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Predicted distribution of small-toothed palm civet *Arctogalidia trivirgata* (Mammalia: Carnivora: Viverridae) on Borneo

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Wilting et al. (2016: Table 2) list all co-authors' affiliations.

Abstract. Small-toothed palm civet *Arctogalidia trivirgata* occurs widely across Borneo. Eighty-two spatially precise records were used to model its distribution on the island. While the model predicts some regions of low suitability, the scatter of records (mostly insufficiently spatially precise for use in the model) within them and the generally low relevant search effort make a conclusion of genuine low suitability of these areas premature. Modern surveys rely heavily upon ground-level camera-trapping, a technique demonstrably unsuited to this largely arboreal species, which is therefore often overlooked unless spotlighting or arboreal camera-trapping is undertaken. It is at least locally numerous in Borneo and occurs over a wide altitudinal range, well above the heavy deforestation of the lowlands. Its arboreal habits are likely to insulate it from trapping. Its use of monoculture plantations is unclear, but if it does not use these, its total Bornean population is likely to have declined roughly in proportion to the level of forest conversion in the last few decades. However, its survival on Singapore even a century after forest cover was reduced to small, degraded isolates indicates high adaptability to forest encroachment, provided some native forest survives, although such tolerance cannot yet be confirmed for Borneo. Even if oil palm, rubber and acacia plantations are unsuitable for small-toothed palm civet, current plans across Borneo for native forest retention through protected areas and low-impact logging appear sufficient to ensure its long-term survival.

Key words. Borneo Carnivore Symposium, Brunei, conservation priorities, habitat suitability index, Indonesia, Malaysia, Species distribution modelling, survey gaps, three-striped palm civet

Abstrak (Bahasa Indonesia). Musang Akar *Arctogalidia trivirgata* dijumpai secara luas di Borneo. Sebanyak 82 catatan perjumpaan digunakan untuk pemodelan persebaran di pulau ini. Walau pemodelan menghasilkan pendugaan atas beberapa wilayah yang rendah tingkat kesesuaiannya, tersebarnya catatan yang ada (sebagian besar catatan tidak terlalu baik digunakan dalam pemodelan ini) serta rendahnya data yang sesuai, ada dugaan bahwa jenis ini sebenarnya tersebar merata. Cara survey termodern sangat bergantung pada perangkap kamera yang umumnya ditempatkan di atas permukaan tanah, suatu teknik yang tampaknya kurang sesuai untuk jenis satwa arboreal ini, sehingga kerap tidak terdeteksi terkecuali menggunakan lampu sorot atau perangkap kamera yang penempatannya disesuaikan untuk hewan arboreal. Setidaknya jenis ini dijumpai banyak di Borneo and tersebar pada ketinggian wilayah yang cukup luas, di atas wilayah yang telah gundul hutannya pada dataran rendah. Sifatnya yang arboreal menjadikan satwa ini sering terlepas dari pantauan. Kehadirannya di wilayah hutan monokultur belum jelas, dan seandainya jenis ini tidak menggunakan wilayah ini, maka total populsi di Borneo tampaknya menurun selaras dengan konversi hutan yang telah terjadi selama beberapa dekade ke belakang. Namun, bertahannya satwa ini di kawasan Singapura, seabad setelah konversi hutan terjadi, yang hanya menyisakan sejumlah kecil luasan hutan dan terisolasi, menandakan tingginya tingkat adaptasi satwa pada suatu wilayah yang terganggu. Namun hal semacam ini belum dapat dipastikan terjadi di Borneo. Walaupun seandainya perkebunan kelapa sawit, karet dan acacia tidak sesuai untuk Musang Akar, perencanaan yang ada saat ini di wilayah Borneo dalam hal mempertahankan hutan alam melalui penetapan kawasan lindung dan teknik pembalakan berdampak rendah, tampaknya sudah cukup untuk mempertahankan keberlanjutan hidup satwa ini untuk jangka panjang.

