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ORIGINAL ARTICLE

The conservation status of small carnivores in the Ke Go – Khe Net Lowlands, Central Vietnam

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Abstract.

The Ke Go – Khe Net Lowlands are one of the largest remaining tracts of lowland evergreen forest in central Vietnam. Based on confirmed records and predicted distribution, the landscape was identified as a priority for small carnivore conservation, including for the Vulnerable (*sensu* IUCN Red List of Threatened Species) Owston's Civet *Chrotogale owstoni*. Targeted small carnivore surveys using camera trapping and spotlighting were undertaken in 2006, 2007 and 2010. Despite a relatively high survey effort of 1,171 effective camera-trap nights and 101 hours of spotlighting, only six small carnivore species were confirmed, none of which is considered a priority for conservation even at the national level. These survey results evidence a landscape where a wide range of animal taxa, including small carnivores, are either locally extinct or significantly declined in population. At a regional level, the priority conservation action must be to secure sites in the Annamese Lowlands that have not yet acquired the Ke Go – Khe Net Lowland's faunally impoverished status, and for which there is a possibility of successfully conserving a range of Annamese endemics and lowland species in-situ. Forested areas along the Quang Binh – Quang Tri provincial border are probably the priority sites, particularly Khe Nuoc Trong in Quang Binh province.

Keywords: camera trapping, conservation priorities, habitat use, lowland forest

Introduction

Vietnam lies on the eastern border of mainland South-east Asia and is a global priority for biodiversity conservation (Olson & Dinerstein 1998, Stattersfield *et al.* 1998, Myers *et al.* 2000, Brooks *et al.* 2002, 2006, CEPF 2012). Vietnam has been identified as a core country for small carnivore conservation (Schreiber *et al.* 1989). There are 23 small carnivore species recorded in Vietnam (Roberton 2007).

The key threats facing Vietnam's biodiversity include the loss and degradation of natural habitats, and the overexploitation of wildlife and plants for sale into the illegal wildlife trade (Sodhi *et al.* 2004, Sterling *et al.* 2006, CEPF 2012, Brook *et al.* 2014). Small carnivores represent one of the largest proportions of the wildlife trade in Vietnam (Bell *et al.* 2004, Roberton 2007). Although there are reports of small carnivores in the traditional

medicine trade, pelt trade and pet trade, the primary demand for small carnivores comes from consumption in wild meat restaurants across Vietnam and in in the adjacent country of China (Bell *et al.* 2004).

Central Vietnam contains a range of diverse and endemic mammalian taxa, forming part of the Greater Annamites Ecoregion which consists of the Annamite mountain range, associated foothills and the Annamese Lowlands (Baltzer *et al.* 2001, Sterling *et al.* 2006, CEPF 2012). The Ke Go – Khe Net Lowlands supports one of the largest remaining areas of lowland evergreen forest in the Annamese Lowlands (BirdLife International 2015a, 2015b). A number of globally threatened animal species have been recorded from the landscape, including Ha Tinh Langur *Trachypithecus hatinhensis*, Gaur *Bos gaurus*, Large-antlered Muntjac *Muntiacus vuquangensis* (sometimes referred to as *Megamuntiacus vuquangensis*; *e.g.*, Le Trong Trai *et al.* 1999), White-winged Duck *Asarcornis scutulata* and Vietnamese Pheasant *Lophura hatinhensis* (Eames *et al.* 1994, Le Trong Trai *et al.* 1999, 2001). Vietnamese Pheasant is no longer considered a valid species and is now thought to be a variant of the Critically Endangered Edwards' Pheasant *Lophura edwardsi* (Hennache *et al.* 2012).

In the 1990s the Ke Go – Khe Net Lowlands received significant international attention through the rediscovery of 'Vietnamese Pheasant', an Annamese endemic (Robson *et al.* 1993, Eames *et al.* 1994). The site has since been surveyed for its general biodiversity, with a focus on bird species (Le Trong Trai *et al.* 1999, 2001; although both of these reports include records originally described in Robson *et al.* 1993 and Eames *et al.* 1994) and more recently for Nomascus gibbons (Van Ngoc Tinh *et al.* 2010).

There have been 14 small carnivore species reported in interviews from the Ke Go – Khe Net Lowlands including Binturong *Artictis binturong*, Spotted Linsang *Prionodon pardicolor* and Eurasian Otter *Lutra lutra* but, prior to the survey described herein, only had been six confirmed (through reliable field observation, camera trap photographs or identifiable remains) records (Roberton 2007). Small carnivore records based on interview data are extremely unreliable and should not be considered confirmed records or, often, even worthy indications of presence; local names for a single 'species' can also be used to describe an entire taxonomic group (*e.g.*, civets), or even two very different species (*e.g.*, Fishing Cat *Prionailurus viverrinus* and Large-spotted Civet *Viverra megaspila*; Holden & Neang 2009).

