PRESENCE OF EVIDENCE AND FACTORS AFFECTING DISTRIBUTION OF EURASIAN OTTER (*Lutra lutra*) IN THE PELMA RIVER, RUKUM EAST, NEPAL

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ABSTRACT

This study presents evidence of Eurasian otters (Lutra lutra) *and factors influencing distribution in the Pelma River. A survey for indirect signs (scat/spraint, latrine, tracks and holt/den) was carried out on one side of the river bank to understand otter presence/absence and distribution while camera traps were used for species images and identification. Mann-Whitney U test, Spearman's correlation coefficient and logistic regression model (backward stepwise regression) were applied to understand habitat factors (11 variables) affecting otter distribution. A total of 64 spraints were counted in the entire study (20km) and a dried otter skin was obtained but no camera images were obtained. Spraint density of 3.2 spraints/km^{-1} was obtained which is relatively higher than in adjacent rivers in the area. Fishing and killing of otters were identified as the prevailing threats to the otter in the study river. Mann-Whitney U test showed "elevation" has significant differences in sites with otter signs positive and negative. Elevation obtained a highly significant relation when otter signs are correlated against habitat variables. Logistic regression model noted "elevation" and "small stones" as significant independent variables to predict the probability of positive otter signs with 83.3% accuracy. The predicted variable would be applicable in rivers with similar geographic settings in Nepal with suggestions to critically evaluate the relevance of variables in relation to their local environment. The present study suggests further research on the otter population to assess the exact otter status in the area and need for conservation awareness to prevent killing of otters.*

Keywords: *Elevation; habitat variables; indirect signs; logistic regression model; Mann-Whitney U test; Spearman's correlation coefficient; spraint density; threats*

INTRODUCTION

The Eurasian otter (*Lutra lutra*) is believed to be widely distributed in wetlands such as rivers, marshes and lakes in Nepal (**Acharya, 1997**) with a population estimated at 1,000–4,000 (**Jnawali et al., 2011**). However, the rare sighting of this species for a long time contradicts ideas of a wide distribution and prior estimates. The presence of evidence of this species in wetlands of Nepal was equivocal after 1991 until the recent records from the Roshi River in Kavrepalanchok district (skull of dead Eurasian otter), the Barekot River in Jajarkot district (camera trap images) and direct sighting and photographs from Tubang River in Rukum East district (**Shrestha et al., 2021b**). The nocturnal nature, secretive behavior and lower distribution density of Eurasian otters made it difficult to obtain direct sightings (**Ruiz-Olmo et al., 2001**), obligating indirect signs (scat/spraint, latrine, tracks and holt/den) as the evidence substantiating otter presence during a survey (**Mason and Macdonald, 1986**). However, the signs cannot confirm the otter species especially in areas with multiple otter species. Eurasian otter, smooth-coated otter (*Lutrogale perspicillata*) and Asian small-clawed otter (*Aonyx cinereus*) are otter species reported to be present in Nepal (**Hodgson, 1839**). Plenty of otter spraints were observed during a survey in October 2019 survey in the Sanibheri River and its upstream tributaries; the Uttar Ganga River and lower reach of the Pelma River (**Shrestha et al., 2021a**). However, otter species identification was not made during the 2019 survey. Thus, additional study was carried out to gather evidence of Eurasian otter presence, particularly in the upper reaches of the Pelma River, to examine the factors influencing otter distribution and to develop a predictive model to understand the factors affecting otter distribution in the study river.