Abstrak (Bahasa Malaysia). Musang Akar *Arctogalidia trivirgata* didapati meluas di seluruh Borneo. Lapan puluh dua rekod yang tepat digunakan untuk meramal penyebaran spesis ini di Borneo. Walaupun model ini meramalkan sesetengah daearah kurang sesuai untuk spesis ini, namun ini mungkin akibat usaha pemantauan yang kurang dan penyelerakan rekod-rekod dari daerah-daerah ini (kebanyakan rekod tidak cukup tepat untuk digunakan di dalam proses pemodelan), dan ini bermaksud spesis ini mungkin juga berleluasa di daerah-daerah seperti ini. Pemantauan zaman moden banyak menggunakan perangkap kamera yang diletak atas paras tanah, suatu kaedah yang tidak sesuai bagi spesis seperti ini yang menghabiskan banyak masa di atas pokok dan oleh itu, kerap-kali tidak dapat dikesan; spesis seperti ini hanya dapat dikesan bila pemantauan dijalankan dengan menggunakan lampu suluh (spotlighting) atau apabila perangkap kamera diletak atas pokok. Spesis ini dipercayai berada di Borneo pada jumlah yang tinggi dan didapati di pelbagai aras ketinggian atas paras laut, jauh lebih tinggi daripada kawasan rendah di mana kadar kemusnahan hutan lebih tinggi. Oleh kerana spesis ini banyak menghabiskan masa di atas pokok, ia tidak banyak terjejas oleh jerat dan perangkap yang dipasang oleh pemburu-pemburu. Tahap penggunaan kawasan perladangan kurang jelas, dan sekiranya ia tidak menggunakan kawasan perladangan, maka jumlah populasinya di Borneo

mungkin berkurangan sekadar dengan pertukaran hutan kepada ladang sejak beberapa dekad kebelakangan ini. Namun demikian, spesis ini masih didapati di Singapura seabad selepas litupan hutan di sana terbatas kepada kawasan-kawasan yang kecil, terpencil dan sudah didegradasi. Ini menunjukkan spesis ini mempunyai tahap penyesuaian yang begitu tinggi terhadap pencerobohan hutan, asalkan hutan asal masih wujud; namun ini belum lagi dapat disahakan di Borneo. Walaupun perladangan kelapa sawit, getah dan acacia didapati tidak sesuai untuk spesis ini, namun rancangan pengurusan hutan asal yang sedia ada, melalui rangkaian kawasan terlindung sepenuhnya dan kawasan yang dibalak secara halus dan berlanjutan, mungkin mencukupi untuk memastikan pemuliharaan spesis ini secara jangka panjang.

INTRODUCTION

The palm civet genus *Arctogalidia* Gray, occurs across much of mainland South-east Asia and the Greater Sundas, extending locally into southern China and North-east India (Corbet & Hill, 1992). The many races named were for many decades universally regarded as one species, small-toothed palm civet *A. trivirgata* (Gray). Until 2015, the most recent taxonomic revision of this genus was by Van Bemmel (1952), who documented the morphological differences between the populations in (1) the non-Sundaic part of the range, (2) the Thai–Malay peninsula, Borneo and Sumatra, and (3) Java. He regarded these three forms as conspecific, expressing his findings in now-obsolete form: *A. t.* grex *leucotis* (Horsfield), *A. t.* grex *trivirgata* and *A. t.* gregal form *trilineata* (Wagner), respectively, with both greges including multiple subspecies. Van Bemmel's (1952) analysis was undertaken during "the regrettable trend from about 1920 to 1980, when specific recognition was excessively restrained" (Brandon-Jones et al., 2004): the compression of so much variation within *Arctogalidia* into one nominal species is a prime example of this. There are also vocal differences between animals in Borneo and in the Mekong catchment, representing the two nominal greges (Duckworth, 1997). A very recent genetics-based analysis (Veron et al., 2015) also suggested that the genus *Arctogalidia* contains multiple species, but considered that the Bornean race (which lies within one of van Bemmel's greges) was the most divergent. These authors stressed the need for further investigation before proposing taxonomic change. If the Bornean form (Fig. 1) does comprise an endemic species, this would elevate its global conservation significance and the urgency for conservation action, if any, deemed necessary for the genus in Borneo.

The genus has never been studied in the field anywhere in its range. It is known only from records during general collecting expeditions and surveys, limited observation of captive animals, and some study of museum material (Duckworth & Nettelbeck, 2008 and references therein). The taxonomic diversity within the genus suggests it is particular risky to pool ecological and behavioural information from throughout the genus's range: some might not be applicable to Bornean animals.

