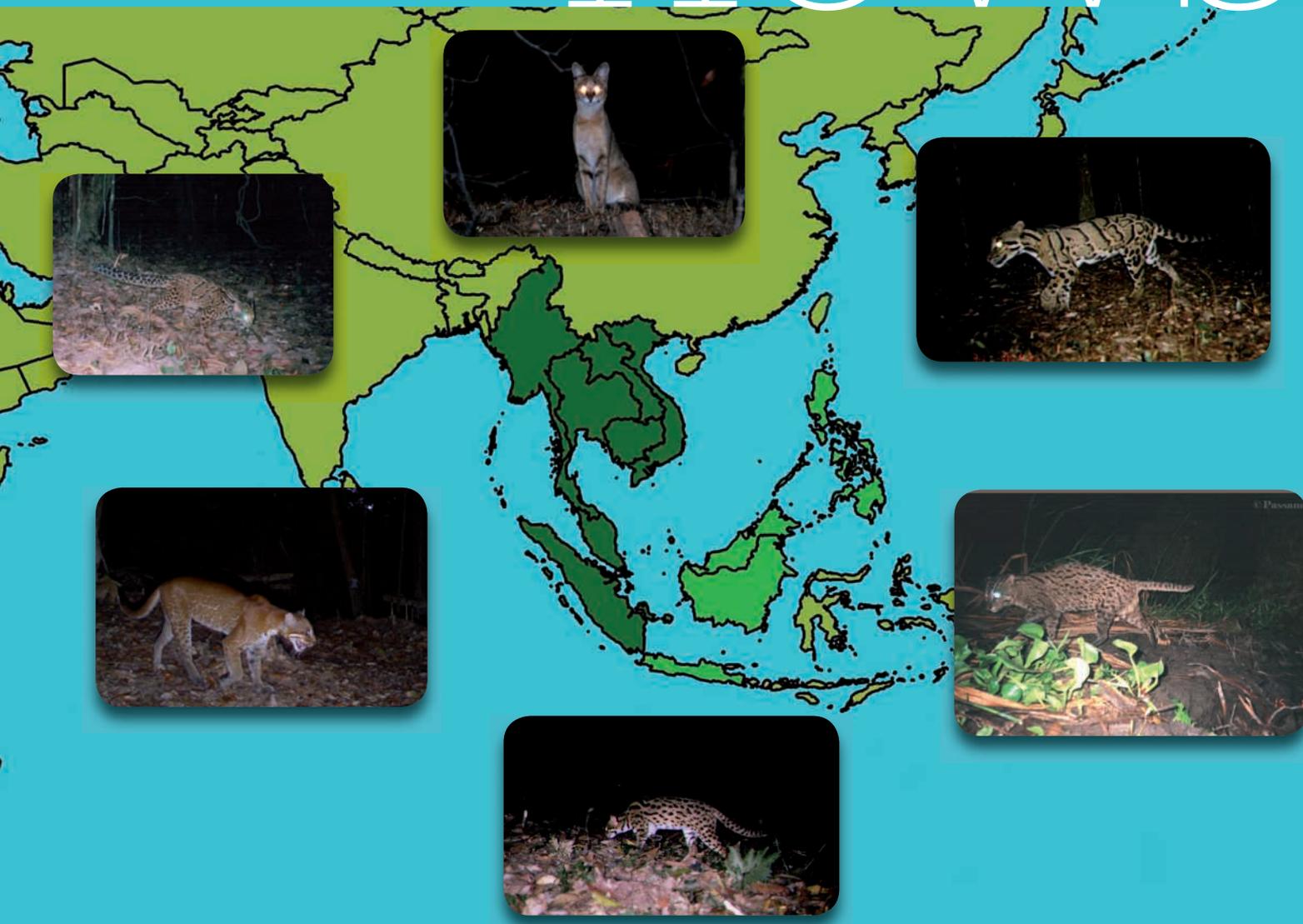


Special ISSUE

N° 8 | SPRING 2014

CAT FLOWERS

Non-*Panthera* cats in South-east Asia





CATnews is the newsletter of the Cat Specialist Group, a component of the Species Survival Commission SSC of the International Union for Conservation of Nature (IUCN). It is published twice a year, and is available to members and the Friends of the Cat Group.