STUDY AREA

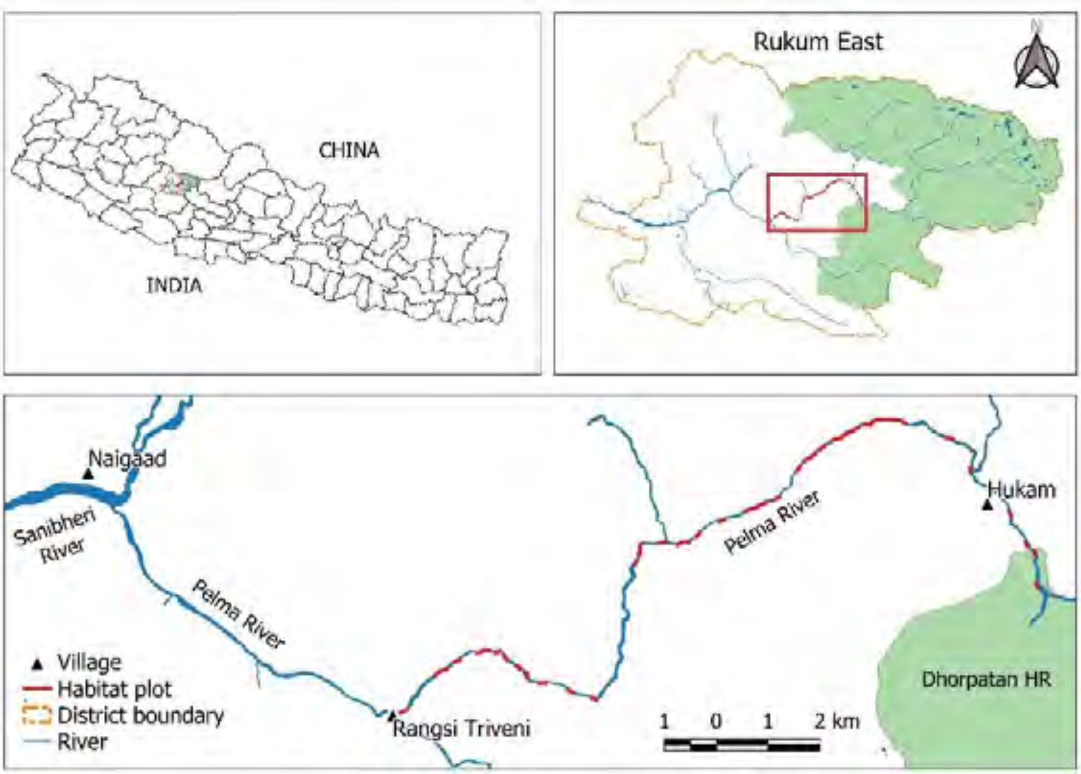

Figure 1. Otter survey study area.

This study was carried out along 20km of the Pelma River segment from Rangsi Triveni (48.633419°N 82.749056°E; 1430m a.s.l.) downstream to Hukam village (28.658241°N 82.876124°E; 1923m a.s.l.) and upstream to the edge of the Dhorpatan Hunting Reserve (Figure 1). The river here is mid-hills with rugged terrain and flows partly through a ravine. Nepalese alder, fern, pine, nettle and reed are the dominant river bank vegetation but in the deep gorge there are exposed bed rocks devoid of vegetation.

METHODS

The survey was carried out for 12 days in March 2021. A survey for otter signs on the river bank and camera traps were used for collecting information on otter presence and species identification.

The survey was carried out on one side of the river bank (**Andrews, 1989; Jamwal et al., 2016)** dividing the entire length (20km) into 1km transect (**Jamwal et al., 2016**). One plot of 100m (along the river bank) by 10m (away from the river bank) was placed at the start of each transect for a total of 20 plots. Observations of otter signs such as tracks, spraints, latrine, prey remains and holts/dens were used as evidence for otter presence (**Macdonald, 1990; Mason and Macdonald, 1991; Wilson and Delahay, 2001; Reuther et al., 2000; Sittenthaler et al., 2020**). In addition, otter parts obtained during the study period were used as further evidence. Spraints were identified by the fishy odour and fish bone remains (**Macdonald, 1990**). Photographs of spraints and otter body parts were confirmed by research specialists in the IUCN Otter Specialist Group. Otter spraints observed were recorded within the plots and whenever encountered outside the plots along the transect, unless prevented by inaccessible terrain (**Jamwal et al., 2016; Shrestha et al., 2021a**). Spraints were recorded separately when more than 5m apart (**Melquist and Hornocker, 1983; Newman and Griffin, 1994**). A site with more than five spraints within 5m was defined as a latrine site. Camera traps (two sets) were installed in the sites with fresh spraint or latrine sites or den sites for 24 hours to record otter images to help with species identification. From the cumulative spraints count in the entire study river length, spraint density per kilometre was calculated since fewer spraints were observed in the plot (**Shrestha et al., 2021a**).