Fig. 1. small-toothed palm civet *Arctogalidia trivirgata*, Sabangau Peat-swamp Forest, Central Kalimantan, 28 July 2011 (Photograph by: Susan M Cheyne/OuTrop).

Large parts of its range have few recent records (e.g., Myanmar and India; Than Zaw et al., 2008; Kakati & Srikant, 2014), but there is nothing (such as extensive spotlight survey failing to find the species) to indicate that this does not simply reflect low use of techniques suitable to detect the species. This might be true even for Java, the only part of the genus's range with plausible suggestion that it might be anything other than widespread and common (Eaton et al., 2010; Rode-Margono et al., 2014). *Arctogalidia* is highly arboreal, strictly nocturnal and, throughout its range, sympatric with many small carnivore species. Hence, it is not amenable to survey by daytime direct observation, camera-trapping (as conventionally operated in South-east Asia, at ground level), signs or village reports; only night-time direct observation (spotlighting) or arboreal camera-trapping detect it often (e.g., Duckworth & Nettelbeck, 2008; Wahyudi & Stuebing, 2013). Willcox et al. (2012) traced many conventional camera-trap surveys that did not find the species where other means showed it to occur. Two startling indications of how easily overlooked it is by conventional camera-trapping come from Borneo. In a concession in Bintulu division, Sarawak, where none was camera-trapped in about 2000 camera-trap-nights, 10 were seen in two hours' exploratory spotlighting (Belden et al., 2007); and in one part of East Kalimantan, heavy ground-level camera-trapping did not record the species, yet when camera-traps were set up in the trees it became

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the third most commonly photographed small carnivore overall (Wahyudi & Stuebing, 2013). Similarly, in Thung Yai Naresuan Wildlife Sanctuary, Thailand, camera-traps placed on the ground with a few on leaning logs crossing small streams never recorded this species in more than 10,000 camera-trap-nights across three years; yet in only 43 hours of spotlighting, small-toothed palm civet was encountered 14 times (sometimes as duos) (Chutipong *et al*., 2014).

The genus is evidently common at least in some areas, but nothing else is known about population densities or home-range sizes. It is often seen eating fruit in fruiting trees (e.g., Duckworth, 1997; Willcox et al., 2012) but stomach contents show it to be partly carnivorous (Pocock, 1939; Davis, 1962; Harrison, 1962; Lim & Betterton, 1977). While its overall diet, let alone any seasonal variation in it, is poorly known, its unusual dental characters suggest it is frugivorous (Gregory & Hellman, 1939). Apparently in contrast to other Asian palm civets, it often feeds in fruiting trees in groups (Nakabayashi et al., 2012 and references therein; Willcox et al., 2012).

Small-toothed palm civet is categorised as Least Concern on The IUCN Red List of Threatened Species (IUCN, 2015). There is no suggestion that population declines (which are presumably underway, at least in proportion to the extent of conversion of forest into non-forest habitats) are steep enough (at least a fifth of the global population lost in the last 15 years, or expected to be lost in the next 15) to warrant a categorisation even as Near Threatened, and it is too numerous and widespread to trigger any range or population size criterion (see thresholds in IUCN, 2012). The species is protected under the Sarawak Wild Life Protection Ordinance 1998 and the Sabah Wildlife Enactment 1997 under Schedule 2 Part I whereby only limited hunting and collection are permitted, upon the issuance of license. It is not protected in Brunei or in Indonesia.

RESULTS AND DISCUSSION

Species occurrence records. In total 208 records were collated; 70 were excluded from modelling because their spatial precision was too low (over 5 km; Categories 4 and 5), and only 17 records both had high precision (within 2 km, Category 1) and were generated within 2001–2011 (Table 1, Fig. 2). Most records were collected from Malaysia and North and East Kalimantan, with fewer from West and Central Kalimantan, and only one each from South Kalimantan and the Brunei Darussalam–Sarawak border area. Only 48 (Balanced Model = M_1) or 82 (Spatial Filtering Model = M_2) records were used for modelling: many others were too close to others (within 2 km) to be considered spatially independent, while the large number from Sabah biased the model for the rest of Borneo, so only a proportion from the state was used in the Balanced Model (see Kramer-Schadt et al. (2016) for details).

