The Vulnerable fishing cat *Prionailurus viverrinus* and other globally threatened species in Cambodia's coastal mangroves

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Abstract The Vulnerable fishing cat *Prionailurus viverrinus* faces a perilous future in South-east Asia. It was last sighted in Cambodia in 2003. We deployed 16 camera traps at four sites in southern Cambodia during January–May 2015 to determine if the fishing cat was still present in the country. Eight photograph/video captures of fishing cats were recorded from the mangroves in Peam Krasop Wildlife Sanctuary and one from Ream National Park, but there were no records from Botum Sakor National Park or Prey Nup. A number of other globally threatened species were also photographed in Peam Krasop Wildlife Sanctuary: the Sunda pangolin *Manis javanica*, the hog deer *Axis porcinus* and the large-spotted civet *Viverra megaspila*. We learnt of the killing of an alleged fishing cat at the Sanctuary in July 2015 in retaliation for raiding fishing nets. Illegal hunting and capture of fishing cats for the wildlife trade were reported by local informants at all sites. We provide photographic and video evidence of the fishing cats and highlight the importance of Cambodia's mangroves for threatened species conservation.

Keywords Cambodia, economic land concession, fishing cat, mangroves, *Prionailurus viverrinus*, South-east Asia

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The Vulnerable fishing cat *Prionailurus viverrinus* may be approaching extinction in South-east Asia (Duckworth, 2016). There are few recent records from across the region (Mukherjee et al., 2016). Although this may be a result of low survey effort, it does suggest that populations in these countries are either very small, plausibly extinct (e.g. Vietnam; Willcox et al., 2014) or entirely absent (e.g. Lao PDR; Mukherjee et al., 2016). A single camera-trap photograph of a fishing cat taken in 2003 in Kulen Promtep Wildlife Sanctuary (Rainey & Kong, 2010) may be Cambodia's only previously confirmed record. Although there have been numerous unconfirmed claims (e.g. Royan, 2009), and captive fishing cats have been held in Phnom Tamao Zoo (Duckworth et al., 2005), their presence in other parts of the country cannot be verified. Cambodia retains large areas of potentially suitable wetland habitats similar to those used by fishing cats in other countries (e.g. Adhya, 2011; Cutter, 2015). These include marshes, swamps, tidal creeks, rice paddies and mangroves. Cambodia's coastal mangrove forests have not been exploited as heavily as in neighbouring countries (Marschke & Nong, 2003), and mangroves are known to provide habitat for fishing cats in India (Mukherjee et al., 2012). With the aim of detecting fishing cats in Cambodia we deployed camera traps at four wetland sites covering a wide area in the south of the country, three within and adjacent to coastal mangroves and one in Botum Sakor National Park.

The four sites were chosen based on preliminary investigations and interviews with local people that indicated they may support fishing cats. All sites are either nationally or privately protected for conservation. Peam Krasop Wildlife Sanctuary (246 km²) is located near the Thai border in Koh Kong Province (Fig. 1) and overlaps the Koh Kapik and Associated Islets Ramsar Site (Marschke & Nong, 2003). It is part of one of the best conserved mangrove forests in the Gulf of Thailand (Marschke & Nong, 2003). The Sanctuary is adjacent to Botum Sakor National Park (1,826 km²), which is located on a peninsula along the south-west coast (Fig. 1), and comprises lowland evergreen and semi-evergreen broad-leaved forest, melaleuca forest, grassland, mangrove and patches of *Oncosperma tigillarium* palm. Botum Sakor National Park was the site of a suspected (Mukherjee et al., 2016) fishing cat record from 2008 (Royan, 2009). Ream National Park (147 km²) has extensive mangroves, with adjacent forests, mudflats and freshwater marshes (IUCN, 2003), and is bordered by Prey Nup to the south. At Prey Nup we surveyed a 10 km² privately protected

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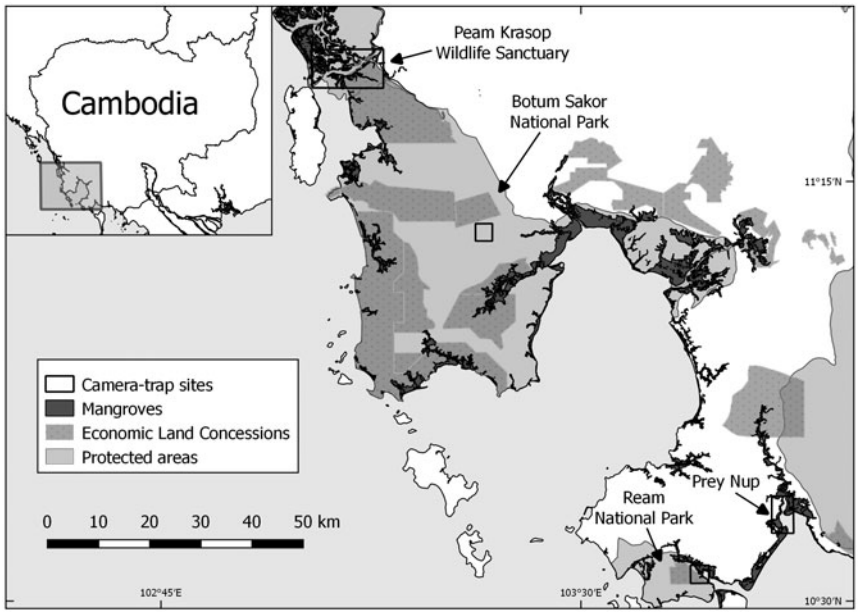

