Journal of

Indonesian Natural History

July 2018 Vol.6 No.1

The *Journal of Indonesian Natural History* is published biannually by the Department of Biology at the Andalas University, Padang, Sumatra Barat, Indonesia, in collaboration with Copenhagen Zoo, Denmark. The Department of Biology at Andalas University is dedicated to educating Indonesian biologists in the study and conservation of Indonesia's biodiversity and natural history. Copenhagen Zoo, through its Research and Conservation Division, supports *in-situ* conservation in Southeast Asia by assisting local organizations and individuals who undertake research, capacity building and the implementation of conservation programmes and projects.

The *Journal of Indonesian Natural History* is published by the Department of Biology, Andalas University, Indonesia in collaboration with Copenhagen Zoo, Denmark. It is available for free from www.jinh.net

Cover photo: A single tree standing green among withered neighbours after a long punishing dry season in Baluran National Park © Carl Traeholt, Copenhagen Zoo.

EDITORIAL

New Indonesian research regulations for international collaboration - making the case

Carl Traeholt[1]

[1] Copenhagen Zoo, Roskildevej 38, Denmark

Corresponding author: Carl Traeholt, email: *ctraeholt@gmail.com*

Every nation in the World has an obligation to manage its own natural resources, primarily to the benefit of its own citizens. This includes intellectual property rights and rights of origin. Indonesia is the World's second most biodiversity rich nation in the World. Its natural beauty, combined with its cultural and biological diversity is unrivalled. For hundreds of years, the Indonesian archipelago has been the target of historians, naturalists and traders, all with an interest in part of Indonesia's vast natural resources. In a broader context, it is always positive to a nation to be openly exchanging knowledge and trade with other nations, as long as it is not at the expense of its nearby communities and citizens.

Unfortunately, the world has seen a significant rise in biopiracy, a term that was created by Canadian NGO "Rural Agricultural Foundation International" in 1993. Indonesia has not been spared of this trend and, considering the estimated US$ 15 Billion value in medicinal plants alone, it is not surprising that Indonesia continues to face this challenge. In 2006-7 avian influenza (H5N1) epidemic, Indonesia was hit hard. By February 2007, however, Indonesia stopped sharing the virus causing the illness and brought upon itself the wrath of the Global community concerned that it could lead to a worldwide pandemic. But the reason for the country's action was perhaps best understood in Thailand's response to the same epidemic, when they raised similar issues at WHO's Executive Board meeting in January 2007, where they argued that many poor and developing countries send their virus samples to rich countries to produce antivirals and vaccines. And when the pandemic occurs, the rich countries capitalise on it and trade it at prices that are often prohibitive to the countries of origin. The result is that "they survive and we die", as Thailand's representative to WHO mentioned (Fidler, 2007). Indonesia was not opposed to the sharing of information and virus samples, but on the condition that every country had equal opportunity to get access to vaccine and antivirals if such a pandemic occurs. Many legal reviews even sided with Indonesia's rights despite also having to consider international patent laws (Fidler, 2007; Smallman, 2013; Zainol et al., 2011).

Since the 2007 epidemic, biopiracy has continued, albeit in different forms, which prompted the Indonesian government to take action through legislation (Long, 2017; Metha, 2018; Rochmyaningsih). The plan for foreign researchers have made scientists fear it will scare off potential collaborators and hamper experiments. The proposals also suggest tough new penalties, including prison sentences, for foreign scientists who break some existing rules, such as the requirement to have a research permit.

These new legislative steps have stirred up many academicians, who have met with politicians in the hope of convincing them to reconsider the proposals. The general concern is that the new regulations will repel foreign scientists to do research in Indonesia, which will likely impede the rapid development and progress of Indonesia's science. International scientists continue to contribute significantly to Indonesian research, because they often have more experience, larger budgets and more sophisticated technology. Other scientist believe that new law is unworkable for most foreigners, because a scientist could work for years on a scientific project and end up with outcomes that do not benefit Indonesia. In such cases, the new law prevents the scientist from publishing.

