

Camera-trap records of small carnivores from eastern Cambodia, 1999–2013

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Abstract

Camera-trapping targeted at large mammals was conducted across nine lowland areas (predominantly under 300 m asl) in eastern Cambodia between 1999 and 2013. At least 10 small carnivore species were recorded including, based on *The IUCN Red List of Threatened Species*, two categorised as Vulnerable (Large-spotted Civet *Viverra zibetha* and Binturong *Arctictis binturong*) and two as Near Threatened (Large Indian Civet *V. zibetha* and Hog Badger *Arctonyx collaris*). Over 75% of small carnivore camera-trap encounters were of Large Indian Civet or Common Palm Civet *Paradoxurus hermaphroditus*, indicating that these species remain widespread and common in eastern Cambodia's lowland forests. Possible declines of Hog Badger, Large-spotted Civet and Small Indian Civet *Viverricula indica* are noted but further research is merited. This is particularly important for Large-spotted Civet, given the likely high significance of this region to its global conservation status.

Keywords: *Arctonyx collaris*, Hog Badger, lowland forest, Large Indian Civet, Large-spotted Civet, Mondulkiri, Phnom Prich, *Viverra megaspila*, *Viverra zibetha*

ការវាយតម្លៃប្រព័ន្ធគ្រប់គ្រងប្រភេទមំសាសត្វថ្នាក់ទាបនៅក្នុងតំបន់

ភាគខាងកើតប្រទេសកម្ពុជា ពីឆ្នាំ១៩៩៩ ដល់ ឆ្នាំ២០១៣

ការដាក់កាមេរ៉ាថតរូបស្វ័យប្រវត្តិដែលសំដៅទៅលើពួកចំណីសត្វដែលមានមាតិកាខ្ពស់ដែលបានធ្វើឡើងក្នុងរវាងឆ្នាំ ១៩៩៩-២០១៣ នៅទូទាំង ៩តំបន់ទំនាបកណ្តាល (ភាគច្រើនមានរយៈកំពស់ក្រោម ៣០០ម ខ្ពស់ជាង នីវ៉ូទឹកសមុទ្រ) ស្ថិតនៅភាគខាងកើតប្រទេសកម្ពុជា។ យ៉ាងណាចំណាស់មានប្រភេទមំសាសត្វថ្នាក់ទាបចំនួន ១០ប្រភេទត្រូវបានកត់ត្រាជាប្រភេទដែលទទួលបានគ្រោះថ្នាក់នៅក្នុងបញ្ជីក្រហមរបស់អង្គការសហភាពអភិរក្ស ពិភពលោក The IUCN Red List ដែលមានដូចជា ប្រភេទងាយទទួលបានគ្រោះថ្នាក់ពីប្រភេទគីសត្វសំពោច *Viverra megaspila* និងសត្វឈ្មួសប្រុងប្រសំពោច *Arctictis binturong*, ប្រភេទសត្វជិតទទួលបានគ្រោះថ្នាក់ ពីប្រភេទគីសត្វខ្លី *Viverra zibetha* និងសត្វជ្រូកពោន *Arctonyx collaris* ។ ភាគច្រើននៃប្រភេទមំសាសត្វ ថ្នាក់ទាបដែលកាមេរ៉ាស្វ័យប្រវត្តិថតបាន (ច្រើនជាង ៧៥%) គឺប្រភេទសត្វខ្លី និងសត្វសំពោចក្រអូប *Paradoxurus hermaphroditus* ដែលបង្ហាញថាសត្វប្រភេទនេះនៅមានពាសពេញ និងជាសមញ្ញនៅក្នុងតំបន់ ទំនាបកណ្តាលភាគខាងកើតប្រទេសកម្ពុជា។ ការចម្លងដែលអាចកើតមានចំពោះសត្វ ៣ប្រភេទ (សត្វជ្រូកពោន, សំពោច និងសត្វសំពោចវល្លី រឺសំពោចតូច *Viverricula indica* គឺត្រូវបានកត់សំគាល់ ប៉ុន្តែទាមទារអោយមាន ការសិក្សាស្រាវជ្រាវបន្ថែមទៀត។ វាមានសារៈសំខាន់ជាពិសេសសម្រាប់សត្វសំពោចដែលបានបង្ហាញពី សារៈសំខាន់ខ្ពស់នៅតំបន់នេះដើម្បីការអភិរក្សសត្វប្រភេទនេះជាសកល។