The confirmed records comprise Crab-eating Mongoose *Herpestes urva*, Small Asian Mongoose *H. javanicus*, Yellow-throated Marten *Martes flavigula*, ferret badger *Melogale*¿ sp., Asian Small-clawed Otter *Aonyx cinereus* and Yellow-bellied Weasel *Mustela kathiah* (Le Trong Trai *et al.* 1999, 2001, C. Robson pers. comm. in Roberton 2007). Roberton (2007) highlighted the area as a priority for small carnivore conservation, as it contained apparently suitable habitat for a number of globally threatened small carnivore species,

including the Vulnerable (*sensu* IUCN Red List) Owston's Civet *Chrotogale owstoni*, a species, indeed genus, known only in Lao PDR, Vietnam and south China (Schreiber *et al.* 1989).

This paper summarises the records obtained during targeted small carnivore surveys in the Ke Go – Khe Net Lowlands during 2006, 2007 and 2010.

Materials and methods

Study area

Covering approximately 48,000 ha, the Ke Go – Khe Net Lowlands is one of the largest remaining patches of Wet Evergreen Forest (*sensu* Rundel 2009) in the Annamese Lowlands (BirdLife International 2015a, 2015b). The landscape comprises two contiguous sites: Ke Go Nature Reserve [NR] in the north (18° 05′ N, 105° 59′ E) and Khe Net proposed NR in the south (18° 02′ N, 105° 58′ E).

A 1996 survey of Ke Go NR classified vegetation types into four broad categories based on the level of human impact: lightly disturbed broadleaf evergreen forest; heavily disturbed broadleaf evergreen forest; plantation; and scrub and grassland (see Le Trong Trai *et al.* 1999). Commercial tree species are selectively logged from lightly disturbed broadleaf evergreen forest, but much of this vegetation type remains little changed. Heavily disturbed broad-leaved evergreen includes areas that have been completely cleared and are now secondary forest, and some areas that have managed to retain some plant species and structure associated with primary forest, despite heavy anthropogenic disturbance. Approximately 74% of Ke Go NR was classified as heavily disturbed broadleaf evergreen forest, with only the more inaccessible steep slopes and hill tops retaining some of the least anthropogenically disturbed forest (Le Trong Trai *et al.* 1999). No equivalent published figures on habitat quality exist in English for Khe Net proposed NR, but, based on direct observation, the site contains similar habitat types and shows similar patterns of human-induced disturbance; all accessible lowland areas are now mostly secondary forest and retain few large (over 15 m high) trees. At the edges of southern extent of the landscape there are eucalyptus and rubber plantations. A network of permanent rivers and streams dissects this landscape.

The topography of the Ke Go – Khe Net Lowlands is undulating hills, not reaching over 500 m. The wet season is characterised by regular rainfall and extends from August to October, with an annual rainfall of 2,200 mm to 2,900 mm. From November to March the area experiences a dry season with very little rain. Temperature ranges from an average of 25 °C in July to 11 °C in January.

There were approximately 50,000 people living in the buffer zone of Ke Go – Khe Net Lowlands in 1999 of mainly Kinh ethnicity (who comprise the majority ethnic group in Vietnam) with small numbers of Muong and Nguon minority groups (Le Trong Trai *et al.* 1999, 2001). Many of these households undertake activities that are threats to the landscape which include hunting, timber extraction, firewood collection, and oil extraction from *Cinnamomum parthenoxylum* and other trees of the family Lauraceae (Le Trong Trai *et al.* 1999, 2001).

Methods

Field survey methods

Four methods were used to obtain small carnivore field records: diurnal searches for tracks and signs, live trapping, nocturnal spotlighting walks and camera trapping.

Field surveys were conducted in the Ke Go – Khe Net Lowlands intermittingly from October to March 2007 and then again from January to May 2010. The 2006 survey was conducted in the lower-elevation areas, often near some of the major streams and rivers in Ke Go-Khe Net Lowlands. The 2010 survey focused on the hill range that runs between Ke Go NR and Khe Net proposed NR; the majority of this hill range is in the former.

Night-spotting and diurnal walks

Human-made pathways were followed in the forest for both diurnal and night walks (see Duckworth 1998). Trails were selected that passed through both secondary and primary forest, with relatively little time spent in plantations, grassland or scrub areas. Night-spotting was conducted once along the banks of the Ke Go Reservoir (approximately 3,000 ha) from a boat. The habitat on the banks of the reservoir is highly degraded and has been completely cleared in many places, with grasses and other low-lying vegetation (less than 1m high) dominant.

LED head-torches were used to detect the eye shine of mammals by scanning trees and other vegetation along the main trails, in addition to along the trail itself (see Duckworth 1998). A number of globally threatened small carnivore species give a strong eye-shine and are detectable using this method (*e.g.*, Mathai *et al.* 2013: Table 1), including Owston's Civet *Chrotogale owstoni* (Duckworth 1997). When eye-shine was detected, a stronger (approximately two million candle-power) spot-light was used to help confirm the identity of the species. If far from the edge of the pathway or obscured by vegetation, binoculars were used to assist identification.

