to increasing soil erosion and sedimentation, industrialization, urbanization, and global climate change (CHOWDHURY et al. 2015, MISHRA et al. 2020, MUKHERJEE et al. 2012, TAYLOR et al. 2016). Nationally, fishing cat has been categorized as "Endangered" species with their distribution believed to encompass large parts of the southern lowland of Nepal's Terai region (JNAWALI et al. 2011). However, the actual distribution of fishing cat is not well understood in Nepal. Most of the fishing cats presence information is based on opportunistic records during the surveys targeted at large flagship species like tigers *Panthera tigris* (YADAV et al. 2018, POUDEL et al. 2019, TIMILSINA et al. 2021).

The evidence of fishing cats have been recorded from five protected areas of Nepal namely Koshi Tappu Wildlife Reserve, Chitwan National Park, Bardia National Park, Shuklaphanta National Park and Parsa National Park and three other sites (namely Jagadishpur Reservoir of Kapilvastu, Sunsari and Bara districts) outside of the protected areas in Nepal's Terai region (MISHRA et al. 2021). Around 70% of fishing cat range lies outside the protected areas in Nepal (MISHRA et al. 2022). Fishing cat is a habitat specialist, prefers wetlands such as water bodies, swamps and marshes with dense tall grassland (MISHRA et al. 2018, MUKHERJEE et al. 2012) and areas with culverts and bridges nearby water bodies (MUKHERJEE et al. 2012). Fish are the major diet of fishing cat with contribution

over 70% (SUNQUIST and SUNQUIST 2002) followed by birds and insects (MYERS et al. 2006). Occasionally, they may prey on small civets, young fawns of spotted deer, wild pigs, domestic goats, calves, dogs, poultry and water fowls where sometime seen scavenging tiger kills and livestock carcasses (NOWELL and JACKSON 1996).

This wetland dependent species is vulnerable to habitat loss and degradation as wetlands are most threatened ecosystem globally (DAVIDSON et al. 2018). Poaching, retaliatory killing, guard dog, movement of cats and livestock around the fish farm as well as core areas and nowadays road accidents are also reported as the major threats to fishing cat throughout its distributional range (MUKHERJEE et al. 2016, MISHRA et al. 2021).

Globally, fishing cat population has declined by 30% by last 15 years and is projected to decline by 30% in upcoming time (MUKHERJEE et al. 2016). In Nepal, detailed information on the distribution and status of small cats is sparse. Little information is available based on the historic references and signs survey designated for large felids in protected areas of Nepal (POUDEL et al. 2019). Also, research priorities are slanted towards big cats despite of the feline richness in the country (ARYAL et al. 2018). In this paper, we assess the distribution status, habitat use and major conservation threats that are impending the survival of this charismatic species in Shuklaphanta National Park (ShNP) of Western Nepal. Our study may contribute to know about the current distribution and habitat use of fishing cat in ShNP. This study can also be the basis to open up the further research areas using evidence based photographic and genetic level studies and developing appropriate conservation plan for the long term conservation of this threatened species.

Materials and Methods

Study area

We conducted our study in the core area of Shuklaphanta National Park (ShNP), which is located at the southwestern corner of Sudurpaschim Province of Kanchanpur district in Nepal (latitude – 28°50′25″N and longitude – 80°13′44″E) – Figure 1. It covers an area of 305 km^2 extending from an altitude of 174 to 1,386 m from mean sea level. It was gazetted in 1976 as Royal Shuklaphanta Wildlife Reserve and later in 2017; it was converted into national park. The area of 243.5 km^2 surrounding the reserve was declared as buffer zone in 2004 and it is comprised of mainly agriculture land (70%) followed by forests (21%), water bodies (7%) and grasslands (2%) (ShNP 2017).

