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Siberian Weasel *Mustela sibirica* (Photo: Kaushal Yadav)

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SHORT COMMUNICATION

First record of Honey Badger *Mellivora capensis* in Deukhuri Valley, Dang district, mid-western Nepal

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Abstract.

Honey Badger *Mellivora capensis* is one of the least known mammals in Nepal and recorded from only a few areas in the country. During a camera-trap survey for Striped Hyaena *Hyaena hyaena* from May to July 2016, Honey Badger was recorded for the first time in Dang district, mid-western Nepal. This is a new locality record for Honey Badger in Nepal.

Keywords: camera-trapping, protected areas, Dang, Nepal

Honey Badger *Mellivora capensis* is listed as Least Concern on *The IUCN Red List of Threatened Species* (Do Linh San *et al*. 2016). The species has a large range which extends through most of sub-Saharan Africa from the Western Cape, South Africa, to southern Morocco and south-western Algeria, and then through Arabia, Iran and western Asia to Middle Asia (Turkmenistan, Uzbekistan), the Indian peninsula and Nepal (Do Linh San *et al*. 2016). It is considered rare or to exist at low densities across most of its range (Vanderhaar & Hwang 2003). Honey Badger is one of the least known small carnivores of Nepal (Jnawali *et al.* 2011). Only a few records are available for this species in the country (Baral & Shah 2008, Thapa 2014). Its presence is known from only a few areas in Nepal (Jnawali *et al.* 2011) and there are no known records of Honey Badger from Dang district.

Dang district is located in western Nepal (28°7'N and 82°18'E) and covers an area of 2,955 km². Dang district consists of two valleys, the Dang and Deukhuri valleys. The survey was in an area of approximately 185 km² which includes a major part of the Deukhuri Valley. Deukhuri Valley is surrounded by forest-covered hills that connect Bardia, Banke and Chitwan national parks through the Churia forests in the Dovan bottleneck. The valley is connected with Banke National Park in the west and an intact forest in the south connects with Sohelwa Wildlife Sanctuary in India (Khanal and Baniya 2018). The valley lies outside of Nepal's protected area system, however, it has been identified as one of Nepal's Important Bird and Biodiversity Areas (IBAs; Baral & Inskipp 2005, Khanal 2015*). Shorea robusta*, *Dalbergia* and *Acacia* dominate the forested habitat types found here. Degraded forests are found in patches.

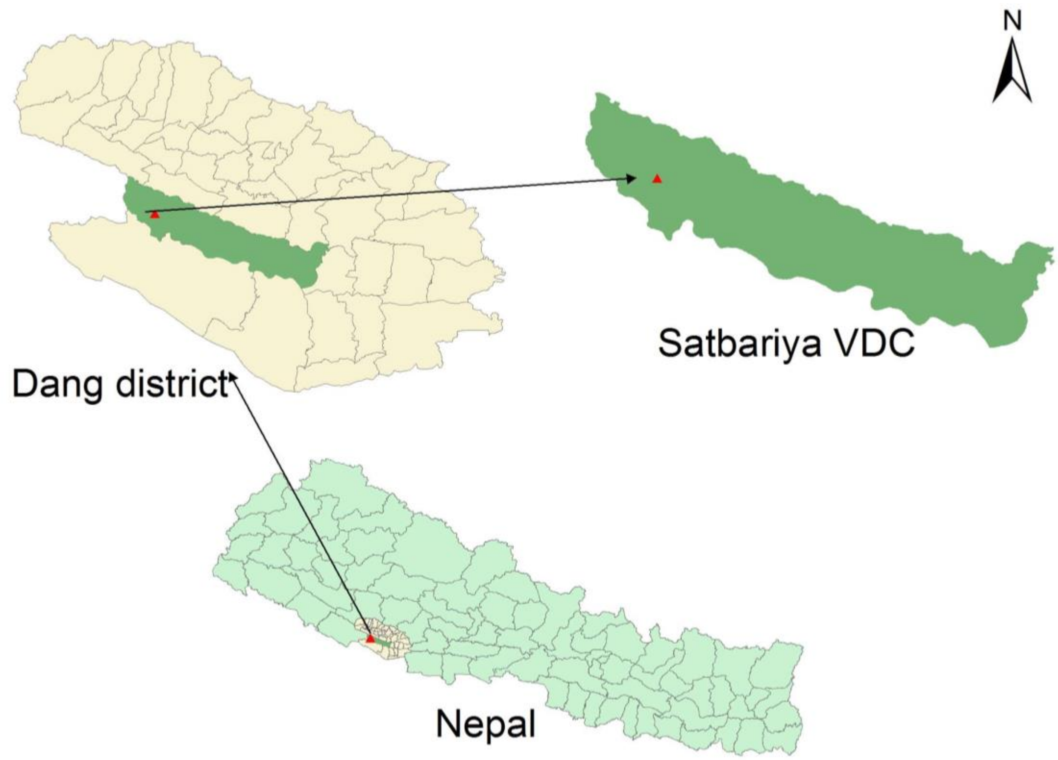

Figure 1. Location of Honey Badger *Mellivora capensis* record (red triangle) in Dang district, mid-western Nepal.

The survey was targeted at Striped Hyaena *Hyaena hyaena* in Deukhuri valley from May to July, 2016. Camera-trapping and sign surveys were the primary methods. The survey area was divided into the grids of 5 × 5 km. Grids with more than 50% forest cover were selected and grids which lie on human settlement areas, agricultural fields, rivers and large river banks were excluded from camera-trapping and sign surveys. In each grid, Browning XR camera-traps were placed on forest trails and by waterholes. If any animal carcasses were found camera-traps were set by these. Single camera-traps were deployed at each station in each grid and were left for 15 nights. A total of 22 grids were selected for the camera-trapping. The camera-traps were deployed for 330 camera-trap-nights. Three to four small pieces of chicken were used as bait at each station. The chicken bait was staked into the ground. Carcasses that were opportunistically encountered were left undisturbed with no bait, and the camera-trap was set facing the carcass. From the total, 86% of camera-traps were baited with chicken and 14% of the camera-traps were set facing carcasses.

The camera-traps produced a total of 10,232 images over 320 camera-trap-nights. Out of 22 camera-trap stations Honey Badger was recorded in one camera-trap station: a single image of Honey Badger was captured on 16 June 2016 at 23h09 in Kalikhola Community

Forest of Satbariya Village Development Committee of Deukhuri valley at an altitude of 231 m asl (Figure 2).

Figure 2. Camera trap image of Honey Badger *Mellivora capensis* in Dang district, Nepal. June 2016.

The successful camera-trap was placed in a regenerated area of forest at the base of a *Terminalia arjuna* tree, 100 m from a seasonal water source and 5 m from a trail used by livestock and humans. The area is used by local villagers for collecting fuel wood and grazing livestock. No Honey Badger signs were observed from other parts of the study area during the survey period.

This species has been recorded within the protected areas of Bardia National Park, Chitwan National Park, Parsa Wildlife Reserve (now Parsa National Park), Shukla Phanta Wildlife Reserve (now Suklaphanta National Park) and the districts of Banke and Kailali. The record presented in this paper is a new locality record for Honey Badger in Nepal.

There is limited information available on this species in Nepal in which to compare this record to. The camera-trap record in Dang was in an area dominated by *Terminalia arjuna, Dalbergia sissoo, Syzigium kumini* and *Shorea robusta*. Cattle grazing is common in this forest, as is the collection of fire wood by local people; the habitat is human-impacted and not pristine natural habitat. This record may suggest that the species can tolerate such disturbances, though a single record is not enough to evidence this fully. There is little available information on Honey Badger in Nepal and at a national-level has been assessed as an Endangered species. Other potential Honey Badger sites could lie outside Nepal's protected areas; targeted surveys in forested areas as well as in protected areas for this species would help to clarify this species' status in the country.

Acknowledgements

We would like to acknowledge the Rufford Foundation for their financial support for conducting Striped Hyaena related research in the Deukhuri Valley of Dang and Department of Forest, Nepal for providing the camera-trapping permission. We are thankful to District Forest Office, Dang, Narti and Gadawa Community Forest Coordination Committee for their support and coordination during the field survey, Prof. Karan Bahadur Shah, Dipendra Adhikari, Sabita Malla, Shailendra Yadav, Som G.C., Baburam Lamahichane, Kalpana Jha, Laxmi Rai for providing information on records of Honey Badger. A reviewer greatly improved the quality of this manuscript. Last but not the least we would like to acknowledge Raju Acharye, Yadav Ghimirey, Jeevan Rai, Kausal Yadav from Friends of Nature (FON, Nepal) for their inspiration in research and encouragement to write this paper also Bidhya Sharma, Arun Sharma, Suman Ghimirey, Manish Acharye, Suman Khadka for their support.

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IUCN/SSC Small Carnivore Specialist Group

SHORT COMMUNICATION

Western Polecat *Mustela putorius* distribution in Greece

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Abstract.

Western Polecat *Mustela putorius* is a mustelid species native to Greece. The species is poorly understood in the country and it is listed as Not Evaluated in The Red Data Book of Threatened Animals of Greece. Records based on road-kill observations were collected from January 2008 to February 2018. These records have extended the known range of the species into western and north-western Greece. A review on the species occurrence in neighbouring countries (Albania, the Former Yugoslav Republic of Macedonia (FYROM), Bulgaria and Turkish Thrace) is also presented here.

Keywords: *Mustela putorius*, road-kill observations, geographic range, Greece, Balkan Peninsula.

Western Polecat *Mustela putorius* is a mustelid species with a widespread distribution in Western Europe and into the east to the Ural Mountains in the Russian Federation (Skumatov *et al*. 2016). In Greece, Western Polecat was thought to be restricted to the northern and north-eastern areas of the country (Figure 1; Mitchell-Jones *et al*. 1999, Skumatov *et al.* 2016) and published data records in Greece are from the Evros district in Thrace (Helmer & Scholte 1985). The species is also present in the southern Balkan countries neighbouring Greece (Bulgaria, the Former Yugoslav Republic of Macedonia (FYROM), and Albania) and in European Turkey (Kurtonur *et al*. 1994, Prigioni 1996, Mitchell-Jones *et al*. 1999, Kryštufek & Petkovski 2003, Apostolova *et al*. 2016, Croose *et al*. 2018).

Western Polecat is considered as Least Concern on the IUCN Red List of Threatened Species (Skumatov *et al.* 2016). It is listed on Appendix III of the Bern Convention and on Appendix V of the EU Habitats Directive (Skumatov *et al*. 2016). The species is listed as Not Evaluated in The Red Data Book of Threatened Animals of Greece (Legakis & Maragou 2009) because there are no adequate data on its distribution and population trends in order to determine its conservation status in the country. Western Polecat is fully protected in Greece by a Presidential Decree (PD no. 67/1981).

Figure 1. Map of mainland Greece with the 28 Western Polecat *Mustela putorius* records (black dots). The administrative regions of Greece are separated by grey solid lines. The shaded area covers the species' previously documented range in Greece (Source: IUCN Red List of Threatened Species 2016).

