
Diversity of carnivorous mammals in Batutege Nature Reserve, Lampung, Sumatra

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ABSTRACT

The Batutege Nature Reserve (BNR) covers an area of 58.162 ha of which 10,085 ha remain natural, with the rest utilised by surrounding communities. To ensure protection of the remaining undisturbed forest, the forest management unit Batutege in cooperation with International Animal Rescue Indonesia conducted conservation activities in BNR for the past 10 years. In 2017, we conducted a systematic camera trap survey of animal diversity by deploying 33 cameras in grids of 2 x 2 km for a period of 11 months. Analysis of camera trapping data revealed a total of 3507 individuals belonging to 41 species with 60-minute independence of each capture was obtained. Thirteen species of carnivorous mammals were captured constituting to 8.47% of total individual animals captured. *Mydaus javanensis* (n = 108), *Hemigalus derbyanus* (n = 56) and *Prionodon linsang* (n = 29) were the most captured, while *Panthera tigris sumatrae* ranked ninth in the number of independent captures. The presence of these carnivores indicate the biodiversity richness in an area where encroachment and forest conversions have caused increasing fragmentation. The only conservation management strategy implemented in this region has been the establishment of exploitable forest and core forest zones. To mitigate the impact of habitat fragmentation, we recommend that corridors are created between the core blocks in Batutege Protected Forest to adjacent conservation areas.

ABSTRAK

Hutan Lindung Batutege memiliki luas kawasan 58.162ha dan tersisa 10.085 ha yang masih alami, selebihnya sudah digarap oleh masyarakat. Hutan yang tersisa tersebut merupakan benteng terakhir dari keanekaragaman hayati yang ada di kawasan HL Batutege. KPHL Batutege bekerjasama dengan Yayasan IAR Indonesia (IARI) telah melakukan kegiatan konservasi di HL Batutege 10 tahun. Pada tahun 2017, IARI melakukan survei keanekaragaman satwa dengan pemasangan 33 Camera trap dengan system grid 2 x 2 km selama 8 bulan. Data awal dianalisis dengan Jim software®. Hasil analisis, didapatkan 3507 individu dalam 41 jenis satwa dengan tingkat independensi tiap foto per 60 menit. Mamalia karnivora didapatkan 13 jenis dengan persentase 8.47 % dari seluruh individu satwa. *Mydaus javanensis* (n=108), *Hemigalus derbyanus* (n=56) dan *Prionodon linsang* (n=29) adalah jenis karnivora yang menempati urutan ketiga teratas. Sedangkan *Panthera tigris sumatrae* menempati urutan ke 9. Kehadiran jenis karnivora tersebut, mengindikasikan kekayaan keanekaragaman hayati dalam kawasan yang semakin terfragmentasi dengan alasan perambahan dan alih fungsi hutan menjadi kebun. Upaya konservasi yang telah dilakukan yaitu dengan menetapkan zona dari fungsi kawasan - zona pemanfaatan dan inti. Rencana konservasi jangka pendek yang sedang digagas adalah mengurangi potensi konflik antara manusia dan satwa liar, dan di jangka waktu panjang mengatasi dampak akibat fragmentasi dengan menciptakan penghubung antara blok inti HL Batutege ke kawasan konservasi sekitarnya.

Key words: Carnivore, Biodiversity, Conservation, Camera-trapping, Batutege, Lampung, Sumatra

INTRODUCTION

Deforestation of tropical forests constitutes one of the greatest threats to biodiversity and the conservation of nature. One of conservation biologists' many responses to this threat has been

to develop quantitative indicators that can be used to assess whether global/national Sustainable Development Goals (e.g. halt the biodiversity loss) are being met (Balmford et al., 2005). Whilst being one of the most biodiversity-rich and ecologically complex nations in the world, Indonesia provides one particularly pertinent

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example of the devastating effects of deforestation, (Böhnert, 2016). Although covering only 1.3% of the globe, the Indonesian archipelago accounts for nearly 10% of the world's remaining tropical forest (BAPPENAS, 1993). However, Indonesia's forest cover has declined dramatically in the past decade (Jepson et al., 2001; Whitten et al., 2001) and 20 million ha of Indonesia's forests have been lost since 1989, at an average annual deforestation rate of 1.7 million ha (Holmes, 2002).