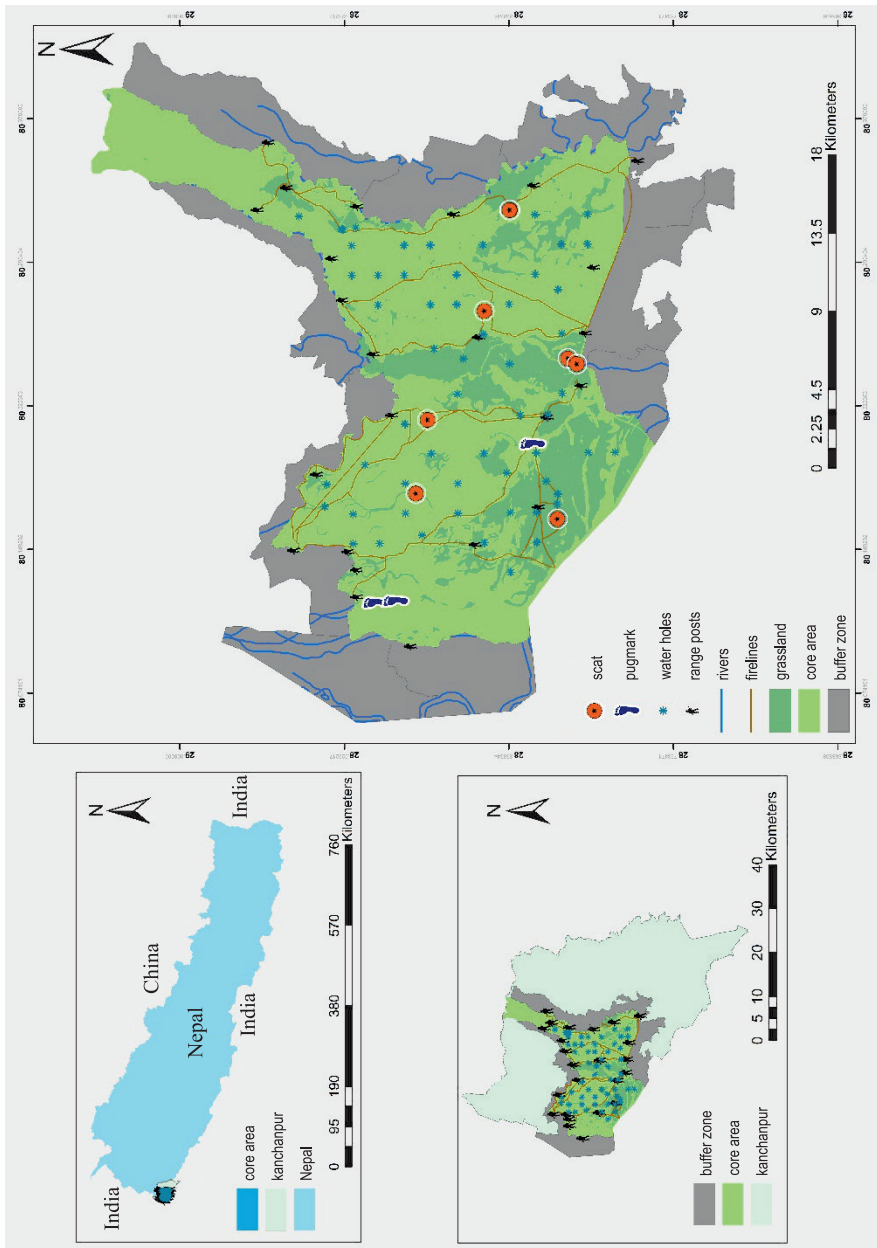

Fig. 1. The study area map showing park core area and buffer zone along with major land cover types and the location of fishing cat's scats and pugmarks detected during field survey 2019

It is bounded by the Syali River in the east, Mahakali in the west, Siwalik Hills in the north and east, and the Lagga Bagga forests and grasslands of Pilibhit Tiger Reserve lie in the Indian side in the south (DNPWC 2017). The park is an important part of the Terai-Duar Savanna and Grasslands eco-region with the major grass species are *Imperata cylindrica, Heteropogon contortus, Phragmites karka* and *Saccharum spontaneum* and this vegetation covers about 27% of the park's total area (ShNP 2017). The majority of park area is covered by the forests (60%) with Sal *(Shorea robusta)* dominant forest and other associated trees include *Terminalia alata, Largestromia parviflora* and *Pterocarpus marsupium* and other riverine forests such as Khair *(Acacia catechu)* and Sissoo *(Dalbergia sisoo)* (DNPWC 2017). The park provides prime habitat to globally threatened species such as Asiatic elephant *(Elephas maximus)*, one-horned rhinoceros *(Rhinoceros unicornis)*, Royal Bengal tiger *(Panthera tigris)*, sloth bear *(Ursus ursinus)*, smooth-coated otter *(Lutrogale perspicillata)*, fishing cat *(Prionailurus viverrinus)*, hispid hare (*Caprolagus hispidus),* hog deer (*Axis porcinus*) and rusty-spotted cat *(Prionailurus rubiginosus)* (DNPWC 2017, SADADEV et al. 2021).