Habitat associations. The eight respondents of the questionnaire varied widely in their assessment of suitable land-cover for small-toothed palm civet (Table 2); for a third of the 15 categories respondents varied between 0 or 1 and 4, the maximum possible range. The only strongly consistent responses were for lowland forest (highly suitable) and burnt forest, mixed crops, bare areas, water and fishponds, and water (unsuitable). Other highly-ranked habitats, on average, comprised upland and lower montane forest, and lowland and upland forest mosaics. Other low-ranked habitats, on average, comprised young plantations and crops, old plantations, mangrove and swamp forest. The wide range of opinion doubtless reflects the limited familiarity most people have with this species. In some habitats it can be difficult to find practicable spotlighting routes, e.g., mangroves, swamp forest and upper montane forest; unsurprisingly, these habitats had individual assessments ranging from 0 to 4. More surprising was the high diversity of opinions for old plantations, suggesting a lack of spotlighting in them (or at least awareness of results), despite their often easy access.

Small-toothed palm civet records come overwhelmingly from evergreen forest throughout its range. The only known record from within deciduous forest anywhere in the genus's range may be a duo observed on three consecutive nights in a fruiting *Elaeocarpus* L. amid mixed deciduous forest, some 400 m from the nearest patch of evergreen forest in Thung Yai Naresuan Wildlife Sanctuary, Thailand (Chutipong et al., 2014; W. Chutipong in litt., 2014).

Records include some from heavily degraded areas provided some contiguity of canopy remains (e.g., Duckworth, 1997; Willcox et al., 2012; Chutipong et al., 2014). The extent to which populations can persist in entirely degraded landscapes has not been assessed. Although there are many records from little-degraded forest, there is little information specific to use of logged areas in Borneo. Heydon & Bolloh (1996) confirmed persistence in recently logged forest but had too few sightings to test whether densities differed from those in primary forest. Based on the use of heavily degraded areas, provided some contiguity of canopy remains, in mainland South-east Asia (e.g., Duckworth, 1997; Willcox et al., 2012), and woodland dominated by non-native trees in Java (Moore & Wihermanto, 2014), it seems implausible that low-impact logging would eradicate the species widely on Borneo; its effects on density cannot meaningfully be speculated upon.

The extent to which it uses the habitats given inconsistent responses in Table 2 is unclear. Across its range, there are few records above about 1500 m altitude (from Gunung [=Mount] Kinabalu; Medway, 1977) but it has recently been spotlit on Gn. Kinabalu at 1700 m (November 2013; JAE pers. obs.) and found many times (during 2004–2015) within 1800–2100 m in Kerinci Seblat National Park, Sumatra (J. Holden in litt., 2015; JAE pers. obs.), suggesting that the rarity of records at higher altitudes might reflect paucity of survey effort more than of animals. There are various records from plantations (coconuts, Miller, 1901; native *Melaleuca* L., Willcox et al., 2012) but we traced insufficient spotlight or arboreal camera-trapping survey effort in the major plantation species in Borneo today (oil palm, rubber and acacia) to determine whether this civet uses them significantly. Wahyudi & Stuebing (2013) did not camera-trap it (despite heavy

Table 1. Summary of occurrence records for small-toothed palm civet *Arctogalidia trivirgata* on Borneo.

Spatial Precision	Total No. of Records	No. of Records in M_1	No. of Records in M_2	No. of Recent Records 2001–2011
Category 1 below 500 m	19	10	16	17
Category 2 500 m – 2 km	18	3	12	3
Category 3 2–5 km	101	35	54	13
Category 4 above 5 km	42	–	–	5
Category 5 (no coordinates*)	28	–	–	3
Total	**208**	**48**	**82**	**41**

M_1 = Balanced Model; M_2 = Spatial Filtering Model (2 km); *only coarse location description was available.

Table 2. Land-cover reclassification for small-toothed palm civet *Arctogalidia trivirgata* based on questionnaire results of eight respondents working on carnivores on Borneo.