Habitat variables were studied to understand the factors linked with otter distribution and these were recorded both in the plots within the transect and also at sites with spraints outside the transect. Separate plots (100m x 10m) were set when spraints were observed more than 100m apart in the transect. Two types of variables were used in this study: scalable and categorical variables. Scalable variables are elevation, river width, bank slope (left bank and right bank), river flow, river depth and bank substrate (sand and mud, pebbles and small stones, large stones, rock boulders) while categorical variables are otter signs indicating presence and absence, and human disturbance (none, light, moderate and severe).

Of the habitat variables, elevation was recorded using Garmin GPSMAP 64s. River width (distance from bank to bank) was measured through Rangefinder, River bank slope was measured using a Clinometer (**Nawab and Hussain, 2012**). River flow (m/s) was measured using a floating ball method. River depth (m) was measured using a measuring scale (1m length) at the river bank closest to the recorded spraint site. River bank substrate was categorically differentiated based on diameter into (1) sand and mud (<5mm), (2) small stones (5–50cm), (3) large stones (50–100cm) and (4) boulders (>100cm). Mean substrate attributes were calculated by averaging each percent category thus the total percentage may not be equal to 100% because of the use of mid-points of values in calculations. Habitat disturbances were categorically differentiated as none, light, moderate and severe based on observation of abundance of dogs and cow tracks, trash and proximity to houses (**Jamwal et al., 2016**).

Mann-Whitney U test and Spearman's correlation coefficient were applied for statistical analysis because of non-normal distribution of habitat variables. Mann-Whitney U test was applied to identify the significant difference in habitat variables among sites with positive and negative sites (**Madsen and Prang, 2001).** Spearman's correlation coefficient was applied for assessing the relationship of otter signs with habitat variables and among habitat variables (**Hysaj et al., 2013**).

Logistic regression model (backward stepwise regression) was applied (**Miller et al., 2002; Medina-Vogel et al., 2007; Yoxon, 2013; Balestrieri et al., 2015; Jo et al., 2017**) to examine the influence of selected habitat variables on otter detection and non-detection with a vector of 1s (otter positive sites) and 0s (otter negative sites) as the binary dependent variables. This tool is used for species distribution models and has high accuracy due to both presence and absence data (**Brotons et al., 2004**). Variables that are not significant on a 0.05 level in a stepwise and backward selection were dropped subsequently from a model. A classification table was used to compare predictions to the observed outcomes to understand the accuracy of the model applied (**Yoxon, 2013**). Selected variables were used for model development in a linear form as: $\text{logit}(p) = I + \beta x$, where, "p" is probability of otters to be present, "I" is Intercept parameters and "β" is vector slope parameters (**Madsen and Prang, 2001**).

RESULTS AND DISCUSSION

Evidence of otter presence

In total, 64 spraints were counted throughout the length of the river studied (Figure 2) and a dried otter skin was obtained (Figure 3). Few tracks were observed but these could not be identified because the prints were unclear. Otters are secretive and preferred natural caves and holes in rock piles (**Wood, 1978/79**) or a densely vegetated river bank (0.5m) with mature trees having a higher root network that precludes domestic stock penetration (**Andrews, 1989**) and areas with low human disturbance (**Green and Green, 1987)**. Settlements are closer to the study area (Figure 2) with grazing livestock at the river bank. Despite the presence of natural rock piles suitable for holts, the human disturbance (fishing, washing, visitors at natural hot water springs at the river bank) posed insecurity for otters in the river.

