

Small carnivore records from a threatened habitat linkage in Terengganu, Peninsular Malaysia

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Abstract

Habitat loss and fragmentation are a key threat to the survival of several small carnivore species in Southeast Asia. Enhancing habitat connectivity is therefore an important conservation strategy. In Peninsular Malaysia, the government plans to connect its fragmented forests via 17 habitat linkages to form a large contiguous forest complex known as the Central Forest Spine. Small carnivore species composition in these linkages remains poorly documented. Of the 12 species detected in and around Linkage 7, in the state of Terengganu, four are categorised as Vulnerable by *The IUCN Red List of Threatened Species*: Binturong *Arctictis binturong*, Banded Civet *Hemigalus derbyanus*, Oriental Small-clawed Otter *Aonyx cinereus* and Smooth-coated Otter *Lutrogale perspicillata*. A photograph of Crab-eating Mongoose *Herpestes urva* with young is the first record of this species from Terengganu, extending eastwards its known distribution in Peninsular Malaysia. Forests in and around this linkage are threatened by disturbance associated with an existing road, and the construction of a nearby dam. The study area's relatively high recorded small carnivore species richness, and its complement of globally threatened small carnivore species, supports its inclusion into a proposed protected area (known as the Kenyir Wildlife Corridor). Information on small carnivores in other linkages warrants publication, especially from camera-trap surveys that consciously account for microhabitat use and behavioural variation between different species. This would allow a clearer understanding of small carnivore communities in Peninsular Malaysia.

Keywords: Central Forest Spine, conservation, habitat linkage, Kenyir, road, selective logging

Introduction

Suitable habitats for forest-dependant small carnivores are disappearing faster in Southeast Asia than anywhere else in the world (Schipper *et al.* 2008). In fact, about 21–48% of regional populations of mammal species may be extinct by 2100, according to one alarming study (Brook *et al.* 2003). One key mammal conservation strategy for the region has been the establishment of corridors or linkages to restore ecological connectivity between fragmented habitats (e.g. Kawanishi *et al.* 2003, DWNP 2008, Clements *et al.* 2012b). Unfortunately, there is a paucity of research on the functional role of such corridors in this region (Sodhi *et al.* 2010), with almost nothing known about their small carnivore communities.

In Peninsular Malaysia, the Federal government's provisional plan to restore ecological connectivity between four fragmented forest complexes via a network of 17 habitat linkages (hereafter known as linkages; Fig. 1) is known as the Central Forest Spine Master Plan for Ecological Linkages (DTCP & DOF 2012). These linkages are threatened by anthropogenic disturbance. For example, all but two of the 17 are bisected by roads (Fig. 1; DTCP & DOF 2012), which have negative impacts on some mammal, bird and amphibian species in the tropics (Laurance *et al.* 2009).

Many linkages within the Central Forest Spine also comprise production forest reserves designated for selective timber extraction (DTCP & DOF 2012). Selectively logged and otherwise disturbed forests can have high conservation value for mammals (Wells *et al.* 2007, Berry *et al.* 2010, Foster *et al.* 2011, Giam *et al.* 2011, Gibson *et al.* 2011, Schwitzer *et al.* 2011, Putz *et al.* 2012), particularly for larger mammals in Peninsular Malaysia (Rayan & Mohamad 2009, Clements *et al.* 2012a, Rayan *et al.* 2012), but the species-specific effects of commercial logging on most small carnivores are uncertain (Colón 2002, Meijaard & Sheil 2008). Several studies in logged forests have recorded a decline in some species of small carnivores (Heydon & Bulloh 1996, Colón 1999), whereas others suggest that many