Sumatra, Indonesia's second-largest island, is experiencing the most rapid deforestation in the archipelago (Holmes, 2002). Over the past decade, the island has lost an estimated 6.7 million ha of forest, resulting in 29% loss of forest cover (Kinnaird et al., 2003). This is attributed to various factors, including logging (legal and illegal), development of estate crops (primarily oil palm, pulpwood and coffee plantations), conversion to agriculture by large multi-national companies, opportunistic settlers and those arriving through Indonesia's official transmigration program, and forest fires (Holmes, 2002; Robertson and Van Schaik, 2001; Sunderlin, 1999; Barber and Schweithelm, 2000; Whitten and Damanik, 2000).

Such high levels of disturbance have negative impacts on Sumatra's rich biodiversity. Sumatra has more mammal species than any other Indonesian island, many of which are dependent on lowland forest ecosystems (Nowak 1991; Payne et al. 1985). Sumatra supports populations of most of Asia's large mammals, such as Sumatran rhinoceros (*Dicerorhinus sumatrensis*), elephant (*Elephas maximus*), Malayan tapir (*Tapir indicus*), serow (*Capricornis sumatraensis*), two species of orangutan (*Pongo abelii*, *Pongo tapanuliensis*), three species of gibbon (*Hylobates lar vestitus*, *Hylobates agilis* and *Symphalangus syndactylus*), dhole (*Cuon alpinus javanicus*), sun bear (*Helarctos malayanus*) and eight species of felids, most notably the endemic Sumatran tiger (*Panthera tigris sumatrae*).

In 2011, a Forest Management Unit (Kesatuan Pengelolaan Hutan Lindung, KPHL) was established for the management and protection of 58,162 ha (SK.650/Menhut-II/2010) of

protected area in Batutegei. KPHL has since been working closely with local communities that are established and settled within the protected area and who are dependent on forest land and products enabled by a Community Forest Scheme (Hutan Kemasyarakatan). Despite these initiatives and its huge ecological importance, Batutegei Nature Reserve (BNR) and its surrounding areas have suffered massive deforestation. The core zone of BNR is surrounded by forest land used to practice mixed-crop farming and/or agroforestry. Communities in this area depend mainly on small-scale coffee production and large expanses of multi-crops, predominantly pepper, cacao, avocados amongst others. Satellite imagery (Landsat, 2011) shows 20.43% of the remaining protected area is secondary forests and 79.57% of agricultural crop cover and cleared forest land. In addition, forest clearing for farming and timber, has led to a decrease in biodiversity and caused large scale soil erosion that hampers future forest regeneration (Riniarti and Setiawan, 2014).

Since 2008, International Animal Rescue Indonesia (IARI) foundation has been actively working in collaboration with the Batutegei management authorities to protect the remaining forest areas of BNR. Some of the activities conducted have involved working with the local communities in sustainable farming methods, conducting habitat and biodiversity surveys, establishing and training forest patrol teams and conducting education and awareness activities. In line with this and in order to be able to determine the biodiversity value and the conservation importance of this forest, this particular presence-absence study through camera trapping was conducted. The main goal is to provide further evidence to KPHL and to all other stakeholders on the urgency and importance of protecting the remaining forest land based on the presence of carnivores as keystone species for the ecosystem (Ripple et al., 2014) and to develop and establish strategies for the conservation management of these key species in this landscape. Increasing the knowledge and understanding of the importance of preserving BNR will assist in drawing more attention, funding and support for the conservation of this area.