There may be weaknesses in the new proposal that risk creating unwanted consequences. However, on the other hand, a scientist that simply stick to the rules have nothing to fear. In the end of the day, if every foreign scientist embrace the *gist* of the Nagoya Protocol, CITES rules and the general notion that everyone that comes to Indonesia, be it as a tourist, a football player or a scientist is a guest to a foreign sovereign nation and should behave as such. In such cases, one should not have anything to fear either. The Nagoya Protocol prescribes *"the fair and equitable sharing of benefits arising from the utilization of genetic resources, thereby contributing to the conservation and sustainable use of biodiversity"*. The central idea of this is the *fair and equitable sharing of benefits*, which for centuries have been abused --- and continue to be to this day. Indonesia has had its fair share of abuse, with the latest high profile case relating to the 2006-7 avian influenza (H5N1) epidemic.

Of course, the draft law remains vague and if it is not made clearer and more straight forwards, there is indeed a risk that it may turn away foreign researchers because of an unclear risk of being fined or sent to jail. However, if there is a clear message that regulations for international science are meant to protect Indonesia's natural resources and to increase local science capacity, there should also be a clear path ahead, even if international scientists will have to submit their raw data to the research ministry; involve Indonesian colleagues as equal partners in research projects; and name all Indonesian researchers involved in a project on every peer-reviewed paper that arises from the work. In reality, what is actually wrong with that in the first place? Does this not merely state the obvious --- that is, as a visitor and a visiting scientist to a foreign nation, ought one not comply with such standards even if there was no statutory rules to enforce it? It is only natural that penalties will be administered on researchers who break existing regulations. As it is proposed, foreign scientists will still need a government permit to do research, and a special transfer agreement to remove specimens, but breaking these rules would be upgraded to a criminal offence rather than a pointed finger.

It can always be argued that the proposed violator of the "visiting researcher" permits is punished too severely i.e. s/he could face a prison sentence of up to 2 years, or hefty fines of as much as 2 billion Indonesian rupiah (~US$145,000) in contrast to the current penalty for a researcher who violates a permit can vary from a verbal warning to the permit being revoked. To date, there has been no national policy or penalty for scientists who remove specimens without an agreement and the author has witnessed several cases, where this has taken place against the current rules and after several warnings against it.

Naturally, the issue has divided researchers in two camps with different opinions; some support the proposal to strengthen the rules, including introducing penalties whereas other feel it is unworkable. Whatever the results of the deliberations, the law, once completed, can only be strengthened through a healthy debate, input and ideas from both Indonesian and foreign scientists. And while the government maintains that it continues to encourage foreign scientists to publish research conducted in Indonesia, it could be some time before the proposals become law, because members of the house have to debate the draft, and they are preparing for an election in April, 2019.

References

Fidler, D.P. (2007). Indonesia's Decision to withhold influenza virus samples from the World Health Organization: Implications for international law. *Insights* **4(11)**:

Jong, H.N. (2017). Foreign researchers 'steal' Indonesia's genetic resources. Jakarta Post, February 22nd, 2017.

Metha, H. (2018). Indonesia strengthens laws against biopirates. *The Business Times*, June 8th, 2018.

Ompusunggu, M. (2018). Foreign researchers' access to TNI museums restricted. *Jakarta Post*, February 9th, 2018.

Ompusunggu, M., Muryanto, B. and A. Gunawan (2018). Indonesian state universities welcome foreigners as permanent lecturers. *Jakarta Post*, April 16th, 2018.

Rochmyaningsih, D. (2018). Indonesia plans strict foreign research laws. *Nature* **557**: 476.

Smallman, S. (2013). Biopiracy and vaccines: Indonesia and the World Health Organization's new Pandemic Influenza Plan. *Journal Of International & Global Studies* **4(2):** 20-36.

Tasevski, O. (2018). What's behind the move to limit foreign researchers' access to Indonesia's military museums. *The Conversation*, February 28th, 2018.

UNDP (2011). Nagoya Protocol. Secretariat of the Convention on Biological Diversity United Nations Environmental Programme.

it..

Zainol, Z.A., Amin, L., Akpoviri, F. and R.Ramli (2011). Biopiracy and states' sovereignty over their biological resources. *African Journal of Biotechnology* **10(58):** 12395-12408.