Road-kill observations in Greece

Between January 2008 and February 2018, 28 Western Polecats were recorded, all as road-kill observations (Figure 1). These records were collected during routine driving in Greece. All sites where dead animals were found, were marked using a Global Positioning System (GPS) receiver. Most records (23) came from western and north-western Greece, specifically from the Regions of Epirus and Dytiki Makedonia. The remaining five records were from north-central and north-eastern Greece, from the Regions of Kentriki Makedonia and Anatoliki Makedonia – Thraki.

Sixteen of the records were in the lowlands (under 500 m asl), close to wetlands (*i.e.*, rivers and river deltas, lakes and streams), where agricultural land dominated, interspersed with riparian forests, low shrubs and maquis (*i.e.*, typical habitat of the Mediterranean region). The remaining 12 dead animals were found in higher altitudes (around 500 – 900 m asl), in woodland areas, mostly in deciduous forest. One record was from the south of Lake Kerkini, in Serres district, in Kentriki Makedonia (Figure 2). Twenty-two Western Polecats were recorded on provincial and regional roads and the remaining six animals were recorded on highways.

Figure 2. Photograph of a dead Western Polecat *Mustela putorius* on a highway, in Serres district, close to the River Strymon, in the Region of Kentriki Macedonia, 2016 (Photo: T. Kominos).

Records from neighbouring countries

In Albania the species has a known geographic range from the northern and central areas of the country (Prigioni 1996, Mitchell-Jones *et al*.1999, Beqiraj & Dhoha 2007), while it is categorized as Endangered on the National Red List (National Red List 2013 as reported in Croose *et al*. 2018). The species was recently documented further south, in the Albanian part of Lake Ohrid (IUCN/ICOMOS 2016), as well as in central-southern Albania, along the designated route of the Trans Adriatic Pipeline (TAP 2013). The Western Polecat is found in the southernmost wetland complex of Albania, the RAMSAR site of Butrint, where its status is considered rare (MFAG/ECAT 2006). This area is adjacent to the Greek border and close to where the species was recorded by the authors in the in Kalamas River Delta, Thesprotia district (Figure 3).

Figure 3. Photograph of a dead Western Polecat *Mustela putorius* on a provincial road, in Kalamas River Delta, in Thesprotia district, in the Region of Epirus, 2017 (Photo: T. Kominos)

In FYROM, the Western Polecat is widespread with a scattered distribution; most records are from the northern, eastern and south-western areas (Kryštufek & Petkovski 2003). The nearest Western Polecat records in FYROM come from south-western areas, with recent observations in the Studenchishte Marsh, a wetland bordering Lake Ohrid (Apostolova *et al*. 2016). This area is nearby the trilateral international Prespa Park (Megali & Mikri Prespa Lakes), which is situated in Greece, Albania and FYROM. Dead Western Polecats were observed by the authors of this paper in the Greek side, in Florina district, in Dytiki Makedonia.

Information about the Western Polecat's distribution and conservation status is largely based on inferences from sporadic observations and experts' opinion. Due to lack of systematic research in Greece and other range countries its population trend is unclear. However, thorough documentation of incidental road-kill observations has dramatically increased knowledge of this species' distribution in Greece. The habitats where these records were obtained, supports the species' current categorization as Least Concern on The IUCN Red List of Threatened Species. Similar efforts in other range countries could be equally insightful and should be encouraged.

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The authors would like to thank Kontsiotis Vaseilios for providing data on a dead animal from the Region of Anatoliki Makedonia-Thraki and Gasteratos Giannis for providing the reference on the Western Polecat in Butrint, Albania. They would also like to thank Dr. Boris Kryštufek and Daniel Willcox for their helpful comments and edits on the manuscript.

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SHORT COMMUNICATION

First photographic record of Common Palm Civet *Paradoxurus hermaphroditus* from the mangroves of Andhra Pradesh, India

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Abstract.

The Godavari Estuary is a regionally important mangrove forest located on the east coast of India. These mangroves are threatened by aquaculture ponds and predicted sea level rise. A 2014 – 2017 camera-trap survey for Fishing Cat *Prionailurus viverrinus* produced the first confirmed record of Common Palm Civet *Paradoxurus hermaphroditus* in these mangrove forests.

Keywords: estuary, Godavari, mangroves, camera-traps, small carnivore

Common Palm Civet *Paradoxurus hermaphroditus* is widely distributed in South and South-east Asia (Patou *et al*. 2010). In India, it mainly occurs in moist and dry deciduous forests at lower altitudes (Mudappa 2013) but is also known to use a wide range of other habitats such as coffee plantations, swamp forests, mangroves, villages, and urban environments (Duckworth *et al*. 1997). In some parts of its range, it is common in human-modified habitats (Krishnakumar & Balakrishnan 2003, Spaan *et al*. 2014). It is categorized as Least Concern on *The IUCN Red List of Threatened Species* (Duckworth *et al*. 2016). Common Palm Civet is primarily a nocturnal species and is partly arboreal (Gupta 2004, Muddappa 2013).

Common Palm Civets can be one of the most commonly camera-trapped small carnivores (e.g. Wahyudi & Stuebing 2013). However, there are few records of its occurrence in mangrove forests (Kar & Satpathy 1995, Khan 2008, Mallick 2011). Most of these records suggest its presence in habitats surrounding mangroves but not inside. In this note, we present a camera-trap record of a Common Palm Civet inside a mangrove forest on the eastern coast of India.

The Coringa Wildlife Sanctuary is in East Godavari district of Andhra Pradesh and lies at the northern part of a delta formed by Godavari River (16°59’N, 82°20’E). The Godavari River is the second longest river in India after the Ganges. After traversing 1,465 km it empties into sea in the form of two major distributaries: Vasista-Godavari and Gowthami-Godavari. At the confluence of the Gowthami-Godavari River and the Bay of Bengal is an extensive deltaic system referred to as the Godavari Delta. Around 236 km^2 of the mangrove forests are protected as the Coringa Wildlife Sanctuary (Ravishankar *et al*. 2004) but these are threatened by aquaculture ponds and predicted sea level rise.

A total of 21 camera-traps (Cuddeback Ambush) were used in 20 different surveys in the sanctuary between June 2014 to May 2017. In each survey, the camera-traps were left for a minimum of 25 consecutive nights. These camera-traps were active for 24 hours. The time delay between photographs was set to a minimum of 5 seconds and all camera-traps were placed at 20–40 cm from the ground.

On 17 February 2017 at 02h53 one camera-trap recorded a solitary Common Palm Civet (Figure 1). The station was located along the bank of Gullarasi Kaluwa, a subtidal creek that connects two larger creeks in the sanctuary (Figure 2). The habitat was a mangrove forest dominated by *Excoecaria agallocha* and *Avicennia marina*. During spring tides, water enters the site due to its proximity to the bank. Two nearest villages, Ramanapalem and Chinna Boddu Venkatapalem are at least 6 km away while the Kakinada Bay is around 3 km to the north of this site. Human influence around this site is limited to fishermen, crab collectors, and the occasional timber collectors.

Figure 1. Camera-trap image of a Common Palm Civet *Paradoxurus hermaphroditus* from Coringa Wildlife Sanctuary, Andhra Pradesh, India

Common Palm Civets are commonly reported by the locals in coconut plantations as well as from the villages that surround the mangrove forests but the species presence inside the sanctuary was unconfirmed. However, a single capture does not imply a regular use of mangroves by this species; the animal might be vagrant visitor to these forests. The species has been reported to feed on other smaller vertebrates (Krishnakumar & Balakrishnan 2003, Maurya *et al.* 2017); it is possible that it was feeding on the rodents that tend to nest on the top of the mangrove trees.

Common Palm Civet is a widely occurring species and has been reported from different types of habitats, including human-dominated landscapes. In a study on the mammal diversity of Sunderbans Tiger Reserve in India, Common Palm Civet was reported to be a commonly occurring species in the reclaimed lands near to the mangroves (Mallick 2011). To the best of our knowledge, this is the first photographic evidence of Common Palm Civet inside a block of dense mangrove forest.

Figure 2. Mangroves near the trap location inside the Coringa Wildlife Sanctuary, Andhra Pradesh, India.

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SHORT COMMUNICATION

Observations of Siberian Weasel *Mustela sibirica* in Api-Nampa Conservation Area, Darchula district and Humla district, Nepal

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Abstract.

Siberian Weasel *Mustela sibirica* is categorized as Least Concern in The IUCN Red List of Threatened Species. It is one of the largest weasels found in Nepal. Its known distribution in Nepal is within the Himalayan region of the country. This paper documents four observations of the species made in Humla district (three observations) and Api-Nampa Conservation Area, Darchula district (one observation) in the Nepalese Himalayas.

Keywords: Darchula, Himalaya, Humla, Nepal

Six species of *Mustela* have been reported to occur in Nepal, comprising Mountain Weasel *Mustela altaica*, Stoat *M. erminea*, Yellow-bellied Weasel *M. kathiah*, Stripe-backed Weasel *M. strigidorsa*, Siberian Weasel *M. sibirica* and Steppe Polecat *M. eversmanii* (Baral & Shah 2008, Ghimirey & Acharya 2012, Chetri *et al*. 2014, Thapa 2014). However, Stripe-backed Weasel and Stoat are not confirmed to exist in Nepal: see Abramov *et al*. (2008) and Mitchell (1975) respectively. Abramov *et al*. (2016) and Thapa (2014) corroborate Mitchell (1975) regarding the status of Stoat in Nepal.

All available literature supports the presence of Siberian Weasel in Nepal. However, there have been very few publications documenting its occurrence in the higher Himalayan region of the country. The species is categorized as Least Concern both globally (Abramov *et al*. 2016) and in Nepal (Jnawali *et al.* 2011) because of its wide distribution, presumed large population and absence of any known major threats. However, Ghimirey *et al*. (2014) made a case for Data Deficient at the national level considering how little information there is on this species in Nepal. Previous records of the species in Nepal are given and discussed in Ghimirey & Acharya (2012) and Ghimirey *et al*. (2014). A recent taxonomic research has concluded that the Siberian Weasel found in the western Himalayas (*i.e.*, Kashmir and Sikkim) in India and Nepal could be a different species (Abramov *et al*. 2018).