Nylon loops set for fish become a potentially lethal trap to the otter when they become entangled. The otter pelt collected during the study had a deep cut mark on the toes caused by trying to disentangle it. This otter had clearly visible claws, a tapering cone-shaped tail (**Kruuk, 2006**), dense dark-brown pelage throughout the body (**Larivière and Jennings, 2009**) with lighter coloured fur near the throat (**Sivasothi and Nor, 1994**). These features are identical to the Eurasian otter, substantiating the presence of this species in the study river (Figure 3). Eurasian otters are also known in the Tubang River (**Shrestha et al., 2021b**) downstream of the study river which also suggests the pelt is of this species. While the pelt does confirm the presence of Eurasian otters in the study river, on the other hand it also conveys otter–human competition for prey species (fish) resulting in killing of otters. This is the key threat to otters besides human disturbance and livestock penetration in the otter habitat. However, the effect of human disturbance is low due to the extremity of geographic terrain. Sprints are distributed evenly in major portions of the river length while occasional and limited at the upper stretch (Hukam area, Figure 2) where human activities of the river are observed relatively more.

Through the cumulative spraints count (64) in the entire study length (20km), spraint density of 3.2 spraints km^{-1} was obtained. This is a relatively higher spraint density compared with the lower reach of the Pelma River (2.38 spraints km^{-1}) and the Sanibheri River (1.14 spraints km^{-1}) downstream and the adjacent Uttar Ganga River (spraint density-2.67 spraints km^{-1}) (**Shrestha et al., 2021a**). Higher spraint density may be an indicator of good otter habitat and this would be best supported by a population study in the river. Furthermore, spraint abundance directly relates with fish biomass availability (**Hutchings and White, 2000; White et al., 2003; Almeida et al., 2012**). Therefore, population and prey species availability in the study river could benefit conservation of otters.

