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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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The decline of non-*Panthera* cat species in Vietnam

Vietnam is likely to have once supported globally significant populations of leopard cat *Prionailurus bengalensis*, Asiatic golden cat *Catopuma temminckii*, marbled cat *Pardofelis marmorata* and mainland clouded leopard *Neofelis nebulosa*, and probably also fishing cat *Prionailurus viverrinus*. Jungle cat *Felis chaus* is also recorded for Vietnam but the limited extent of the species's preferred habitat type, deciduous forest, means that it is unlikely to have ever been widely distributed in the country. The current conservation status of all these small cat species in Vietnam is poorly understood. All traceable verifiable small cat field records from 1 January 1995 to 31 October 2013 were collated and reviewed, as were the results of camera-trap surveys that did not record any cats at all. Only leopard cat had a sizeable number of confirmed records. Several surveys of >1,000 camera trap nights did not record any other species of small cat. Indiscriminate cable-snare trapping is likely to have caused significant declines in Vietnam's non-*Panthera* cat species, and probably extirpated Asiatic golden cat, mainland clouded leopard and marbled cat from plausibly many of Vietnam's protected areas. Vietnam is unlikely to still hold globally significant populations of these three species and immediate conservation efforts should focus on the two countries in Indochina that are still likely to: Cambodia and Lao PDR. The last confirmed fishing cat record for Vietnam is now 13 years old, but given this species's relative tolerance to human-induced habitat changes, and the relatively low amount of snare-trapping in its preferred wetland mosaic habitats, targeted searches for this species in Vietnam are warranted and are a regional conservation priority.

Vietnam lies in the Indo-Burma hotspot (Myers et al. 2000, CEPF 2012), among the most biodiverse regions on Earth. It covers approximately 330,000 km² of land from sea level to 3,000 m, with one of the longest coastlines in the region (3,260 km) and two large deltas: the Mekong in the south and the Red River in the north. The Annamite Mountains, along much of the country's western border, are recognised for their high endemism (Baltzer et al. 2001, Sterling et al. 2006, CEPF 2012). In the North, the Hoang Lien Mountain Range, seen by some as the Himalayas' eastern extremity, contains several Sino-Himalayan plant and animal species. Vietnam has a diverse range of habitats including evergreen, semi-evergreen and deciduous forests, limestone karsts, and various types of wetland including *Melaleuca cajuputi*-dominated peat-swamp forest.

Historical records of non-*Panthera* (hereafter 'small') cats in Vietnam comprise six species (e.g. Osgood 1932, Delacour 1940; Supporting Online Material SOM T1). Based on habitats occupied by each species elsewhere in South-east Asia, the country previously would have supported large populations of at least four of these; however, jungle cat was plausibly confined in Vietnam to its restricted

deciduous dipterocarp forests (Duckworth et al. 2005) and fishing cat may have been mostly coastal, as has been suggested for some other South-east Asian range countries (Duckworth et al. 2010).

Vietnam is within a national species extinction crisis. Javan rhinoceros *Rhinoceros sondaicus*, kouprey *Bos sauveli*, hog deer *Axis porcinus*, and Bengal florican *Houbaropsis bengalensis* (Platt & Ngo 2000, Brook et al. 2011, IUCN 2013) were extirpated from Vietnam during the late twentieth century and early twenty-first century. Other species perilously close to extirpation include Asian elephant *Elephas maximus*, giant ibis *Thaumatibis gigantea*, and tiger *Panthera tigris* (IUCN 2013).

These losses, and ongoing declines in many others, are driven by wildlife hunting and in some cases exacerbated by habitat loss. Vietnam's human population is high (93 million) and much lowland evergreen forest, grassland and wetland are now agriculture (Wege et al. 1999, Brooks et al. 2002, Sodhi et al. 2004). Even the higher altitude forest types, better protected by natural factors, still suffer severe human-induced disturbance.

Vietnam's pernicious wildlife trade includes animals ranging in size from tokay gecko

Gekko gecko to Asian elephant (Bell et al. 2004, Robertson 2007, Venkataram 2007). Very heavy indiscriminate snaring and targeted hunting are driven by a demand for wild meat, exotic pets, pelts, and for body parts, some to be used in traditional medicine. Urban Vietnam consumes so much wildlife, in part as a symbol of wealth and status, that local subsistence use of wild mammals is increasingly rare (Robertson 2007, Venkataram 2007, TRAFFIC 2008, Drury 2011). Much is also exported, notably to China.

Impacts of these factors on Vietnam's small cats are unclear. Most small cats are elusive, low-density species and therefore hard to detect, and so are rarely targeted during field surveys and are outside the focus of most mainstream conservation initiatives. This review collates modern verifiable records for Vietnam's non-*Panthera* cats, to clarify each species's national conservation status.

Methods

Wildlife surveys during the 1990s were generally reconnaissances of the conservation significance of declared or potential protected areas. Most focused on diurnal land vertebrates and lasted less than a month. Such surveys are poorly suited to elusive, low density, partly nocturnal animals such as small cats. Their verifiable small cat records were mostly of captive animals and hunted remains where a local provenance seemed likely; a few were direct sightings.