Weasel live-trapping

Single-door humane traps 10 × 10 × 50 cm (locally made using stainless steel, similar in style to a Tomahawk single-door trap) were used to target weasels *Mustela* sp., as this

taxonomic group is very difficult to record using camera traps or by direct observation. Twelve traps were set within Ke Go Nature Reserve from 17 to 22 October 2006 and checked on subsequent mornings. Baits for the traps contained Hawbaker's weasel lure and beef sausage. Commercially available weasel lures were used as it was thought they might aid the survey; none of the lures used have a proven efficacy for attracting South-east Asian forest weasels.

Table 1. Small carnivore species recorded in Ke Go – Khe Net Lowlands, October 2006 – March 2007 and January – July 2010.

Common Name	Scientific Name	Record Type	m asl	Habitat Type	Date	Time
Stripe-backed Weasel	*Mustela strigidorsa*	CT	130	SEF	Oct06	night-time*
Yellow-throated Marten	*Martes flavigula*	O	100	SEF	14Oct06	15h10
		CT	100	SEF	3Nov06	15h03
		C	n/a	n/a	9Nov06	n/a
		CT	150	SEF	28Jan07	night-time*
		CT	300	HD-EF	8Jun10	22h31
Ferret badger	*Melogale* sp.	CT	300	LD-EF	22May10	night-time*
		CT	300	LD-EF	14Jun10	night-time*
		CT	300	LD-EF	2010	night-time*
		CT	300	LD-EF	1Jun10	19h58
Large-toothed Ferret Badger	*Melogale personata*	R	n/a	n/a	7Mar10	n/a
Large Indian Civet	*Viverra zibetha*	O	50	EP	25Oct06	21h50
		O	100	SEF	14Nov06	21h34
		O	100	SEF	15Nov06	19h45
Common Palm Civet	*Paradoxurus hermaphroditus*	C	n/a	n/a	9Nov06	n/a
		CT	220	SEF	20Nov06	night-time*
		CT	235	LD-EF	12Jun10	21h51
		O	300	LD-EF	18Mar10	20h00
Small-toothed Palm Civet	*Arctogalidia trivirgata*	O	150	SEF	26Mar10	20h10
		O	160	HD-EF	28Apr10	21h30

Notes: Record Type: O = Directly observed, CT = Camera trapped, R = Remains
Habitat: SEF = Secondary evergreen forest, LD-EF = Lightly disturbed lowland evergreen forest, HD-EF = Heavily disturbed lowland evergreen Forest, EP = Eucalyptus plantation
All elevations were recorded using a GPS and are therefore approximate
* = time not recorded on the camera trap unit

Camera trapping

Over the 2006–2007 survey period, eleven DeerCam DC 300 camera traps loaded with ISO 200 film and were set at eleven camera trap stations, all within secondary habitats.

Four DeerCam DC 300 (with ISO 200 film), nine Cuddeback Capture, one Cuddeback Excite and one Bushnell Trophy Cam (all three models are digital) were set during 2010. All of these camera traps were set along the near intact evergreen forest that runs along the hill range that forms the border between these two sites.

The following settings were applied to all camera traps in both 2006 and 2010. Fifteen second delay between photographs for non-digital cameras and 30-second delay for digital cameras (except for the one Bushnell Trophy Cam which had a 15-second delay, and the Cuddeback Excite which had a 60-second delay) and with the trigger sensor at high/auto-high sensitivity. Cameras were set 20–30cm from the ground to maximise the possibilities of successful detection (most small carnivore species have a shoulder height of

below 30 cm), and pointed either North or South to avoid over/under exposure. Any vegetation was removed from a 3 m zone in front of the camera trap to increase the sensor's ability to detect the target species and to avoid vegetation preventing successful identification; this perhaps reduces the chance of finding linsangs *Prionodon* and weasels (see Chutipong *et al.* 2014). In 2010 the digital cameras also had stainless steel cases designed to help reduce theft/tampering and rainwater penetration. All cameras were checked every 30 to 45 days and a new 36 exposure film inserted and if digital, memory cards replaced.

Natural baits and commercially available artificial lures were used to attract small carnivores to a camera trap's detection zone. Fixed distances of 2.5 to 3m were set between the camera trap and a 'target log'. Baits and/or artificial lures were then applied to these 'target logs', including Hawbaker's weasel lure, Hawbaker's wild cat lure, Kishel's crossbreed lure, Kishel's weasel lure, dried fish, shrimps, honey, fish oil, raw duck egg, beef sausage and/or shredded fish. Details for all camera trap stations are in Table 2.