For joining the Friends of the Cat Group please contact Christine Breitenmoser at ch.breitenmoser@kora.ch

Original contributions and short notes about wild cats are welcome **Send contributions and observations to ch.breitenmoser@kora.ch.**

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This **Special Issue of CATnews** has been produced with support from the Taiwan Council of Agriculture's Forestry Bureau, Zoo Leipzig and the Wild Cat Club.

Design: barbara surber, werk'sdesign gmbh
Layout: Christine Breitenmoser, Jonas Bach
Print: Stämpfli Publikationen AG, Bern, Switzerland

ISSN 1027-2992 © IUCN/SSC Cat Specialist Group

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Cover Photo: Non-*Panthera* cats of South-east Asia:
From top centre clock-wise
jungle cat (Photo K. Shekhar)
clouded leopard (WCS Thailand Prg)
fishing cat (P. Cutter)
leopard cat (WCS Malaysia Prg)
Asiatic golden cat (WCS Malaysia Prg)
marbled cat (K. Jenks)

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The status of jungle cat and sympatric small cats in Cambodia's Eastern Plains

South-east Asia is a global hotspot for cat diversity with up to eight species occurring sympatrically. The Eastern Plains Landscape of Cambodia contains the largest extent of deciduous dipterocarp forest remaining in Indochina. Two protected areas within the Eastern Plains Landscape (Mondulkiri Protected Forest and Phnom Prich Wildlife Sanctuary) were camera-trapped extensively (>220 locations; >18,500 camera-trap nights) between 2008 and 2012. Six cat species, leopard *Panthera pardus* (391 encounters), leopard cat *Prionailurus bengalensis* (122 encounters), jungle cat *Felis chaus* (19 encounters), marbled cat *Pardofelis marmorata* (four encounters), mainland clouded leopard *Neofelis nebulosa* (three encounters), and Asiatic golden cat *Catopuma temminckii* (two encounters) were photographed. Leopard cats were encountered equally frequently across forest types (deciduous dipterocarp forest and mixed deciduous/semi-evergreen forest) but jungle cats were photographed more often in deciduous dipterocarp forest. Activity patterns also differed between the two species with jungle cat more diurnal than leopard cat. This represents the first published analysis of jungle cat habitat preferences and activity patterns in South-east Asia and provides further evidence that jungle cat is a deciduous dipterocarp specialist in Indochina. With few areas of extensive undisturbed deciduous dipterocarp forest elsewhere in the species' South-east Asian range, the Eastern Plains jungle cat population is likely to be regionally significant.

Wild cats are amongst the most threatened families of land mammals with 24 of 35 species listed by IUCN as Threatened or Near Threatened. South and South-east Asia is a global hotspot for cat diversity with up to eight species occurring sympatrically in mainland South-east Asia and north-east India (Grassman et al. 2005a, Choudhury 2010). The lowland forests of northern and eastern Cambodia, and adjacent areas of southern Laos and western Vietnam, represent one of the largest and most remote areas of lowland deciduous forest remaining in mainland South-east Asia (Tordoff et al. 2005). Although studies of wild cats involving camera-trapping and radio-telemetry have been undertaken in mixed-deciduous and semi-evergreen forests in Thailand (Grassman et al. 2005a,b, Austin et al. 2007) there is little published information on the status, ecology or conservation of wild cats from the lowland deciduous forests of Indochina which might support a similar diverse assemblage of species.