Data collection

The field study was carried out between February and March 2019. Preliminary survey was carried out to identify potential habitats used by fishing cat in Shuklaphanta National Park before starting the actual field work. In consultation with the concerned stakeholders (park warden, experienced park staffs, local fishermen and nature guides), areas around Mahakali river, Baba Tal, Rani Tal, Salgaudi Tal, Kalikeech Tal, Sighpur, Pipariya, Shuklaphanta, Tara Tal, Chaudaha River, Kuwa Dada, Ghumauna, Bannikheda, Kapton Ghat inside national park were selected as potential sites for fishing cat survey.

Transect walk

For recording fishing cat distribution, we used a transect survey – a method widely used to monitor large mammals and felid species. Altogether 14 strip transects with length ranging between 1–2 km and 5 m width were laid randomly along the walking trails and existing paths of the park where direct sightings of fishing cat frequently detected by the park authority and the nature guides (Supplementary Information – Tab. Appx. 1). Transect walks followed major potential habitat types, viz waterholes, river or stream banks, marshy areas with grassland. Two co-authors and one experienced park staff walked slowly through each

transect to locate and identify the direct (direct sightings) and indirect signs (scats, pug marks) for consideration of fishing cat distribution in the study area. In each transect, transect number, site name, length and direction of transect, GPS location of starting and end point of transects, major vegetation types were recorded in the survey forms. Information on signs site, sign types (scats and pugmarks) were also recorded and also took their photographs for further validation. Spotted scats were identified on the basis of scraps, size, color, undigested prey remains in the feces, location and tracks followed by fishing cats based on local knowledge and photographs. Pugmarks were distinguished by visually observing the evidences of fish scales along the tracks followed by the fishing cat or nearby the spotted pugmarks.

Habitat use mapping

Habitat parameters (such as forest types, grasslands, shrub lands, cultivated lands, sand banks, river, streams, waterholes, etc) were recorded at the location of transects where signs (scats and pugmarks) or direct sighting of fishing cat were encountered. To quantify the habitat types used by fishing cat, we utilized the land cover of Nepal 2010 (ICIMOD 2013) and created a buffer of 1.5 km from the point of fresh scat and pugmarks collected from the field in accordance to the home range of fishing cat (SUNQUIST and SUNQUIST 2002). The habitat types within the buffer area were quantified using Arc GIS 10.8.

Threat assessment

Key informant interviews (n = 11) (7 park staffs, 3 National Trust for Nature Conservation staffs and 2 nature guides) were conducted to identify the major conservation threats to fishing cat which were further verified through the direct field visits and were ranked with relative threat ranking method (*Resources for implementing…* 2007) following (CHHETRI et al. 2020). To understand and quantify the major threats three criteria scope, severity and urgency were used (*Resources for implementing…* 2007).

Data analysis

Field data were analyzed using MS Excel and distribution map of the fishing cat was produced on the basis of available signs data (pugmarks and scats) using ArcGIS 10.8 version. Scats were identified by utilizing local knowledge and expert judgment (two co-authors and one experienced park staff and consultation of experienced nature guides) on the basis of

scraps, size, color, undigested prey remains in the feces, location and tracks followed by fishing cats based on knowledge and photographs. Similarly, pugmarks were identified on the basis of size and the evidences of fish scales along the tracks followed by the fishing cat or nearby its pugmarks. Major habitat types used by the fishing cat within the 1.5 km buffer were analyzed and presented as frequencies and percentages. Similarly, for conservation threat assessment, a relative threat ranking method was used (*Resources for implementing*... 2007, KAFLE et al. 2020) and three scales of classification – scope, severity and urgency were used to identify and rank the major existing threats. Three criteria were assigned to each of the identified issues and allotted a relative rank from high (5) to low (1) based on scales of WWF (2007), and finally, it was reclassified into 4 sub-classes very high, high, moderate and low (Tab. 1).