METHODS

Study area

This study was conducted in Batutegi Nature Reserve (BNR), a tropical forest located in southern Sumatra, Tanggamus Regency, Lampung Province (50.077-50.37 S; 104.436-104.894 E) (Fig.1). BNR covers an area of approximately 60,000 ha with a core zone of 10,000 ha (50.11 – 50.204 S; 104.658 – 104.806 E) and lies within the watershed of the Way Sekampung, Way Seputih and Way Rilau rivers. This area serves as a water catchment area for the Batutegi dam, built between 1995 and 2003 and covering an area of approximately 3,560 ha, being the main source of water for the Lampung province.

Camera trapping

A camera trapping study was conducted within the core area of BNR, covering approximately 10,000 ha ranging from 300 to 880 masl. Data was collected over a 11-month period (March 2017 to

February 2018), covering both wet and dry season. Thirty-three camera traps (Bushnell Trophy Cam Model 119678C) were set in a grid formation with approximately equal distances between trap locations (~2km). Camera placement were passive and random, i.e. not favouring locations such as feeding or drinking sites, where animal abundance may be higher than average. Cameras were placed covering varied habitat types using a stratified sampling design.

To prevent damage, all cameras were encased in protective boxes and strapped to tree trunks. Positions of the cameras were determined by the most common path taken by animals, based on animal tracks found around the location where the camera were set up. The infrared beam was set at a height of 50 cm so that the cameras would be triggered by the passage of any medium-sized mammal or bird. The cameras had a pre-set delay of minimum of 5 second between triggers. The cameras were set to 24-hr operation and no baits or lures were used. Trigger events were considered