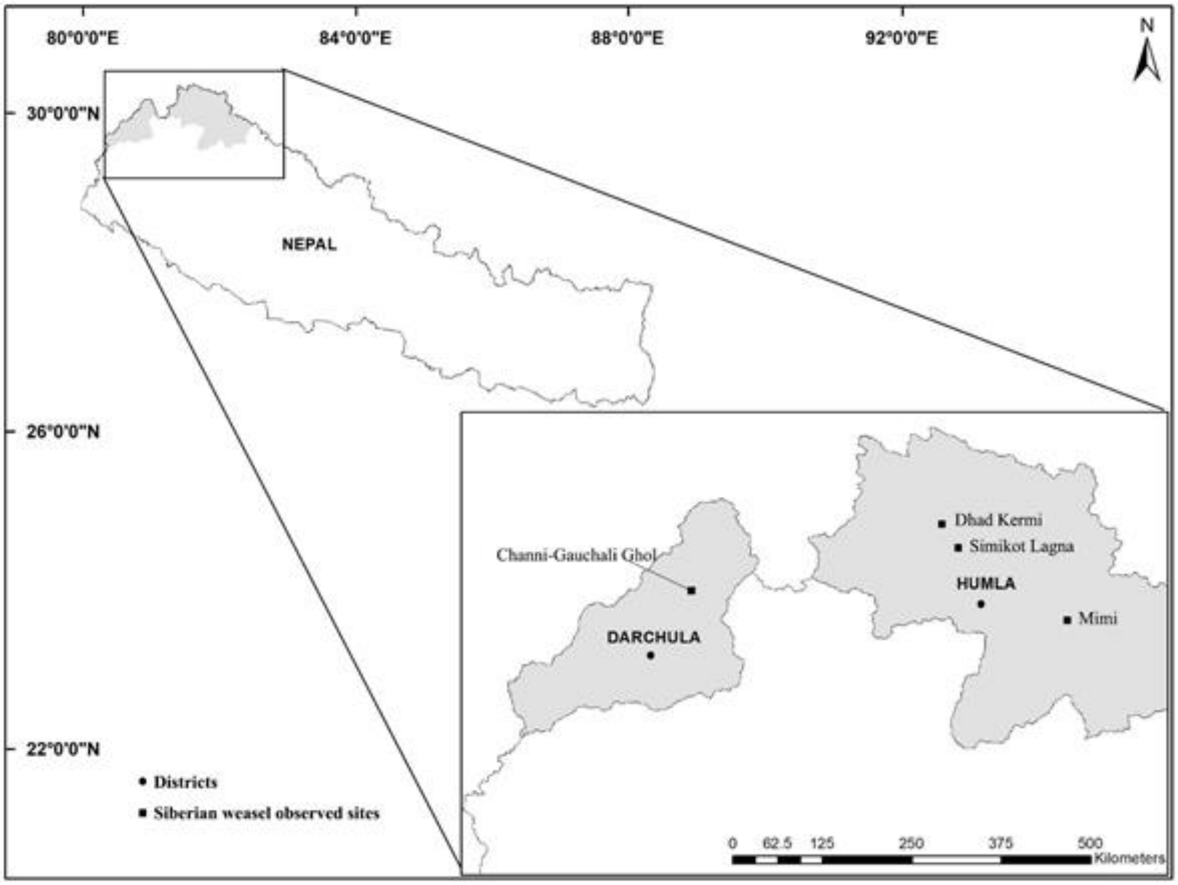

Figure 1. Siberian Weasel *Mustela sibirica* records in Humla and Darchula districts between 2013 and 2015.

Observations

Mimi, Chankheli Rural Municipality, Humla district

This is the first known observation of Siberian Weasel in Humla district. An adult Siberian Weasel was observed on 20 September 2013 at around 10h00 near Mimi village (Figure 1). The site is located at 29°44’N and 82°04’E and the altitude is between 2100 and 2200 m asl. The day was sunny and the weasel came to within 25 m whilst AP was sitting on the balcony of a house overlooking a small garden. After raising its head for few seconds, it ran away from the garden. The whitish patch around its muzzle was clearly visible. The Mimi village is surrounded by low-lying thickets uphill and agriculture downhill.

Dhad Kermi

The second observation for Humla district was made near the village of Dhad Kermi on the way to Hilsa (a village) by KY on 22 April 2014. The location is near Karnali River, the longest river in Nepal. The place is located at 30°03’N and 81°44’E and is located at an altitude of about 2590 m asl, recorded using a GPS Garmin unit (Figure 1). The weasel was sighted at 11h14 and the weather was sunny with intermittent cloud cover. The location is around 850 m from Dhad Kermi, the nearest human habitation.

The weasel was sighted in an open rocky field above the main foot trail (Figure 2). The reddish-brown body was seen well because of the clear daylight. On sensing the observers, it hid quickly in a rocky crevasse and stayed there for approximately two minutes. The front view of the weasel was visible when looking through the narrow crevasse. It was thought to have escaped when presumably the same animal was seen within a minute and on top of a rock that was 15 m away. After 10–15 seconds, a Siberian Weasel, possibly the same animal, was observed on a rock after maintaining a distance (approximately 200 m) from the observers for around 4 to 5 minutes.

Figure 2. Siberian Weasel *Mustela sibirica* running away after noticing the observers at Dhad Kermi on 22 April 2014. (Photo: Kaushal Yadav).

Simikot Lagna

The third observation was made on 23 April 2014 by KY near a mountain pass (locally known as a *lagna*) called Simikot Lagna. The location is very near to Simikot, the headquarters of Humla district (Figure 1). The site is located at 29°58’N and 81°48’E and is at an altitude of 3246 m asl as recorded by a GPS Garmin unit. The location was around 600 m from the nearest human settlement. The time at the sighting was 13h49 and the day was overcast during the sighting.

The weasel was sighted on a large rock boulder between the foot trail and a harvested barley field (Figure 3). The weasel was then seen running on the stone wall that bordered the field. The observation lasted no longer than two minutes as it was being chased by a mule herder. The mule herder later stated that the species, locally known as *nyaul*, would serve as medicine for muscle pain. Apparently, the preparation for this is that the weasel meat should be first roasted and then consumed.

Figure 3. Siberian Weasel *Mustela sibirica* sighted during midday on 23 April 2014 at Simikot Lagna (Photo: Kaushal Yadav).

Api-Nampa Conservation Area, Darchula district

An observation in Api-Nampa conservation area (ANCA) was made on 24 July 2015 by SG. The time of observation was 15h15. The day was cloudy during observation soon followed by rain. The location was Channi-Gauchhali Ghol located in upper Chamelia Valley inside ANCA, Darchula district (Figure 1). The place of observation falls at 29°59'N and 80°56'E and recorded by GPS unit at an altitude of 4300 m asl. The sighting was made on big boulders of rock with several gaps between them (Figure 4).

Figure 4. Siberian Weasel *Mustela sibirica* giving a curious look to the observers in Channi-Gauchhali Ghol, ANCA, Darchula during afternoon of on 24 July 2015 (Photo: Suresh Ghimire).

Siberian Weasel is known as *Nyaul* in Humla district and is believed to have medicinal value; the brief encounter and conversation with a mule herder supports this. The name *Nyaul* for this species was further confirmed by our local guides who explained us the process of preparing medicine from this species. The cooked flesh of the species is eaten for the treatment of lower back pain (Devraj Shahi & Prem Shahi pers. comm. 2014). This species is mostly seen during the barley harvest season near agricultural land and sometimes sighted nearby water bodies too (Devraj Shahi & Prem Shahi pers. comm. 2014). These local guides allegedly saw this species on the bank of Karnali River in mid-March 2014.

There have been recent records of Siberian Weasel from Manaslu Conservation Area (Katuwal *et al.* 2013) and also from outside Rara NP in Mugu district (Ghimirey *et al*. 2014). Earlier, Baral & Shah (2008) have mentioned the distribution of this species from the Himalaya region along Nepal. Jnawali *et al.* (2011) reported its occurrence from Rara National Park which was at that time the westernmost record of this species. The new observations presented here have extended the westernmost record to Api-Nampa Conservation Area of Darchula district, as well as verifiable records of this species from Humla district.

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We thank Research Center for Applied Science and Technology (RECAST), Tribhuvan University, International Center for Integrated Mountain Development (ICIMOD) and WWF Nepal for providing financial assistance for conducting the field work. We are grateful to our friends Jeevan Rai and Naresh Kusi for a great company during the field work. Ethno-zoological information on the species possessed by our guides Dev Raj Shahi, Amar Bista, Ramesh Bista and Bahadur Bist was amazing and we highly acknowledge their contribution by sharing that knowledge with us. Will Duckworth provided comments that greatly improved this manuscript.

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IUCN/SSC Small Carnivore Specialist Group

ORIGINAL CONTRIBUTION

Records of Sunda Stink-badger *Mydaus javanensis* confirm the species' presence across Indonesian Borneo

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Abstract.

We confirm the continuous presence of Sunda Stink-badger *Mydaus javanensis* in Kalimantan (Indonesian Borneo) through photographic evidence and six other encounters of the species. Together with one additional sighting of the species in Indonesian Borneo reported in the literature, this indicates that the species still occurs in all of the five provinces of Kalimantan. The scarcity of records may indicate that the species is indeed rare in Indonesian Borneo or it may be underreported. We call for further field and interview surveys to better understand what is threatening the species' survival in both Indonesian and Malaysian Borneo.

Keywords: Asia, camera trapping, Carnivora, conservation, mammalogy, oil palm tropical forest.

A recent review of all readily traced distribution records of Sunda Stink-badger *Mydaus javanensis* on Borneo noted that records from West, Central, South and East Kalimantan (Indonesian Borneo), were mostly from the late 19th and early 20th centuries, with recent confirmed records in these areas very scarce or doubtful (Samejima *et al*. 2016). The records from Borneo were used to model habitat suitability across the island, with resulting spatial patterns indicating much higher habitat suitability in the north-eastern half of Borneo compared with the southern-western half. Samejima *et al*. (2016) noted, however, that the analyses may have been influenced by survey bias, with far fewer mammal surveys being conducted in the Indonesian part of Borneo than in the Malaysian part. Consultation for the current paper with various experienced Indonesian field surveyors indicates that, indeed, there appears to be a survey bias, with records from Indonesia existing, but not making it into the published literature. To inform understanding of the ecology and distribution of this species and threats to its survival, we here present seven new recent records of Sunda Stink-badger in Kalimantan.

First record. 15 March, 2018. Location: Protected forest adjacent to oil palm plantation area of PT. ALM, Ketapang District, West Kalimantan Province, Indonesia (1°49.798' S, 110°43.799' E). A Sunda Stink-badger was camera trapped (Figure 1) in a

Protected Forest area (*Hutan Lindung*) adjacent to a community garden. This area is a riparian border of the river. The image was captured as the animal walked past the camera at 01h58.

Figure 1. First photographic evidence of Sunda Stink Badger *Mydaus javanensis* in Kalimantan: protected forest adjacent to oil palm plantation area of PT. ALM, Ketapang District, West Kalimantan Province, Indonesia, 15 March, 2018 (Photo: Y. Santosa, 2018)).

Second record. 2016. Location: Sungai Joloy, Hutan Lindung Bukit Batikap, Murung Raya Distict, Central Kalimantan (0°49.800’ S, 112°32.400’ E). This is a remote area, dominated by lowland Dipterocarp forest. One Sunda Stink-badger was clearly observed by one of us (KO) from about 7 m distance, around 11h00 while following a rehabilitated Bornean Orangutan *Pongo pygmaeus* and its baby. The stink-badger was on top of a fallen, dead tree. It fled before a photo could be taken, leaving behind a strong smell.