Land-cover Class	Mean of Reclassification	Range of Reclassifications
Lowland forest	3.88	3–4
Upland forest	3.38	2–4
Lower montane forest	3.00	1–4
Upper montane forest	2.00	0–4
Forest mosaics/lowland forest	2.58	*
Forest mosaics/upland forest	2.41	#
Swamp forest	1.75	0–4
Mangrove	0.86	0–4
Old plantations	1.71	0–4
Young plantations and crops	0.57	0–2
Burnt forest area	0.14	0–1
Mixed crops	0.29	0–1
Bare area	0.00	0–0
Water and fishponds	0.13	0–1
Water	0.00	0–0

*/#Calculated based on the mean of the reclassification of old plantation and *lowland forest or # upland forest respectively.
Habitat suitability rank ranges from 0 (unsuitable) to 4 (most suitable); further detail, and on land-cover classes, in Kramer-Schadt et al. (2016)

search effort) in oil palm stands at an area of East Kalimantan where they did find it commonly in the remnant native forest patches. It is known to use swamp-forest in Borneo, it has once been recorded (by ground-level camera-trapping) at Sabangau, Central Kalimantan (SMC pers. obs.; Fig. 1), and it has been spotlit in such habitat at Gunung Palung, West Kalimantan (AJM pers. obs.); various records from such forest in other countries (Syakirah et al., 2000; Willcox et al., 2012), suggest that it might be occupied widely in Borneo. In sum, this imperfect consensus on suitable habitat, coupled with the use of information from outside Borneo, may have produced reclassification means diverging from this civet's habitat use in Borneo.

Habitat suitability index (HSI) model. The predictive suitable habitat map (Fig. 3) suggests somewhat lower suitability south of the equator than to the north, potentially an artefact of uneven surveying. Although there are seven category 4 records (not used in the model) from southern Borneo, there are few precisely located records from this region: three, one and six, in categories 1, 2 and 3 respectively. This paucity, together with the area's rather different climate, increases the likelihood that southern Borneo would be predicted in error to be unsuitable. The wide spread of the imprecisely located records suggests that the species occurs in much of this area. Fig. 3 suggests large overlap between the protected area system and predicted small-toothed palm civet range, consistent with the location of many protected areas in forest, the habitat in which most spotlighting