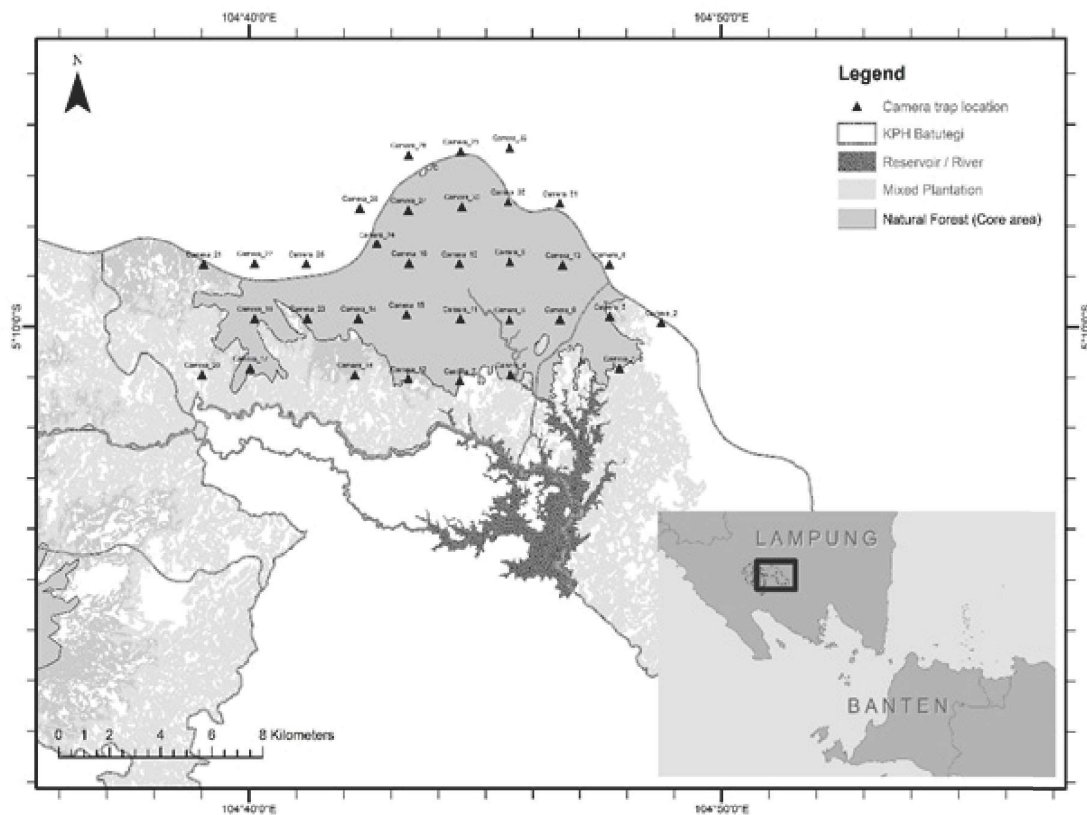


Figure 1. Map of study location and placement of 33 camera traps in the core area of BNR.

“independent” if two events were >60min apart. Cameras were checked one week after placement to ensure optimal deployment. Batteries and memory cards were replaced every three months. Data from each camera was collected three times over the study period in July 2017, December 2017 and February 2018. Camera trap data from March 2017 to February 2018 were considered for this particular study.

Camera trap pictures were renamed using ReNamer® and sorted manually into folders for each species and into sub-folders indicating the number of individuals in each photographic capture of the species. This data was further analysed using a software for the analysis of camera trap data developed by Dr. Jim Sanderson (Sanderson and Harris, 2013) to calculate relative abundance indices of each species.

RESULTS

From March 2017 to February 2018, a total of 3207

trap nights produced 3507 independent wildlife photographs (excluding captures where individuals were unidentified). Sequential photographs of the same animal were not counted. Thirteen carnivore species were identified from 304 photographs (8.47% of total) of which nine were small carnivores (85.53%; n=231) and four felids (14.47%; n=44) (Tab.1).

Felids

The golden cat (*Catopuma temminckii*) was the most frequently photographed felid making up 11.22% of all the carnivore species recorded and with a relative abundance index of 0.15. The Sumatran tiger (*Panthera tigris sumatrae*) was recorded seven times in total at two camera locations with a relative abundance of 0.15. Analysis of stripe patterns of recorded individuals revealed two distinct individuals, (male and female) at each location. The marbled cat (*Pardofelis marmorata*) was the second most frequently recorded felid species; 10 records at five different camera locations amounted to 5.10% of all carnivore species with a relative abundance of 0.21. Apart from the

Table 1. List of carnivore species recorded with camera traps in BNR. N = number of records; % = percentage of the total number of pictures; α = number of independent pictures.

| Species | Scientific Name | N | % | α | IUCN Red list Status |
|--------------------------|---------------------------------|-----|------|----------|-----------------------|
| Bear cat | <i>Arctictis binturong</i> | 15 | 0.43 | 12 | Vulnerable |
| Banded palm civet | <i>Hemigalus derbyanus</i> | 56 | 1.60 | 19 | Near Threatened |
| Masked palm civet | <i>Paguma larvata</i> | 27 | 0.77 | 11 | Least Concerned |
| Small-toothed palm civet | <i>Actogalidia trivirgata</i> | 2 | 0.06 | 2 | Least Concerned |
| Yellow-throated marten | <i>Martes flavigula</i> | 6 | 0.17 | 3 | Least Concerned |
| Short-tailed mongoose | <i>Herpestes brachyurus</i> | 1 | 0.03 | 1 | Near Threatened |
| Sun bear | <i>Helarctos malayanus</i> | 16 | 0.46 | 9 | Vulnerable |
| Sunda stink badger | <i>Mydaus javanensis</i> | 108 | 3.08 | 24 | Least Concerned |
| Banded linsang | <i>Prionodon linsang</i> | 29 | 0.83 | 13 | Least Concerned |
| Golden cat | <i>Catopuma temminckii</i> | 22 | 0.63 | 10 | Near Threatened |
| Marbled cat | <i>Pardofelis marmorata</i> | 10 | 0.29 | 5 | Near Threatened |
| Sumatran tiger | <i>Panthera tigris sumatrae</i> | 7 | 0.20 | 2 | Critically Endangered |
| Leopard cat | <i>Prionailurus bengalensis</i> | 5 | 0.14 | 4 | Least Concerned |

four main big felid species, the banded linsang (*Prionodon linsang*), belonging to the sister group of the cat family, Felidae (Gaubert & Veron, 2003) was the second most frequently detected species of all carnivores captured in the region, constituting to 29 exposures (14.80% of all carnivores) and a relative abundance index of 0.61.