Third record. 2008. Location: Orangutan Research Station Tuanan, Tumbang Mangkutup, Mantangai Subdistrict, Kapuas District, Central Kalimantan Province, Indonesia. Tuanan (2°5.400’ S, 114°15.599’ E) is located in the Mawas Reserve and the study area encloses approximately 7.5 km^2 of peat swamp forest, which has been subject to logging in the past. A Sunda Stink-badger was observed for about 2 minutes initially from a distance of about 2 m, when one of us (KO) was walking on a board walk at 05h00. The animal was seen underneath the board walk, but it was not possible to take a photograph. The animal left a strong smell when it ultimately fled. At this time, the swamp area where the animal was encountered was dry. It was seen only once in this location over a period of 10 years of surveys. Local people in the area refer to the Sunda Stink-badger as the *Hantu Ribut* or “noisy ghost”.

Fourth record. August 2015. Location: Housing Complex Bukit Permata Indah, Sungai Ulin, Banjar Baru Subdistrict, Banjar Baru city, South Kalimantan Province, Indonesia (3°27.000’ S, 114°52.200’ E). The housing complex is on the eastern side of Banjar Baru city, in an area with mixed housing, agricultural fields and patches of remnant swamp forest. One of us (KO) saw a Sunda Stink-badger directly during a morning survey at 06h30. The animal was clearly seen on the ground, on an asphalt path in the housing complex from a distance of about 4 m. It could be approached to about 3 m after which it disappeared in a road-side ditch. In local language the animal is referred to as *Gubang* or *Sado*.

Fifth record. 2001. Location: Desa Tumbang Mangkutup, Mantangai Subdistrict, Kapuas District, Central Kalimantan Province, Indonesia (2°5.997’ S, 114°18.000’ E). Sunda Stink-badgers were reportedly seen quite frequently in early morning and late afternoon by two former logging operators (Mr Didi and Mr Samsi) in the area of the area of the Ulin, Upak and Kaliwang tributaries of the Mangkutup River. This is an area of now-degraded peat and fresh water swamp forest, but in 2001 the condition of these forests was according to the informants much better at the time. The Stink-badgers were seen on dry land adjacent to the swamp forests.

Sixth record. 9 August, 2017. Location: PT, ASMR-BGA oil palm plantation, Kumai Subdistrict, Kotawaringin Barat District, Central Kalimantan Province, Indonesia (2°46.798’ S, 111°45.000’ E). Two Sunda Stink-badgers were seen by an observation team (Giga, Windi, and Joni) in an oil palm plantation (five years old oil palm) from a distance of about 5 meters. The area is directly adjacent to the Kumai Seberang village in the west, a large oil palm plantation in the north, the Sekonyer River in the south, and a smallholder oil palm plantation in the east. The two animals were seen walking from one block to another at about 20h00. The encounter was very short and the animals were finally lost in the bushes, making it impossible to take a photograph. This animal has several local names: *Sigung*, *Teledung*, and *Goang*.

Seventh record. 2006. Location Hutan Wehea, Desa Nehes Liah Bing, Muara Wahau sub District, East Kutai District, East Kalimantan Province (1°34.799’ N, 116°36.000’ E). One Sunda Stink-badger was clearly observed by NA and a second observer (Purnomo) from about 10 m distance, around 09h15 while conducting an Bornean Orangutan population survey in Wehea forest. The stink-badger was on the ground. It fled before a photo could be taken, leaving behind a strong smell.

The seven new records and reports of Sunda Stink-badger from the Indonesian part of Borneo add to our understanding of the distribution of the species. Not all these reports can be accepted as incontrovertible records, as not all were accompanied by photographic or other evidence. Decades of field experience of the authors in Borneo's forests and experience in identifying mammal species, however, add significantly to the credibility of the records of this visually highly distinctive species. They thus confirm that Sunda Stink-badger still occurs in multiple well-spaced parts of Kalimantan, including in areas dominated by freshwater and peat swamp forests, and even in suburban areas – similar to where it is frequently seen in Sabah (Malaysian Borneo; Samejima *et al*. 2016). Our seven records are distributed across four of Kalimantan's five provinces, West, Central, South and East Kalimantan, while another recent sighting from North Kalimantan (Rustam & Giordano 2014) indicates that Sunda Stink-badger remains present in all of Kalimantan's provinces.

Five of our seven records were in areas that the habitat mapping by Samejima *et al*. (2016) considered low suitability (blue areas in Figure 2). Our new records from Kalimantan therefore suggest that further work is needed on mapping the distribution of the species and modelling habitat suitability. This was noted by Kramer-Schadt *et al*. (2016) who emphasised that despite the extensive efforts to compile existing information for Bornean carnivores, "so few or spatially biased occurrence records exist for some species that the model outcomes … must be interpreted cautiously". Spatial biases are often encountered in species distribution modelling and despite various attempts to overcome these biases (Kramer-Schadt *et al*. 2013), the current example indicates that any distribution models based on spatially unequal sampling need to be cautiously interpreted. Furthermore, in general the southern half of Borneo was under-represented for almost all Bornean carnivores modelled for such effort; such potential bias should be considered for cautiously using the resulting maps of such exercise.

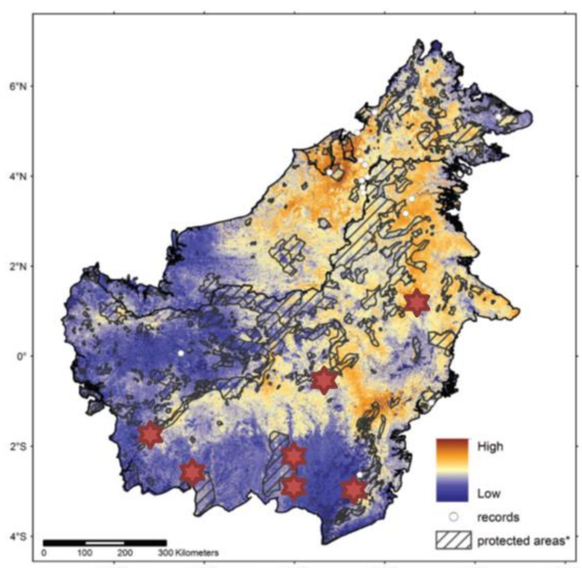

Figure 2. Habitat suitability map for Sunda Stink Badger *Mydaus javanensis* by Samejima *et al*. (2016), with the seven new records in red.

Despite recognition of sampling bias and potential underreporting of records from Kalimantan, the scarcity of records of Stink-badgers in Kalimantan appears to be real. It begs the question what causes this scarcity. Variation in habitat suitability may not well explain the scarce records, with the majority of new records coming from areas of apparent low ecological suitability. Anthropogenic factors (e.g., hunting for food) might play a role as suggested by Samejima *et al*. (2016), but without additional records and ethnobiological information it is hard to test this hypothesis. We therefore call for further surveys that could detect the species, specific requests to Indonesian biologists who spend much time in the field in Kalimantan about any records of the species, and ethnobiological surveys that establish what local people know about Sunda Stink-badger in Kalimantan.

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ORIGINAL CONTRIBUTION

Habitat use of Bornean Ferret Badger *Melogale everetti* in Sabah, Malaysian Borneo

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Abstract.

Bornean Ferret Badger *Melogale everetti* is endemic to the uplands of the Mount Kinabalu and the Crocker Range, Sabah, north Borneo; it is currently categorized as Endangered on The IUCN Red List of Threatened Species. No systematic survey has been conducted and its ecology is largely unknown. To better understand the ecology of Bornean Ferret Badger and the influences of human impacts on the species, a targeted camera-trap survey was conducted. Camera-traps were set up in an area between Crocker Range Park and Tenompok Forest Reserve, along a ridge connecting Mount Kinabalu with the Crocker Range. This area is inhabited by local people and includes old-growth forests, secondary forests and slash-and-burn fields. A total of 112 images of Bornean Ferret Badger were obtained from old-growth forests and from slash-and-burn fields, but none from secondary forests. The encounter rate for this species was not significantly different between old-growth forests and slash-and-burn fields and highest among the 10 wild carnivores recorded in the survey area. The elevation range of the camera-trap records was 990–1440 m. These findings indicate that the habitat of Bornean Ferret Badger in this landscape includes slash-and-burn fields and old-growth forests. However, its population trends must be carefully monitored; the camera-traps often detected Domestic Dogs *Canis familiaris*, which could be a major threat to this species, both within and outside the protected area.

Keywords: Bornean Ferret Badger, camera-trap, Crocker Range Park, Kinabalu Park, slash-and-burn field.

Introduction

Bornean Ferret Badger *Melogale everetti* is one of the least known small carnivores in the world. All that is known for certainty is that it is endemic to the island of Borneo and that it has an extremely restricted distribution range within the island. Reliable records after the 1970s are limited to the uplands and highlands around Mount Kinabalu (Payne *et al.* 1985, Dinets 2003) and Crocker Range Park (Wong *et al.* 2011) in northern Borneo. The species' distribution range is estimated to be around 4,200 km^2 (Wilting *et al.* 2015).

Reflecting this extremely restricted distribution range, Bornean Ferret Badger is currently classified as Endangered in The IUCN Red List of Threatened Species (Wilting *et al.* 2015). However, its actual population status and major threats have not been systematically evaluated so far.

Although Bornean Ferret Badger could be threatened by multiple factors, including climate change and hunting, one of the main threats could be habitat degradation (Struebig *et al*. 2015). The montane forest within Kinabalu Park and Crocker Range Park is relatively well-protected from human activities, however, the habitat outside the parks has been converted into slash-and-burn agriculture by local people. Given that this species might occur at low densities even within protected areas (Wilting *et al.* 2015) and thus total population size within the parks could be small, the species' population viability may be largely dependent on habitat suitability outside the parks. Furthermore, the montane forest of Kinabalu Park and Crocker Range Park is not continuous and is separated by unprotected and highly human-impacted habitats. Therefore, if Bornean Ferret Badger is vulnerable to habitat conversion, population exchange and gene flow between the two parks are unlikely to take place; these might be critical to population viability. Here we present a systematic survey for Bornean Ferret Badger in order to assess its habitat use and potential threats in the area.

Materials and methods

Survey area

The survey area (5°56'N, 116°28'E) is located on a ridge between Tenompok Forest Reserve (19 km^2) and Crocker Range Park (1,400 km^2; Figure 1). Most of the forests in Tenompok Forest Reserve and Crocker Range Park are strictly protected old-growth forests. The area between the forest reserve and the park has been allocated to local people and consists of secondary forests and slash-and-burn fields. The area consists of a mixture of old-growth forests inside the forest reserve and the park, and secondary forests and slash-and-burn fields outside. The altitude of this area ranges from about 900–1400 m asl. The average annual rainfall is 2000–2500 mm (Fujiki *et al.* 2017).