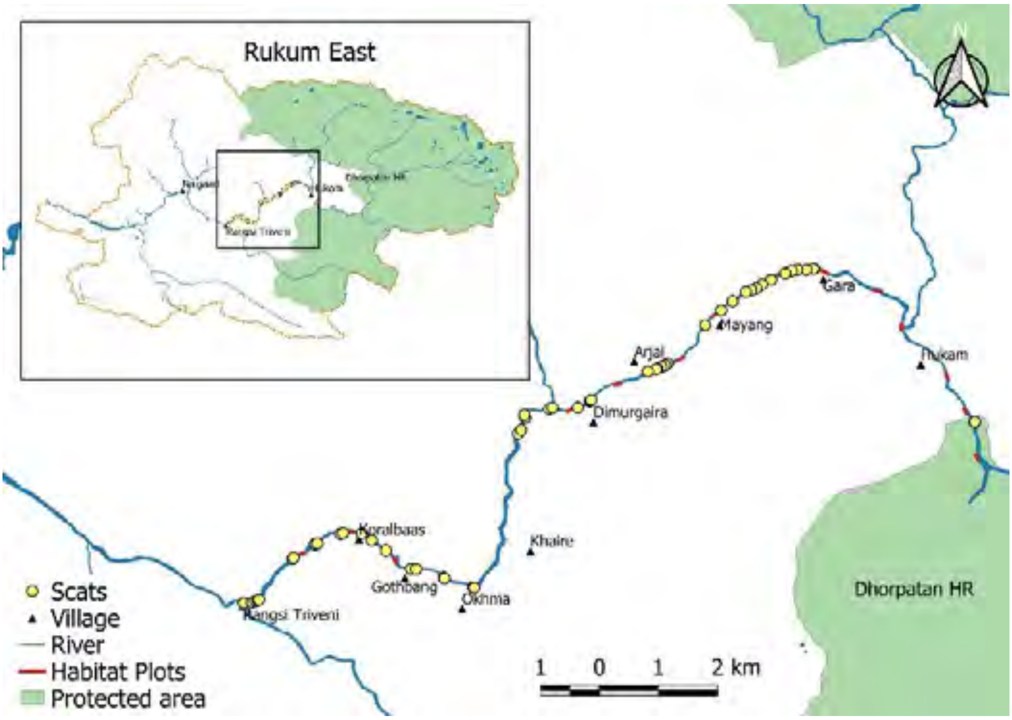

Figure 2. Otter spraint distribution along the study river length.

Figure 3. Front view of snout (A), lighter coloured fur at throat (B), dorsal view of feet with deep cut from entangled fishing loop (C) and whole otter skin specimen (D).

Factors affecting otter distribution

Habitat variables differ markedly within the study area. The higher variance in elevation, river width, bank slopes and bank substrate (primarily boulders and small stones) showed as the main determinants of otter presence and absence (Table 1). Mann-Whitney U test showed elevation is significantly different with regard to otter sign presence and absence (0.009, $p<0.05$) among 11 habitat variables tested (Figure 4). Unlike the factor obtained in this study, Mann-Whitney U test applied in the study of habitat factors in relation to presence and absence of Eurasian otters in Denmark found that river width, water depth, river substrate characteristics, water flow and bank vegetation have significant difference (**Madsen and Prang, 2001**).

Table 1. Descriptive statistics of habitat variables in the study area

Habitat variables	Mean	Standard Deviation	Sample Variance	Kurtosis	Skewness	Minimum	Maximum
Elevation (m)	1650	130	17089	–0.66	0.02	1431	1923
Sand and mud (%)	11.67	9.96	99.29	–0.88	0.59	0.00	30.00
Small stones (%)	25.21	14.25	203.15	–0.98	0.19	0.00	50.00
Large stones (%)	33.44	10.73	115.06	2.19	1.14	15.00	70.00
Boulders (%)	29.17	21.59	466.31	–1.16	0.14	0.00	70.00
River flow (m/s)	1.39	0.34	0.12	–1.55	–0.07	0.88	1.87
River width (m)	27.65	10.80	116.66	2.17	1.26	12.00	65.00
River depth (m)	0.55	0.19	0.04	2.07	1.41	0.20	1.05
Right bank slope	46.96	19.44	377.91	0.29	0.87	15.00	90.00
Left bank slope	38.79	13.76	189.23	0.93	0.74	10.00	80.00