Results

Field surveys covered all major habitat types, with particular focus on the lightly and heavily disturbed lowland evergreen forest that was described in Le Trong Trai *et al.* (1999), with less time in plantations, scrub, secondary forest, and grassland. In total, the survey team conducted approximately 101 hours of night-spotlighting (59 hours in Ke Go NR and 42 hours in Khe Net proposed NR), and 81 hours of diurnal sign surveys (49 hours in Ke Go NR and 32 hours in Khe Net proposed NR). In addition 12 traps were laid for a total of 42 trap-nights for weasels. A total of 1,171 camera trap nights was conducted from 22 October 2006 to 24 March 2007 and 23 January to 7 July 2010. Eight of the camera traps either failed or were stolen, reducing the survey effort using this method.

In total there were 19 small carnivore records, with six species confirmed for the landscape: Stripe-backed Weasel, Large-toothed Ferret Badger, Yellow-throated Marten, Large Indian Civet, Common Palm Civet and Small-toothed Palm Civet (Table 1). Thirteen other mammal species were recorded during the survey; none is globally threatened (Table 3). Domestic dog *Canis familiaris* and local people were regularly recorded on camera traps and by direct observation, often well within the core zone of the landscape. The live-trapping only produced one mammal record: an unidentified squirrel *Callosciurus* sp. Sign surveys cannot produce species level records for small carnivores unless verified by other means (*e.g.*, DNA analysis of scats); however, they can provide a useful preliminary indication of the conservation status of small carnivores in general, and for directing camera trap placement and spotlighting. There were no sign or track records collected during the surveys, providing further evidence of a small carnivore community with depressed populations.

Table 2. Camera-trap effort for recording small carnivore species in Ke Go – Khe Net Lowlands, October 2006 – March 2007 and January – July 2010.

Site	m asl	Lat Long	Artificial lure and bait	Microhabitat	Date set	Trap days	Small carnivores	Other mammals	Disturbances
KGNR	130	18° 06′ 01″ N 105° 51′ 42″ E	Hawbaker's Weasel lure, dried fish & shrimps, sausage, fish oil, honey	n/a	22Oct06	153	Stripe-backed Weasel *Mustela strigidorsa*	Northern Treeshrew *Tupaia belangeri*	Domestic dog
KGNR	100	18° 06′ 21″ N 105° 56′ 26″ E	Hawbaker's Weasel lure, dried fish & shrimps, one duck egg, sausage	n/a	27Oct06	95	Yellow-throated Martin *Martes flavigula*	Lesser Oriental Chevrotain *Tragulus kanchil*	
KNpNR	120	18° 02′ 29″ N 105° 55′ 36″ E	Hawbaker's Weasel lure, dried fish, fish oil, sausage, honey	n/a	14Nov06	125		Northern Pig-tailed Macaque *Macaca leonina*	Local Person
KNpNR	230	18° 02′ 12″ N 105° 55′ 14″ E	Hawbaker's Weasel lure, dried fish, sausage	n/a	14Nov06	37	Common Palm Civet *Paradoxurus hermaphroditus*	Northern Treeshrew	
KNpNR	170	18° 02′ 49″ N 105° 56′ 02″ E	Hawbaker's Weasel lure, dried fishes, fish oil, sausage, honey	n/a	15Nov06	87		Northern Pig-tailed Macaque, Northern Treeshrew, Red-cheeked Squirrel *Dremomys rufigenis*	Local Person
KNpNR	200	18° 02′ 25″ N 105° 56′ 27″ E	Hawbaker's Weasel lure, dried fish, fish oil, sausage, honey	n/a	15Nov06	125		East Asian Porcupine *Hystrix brachyura*, Northern Treeshrew, Red-cheeked Squirrel, Pallas's Squirrel *Callosciurus erythraeus*	Local Person
KNpNR	150	18° 06′ 02″ N 105° 51′ 56″ E	Hawbaker's Weasel lure, dried fish, fish oil, sausage, honey	n/a	27Jan07	55		Northern Treeshrew	
KNpNR	150	18° 02′ 13″ N 105° 55′ 56″ E	Hawbaker's Weasel lure, dried fish, fish oil, sausage, honey	n/a	25Jan07	55	Ferret badger *Melogale*	Northern Pig-tailed Macaque, Northern Treeshrew	
KGNR	420	18° 08′ 05″ N 105° 53′ 22″ E	Hawbaker's Wildcat No. 2	Set facing a tree that had fallen over naturally and had started to rot	23Mar10	48		Macaque, Red-cheeked Squirrel, Pallas's Squirrel	
KGNR	360	18° 07′ 03¨ N 105° 54′ 49¨ E	Kishel's Weasel lure	One large (>20 m) tree within 7 m. No nearby animal/man-made trails. 5 m uphill from a small rocky gully	27Apr10	13		Macaque	
KGNR	410	18° 07′ 28″ N 105° 55′ 01″ E	Hawbaker's weasel lure	Along the main man-made pathway that ran along a hill ridge line	12May10	55		Northern Pig-tailed Macaque, Black Giant Squirrel *Ratufa bicolor*	Local Person
KGNR	300	18° 07′ 25" N 105° 54′ 53" E	Hawbaker's Wildcat No. 2	Pointed at a series of thick lianas, no shrub layer. Substrate dotted with rocky outcrops. <10 m from a main trail. Within 5m of Small-toothed Palm Civet sightings	27Apr10	70	Ferret badger	Northern Pig-tailed Macaque	
KGNR	300	18° 06' 00″ N 105° 55' 56″ E	Hawbaker's Wildcat No. 2	Rocky outcrop, thick creepers and dense shrub layer. <4 m from an animal trail	5May10	59	Ferret badger		
KGNR	240	18° 06′ 02″ N 105° 55′ 59″ E	Hawbaker''s weasel	Rocky outcrop, fruiting plants (*Syzygium*) nearby, evidence of mammals in the area (Wild Pig faeces). Within 2 m of an animal trail	5May10	60	Common Palm Civet	Asian Brush-tailed Porcupine *Atherurus macrourus*, Stump-tailed Macaque *Macaca arctoides*, Northern Pig-tailed Macaque	
KGNR	260	18° 08′ 35″ N 105° 53′ 35″ E	Kishel's Weasel lure	Set adjacent to a small man-made pathway, <50 m from a stream	9May10	54		Northern Pig-tailed Macaque	
KNpNR	300	18° 03′ 32″ N 105° 57′ 31″ E	Hawbaker's Wildcat No.2	Some large (approx. 20–25 m) *Vatica odorata* trees nearby.	19May10	40	Ferret badger	Northern Pig-tailed Macaque	Domestic Dog
KNpNR	300	18° 03′ 33″ N 105° 57′ 27″ E	Kishel's Weasel lure	Large number of rocky outcrops <1 m from man-made pathway.	19May10	40			
					TOTAL	**1,171**			