FIG. 1 Camera-trap locations in Peam Krasop Wildlife Sanctuary, Botum Sakor National Park, Ream National Park, and Prey Nup, in southern Cambodia.

TABLE 1 Details of camera-trap stations deployed at Peam Krasop Wildlife Sanctuary, Ream National Park, Prey Nup and Botum Sakor National Park in southern Cambodia (Fig. 1), with the number of trap-nights and a description of the habitat for each station.

Camera-trap station	Number of trap-nights (deployment period)	Habitat description	Notes
Peam Krasop Wildlife Sanctuary			
1	125 (21 Jan.–26 May 2015)	A raised earth platform (c. 3 × 7 m) adjacent to a c. 10 m wide channel on a mangrove island	
2	125 (21 Jan.–26 May 2015)	Mangrove forest inundated by up to 5–10 cm of water at high tide	
3	125 (21 Jan.–26 May 2015)	Path through non-inundated mangrove forest next to a 100 × 50 m water hole	
4	(21 Jan.–10 Apr. 2015)	Mangrove forest next to a narrow channel	Camera malfunctioned
5	125 (21 Jan.–26 May 2015)	Path through dry-land forest habitat adjacent to mangroves	
6	(21 Jan.–26 May 2015)	Path through dry-land forest habitat adjacent to mangroves	Camera stolen
Ream National Park			
7	71 (14 Mar.–24 May 2015)	Small water hole in mangrove forest	
8	71 (14 Mar.–24 May 2015)	Shallow 2 m wide channel in mangrove forest	
9	71 (14 Mar.–24 May 2015)	Elevated path through the mangrove forest	
Prey Nup			
10	71 (13 Mar.–23 May 2015)	Mangrove forest, 50 m away from a main channel	
11	71 (13 Mar.–23 May 2015)	Mangrove forest inundated by up to 0.2 m of water at high tide	
12	(13 Mar.–23 May 2015)	Mangrove forest 10 m away from a main channel	Camera malfunctioned
Botum Sakor National Park			
13	111 (8 Feb.–30 May 2015)	Edge of a 40 × 30 m waterhole in dry-land forest	
14	111 (8 Feb.–30 May 2015)	Edge of a 40 × 30 m waterhole in dry-land forest	

mangrove forest that runs along the Kampong Smatj River, backed by rice paddies.

During January–May 2015 we deployed 16 8-megapixel Trophy Cam HD Hybrid Trail infra-red flash cameras (Bushnell Corporation, Overland Park, Kansas) in mangroves and adjacent freshwater wetlands and waterholes (known locally as *trapeangs*) at the four sites (Table 1). Camera-trap stations were selected following the advice of local people and park rangers. Fresh fish baits were staked in front of each camera trap. When a camera's

TABLE 2 Medium–large bodied species recorded by camera traps in Peam Krasop Wildlife Sanctuary (six sites (two failed), 500 trap-nights), Ream National Park (five sites (one failed), 284 trap-nights), Prey Nup (two sites (one failed), 71 trap-nights) and Botum Sakor National Park (two sites, 222 trap-nights), in southern Cambodia (Fig. 1). Species are grouped according to their status on the IUCN Red List.

Species	Peam Krasop Wildlife Sanctuary	Ream National Park	Prey Nup	Botum Sakor National Park	Total	Capture frequency per 100 trap-nights
Critically Endangered						
Sunda pangolin *Manis javanica*	1				1	0.09
Endangered						
Hog deer *Axis porcinus*	1				1	0.09
Large-spotted civet *Viverra megaspila*	22				22	2.04
Vulnerable						
Fishing cat *Prionailurus viverrinus*	8	1			9	0.84
Lesser adjutant *Leptoptilos javanicus*				3	3	0.28
Sambar *Rusa unicolor*	3			7	10	0.93
Smooth-coated otter *Lutrogale perspicillata*	16				16	1.49
Woolly-necked stork *Ciconia episcopus*		1		1	2	0.19
Least Concern						
Chinese pond-heron *Ardeola bacchus*		5	2	3	10	0.93
Collared kingfisher *Todiramphus chloris*	1				1	0.09
Common palm civet *Paradoxurus hermaphroditus*	10	5	4	17	36	3.34
Common water monitor *Varanus salvator*	10			1	11	1.02
Greater coucal *Centropus sinensis*		2	1		3	0.28
Human *Homo sapiens*	26	7	22	10	55	5.11
Leopard cat *Prionailurus bengalensis*	8	1	3	1	13	1.21
Lesser mousedeer *Tragulus kanchil*				1	1	0.09
Little egret *Egretta garzetta*		16	7		23	2.14
Long-tailed macaque *Macaca fascicularis*	13				13	1.21
Northern red muntjac *Muntiacus vaginalis*				2	2	0.19
Oriental magpie-robin *Copsychus saularis*	18				18	1.67
Red junglefowl *Gallus gallus*				6	6	0.56
Ruddy kingfisher *Halcyon coromanda*		8			8	0.74
Javan mongoose *Herpestes javanicus*		8	1		9	0.84
White-breasted waterhen *Amaurornis phoenicurus*	8				8	0.74
Not Evaluated						
Dog *Canis familiaris*	14		7	2	23	2.14
Species richness	15	10	8	12	25	
No. of captures	159	54	47	54	304	