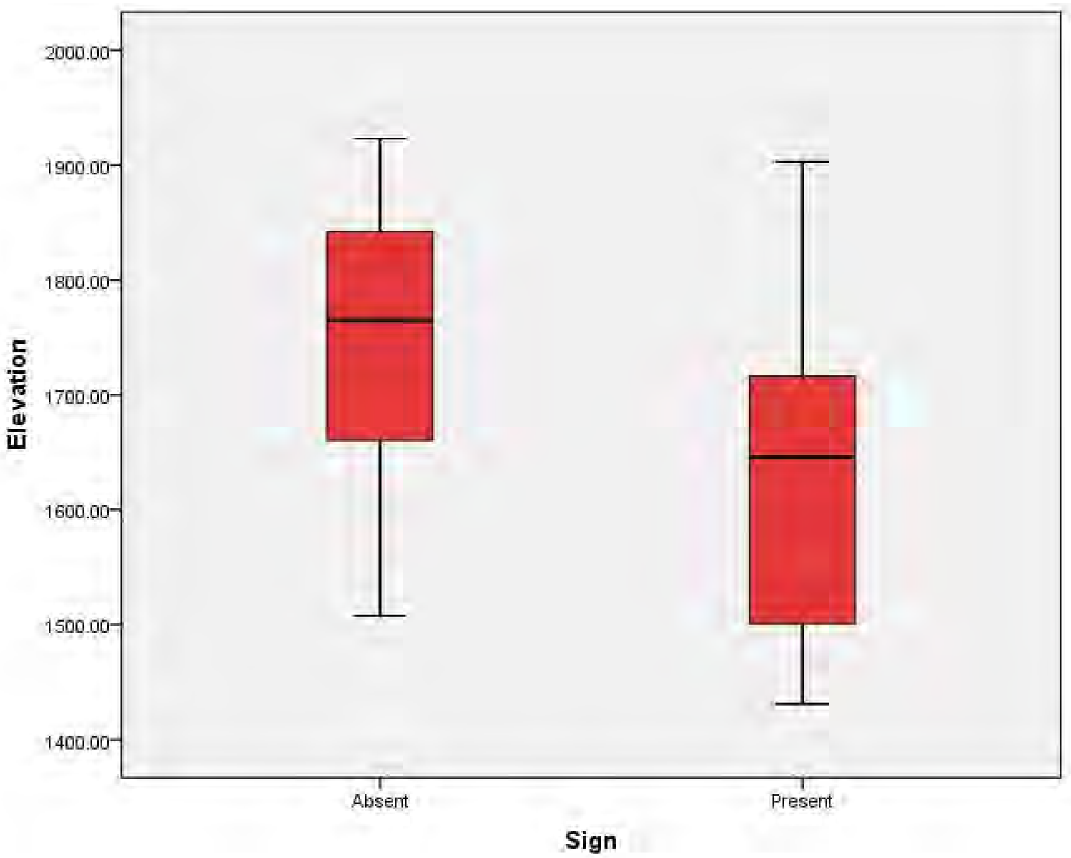

Figure 4. Box plot showing relation between otter signs and elevation (meter).

By correlating otter distribution through signs found against habitat variables, elevation showed a highly significant negative relation (–0.381, p<0.01). Whereas, insignificant relationships were obtained with other variables (Table 2). Insignificant correlation of spraint distribution with other variables besides elevation could be due to low variation in parameters. Other researchers have found spraints to be positively correlated with boulders (**Chettri and Savage, 2014, Shrestha et al., 2021a)** unlike in this study. Otter prefers river site riffles with boulder substrates for fishing (**Durbin, 1993**) and consuming prey whilst resting on boulders (**Jamwal et al., 2016**).

While correlating within the habitat variables, a highly significant positive correlation of elevation was obtained with boulders and river flow while a significant negative relationship was observed in sand and small stones. The smaller the amount of variability in independent and dependent variables, the lower the apparent correlation exists.

Table 2. Spearman's correlation coefficient matrix between otter sign and habitat variables and within the habitat variables

Habitat variables	Elevation	Sign	Sand and mud	Small stones	Large stones	Boulders	River flow	River width	River depth	Right bank slope	Left bank slope	Disturbance
Elevation	1											
Sign	–0.38**	1										
Sand and mud	–0.31*	–0.09	1									
Small stones	–0.44**	–0.16	0.70**	1								
Large stones	–0.14	–0.01	–0.26	–0.10	1							
Boulders	0.46**	0.11	–0.74**	–0.86**	–0.21	1						
River flow	0.31*	–0.21	–0.18	–0.35*	0.15	0.21	1					
River width	–0.44**	–0.03	0.37**	0.53**	0.19	–0.70**	–0.27	1				
River depth	0.03	0.14	–0.28	–0.27	–0.01	0.30*	0.05	–0.21	1			
Right bank slope	0.31*	–0.10	–0.26	–0.40**	0.03	0.40**	0.76**	–0.40**	–0.01	1		
Left bank slope	–0.48**	0.20	0.43**	0.49**	0.08	–0.54**	–0.28	0.37**	0.01	–.45**	1	
Disturbance	–0.23	0.07	0.50**	0.27	0.04	–0.36*	0.00	0.17	–0.41**	–0.05	0.37**	1
** Correlation is significant at the 0.01 level (2-tailed).												
* Correlation is significant at the 0.05 level (2-tailed).												

