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Non-*Panthera* cats in South-east Asia



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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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Recent distribution records, threats and conservation priorities of small cats in Thailand

Although small cats are presumed important as mesopredators in mammalian food chains, they have been largely ignored by biodiversity assessments of Thailand's protected areas. In November 2009, a workshop involving regional specialists and participants from local universities, conservation organizations and government agencies was convened to assess the current status and distribution of small carnivores. In this paper, we review the small cat by-catch from 24 camera-trap surveys primarily targeting tigers *Panthera tigris* and other large mammals, two radio-telemetry studies, and a small number of direct sightings from 16 protected areas across Thailand. These data were collected between 1996 and 2011 and form the most current available information on distribution and threats for small cats in the country. A total of seven small to medium cat species have been recorded in Thailand. No cat species is restricted to Thailand and while some (leopard cat *Prionailurus bengalensis*, mainland clouded leopard *Neofelis nebulosa*, Asiatic golden cat *Catopuma temminckii* and marbled cat *Pardofelis marmorata*) are evidently widespread across the country where habitat is available, abundance and ranging patterns in the recorded sites are poorly understood. Fishing cat *Prionailurus viverrinus*, jungle cat *Felis chaus* and flat-headed cat *Prionailurus planiceps* are each known from few Thai records and localities, and populations may be particularly threatened due to persecution, and loss and degradation of habitat. Small and medium cats in general may be persecuted but seldom appear in wildlife trade inside Thailand with the exception of the clouded leopard. A thorough review of Thai historical records of small cats, to look for patterns of range contraction and habitat use, is needed, with a focus on those species which have not been widely found today (fishing cat, flat-headed cat and jungle cat).

Thailand is part of the range of many mainland Southeast Asian carnivore species (Corbet & Hill 1992). Most of the country falls in the Indochinese division of the Indochinese sub-region. Sundaic and Indochinese faunas differ distinctly and there is a high latitudinal species turnover. Some Sundaic influences extend north to about 15–16°N, while some Indochinese species occur south through Thailand into Malaysia, with many species having range boundaries in the peninsula (Woodruff & Turner 2009). Over the last 50 years, Thailand has seen major forest conversion which continues today though at significantly reduced rates (FAO 2010). Based on 2007 data, >90% of lowland areas (0–200 m) are dominated by agriculture (mostly rice fields, fruit, rubber and oil palm plantations), settlements and industry. Most of remaining lowland forest habitats (>90%) are smaller than two square kilometres (N. Tantipisanuh, unpubl. data). Lowland rainforest, freshwater swamp forest and primary mangrove forest

have been almost completely lost (Woodruff 1990).

Aside from a few dedicated efforts to elucidate their distribution and abundance (Rabinowitz 1990, 1991, Kanchanasaka 2001a, b), small carnivores (including the smaller cat species) have largely been ignored by recent biodiversity assessments although they are presumed to be important as mesopredators in mammalian food chains due to their dependence on small mammalian prey (Lekagul & McNeely 1988, Sunquist & Sunquist 2002). However, due to increasing conservation interest, intensive surveys using camera-traps have been conducted for tigers across suitable remaining habitats within Thailand and these and other surveys have incidentally produced positively identifiable records of small cats and other carnivores.

A meeting was held in Bangkok on 26–27 November 2009 to collate records of small carnivores (defined there as all species in the Order Carnivora typically under 15 kg) in

Thailand and discuss their conservation and research needs (Chutipong et al. 2010). The review period is between January 1996 and August 2009 inclusive, although reports of exceptional interest from up to May 2011 are also included. All individuals working in government agencies, academic institutions and international NGOs, known to have undertaken extensive camera-trapping in Thailand in this period, were contacted; some were not able to attend or otherwise join in the record collation process. As far as we know, those who did not attend the workshop have conducted surveys in the same areas as those that we have reported here. However, there are significant parts of Thailand, where, from our knowledge, no camera-trap surveys have been conducted e.g. northern and the central plain of Thailand. We considered the current threats for all small carnivores and discussed the possible research and conservation needs for highly threatened species. This compilation covers all Thai cat species except tiger and leopard *Panthera pardus* whose statuses are treated elsewhere (Lynam et al. 2001, Lynam et al. 2006, Ngoprasert et al. 2007, Simcharoen et al. 2007, Simcharoen et al. 2008, Steinmetz et al. 2009, Lynam 2010 and Walston et al. 2010).

Methods

Study areas

Thailand comprises 513,115 km² of land between latitudes 5°37' N and 20°30' N (ca. 1,500 km north–south), ranging in elevation from sea level to 2,565 m. Climate varies between areas from a long, harsh dry season, to those with only a short, dry season, and all intervening stages. Most land areas were forested until the advent of commercial forestry after 1897 (Usher 2009). Terrestrial wildlife habitats can be divided into seasonal evergreen forest, mixed deciduous forest, deciduous dipterocarp forest, scrub, wetlands (of many types) and agricultural land. These main habitat types vary with elevation, although the extent to which mammals do so in Thailand is surprisingly poorly known (Steinmetz et al. 2008). There are no strictly marine species of small carnivore in Thailand, so marine (as distinct from littoral) habitats are not considered here.