Table 1

Scales of ranking of scope, severity and urgency in relative threat ranking adapted from WWF (2007)

Criteria and rankings	Definition
Scope	the geographical scope of impact on the biological target that can reasonably be expected within 10 years under current circumstances
Very high	the threat is likely to be pervasive in its scope, affecting the target across all or most (71–100%) of its occurrence/population
High	the threat is likely to be widespread in its scope, affecting the target across much (31–70%) of its occurrence/population
Medium	the threat is likely to be restricted in its scope, affecting the target across some (11–30%) of its occurrence/population
Low	the threat is likely to be very narrow in its scope, affecting the target across a small part (1–10%) of its occurrence/population
Severity	the level of damage to the biological target that can reasonably be expected within 50 years under current circumstances
Very high	within the scope, the threat is likely to destroy or eliminate the target or reduce its population by 71–100% within 10 years or 3 generations
High	within the scope, the threat is likely to seriously degrade/reduce the target or reduce its population by 31–70% within 10 years or 3 generations
Medium	within the scope, the threat is likely to moderately degrade/reduce the target or reduce its population by 11–30% within 10 years or 3 generations
Low	within the scope, the threat is likely to only slightly degrade/reduce the target or reduce its population by 1–10% within 10 years or 3 generations
Urgency	this characteristic is used to assess the certainty and time scale over which impacts of the threat will be observable

cont. Table 1

Very high	the effects of the threat are already observable and there is an importance to take action to deal with the threat within a year
High	the effects of the threat are likely to occur and the threats are expected within the next 1–10 years
Medium	the effects of the threat are likely to occur and the threats are expected within the next 10–25 years
Low	the effects of the threat are unlikely to occur and the threats are expected in about 25 years from now

Results

Distribution of fishing cat

We found that there was not any direct sightings of fishing cat during the entire field work period. So we considered two kinds of indirect signs i.e., scats and pugmark as a presence of fishing cat in ShNP. All together 10 indirect signs were detected along the 8 transects out of 14 transects. Among them, fresh scats (n = 3) and pugmarks (n = 2) were detected from transect 6, 9 and 11 (supplementary information – Tab. Appx. 2), where the frequent sightings of fishing cat were also recorded by the park authority while doing daily patrolling operations and nature guides. The majority of signs (n = 7) were distributed in nearby the wetland with sparse sal forest, riverine forest and edge of grassland with marshy areas (Fig. 1, supplementary information – Tab. Appx. 2).

Habitat use of fishing cat

The majority of signs were detected on animal trails at the edge (within 30 m) of waterholes, marshy areas, riverine forest and grassland with sparse sal forest (Fig. 2, supplementary information – Tab. Appx. 2). The results conclude that major habitat characteristics used by fishing cat include grasslands (30.6%), cultivated land (21.77%) and forests (21.14%) respectively (Fig. 2, Tab. 2).

Table 2

Details of habitat within 1.5 km radius of fishing cat's fresh signs detected along the transects in Shuklaphanta National Park, Nepal

Transects	Site name	Habitat types area in hectares within 1.5 km radius of fresh scat and pugmarks detected sites						
		forest	shrub land	grass-land	swamp area (wetland)	culti-vated land	water bodies	sandy area (river bank)
Transect 6	Pipariya	169.80	120.91	–	1.23	109.21	135.40	170.23
Transect 9	Shuklaphanta	–	–	647.57	–	–	59.22	–
Transect 11	Tara taal	278.33	68.80	1.56	–	352.45	1.71	3.87
Total		448.13	189.71	649.13	1.23	461.66	196.33	174.10
		21.14%	8.95%	30.6%	0.06%	21.77%	9.26%	8.21%