Jungle cat occurs widely across tropical and sub-tropical Asia from Arabia and North eastern Africa to South-east Asia (Corbett & Hill 1992) with recent possible records from the Malay Peninsula (Sanei & Zakaria 2010). The species is listed by IUCN as Least Concern and, despite apparent declines in some ar-

reas, is generally regarded as the most common and widely distributed wild cat in the Indian subcontinent (Duckworth et al. 2005). However, Duckworth et al. (2005) reviewed the status of jungle cat in Indochina (*sensu* Cambodia, Laos and Vietnam) and documented considerably fewer historical and recent records than most other small-medium size cats in these countries (e.g. leopard cat, Asiatic golden cat, clouded leopard). Recent and historical observations were mostly from remote lowland deciduous dipterocarp forest in northern and eastern Cambodia. Duckworth et al. (2005) suggested that jungle cats were highly threatened in Indochina due to dependence upon heavily hunted, relatively accessible, lowland deciduous dipterocarp forest with no evidence of the species using closed semi-evergreen and evergreen forest which may act as source populations for other cat species. Given the lack of information on the species' ecology, habitat use and behaviour, together with the species' potentially perilous conservation status across Indochina, Duckworth et al. (2005) recommended that all jungle cat records from the region merited publication.

Extensive reconnaissance camera-trapping was undertaken across Cambodia, including the areas covered in this paper, between

1999 and 2007 and records of cats from that period in eastern Cambodia are dealt with in summary by Gray et al. (2012). Subsequently, since 2008, the World Wide Fund for Nature (WWF), in collaboration with the Cambodian government, has undertaken extensive biodiversity monitoring, primarily using camera-trapping and line transects, in two protected areas, Mondulkiri Protected Forest and Phnom Prich Wildlife Sanctuary, in eastern Cambodia. This paper summarises camera-trap records of wild cats from this data-set to provide a preliminary assessment of their status and ecology within these protected areas.

Methods

Study Area

Mondulkiri Protected Forest (MPF; 3,630 km²; approximate location 12°08' N/106°05' E) and Phnom Prich Wildlife Sanctuary (PPWS; 2,200 km²; 12°40' N/107°00' E) form part of the transboundary Eastern Plains Landscape protected area complex (which also includes Seima Protection Forest and Lumphat Wildlife Sanctuary in Cambodia and Yok Don National Park, Vietnam; Fig. 1). The general elevation is under 300 m and both sites are dominated by deciduous dipterocarp forest (approximately 80% in MPF; 70% in PPWS) with smaller areas of mixed deciduous forest (in west and south-east MPF, 9% and throughout PPWS, 23%). Other habitats include, to a lesser extent, semi-evergreen forest in PPWS (9%) and small areas of MPF (1%). There have been few botanical studies published on the composition of the forest types in the study area but Pin et al. (2013) provides data on the species composition and stand structure of deciduous dipterocarp forest in MPF and PPWS.

Camera-trapping

Between December 2008 and December 2012 parts of central and western MPF and eastern PPWS were extensively camera-trapped using commercially available infra-red, digital camera units with passive in-frared motion detection (Reconyx RapidFire Professional PC90; WI, USA) in which all photographs are digitally stamped with date and time. Cameras were placed in locations (e.g. alongside roads and footpaths, dry stream beds and at seasonal waterholes) chosen to maximise chances of encountering large terrestrial mammals, primarily large carnivores (leopard and tiger *Panthera tigris*) and wild cattle (banteng *Bos javanicus* and gaur *Bos gaurus*). A total of 226 camera-trap locations (72 in Mondulkiri Protected Forest; 154 in Phnom