Other carnivores

Non-felid carnivore species captured belong to the taxonomic groups; Viverridae, Ursidae, Mustellidae, Herpestidae and Mephitidae (Tab. 2). The Sunda stink badger (*Mydaus Javanesis*) was the most frequently recorded small carnivore constituting to 35.53% of the total carnivore captures. They were also photographed on 72% of all the camera traps (24 cameras). Species of the family Viverridae were also commonly recorded, accounting for 51.02% of the total carnivore exposures. Banded Palm Civet (*Hemigalus debryanus*) were recorded 28% of the time in more than 50% of the camera traps. However, the small toothed palm civet (*Actogalidia trivirgata*) was only recorded twice on two separate

cameras, the rarest among the Viverrids. Apart from common small carnivore species, the presence of sun bears (*Helarctos malayanus*) (n=16) and the short tailed mongoose (*Herpestes brachyurus*) (n=1) was confirmed in this study.

DISCUSSION

This study aimed at documenting the presence of mammalian carnivore species in the core forest region of BNR and represents the largest camera trapping dataset of a wide range of mammalian carnivore species in the area. Conservation initiatives in this region have been limited due to a lack of knowledge on the biodiversity and the ecology of important species. Like other protected forests in Sumatra, BNR is isolated within a mosaic of anthropogenically modified areas i.e. agriculture and urban development. The persistence of illegal logging and habitat degradation remain a major threat to the region's biodiversity, including felids. Limited funds, trained staff, poor law enforcement and lack of accurate up to date ecological information hinder effective management of the area. As a part of a long-term project in BNR in collaboration with KPHL, this study provides important information about the species diversity in this region. This is especially important for planning and implementing effective conservation strategies in the area.

BNR is home to the golden cat, marbled cat, leopard cat and the Sumatran tiger. The golden cat was recorded most frequently. However, no evidence was found of the clouded leopard, presumed to be the second most common felid species found in Sumatra (McCarthy et al., 2015; Pusparini et al., 2014). Additionally, we recorded the fewest photographs of leopard cats, the only felid not classified as either threatened or endangered by the IUCN. Other studies by Pusparini et al. (2014) in Gunung Leuser National Park, Holden (2011) in Kerinci Seblat National Park and McCarthy et al. (2015) in Bukit Barisan Selatan National Park

Table 2. Relative Abundance Indices (RAI) of 13 mammalian carnivore species recorded.

| Common name | RAI |
|--------------------------|------|
| Sunda stink badger | 2.26 |
| Banded palm civet | 1.17 |
| Banded linsang | 0.61 |
| Masked palm civet | 0.57 |
| Golden cat | 0.46 |
| Sun bear | 0.34 |
| Bear cat | 0.31 |
| Marbled cat | 0.21 |
| Sumatran tiger | 0.15 |
| Yellow-throated marten | 0.13 |
| Leopard cat | 0.1 |
| Small-toothed palm civet | 0.04 |
| Short-tailed mongoose | 0.02 |



Figure 2 & 3. The first melanistic Golden Cats (*Catopuma temminckii*) captured on camera #22 (left) and camera #23 (right) from the area.