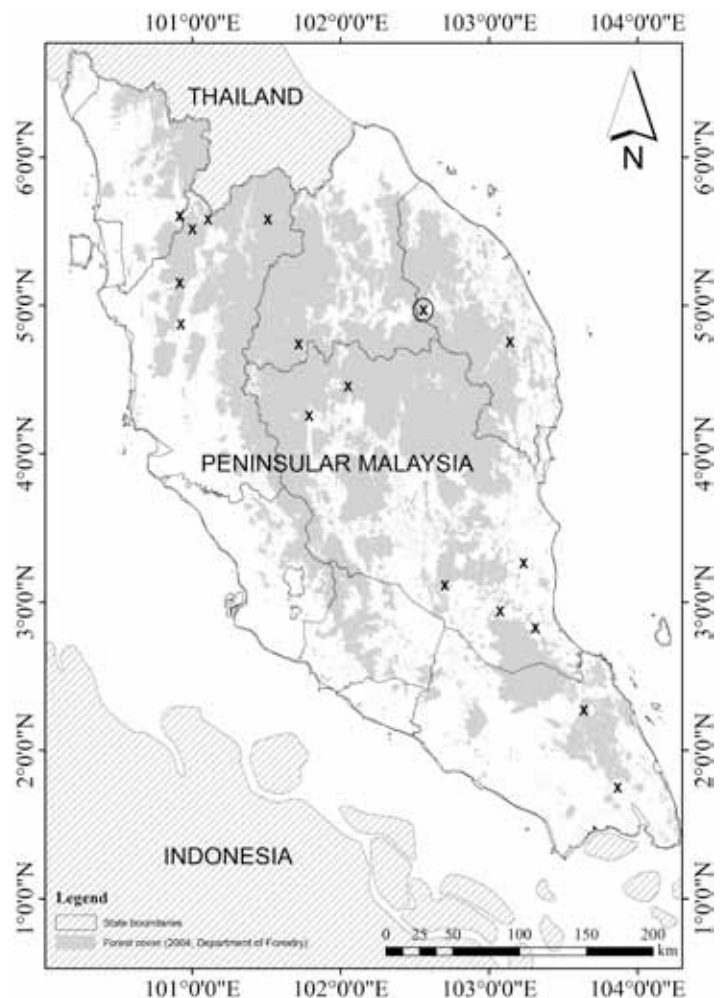


Fig. 1. Locations of 17 linkages ('x') identified by the Malaysian Federal government in the country's Central Forest Spine, including Linkage 7 (circled), subject of this study.

species persist without significant population declines (Syakirah *et al.* 2000, Meijaard & Sheil 2008, Samejima *et al.* 2012).

Twenty species of small carnivores from four families (Viverridae, Prionodontidae, Mustelidae and Herpestidae) inhabit Peninsular Malaysia (Francis 2008). In Malaysia, recent records of small carnivores come mainly from production forest reserves (e.g. Rayan & Shariff 2008, Mathai *et al.* 2010, Wiltling *et al.* 2010) and protected areas (e.g. Kawanishi & Sunquist 2004, Brodie & Giordano 2011, Matsubayashi *et al.* 2011). Because the designation of linkages is relatively recent at a national policy level (DTCP & DOF 2012), very little information is available on the small carnivores within them.

This paper reports the species composition and detection rates of small carnivores in and around one of Peninsular Malaysia's 17 habitat linkages – Linkage 7, in the state of Terengganu. These are the first published data on small carnivores from a linkage in this country.

Location, materials and methods

Located in the State of Terengganu, Linkage 7 is one of 17 habitat linkages identified within the Central Forest Spine (Fig. 1). A 60-km road with 10 underpasses (i.e. elevated road structures for vehicles) cuts through this linkage (Fig. 2). The study area consists of two forest blocks totalling 158 km², with the lower forest block encompassing Linkage 7 (see DTCP & DOF 2012). Both forest blocks span four production forest reserves (Tembat, Petuang, Hulu Temomong and Hulu Nerus), which contain both lowland and hill dipterocarp forests. They were first selectively logged in the 1970s. No logging was conducted in either block during the present study, but forests were being clear-felled for construction of a hydro-electric dam outside the study area (over 6 km away; Fig. 2). No permanent human settlements exist in the forest blocks.

Records were derived from a camera-trapping survey to investigate habitat use by mammals in and around Linkage 7 (Clements & Laurance 2012). Camera-trapping was conducted between April 2011 and March 2012, across dry (April–September) and wet seasons (October–March). The lower and upper forest blocks were stratified into 21 and 22 cells (2 × 2 km), respectively. Within each cell, a camera-trap was deployed in the upper-left sub-cell (1 × 1 km) during the first 60-day sampling occasion, before being moved in a 'Z' - shaped manner until every sub-cell was surveyed. The lower and upper forest block respectively thereby had an array of 21 and 22 operational camera-traps during each of four sampling occasions. Within each sub-cell, camera-traps were placed close to the centre of the sub-cell, to minimise clumping, and/or on linear features known to have high detection probabilities for some large mammals (e.g. animal trail, ridge or old logging road). Camera-traps were attached to tree trunks ~50 cm above ground level and 2–5 m from the trail's centre. This survey design will have resulted in low detection rates of any small carnivore species that avoid these types of trails.