Most areas of natural and semi-natural vegetation lie within the boundaries of 426 protected areas (see the map of Thailand's protected areas in the Supporting Online Material), with the coverage skewed towards higher elevations and not evenly spread across its

regions (Tantipisanuh & Gale 2013). These protected areas collectively cover 103,810 km² (ca. 20%) of Thailand. While there are some globally outstanding large protected area complexes, most notably the Western Forest Complex of 17 protected areas totalling 18,000 km² (Prayurasiddhi et al. 1999, Simcharoen et al. 2007), many other protected areas are small (more than 65% are less than 200 km²), feature proportionately larger areas of disturbed habitats around their perimeters, and are isolated from other natural habitats. Nine organisations conducted surveys in 16 of the larger protected areas chosen from the suite of available habitats (Fig. 1). There was no available survey data from the north and the central plain at the time of the workshop.

Camera-trap survey data

Before the workshop, a questionnaire was sent to researchers conducting camera-trap surveys in Thailand, asking for camera-trap records of all carnivores except bears, and basic information about the surveys which generated them. Details of camera trapping surveys, including species present, survey sites, survey period, survey effort (number of camera-trap-nights), number of camera locations, survey coverage (km²), habitat types, and their elevation range at each survey site, were sought (Supporting Online Material SOM Table T1). Survey coverage was estimated by creating minimum convex polygons around the outermost camera locations. For sites with multi-year surveys we calculated and reported survey coverage per year. We obtained elevation at each camera-trap location from the ASTER Global Digital Elevation Model (<http://www.ersdac.or.jp>) with the purported accuracy 7–14 m, with the majority of locations below 1,000 m (the original ASTER GDEM data is the property of METI and NASA).

We did not quantify area-specific survey-effort to a precise single figure due to the large variation between sites in study design as well as in numerous other characteristics. The surveys varied widely in other essential parameters affecting species caught and their capture probability, such as height above ground of the camera-traps, use of baits and lures, microhabitats selected for camera trap placement (such as on/off trails, beside/away from surface water), duration of camera-trapping at each position, model of camera-traps used, and their age/reliability. In part, this reflects the varying objectives of the different surveys and also the personal choice of individual researchers. In nearly all