Introduction

The forests of eastern Cambodia are globally significant for biodiversity conservation in particular for their large extent of lowlands not yet widely converted to agriculture and other anthropogenic habitats, together with populations of globally threatened large mammals and waterbirds (Tordoff *et al.* 2005, Phan *et al.* 2010, Gray *et al.* 2012a, O’Kelly *et al.* 2012, Wright *et al.* 2012). Since 1999 WWF Cambodia has partnered with the Royal Government of Cambodia to undertake biodiversity surveys and monitoring, including extensive camera-trapping, in various areas, within and outside the protected area network, across the eastern Cambodian provinces of Kratie, Mondulkiri, Rattanakiri and Stung Treng (Phan *et al.* 2010, Gray *et al.* 2012b). Since 2008 this has focused on the cores of two protected area (Phnom Prich Wildlife Sanctuary [Phnom Prich

WS] and Mondulkiri Protected Forest [Mondulkiri PF]) in the Eastern Plains Landscape, Mondulkiri province (Phan *et al.* 2010, Gray & Prum 2012). These two survey areas, mostly below 300 m asl, hold mostly deciduous dipterocarp forest (Pin *et al.* 2013). A little mixed deciduous and highly deciduous semi-evergreen forest (*sensu* Rundel 1999) occurs in Mondulkiri PF. Phnom Prich WS has much naturally patchy semi-evergreen forest. Cambodia was historically poorly collected and surveyed for small carnivores, as for many other mammals of this size-class (Walston 2001), with various species and even genera being found for the first time only recently (e.g. Schank *et al.* 2009). This paper documents the small carnivores (i.e. Herpestidae, Mustelidae [excepting otters (Lutrinae)], Prionodontidae and Viverridae) camera-trapped in order to assist with understanding their global conservation status.

Methods

The camera-trapping here described covered two phases:

June 1999 to November 2007

Nine broadly distributed survey areas in eastern Cambodia, both east (seven areas) and west (two areas) of the Mekong river, were camera-trapped (Fig. 1; reproduced from Gray *et al.* [2012b]). Objectives were largely to document the presence (or non-recording) of globally threatened large mammals (particularly Asian Elephant *Elephas maximus*, Eld's Deer *Cervus eldi*, Hog Deer *Axis porcinus*, wild cattle *Bos* and large carnivores) with cameras placed at locations expected to maximise encounters with these species, and also to minimise the risk of camera theft. CamTrakker (CamTrak South, Inc., Watkinsville, GA 30677 USA) passive infra-red sensor camera-traps were used. Gray *et al.* (2012b) gave more details of methodology, including of data-extraction from this disparate, poorly managed dataset. Unfortunately, effort (e.g. the number of camera-trap nights in each survey area) is no longer available for these surveys.

December 2008 to February 2013

Parts of central and western Mondulkiri PF and eastern Phnom Prich WS were extensively camera-trapped using commercially