Camera trapping, among the best methods for verifiable records with accurate locations, was used effectively from 1998 onwards. Most of the large-scale such surveys aimed to establish a site's conservation significance for mammals and birds. Few surveys targeted small carnivores. Camera trap-use declined from 2005, and few surveys ever exceeded one year, hindering assessment of these species' population trends.

Hence to inform small cat conservation status in Vietnam, this review collates all traceable field records for small cats (excluding domestic cat *F. catus*) in Vietnam from 1 January 1995 to 31 October 2013. Records were compiled from direct observations, camera trap images, and remains and captives in villages within and near natural or semi-natural areas, where origin was explicitly investigated. Direct observations were only considered confirmed if supported by photographic evidence and/or supporting notes, with the exception of leopard cat records which seem very rarely erroneous. Notes were not requir-



Fig. 1. Asiatic golden cat camera trapped on 28 March 2004 in Pu Luong NR, North Vietnam (Photo PL-CP, FFI/FPD Vietnam).

ed for observers with significant experience examining small cat museum specimens and a known cautious approach to identification. Reports from local villagers/hunters were not collated. In Vietnam, single species can bear multiple local names, and several species can be grouped under one name e.g. 'meo rung', literally 'jungle/forest cat', is also the most commonly used Vietnamese name for leopard cat. Interviewees evidently readily apply names for types of 'cat' inconsistently between biological species and even between cats and other taxonomic groups such as civets (Viverridae). Interviews for superficially similar small carnivore species are thus extremely unreliable (see Sampaio et al. 2011) and are not used here.

Identification of field signs (e.g. footprints, faeces, prey remains) from small carnivores in Vietnam is extremely difficult. Footprints can sometimes be identified as those of small cats, but with several similarly sized cat species potentially present anywhere, identification to species is irresponsible. Faeces offer reliable records only if identified using DNA analysis (see references in Duckworth et al. 2010). Therefore, sign records identified visually were excluded from this review.

Species accounts

Marbled cat

A marbled cat was reportedly observed at 600 m outside the core area of Pu Mat Nature Reserve NR. No identification details were given, the authors stated (Frontier Vietnam 1995: 23) that their team lacked experienced mammal surveyors, and leopard cat and marbled cat have somewhat similar pelage. The record must thus be considered provisional.

A recently killed marbled cat, reportedly caught locally, was seen in Dac Plo com-

mune, west of the northerly part of Ngoc Linh proposed NR, Kon Tum province (Le Trong Trai et al. 1999). A marbled cat 'specimen' was observed during village interviews in Cham Chu proposed Nature Reserve, Tuyen Quang province (Le Khac Quyet et al. 2001). No details were provided on whether the 'specimen' was freshly killed or a preserved skin or other part, but the report states that it had a 'known location of capture and caught within the previous year'. No supporting notes or photographs could be traced for these records, and therefore both have been considered provisional.

One 'captured animal' was observed in the village of Phu Nhieu on 24 September 1998, approximately 2 km from the border of Phong Nha Khe Bang National Park NP, Quang Binh province (Timmins et al. 1999). The marbled cat was reported by hunters to have been cable-snared in Khe Lan valley. Though the exact locality of Khe Lan valley could not be traced, it seems likely, based on the village's proximity to the protected area, that the marbled cat was caught either in Phong Nha Khe Bang NP or forest near the NP.

A marbled cat was camera trapped at 2,060 m a.s.l. in upper montane forest (21°39'0.3"N/104°04'53"E), in Mu Cang Chai district, Yen Bai province on 23 October 2004 (Flora and Fauna International, Vietnam Programme, unpubl. data). This was the only traced camera record for this species.

Asiatic golden cat

Asiatic golden cat has been camera trapped in three sites: Pu Luong NR (Do Ngoc Cuong 2004; Fig. 1), Pu Mat NR (SFNC 2000) and Song Thanh NR (Long 2005). The latter site had two locality records, one each within the Nam Giang Main and Phuoc Son West Forest Management Units FMUs in Long (2005). Both of these records are within Song Thanh NR (B. Long in litt. 2014). The Pu Luong NR record was on 28 March 2004 on 'a valley floor near a water source' at ca. 600 m (Do Ngoc Cuong 2004). Camera trapping in Pu Mat NR gave four records from three locations (SFNC 2000). Two were from one camera trap (in the Khe Toi survey sector) and could have been of the same individual (SFNC 2000). Only one had an elevation given: ca. 400 m in the Khe Khang survey sector (SFNC 2000). The fourth, final, record was added in proof and was taken in the Khe Bu survey sector; no further details were available.

The only direct sighting traced was one at approx. 5 m distance in secondary forest in

Ba Na NR (Frontier Vietnam 1996). No further details on the observation could be traced, so this record is treated as provisional.