motion sensor was activated three photographs were taken consecutively, followed by a 60-second video. The minimum gap between photograph/video captures was 1 hour. A capture therefore comprised any number of photographs and videos of the same individual, or individuals, taken within 1 hour of each other. Data on large and medium-sized mammals, birds and reptiles, including date, time and behaviour, were collated from camera-trap photographs and videos. Capture frequency was calculated as the number of captures per 100 trap-nights.

We recovered 13 cameras, deployed for a total of 1,077 trap-nights. Twenty-five species (14 mammals, 10 birds and one reptile), eight of which are categorized as threatened on the IUCN Red List (Table 2; Plate 1), were recorded from the four sites. Humans were the most frequently recorded, followed by the common palm civet *Paradoxurus hermaphroditus* and the little egret *Egretta garzetta* (Table 2). The largest number and greatest abundance of threatened species were recorded from Peam Krasop Wildlife Sanctuary, which also had the highest recorded species richness and total number of photograph captures. However, sites were not directly comparable because of differences in sampling effort, of which Peam Krasop had the highest (Table 1). Most of the people photographed were setting and collecting crab traps, fishing or collecting non-timber forest products, and many of them were accompanied by domestic dogs. Photographs/videos of fishing cats were recorded at station 1 in the Sanctuary on eight separate occasions (Plate 1). In the videos, cats were observed sniffing, licking and marking the ground (Supplementary

PLATE 1 Camera-trap photographs of (a, b) fishing cat *Prionailurus viverrinus*, Peam Krasop Wildlife Sanctuary, (c) fishing cat, Ream National Park, and (d) Sunda pangolin *Manis javanica*, (e) large-spotted civet *Viverra megaspila*, and (f) hog deer *Axis porcinus*, in coastal mangroves of southern Cambodia.

Video S1) and defecating (Supplementary Video S2). One video showed a wet cat, apparently having emerged from the water (Supplementary Video S3). A fishing cat was photographed at station 9 in Ream National Park (Plate 1). There were no records of fishing cats from either Prey Nup or Botum Sakor. Both trap stations that recorded the fishing cats were located in mangrove forests. The station at Peam Krasop was also visited by smooth-coated otters *Lutrogale perspicillata*, common water monitors *Varanus salvator*, long-tailed macaques *Macaca fascicularis*, and people and their domestic dogs (Table 2). The station at Ream National Park was also visited by a leopard cat *Prionailurus bengalensis*, common palm civets, Javan mongooses *Herpestes javanicus* and people.

As has occurred elsewhere (e.g. Mukherjee et al., 2012; Cutter, 2015), hunting and persecution are potential threats to fishing cats in coastal Cambodia. In July 2015 we received a report of an alleged fishing cat having been killed in Peam Krasop Wildlife Sanctuary by a local fisher in retaliation for raiding his nets. Although we could not confirm that the animal killed was a fishing cat, this indicates that mammalian predators are persecuted at this site. Local people at all sites reported that fishing cats, or morphologically similar species, have been persecuted and also captured for the wildlife trade.

Our photographs/videos confirm that fishing cats are still present in Cambodia, at two mangrove sites where they were previously unrecorded. In addition to the discovery of fishing cats we also recorded five other threatened species at Peam Krasop, highlighting the Sanctuary's importance for threatened species conservation. However, the Sanctuary was subjected to a much greater survey effort than the other sites, which were all home to a diversity of species and are thus also worthy of further conservation effort. Despite the threat posed by hunting and persecution our findings are encouraging, as our relatively modest survey effort yielded records of fishing cats and a number of other threatened species. Extensive surveys of Cambodia's mangroves are warranted, as they may be a stronghold for fishing cats and other threatened species.

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Author contributions

All authors contributed to the study design, analysed camera-trap data and wrote the article. TR, VHM and JH undertook field work. TR, VHM and NJS summarized the camera-trap data. TR and NJS managed the programme, NJS obtained the funding.

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