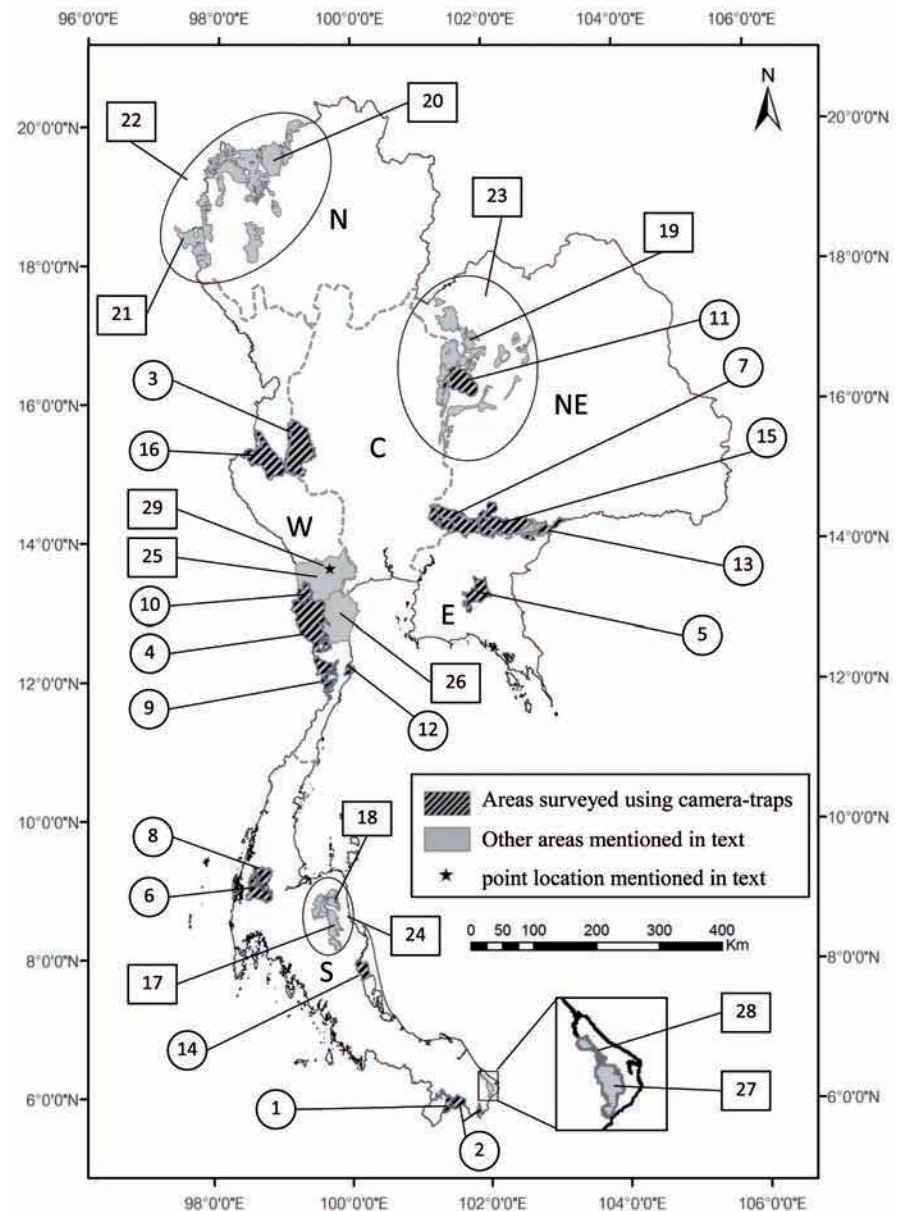


Fig. 1. Location of 16 protected areas in Thailand where the camera-trap data were gathered (circles) and 13 additional areas where cat records are given in the text (squares). (1) Bang Lang National Park NP, (2) Hala-Bala Wildlife Sanctuary WS, (3) Huai Kha Khaeng WS, (4) Kaeng Krachan NP, (5) Khao Ang Rue Nai WS, (6) Khao Sok NP, (7) Khao Yai NP, (8) Khlong Saeng WS, (9) Kuiburi NP, (10) Maenam Pachi WS, (11) Phu Khieo WS, (12) Khao Sam Roi Yod NP, (13) Ta Phraya NP, (14) Thale Noi Non-hunting Area, (15) Thap Lan NP, (16) Thung Yai Naresuan WS – West, (17) Khao Luang NP, (18) Khao Nan NP, (19) Phu Kra-dueng NP, (20) Doi Chiang Dao WS, (21) Salawin WS, (22) Lum Nam Pai-Salawin Forest Complex (hereafter FC), (23) Phu Khieo-Nam Nao FC, (24) Khao Luang FC, (25) Ratchaburi Province, (26) Phetchaburi Province, (27) Pru Toh Daeng swamp forest, (28) Su-ngai Padi District, (29) Khao Prathub Chang Wildlife Breeding Centre. Regions on the map: N=North, NE=Northeast, W=West, C=Central, E=East and S=South.

the study areas, nearly all camera-trap effort was in evergreen rather than deciduous forest, and in forests rather than scrub or grasslands. However, there were two surveys targeting fishing cat *Prionailurus viverrinus* in wetland habitats. Average camera trap spacing was $1.37 \pm \text{SE } 0.24$ km (range 0.5–2.8 km).

Because of the large variation between survey areas in camera-trap survey effort and methods, no between-survey area analyses were conducted: each of the many differences that would be found might reflect differences in survey methods rather than anything biologically meaningful. The results are therefore presented on a species-by-species

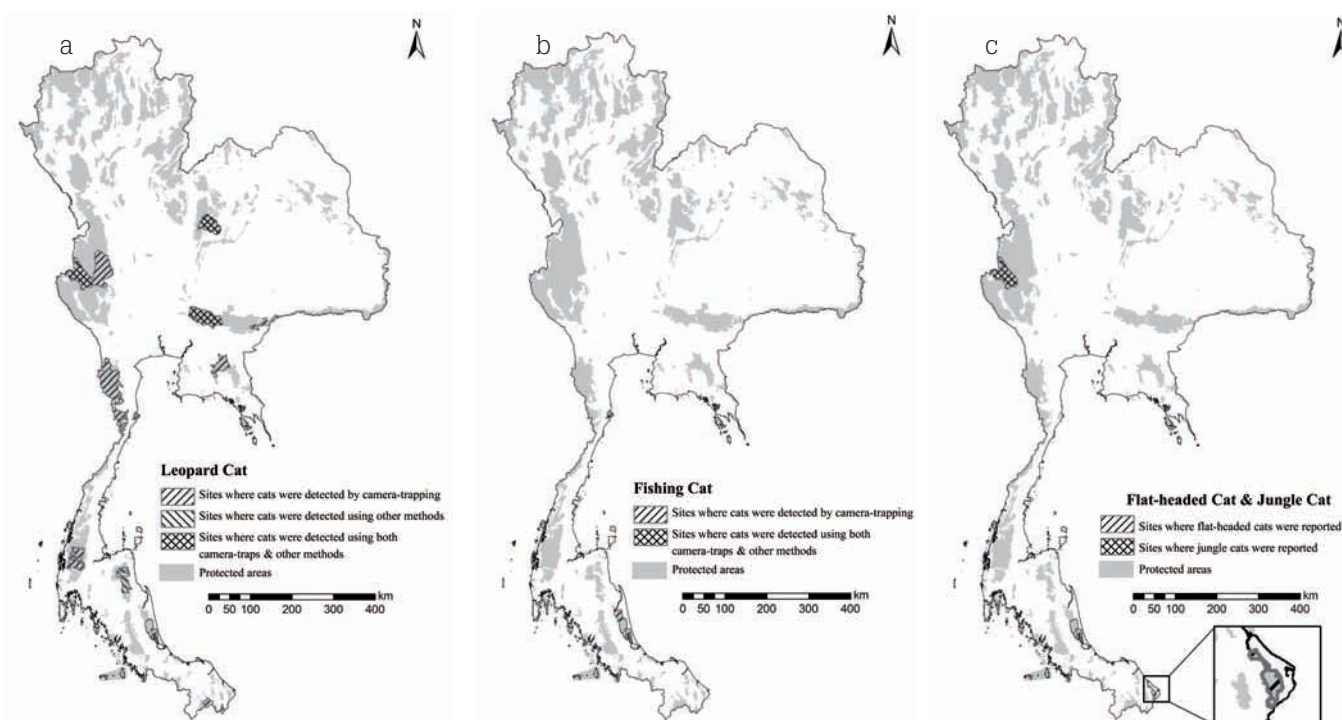


Fig. 2. Distribution maps of seven cat species: (a) leopard cat, (b) fishing cat, (c) flat-headed cat and jungle cat; next page: (d) Asiatic golden cat, (e) marbled cat, and (f) clouded leopard. The sources of the records were separated into 3 groups: (1) camera-trap only, (2) other sources, and (3) both camera-trap and other sources.