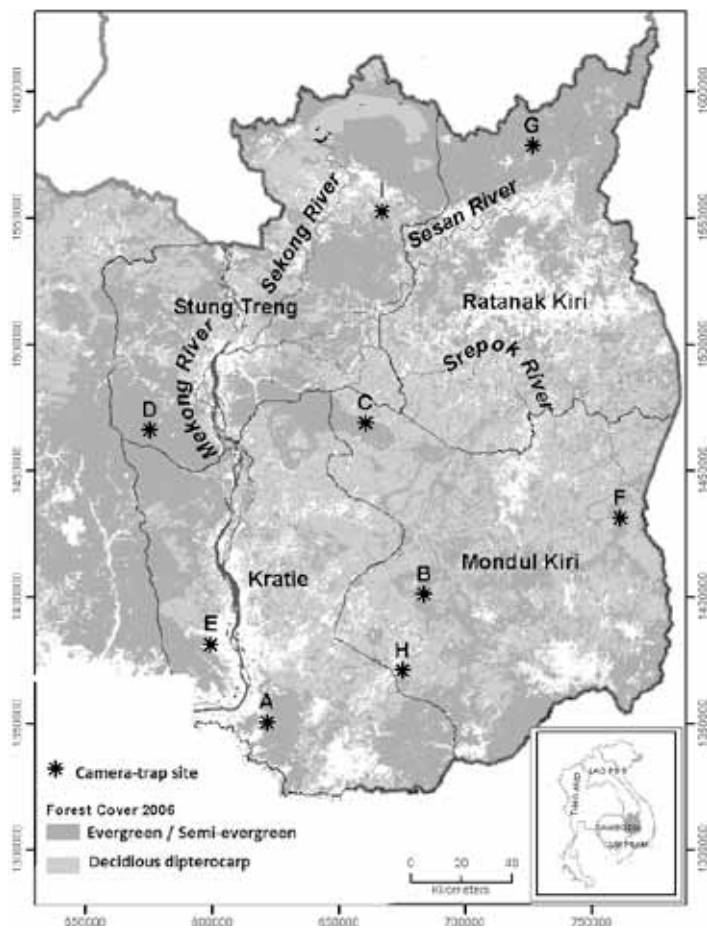


Fig. 1. Approximate locations of survey areas camera-trapped by WWF in eastern Cambodia, 1999–2007. A, Chhlong; B, Phnom Prich Wildlife Sanctuary; C, Prey Khieu; D, Prey Long; E, Prek Prasab; F, Mondulkiri Protected Forest; G, Virachey National Park; H, west Seima/Snoul; I, Western Siem Pang. Reproduced from Gray *et al.* (2012b).

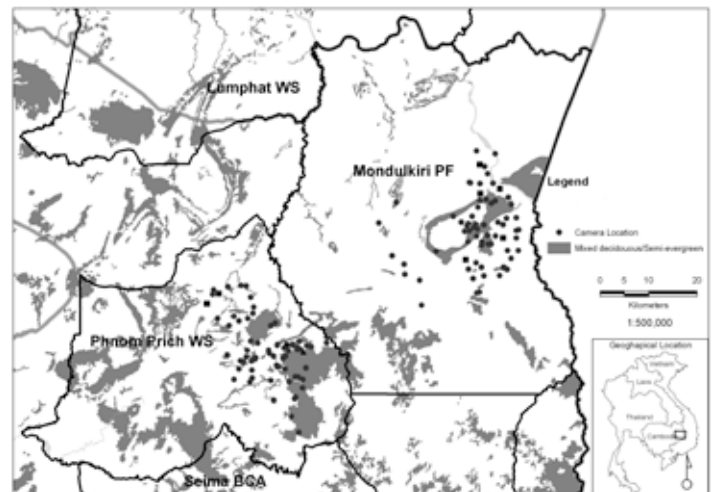


Fig. 2. Approximate location of camera-trap stations in Phnom Prich Wildlife Sanctuary and Mondulkiri Protected Forest between 2008 and 2013. Extent of mixed deciduous/semi-evergreen forest indicated; all white areas within protected areas represent deciduous dipterocarp forest. Reproduced from Gray *et al.* (2014).

available infra-red, digital camera units with passive infrared motion detection (Reconyx RapidFire Professional PC90, Holmen, WI, USA; Cuddeback Ambush IR, Green Bay, WI, USA) in which all photographs are digitally stamped with date and time. Fig. 2 (reproduced from Gray *et al.* 2014) shows the approximate locations of these camera-trap stations. Camera-traps were placed in locations (e.g. alongside roads and footpaths, dry stream beds and at seasonal waterholes) chosen to maximise chances of encountering large ground-living mammals, primarily large carnivores (Mainland Clouded Leopard *Neofelis nebulosa*, Leopard *Panthera pardus* and Tiger *P. tigris*) and wild cattle (Banteng *Bos javanicus* and Gaur *B. gaurus*). No camera-traps were baited. All were continuously operational, placed on trees at 20–150 cm (mean 50 cm) above the ground. All notionally independent encounters with small carnivores, defined when successive photographs of the same species at the same station were separated by at least 30 minutes, were extracted from the camera-trap data and recorded. All species identifications from the photographs were made by Pin Chanratana, with support from TNEG.