Population dynamics and ecology of Javan leopard, *Panthera pardus melas*, in Gunung Gede Pangrango National Park, West Java

Anton Ario[1], **Supian**[1], **Eryan Hidayat**[1], **Rijwan Hidayatullah**[1], **Ayi Rustiadi**[2], **Agung Gunawan**[2], **Tangguh Triprajawan**[2], **Iyan Sopian**[2], **Robi Rizki Zatnika**[2], **Dadan Maulana Yusup**[2], **Woro Hindrayani**[2], **Tintin Retno Pramesti**[2], **Ali Mulyanto**[2] and **Dadang Iskandar**[2]

[1]Conservation International Indonesia, Jalan Pejaten Barat No. 16A, Kemang, Jakarta 12550
[2]Balai Besar Taman Nasional Gunung Gede Pangrango, Jalan Raya Cibodas, Kabupaten Cianjur, Jawa Barat 43253

Corresponding author: Anton Ario; *E-mail: aario@conservation.org*

Abstract

Since 1980, the presence of Javan leopard in Gunung Gede Pangrango National Park (GGPNP) was recorded based on footprints, faeces, food scraps, urine, and scratches on trees. In GGPNP the first camera trap picture of a Javan leopard emerged in 2002, which evolved into a long-term study from 2002 to 2017 to determine the population dynamics and ecology of the species in Bodogol-GGPNP area. We deployed 14 camera traps in a 2x2 km grid system covering an area of approximately 32 km² for six months per year. We obtained a total of 453 photos of Javan leopard from 10,080 trap days. Results from the 2002 to 2005 period indicate that there were three individuals, consisting of 1 adult male (M1) and 2 adult females (M1) of which one was melanistic (M2). In period 2006 to 2011, we recorded five individuals consisting of M1, a juvenile male (M2), F1, F2 and juvenile female (F3). In the period 2012 to 2014, we recorded four individuals (M1, M2, F2 and F3). In 2015, the juvenile male (M3) died and we identified a new adult female (F4). By 2016 we recorded five individuals (M1, M2, F2, F3, and F4). By 2017, we did not detect M1 anymore, but recorded a new adult female (F5) (M2, F2, F3, F4 and F5). These results provide useful insights into the population dynamics of Javan leopard, important for the future management of the species.

Abstrak

Sejak 1980 kehadiran macan tutul jawa di Taman Nasional Gunung Gede Pangrango (TNGGP) diketahui berdasarkan temuan jejak berupa tapak kaki, kotoran, sisa makanan, urine, dan cakaran di pohon. Pada tahun 2002, pertama kali macan tutul jawa terfoto dengan menggunakan camera trap. Studi jangka panjang selama tahun 2002-2017 dilakukan untuk mengetahui dinamika populasi dan ekologi macan tutul jawa di Resot Bodogol, TNGGP. Menggunakan grid cell 2x2 km², camera trap terpasang di 14 stasiun pada studi area 32 km² selama 6 bulan setiap tahun. Total foto independen macan tutul jawa diperoleh 453 foto dalam 10.080 hari rekam. Hasil pemantauan diketahui pada periode 2002-2005 terdeteksi 3 individu dengan komposisi 1 jantan dewasa (M1), 1 betina dewasa (F1) dan 1 betina dewasa-melanistik (F2). Pada periode 2006-2011, terdeteksi 5 individu dengan komposisi M1, 1 jantan anak (M2), F1, F2, dan 1 betina anak (F3). Pada periode 2012-2014 terdeteksi 4 individu yaitu M1, M2, F2 dan F3. Pada tahun 2015, jantan anak (M3) mengalami kematian, dan terdeteksi individu baru berkelamin betina dewasa (F4), sehingga pada tahun 2016 terdeteksi 5 individu dengan komposisi M1, M2, F2, F3, F4. Pada tahun 2017, M1 tidak terdeteksi, terdapat individu baru yang terdeteksi yaitu betina dewasa (F5) sehingga komposisi individu adalah M2, F2, F3, F4 dan F5. Hasil yang diperoleh berguna dalam pengelolaan satwa macan tutul jawa dimasa mendatang karena informasi ini belum pernah tersedia.