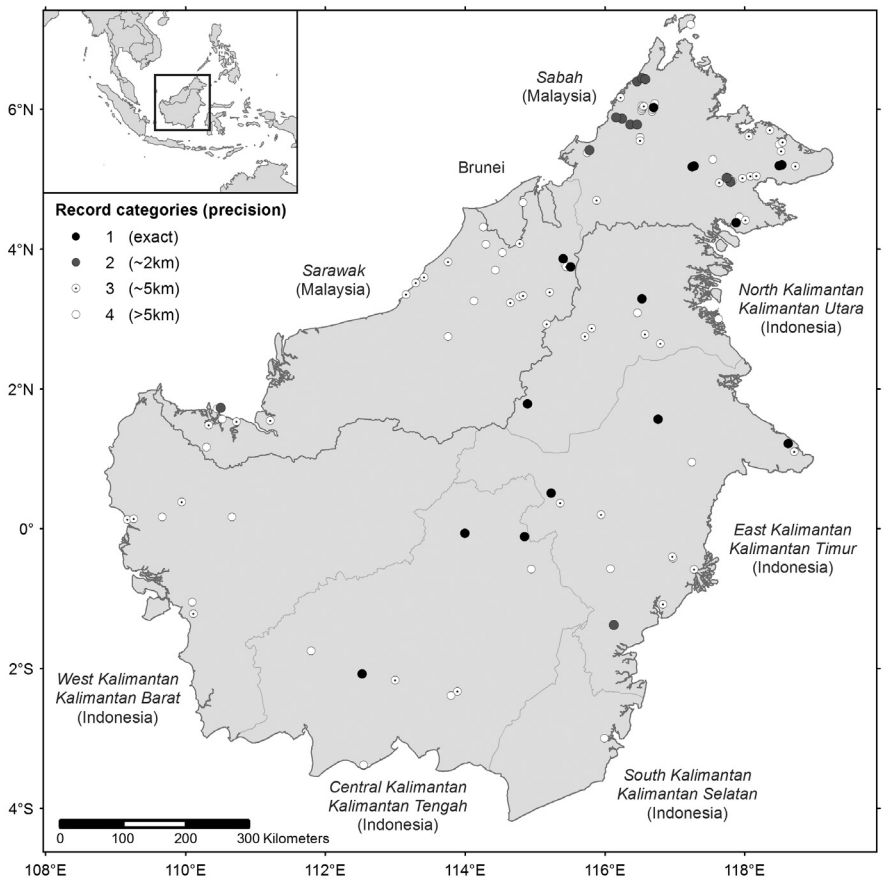

Fig. 2. Location of small-toothed palm civet *Arctogalidia trivirgata* occurrence records in Borneo, showing categories of spatial precision as well as country and state boundaries.

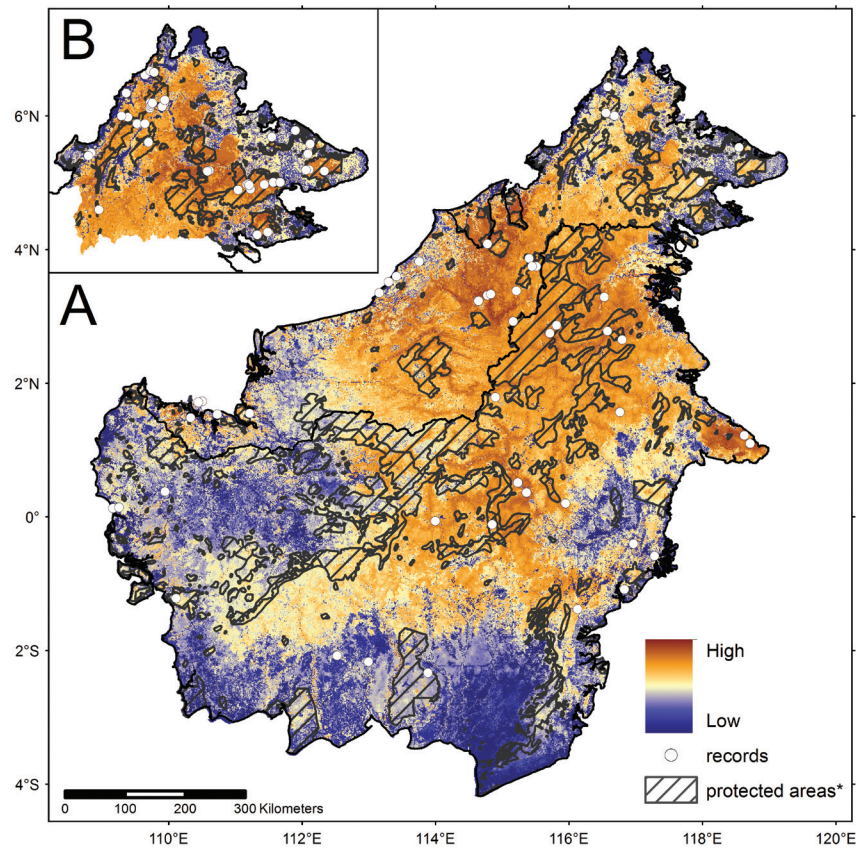

Fig. 3. Predictive Habitat Suitability Index (HSI) models for small-toothed palm civet *Arctogalidia trivirgata* including location records used in models. A, Balanced Model for the island of Borneo; B, Spatial Filtering Model for Sabah, Malaysia. Sources for protected area information: see Kramer-Schadt et al. (2016).

occurs, and thus records are made. Hence, identification of priority areas for the species is not necessary; nor, given the restraints on the model's output imposed by the uneven survey effort across the area and habitats of Borneo, would it be appropriate.

Brunei Darussalam. Nearly all Brunei is predicted to be highly suitable. This reflects the predominant natural vegetation cover of lowland and hill dipterocarp forest, and a lower proportion of conversion to monoculture plantations and other non-forest uses than in much of the rest of Borneo. The paucity of records traced is likely to reflect lower survey effort there, not a genuine scarcity: this pattern is shown by many other Bornean carnivores, and many records of small-toothed palm civet come from close to Brunei.