Results and discussion

In both study phases (1999–2007 and 2008–2013) at least 10 small carnivore species were camera-trapped (Tables 1 & 2) including two species listed as globally Vulnerable on *The IUCN Red List of Threatened Species* (IUCN 2014), Binturong *Arctictis binturong* and Large-spotted Civet *Viverra megaspila*, and two listed as globally Near-Threatened, Hog Badger *Arctonyx collaris* and Large Indian Civet *V. zibetha* (Table 3). Ferret badgers *Melogale* were recorded but could not be reliably identified to species, following the cautions of Schank *et al.* (2009). The only documented specimens from Cambodia, including one from Mondulkiri, are of Large-toothed Ferret Badger *M. personata* (Schank *et al.* 2009), which is categorised on the *IUCN Red List* as Data Deficient.

Gray *et al.* (2010), based largely on part of the dataset analysed here, concluded that the Eastern Plains Landscape

Table 1. Number of camera-trap encounters for all small carnivores from eastern Cambodia between 1999 and 2007.

Species	A	B	C	D	E	F	G	H	I	Total
Yellow-throated Marten		3(3)	2(2)	1(1)		1(1)				7
Hog Badger		4(3)	1(1)	6(4)		1(1)	4(3)			16
Ferret badger		3(2)		1(1)						4
Large Indian Civet	5(3)	40(19)	6(4)	12(6)			10(9)			73
Large-spotted Civet		16(8)	8(4)	4(3)		6(5)	1(1)		3(1)	35
Small Indian Civet		20(12)	3(2)	3(2)	10(3)	1(1)	4(3)	5(3)	1(1)	47
Common Palm Civet	24(9)	33(21)	10(3)	13(6)	3(2)	2(2)	40(21)	1(1)		126
Binturong	1(1)	1(1)		1(1)						3
Small Asian Mongoose	2(1)			1(1)					1(1)	4
Crab-eating Mongoose				1(1)						1

Columns 'A' – 'I' indicate the number of notionally independent (see text) encounters (and number of camera-trap stations with records) from nine survey areas: A, Chhlong; B, Phnom Prich Wildlife Sanctuary; C, Prey Khieu; D, Prey Long; E, Prek Prasab; F, Mondulkiri Protected Forest; G, Virachey National Park; H, west Seima/Snoul; I, Western Siem Pang. More details of each area are given in Gray *et al.* (2012b). Scientific names are given in Table 3.

Table 2. Number of notionally independent (see text) camera-trap encounters of small carnivores from Phnom Prich Wildlife Sanctuary (PPWS) and Mondulkiri Protected Forest (MPF) (and number of camera-trap stations with records) between 2008 and 2013.

	2013	2012	2011	2009/2010
Protected areas	PPWS	PPWS	PPWS	PPWS & MPF
Number of camera-trap stations	83	65	19	~ 170
Number of camera-trap-nights	5,283	5,301	1,926	~ 12,570
Dates of survey	Dec 2012 – Feb 2013	Dec 2011 – Jun 2012	Aug 2010 – Sep 2011	Dec 2008 – Feb 2010
Targets for camera-trapping	Clouded Leopard	Leopard	Wild cattle & Elephant	Leopard & Tiger
Broad habitat type	SEF	SEF/DDF	SEF/DDF	DDF
Yellow-throated Marten	15 (13)	7 (7)	3 (3)	6 (4)
Hog Badger	0	1 (1)	1 (1)	9 (5)
Ferret badger	7 (3)	0	2 (2)	0
Large Indian Civet	46 (25)	41 (22)	24 (7)	103 (35)
Large-spotted Civet	0	4 (3)	0	25 (13)
Small Indian Civet	1 (1)	20 (12)	1 (1)	2 (2)
Common Palm Civet	184 (53)	102 (36)	86 (11)	72 (37)
Binturong	2 (2)	0	0	0
Small Asian Mongoose	0	0	1 (1)	6 (5)
Crab-eating Mongoose	8 (5)	5 (2)	5 (3)	3 (2)