Theft, malfunction, damage from Asian Elephants *Elephas maximus*, and blockage from vegetation all prevented use of some camera-traps' data. The 158 sub-cells providing usable data lay within an elevational range of 167–732 m (Datum WGS 84, indicative elevation derived from 1 km²-resolution digital elevation model from the Shuttle Radar Topography Mission elevation database and thus highly approximate, especially in rugged terrain). 'Day' detections occurred between 07h00 and 18h59, and 'night' detections between 19h00 and 06h59, following Kawanishi & Sunquist's (2008) study in a nearby area with similar sun-set and -rise times. No attractants were employed around the cameras. Camera-trap photos were catalogued using software Camera Base version 1.4 (<http://www.atrium-biodiversity.org/tools/camerabase>). To

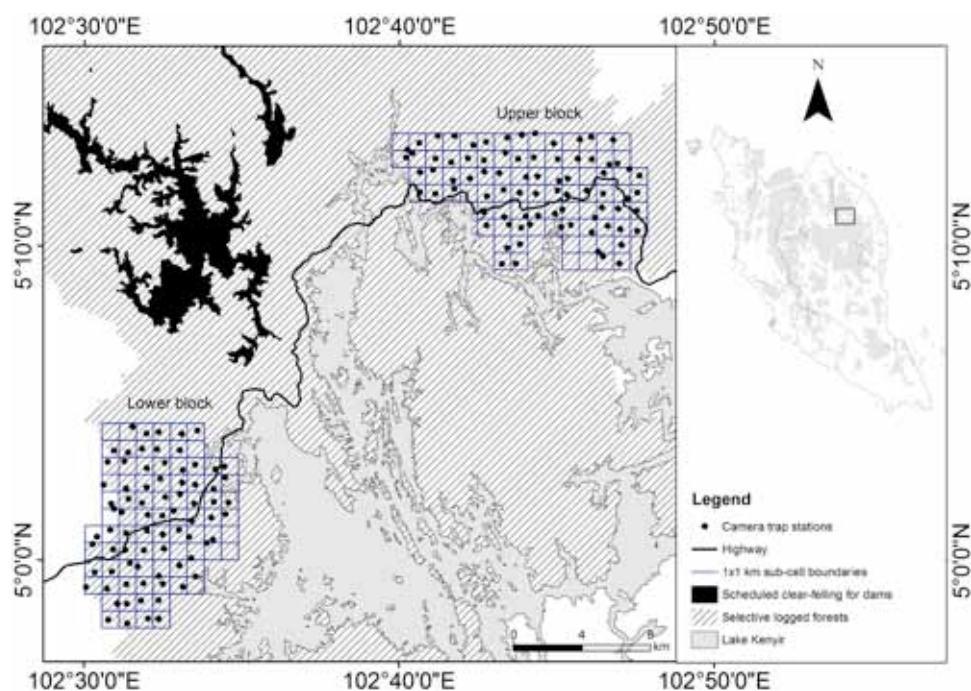


Fig. 2. Locations of 158 camera-trap stations within two forest blocks that were stratified into 1 × 1 km sub-cells in and around Linkage 7, Terengganu, Peninsular Malaysia.

facilitate comparisons with other studies, a notionally independent photograph was defined as a photograph of a species taken at least 0.5 hr after the previous photograph of the same species at the same camera-trap station.

Results and discussion

Twelve species of small carnivores were detected in and around Linkage 7, all of which are typical of lowland and hill dipterocarp forests. Nine of them were camera-trapped over 10,502 camera-trap-nights, one was camera-trapped subsequently, one was found as a roadkill and another was photographed *in situ* (Table 1, Appendix 1). Kawanishi & Sunquist (2004), in the adjacent Taman Negara National Park, with its boundary ~4 km from our nearest camera-trap, detected nine species of small carnivores from 14,054 camera-trap-nights.

In and around Linkage 7, the most frequently camera-trapped small carnivore was Banded Linsang *Prionodon linsang* (Table 1). This is surprising given its typical relative paucity of records during camera-trapping (e.g. Mathai *et al.* 2010, Wilting *et al.* 2010, Brodie & Giordano 2011), including in Peninsular Malaysia (Taman Negara, Kawanishi & Sunquist 2004; Gunong Basor Forest Reserve, Rayan 2007).