basis and while records of a given species at a given survey area confirm its presence, the lack of records does not confirm its absence. Camera-trap photographs of small cats were reviewed for identification ($n=219$) by eight surveyors, including several from outside Thailand but with extensive regional experience. This review found that the overall reliability of identifications was high (96.8%), suggesting that field surveyors motivated enough to participate in such a collaborative process are also careful in their identifications of small cats. Nonetheless, records that would have been of particular significance (notably any suggesting occurrence of a species at a protected area) with no available

photograph for validation were removed from the dataset. Non-validated photographs for species known to be present (by other available photographs) in that survey area at that time were retained.

Additional records from workshop

Records mentioned in the workshop with no specimen or photograph available for third-party validation have been included only after careful consideration. Direct sighting records have been included only for observers demonstrably familiar with the species of Thailand (either through extensive examination of museum skin specimens or camera-trapping).

Other records

In addition to records obtained during the workshop, other relevant records derived from Journal of Wildlife in Thailand (Faculty of Forestry, Kasetsart University) and second-hand reports (Department of National Park, Wildlife and Plant Conservation) were included only in exceptional cases after careful consideration because the reliability of such reports can rarely be determined.

Results

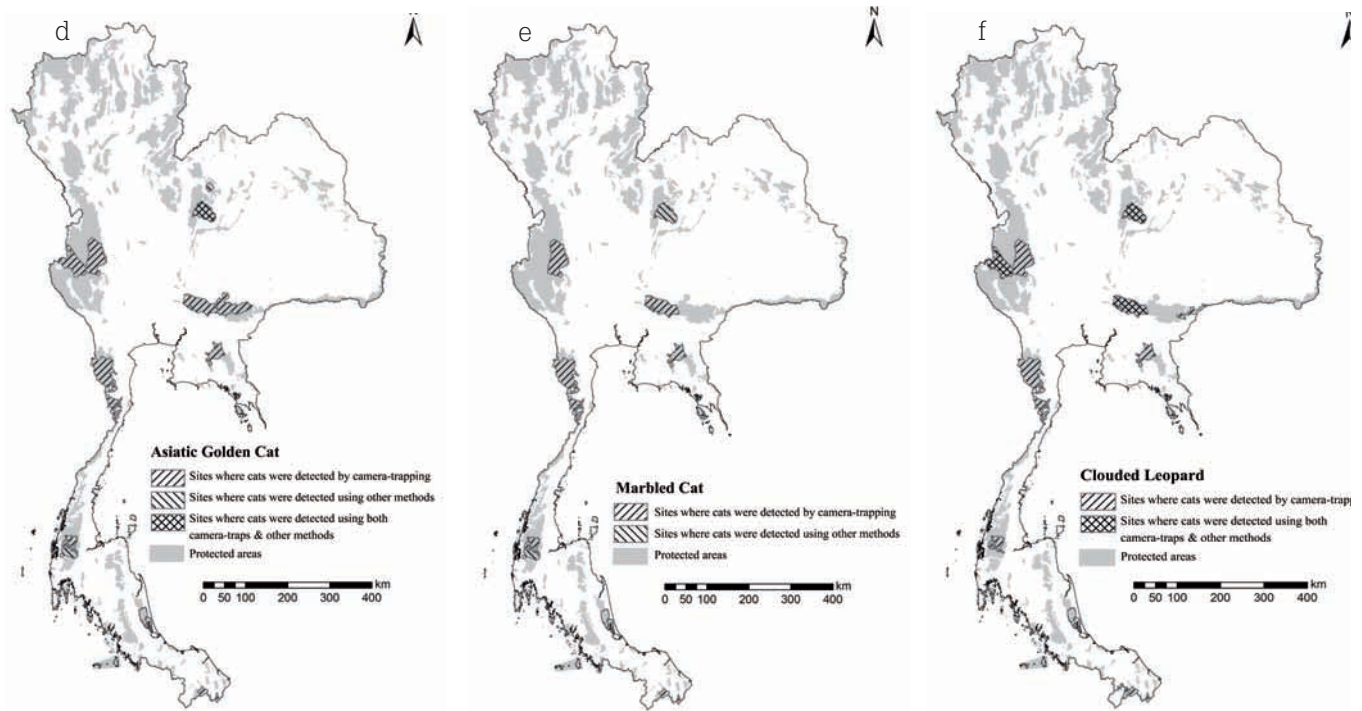
There are five species of cats with camera trap records and among these, three species (leopard cat, Asiatic golden cat and clouded leopard) occurred in over 50% of the 16 sites from which camera-trap survey data were available (SOM T1). When we incorporated the additional (non-camera trap) records, leopard cat (75% of sites), Asiatic golden cat (63%), clouded leopard (56%) and marbled cat (50%) were the most widely distributed in the surveyed sites. Fishing cat was much less widespread even though it was the survey target at several sites (25% of survey target sites had presence); there were no records clearly attributable to fishing cat at any of the 'non-target' sites.