SEF = Semi-evergreen Forest, DDF = Deciduous Dipterocarp Forest. Scientific names are given in Table 3.

is of high global significance for Large-spotted Civet, but camera-trapping has generated just four records of the species since 2010. This is quite likely to reflect the recent proportionally more camera-trapping in mixed deciduous and semi-evergreen forest in Phnom Prich WS, than in deciduous dipterocarp forest in Mondulkiri PF (Table 2), based on the conclusion of Gray *et al.* (2010) that the species is a deciduous dipterocarp specialist in eastern Cambodia. (Records come from other habitats elsewhere in Indochina, including semi-evergreen forest far from any deciduous dipterocarp forest; e.g. Austin [1999].)

A combination of methods (e.g. camera-trapping combined with nocturnal spotlighting) may assist comprehensive documentation of small carnivore communities in Indochina (see, e.g., Wilcox *et al.* 2012). However it is likely that, particularly in the more intensively camera-trapped Mondulkiri PF and Phnom Prich WS, most of the widespread and readily camera-trapped small carnivores have now been found. The globally Vulnerable Owston's Civet *Chrotogale owstoni*, togeth-

er with Masked Palm Civet *Paguma larvata*, Yellow-bellied Weasel *Mustela kathiah* and Spotted Linsang *Prionodon pardicolor*, might be found to occur in the more hilly and evergreen dominated areas of eastern Cambodia given their presence in adjacent areas of Vietnam (Dang & Le 2010) or the Cardamom mountains of southwest Cambodia and parts of Thailand (Holden & Neang 2009, Redford *et al.* 2011, Phan *et al.* 2014). Small-toothed Palm Civet *Arctogalidia trivirgata* is highly likely to occur in the landscape's evergreen forests but is rarely camera-trapped (Willcox *et al.* 2012); there are recent records from spotlighting in Mondulkiri (Walston & Duckworth 2003) and riverine forest bordering deciduous dipterocarp forest in Western Siem Pang district, Stung Treng province (D. H. A. Wilcox *in litt.* 2014).

All 2008–2013 camera-trap stations lay below 300 m asl. The precise altitudinal distribution of camera-trap stations during the 1999–2007 surveys is unknown, but most, possibly excepting some in Virachey National Park, would also have been in forest below 300 m asl. Two small carnivore species

Table 3. Percentage of all small carnivore camera-trap encounters in each camera-trapping phase (1999–2007 and 2008–2013) in Phnom Prich Wildlife Sanctuary and Mondulhiri Protected Forest represented by each species.

Species	IUCN	% of encounters, 1999–2007	% of encounters, 2008–2013
Yellow-throated Marten <i>Martes flavigula</i>	LC	3	4
Hog Badger <i>Arctonyx collaris</i>	NT	4	1
Ferret badger <i>Melogale</i>	LC/DD	2	1
Large Indian Civet <i>Viverra zibetha</i>	NT	31	27
Large-spotted Civet <i>Viverra megaspila</i>	VU	17	4
Small Indian Civet <i>Viverricula indica</i>	LC	16	3
Common Palm Civet <i>Paradoxurus hermaphroditus</i>	LC	27	56
Binturong <i>Arctictis binturong</i>	VU	1	<1
Small Asian Mongoose <i>Herpestes javanicus</i>	LC	0	1
Crab-eating Mongoose <i>Herpestes urva</i>	LC	0	2