The presence of Crab-eating Mongoose *Herpestes urva*, which has been considered in Malaysia to be rare and patchily distributed (Lim 1991), represents the first record for the state of Terengganu, extending its known range south-eastwards by over 100 km from the previous eastern-most record in Peninsular Malaysia (Gunung Basor, Kelantan, 3°49'53"N, 103°35'30"E; Rayan & Shariff 2008). One image had an adult with three juveniles, three weeks after a photograph of a lone individual at the same station (Fig. 3). The approximate elevations of the species's records, within 600–700 m (Appendix 1), fall within the known range used in Malaysia (10–1,400 m; Rayan & Shariff 2008).

All five detections of Crab-eating Mongoose were during the day, but all those of Large Indian Civet *Viverra zibetha*, Masked Palm Civet *Paguma larvata* and Common Palm Civet

Paradoxurus hermaphroditus were by night, consistent with previously documented activity patterns of these four species (e.g. Van Schaik 1996, Duckworth 1997, Grassman 1998, Azlan 2006, Francis 2008). A third of the Binturong *Arctictis binturong* photos were taken during the day, supporting the notion that they are not solely nocturnal (e.g. Nettelbeck 1997, Brodie & Giordano 2011). All adult individuals of small carnivore species were detected singly except for Yellow-throated Marten *Martes flavigula*, which was detected in duos in three out of seven photographs; others have also found them in duos or small groups (Duckworth 1997, Grassman *et al.* 2005, Parr & Duckworth 2007).

Eight species of small carnivore known to occur in Peninsular Malaysia were not detected. Of four possible explanations for this, the first is inappropriate habitat. For example, the study area's dense rainforest is unlikely to support Small Asian Mongoose *Herpestes javanicus* and Small Indian Civet *Viverricula indica*, which may occur mainly in open scrub-like



Fig. 3. Camera-trapped adult Crab-eating Mongoose *Herpestes urva* with three juveniles, Linkage 7, Terengganu, Peninsular Malaysia, 27 December 2011.

Table 1. The 12 small carnivore species detected in and around Linkage 7. Terengganu, Peninsular Malaysia, 2011–2012.

Species	N	PCRI	Stations	Red List	Day	Night
Yellow-throated Marten <i>Martes flavigula</i>	7	0.07	6	LC	6	1
Oriental Small-clawed Otter <i>Aonyx cinereus</i> **	-	-	1	VU	-	-
Smooth-coated Otter <i>Lutrogale perspicillata</i> ***	-	-	1	VU	-	-
Banded Linsang <i>Prionodon linsang</i>	9	0.09	9	LC	0	9
Malay Civet <i>Viverra zibetha</i>	2	0.02	2	LC	0	2
Large Indian Civet <i>Viverra zibetha</i>	4	0.04	4	NT	0	4
Banded Civet <i>Hemigalus derbyanus</i>	2	0.02	2	VU	0	2
Masked Palm Civet <i>Paguma larvata</i>	5	0.05	4	LC	0	5
Common Palm Civet <i>Paradoxurus hermaphroditus</i>	2	0.02	2	LC	0	2
Binturong <i>Arctictis binturong</i>	3	0.03	3	VU	1	2
Small-toothed Palm Civet <i>Arctogalidia trivirgata</i> *	-	-	-	LC	-	-
Crab-eating Mongoose <i>Herpestes urva</i>	5	0.05	2	LC	5	0

N = notionally independent detections (0.5 hr intervals); PCRI = Photographic Capture Rate Index (N/100 camera-trap-nights; based on O'Brien *et al.* 2003) over 10,502 camera-trap-nights; Stations = number of camera-traps (out of 158) that detected the species; Red List = IUCN Red List of Threatened Species category; Day = number of day detections; Night = number of night detections.

*identified from a roadkill within the study area. **daytime detection during ongoing camera-trapping survey in the study area. ***species photographed by day *in situ*.