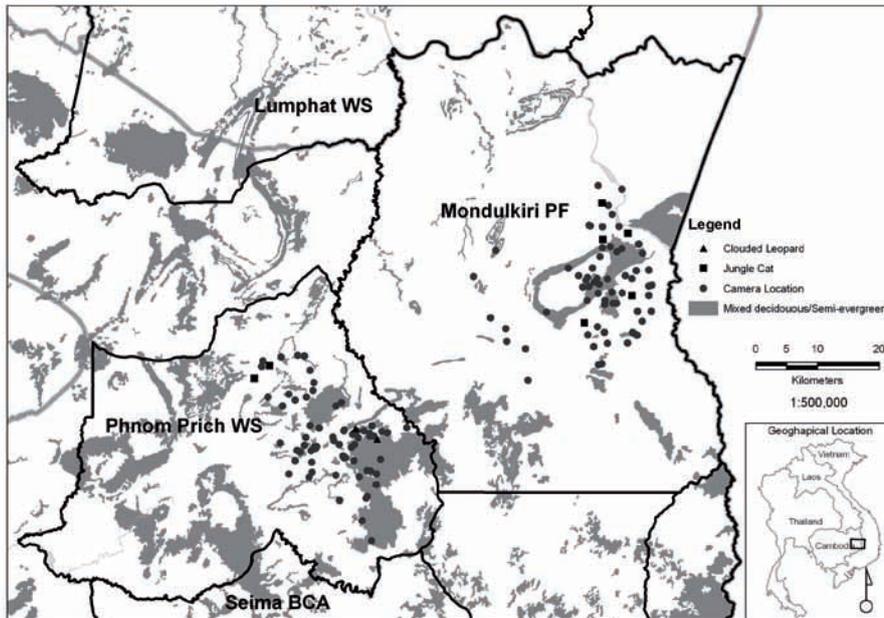


Fig. 1. Location of camera-traps (and all jungle cat and clouded leopard records) within Mondulkiri Protected Forest and Phnom Prich Wildlife Sanctuary, eastern Cambodia. Extent of mixed deciduous/semi-evergreen forest indicated; all white areas within protected areas represents deciduous dipterocarp forest.

Prich Wildlife Sanctuary) were trapped for 18,952 camera-trap nights (Fig. 1).

No cameras were baited and all were continuously operational. All cameras were placed on trees between 20 and 150 cm (mean 50 cm) above the ground. All notionally independent encounters with wild cats, defined when successive photographs of the same species at the same location were separated by more than 30 minutes, were extracted from the camera-trap data and the date, time and camera-trap location were recorded. All species identifications from the photographs

were made by the lead author (TNEG). For any photographs where identification may have been unclear (for example some photographs of leopard cats which could be confused with fishing cats *Prionailurus viverrinus*) confirmation was sought from members of the IUCN SSC Cat Specialist Group.

Camera-traps were classified as located within either deciduous dipterocarp forest, mixed deciduous/semi-evergreen forest, or boundary areas (see below) as defined by remotely-sensed forest cover data-set (JICA 2003). Mixed deciduous and semi-evergreen

forests were combined as the remotely-sensed data-set used did not distinguish these two forest types consistently. Boundary areas, approximating the ecotone between forest types, included all camera-trap locations <2-km from habitat edge as indicated by the remotely sensed habitat classification. The classification of these camera-trap locations as boundary areas, although arbitrary, is necessary due to both potential inaccuracies in JICA habitat classification and to reflect that whilst camera-traps record a point in space, animal movements are more extensive. Therefore it is possible that home-ranges of individuals photographed in boundary areas encompass both deciduous dipterocarp and mixed deciduous/semi-evergreen forest. Based on all jungle cat and leopard cat encounters between 2008 and 2010 the corresponding encounter rates were calculated at each camera-trap location, defined as the number of independent encounters per 100 trap-nights. The mean and 95% confidence intervals of these encounter rates for both species were calculated for camera-traps located in deciduous dipterocarp forest ($n=26$), boundary areas ($n=79$) and mixed deciduous/semi-evergreen forest ($n=36$). Activity patterns for all cat species encountered between 2008 and 2012 were calculated based upon the time imprinted on photographs of each independent encounter. We assume that the time of day of encounters in camera-traps correlates with the species activity levels.

Results

In total, six cat species (leopard, leopard cat, jungle cat Fig. 2, marbled cat Fig. 4, Asiatic golden cat Fig. 3, and clouded leopard Fig. 7) were photographed during this study. Leopards were the most frequently captured cats with a total of 391 independent captures. Of the smaller cats, leopard cats were captured on 124 occasions from 32 locations: 13 in MPF and 44 in PPWS. Jungle cats were photographed on 20 occasions from eight camera-trap locations: six in MPF and two in PPWS (Supporting Online Material SOM T1, Fig. 1). Fifteen (75%) of the jungle cat captures came from three locations: two camera-traps located beside small vehicle roads in PPWS and one camera-trap at a seasonal waterhole (*trapeang*) in MPF (SOM T1). At three camera-trap locations, two in MPF and one in PPWS, both leopard cats and jungle cats were photographed.