A captive animal and remains were observed in Ben En NP in 1997 and 1998 respectively (Frontier Vietnam 2000), and a 'specimen' (age and body part unclear) was observed in Mu Cang Chai Species/Habitat Conservation Area SHCA, Yen Bai province (Le Trong Dat & Le Minh Phong 2010). These three records lacked photographs or supporting notes so all are treated as provisional. Single confiscations were reported in 2004 and 2005, near or within Chu Yang Sin NP (Birdlife International 2010). That in December 2004 was reportedly from a hunter in Hoa Phong commune, which forms part of Chu Yang Sin NP; the animal was released in January 2005. The 2005 confiscation was transferred to Saigon Zoo, Vietnam and a photograph of this animal is included in the report (Le Trong Trai in litt. 2013).

Clouded leopard

One was camera trapped on 19 December 2003 in primary evergreen forest on limestone at 610 m in Pu Luong NR (20°32'09"N/105°05'52"E; Do Ngoc Cuong 2004; Fig. 2). In February 2001 one was directly observed in Hang Toong Chung forest, Yen Bai province (Le Trong Dat et al. 2001, Long et al. 2001, Swan & O'Reilly 2004, where located in Mu Cang Chai SHCA), for a few seconds at 05:00 h resting on the branch of a large tree (Le Trong Dat in litt. 2013). On 5 March 2001 a fresh skin was observed in Che Thao village, Yen Bai province (Le Trong Dat et al. 2001, Long et al. 2001) of an adult recently trapped from Che Thao forest (Le Trong Dat in litt. 2013), which is within the Mu Cang Chai SHCA. All these records are treated as confirmed following the production of additional record details. One other 'specimen' record was traced for Mu Cang Chai SHCA (Le Trong Dat & Le Minh Phong 2010) but as there were no record details in the report and none could be traced, it has been treated as provisional.

Jungle cat

Duckworth et al. (2005) traced only two pre-2003 records for jungle cat in Vietnam, both mounted skins: one reportedly from Kon Tum province (undated), the other bought in a market in Gia Lai province in the mid-1990s.

On 23 March 2009 a juvenile and a female jungle cat were photographed 200 m apart during a spotlighting survey in Phu Quoc Island (Huong Trung Thanh et al. 2009, includ-

ing photographs of both). A juvenile was sighted at the same location on 24 March 2009. The juvenile shows large pointed ears and white cheek patches typical of jungle cat, but the photograph of the female is less clear (S. Mukherjee in litt. 2013), even on the original photographs. Domestic cats observed by DHAW in the Mekong Delta superficially resembled jungle cat (relatively short banded tail, golden brown coat with mostly faint markings bolder on the upper forelegs and black tips to solid-coloured ears), suggesting the possibility of past hybridisation. Therefore these individuals might not be pure jungle cats and a particularly cautionary approach should be used when identifying this species, especially outside its core range. These sightings were at approximately 350 m a.s.l. in lowland evergreen forest, a habitat type not used extensively by the species in SE Asia (Duckworth et al. 2005, Gray et al. 2014, this issue). A claim of golden jackal *Canis aureus* from Phu Quoc Island (Dang Huy Huynh 1994) and unconfirmed records (no indication of source in the report and could be based on interviews) of dry forest/open habitat birds, including rufous-winged buzzard *Butastur liventer* and white-rumped falcon *Polihierax insignis* (Nguyen Xuan Dang 2009) suggest that the island may contain more typical jungle cat habitat, perhaps the open 'savannah-like habitat' with sparse *Melaleuca* of Abramov et al. (2007). Most survey effort to date focused on the island's savannah, so the current extent of this habitat type and whether it does support a suite of dry forest species is unknown. Huong Truong Thanh et al. (2009) gave a (datum-less) UTM locator but all likely datums place the record inland in Kien Giang province, precluding any assessments of the record's proximity to more typical habitat on Phu Quoc Island.

Jungle cat is/was probably mainly restricted in Vietnam to the provinces of Gia Lai, Kon Tum and Dak Lak, which support most of the country's deciduous forest (Duckworth et al. 2005). However, this may not necessarily all have been suitable habitat. Long-term camera trapping in deciduous forest in Huai Kha Khaeng Wildlife Sanctuary WS, Thailand, failed to detect the species (Simcharoen et al. 2014, this issue). The absence of records from Huai Kha Khaeng WS has been suggested to reflect the site's more hilly deciduous forest; sites that jungle cat formerly used in Thailand (which have now all been cleared), were typically lower and on flatter land, supporting scrub and deciduous forest, or agri-

cultural mosaics. It is therefore plausible that similar, as yet unknown, factors influence jungle cat distribution in deciduous forest in Vietnam, which is higher and less plains-like than the deciduous forest on the Cambodian side where jungle cat is still regularly recorded (Gray et al. 2014, this issue). The species might thus be naturally either very rare in or now absent from Vietnam.