areas (e.g. Francis 2008). In Peninsular Malaysia, Short-tailed Mongoose *Herpestes brachyurus* seems to have been detected only below 100 m (Wells 1989), although it ranges higher in Borneo (e.g. Mathai *et al.* 2010, Matsubayashi *et al.* 2011) and thus might yet be found at much higher elevations on Peninsular Malaysia. The second possible explanation is camera-trap placement. Non-detection of Hairy-nosed Otter *Lutra sumatrana* and Otter Civet *Cynogale bennettii* could reflect placement of most camera-traps away from water bodies. The non-detection of Malay Weasel *Mustela nudipes* could reflect camera-trap placement inimical to detecting this species, typically camera-trapped only rarely (Duckworth *et al.* 2006, Ross *et al.* 2013). A third possible explanation is extinction: the introduced Indian Grey Mongoose *Herpestes edwardsii* is now likely to be extinct in Peninsular Malaysia (Wells 1989, Francis 2008, DWNP 2010). The fourth explanation is that the species may have never naturally occurred in this geographical area. Earlier, generalised, claims of an extensive distribution of Large-spotted Civet *Viverra megaspila* in Peninsular Malaysia (Corbett & Hill 1992, Papeş & Gaubert 2007, Francis 2008), are contested by detailed collation and evaluation of records from the country, which suggests strongly that it inhabits only the northwest of Peninsula Malaysia (Jennings & Veron 2011).

Conclusion

The species composition of small carnivores in Peninsular Malaysia's habitat linkages was hitherto little known. The 12 species detected in Linkage 7 represent one of the highest small carnivore species totals documented from a single study in Peninsular Malaysia to date. Four of these species are globally threatened (all categorised as Vulnerable) according to *The IUCN Red List of Threatened Species* (IUCN 2012), indicating high conservation importance of the linkage for small carnivores in this country. Forests surrounding this linkage continue to be subjected to various disturbances (Clements & Laurance 2012) such as the construction of hydroelectric dams and poaching (which can potentially include small carnivores; Shepherd & Shepherd 2010). Protection of forests in and around Linkage 7 should therefore be enhanced, not only to conserve the four Vulnerable species, but to maintain habitat connectivity between Taman Negara and nearby selectively logged forests. Indeed, GRC proposed that both forest blocks be included as part of a proposed larger protected area (i.e. state park) to be known as the Kenyir Wildlife Corridor (Fig. 2). Upon formal submission to the Terengganu state government, infrastructure development along the linkage was put on hold pending further assessments by environmental consultants to improve management recommendations for the area (Hance 2012).

A clearer overview of small carnivore communities within the Central Forest Spine's linkages would be helped by further publication of information on small carnivores, including records from camera-trapping studies with other objectives. Camera-trapping designs that consciously account for microhabitat and behavioural variation could enhance recording rates of species typically not well recorded by this method. Specifically, camera-traps could be deployed near small streams or pools, and employ lures or baits. Species that are either Vulnerable or Endangered, but not detected by this study (Hairy-nosed Otter,

Otter Civet and, further north, Large-spotted Civet), are priority 'targets' for future small carnivore studies in the linkages.

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References

- Azlan J. B. A. G. A., M. 2006. Mammal diversity and conservation in a secondary forest in Peninsular Malaysia. *Biodiversity and Conservation* 15: 1013–1025.
- Berry, N. J., Phillips, O. L., Lewis, S. L., Hill, J. K., Edwards, D. P., Tawatao, N. B., Ahmad, N., Magintan, D., Khen, C. V., Maryati, M., Ong, R. C. & Hamer, K. C. 2010. The high value of logged tropical forests: lessons from northern Borneo. *Biodiversity and Conservation* 19: 985–997.
- Brodie, J. & Giodano, A. 2011. Small carnivores of the Maliau Basin, Sabah, Borneo, including a new locality for Hose's Civet *Diplogale hosei*. *Small Carnivore Conservation* 44: 1–6.
- Brook, B. W., Sodhi, N. S. & Ng, P. K. L. 2003. Catastrophic extinctions follow deforestation in Singapore. *Nature* 424: 420–423.
- Clements, G. R. & Laurance, W. F. 2012. *Mitigating the impacts of roads on Tigers and prey in Peninsular Malaysia*. Final report to the U.S. Fish and Wildlife Service. James Cook University, Cairns, Australia.
- Clements, G. R., Rayan, D. M., Aziz, S. A., Kawanishi, K., Traeholt, C., Magintan, D., Yazi, M. F. A. & Tingley, R. 2012a. Predicting the distribution of the Asian Tapir in Peninsular Malaysia using maximum entropy modelling. *Integrative Zoology* 7: 402–409.
- Clements, G. R., Yap, W. & Henry, P. 2012b. Towards safer passages: the Kenyir habitat linkage project. *Malaysian Naturalist* 65: 56–59.
- Colón, C. P. 1999. *Ecology of the Malay Civet (Viverra zibellina) in a logged and unlogged forest in Sabah, East Malaysia*. ETDC Collection for Fordham University (Paper AAI9926910), New York, U.S.A.
- Colón, C. P. 2002. Ranging behaviour and activity of the Malay Civet (*Viverra zibellina*) in a logged and an unlogged forest in Danum Valley, East Malaysia. *Journal of Zoology, London* 257: 473–485.
- Corbet, G. B. & Hill, J. E. 1992. *The mammals of the Indomalayan*