'IUCN' column gives global category on *The IUCN Red List of Threatened Species* (IUCN 2014): DD = Data Deficient, LC = Least Concern, NT = Near Threatened, VU = Vulnerable.

recorded, Hog Badger and Crab-eating Mongoose *Herpestes urva*, were speculated, based on a fair number of records, to be largely or entirely restricted to hill forest in Lao PDR (Duckworth *et al.* 1999). Helgen *et al.* (2008: 369) characterised Hog Badger by “typical absence from lower-elevation habitats and preferred occurrence in little-disturbed hill and lower montane forests above about 500–600 m”. Our records of at least 23 Hog Badgers from below 300 m (i.e. all records excluding those from Virachey National Park) suggest that the high proportion of Hog Badger records from hill forest elsewhere in Indochina might be an artificial pattern, perhaps induced by easier hunting in lowland areas. Similarly the 22 records of Crab-eating Mongoose indicate that, at least in eastern Cambodia, the species is unlikely to be strongly associated with hills.

By far the most frequently encountered small carnivores (representing 78% of all small carnivore encounters) were Common Palm Civet *Paradoxurus hermaphroditus* and Large Indian Civet. This suggests that both remain common and widespread throughout the lowland forests of eastern Cambodia. Large Indian Civet is categorised as globally Near Threatened as a result of “circumstantial evidence of trapping-driven declines in heavily hunted and fragmented areas” (IUCN 2014) exacerbated, presumably, by the lack of substantial populations (in contrast to a number of other mammals highly threatened in Indochina such as Sambar *Rusa unicolor*, Jungle Cat *Felis chaus* and Gaur *Bos gaurus*) in the Indian subcontinent away from the north-east. However, recent Large Indian Civet records from further west in the Terai Arc (Bista *et al.* 2012, Ghimirey & Acharya 2014), together with the species's continued abundance in Cambodia and Myanmar (Than Zaw *et al.* 2008), suggest that this listing should be reconsidered.

Encounter rates of small carnivores varied considerably between species. This is likely to result from variation in camera-trap placement, microhabitat use and locomotion preferences, as well as species' actual abundance. As such it is difficult, potentially misleading, to extrapolate additional conclusions from this dataset. The lack of data on sampling effort during 1999–2007 precludes comparing encounter rates between those periods. Nevertheless, comparing the percentage representation of each species within the total series of small carnivore records, between the two camera-trapping phases in Phnom Prich WS and Mondulhiri PF (the only two areas sur-

veyed during both phases) exposes some interesting potential trends (Table 3). The proportional representation of Hog Badger, Large-spotted Civet and Small Indian Civet *Viverricula indica* declined between 1999–2007 and 2008–2013. Most parsimoniously, these trends might represent stochasticity. A decline in proportional representation of some species could also reflect population increases in other species rather than any change in the former species' status. However, Hog Badger is a known target for use in traditional medicine in eastern Cambodia (TNEG pers. obs., based on discussions with local villagers on observing the species in the field) and some recent camera-trapping elsewhere in Cambodia (Edwards 2012) has also reported low/zero encounters with Small Indian Civet. The proportionate decline in Large-spotted Civet records between the camera-trap phases offers a particular potential conservation concern. However it is unclear whether this reflects a genuine decline in animals or simply a proportional shift of camera-trapping effort away from deciduous dipterocarp dominated areas to semi-evergreen forests.

Jungle Cat and Large-spotted Civet, both largely deciduous dipterocarp specialists in at least parts of Indochina, declined and disappeared from most of their South-east Asian ranges without anybody documenting the main contraction phase (Duckworth *et al.* 2005, Gray *et al.* 2010). Therefore, more regular collation of camera-trap and other records for these, and other, small carnivores is merited. This is particularly important given the intensive and ongoing threats to the conservation integrity of the landscape from both large-scale habitat conversion and hunting. Levels of snaring in both Phnom Prich WS and Mondulhiri PF appear to be increasing in parallel with other illegal activities, particularly targeted logging for luxury timber along the Cambodia–Vietnam border which seems, invariably, associated with significant additional resource extraction.

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