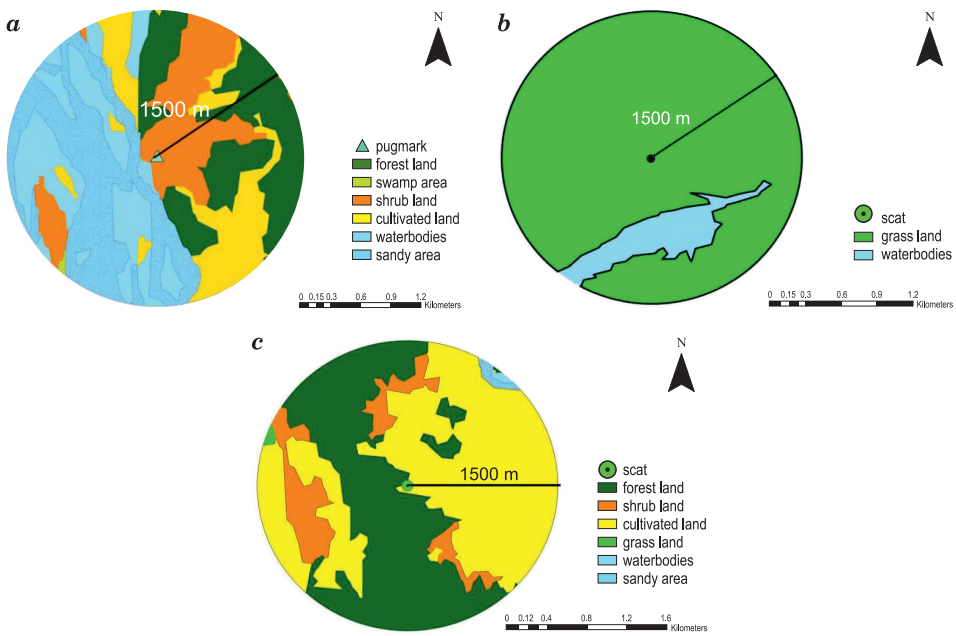

Fig. 2. Habitat use map of fishing cat within 1.5 km radius of signs detected sites along transect 6 (*a*), transect 9 (*b*) and transect 11 (*c*)

Conservation threats of fishing cat

Among five threats identified during the field survey and key informant interviews, over fishing (31.11%), wetland depletion (28.89%) and lack of recognition of fishing cat habitat (20%) are the most prominent issues as very high ranked threats of fishing cat in the study area (Tab. 3). A detailed ranking classes of all five main threats are shown in Table 3.

Table 3
Relative ranking of threats to fishing cat in Shuklaphanta National Park, Nepal

Threats	Scope	Severity	Urgency	Total	Percentage [%]	Threat category
Wetland depletion	5	4	4	13	28.89	very high
Over fishing	4	5	5	14	31.11	very high
Electrocution or poisoning	1	2	2	5	11.11	high
Human influence	2	1	1	4	8.89	moderate
Lack of recognition of fishing cat habitat	3	3	3	9	20.00	very high
Total	15	15	15	45	100.00	–

Discussion

Fishing cats were majorly distributed in and around wetland habitats in the patchy form. The indirect signs, i.e. scat and pugmarks were observed in those areas where the bushes and water bodies were abundant. Previous studies suggested that fishing cat prefer open structured features, water bodies with dense tall grassland (MISHRA et al. 2012) and areas with culverts and bridges nearby water bodies (MUKHERJEE et al. 2012), and our findings are consistent with those studies. The reason could be that the dense tall grassland and bushes help them to hide from their predators and might have used these habitats for shade and prey on grassland birds since, fishing cat are found to prey on birds and rodent species occasionally (HAQUE and VIJAYAN 1993). Further, about 70% of their diet is composed of fish (SUNQUIST and SUNQUIST 2002) and this could be the reason to live in the proximity of water bodies. Our study indicated that sal forest, riverine forest, sandy area or river banks, grassland with marshy area and wetland with sparse sal forests are the major habitat types used by the fishing cat. These results coincide with the results of (MUKHERJEE et al. 2016) where they found that sub-tropical forest areas, tall and short grasslands (flooded), wetlands, marshlands were found to be the major habitat. However, with the limitation we used sign survey method (scats and pugmarks) by utilizing the local field knowledge and expert judgment of Shuklaphanta National Park staffs and senior nature guides who are familiar to the area, which might not accurately represent their actual distribution and habitat use in ShNP as there are other sympatric small carnivores occurrence in the area. Further our study revealed that over fishing, wetland depletion, lack of recognition of fishing cat habi-