- region: a systematic review. Oxford University Press, Oxford, U.K.
- [DTCP & DOF] Department of Town and Country Planning & Department of Forestry 2012. *Central Forest Spine: summary of master plan for ecological linkages*. DTCP, Kuala Lumpur, Malaysia.
- Duckworth, J. W. 1997. Small carnivores in Laos: a status review with notes on ecology, behaviour and conservation. *Small Carnivore Conservation* 16: 1–21.
- Duckworth, J. W., Lee, B. P. Y. H., Meijaard, E. & Meiri, S. 2006. The Malay Weasel *Mustela nudipes*: distribution, natural history and a global conservation status review. *Small Carnivore Conservation* 34&35: 2–21.
- [DWNP] Department of Wildlife and National Parks 2008. *National Tiger action plan for Malaysia*. DWNP, Kuala Lumpur, Malaysia.
- [DWNP] Department of Wildlife and National Parks 2010. *Red List of mammals for Peninsular Malaysia*. DWNP, Kuala Lumpur, Malaysia.
- Foster, W. A., Snaddon, J. L., Turner, E. C., Fayle, T. M., Cockerill, T. D., Ellwood, M. D. F., Broad, G. R., Chung, A. Y. C., Eggleton, P., Khen, C. V. & Yusah, K. M. 2011. Establishing the evidence base for maintaining biodiversity and ecosystem function in the oil palm landscapes of South East Asia. *Philosophical Transactions of the Royal Society B: Biological Sciences* 366: 3277–3291.
- Francis, C. M. 2008. *A field guide to the mammals of South-east Asia*. New Holland, London, U.K.
- Giam, X., Clements, G. R., Aziz, S. A., Chong, K. Y. & Miettinen, J. 2011. Rethinking the 'back to wilderness' concept for Sundaland's forests. *Biological Conservation* 144: 3149–3152.
- Gibson, L., Lee, T. M., Koh, L. P., Brook, B. W., Gardner, T. A., Barlow, J., Peres, C. A., Bradshaw, C. J. A., Laurance, W. F., Lovejoy, T. E. & Sodhi, N. S. 2011. Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature* 478: 378–381.
- Grassman, L. I., Jr 1998. Movements and fruit selection of two Paradoxurinae species in a dry evergreen forest in southern Thailand. *Small Carnivore Conservation* 19: 25–29.
- Grassman, L. I., Jr, Tewes, M. E. & Silvy, N. J. 2005. Ranging, habitat use and activity patterns of Binturong *Arctictis binturong* and Yellow-throated Marten *Martes flavigula* in north-central Thailand. *Wildlife Biology* 11: 49–57.
- Hance, J. 2012. Development halted in crucial wildlife corridor in Malaysia. <<http://news.mongabay.com/2012/1107-hance-kenyir-corridor.html>>. Downloaded on 11 September 2012.
- Heydon, M. J. & Bulloh, P. 1996. The impact of selective logging on sympatric civet species in Borneo. *Oryx* 30: 31–36.
- IUCN 2012. *IUCN Red List of Threatened Species*. Version 2012.2. <www.iucnredlist.org>. Downloaded on 31 October 2012.
- Jennings, A. P. & Veron, G. 2011. Predicted distributions and ecological niches of 8 civet and mongoose species in Southeast Asia. *Journal of Mammalogy* 92: 316–327.
- Kawanishi, K. & Sunquist, M. 2004. Conservation status of Tigers in a primary rainforest of Peninsular Malaysia. *Biological Conservation* 120: 329–344.
- Kawanishi, K. & Sunquist, M. E. 2008. Food habits and activity patterns of the Asiatic Golden Cat (*Catopuma temminckii*) and Dhole (*Cuon alpinus*) in a primary rainforest of Peninsular Malaysia. *Mammal Study* 33: 173–177.
- Kawanishi, K., Siti Hawa Y., Abdul Kadir A. H. & Rahmat T. 2003. Distribution and potential population size of the Tiger in Peninsular Malaysia. *Journal of Wildlife and Parks (Malaysia)* 21: 29–50.
- Laurance, W. F., Goosem, M. & Laurance, S. G. W. 2009. Impacts of roads and linear clearings on tropical forests. *Trends in Ecology and Evolution* 24: 659–669.
- Lim B. L. 1991. Mongooses of Malaysia. *Nature Malaysiana* 16: 4–7.
- Mathai, J., Hon, J., Juat, N., Peter, A. & Gumal, M. 2010. Small carnivores in a logging concession in the Upper Baram, Sarawak, Borneo. *Small Carnivore Conservation* 42: 1–9.
- Matsubayashi, H., Bernard, H. & Ahmad, A. H. 2011. Small carnivores of the Imbak Canyon, Sabah, Malaysia, Borneo, including a new locality for the Hose's Civet *Diplogale hosei*. *Small Carnivore Conservation* 45: 18–22.
- Meijaard, E. & Sheil, D. 2008. The persistence and conservation of Borneo's mammals in lowland rain forests managed for timber: observations, overviews and opportunities. *Ecological Research* 23: 21–34.
- Nettelbeck, A. R. 1997. Sightings of Binturongs in the Khao Yai National Park, Thailand. *Small Carnivore Conservation* 16: 22–24.
- O'Brien, T. G., Kinnaird, M. F. & Wibisono, H. T. 2003. Crouching Tigers, hidden prey: Sumatran Tiger and prey populations in a tropical forest landscape. *Animal Conservation* 6: 131–139.
- Papeş, M. & Gaubert, P. 2007. Modelling ecological niches from low numbers of occurrences: assessment of the conservation status of poorly known viverrids (Mammalia, Carnivora) across two continents. *Diversity and Distributions* 13: 890–902.
- Parr, J. W. K. & Duckworth, J. W. 2007. Notes on diet, habituation and sociality of Yellow-throated Marten *Martes flavigula*. *Small Carnivore Conservation* 36: 27–29.
- Putz, F. E., Zuidema, P. A., Synnott, T., Peña-Claros, M., Pinard, M. A., Sheil, D., Vanclay, J. K., Sist, P., Gourlet-Fleury, S., Griscom, B., Palmer, J. & Zagt, R. 2012. Sustaining conservation values in selectively logged tropical forests: the attained and the attainable. *Conservation Letters* 5: 296–303.
- Rayan, D. M. 2007. *Tiger monitoring study in Gunung Basor Forest Reserve, Jeli, Kelantan*. WWF Malaysia, Petaling Jaya, Malaysia.
- Rayan, D. M. & Mohamad, S. W. 2009. The importance of selectively logged forests for Tiger *Panthera tigris* conservation: a population density estimate in Peninsular Malaysia. *Oryx* 43: 48–51.
- Rayan, D. M. & Shariff, W. M. 2008. New locality records of the Crab-eating Mongoose *Herpestes urva* in Peninsular Malaysia as revealed by camera-trapping. *Small Carnivore Conservation* 39: 26–29.
- Rayan, D. M., Mohammed, S. W., Dorward, L., Aziz, S. A., Clements, G. R., Christopher, W. C. T., Traeholt, C. & Magintan, D. 2012. Estimating the population density of the Asian Tapir (*Tapirus indicus*) in a selectively logged forest in Peninsular Malaysia. *Integrative Zoology* 7: 373–380.
- Ross, J., Hearn, A. J. & Macdonald, D. W. 2013. Recent camera-trap records of Malay Weasel *Mustela nudipes* in Sabah, Malaysian Borneo. *Small Carnivore Conservation* 49: 20–24.
- Samejima, H., Ong, R., Lagan, P. & Kitayama, K. 2012. Camera-trapping rates of mammals and birds in a Bornean tropical rainforest under sustainable forest management. *Forest Ecology and Management* 270: 248–256.
- Schipper, J., Hoffmann, M., Duckworth, J. W. & Conroy, J. 2008. The 2008 IUCN red listings of the world's small carnivores. *Small Carnivore Conservation* 39: 29–34.
- Schwitzer, C., Glatt, L., Nekaris, K. A.-I. & Ganzhorn, J. U. 2011. Responses of animals to habitat alteration: an overview focussing on primates. *Endangered Species Research* 14: 31–38.
- Shepherd C. R. & Shepherd L. A. 2010. The trade in Viverridae and Prionodontidae in Peninsular Malaysia with notes on conservation and legislation. *Small Carnivore Conservation* 42: 27–29.