Keywords: Key words: bodogol, camera trap, ecology, population

Introduction

The javan leopard (*Panthera pardus melas*) is one of 9 sub-species of leopards in the world (Meijaard, 2004). It is listed as an endangered species in Indonesia under the Law No.5 year 1990 and Government Regulation No. 7 year 1999 and the IUCN Red-list lists it as Critically Endangered (Ario et al., 2008). It is one of the world's rarest large cats and included in CITES Appendix 1 (Soehartono & Mardiastuti, 2002).

Javan leopards primarily roam Java's remaining

Submitted 1st March, 2018. Accepted 20th March, 2018

forests, from Ujung Kulon National Park to Alas Purwo National Park as well as on Kangean and Nusa Kambangan islands. Javan leopards also utilise habitat outside conservation areas (e.g. production forests) in landscapes ranging from coastal lowland forests to mountainous forests 2,500m above sea level.

Only 21,747km^2 (~16,2%) remain of Java's original forest cover (KLHK, 2014). Habitat loss and human-wildlife conflicts constitute the main threats to their survival. A large part of their original habitat has been developed into agricultural land, rural development and settlements, causing the species to become locally extinct across most of its original dispersal range (Gunawan et al., 2009).

Until 2002, the presence of Javan leopard in GGPNP was known primarily based on footprints, faeces, urine and scratches on the trees. Since camera traps are excellent for detecting terrestrial mammals (Griffiths and Schaick, 1993; Kays & Slauson, 2008) and has become an indispensable tool in many wildlife studies (Sunarto et al., 2013). In 2002, Conservation International Indonesia and GGPNP commenced a camera trap survey as part of assessing the population status and distribution of the species in GGPNP. This study aimed understanding the population dynamics and ecology of a small isolated population of Javan leopard in GGPNP.

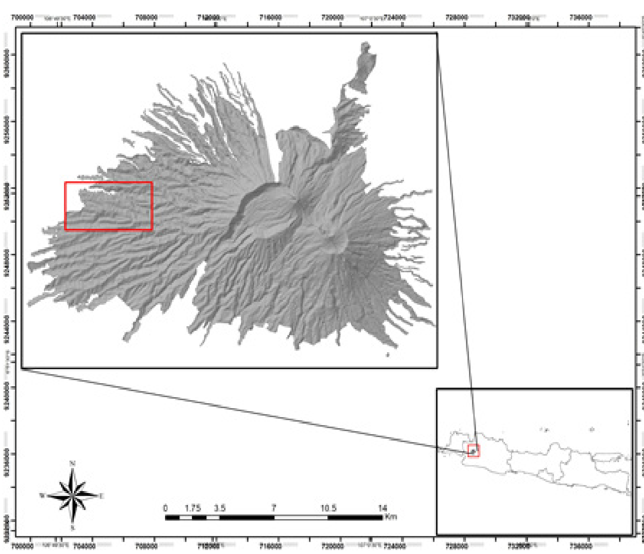

Figure 1. Gunung Gede Pangrango National Park study area.

Methods

Study Area

Gunung Gede Pangrango National Park is one of five oldest national parks in Indonesia. It is located in West Java (106°51'-107°02'E / 6°41'-65°1'S) and spans 242.7 km². A majority of the park consists of tropical mountain forest ecosystem at an altitude between 700-3019m asl. The study area covered 32 km² (106°51'16.8" E / 06°46'35.1" S) at an altitude range from 700 -1500m asl (Fig.1).

Camera Trapping

We deployed 14 camera traps at 14 trapping stations in a 2 x 2 km grid system, encompassing an area of approx. 32 km². The cameras were active for six months each year from 2002 to 2017. Camera traps were placed in a 2 × 2 km grid cell system for three months, before moving it to another location to increase capture probability at same cell.

We deployed camera traps a locations with evidences of Javan leopard presence e.g. footprints, faeces, urine, as well as scratch on the trees to maximise the chances of positive recording. We visited checked camera conditions, replaced batteries and memory cards approx. once every three weeks. We replaced damaged and/ or lost camera traps with new units. All results were entered into database for monthly sampling categories.