Other possible habitats that may have formerly supported jungle cat populations are the shrub/thicket formations that occur at various places along Vietnam's coast, and the coastal dry forests (in lowlands and lower hill slopes) of Khanh Hoa, Ninh Thuan and Binh Thuan provinces. Jungle cat populations are unlikely to persist in these habitats in Vietnam (if they were ever there at all); the human population density along Vietnam's coastline is high, and nearly all of Khanh Hoa, Ninh Thuan and Binh Thuan's lowlands have been converted to agriculture. A possible exception is Nui Cha NP, Ninh Thuan province, which does contain examples of lowland scrub habitats and has been under-surveyed for fauna. The probability of jungle cat persisting in a 250 km² protected area that has 30,000 people living inside it (BirdLife 2004), a large proportion of which are likely to depend on natural resources (including wildlife) for subsistence during the province's long and harsh dry season, seems low.

Leopard cat

Of 28 locations with 34 leopard cat records (SOM T2, F1), 19 are formally protected, two are proposed nature reserves, three are production forests (State Forest Enterprises SFEs and Fishery and Forestry Enterprises FFEs) of varying levels of activity, two are ambiguous, and one was in agricultural land in the Red River Delta. Most records (32) were based on direct observation and/or camera trap photographs. Three site records were based on remains and captives for which a local provenance is likely: one freshly dead, near Tam Dao NP (Nguyen Xuan Dang et al. 2006), a captive near Pu Hoat NR (Frontier Vietnam 2000), and a 'specimen' caught within the last year observed near/within Cham Chu NR (Le Khac Quyet et al. 2001).

Within a few kilometres of Hanoi's city centre along the Red River (approximately 31°03'14"N/105°50'55"E), a duo was seen at 14:09 h on 16 November 2012 (Fig. 3), and, 400 m away, in May 2013, in riverine scrub and grass amid a complex mosaic of crops,



Fig. 2. Clouded leopard camera trapped on 19 December 2003 in Pu Luong Nature Reserve, North Vietnam (Photo PL-CP, FFI/FPD Vietnam).

small trees and fallow land (SOM F2, S. Delonglee in litt. 2013).

These cats could conceivably have been released or escaped animals (or descendants of such) brought to Hanoi by people. Leopard cats are traded, amongst other reasons, as pets in Vietnam (Carnivore and Pangolin Conservation Program CPCP, unpubl. confiscation data). Vietnam's Forest Protection Department FPD often releases animals confiscated from illegal holdings or trade into the nearest natural or semi-natural habitat, even if this be outside the species's known distribution. Releases are usually into well-known forested protected areas: the nearest such areas to Hanoi, Ba Vi NP and Tam Dao NP, are both approximately 60 km from the sighting.

On the day of the November sighting, a known hunter at this site, and farmers who live and work in the area, all suggested long-term presence of leopard cat (S. Delonglee in litt. 2012). The area is heavily hunted for resident and migratory birds, using mist-nets and guns; cable snaring is apparently not used there.

This site, and its surrounds, has never been surveyed for small carnivores so it is unknown whether it historically supported a leopard cat population. However, degraded habitats support leopard cats in other parts of Vietnam, including active forestry enterprises (U Minh Ha FFEs; DHAW pers. obs., La Nga SFE; Nguyen Xuan Dang et al. 2004a), and protected areas with significant levels of human-induced habitat disturbances (e.g. Le Trong Trai et al. 1999, Frontier Vietnam 2000, Nguyen Xuan Dang et al. 2004b), and in agricultural landscapes in other range countries (e.g. Rajaratnam et al. 2007, Lorica & Heaney 2013). This, in combination with the lack of snaring at the Red



Fig. 3. An uncropped photograph of a leopard cat seen on 16 November 2012 along the Red River, Hanoi (Photo S. Delonglee).

River site, the substantial distance from likely FPD release sites, and the local people's information all suggest that these sightings are plausibly wild leopard cats, not of escaped/released animals.

Leopard cat is the most commonly recorded small cat species in Vietnam with confirmed field records from both protected and non-protected sites and a wide range of habitats including; *Melaleuca* dominated swamp forest (Fig. 4), secondary and degraded habitats, deciduous forest, semi-evergreen forest, and evergreen forest at various altitudes from lowland to upper montane. Altitudes were rarely stated, but vary from a few metres above sea level (U Minh Thuong NP; Nguyen Xuan Dang et al. 2004b) to at least 2,200 m a.s.l (Hoang Lien Son-Van Ban NR; Swan & O'Reilly 2004).

Fishing cat

Fishing cat was camera trapped on five dates (21 March, 8, 10 and 21 June and 4 August 2000) in U Minh Thuong NP (Nguyen Xuan Dang et al. 2004b). Additionally an animal identified as fishing cat was watched along Canal KT1 (9°36'40"N/105°05'46"E) at 14:24 h on 11 November 2000. On 19 November an adult female was found dead along Canal 120 (9°37'50"N/105°03'58"E), possibly having succumbed to rat poison. U Minh Thuong NP, dominated by *Melaleuca cajuputi*, has a core zone of 85 km² and buffer zone of 133 km². The area is <1 m altitude, and is surrounded by intensive rice farming (Safford et al. 1998, Sage et al. 2004).