Leopard cat

Records from workshop: Leopard cats are widely distributed in Thailand, being recorded by the camera-traps in 11 out of 16 sites (Fig.



Fig. 3. Leopard cat pictured in Thung Yai Naresuan Wildlife Sanctuary on 4.12.2007 (Photo to W. Chutipong).



2a). In addition, there were direct sightings at Khao Sam Roi Yod National Park (P. Cutter, unpubl. data; Fig. 1). Leopard cats were found in various habitat types, both forest and non-forest and over a wide elevational range (96 m in Khao Ang Rue Nai WS to 1,345 m in Huai Kha Khaeng WS; SOM T1).

Other records: There are camera-trap records from Khlong Saeng Wildlife Sanctuary (Kanchanasaka 2001a) but they were not available for confirmation, and putative direct sightings at Khao Luang National Park and Khao Nan National Park (N. Bhumpakphan, unpubl. data; Fig. 1, 2a).

Fishing cat

Records from workshop: Records of fishing cat came from three sites (Fig. 2b). Khao Sam Roi Yod National Park is believed to be the site with the largest remaining population (P. Cutter, unpubl. data; Fig. 1). More than 20 individuals were identified from camera trap photographs and live-captures in the area. Camera trap evidence suggests occurrence in nearby wetlands adjacent to the south of Khao Sam Roi Yod National Park. Fishing cats in Khao Sam Roi Yod National Park were usually found in rice fields, where diverse prey are available, and in secondary mangrove forest. They appeared to be tolerant of human presence. Evidence suggests that the fishing cat may restrict its range to wetland habitat of lowland areas (<300 m; Cutter 2009). A camera trap record from Kaeng Krachan National Park (Phetchburi Province) in 2002 (Fig. 1) came from a camera set at 336 m in

mixed deciduous forest with distance to nearest water body of 1.9 km. However, a rehabilitated fishing cat was released near the survey area from a wildlife rescue centre in Phetchburi (E. Wieks, pers. comm.; Fig. 1) and so the wild origin of the camera-trapped cat is questionable.

Other records: Surveys at Khlong Saeng and Maenam Pachi Wildlife Sanctuaries (Fig. 1; using similar methods to those at Khao Sam Roi Yod) did not reveal evidence of fishing cats (Cutter & Cutter 2009). A sighting reported as a fishing cat from Khlong E Tow, 4 km west of the Khao Yai National Park Headquarters, in seasonal evergreen forest by T. Charoendong in 2000 (Lynam et al. 2006) remains unconfirmed. Camera trapping in previous and subsequent years, including in and around the location where

the observation was made, failed to detect the species (SOM T1) so the validity of the identification is considered questionable. A record of fishing cat from May 2007 was reported from Pattani Province in southern Thailand (www.fishing-cat.wild-cat.org). Two cats were caught in a patchy mangrove forest near Bangplamor Village, 15 minutes drive from the Pattani Campus of Prince Songkla University; one cat died in captivity and the other was released eventually (W. Karntanut, pers. comm.).

Flat-headed cat

Records from workshop: Flat-headed cat was not camera trapped in any of the 16 sites. This cat is very rarely recorded in Thailand, at least in part because its distribution in the country is limited to the extreme south.



Fig. 4. Fishing cat pictured in Thale Noi Non-Hunting Area on 15. 2.2007 (Photo P. Cutter).



Fig. 5. Asiatic golden cat pictured in Thung Yai Naresuan Wildlife Sanctuary on 24.12.2011 (Photo W. Chutipong).

Other records: Kanchanasaka (1995) reported the flat-headed cat from Pru Toh Daeng swamp forest (Fig. 2c). Kanchanasaka's survey team saw the cat in the evening at two locations: (1) near the Su-ngai Padi River and (2) an area between Melaleuca forest and swamp forest near Su-ngai Padi II road. In 2005, two flat-headed cats were confiscated from wildlife traffickers and brought to the Khao Prathub Chang Wildlife Breeding Centre where they were looked after (Fig. 1). They were suspected of being smuggled from Peninsular Malaysia for the pet trade (Manager Online 2005).

Asiatic golden cat

Records from workshop: Asiatic golden cat was recorded in nine of the 16 sites (Fig. 2d). In other parts of Thailand, there were direct sightings at Khao Sok National Park in 1996 (A. Lynam, unpubl. data; Fig. 1). Asiatic golden cats were recorded in various forest types both primary and secondary, and across a wide range of elevations (from 144 m in Khao Ang Rue Nai Wildlife Sanctuary to 1,310 m in Khao Yai National Park; SOM T1), suggesting that low to mid-elevations were not a limiting factor to the occurrence of this species.

Other records: Camera trap records from Khlong Saeng Wildlife Sanctuary were reported by Kanchanasaka (2001a) but were not available for confirmation (Fig. 1). In other parts of Thailand, there were putative direct sightings at Phu Kradueng National Park in 1983 (N. Bhumpakphan, unpubl. data; Fig. 1).