Notes: KGNR = Ke Go Nature Reserve, KNpNR = Khe Net proposed Nature Reserve / m asl = All elevations were recorded using a GPS and are therefore approximate microhabitat: microhabitat was not recorded during the 2006–2007 field surveys. All camera traps for the 2006–2007 survey were placed in secondary evergreen forest. All camera traps in the 2010 survey were placed along the hill range that lies between the two sites; habitat was predominantly lowland evergreen forest that undergone significant levels of human-induced disturbances, particularly selective logging. Trap days = the number of effective camera trap days, taken as the total number of 24-hour periods that the camera trap was operational for (*i.e.*, until the last clear photograph). If using multiple lures/baits, these were applied simultaneously at the camera trap station.

Table 3. Large mammal species confirmed to be present during surveys in the Ke Go – Khe Net Lowlands.

Common Name	Scientific Name	C. R. Robson 1990[1]	Le Trong Trai *et al.* 1999[2]	Le Trong Trai *et al.* 2001[3]	This survey
Northern Treeshrew	*Tupaia belangeri*		O	R	CT
Pygmy Loris	*Nycticebus pygmaeus*				O
Northern Pig-tailed Macaque	*Macaca leonina*		O	O	CT
Stump-tailed Macaque	*Macaca arctoides*		O	O	CT
Hatinh Langur	*Trachypithecus hatinhensis*			O	
Gibbon	*Nomascus*		H		
Yellow-throated Marten	*Martes flavigula*	O	O		CT, O
Stripe-backed Weasel	*Mustela strigidorsa*				CT
Yellow-bellied Weasel	*Mustela kathiah*	O			
Ferret badger	*Melogale* sp.		R[4]	O[4]	CT
Large-toothed Ferret Badger	*Melogale personata*				R
Asian Small-clawed Otter	*Aonyx cinereus*	O			
Common Palm Civet	*Paradoxurus hermaphroditus*				CT, O
Small-toothed Palm Civet	*Arctogalidia trivirgata*				O
Large Indian Civet	*Viverra zibetha*				O
Small Asian Mongoose	*Herpestes javanicus*		O	O	
Crab-eating Mongoose	*Herpestes urva*		O	O	
Leopard Cat	*Prionailurus bengalensis*		O		
Chevrotain	*Tragulus* sp.				CT
Sambar	*Cervus unicolor*		T	R	
Large-antlered Muntjac	*Muntiacus vuquangensis*		R	R	
Red Muntjac	*Muntiacus muntjak*		T	R	
Wild Pig	*Sus scrofa*		T	R	T
Black Giant Squirrel	*Ratufa bicolor*		O	O	CT, O
Cambodian Striped Squirrel	*Tamiops rodolphii*		O	O	O
Pallas's Squirrel	*Callosciurus erythraeus*		O	O	CT, O
Red-cheeked Squirrel	*Dremomys rufigenis*		O	O	CT
Hoary Bamboo Rat	*Rhizomys pruinosus*		O	O	
East Asian Porcupine	*Hystrix brachyura*		R	R	CT
Asian Brush-tailed Porcupine	*Atherurus macrourus*		O	R	CT

Notes: O = Directly observed, CT = Camera trapped, R = Remains (equivalent to 'S' or 'specimen' as used in Le Trong Trai *et al.* 1999, 2001), T = Tracks or signs, H = Heard.