Further surveys in the U Minh Wetlands in 2008 and 2010 failed to record fishing cat

(CPCP, unpubl. data). The former focused on U Minh Ha NP whilst the latter focused on the U Minh Ha FFEs, an area of active SFEs. Both sites contain habitat types similar in structure and plant species composition to U Minh Thuong NP, though neither has any extensive open swamp. All three comprise the U Minh Wetlands, but connectivity is limited. All three are surrounded by agriculture, and the relatively large town of U Minh separates U Minh Ha NP from the FFEs. The 2008 and 2010 surveys used camera traps, spotlighting and diurnal observations to record small carnivore species, methods comparable to those of Nguyen Xuan Dang et al. (2004b), and to a greater total survey effort. Fishing cat was recorded in neither 2008 nor 2010. Hoang Truong Thanh et al. (2009) listed three occurrences for fishing cat in U Minh Thuong NP in '2007', but two were based on local reports and the one specimen referred to had been collected in 2000. Therefore fishing cat has not been reliably recorded in the U Minh area since 2000.

Discussion

Records of small cat species in Vietnam

Leopard cat was by far the most commonly recorded small cat in Vietnam during 1995-2013, in a wide range of habitats; it seems to be a habitat generalist, as in other parts of its range (Duckworth et al. 2005, Rajaratnam et al. 2007, Lorica & Heaney 2013). Its persistence where most, if not all, similar sized and larger mammal species are extirpated e.g. Red River Delta, suggests relative tolerance of anthropogenic pressures, including hunt-

ing. Compared with other small cat species, spotlighting can detect this species effectively (see SOM T2). Leopard cat plausibly remains relatively common in Vietnam, persisting in various natural/semi-natural habitats and in agricultural landscapes where there is some connectivity to the latter; leopard cats that are killed in cleared/mostly agricultural areas can be replaced by animals diffusing out of more densely forested habitats. Areas of land with high-intensity agriculture and with little or no connectivity to more natural/semi-natural habitats, which now make up a large proportion of Vietnam's lowlands, might be less likely to support any leopard cat populations. Leopard cat is one of the most frequently recorded small carnivore species in Vietnam's illegal wildlife trade (Education for Nature Vietnam's ENV wildlife crime bulletins, November 2006 - August 2013; CPCP confiscation data). The offtake that it can withstand is unknown, so there might be long-term conservation issues for species in Vietnam.

No other small cat had many confirmed records. Three site records were traced for golden cat, as well as several provisional records. Elsewhere in the region golden cat is, after leopard cat, amongst the more frequently recorded small cat species (Duckworth et al. 2005, Tantipisanuh et al. 2014, this issue). Marbled cat had the fewest confirmed records of evergreen forest species, as is also regionally typical.

Jungle cat is unlikely to have ever had a wide distribution in Vietnam: deciduous forest is relatively limited, whilst widespread hunting presumably excludes it from scrub and agriculture it might otherwise occupy (Duckworth et al. 2005). In contrast to leopard cat, jungle cat lacks populations in dense forest that could diffuse out to replace animals killed in agricultural/cleared habitats.

Even if Phu Quoc is later confirmed to hold jungle cat, the island's population is likely to be small and perhaps not a conservation priority; the island is small (574 km²), dominated by evergreen forest, historically probably had only little scrub/open forest and thus few jungle cats, and is now threatened by unregulated tourism development. Similarly, even if Gia Lai, Kon Tum and/or Dak Lak provinces hold jungle cat, populations would probably be of low global significance: much larger areas of deciduous forest in Cambodia still contain a suite of dry forest specialist species extinct or close to local extinction in Vietnam (Gray et al. 2014, this issue). Efforts to

conserve jungle cat in Indochina should thus focus on Cambodia.