Leopard cats were photographed by camera-traps located in dipterocarp forest, mixed de-



Fig. 2. Jungle cat in Mondulkiri Protected Forest, May 2009 in deciduous dipterocarp forest.

ciduous/semi-evergreen forest and boundary areas; capture rates were higher in deciduous dipterocarp forest (Fig. 5). In contrast, jungle cats were never photographed in mixed deciduous/semi-evergreen forest and showed a strong preference for deciduous dipterocarp forest (Fig. 5). The clouded leopard photographs came from mixed deciduous/semi-evergreen forest (2) and boundary areas (1) while marbled cat captures showed a similar pattern with photographs from within mixed deciduous/semi-evergreen forest (3) and boundary areas (1) (SOM T1). The single location in which an Asiatic golden cat was photographed, on two separate occasions, was from tall deciduous dipterocarp forest close to semi-evergreen forest classified as a boundary area, possibly reflecting the species' use of a variety of forest types. Activity patterns of leopard cat and jungle cat differed substantially; with jungle cat captures more often during the day and leopard cat more nocturnal (Fig. 6). Marbled cat (4:49 h; 5:15 h; 7:36 h; 18:54 h), clouded leopard (4:31 h; 20:42 h; 20:52 h), and Asiatic golden cat (5:34 h; 22:22 h) were captured one to three hours before and after dawn and dusk.

Discussion

The lowland deciduous forests of northern and eastern Cambodia are globally important for cat conservation (Tordoff et al. 2005, Rainey & Kong 2010, Gray et al. 2012). In our extensive camera-trapping within the core areas of Mondulkiri Protected Forest (MPF) and Phnom Prich Wildlife Sanctuary (PPWS) leopard was the most frequently encountered cat species (Gray & Prum 2012). In addition we photographed five other species of cat including the globally vulnerable clouded leopard and marbled cat and the near-threatened Asiatic golden cat. The Asiatic golden cat photographs represent the first camera-trap records of this species from Mondulkiri province although there are unconfirmed reports of sightings from both Seima Protection Forest and MPF. The only other eastern Cambodian records are from Virachey National Park where four camera-trap photographs were obtained between 1999 and 2001 (Gray et al. 2012). Despite the intensive camera-trapping, two cat species possibly present in the landscape (tiger and fishing cat) were not photographed.

The presumed extirpation of tiger within the study region has been discussed elsewhere (Gray et al. 2012, O'Kelly et al. 2012). The status of fishing cat in Cambodia is unclear with



Fig. 3. Asiatic golden cat in Mondulkiri Protected Forest, September 2011.

few confirmed records and none east of the Mekong River (Royan 2009, Rainey & Kong 2010). Indeed few records exist from South-east Asia away from coastal areas (Duckworth et al. 2010). However one confirmed camera-trap record of fishing cat from Kulen Promtep Wildlife Sanctuary in Preah Vihear's northern plains is from a deciduous dipterocarp dominated landscape, ecologically very similar to our study region (Rainey & Kong 2010). Regular verbal reports of *Kla Dtray* (literally fish cat or fish tiger) from local villagers and community rangers across Cambodia, including within our study area, seem likely to represent confusion over the Khmer name which, though often translated as 'fishing cat', seems likely to be used by local people

as a generic name for all small cats and even *Viverra civets* (Holden & Neang 2009). The continued lack of evidence of fishing cat presence in eastern Cambodia, despite camera-trapping in and around seasonal waterholes (*trapaeng*) and stream-beds (approximately 3,000 camera-trap nights from *trapaeng* and stream-beds in MPF; <500 camera-trap nights from stream-beds in PPWS) suggests that, if at all present, the species is extremely rare or localised. However the fact that the Asiatic golden cat was only captured on two occasions from a single camera-trap location indicates that species occurring at low densities or with strong habitat specificity might be missed.