The old-growth forest (elevation range during this survey was approximately 1210–1440 m asl) within Tenompok Forest Reserve and Crocker Range Park, consists of lower montane vegetation dominated by Fagaceae. The maximum tree height was about 30 m. Tenompok Forest Reserve and Crocker Range Park were established in 1984. The old-growth forests in this survey area have been preserved for more than 30 years. Secondary forests (1140–1260 m asl), mostly in the form of recent regrowth, occur along the ridge top with estimated ages of 10–30 years since the last burning by local communities. Secondary forests here are characterized by the dominance of Macaranga trees with a maximum tree height of about 10–20 m. It appears that the secondary forests have been maintained for 10–30 years because local people rarely convert these to slash-and-burn field due to the remoteness from their communities, which are 1 to 2 km away. The slash-and-burn fields (960–1270 m asl) consists of a mixture of farmlands (*i.e.*, rice fields, small plantations of rubber trees or coffee trees) and abandoned fields that were burnt 1–15 years prior to this camera-trap survey. Grassland or short pioneer shrubs occur in the abandoned fields and include the genera *Eupatorium*, *Thysanolaena*, *Imperata*, *Melastoma* and *Clethra*. See Fujiki *et al.* (2017) for further details of the survey area.

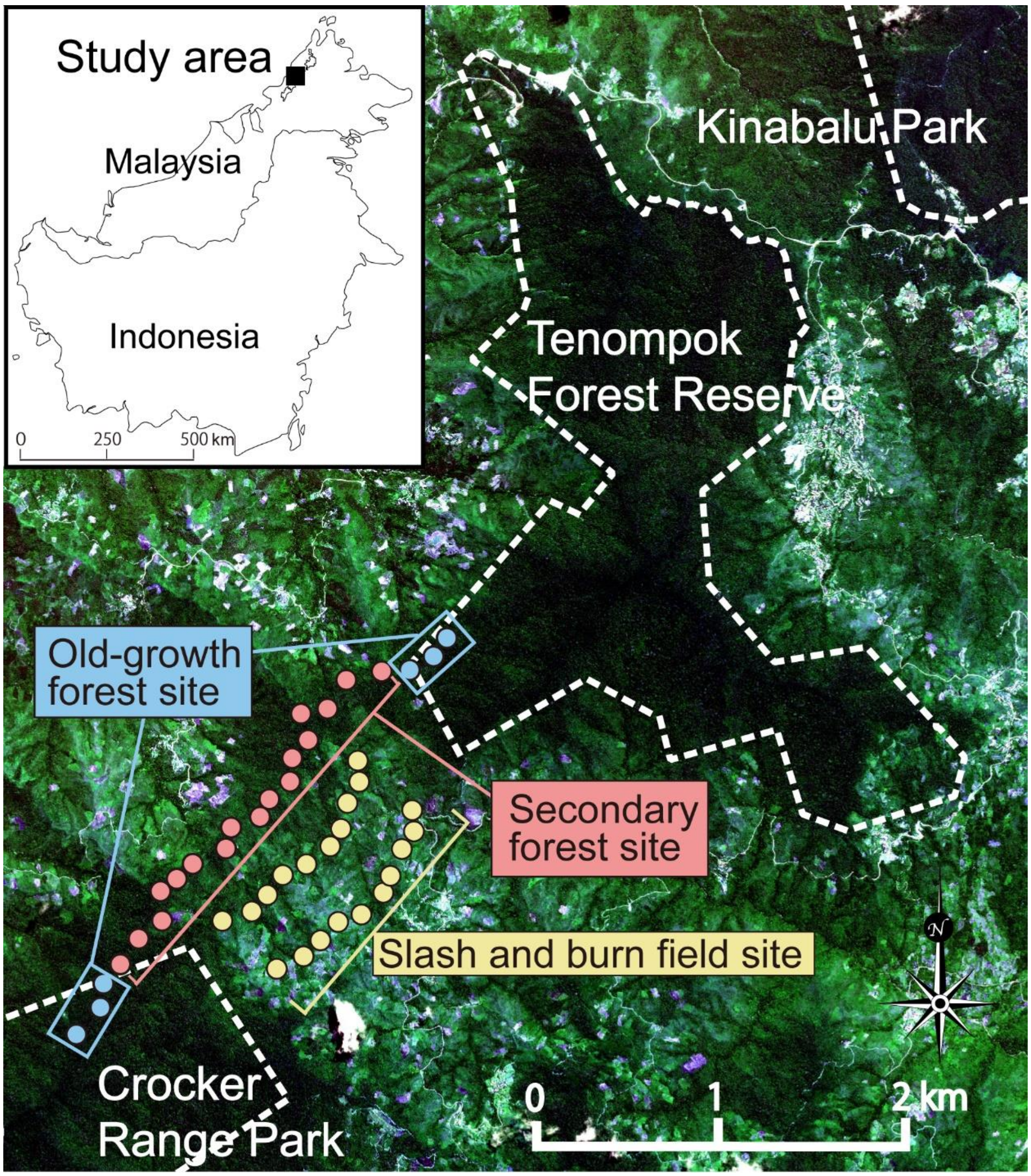

Figure 1. A satellite image of the study sites located between Crocker Range Park and Tenompok Forest Reserve in Sabah, Malaysia (Borneo). Dotted lines are the boundary of the forest reserve or the park and points are the locations of the camera-traps.

Methods

Three parallel transect lines were set up between Crocker Range Park and Tenompok Forest Reserve along the ridge (Figure 1). The longest line was located along the ridge top connecting Crocker Range Park with Tenompok Forest Reserve. This line crossed old-growth forests and secondary forests. In total, 23 camera-traps (Bushnell Trophy Cam) were set along this line (6 camera-traps in old-growth forests, and 17 camera-traps in secondary forests). Each camera was set 50 m downward on either slope from the top of the ridge, and subsequently shifted to the other slope side across the ridge twice to reduce the bias of camera-trap positions. The other two transect lines were located in slash-and-burn fields downslope of the ridge and ten cameras were set along each transect line (*i.e.*, 20 camera-traps in the slash-and-burn fields); there was some overlap in altitudinal range between these transects. All camera-traps on each transect line were set at 250 m intervals. The survey lasted for two years from February/March 2013 to February 2015 on the longest line, and for about 6 months from September 2014 to February 2015 on the two lines in the slash-and-burn fields.

Cameras were set to record 10 second video. Although video recordings of nocturnal animals were monochrome, it was not difficult to recognize Bornean Ferret Badgers from the other carnivores. Bornean Ferret Badger has a white line on the back from head to forelimb and between eyes, and the ears and lower cheek are white (Payne *et al*. 1985). Also, the length of its tail is about half of its head and body length (Figure 2). The tail's length and club-like shape are distinctive from the other animals that have similar body sizes in Borneo (Payne *et al.* 1985). A video recording was considered as evidence of a single visit by a given species, provided that the recording was obtained at a time interval of 30 minutes or greater after the previous recording of the same species. The number of notionally independent video records per 100 camera-trap-days for each camera-trap was defined as the encounter rate. Camera-traps in each habitat type (*i.e.*, the old-growth forest, the secondary forest and the slash-and-burn fields) were treated as replicates. Mean ± SD encounter rates was calculated for each habitat category. A Kruskal–Wallis test and Steel–Dwass test for multiple comparison were used to test for statistically significant differences in encounter rates between the old-growth forest, the secondary forest, and the slash-and-burn fields.

Results

A total of 112 video recordings of Bornean Ferret Badgers were obtained, all at night (Figure 3). The encounter rate of Bornean Ferret Badger in the old-growth forest was 2.20 ± 3.89 (mean ± SD). In 3,292 camera-trap-days it was detected at three out of the six camera-trap stations set in the old-growth forest at an elevation range of 1380–1440 m asl. In the secondary forest, no images of Bornean Ferret Badger were obtained despite 12.126 camera-trap-days spread across 17 stations. The encounter rate of Bornean Ferret Badger in slash-and-burn fields was 1.28 ± 1.91 (mean ± SD). In 3,242 camera-trap-days, it was detected at

9 out of the 20 camera-trap stations set in the slash-and-burn fields, at an elevation range of 990–1270 m asl. There was no significant difference in encounter rates between the old-growth forest and the slash-and-burn fields ($p > 0.05$, Steel–Dwass test). The encounter rate in the secondary forest was significantly lower than that of the old-growth forest or the slash-and-burn field ($p < 0.05$, Steel–Dwass test; Figure 4). In total 10 wild carnivore species and one domestic carnivore species, Domestic Dog *Canis familiaris*, were filmed (Table 1). The encounter rate of Bornean Ferret Badger was the highest among the carnivores both in the old-growth forest and in the slash-and-burn fields.

Figure 2. An example of a Bornean Ferret Badger captured by a camera-trap. This species has a white line on its back from head to forelimb. Its ears are white, and the length of its tail is about a half of its head and body length.

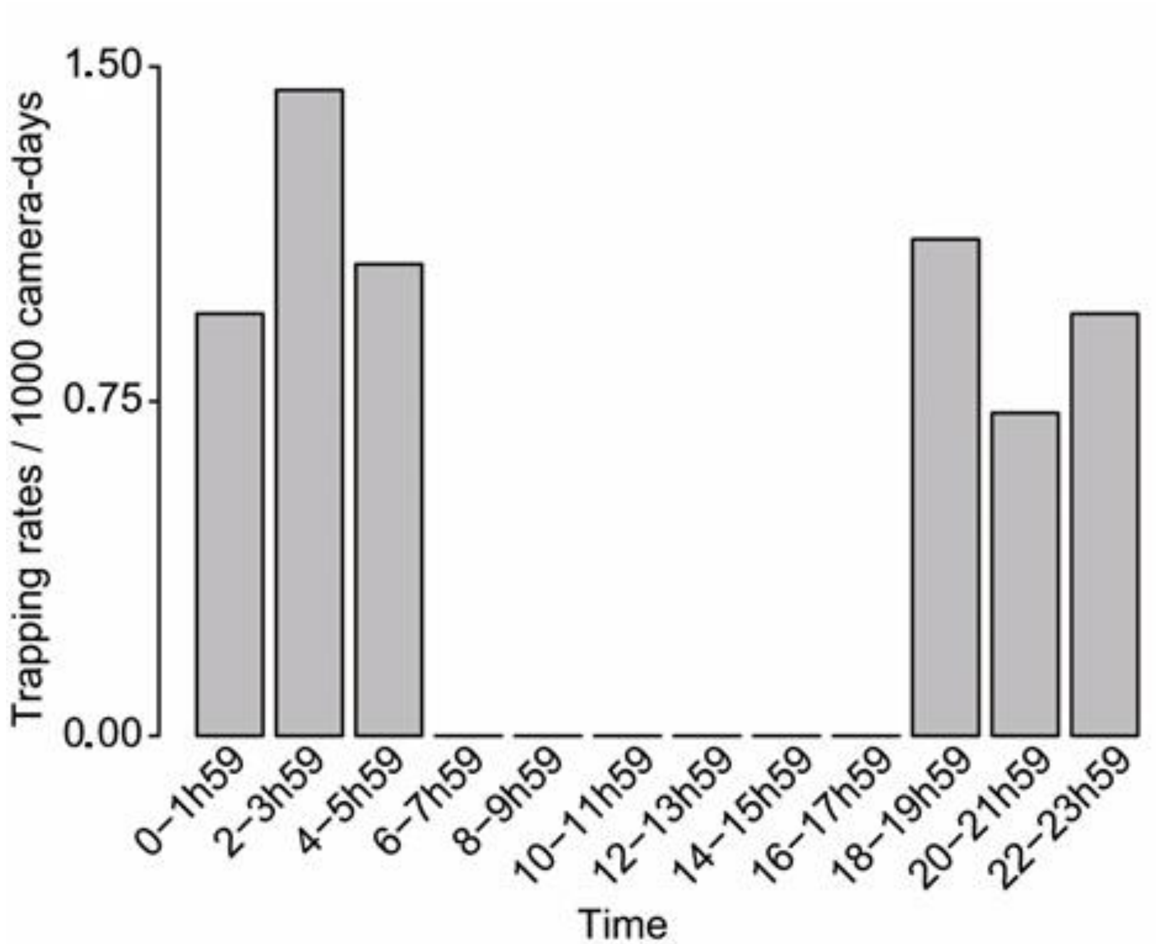

Figure 3. Patterns of the detection of Bornean Ferret Badger (112 records) in 17,962 camera-trap-days with all cameras combined.