- Sodhi, N. S., Koh, L. P., Clements, R., Wanger, T. C., Hill, J. K., Hamer, K. C., Clough, Y., Tschardtke, T., Posa, M. R. C. & Lee, T. M. 2010. Conserving Southeast Asian forest biodiversity in human-modified landscapes. *Biological Conservation* 143: 2375–2384.
- Syakirah, S., Zubaid, A., Prentice, C., Lopez, A., Azmin, M. R. & Mohd-Yusof, A. 2000. A small-mammal survey at Tasek Bera, Pahang, Malaysia's first Ramsar site. *Malayan Nature Journal* 54: 31–41.
- Van Schaik, C. P. & Griffiths, M. 1996. Activity periods of Indonesian rain forest mammals. *Biotropica* 28: 105–112.
- Wells, D. R. 1989. Notes on the distribution and taxonomy of peninsular Malaysian mongooses (*Herpestes*). *Natural History Bulletin of the Siam Society* 37: 87–97.
- Wells, K., Kalko, E. K. V., Lakim, M. B. & Pfeiffer, M. 2007. Effects of rain forest logging on species richness and assemblage composition of small mammals in Southeast Asia. *Journal of Biogeography* 34: 1087–1099.
- Wilting, A., Samejima, H. & Mohamed, A. 2010. Diversity of Bornean viverrids and other small carnivores in Deramakot Forest Reserve, Sabah, Malaysia. *Small Carnivore Conservation* 42: 10–13.