The multiple fishing cat records from U Minh Thuong NP during a short survey in 2000 (Nguyen Xuan Dang et al. 2004b), and the lack of records in Vietnam from forest habitats that have been well surveyed using camera traps placed along forest trails, salt licks, in natural clearings etc., suggest that this species may be very localised, perhaps primarily close to watercourses or wetlands. The failure of more recent surveys in U Minh Ha NP and the intervening U Minh Ha FFEs (CPCP unpublished survey data) to produce any fishing cat records is of concern: thirteen years have passed since the records from U Minh Thuong NP. Recent confirmed records of this species in small remnant patches of wetland in Howrah, a city district of Kolkata, India (Adya 2011), do not suggest that fishing cat is a forest obligate that needs large intact areas of forested wetland. Though small in size and depauperate compared to some of the region's wetlands, Vietnam's U Minh wetlands might thus still support a significant fishing cat population. Clarification of whether fishing cat persists in the wider U Minh wetland landscape is urgently needed. All surveys, even the camera trap surveys, reviewed here were too brief to conclude that the small cat species not recorded were genuinely absent from the site. However, comparable camera-trapping elsewhere in South-east Asia typically detects clouded leopard, golden cat, leopard cat, and jungle cat frequently when in suitable habitat. Marbled cat is typically found less often than these species, but still regularly and widely. All these five small cat species can be recorded using camera traps set for other species including tiger and large ungulates (e.g. Holden 2001, Azlan & Sharma 2006, Datta et al. 2008, Gray et al. 2012, Tantipisanuh et al. 2014, this issue). The great paucity of small cat records (excepting leopard cat) from camera trap surveys in Vietnam, even those with efforts exceeding 1,500 effective camera trap nights amid large extents of suitable habitat, thus reflects small cats' genuine scarcity in these areas (SOM T3; Fig. 5). Of particular concern is that camera-trap surveys were undertaken in several of the largest remaining evergreen forest blocks. Three recent targeted small carnivore surveys, two surveys for Edwards's pheasant *Lophura edwardsi* and one ongoing saola *Pseudoryx nghetinhensis* survey in Vietnam, in habitat suitable for clouded leopard, golden cat and marbled cat, had camera trap

survey effort that should have been, based on encounter rates in other countries, sufficient to record these species if present at comparable densities. They recorded only leopard cat. The lack of post-2000 fishing cat records requires specific consideration. Very few fishing cat records are produced from camera trap 'by-catch' anywhere in South-east Asia. The lack of incidental fishing cat records in the region suggests a distribution largely outside (at major habitat and/or microhabitat scale) that targeted during camera trap surveys for e.g. tigers, and/or rarity within the region. The great rarity of camera trap 'by-catch' records of this species anywhere combined with relatively recent records in Vietnam strongly urges targeted searches for fishing cat in the country.

In 1995, leopard cat was seen in a brief survey of Ke Go NR (Le Trong Trai et al. 1999) but the much more intensive specific small carnivore surveys in October 2006 - March 2007 and January - July 2010 failed to record any cat species (CPCP, unpubl. data). This is probably because of the widespread intensive hunting: approximately 1,200 cable-snare traps were collected during the survey and active hunting/logging camps were seen on nearly every major pathway. Hunting at Ke Go NR has, based on camera trap data and incidental records collected during the survey, reduced populations of similar sized and larger mammal species including relatively tolerant species such as common palm civet *Paradoxurus hermaphroditus* (four records) and wild pig *Sus scrofa* (no records) (CPCP unpublished survey data). Wild pig had been previously recorded in Ke Go NR (Le Trong Trai et al. 1999). Similarly in Phong Nha - Khe Bang NP no cat records resulted from approximately 1,800 camera trap nights; 500 cable-snare traps were collected there over 30 days, and wildlife hunting is assumed to be the main reason for population declines suspected in a wide range of mammals there (Nguyen Xuan Dang et al. 2012).

Despite Cat Tien NP's failure to protect Javan rhinoceros (Brook et al. 2011), it still boasts several globally threatened mammal and bird species including green peafowl *Pavo muticus*, gaur *Bos gaurus* and black-shanked douc *Pygathrix nigripes*, and several small carnivore species are readily camera trapped and spot-lit. An ongoing small carnivore survey in the Nam Cat Tien sector of the park has so far confirmed at least nine small carnivore species by these methods (Nguyen The Truong An in litt. 2013). Over 2,000 camera



Fig. 4. Camera-trap photograph of a leopard cat at the edge of an active *Melaleuca* plantation in the U Minh Ha FFEs taken on the 10 September 2010 (Photo Carnivore and Pangolin Conservation Program).

trap nights recorded only leopard cat. A previous survey in 2006-07 in the same sector recorded seven small carnivore species during approximately 3,500 camera trap nights (Shih-chih Yen 2009). Again, only leopard cat was recorded.

Hunting might be the main factor behind the absence of records for other cat species in Cat Tien NP. Although the main tourist trails and areas close to the FPD headquarters have little if any visible hunting, 500 cable-snare traps were collected in approximately 6 km² on Nam Cat Tien's periphery in 2013 (Nguyen The Truong An in litt. 2013). Relative to Vietnam's other protected areas, hunting in Nam Cat Tien is generally still low, and this incident remains the only significant hunting observation in nearly a year's survey effort, though most survey effort has focused on or near the main tourist routes. The current lack of other small cat records at this relatively well protected site despite a targeted and high survey effort, and an apparently healthy prey base of small-medium sized mammals, reptiles and ground-dwelling bird species, does not bode well for the status of these species at this site. However, it is also possible that species other than leopard cat are naturally absent; Polet & Ling's (2004) extensive compilation also traced records of only leopard cat, and small carnivore distribution in the region is only known at the coarse-habitat scale for the majority of species. Another possible reason for the apparent absences/very low densities