Sarawak, Malaysia. Much of Sarawak is predicted to be highly suitable. This reflects the predominant natural vegetation cover of lowland and hill dipterocarp forest. However, the lowlands, particularly in the west of the state, are considered extensively to be rather unsuitable. The species certainly occurs right down to sea-level (e.g., in Similajau National Park; Duckworth, 1995), but its use of extensive swamp forest is unclear (see above) and much of the lowlands have been converted to monoculture plantations and other non-forest uses in the last 30 years. It is unclear whether the large record-less swathe between Kuching and Bintulu is an area where small-toothed palm civet is rare (even absent), or has simply not been surveyed appropriately to find it.

Sabah, Malaysia. Much of Sabah is predicted to be highly suitable, where natural vegetation cover of lowland and hill dipterocarp forest survives. The coastal and most other lowland areas have seen heavy forest conversion and are therefore predicted to be less suitable now. Many records came from these areas (Fig. 2) in the past.

North Kalimantan, Indonesia. Nearly all of North Kalimantan is predicted to be highly suitable. The predominant natural vegetation cover of lowland and hill dipterocarp forest resembles that in much of Malaysian Borneo.

East Kalimantan, Indonesia. Much of East Kalimantan is predicted to be highly suitable. As with Malaysian Borneo and North Kalimantan, this reflects the predominant natural vegetation cover of lowland and hill dipterocarp forest.

South Kalimantan, Indonesia. South Kalimantan is Borneo's only political unit that is predicted to be largely unsuitable for small-toothed palm civet. This area is particularly under-surveyed relative to the rest of the island and we traced no results of spotlight surveys there, so this civet might occur there much more widely than so far recorded. This area of Borneo has the harshest dry season, although parts of East Kalimantan have lower total annual rainfall (extracted from Hijmans et al., 2005, 2015). Its climatic distinctiveness makes it impossible that the model could predict South Kalimantan as suitable for small-toothed palm civet based on records from other parts of Borneo. Given the genus's great rarity in the deciduous forests of Indochina (see above), it is conceivable that it might be rare in this part of Borneo, particularly if the Bornean taxon is less tolerant of seasonal drying than are the populations in Indochina. The single record traced from South Kalimantan – insufficiently spatially precise to have been modelled – is from around Klumpang Bay, where two were collected by W. L. Abbott (Lyon, 1911; Miller, 1913), a collector unlikely to report a market specimen as if it were an original locality, and who collected for many weeks in the bay's hinterland. In sum, it is plausible that small-toothed palm civet is more widespread or numerous in South Kalimantan than the model suggests.

Central Kalimantan, Indonesia. Central Kalimantan shows a basic division into interior hill areas predicted to be highly to fairly suitable for small-toothed palm civet versus the extensive coastal and interior lowlands that are predicted to be unsuitable, mostly highly so. As discussed above, this pattern could reflect the real distribution of the animal, survey heterogeneity, or some combination of the two. The distribution of actual records (several imprecisely located and thus excluded from the model) suggests that small-toothed palm civet could be found to occur in much of the predicted low suitability area of Central Kalimantan. The confirmed presence of the species in Sabangau Peat Swamp Forest (Fig. 1) at about 10 m a.s.l. and within an area predicted to be largely unsuitable, even though the record was incorporated in the model (Fig. 3) is consistent with this.

West Kalimantan, Indonesia. West Kalimantan is predicted to be almost entirely unsuitable for small-toothed palm civet, other than small parts in its interior. These latter border other provinces and are climatically similar to the more northern parts of Borneo that provided many records for the model. West Kalimantan is not overall well surveyed. The total number of recorded localities (seven) and their location in the west of the province, distant from large areas predicted to be suitable, suggests that Small-toothed Palm Civet might be, or have been before large-scale deforestation, widespread in the province.