Among 11 independent habitat variables, a logistic regression (backward stepwise) model showed elevation and small stones are the main variables significantly ($p < 0.05$) associated with otter presence (Table 3) in the rivers studied. The estimated logit of the probability of otter presence was defined using parameter estimated as follows:

$$\text{logit}(p)= I + \beta x = 27.309 – 0.14*\text{elevation} – 0.096*\text{small stones}$$

Both variables, elevation and small stones, had negative effects on the probability of otter signs which is similarly explained by Spearman correlation coefficient.

Table 3. Results of backward stepwise regression model

	Estimate (B)	S.E.	Wald	df	Sig.	Exp (B)	95% C.I.for EXP(B)	
							Lower	Upper
Elevation	–.014	.005	9.187	1	.002	.986	.977	.995
Small stones	–.096	.043	5.046	1	.025	.908	.835	.988
Constant	27.309	8.631	10.012	1	.002	7.249E+11		

The classification table (Table 4) showed 83.3% accuracy which means this model will correctly predict 83.3% of cases.

Table 4. Classification accuracy of the logistic regression using cut-off value of 0.5

Observed		Predicted		
		Sign		Percentage Correct
		.00	1.00	
Sign	.00	5	6	45.5
	1.00	2	35	94.6
Overall Percentage				83.3

The governing factors may differ with the landscape type. Six habitat variables (location, pH, water depth, trees, river bottom substrate and organic pollution) were identified as predicting factors of Eurasian otter occurrence in Denmark (**Madsen and Prang, 2001**). The logistic regression model based on detection and non-detection data identified water quality and human disturbance as predicting variables in otter distribution in South Korea (**Jo et al., 2017)** whereas MaxEnt presence-only model in the same study predicted elevation among many contributing factors to predict habitat use. **Robitaille & Laurence (2002)** marked elevation as a poor indicator of otter occurrence in the European continent, contrasting with the predicted factor (elevation) in the present study. Thus, the potential user should critically evaluate the relevance of each variable in relation to their local environment (**Madsen and Prang, 2001**). Thus the predicted variable may be suitable for identifying otter habitats in similar habitats in Nepal.

CONCLUSION

Eurasian otters are yet to be prioritised as focus species for study in Nepal. The wider distribution of Eurasian otters in Nepal is anecdotal and population estimates are equivocal. The species presence in wetland and rivers in Nepal was ambiguous due to lack of substantial evidence. Dry pelt and spraints provided evidence to support the occurrence of Eurasian otters in the Pelma River, East Rukum. Spraint was found throughout the entire study area except in areas with higher human activities. Fishing in the river is a common practice in the study river with occasional killing of otters identified as threats to otters in the area. The rugged terrain was found influential in setting the habitat variables and therefore to otter signs distribution. Elevation is a highly significant environmental factor governing the distribution of otter signs and/or otter presence and absence. A logistic regression model identified elevation and small stones among habitat factors predicting otter distribution in the study river. The relevance of predicting variables could be applicable in rivers with similar geographic settings in Nepal. However, the users should critically evaluate the relevance of variables in relation to their local environment. Through this study, it is evident that the Eurasian otter is present in the area but there are prevailing threats to otters. Further studies are necessary on the otter population to understand the exact status of this species in the area and there is a need for conservation awareness to prevent otters from being deliberately killed. The findings of this study will be useful in the formulation of conservation action to safeguard otter population.

Acknowledgements

Authors express their gratitude to the Department of Forest and Soil Conservation, Nepal for study permission. We are thankful to the International Otter Survival Fund (IOSF) for the grant support to carry out this study. Thanks are also due to Melissa Savage for guidance and supervision.

Disclosure statement

No potential conflict of interest was reported by the authors.

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