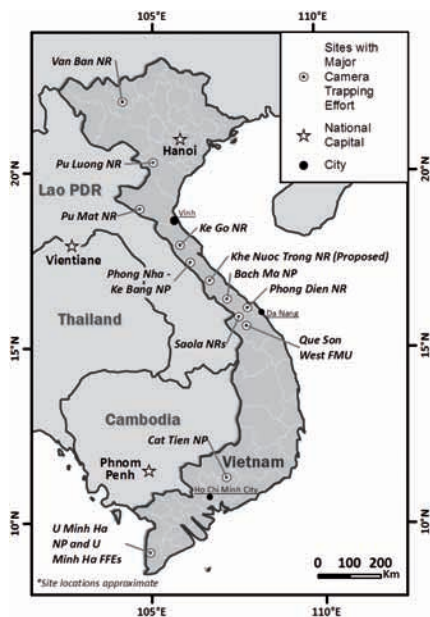


Fig. 5. Approximate location of sites listed in SOM T3. Bach Ma NP and Phong Dien NR are indicated separately on this map but are part of the WWF 'Green Corridor Forest Landscape' that runs approximately north-south across Hue province (Dickinson & Van Ngoc Thinh 2006). Likewise with Que Son West FMU, which was one of several survey sites in Quang Nam province in Long (2005), but has been shown as single site for clarity.

of small carnivores that ought to be present and in some cases relatively common at this site, is the as yet unknown indirect effects of the defoliants that were sprayed over the area now comprising Cat Tien NP during the America-Vietnam war (Polet & Ling 2004).

Threats to small cat species in Vietnam

Although historical information is too patchy to be sure of past small cat status in Vietnam, it seems likely that all species were formerly considerably more common. Though the more tolerant and widespread leopard cat is still relatively easily observed in parts of Vietnam (Table 2), even its numbers are likely to have declined. Hunting, notably indiscriminate snaring, is doubtless the main factor behind these suspected declines, as it is for many threatened mammal, bird and reptile species in the country (CEPF 2012). Vietnam's only areas afforded some respite from hunting are those that are naturally barely accessible (Eberhardt 2012), and the vicinities of FPD headquarters and the main tourist trails in protected areas, which do at some sites show signs of wildlife recovery. Crucially though, these areas have not yet

shown any cat recovery; however, this has only been well tested at Cat Tien NP where other possible factors (discussed earlier) may be at play.

Few survey reports reviewed quantified threats (notably excepting Timmins & Trinh Viet Cuong 2001, Long 2005, Nguyen Xuan Dang et al. 2012), but nearly all described hunting pressures at their respective sites as 'high'. Ground-level trapping, usually in the form of cable-snares, is widespread in Vietnam's forests and there are several reports of thousands of snares confiscated annually from some individual PAs (Birdlife International 2010, CPCP, unpubl. data), and in some cases tens of thousands (WWF 2013). The only sites not intensively targeted with this hunting method appear to be areas where most ground-dwelling fauna has already been depleted, such as in Cuc Phuong NP and Ngoc-Son Ngu Luong NR where hunting methods have switched to those suitable for arboreal species i.e. guns and crossbows (DHAW pers. obs.), or where the habitat only supports using this method for part of the year e.g. the seasonally flooded U Minh Wetlands in the Mekong Delta (DHAW pers. obs.).

Cable snares are usually placed in lines along man-made pathways, sometimes in the hundreds, with drift fences of cut vegetation alongside to funnel fauna across the snares' triggers. This unselective method seems likely to be an extremely effective way to hunt small cats. Trail use varies between ecologically similar species (Harmsen et al. 2010), but leopard cat, clouded leopard, Asiatic golden cat, jungle cat and marbled cat have all been recorded along such trails by camera traps (e.g. Grassman 2003, Do Ngoc Cuong 2004, Kawanishi & Sunquist 2008, Wibisono & McCarthy 2010, Majumder et al. 2011), and so are presumably vulnerable to this hunting method.

Several potential small cat prey items e.g. macaques *Macaca*, wild pig, chevrotains *Tragulus*, and red junglefowl *Gallus gallus*, are hunted in protected areas in Vietnam to supply the illegal wildlife trade. Whilst intensive hunting pressures, particularly unselective cable-snaring, have caused apparent population declines in some of these prey items at some sites (e.g. the Ke Go-Khe Net Lowlands; CPCP, unpubl. data), other sites included in this review seem to retain relatively healthy prey bases of small to medium sized animals, yet among cats have only recorded leopard cat e.g. Cat Tien NP (Shih-chih Yen 2009), and the Saola NRs (WWF-Vietnam,

unpubl. data), or no cats at all e.g. Phong Nha Khe Bang NP (Nguyen Xuan Dang et al. 2012). Though the ecology of most of these small cat species is poorly known, several of the smaller possible prey items e.g. murid rodents, still appear relatively abundant in the majority of Vietnam's protected areas. Few of these smaller prey items are targeted for the wildlife trade, at least at an international level, and the impact of ground-level trapping on small animals (i.e. <1 kg), especially those species that are semi-arboreal/arboreal, is likely to be negligible. It therefore seems unlikely that prey depletion is a main threat to Vietnam's small cats, at least not to the extent it is for larger carnivores in South Asia (e.g. tiger; Datta et al. 2008, Barber-Meyer et al. 2013). Clouded leopard does take larger prey than Vietnam's other five small cat species, including primates (Matsuda et al. 2008), which are targeted for the illegal wildlife trade (Geissmann et al. 2000). The extent to which this species is dependent on species themselves depleted by overhunting is however unknown.