Table 1. Carnivore species recorded by camera-traps and mean +/-SD of their encounter rates (number of notionally independent records per 100 camera-trap-days) in each habitat type in the survey area

English name	Scientific name	Old-growth*		Secondary**		Slash and burn***		Elevation (m)	
		No.[¥]	Frequency	No.	Frequency	No.	Frequency	Min	Max
Bornean Ferret Badger	*Melogale everetti*	67	2.20 ±3.89	0	0	45	1.28 ±1.91	986	1258
Banded Linsang	*Prionodon linsang*	18	0.60 ±1.12	51	0.35 ±0.96	9	0.27 ±0.59	988	1438
Binturong	*Arctictis binturong*	0	0	1	0.01 ±0.05	0	0	1339	1339
Collared Mongoose	*Herpestes semitorquatus*	0	0	4	0.02 ±0.12	0	0	1194	1385
Hose's Civet	*Diplogale hosei*	0	0	1	0.01 ±0.05	0	0	1355	1355
Leopard Cat	*Prionailurus bengalensis*	1	0.03 ±0.11	15	0.09 ±0.32	0	0	1194	1355
Malay Weasel	*Mustela nudipes*	3	0.11 ±0.26	9	0.06 ±0.18	3	0.09 ±0.29	988	1437
Marbled Cat	*Pardofelis marmorata*	1	0.03 ±0.12	0	0	0	0	1437	1437
Masked Palm Civet	*Paguma larvata*	14	0.42 ±0.50	54	0.34 ±1.07	9	0.27 ±0.58	988	1437
Yellow-throated Marten	*Martes flavigula*	6	0.17 ±0.38	15	0.09 ±0.26	5	0.15 ±0.32	1060	1361
Domestic dog	*Canis familiaris*	2	0.08 ±0.24	21	0.15 ±0.39	32	0.97 ±3.55	988	1355

*3,292 camera-days, **12,126 camera-days, ***3,242 camera-days, [¥] Number of detections.

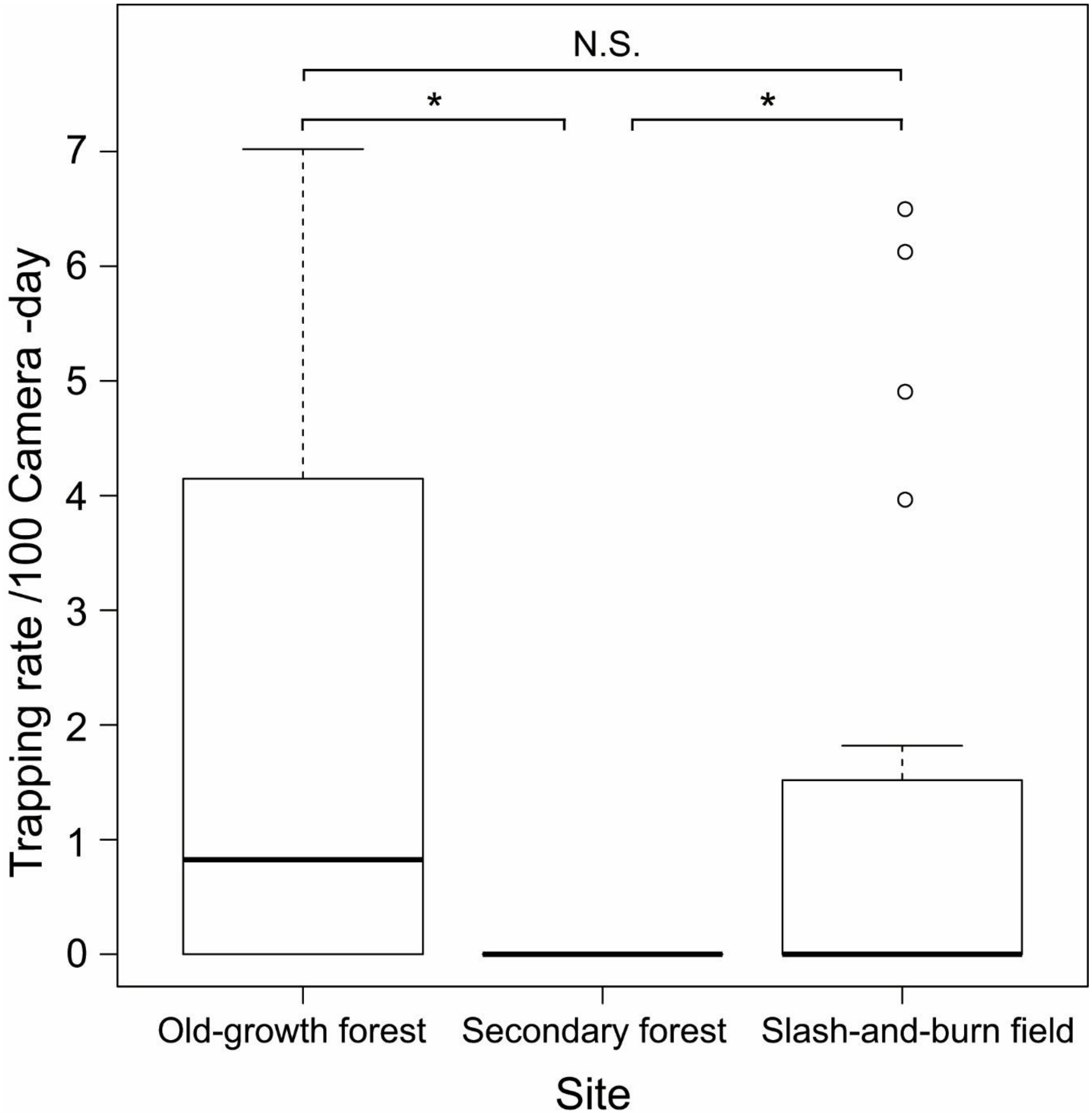

Figure 4. Boxplot indicating camera-trap encounter rates of Bornean Ferret Badger in each of the tree land categories. (* $p < 0.001$, Steel–Dwass test)

Discussion

In this survey, Bornean Ferret Badger inhabits old-growth forest and the slash-and-burn fields. Surprisingly, the encounter rates of Bornean Ferret Badgers were significantly higher in the old-growth forest and in the slash-and-burn field than in the secondary forest, though most records of Bornean Ferret Badger are from protected forests (Wilting *et al*. 2016). In both the old-growth forest and the slash-and-burn fields, the encounter rates of Bornean Ferret Badger were highest among the 10 wild carnivores recorded in the study site. The slash-and-burn fields had many holes (width about 8 cm, height about 10–13 cm, depth about 10 cm), which may have been foraging digs by Bornean Ferret Badgers.

The relationship between camera-trap encounter rates and the abundance of animals on the ground cannot be determined, but it is clear that this species uses both habitats regularly and may be among the most numerous small carnivore species in each. The only previous camera-trap survey in Crocker Range Park camera-trapped Bornean Ferret Badger less frequently than many other small carnivores (A.J. Hearn and J. Ross pers. comms. in Wilting *et al.* 2015). Thus, the population of Bornean Ferret Badgers may be greatly different between areas, although these divergent results might also reflect differences in camera-trapping style.

The absence of Bornean Ferret Badger camera-trap records in the secondary forest is surprising. Soil condition in the secondary forest was different from those of the old-growth forest and the slash-and-burn field. Given that Bornean Ferret Badger depends on ground-dwelling insects and earthworms (Payne *et al.* 1985), it is likely that soil condition directly influences the abundance of food resources and foraging efficiency. The species' abundance may depend on the physical soil condition such as soil moisture, rather than forest structure.

Bornean Ferret Badger was recorded only during night, which suggests that it is strictly nocturnal. This nocturnal habit might partly explain why this species was considered scarce in earlier assessments (Wilting *et al.* 2015). A similar case was reported in an African rainforest. Black-footed Mongoose *Bdeogale nigripes* was thought to be very rare and assumed to be a forest dweller: however, recent camera-trapping studies have shown that it is relatively common even within disturbed habitats (Bahaa-el-din *et al.* 2013). The range of habitats that Bornean Ferret Badger uses and its population size could have been underestimated due to the difficulties in detecting this species.

The abundance of Bornean Ferret Badger in slash-and-burn fields might suggest that it is relatively tolerant to habitat disturbances and degradation. Whether this species can thrive in isolated slash-and-burn fields not surrounded by old-growth forests is not known. Even if the species can persist in non-forested landscapes, its population trends must be monitored carefully. Domestic Dogs were camera-trapped often both within and outside protected areas. Domestic Dogs can be a major threat to wildlife (Imazato 2012), so it is critical to determine the effects of predation by dogs on Bornean Ferret Badger populations; disease risks such as rabies and canine distemper might be another threat. The apparent use of slash-and-burn fields does not necessarily mean that the Bornean Ferret Badger can thrive in intensive agriculture, which is widely spreading in the upland areas around the Kinabalu Park; intensive agriculture might be a serious threat to the Bornean Ferret Badger. Further research on this species' tolerance to human impacts and threats such as Domestic Dogs is warranted.

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IUCN/SSC Small Carnivore Specialist Group

ORIGINAL CONTRIBUTION

Predicting Greater Grison *Galictis vittata* presence from scarce records in the department of Cordoba, Colombia

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Abstract.

The Greater Grison, *Galictis vittata*, is a poorly known species in Colombia. Throughout its range major knowledge gaps exist regarding its ecology and conservation. To compile and analyse information about the species´ distribution records in the department of Cordoba, Colombia and assess its presence probability according to landscape attributes, we conducted a literature review of all wildlife studies in the region and compiled all possible direct presence records of the species in the department. We generated random location points and characterized each distribution and random location by their distance to landscape attributes and land-cover type and modelled landscape presence using a Multiple Logistic Regression approach. We found 33 records of the species in Cordoba with most of the records distributed in the subregion of Alto Sinú (36%). Higher presence probabilities are localized in areas near forests mostly in the southern parts of the department, showing the species is still related with the largest forest blocks. Grisons appears to potentially tolerate some levels of disturbance but is still dependent to forest. The influence of natural habitats and abundance across the department and other areas of its distribution remain to be evaluated.