[1]Craig Robson, pers. comm. Observations during birding trips to Ke Go Nature Reserve in February 1990. Taken from Roberton (2007).

[2]Le Trong Trai *et al.* (1999) listed an observation of Swinhoe's Striped Squirrel *Tamiops swinhoei*. This record has been omitted from this table as it is in error; the species only occurs in the northern highlands of Vietnam.

[3]Le Trong Trai *et al.* (2001) listed a track record for Eurasian Otter *Lutra lutra*. This record has been omitted from this table. The landscape could support as many as four otter species; tracks/prints are not a reliable way to record an otter species.

Sources:

[4]A specimen and an observation of *Melogale personata* was recorded in Le Trong Trai *et al.* (1999) and Le Trong Trai *et al.* (2001), respectively. The species identity is impossible to confirm in the field without assessing the dentition, and as there were no notes supporting these identifications, both records are re-labelled here as unidentified *Melogale*.

Species accounts

Stripe-backed Weasel Mustela strigidorsa

In Ke Go NR in October 2006 a single animal was camera trapped, possibly during the early morning/late afternoon/night (the photograph was not time-stamped, but the flash was triggered and the photograph's background suggests that light-levels were low) in secondary evergreen forest at approximately 130 m asl (18° 06′ 01′′ N, 105° 51′ 42′′ E; Figure 1). The camera trap was located on a hill side, approximately 150 m from a small stream and 25 m from a human-made pathway. The camera trap site was baited with Hawbaker's weasel lure and beef sausage. There is no evidence in the photograph to suggest that the animal was attracted to these baits and lures.

Figure 1. Cropped camera trap photograph of Stripe-backed Weasel *Mustela strigidorsa*, Ke Go Nature Reserve, 2006 (Photo: SVW).

Yellow-throated Marten Martes flavigula

Yellow-throated Marten was recorded twice within the landscape. At 15h10 on 14 October 2006 at 18° 05´ 29´´ N, 106° 00´ 29´´ E, a duo was observed running across the main access road (largely unpaved though it was gravelled in parts), and a duo was camera trapped at 15h03 on 3 November 2006 at 18° 07´ 38´´ N, 105° 56´ 26´´ E. Both records were at approximately 100 m asl. Baits and lures used at the camera trap station included beef sausage, dried fish, shrimp, one duck egg and Hawbaker's weasel lure. Both records were within secondary evergreen forest and in Ke Go NR. This species has already been confirmed in the landscape through observations in 1990 (C. Robson, pers. comm. in Roberton 2007) and 1996 (Le Trong Trai *et al.* 1999) both in Ke Go NR, and in 2000 in Khe Net proposed NR (Le Trong Trai *et al.* 2001).

Ferret badger Melogale *sp.*

One ferret badger observed in captivity on 9 November 2006 in Kim Lich village, Kim Hoa commune, Tuyen Hoa district, Quang Binh province, had reportedly been snare-trapped near the village; presumably opportunistically as there is no known targeted trade/hunting of either ferret badger species in Vietnam. It was released back into the forest before its

dentition could be checked and the species confirmed. Both Small-toothed Ferret Badger *M. moschata* and Long-toothed Ferret Badger are predicted based on habitat and regional specimen records to be present within the landscape (Roberton 2007), and the syntopy of these two species has been proven much further south in the country (Abramov & Rozhnov 2014). The only known reliable visual ways to distinguish between Small-toothed Ferret Badger and Large-toothed Ferret Badger is by assessing the dentition or, for males, the baculum (*e.g.*, Schank *et al.* 2009, Abramov & Rozhnov 2014).

On 7 March 2010 a dead ferret badger was brought in by a domestic dog to Xuyen A Forest Protection Department [FPD] station, Thuan Hoa commune, Tuyen Hoa district, Quang Binh province. It was unclear whether the dog killed the ferret badger or had found it poisoned, as there was no obvious signs of physical injury. Photographs of the dentition were taken and confirmed the specimen to be Large-toothed Ferret Badger *M. personata* (Figure 2). The ferret badger was promptly gutted, cooked and eaten by an FPD ranger stationed at Xuyen A FPD Station. There were an additional six camera trap ferret badger records over the survey; this was the most common small carnivore taxon in the landscape.

Common Palm Civet Paradoxurus hermaphroditus

A Common Palm Civet seen on 9 November 2006 in captivity in the village of Kim Lu, Kim Hoa commune, Tuyen Hoa district, had been bought from a local hunter.

At 19h45 on 14 November 2006 at 100 m asl, a Common Palm Civet was observed approximately 5 m up an unidentified tree species in heavily disturbed lowland evergreen forest that had been selectively logged in the past. The animal appeared indifferent to the observers and was observed for approximately 5 minutes. Distance from the observers to the animal was not recorded. On 15 November 2006, a Common Palm Civet was seen in the same tree at 21h34. It could not be determined whether this was the same individual seen the previous evening.