Figure 4. Photographic captures of the same male Sumatran Tiger (*Panthera tigris sumatrae*) in 2014 (left) and 2017 (right), respectively.

also recorded leopard cats infrequently. However, lack of detection does not mean lack of presence and our sampling design within the core forest area may not reflect the true status of this species as they have been recorded commonly in disturbed forests and agricultural areas (Mohamed et al., 2013; Rajaratnam et al., 2007; Scott et al., 2004).

Our study included the first photographic confirmation of a melanistic golden cat in south Sumatra adding to the only existing evidence of this morph from Kerinci Seblat National Park in

West-Central Sumatra. Melanistic individuals were only captured in two of 10 cameras (Fig. 2 & 3). It is uncertain whether the melanistic records are the same individual.

An important result of this study was the record of the critically endangered (IUCN, 2008) Sumatran tiger (*Panthera tigris sumatrae*) in this fragmented forest area. The first camera trap evidence of a tiger in BNR was in 2010 as a part of a biodiversity study conducted by IARI. The tiger was captured in the core forest area of BNR

within the present study area, but it was impossible to determine the sex of the individual. As a part of IARI's and Conservation of Natural Resources Agency (BKSDA, Lampung) study to determine the presence of Sumatran tigers in BNR, a female and a male tiger were photographed in 2013 and 2014, respectively, in two different locations within the core area of the forest. Only one individual was identified through comparative stripe pattern analysis with those captured in this present study (Fig. 4), suggesting that the male tiger recorded in 2014 is the same individual captured in this study.

Apart from the four felids, civets were the most frequently captured on the camera trap. The second most commonly captured carnivore was the banded linsang. This result is inconsistent with other studies indicating the low encounter/capture rate of the banded linsang within its range (Azlan and Lading 2006; Cheyne et al., 2010; Wilting et al., 2010). The short tailed mongoose was only recorded once on camera trap, however this low detection rate maybe due to the habitat selected for this study in the core forested area, while mongooses, civets and yellow throated martens are typically found in open evergreen scrub-lands, grasslands and degraded forests (Duckworth et al., 2008; Jennings and Veron, 2011).

We did not record any flat-headed cat, clouded leopard or Sumatran hog badger during this study. Supporting our finding is the lack of evidence of the flat headed cat in the nearest National Park, Bukit Barisan Selatan National Park (McCarthy, 2015 and Wilting et al., 2012). Additionally, our study design did not specifically target habitats where these species are commonly recorded, although the randomized design of our study include camera placements in a variety of different but limited habitat types. In addition, camera traps are generally deployed with a specific target (in this study, the Sumatran tiger), reducing the probability of capturing species with varying home range sizes, habitat types and aspects of natural history (Sollman et al., 2013). Deployment and data retrieval from camera traps over a longer period may increase capture rates of certain species and

the overall biodiversity data (Burton et al., 2015; O'Connell et al., 2010). Focusing on guilds or targeting non-detected species, altering the study design and camera placement can help maximise species detection.

Relative abundance indexes were similar for carnivore species, although capture rates Sunda stink badger, banded and masked palm civet, banded linsang and golden cat were higher. Due to the small sample sizes, comparisons between these indices are difficult to interpret, because it may be biased towards, for example, camera placements (height and location of cameras) and favouring certain species over others. Low capture rates of certain species may also imply that they are uncommon in the core area of BNR and highlight the importance of implementing conservation strategies. A detailed and comprehensive long-term study will likely be able to identify the actual status and risk of extinction of these species from the area.

All cameras were placed in the core forest area of BNR and the immediate area around the camera locations were cleaned to increase the probability of getting clear images. Furthermore, they were set primarily for terrestrial animals, which may have resulted in a bias against species that prefer dense undergrowth or that are predominantly arboreal. Conversely, the isolation of BNR and its limited size of only 10,000 hectares may limit the number of species present in this habitat. This study serves as an important reminder of the need for conservation initiatives for terrestrial carnivores in BNR.