tat, electrocution or fish poisoning and human influence as existing severe threat in and around the national park which are similar to the study carried out by (MISHRA 2013, MISHRA et al. 2021). DAVIDSON et al. (2018) reported that wetland ecosystem is the most threatened ecosystem worldwide which makes fishing cat vulnerable. Likewise, electrocution or poisoning in the privately owned fish ponds or aquaculture by local communities in the eastern Nepal to are known to retaliate fishing cat to death (TAYLOR et al. 2016, MISHRA et al. 2021) however none of such death cases reported in our study. Shrinkage of wetlands, flooding and exploitation of riparian vegetation by the grazing livestock are identified as a threat by (TAYLOR et al. 2016, MISHRA et al. 2018) which supports our study. Human disturbance and over fishing were also major threats to the species as highlighted by SUNQUIST and SUNQUIST (2002), CUTTER and CUTTER (2009) which are consistent to our study.

Conclusion

Our study concludes that the fishing cat is distributed in and around the wetland habitat in the patchy form. Further, our study identified sal forest, riverine forest, sandy area or river banks, grasslands with marshy area and wetland with sparse sal forest as major habitat for the fishing cat. The major threat that are impending the survival of fishing cat in and around the study area were identified as over fishing, wetland depletion, lack of recognition of fishing cat habitat, electrocution or poisoning and human influence. Conservation of wetland habitats, increase fish stock in the wetlands and conservation awareness programs focusing fishing cat distribution sites should be included in ShNP conservation planning to ensure their survival. We also recommend the evidence based photographic capture-recapture survey and genetic level study to determine the actual status and distribution of fishing cat as well as habitat use by GPS tagging in ShNP.

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Appendix

Table Appx. 1

Detailed information of 14 transects laid down in Shuklaphanta National Park, Nepal

Transect name	Site name	Transect length [m]
Transect 1	Baba Tal	1120
Transect 2	Baba Tal	1020
Transect 3	Salgaudi Tal	1070
Transect 4	Rani Tal	1540
Transect 5	Sighpur	1300
Transect 6	Pipariya	2000
Transect 7	Kapton Ghat	1250
Transect 8	Silalake chowk, pillar No 24	1290
Transect 9	Shuklaphanta	1000
Transect 10	Baba Tal to Kuwadada	1400
Transect 11	Tara Tal	1020
Transect 12	Between Chaudaha river and kalikeech Tal	1640
Transect 13	Ghumauna Tal	1310
Transect 14	Bannikheda (Chaudaha River side)	1070

Table Appx. 2
Details of indirect signs detected location during transect walk (February-March, 2019) along with site descriptions in Shuklaphanta National Park, Nepal

Transect	Sign number	Site name	Habitat type	Dominant vegetation	Ground cover	Distance from water source [m]
Transect 3	1 Scat	Salgaudi	Riverine Forest	*Syzygium cumini*	Fiddlehead Fern, Calamus	100
Transect 5	1 Pugmark	Sighpur	Sal Forest	*Shorea robusta*	*Imperata cylindrica,* Naranga, *Citrus maxima*	30
Transect 6	2 Pugmark	Pipariya	Riverine Forest	*Syzygium cumini*	*Imperata cylindrica, Citrus maxima, Ageratina adenophora*	0.5
Transect 9	1 Scat	Shuklaphanta	Grassland (Marshy area)	*Citrus maxima*	*Imperata cylindrica, Citrus maxima*	150
Transect 10	2 Scat	Baba Tal	Sal Forest, Grassland	*Shorea robusta, Calotropis gigantea*	*Imperata cylindrica*, Ekri, Cimpokokan	23
Transect 11	2 Scat	Tara Tal	Wetland, Sal Forest	*Shorea robusta, Centella asiatica*	*Centella asiatica*, *Cynodon dactylon*, *Ageratina adenophora*	5
Transect 12	1 Scat	Chaudaha river	River bank	*Ipomoea carnea*	*Ipomoea carnea*	50
Transect 13	1 Scat	Ghumauna Tal	Riverine forest	–	Fiddlehead Fern, Calamus	10