A Common Palm Civet was camera trapped on 20 November 2006 in secondary evergreen forest with a high density of bamboo (08° 02´ 12´´N, 105° 55´ 14´´ E, 220 m asl). The camera-trap was located at the foot of a hill approximately 50 m from a small stream and was baited with Hawbaker's weasel lure, dried fish and beef sausage.

On the 12 June 2010 at 21h51 a Common Palm Civet was camera trapped at 235 m ASL. The animal was photographed in lightly disturbed lowland evergreen forest, near the top of Moc Buoi hill, Ke Go NR (18° 06´ 02´´ N, 105° 55´ 59´´ E), an area that was relatively inaccessible. The camera trap was placed within 2 m of a well-used animal trail where wild pig Sus and unidentified mammal faeces had been found. One *Syzygium* tree on this animal trail was in fruit at the time.

Figure 2. Photograph showing the dentition of a dead Large-toothed Ferret Badger *Melogale personata* brought in by a domestic dog to Xuyen A FPD Station, Khe Net Nature Reserve, 2010 (Photo: D. Willcox/SVW).

Large Indian Civet Viverra zibetha

On 25 October 2006 at 21h50 a single animal was observed in mixed plantation (mainly eucalyptus and some native tree species). The animal was observed standing in a small open patch near the edge of Ke Go Reservoir (18°13´ N, 105° 96´ E, 50 m asl), at a distance of less than 30 m by torch light from a boat.

Small-toothed Palm Civet Arctogalidia trivirgata

Three confirmed records, detailed in Willcox *et al.* (2012), were obtained in the 2010 survey, all during spotlighting and all from Ke Go NR.

Threats to small carnivores

The survey team encountered frequent evidence of illegal hunting in the landscape (*e.g.*, Figure 3). Approximately 1,200 ground-level cable-snare traps, drift fence (a minimum of 2 km in total length) for funnelling animals into the cable-snare traps, and 17 illegal logging/hunting camps were recorded in approximately 30 km² during the 2006, 2007 and 2010 surveys.

Humans were one of the most frequently observed and photographed mammal species in the landscape. Camera traps recorded eight people, seven of whom were carrying chainsaws/heavy machetes, and three domestic dogs. Three camera traps were stolen and one was deliberately burnt also indicating human presence. Additionally, there was a total

of 88 encounters with people during the survey in 2010; people encroaching illegally into the landscape were encountered on a regular, often daily, basis.

Figure 3. Snare traps in an illegal camp in Ke Go Nature Reserve, 2010 (Photo: D. Willcox/SVW).

Although legal logging by state companies ceased in 1997, the roads and tracks constructed for transport are now used by illegal loggers. During the survey, it was not uncommon to see large groups (20+) of people transporting sawn timber (*Vatica odorata*, *Madhuca pasquieri* and *Magnolia* sp. were provisionally identified) from Khe Net proposed NR along the main track. The illegal loggers showed no fear of Forest Protection Department [FPD] Rangers, transporting sawn timber from the forest directly past the front of FPD Ranger stations by bicycle or domestic buffalo, or floating it on bamboo-rafts down the Khe Net River. Most of the large (DBH exceeding 40 cm) trees have now disappeared from the landscape and there is no undisturbed forest remaining within it; large trees were nearly absent even on the tops of some of the relatively inaccessible hills. At least 130 Domestic Water Buffaloes *Bubalus bubalis* were recorded during the survey. The majority of these buffaloes were being used to transport illegally harvested timber out of the forest.

Discussion

This survey confirmed the presence of six small carnivore species in the Ke Go – Khe Net Lowlands. This is a poor return considering the relatively high level of small carnivore focused survey effort. The low number of confirmed records indicates a landscape where most small carnivore species are either locally extinct or depressed in population. Even relatively robust small carnivore species, such as Leopard Cat *Prionailurus bengalensis* and Crab-eating Mongoose *Herpestus urvus*, went undetected, despite being confirmed in earlier surveys (Le Trong Trai *et al.* 1999: Appendix 2). These two species are readily

camera trapped (*e.g.*, Than Zaw *et al.* 2008, Chutipong *et al.* 2014) and are unlikely to have been overlooked if at all common at time of camera trapping. There were some records for other mammal species considered to be relatively tolerant of wildlife hunting and other anthropogenic pressures: an unconfirmed record for Wild Pig *Sus scrofa* in 2010, and a camera trap record for a Chevrotain species *Tragulus* sp. in 2007. Red Junglefowl *Gallus gallus* was only recorded twice; a camera trap photograph in 2006 and a direct observation in 2010. The only other ground-dwelling bird species recorded was Red-collared Woodpecker *Picus rabieri*, recorded once on a camera trap in 2006.