Our study provides evidence of the presence of globally threatened carnivore species in need of better protection and effective management of BNR. The presence of endangered carnivores in small genetically non-viable populations highlights the importance of pursuing a landscape based conservation initiative that includes protecting and connecting biodiversity-rich hotspots to facilitate gene flow and diversity among species. We plan to continue to work with KPHL Batutegi to implement effective strategies in preserving BNR as a stronghold for carnivores in this region.

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REFERENCES

- Arifin, B., Zakaria, W.A. and R.H. Ismono (2018) March. Coffee agroforestry for sustainability of Upper Sekampung Watershed management. In IOP Conference Series: *Earth and Environmental Science* **141(1)**: 012006. IOP Publishing.
- Azlan, J.M. (2003). The diversity and conservation of mustelids, viverrids, and herpestids in a disturbed forest in peninsular Malaysia. *Small Carnivore Conservation* **29**: 8-9.
- BAPPENAS (1993). Biodiversity Action Plan for Indonesia. Indonesian Ministry of Planning, Jakarta, Indonesia.
- Balmford, A., Green, R. and J.P. Scharlemann (2005). Sparing land for nature: exploring the potential impact of changes in agricultural yield on the area needed for crop production. *Global Change Biology* **11(10)**: 1594-1605.
- Barber, C.V. and Schweithelm, J. (2000). Trial by fire. World Resources Institute, Washington, DC.
- Böhnert, T., Wenzel, A., Altenhövel, C., Beeretz, L., Tjitrosoedirdjo, S.S., Meijide, A., Rembold, K. and H. Kreft, H. (2016). Effects of land-use change on vascular epiphyte diversity in Sumatra (Indonesia). *Biological Conservation* **202**:20-29.
- Burton, A.C., Neilson, E., Moreira, D., Ladle, A., Steenweg, R., Fisher, J.T., Bayne, E. and S. Boutin (2015). Wildlife camera trapping: a review and recommendations for linking surveys to ecological processes. *Journal of Applied Ecology* **52(3)**: 675-685.
- Cheyne, S.M., Husson, S.J., Chadwick, R.J., Macdonald, D.W. and S. Hutan (2010). Diversity and activity of small carnivores of the Sabangau Peat-swamp Forest, Indonesian Borneo. *Small Carnivore Conservation* **43**: 1-7.
- Cheyne, S.M. and Macdonald, D.W. (2011). Wild felid diversity and activity patterns in Sabangau peat-swamp forest, Indonesian Borneo. *Oryx* **45(1)**: 119-124.
- Duckworth, J.W. (2008). Status and distribution of small carnivores in Myanmar. *Small Carnivore Conservation* **38**: 2-28.
- Gaubert, P. and Veron, G. (2003). Exhaustive sample set among Viverridae reveals the sister-group of felids: the linsangs as a case of extreme morphological convergence within Feliformia. *Proceedings of the Royal Society of London B: Biological Sciences* **270(1532)**: 2523-2530.
- Holden, J. (2001). Small cats in Kerinci Seblat National Park, Sumatra, Indonesia. *Cat News* **35**: 11-14.
- Holmes, D.A. (2002). Indonesia: Where have all the forests gone?. Environment and Social Development, East Asia and Pacific Region, World Bank.
- Holmes, D.A. (2002). The predicted extinction of lowland forests in Indonesia. Terrestrial ecoregions of the Indo-Pacific: a conservation assessment. Island Press, Washington, DC, pp.7-13.
- Jennings, A.P. and Veron, G. (2011). Predicted distributions and ecological niches of 8 civet and mongoose species in Southeast Asia. *Journal of Mammalogy* **92(2)**: 316-327.
- Jepson, P., Jarvie, J.K., MacKinnon, K. and K.A. Monk (2001). The end for Indonesia's lowland forests? *Science* **292(5518)**: 859-861.