Marbled cat

Records from workshop: Marbled cat was camera-trapped in six of the 16 sites (Fig. 2e). A direct sighting was reported from the Khao Sok National Park (A. Lynam, unpubl. data; Fig. 1). One camera-trap record in this study came from the edge of secondary forest in Kaeng Krachan National Park (Ngoprasert & Lynam 2002; Fig. 1). In Phu Khieo Wildlife Sanctuary, one female marbled cat was radio tagged and its ranging pattern studied (Grassman et al. 2005; Fig. 1). Records of marbled cats came from elevations ranging from 95–1,097 m.

Other records: The species was reported from camera trap surveys in Khlong Saeng Wildlife Sanctuary (Kanchanasaka 2001a; Fig. 1), but the records were not available for confirmation.

Clouded leopard

Records from workshop: Clouded leopards were confirmed in nine of the 16 sites (Fig. 2f). All records of clouded leopards came from natural forest, but survey efforts in disturbed habitats were too limited to speculate on the extent to which the species uses them. Clouded leopards were found in a wide altitudinal range (from 90 m in Khao Ang Rue Nai Wildlife Sanctuary to 1,253 m in Huai Kha Khaeng Wildlife Sanctuary; SOM T1), suggesting that elevation is not a limiting factor for this species' distribution, at least in Thailand.

Other records: This cat species was documented by camera-traps in Khlong Saeng Wildlife Sanctuary (Kanchanasaka 2001a) and Kaeng Krachan National Park (Tanhikorn et al. 2008), but photos were not available for confirmation (Fig. 1).

Jungle cat

Records from workshop: There were no camera trap records of jungle cat and overall there are very few recent records in Thailand.

Other records: One direct sighting came from Thung Yai Naresuan Wildlife Sanctuary - West (Steinmetz & Mather 1996; Fig. 2c) in a sharp transition between semi-evergreen forest on level limestone and drier bamboo-dominated mixed deciduous forest at ca. 400 m, ca. 10–12 km from a village (Duckworth et al. 2005). Four specimens of jungle cat received in 1972 (two from Ratchaburi, one from Phetchaburi and one from a market; Fig. 1) are lodged at the Thailand Institute of Scientific and Technological Research TISTR (Duckworth et al. 2005). Historical records of jungle cats in Cambodia, Lao PDR and Vietnam were

compiled in Duckworth et al. (2005); a companion review for Thailand is warranted. Lekagul & McNeely (1988) suggested the species was common throughout Thailand including the northern parts, at the time of writing their book. Our survey data lacked coverage from northern Thailand, so we cannot confirm whether this is still true.

Discussion

Given the limited survey effort (less than 1,000 trap-nights) and/or spatial coverage (less than three to four home ranges) at seven of the 16 sites (SOM T1), and that leopard cats, Asiatic golden cats, clouded leopards and marbled cats were still found at more than 50% of sites suggests that they are widespread within the larger protected areas of Thailand. In contrast, there were no camera-trap records of jungle cat or flat-headed cat despite our compilation of camera trap records across a 15-year period, presumably in part because very limited sampling was done in open deciduous forest or scrub, or peat and/or swamp areas, the respective presumed favoured habitats for these species. Fishing cats, except for the questionable records in Kaeng Krachan and Khao Yai National Parks (Fig. 1), were found only in sites where surveys specifically targeted them (Khao Sam Roi Yod National Park and Thale Noi Non-hunting Area; Fig. 1). Specific surveys over a wider range of sites outside the protected areas surveyed in this study might be necessary to find evidence of presence of these three rare species. On the basis of these results, no strong conclusions can be made on their national status. However, bearing in mind the rarity with which each appears in captivity or trade, or are found by other incidental ways (road-kill, birdwatcher sightings, etc.), it is likely that none is common in the country and all may be very rare and therefore at risk of national extinction. This is especially true if they occur primarily outside protected areas and thereby receive little or no active protection against poaching or habitat disturbance or conversion.

The surveys collated here were mostly aimed at mammals larger than these cats and cameras were set mainly along forest roads and large trails, especially those actively used by tigers. Smaller carnivores might avoid such pathways due to their habitual use by larger carnivores (Di Bitetti et al. 2006), or people in the protected areas with large number of visitors and/or poachers. Larger carnivores sometimes kill small carnivores; for example leopard predation on leopard cat was recorded

in Kaeng Krachan National Park (Grassman 1997; Fig. 1) although it is unclear how regular this behaviour is. Therefore, surveyors of small cats should consider issues of trail avoidance by some small carnivores due to higher use of such trails by larger carnivores. The natural history of each species remains too poorly known to prescribe optimal survey techniques. As long as this is true, assessments of the small cat community composition needs camera traps to be deployed across a wide variety of habitats (including degraded areas) and include as many microhabitats as possible.