Few surveys in the region publish quantified assessments of wildlife hunting or other threats to biodiversity, hindering any comparison between sites, but, the threats recorded in the Ke Go – Khe Net Lowlands are likely to be at levels sufficient to have caused population declines/local extinctions. The core area of this landscape, the hill range that forms a border between Ke Go NR and Khe Net proposed NR, was clearly being targeted by wildlife hunters and illegal loggers. This area had the highest density of snare traps as well as the largest number of illegal camps. Wildlife hunting, particularly with indiscriminate ground-level cable-snare traps, is surely the main cause for these population declines and likely extirpations of a range of animal taxa, including small carnivores.

The Stripe-backed Weasel record is at the southernmost extent of the species' known distribution and at the lower reaches of its known elevation range (Roberton 2007, Abramov *et al.* 2008). The persistence of Stripe-backed Weasel in secondary evergreen forest, in a landscape where most other similar sized or larger terrestrial animal species are either locally extinct or too low in number to be detected using a relatively high survey effort, may suggest that this rarely recorded species is probably not threatened by either habitat degradation or cable-snare traps. Stripe-backed Weasel is likely to be present in a wide range of both protected areas and non-protected forested areas within its range. Most conventional survey methodologies (including camera trapping) are unsuitable for weasels and it, along with several other weasel species in the region, is probably going undetected and is unlikely to be genuinely absent if suitable habitat is present (*e.g.*, Streicher *et al.* 2010, and weasel records traced in Chutipong *et al.* 2014).

Small-toothed Palm Civet is a highly arboreal, nocturnal species of small carnivore; it is very rarely recorded during general faunal/mammal surveys except if using spotlighting. The relatively large number of records from this site, as well those from other similarly faunally depauperate and degraded habitats in Vietnam, suggest that it is relatively tolerant of habitat degradation as well as wildlife hunting (particularly ground-level trapping), and is very unlikely to be currently threatened within its range (see Willcox *et al.* 2012).

The four remaining small carnivore species recorded are all typical of degraded, faunally impoverished habitats, where wildlife hunting has caused the extirpation of most

other terrestrial animal species (*e.g.*, Pei *et al.* 2010, Streicher & Ulibarri 2014). Common Palm Civet, Yellow-throated Marten and ferret badger have all been recorded in a relatively large number of such habitats in Vietnam (Willcox *et al.* 2014: Table SOM3). Of the four, Large Indian Civet is likely to be more vulnerable to cable-snare trapping; it is ground-dwelling, of a relatively large size, and is likely to be a target for the illegal wildlife trade, of which civet meat forms a significant proportion in Vietnam and China (*e.g.*, Bell *et al.* 2004, Roberton 2007). Though Large Indian Civet was only recorded once during this survey in 2006, its presence in a landscape where most similar sized animals were either locally extirpated or at low and therefore undetectable densities, suggests that this species may be relatively tolerant of intensive hunting pressures, compared to some of the target small carnivores not recorded during these surveys, including Binturong and Owston's Civet.

Conclusions

The Ke Go – Khe Net Lowlands first received international attention through the rediscovery of 'Vietnamese Pheasant' (now Edwards' Pheasant) in the 1990s. This led to half of the landscape being decreed a protected area in 1996. Together with Khe Net proposed NR, this landscape was considered one of the largest contiguous blocks of Annamese lowland evergreen forest remaining in Vietnam, and therefore of global importance to biodiversity conservation.

The survey results in this report evince a landscape where a wide range of animal taxa, including small carnivores, are either locally extinct, or have gone through significant population declines. This includes several animal species considered to be global conservation priorities, including Owston's Civet and Edwards' Pheasant. Camera trapping was undertaken in areas where the latter species had been recorded previously (see Eames *et al.* 1994) and although the civet has no certain record, based on habitat type it is likely to have been present. The main cause in these population declines is wildlife hunting, which has been exacerbated by decades of mismanagement by the Vietnamese authorities mandated to conserve this landscape, and a failure by these authorities to patrol and remove cable-snare traps. This situation is far from unique to the Ke Go – Khe Net Lowlands and similar patterns of negligence and hunting-driven declines have been observed in other protected areas in Vietnam, even those that are relatively well funded and otherwise resourced (*e.g.*, Cat Tien NP: Brook *et al.* 2014).

It is highly unlikely that the Ke Go – Khe Net Lowlands retains globally significant populations of any priority species of bird or large mammal. Better management of the landscape, which should include snare-trap removal and the suppression of illegal logging activities, would help some wildlife populations to recover, and establish the landscape as a potential reintroduction site for priority species. However, the priority conservation action for the Annamese Lowlands and their faunal and floral communities, including the

threatened endemic species, must now be to secure sites that have not yet acquired the Ke Go – Khe Net Lowland's faunally impoverished status, and for which there is a possibility of successfully conserving a range of Annamese endemics and lowland species in-situ. Forested areas along the Quang Binh – Quang Tri border are probably the priority sites, particularly Khe Nuoc Trong, where several globally threatened mammal and bird species have been recorded, including some Annamese endemics (CEPF 2011, Viet Nature Conservation Centre unpublished data).

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