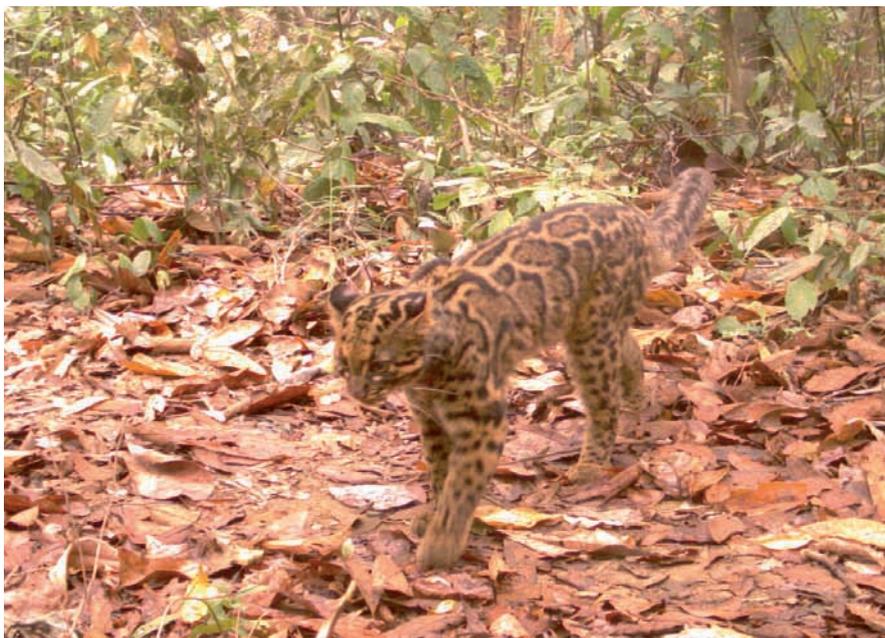


Fig. 4. Marbled cat Phnom Prich Wildlife Sanctuary April 2012.



Fig. 5. Encounter rate (number of independent camera-trap encounters per 100-trap nights; \pm SEM, using per-camera encounter rate as the sample statistic) of jungle cat and leopard cat from camera-traps located in deciduous dipterocarp (DDF), boundary areas (MIX) and mixed deciduous/semi-evergreen (SEG) forest in Mondulkiri Protected Forest and Phnom Prich Wildlife Sanctuary. Note no jungle cat encounters from mixed deciduous/semi-evergreen forest.

Clouded leopards and marbled cats were only photographed in PPWS; semi-evergreen forests are largely absent in MPF, possibly explaining the absence of records of these two species there. Examination of the clouded leopard photographs suggest that those from 2010 and 2011 (approximately 2 km apart) represent the same individual male (J. Kamler, pers. comm. 2013). Both species were previously recorded (clouded leopard three times; marbled cat once) in PPWS during camera-trapping in similar areas between 2002 and 2005 (Gray et al. 2012). Both have also been occasionally recorded during camera-trapping in evergreen forest of the Seima Protection Forest south of PPWS with two photographs of the same clouded leopard individual (2003) and four marbled cat photographs between 2002 and 2006 (WCS *in litt.* 2010). The status of jungle cat in Cambodia outside our study area is unclear, with few, if any, published records since

Duckworth et al. (2005). We do not know of any records from other sites in eastern Cambodia since 2005, when the species was photographed in western Seam Pang and Chhlong (Gray et al. 2012). Although there appear to be no published records from Lumphat Wildlife Sanctuary or Seima Protection Forest, it is likely that jungle cats occur here as the habitat is contiguous with the study area. There have been recent records from deciduous dipterocarp forest in Preah Vihear (anonymous reviewer two, *in litt.*) however these remain unpublished and highlight the need for the region's extensive camera-trap data to be shared and published.