Leopard cat: The absence of leopard cat from four study sites (SOM T1) was possibly due to the low survey effort (less than 1,000 trap-nights) and coverage (less than three to four home ranges; Maffei & Noss 2008, Tobler et al. 2008). However, this is possibly not the case for Bang Lang (SOM T1) where the survey detected the presence of clouded leopard (4 photographs) despite the low survey effort and coverage. The absence of leopard cat from the survey at Bang Lang could have several explanations. There is a strong possibility that it is due to the low abundance and relatively low intensity of trapping effort leading to the species being missed at Bang Lang (<700 trap-nights). A trapping effort at Hala Bala with just over 1,000 trap-nights also failed to detect leopard cats but a later survey with over 10,000 trap-nights did record the species (SOM T1). Moreover, the Bang Lang and earlier Hala Bala surveys targeted tigers and trap locations were placed where tiger signs were detected; these locations may be avoided by leopard cats. Leopard cats were also missing from surveys that employed the same tiger-optimized survey design and camera-trap placement at Temenggor and Bintang Hijau in northern Malaysia (Lynam et al. 2007). Camera trap surveys at Khlong Saeng in 2012 (L. Gibson, unpubl. data) confirmed the species presence there.

Asiatic golden cat: Historical records suggested a wide distribution for the Asiatic golden cat in Thailand (Lekagul & McNeely 1988). The distribution map produced from these records as well as our work is probably incomplete mainly due to limitations in coverage of the surveys and the relatively low survey effort (based on number of trap-nights). Therefore, more camera-trap surveys should be conducted, in particular, in the forest areas in northern Thailand such as the Lum Nam Pai-Salawin Forest Complex, the Phu Khieo-Nam Nao Forest Complex, Doi Chiang Dao and



Fig. 6. Clouded leopard pictured in Ta Phraya National Park on 31.08.1998 (Photo WCS Thailand).

Salawin Wildlife Sanctuaries, and also the Khao Luang Forest Complex in southern Thailand (Fig. 1) where its presence has been suggested but unconfirmed (Nowell & Jackson 1996). Camera trap surveys at Khlong Saeng in 2012 (L. Gibson, unpubl. data) confirmed the species presence there.

Flat-headed cat: Degradation/alteration of Pru Toh Daeng swamp forest (Fig. 1) could significantly impact the survival of the flat-headed cat population in Thailand. A recent habitat model for this species across the entire species range predicted Pru Toh Daeng swamp forest to be the last probable viable habitat for flat-headed cats in Thailand (Wilting et al. 2010).

Marbled cat: The lack of camera trap records of marbled cat may not be an actual reflection of local status, but rather a result of semi-arboreal behaviour. A study in Borneo, where both camera-trap and spotlighting surveys were employed, encountered marbled cats by spotlighting survey twice, but the cat was never detected by camera-trapping (Mohamed et al. 2009), suggesting partly arboreal behaviour may partly explain the low camera trap success rates. Records of marbled cat in this study came from elevations below 1,100 m; however, there are records of these cats in Lao PDR up to at least 1,900 m (Johnson et al. 2009), and from the Himalayan region up to 3,000 m (Sunquist & Sunquist 2002). This suggests that the distribution of the marbled cat is not limited by elevation in other parts of its range and that it is simply overlooked in higher-altitude surveys in Thailand. Camera trap surveys at Khlong Saeng in 2012 (L. Gibson, unpubl. data) confirmed the species presence there.

Clouded leopard: Failure to detect clouded leopards in Huai Kha Khaeng (Fig. 1) in repeat surveys 10 years after their presence was confirmed, requires further consideration (SOM T1). It is likely that the species was absent in the second survey due to a combination of differing density, spatial coverage, and survey effort compared with the first survey rather than changes in status. At Ta Phraya, surveys in 1998 recorded multiple individual clouded leopards but in 2012 only a single camera-trap set far (>10 km) from the forest edge detected clouded leopard (M. Baker, unpubl. data; Fig. 1). As the latter survey covered a wider sampling area and used more camera-traps, it is likely this reflects a real contraction in range for the species, or a reduction in density. The location of the camera-trap that detected the animal is consistent with distribution models from Khao Yai suggesting that clouded leopards are more likely to occur away from the forest edges (Ngoprasert et al. 2012).

Jungle cat: The paucity of jungle cat records in this study is not a strong indication that the species is rare, since edge/non-forest habitats which may support the species were not adequately surveyed. However, it is consistent with the almost complete dearth of recent records in Thailand (e.g. Graham & Round 1994). Given the ongoing paucity of records, a complete review is urgently needed to identify their possible habitats in Thailand. Based on a complete review by Duckworth et al. (2005) and historical distribution from Lekagul & McNeely (1988), future surveys should focus on dry forest (e.g. dry dipterocarp forest, mixed deciduous forest) in north and northeast Thailand (e.g. Lum Nam Pai-Salawin Forest Complex, Phu Khieo-Nam

Nao Forest Complex, Fig. 1). However, forest areas in northern Thailand have been heavily fragmented and ground-dwelling mammals over hunted (Pattनाविबूल & Dearden 2002). This is similar to the situation in some Lao protected areas (Coudrat et al. 2014, this issue) and it is likely that small and medium cat species at best might occur at very low densities there.