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Appendix 1. Geographical coordinates and indicative elevation of the 12 small carnivore species recorded in and around Linkage 7, Terengganu, Peninsular Malaysia, 2011–2012.

Latitude N	Longitude E	Elevation (m)
Yellow-throated Marten <i>Martes flavigula</i>		
4°58'37.2"	102°31'04.8"	216
4°59'38.4"	102°30'54.0"	239
5°10'33.6"	102°46'58.8"	198
5°00'21.6"	102°32'31.2"	203
5°03'25.2"	102°31'22.8"	562
5°12'46.8"	102°43'48.0"	446
Oriental Small-clawed Otter <i>Aonyx cinereus</i>		
5°00'54.0"	102°31'37.2"	218
Smooth-coated Otter <i>Lutrogale perspicillata</i>		
5°03'38.0"	102°33'49.7"	160
Banded Linsang <i>Prionodon linsang</i>		
4°59'38.4"	102°30'54.0"	239
5°00'21.6"	102°32'31.2"	203
4°58'04.8"	102°30'46.8"	286
5°12'46.8"	102°42'10.8"	472
5°11'42.0"	102°47'31.2"	384
5°01'26.4"	102°34'30.0"	412
5°09'25.2"	102°43'40.8"	310
5°00'03.6"	102°33'25.2"	353
4°59'16.8"	102°31'55.2"	184
Malay Civet <i>Viverra zibetha</i>		
4°58'37.2"	102°31'22.8"	233
5°03'00.0"	102°34'26.4"	303
Large Indian Civet <i>Viverra zibetha</i>		
4°59'09.6"	102°30'03.6"	486
5°12'50.4"	102°44'16.8"	357
5°00'18.0"	102°31'19.2"	215
5°12'46.8"	102°43'48.0"	446

Latitude N	Longitude E	Elevation (m)
Banded Civet <i>Hemigalus derbyanus</i>		
5°03'03.6"	102°33'32.4"	242
5°00'21.6"	102°32'31.2"	203
Masked Palm Civet <i>Paguma larvata</i>		
5°03'07.2"	102°30'46.8"	620
5°03'07.2"	102°31'15.6"	662
5°02'24.0"	102°30'39.6"	600
5°00'03.6"	102°33'25.2"	353
5°03'25.2"	102°30'39.6"	825
Common Palm Civet <i>Paradoxurus hermaphroditus</i>		
5°13'30.0"	102°46'04.8"	392
5°13'30.0"	102°46'04.8"	392
4°59'31.2"	102°32'24.0"	179
5°10'01.2"	102°47'02.4"	272
Binturong <i>Arctictis binturong</i>		
4°58'37.2"	102°31'22.8"	233
5°11'49.2"	102°41'45.6"	269
5°10'40.8"	102°43'30.0"	444
Small-toothed Palm Civet <i>Arctogalidia trivirgata</i>		
5°10'40.2"	102°47'48.0"	156
Crab-eating Mongoose <i>Herpestes urva</i>		
5°13'33.6"	102°43'51.6"	673
5°12'57.6"	102°43'22.8"	648