THREATS AND CONSERVATION PRIORITIES

No conservation priorities are obvious for small-toothed palm civet in Borneo. There is no suggestion of cryptic taxa on the island that require conservation intervention. The species occurs widely across the island, with imprecisely located specimens indicating that even those parts of Borneo not predicted by the model to be highly suitable form part, at least locally, of its natural range on the island. It occurs over a wide altitudinal range, with many records from over 500 m (the highest Bornean record being from 1700 m; see above) and thus above the zone of heavy deforestation (more than 97% of the deforestation in Borneo between 1973 and 2010 occurred in the coastal lowlands, below 500 m a.s.l.; Gaveau et al., 2015). Most forest on Borneo is broad-leaved evergreen, from which most records come across its world range. Where suitable survey techniques are used, it is encountered commonly, at least locally, in Borneo (e.g., Wahyudi & Stuebing, 2013). In Vietnam, the genus persists in areas where hunting has eradicated most other

mammals of comparable or larger size (Willcox et al., 2012, 2014). It is one of only two civets surviving and taken as native (two others are suggested potentially to result from trade origin), on Singapore, where habitat fragmentation has been severe, and total habitat has been tiny (presently 12.75 km²) for over a century (Yee et al., 2011; Chua et al., 2012). (No information on presence in comparably small and long isolated forest blocks was traced from Borneo.)

The nocturnal arboreality that causes it to be widely overlooked by various common survey methods also insulates it from hunting by non-baited ground-level snares and other traps, dogs, and daytime active searching with projectiles (Duckworth & Nettelbeck, 2008). These being the predominant hunting techniques across much of the genus's range, there is no information on its tolerance of heavy off-takes (Willcox et al., 2012). The genus can be caught at ground-level traps when these are baited (Chutipong et al., 2014). Whilst cost considerations rule out the possibility that baited trapping could occur on a large-enough scale to drive declines of conservation significance, such trapping might be practicable using synthetic lures not needing frequent replenishment at each trap, if they also bring small-toothed palm civets down from the canopy. Even this seems implausible, given that such a trapping technique has not yet been found in Vietnam or eastern Lao PDR, together comprising an area that is in general hunted much more heavily than is, typically, Borneo (see Coudrat et al., 2014; Willcox et al., 2014).

Spotlight-assisted night-time projectile hunting finds small-toothed palm civet easily, and were there to be a widespread and sharp rise in this technique, its population response cannot be predicted. Such an increase seems unlikely, given that such hunting is labour-intensive, even when hunters work as many fruiting trees into their routes as possible. Moreover, spotlight hunters in Lao PDR say that financial returns are higher from targeting (and this determines the direction in which the light is aimed) ungulates (where reasonable populations persist) or frogs (in areas in which ungulates are severely reduced) than medium-sized arboreal mammals (JWD unpublished data). The relative returns from these different activities could change if market price of small-toothed palm civet were to rise sharply. It is presently an insignificant component of civet trade, at least on neighbouring Java (Nijman et al., 2014). Nonetheless, it is not inconceivable that demand for small-toothed palm civet in the Greater Sundas might rise sharply, given recent cases of rapidly arisen high demand for novelty pets (e.g., Nekaris et al., 2013). Whilst common palm civet *Paradoxurus hermaphroditus* (Pallas) is the species in current predominant use for 'civet coffee' (D'Cruze et al., 2014), it is likely that this species could be used just as effectively.

In common with other forest species, small-toothed palm civet has lost an extensive area of habitat in Borneo in the last few decades, and its population has presumably declined proportionately. Its persistence in the island probably (depending on the extent to which it uses large monoculture plantation-dominated landscapes) depends on the retention of native forests, perhaps preferably as effectively managed protected areas, but low-impact logging concessions seem likely also to be suitable. Forest blocks of either form typically far exceed on Borneo the size likely to be needed to retain, over many generations, populations of small-toothed palm civet. Although the species is regarded nationally as critically endangered on Singapore (Lim et al., 2008), it survives there, where total native forest cover is only 12.75 km² (2.80 km² of primary and 9.95 km² of mature secondary forest) and has been similarly restricted for decades (Yee et al., 2011).

If current plans concerning protected areas and other mechanisms that retain native forest on Borneo are supplanted by major further conversion to non-forest (including exotic plantations), or if a specific large trade demand arises for the species, then small-toothed palm civet's Bornean conservation prospects would need reassessment. As of now it seems secure, with its conservation needs met by forest-use designations (including protected areas) that, to meet the needs of more demanding species and processes, retain forest blocks adequate in size to retain this species.

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