Possible threats to small cats

Rapid economic development over the last 40 years (National Economic and Social Development Board 2011) has brought paved roads to nearly all parts of the country and this, in combination with the long land borders with Malaysia, Myanmar, Lao PDR and Cambodia, provides high connectivity for the regional wildlife markets (Shepherd & Nijman 2008a, Nijman 2010). Domestic legislation protects all wildlife occurring inside protected areas including cats (Ministry of Natural Resources and Environment 2003). While some protected areas are now evolving effective protection for high-trade-value species such as tiger (Simcharoen et al. 2007, Steinmetz et al. 2009, 2010), most are not, and many species are still heavily and illegally hunted throughout most of their Thai range (Lynam 1999, Tungtittiplakorn & Dearden 2002, Lynam et al. 2005, 2006, Brodie et al. 2009). There is an enormous regional trade in wildlife and wildlife products, including various small carnivores, to supply the luxury restaurant trade in China and Vietnam (Bell et al. 2004, Lau et al. 2010, Xu & Compton 2010). Due to a mix of inconsistent legal policies, lack of law enforcement, and poorly trained or inadequately funded staff, Thailand has been repeatedly found to be a crucial node in the international wildlife trade (Nijman & Shepherd 2007, Nijman 2010, Nijman & Shepherd 2010). Many parts of larger cats (tiger, leopard), clouded leopard and Asiatic golden cat (mostly skin and some meat, bone or other organs) are illegally sold at border markets, suggesting threats to their populations in Thailand and neighbouring Myanmar and Lao PDR (Srikosamata & Suteethorn 1994, Shepherd & Nijman 2008b, Oswell 2010). However, recent wildlife meat trade surveys in towns and villages near Kuiburi National Park (Fig. 1) revealed that the only small carnivores in the meat trade were palm civets (Paradoxurinae) (R. Steinmetz, unpubl. data). Similar surveys conducted around the Western Forest Complex (Fig. 1) also found no cases of small cats (A. Pattनाविबूल, pers. comm.).

This conflicting evidence suggests that (1) meat trade for wild cats in Thailand may not be locally significant because cat meat is relatively less desirable (W. Chutipong, pers. obs.), (2) trade found along borders may stem from neighbouring countries, (3) trade in wild cats within the country e.g., pelt trade, if any, was overlooked by the two surveys as they were conducted in towns – far from border where most of trades usually occur, and (4) the absence of wild cat meat trade around the two forest complexes may be an indicator of critically low population status.

Persecution may be a more serious threat to some species than others, especially fishing cats which are frequently killed (but rarely reported) by villagers when they prey on fish and chickens (P. Cutter, unpubl. data).

Due to a relatively aggressive management of forest boundaries around the edges of Thai parks and sanctuaries (Albers & Grinspoon 1997), forest encroachment rates are generally lower than in some neighbouring countries (Sodhi et al. 2010). Felid responses to the impacts from degradation of existing habitats inside protected areas, especially historical logging practices, and land-use change are poorly understood. Therefore, establishing appropriate practices for species conservation is difficult. However, the range of sites from which the four widespread smaller cats were recorded gives no suggestion that current habitat conditions are threatening the survival of any of them.

Conservation priorities

A thorough review of Thai historical records of small cats, to study patterns of range contraction and habitat use, with a focus on those species which cannot be widely found today (fishing cat, flat-headed cat and jungle cat), is needed. Current information on occurrence and geographic distribution of small cats is lacking from the more disturbed areas in northern Thailand where at least one species, jungle cat – currently considered national critically endangered (Nabhitabhata & Chansard 2005), was formerly reportedly common (Lekagul & McNeely 1988). Similarly, there are only a few scattered records of small cats from the central plains and the Gulf of Thailand coastline. These gaps are serious because this implies that for fishing cat, which may be among the most threatened cats in tropical Asia and whose status remains poorly known, it is not clear what conservation management is needed. In addition, jungle cat, fishing cat and flat-headed cat do not seem to signifi-

cantly share distribution with larger cat species which are subjects of intensive survey and conservation efforts inside several of the larger protected areas. Therefore unless dedicated surveys and conservation measures are attempted, these species are unlikely to be recorded or conserved, and so might disappear without our knowledge. Using a precautionary view, these three species should be considered to be at risk of national-level extinction in Thailand.

In general, the largest blocks of secondary forests, wetlands, shrub and non-forest areas that lie outside protected areas amid the lowest human population densities with historical and recent confirmed records should be intensively surveyed to elucidate the status and distribution of fishing cat, flat-headed cat and jungle cat. In addition, similar habitat types believed to be suitable for these species should be targeted in the hopes of finding additional breeding populations worthy of protection. These include wetland habitats of Inner Gulf of Thailand for fishing cat, and peat swamp forests in peninsular Thailand for flat-headed cats (Wilting et al. 2010). Individuals of these three species found in wildlife rescue centres and captive breeding centres, and road kills should be the subject of investigation to determine their origin. This may lead to the discovery of sites still supporting them, which could then be surveyed intensively to determine population status. For these three species, specimens such as animals killed for retribution, hunted/traded specimens of known locality warrant publication and wherever possible, photographic documentation should be opportunistically collected to add to the collection in the Thailand National Science Museum.

Forest-dwelling species such as Asiatic golden cat, marbled cat and clouded leopard are potentially sensitive to the impacts of edge effects, habitat degradation and forest encroachment. Assessments of their responses should be carried out as these factors have been found to be important influences on the distribution and the extinction proneness of other Thai forest mammals (Lynam 1995, Ngoprasert et al. 2007).

National funding agencies (e.g. National Research Council of Thailand, National Science and Technology Development Agency) should be encouraged to fund such countrywide investigations for small cats, and such investigations should be a part of wildlife research programmes undertaken by relevant government agencies such as the Department of

National Parks, Wildlife and Plants Conservation (DNP).

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