Keywords: Carnivora, Multiple Logistic Regression, Mustelidae, Resource Selection Model

Introduction

Small carnivores, generally mustelids, procyonids and mephitids, are among the least studied groups in the Neotropical region, where demographic and life-history information from some countries, such as Colombia, are limited and anecdotal (González-Maya *et al*. 2011). Despite the important role of these species in the ecosystems (Belant *et al.* 2009, González-Maya *et al.* 2009), few researches have been carried out on many basic aspects of their ecology, biology and natural history, and they have been relatively overlooked by science and conservation efforts (Schipper *et al*. 2009). Likewise, among small carnivores, some species (e.g., *Mustela felipei*, *Procyon* spp.) have aroused the interest among biologists, most probably related with distribution range, conservation status, ecosystems function or charismatic appealing (González-Maya *et al*. 2009, Schipper *et al*. 2009).

The Greater Grison, *Galictis vittata* (Schreber 1776), is one of the least known mustelid species in America (Bornholdt *et al.* 2013), with significant information gaps regarding demographic and life-history traits throughout its range (de Oliveira 2009, González-Maya *et al*. 2011). It is an inconspicuous, widely distributed species from Southern

Mexico to Northern Argentina and Southern Brazil (Yensen & Tarifa 2003, Cuarón *et al.* 2016) including some localities from Paraguay (Bornholdt *et al*. 2013). It inhabits tropical lowlands in an elevational range from 0 to 2200 m asl (Escobar-Lasso & Guzmán-Hernández 2014, Cuarón *et al*. 2016). It occupies mainly undisturbed forests and occasionally secondary forests, especially associated to water bodies (Yensen & Tarifa 2003), but there are some reports in disturbed habitats such as coffee and banana plantations, intervened forests and pasturelands (Gallina *et al*. 1996, Gaudrain & Harvey 2003, de la Torre *et al*. 2009). Main threats to Greater Grison are related to deforestation and illegal hunting, mostly as a pest control alternative to poultry predation (Cuarón *et al*. 2016) and for pet-trade (Convention on International Trade in Endangered Species of Wild Fauna and Flora - CITES 2013). The Greater Grison is considered globally as Least Concern by IUCN (Cuarón *et al*. 2016), but few information exists regarding the real conservation status both at local and regional scales, likely product of the generalized low attention to study the species (González-Maya *et al*. 2011).

Currently, most of the available information on the Greater Grison is limited to some incidental reports, without systematic approaches, considering the species probably tolerant to anthropic intervention but occurring at low densities on most of the habitats (Cuarón *et al*. 2016). For Colombia, Alberico *et al.* (2000) described the general distribution of the Greater Grison based on accidental data from few localities, suggesting that this species occur across all over the country. However, recent confirmed reports from Cesar, Sucre (Wieczorek 2001), Antioquia (Cuartas Calle & Muñoz Arango 2003), Caldas (Escobar-Lasso & Guzmán-Hernández 2014), Nariño (Ramírez-Chaves & Noguera-Urbano 2010), Vichada, Meta, Arauca, Caquetá (Ferrer Pérez *et al.* 2009) and Cordoba departments have allowed to draw more precise distribution inferences for the country (Meza-Joya *et al*. 2018). However, ecological information, such as demography, life history, tolerance to disturbed areas or intervention is limited; therefore, assessing its conservation status remains a difficult task.

In light of enormous gaps on the ecology, distribution and threats knowledge of the Greater Grison, and the need for quality data that supports conservation status assessment in Colombia, here we provide new data for the Caribbean region of Colombia. Specifically, we perform a spatial modelling approach to explore the tolerance of the Greater Grison to disturbed areas using a presence probability scheme.

Materials and methods

Study area

Cordoba department is located within the Caribbean region of Colombia (09°25’, 07°15’N and 75°26’, 75°10’W; Figure 1; González-Maya *et al*. 2013). The department extends through 25,000 km^2, including approximately 1,220 km of rivers, 100 km^2 of wetlands, and 165 km of shorelines. The topography is dominated by plains with isolated mountains, with an elevation gradient from 0 to 1250 m asl. Mean annual precipitation ranges from 1,400 to 2,300 mm, mean annual temperature of 28º C and humidity over 80%. The typical vegetation is mangroves, estuarine areas, savannas, tropical dry and rain forests (Marín Ramírez 1992). Geographic regions division includes six subregions: High, Mid and Lower Sinú River, Costanera (coast), Sabanas (savannas) and San Jorge River. Historically, the department have suffered of unsustainable land and resource use, where current predominant land-use is degraded pasturelands and agriculture/cattle production areas, with isolated forest patches and the largest remaining forests mostly restricted to the southern portion of the department (González-Maya *et al.* 2013).

Range distribution database

We compiled information from technical reports and fauna inventories from multiple sources such as thesis, scientific papers, research reports, and semi-popular articles, in order to collect all recent available (2000-present) presences records for the Greater Grison in the department of Córdoba. Technical reports from the Universidad de Córdoba, and the regional environmental authority – Corporación Autónoma Regional de los Valles del Sinú y del San Jorge (CVS and UNAL 2005, Ballesteros *et al.* 2009, Centenaro & Ballesteros 2002, Centenaro & Ballesteros 2004, Centro de Investigaciones Ambientales y de Ingeniería 2001, Consultores-Unidos & Gercon 1997, Consultoría Colombiana 2000, Consultoría del Caribe 1998, Cuervo-Maya *et al*. 2000, De la Ossa 1993, Franco-C 2000, Jiménez 2000, Luna 2000, Montoya-Bohorquez 1993, Noriega-M & Mejia-A 1993, Nuñez-D 2005, Racero-Casarrubia & Hernández 2010, Universidad de Córdoba & Fundación Neotrópicos 1996). We also consulted Museum specimens from national and international collections and public electronic databases including the Instituto de Ciencias Naturales (ICN)- National University of Colombia (Instituto de Ciencias Naturales 2011), and validation assessments (Suárez-Castro & Ramírez-Chaves 2015), VertNet (http://www.vertnet.org) and the Biodiversity Information System in Colombia (Instituto Alexander von Humboldt 2011). In addition, we included first-hand records collected by the Grupo de Biodiversidad of the Universidad de Cordoba between 2006 and 2011 (Ballesteros *et al.* 2006, Ballesteros com. pers.), and monitoring activities of the Parque Nacional Natural Paramillo (PNN Paramillo) by the park staff.

Spatial modelling approach

We georeferenced and characterized each Greater Grison record according to distance to different landscape attributes and types of land cover where the record was obtained. The attributes used included distance to roads, human settlements and rivers, elevation and land-use types (*i.e.*, primary and secondary forest, crops, managed pastures and succession; CVS 2006). To assess if the distribution of the records was random or responded to landscape or human variables, and to estimate presences probabilities we used a logistic regression modelling approach (Pearce & Ferrier 2001). We generated 110 random additional points throughout the department; each random point was also characterized by its land-use and distance to the landscape attributes. We generated Multiple Logistic Regression Models (MLRM) using the distances to landscape (continuous) and land-use of the record variables (discrete as dummy) as independent regression variables, and the confirmed records as the dependent variable (*i.e.*, presence; Imam & Kushwaha 2013). To estimate the presences probabilities and influence of the variables we built the MLRM; the best model was selected based on the Akaike Information Criterion (AIC), and we used the model adjustment, the products odd-ratio of each variable and the likelihood algorithm for the selected model. To analyse the presences probabilities spatially, a grid of 0.03 x 0.03 degrees' cells was created over the department. We calculated the probability derived from the model's function (0-1), and assigned this probability values to each of the grid's cell to generate a presences probability maps for the department. All the analyses were performed using Infostat Software® (Di Rienzo *et al.* 2011).

Results

We found 33 confirmed, georeferenced records of the Greater Grison, distributed in all geographic department sub-regions (Table 1). The localities varied from highly intervened areas, such as the capital city of the department (Montería) or the University campus, to highly preserved forests in the higher parts of the Sinú and San Jorge Rivers.

Table 1. Confirmed records of *Galictis vittata* in the department of Cordoba, Colombia

Sub-region	Municipality	District	Long	Lat	Locality
Upper Sinú	Tierralta	-	76°09'45.00"	07°58'12.00"	Quebrada Tay
			75°57'12.00"	08°23'41.00"	Hacienda Currayao
			76°02'04.00"	08°16'39.60"	Finca Walterra
			75°58'00.00"	07°59'04.00"	East sector Cerro Murrucucú *
			75°58'42.00"	08°00'23.00"	
			75°58'48.00"	07°52'26.00"	
			75°56'16.00"	07°52'40.00"	
			75°57'51.00"	07°55'59.00"	
		Cerro Murrucucú	76°03'31.80"	07°59'17.52"	El Silencio
		Volador	75°59'07.00"	08°19'33.10"	Hacienda Monaco
	Valencia	Villanueva	76°04'16.00"	08°20'15.00"	Hacienda Las Tangas
		Volador	76°03'55.00"	08°18'04.30"	Hacienda Jaraguay
Mid Sinú	Montería	-	75°51'53.30"	08°47'28.10"	Universidad de Córdoba
			75°51'55.13"	08°46'03.02"	Barrio La Castellana
		Betancí	75°49'55.00"	08°22'44.00"	Ciénaga de Betancí
		Loma Verde	76°11'42.00"	08°31'11.50"	Agua Viva
		Martinica	75°59'45.00"	08°43'29.00"	Ciénaga de Martinica
	San Pelayo	Sabana Nueva	75°51'01.10"	09°02'24.70"	Ciénaga La Pacha
Lower Sinú	Lorica	Cotocá	75°50'23.00"	09°07'14.40"	Finca Nueva Colombia
		Pantano Bonito	72°53'47.00"	09°09'49.93"	Ciénaga de Pantano Bonito
Coast	Canalete	-	76°19'16.00"	08°44'28.08"	Hacienda Chimborazo
	Los Córdobas	Santa Rosa de la Caña	76°19'32.00"	08°45'30.00"	Reserva Forestal Campo Alegre
	Moñitos	Río Cedro	76°11'01.00"	09°08'13.52"	Reserva Natural Viento Solar
	Puerto Escondido	Cristo Rey	76°12'17.00"	09°05'37.10"	Finca Leticia
	San Antero	El Molino	75°51'00.00"	09°20'12.00"	Agrosoledad
Sabana	Pueblo Nuevo	-	75°19'28.00"	08°20'28.00"	Hacienda Praga
San Jorge	Ayapel	Los Pájaros	74°52'11.40"	08°19'34.50"	Caño Canchila
	Buenavista	-	75°32'05.70"	08°11'15.90"	Hacienda Betanci-Guacamayas
	Montelíbano	-	75°32'41.20"	07°54'46.20"	Complejo minero – Cerro Matoso
			75°34'14.49"	07°55'05.44"	Sector Balsillas Cerro Matoso
			75°30'48.50"	07°59'16.70"	Las parcelas
		Town	75°24'25.72"	07°59'31.25"	Ecoparque
	San José de Uré	-	75°38'30.84"	07°38'12.86"	Alto Río Uré

*Buffer Zone of Paramillo National Natural Park

Most of records are located in the High Sinú river (36%), followed by Mid-Sinú and San Jorge rivers (21%), Coast (12%), Lower Sinú (6%) and Sabanas (3%). Records of the species increased since 2000 (6%) to 2007 (36%), decreasing by 2010 (24%). Most of the records were located in Managed Pastures (45%), followed by Secondary Forests (19%), Crops (16%), Succession (13%) and Primary Forests (6%). Mean elevation of the records was 302.00 ± 521.78 m, and mean distance to rivers was 5.6 ± 18.7 km, 6.4 ± 20.2 km to roads and 46.17 ± 20.50 km to towns (Table 2).