Despite all cat species in Vietnam being afforded full legal protection, none is unaffected by illegal wildlife trade there. Leopard cat is most frequently traded, apparently in demand as an exotic pet (TQP pers. obs.). Confiscated golden cats both live and dead/frozen (ENV 2010, 2011, 2013a, 2013b) have been recorded. These two species were the most frequent small cats observed in the wildlife trade based on CPCP confiscation data and confiscation reports published by Education for Nature Vietnam ENV from 2006 onwards. Only two possible trade records for clouded leopard were traced during the same time period, and none for the other three species (a single live leopard cat, misidentified as fishing cat was confiscated July 2011; DHAW examined the original photographs and confirmed identification). A two-month survey on bear (Ursidae) bile trade covering Traditional Medicine outlets in all Vietnam's major cities recorded only one species of small cat: leopard cat (TRAFFIC, in press). Since 2011 there have been three records of dead golden cats confiscated from the illegal wildlife trade in Vietnam painted to resemble tiger.

All small cat species have been recorded in the illegal wildlife trade in South-east Asia (Duckworth et al. 1999, 2005, Shepherd & Nijman 2008), with clouded leopard in high demand because of its striking coat pattern (Shepherd & Nijman 2008, Sanderson et al. 2009). The

few recent trade records for clouded leopard in Vietnam are unlikely to reflect decreasing or low demand, which is likely to be increasing as numbers grow of wildlife consumers/users in Vietnam, i.e. middle-class urbanites (Robertson 2007, TRAFFIC 2008). More plausibly there are simply fewer animals to hunt and trade. That leopard cat and golden cat are the small cat species most frequently recorded in the illegal wildlife trade corroborates the field records relative to the other small cat species. Though leopard cat is probably relatively resistant to hunting pressures, it is likely to have gone through significant declines in Vietnam, in part still appearing to be 'common' in the trade because the species's starting population (i.e. prior to the growth of the illegal wildlife trade) was much larger and more widespread, relative to the other small cat species.

Conclusion

The most plausible explanation of the great rarity in Vietnam of recent records of small cats, except leopard cat, is that they are in serious decline in the country and are plausibly being extirpated from an increasing number of protected areas. The rapid loss of natural habitat is unlikely to have been an important driver of current status, even the more forest dependent species, because of the lack of records from even large blocks of surviving and little-degraded habitat.

Targeted hunting of some prey items and indiscriminate cable-snaring of others may have resulted in a depleted prey base for clouded leopard populations at some sites in Vietnam. However, several camera trap surveys at sites with suitable habitat and relatively healthy populations of known prey items have failed to record the species. Hunting, particularly cable-snare trapping, which is widespread and intensive within and outside nearly all of Vietnam's accessible natural and semi-natural areas, irrespective of whether a site is formally protected or not, is surely the main cause of decline in Vietnam's small cats.

Vietnam's protected areas are mostly under 500 km², limiting the resilience of their fauna to hunting. The country may no longer hold significant populations of any globally threatened small cat species, although were hunting controlled, the present habitat could be reoccupied by large and significant numbers of small cats.

Conservation Recommendations

Surveys in U Minh Thuong NP, the last site with confirmed fishing cat records in Viet-

nam, are urgently needed to clarify that species's present status. Any population is likely to warrant direct conservation intervention as it could potentially be of regional significance. Surveys should use camera traps in the same locations as Nguyen Xuan Dang et al. (2004) as well as additional locations to ensure a sufficient coverage of the site.

Targeted surveys for fishing cat in the U Minh landscape as well as other sites in the Mekong Delta are also warranted. In other countries, fishing cat does not need pristine or large areas of habitat to persist, even using small highly modified wetland-agriculture mosaics (Adhya 2011, Mukherjee et al. 2012). The Mekong Delta may thus hold other fishing cat populations. Mui Ca Mau NP is a priority site for a targeted survey as it contains suitable habitat and remains little-surveyed. Vietnam is extremely unlikely to retain globally significant populations of clouded leopard, golden cat, marbled cat or jungle cat. National populations of each are clearly not now large, and there is no suggestion of taxonomic distinctiveness of Vietnamese populations. Both Cambodia and Lao PDR have many fewer people than Vietnam and much larger areas of wild habitat. Crucially, the intensive industrial-scale snare trapping presumed to be the main factor behind the decline in Vietnam's small cat population is not yet widespread in Cambodia (S. Mahood in litt. 2013) and even some areas of Lao PDR remain to be affected (Coudrat et al. 2014, this issue).

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