Habitat preferences and activity patterns of leopard cat and jungle cat

Leopard cats were photographed in deciduous dipterocarp forest, mixed deciduous/semi-evergreen forest and boundary areas across both protected areas. They thus ap-

pear relatively widespread across a variety of forest types in the Eastern Plains Landscape. This matches studies published in mainland South-east Asia which suggest the species is a habitat generalist (Grassman et al. 2005b, Azlan & Sharma 2006, Austin et al 2007). In contrast jungle cats were encountered often only in deciduous dipterocarp forest and were never photographed in mixed deciduous/semi-evergreen forest. The camera-trap locations of all jungle cat photographs from boundary areas were also all in deciduous dipterocarp forest. Leopard cats were encountered more frequently in deciduous dipterocarp forest than jungle cats. This may be due to some specificity in jungle cat habitat preferences at a finer scale than the level of broad forest type which we investigated. Indeed 15 of the 20 (75%) jungle cat encounters were from three camera-trap locations (0.01% of all locations) strongly suggesting a patchy distribution or selection of microhabitats not represented in our camera-trap locations. We provide further evidence that the jungle cat is a deciduous dipterocarp and open country specialist in Indochina (Duckworth et al. 2005). With few areas of extensive undisturbed deciduous dipterocarp forest elsewhere in the species' South-east Asian range, the Eastern Plains jungle cat population is likely to be regionally significant. Studies on leopard cat in South-east Asia generally report nocturnal (Johnson et al. 2009, Kitamura et al. 2010) or cathemeral (Grassman et al. 2005b, Cheyne & Macdonald 2011) activity; our data, with the majority of encounters at night, match this trend. There is no published information on jungle cat activity patterns in South-east Asia. Our records indicate cathemeral activity but with the majority of encounters during day-light hours. Activity patterns of small cats are often related to prey availability (Rabinowitz 1990, Rajaratnam et al. 2007). Whether the differences in peak activity times between jungle and leopard cats in this study are an artefact of small sample size or represent partitioning of food resources warrants further study.

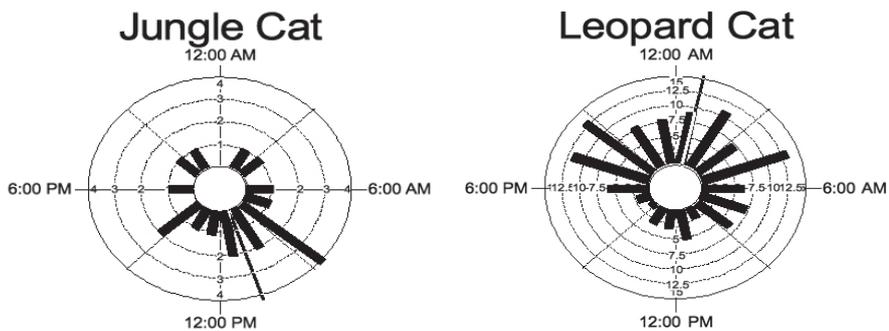


Fig. 6. Frequency histogram, by hour, of camera-trap photographs of jungle cat (A) and leopard cat (B) from camera-trap data in Mondulkiri Protected Forest and Phnom Prich Wildlife Sanctuary.

Acknowledgements

This study was conducted as part of WWF Greater Mekong Cambodia Program's Eastern Plains Landscape project with major funding provided by WWF-US and Humanscale. Work in Mondulkiri Protected Forest is with permission of the Forestry Administration and support from His Excel-



Fig. 7. Clouded leopard in Phnom Prich Wildlife Sanctuary, December 2012.

lency Cheng Kimsun, Men Phymean, Keo Omaliss, Song Keang and Keo Sopheak. Work in Phnom Prich Wildlife Sanctuary is with permission of the Ministry of the Environment and support from His Excellency Chay Samith, Sanrangdy Vicheth and Han Sakhan. Lien Kha, Kheav Oudom, Ing Seangrithy, Lien Nor, Vann Sonny, Men Samorn and Sary Tre assisted with camera-trapping. Tom Evans, Tony Lynam, Hannah O'Kelly, Hugo Rainey, Will Duckworth and Jeremy Holden provided useful information of wild cat status in their study areas. Barney Long, Ed Pollard, Rob Steinmetz, Jan Kamler, Alexander Sliwa, and Pete Cutter provided input into species identification of some cat photographs. Two anonymous reviewers provided valuable comments which improved the quality of the manuscript. Craig Bruce, Nick Cox, Keith Metzner, Seng Teak and Bivash Pandav assisted with project planning, logistics and funding.

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Supporting Online Material SOM Table T1 is available at www.catsg.org/catnews

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