Table 2. Distribution of confirmed records of *G. vittata* (Schreber, 1776) according to distance (km) to human and landscape variables in Cordoba, Colombia.

Variable (km)	**Mean ± SD**	**Ranges**		**Records**	**Rel. Freq.**
		Lower	**Higher**		
Rivers	5.6 ± 18.7	0.14	21.87	32	0.97
		21.88	43.61	0	0.00
		43.62	65.35	0	0.00
		65.36	87.08	0	0.00
		87.09	108.82	1	0.03
Roads	6.4 ± 20.2	0.01	23.46	32	0.97
		23.47	46.93	0	0.00
		46.94	70.39	0	0.00
		70.40	93.86	0	0.00
		93.87	117.32	1	0.03
Towns	46.17 ± 20.50	14.52	35.24	8	0.24
		35.25	55.96	14	0.42
		55.97	76.67	10	0.30
		76.68	97.39	0	0.00
		97.40	118.11	1	0.03
Elevation (m)	302.00 ± 521.78	1	491	26	0.79
		491	981	4	0.12
		981	1471	2	0.06
		1471	1961	0	0.00
		1961	2451	1	0.03

The best performance of MLRM showed significant effect of presence in Secondary Forests and Crops, and distance to towns and roads (Table 3). For town distance, crops and secondary forests the effect was positive, meaning that presence probability increases when distance to towns increase and in areas with crops and secondary forest. For road distance the effect was negative, meaning that presence probability increases when approaching main roads. Spatially, we found higher presence probabilities for the southern portion of the department, coinciding with those areas in lower intervention status (*i.e.*, High Sinu and Paramillo National Natural Park; See Figure 1).

According to our model, there are no areas within the department with zero presence probabilities of the Greater Grison (lower percentage value= 24). The model map indicated a mean probability value per cell of 47.64 ± 13.15, with the highest number of cells in the 38-52% range (47% of cells).

Table 3. Logistic regression model adjusted to selected variables explaining the occurrence of *G. vittata* (Schreber, 1776) records in department of Cordoba, Colombia (AIC=2530). Model: y= -12.67+8.39 (land-use=crops) + 6.25 (land-use secondary forest) + 0.0005 * (dist. Towns) – 0.0005 (dist. Roads).

Parameters	Estimate	Standard error	Odd ratio	*p*
Intersect	-12.67	4.62	<0.001	0.0062
Land-use: Secondary forest	6.25	2.61	3.08	0.0168
Land-use: Crops	8.39	4.22	4430.47	0.0465
Distance to Roads	-0.0005	0.0001	0.99	0.0177
Distance to Towns	0.0005	0.0002	1	0.0115

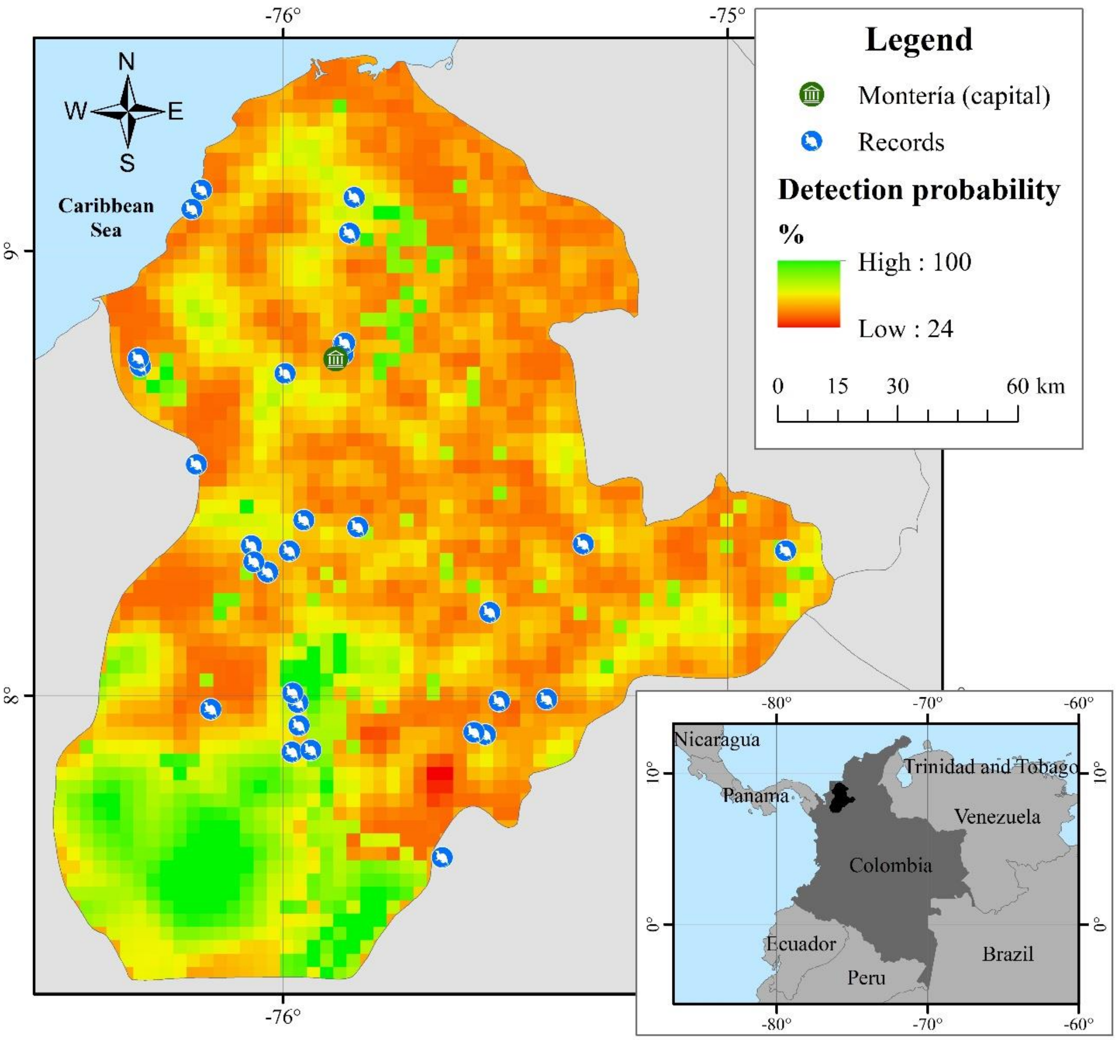

Figure 1. The extrapolated model of presences probabilities for *G. vittata* (Schreber, 1776) and compiled records for department of Cordoba, Colombia (Insert: location of department of Cordoba (black) in Colombia).

Discussion

To our knowledge, this is among the first studies using a spatial modelling approach to evaluate the distribution and presence probabilities of the Greater Grison, the first at landscape scales, and to assess its relative tolerance to different habitat types and disturbed areas, as has been suggested for the species (Gaudrain & Harvey 2003, Yensen & Tarifa 2003, de la Torre *et al*. 2009). Among the most interesting results is the wide variety of records of the Greater Grison from undisturbed to man-made habitats which are relevant for conservation. Our spatial analysis identified the influence of secondary forest and the distance from towns as main explanatory variables of higher record probabilities, followed by the distance to roads and crops which also influenced the model. Although records could be biased by differential sampling efforts and potential visibility nearby human infrastructure, our results have some ecological and conservation implications. These results suggested certain tolerance and ecological plasticity of Greater Grison to altered environments, which supports the idea that Greater Grison may use and move between less conserved and disturbed areas towards more conserved habitats to find specific and available preys (de la Torre *et al.* 2009).

Spatially, our model indicated that Greater Grison is mostly related with forested habitats and areas with lower influence of human settlements, with overall higher presence probabilities for southern Cordoba department along Paramillo National Natural Park and buffer zones. It is important to highlight that for the department of Córdoba the coverage of industrialized crops is low with small-scale and multi-specific crop areas (CVS 2006). These crop areas could improve the availability of small prey and even parts of the crops could be potentially consumed by the species. The presence of Greater Grison in disturbed areas could mean that even when individuals venture into those areas, the species is still likely related with natural habitats for certain aspects of their ecology and natural history, being tolerant to ecotones for resources but still depending on natural forest (de la Torre *et al*. 2009, Pineda-Guerrero *et al*. 2015). Likewise, given the source of the records, for instance, the high percentage associated with towns could be related with the probability of the species to be sighted in open areas (*i.e.*, detection by humans), and not necessarily reflects habitat preference or availability; the best-conserved areas of the department still need systematic efforts to assess presence and occupancy, distribution and ideally population parameters.

In addition, most of the natural ecosystems in the Caribbean region are heavily transformed, mostly for intensive agriculture and cattle production (González-Maya *et al.* 2013). The long-term human intervention on ecosystems have pushed some species (low tolerant) towards natural cover relicts, while other species (high tolerant) are common due to the adaptability or ecological plasticity for landscape matrix use (Andren 1994). It is yet unclear the impact of land use changes over Greater Grison population parameters; thus, it is important to bear in mind that our model only identifies the potential variables that increase presence probabilities, not necessarily indicating population status or any other viability-related parameters. Systematic efforts are needed to estimate demographic and life-history parameters between natural and disturbed habitats to draw more precise conclusions concerning demographic tendencies.

Future work should focus in addressing localities not sampled so far; most of the records come from recent sampling efforts in hydropower dam building projects or locations that were not available for surveys for instance due to violence or presence of illegal groups (Consultores-Unidos & Gercon 1997, Universidad de Córdoba & Fundación Neotrópicos 1996). This also influences the increase in the number of records towards more recent years; however, for the purposes of our analyses the time-frame was adequate to assess the current dynamic land-use types and its influence on the presence of the species. Our data can also be incorporated into future conservation assessments, providing new insights into the species ecology and could be used to direct future studies for the species across its range.

In sum, our study provides new records for the Greater Grison in Colombia and a preliminary approach to its distribution at regional scale in an important portion of the Caribbean region. Our results are also an additional step to support regional assessments for the species. These kind of models as well as other approaches like site-occupancy models (e.g. Kéry *et al*. 2010) and habitat suitability models (e.g. Singh *et al*. 2009) can be used for new field-survey efforts design to identify at local or regional scales areas with the potential presence of the species (and other species).

Finally, our spatial modelling approach is valuable on one hand for exploratory distribution analyses with scarce base information (records) and using geographic information generally available at national or regional scales, being a proxy to potential distribution at regional levels, and to assess how effective could be to detect the effect of landscape variables on species' occurrence; on the other hand, these models represent a useful tool for designing specific studies of poorly-known species and could contribute and be applied in decision making process when applying management and conservation planning at regional scales.

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