- Kinnaird, M.F., Sanderson, E.W., O'Brien, T.G., Wibisono, H.T. and G. Woolmer (2003). Deforestation trends in a tropical landscape and implications for endangered large mammals. *Conservation Biology* **17**(1): 245-257.
- McCarthy, J.L., Wibisono, H.T., McCarthy, K.P., Fuller, T.K. and N. Andayani (2015). Assessing the distribution and habitat use of four felid species in Bukit Barisan Selatan National Park, Sumatra, Indonesia. *Global Ecology and Conservation* **3**: 210-221.
- Mohamed, A., Sollmann, R., Bernard, H., Ambu, L.N., Lagan, P., Mannan, S., Hofer, H. and A. Wilting (2013). Density and habitat use of the leopard cat (*Prionailurus bengalensis*) in three commercial forest reserves in Sabah, Malaysian Borneo. *Journal of Mammalogy* **94**(1): 82-89.
- Nowak, R.M. (1991). Walker's Mammals of the World: Ill. Johns Hopkins Press.
- O'Connell, A.F., Nichols, J.D. and K.U. Karanth, (2010). Camera traps in animal ecology: methods and analyses. Springer Science & Business Media.
- Payne, J., Francis, C.M. and K. Phillipps (1985). Field guide to the mammals of Borneo. Sabah Society.
- Pusparini, W., Wibisono, H.T., Reddy, G.V., Tarmizi, T. and P. Bharata (2014). Small and medium sized cats in Gunung Leuser National Park, Sumatra, Indonesia. *Cat News* **8**: 4-9.
- Rajaratnam, R., Sunquist, M., Rajaratnam, L. and L. Ambu (2007). Diet and habitat selection of the leopard cat (*Prionailurus bengalensis borneoensis*) in an agricultural landscape in Sabah, Malaysian Borneo. *Journal of Tropical Ecology* **23**(2): 209-217.
- Riniarti, M. and Setiawan, A. (2014). Status kesuburan tanah pada dua tutupan lahan di Kesatuan Pengelolaan Hutan Lindung (KPHL) Batutegi Lampung. *Jurnal Sylva Lestari* **2**(2): 99-104.
- Ripple, W.J., Estes, J.A., Beschta, R.L., Wilmers, C.C., Ritchie, E.G., Hebblewhite, M., Berger, J., Elmhagen, B., Letnic, M., Nelson, M.P. and O.J. Schmitz (2014). Status and ecological effects of the world's largest carnivores. *Science* **343**(6167): 1241484.
- Robertson, J.M. and Van Schaik, C.P. (2001). Causal factors underlying the dramatic decline of the Sumatran orang-utan. *Oryx* **35**(1): 26-38.
- Scott, D., Gemita, E. and T. Maddox (2004). Small cats in human modified habitats landscapes in Sumatra. *Cat News* **40**: 23-25.
- Sollmann, R., Mohamed, A. and M.J. Kelly (2013). Camera trapping for the study and conservation of tropical carnivores. *Raffles Bull Zool* **28**: 21-42.
- Sunderlin, W.D. (1999). The effects of economic crisis and political change on Indonesia's forest sector, 1997-99. CIFOR.
- Wilting, A., Cord, A., Hearn, A.J., Hesse, D., Mohamed, A., Tracholt, C., Cheyne, S.M., Sunarto, S., Jayasilan, M.A., Ross, J. and A.C. Shapiro (2010). Modelling the species distribution of flat-headed cats (*Prionailurus planiceps*), an endangered South-East Asian small felid. *PloS One* **5**(3): e9612.
- Wilting, A., Samejima, H. and A. Mohamed (2010). Diversity of Bornean viverrids and other small carnivores in Deramakot Forest Reserve, Sabah, Malaysia. *Small Carnivore Conservatio* **42**: 10-13.
- Whitten, T. and Damanik, S.J. (2012). Ecology of Sumatra. Tuttle Publishing.
- Whitten, T., Holmes, D. and K. MacKinnon (2001). Conservation biology: a displacement behaviour for academia? *Conservation Biology* **15**(1): 1-3.