We identified individual leopards from the spot patterns on the right and left flanks, following a similar system developed by Miththapala et al. in Sri Lanka (1989). Because we only installed a single camera at each station, we were unable to obtain current time right/left flank images and had to manually analyse spot patterns. We recorded the sex of each individual based on with/without genitals.

Results

Camera trap efforts

From 2002 to 2017, a total of 15 survey periods and 135 samplings were undertaken. A total of 10,080 trap days produced 453 independent photos of

Javan leopard. The average number of days needed to get one picture of a Javan leopard was 28 days, producing approx. 4 pictures per 100 trap days.

We identified 20-25 individuals in GGPNP at altitudes of 700m up to 2000m above sea level (Ario et al., 2009).

Population structure and composition

Leopards were classified into three age classes consist of juveniles <12 months, sub-adults 12–36 months and adults >36 months (Bailey, 2005). In 2002, we recorded one sub-adult male (M1) (Fig.3) that was recorded at several camera trap locations in 2003, one of which also recorded M1 with an adult female (F1) (Fig. 4). In 2005, a melanistic adult female (F2) (Fig. 5) was detected and all three individuals were repeatedly recorded during the 2002 to 2005 period.

To new individuals, a juvenile female (F3) and a melanistic juvenile male (M2) were recorded in 2006 and 2011, respectively (Fig. 6, 7). We assume that F3 was the offspring of M1 with F1 and M2 the offspring of M1 with F2. Photographic evidence support this assumption since M1 was recorded pairing with F1 and F2 in the period 2006-2011. In total, we recorded five individuals (M1, M2, F1, F2, F3) from 2002 to 2011 (Fig.2).

The first recorded female (F1) is believed to have died in 2012, perhaps of old age, since we did not record it anymore after 2012 (Fig. 2, Fig.4). The rest (M1, M2, F2 and F3) were joined by a juvenile male (M3), which we believe is the result of another M1-F2 mating. Unfortunately, M3 entered a barn, got trapped and killed by villagers.

Also in 2015, another adult female (F4) (Fig. 8) was recorded in the area that we believed immigrated from an adjacent area. This population composition (M1, M2, F2, F3, and F4) remained in 2016, but yet another adult female (F5) was detected in 2017, possibly also an immigrant (Fig. 8). In 2017, there were no more records of M1. From the first picture of M1 in 2002, we estimated this male to be 3-5 years old, and by 2017 it is highly possible that he has died of old age or killed by a younger and stronger individual. In 2016, M1 was 17-19

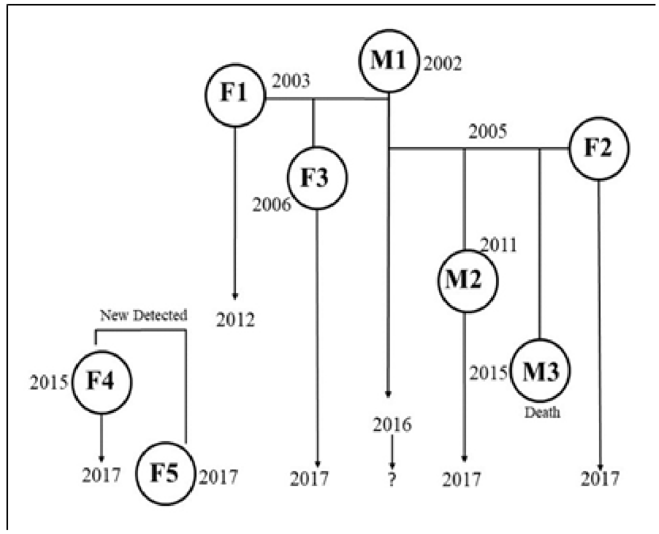

Figure 2. The population composition of leopards in the study area. The main breeding male (M1) was last recorded in 2016 and is likely replaced by his son (M2).

years old, which is exceptional for a male leopard in the wild. Guggisberg (1975), Hunter and Hinde (2005) estimate that leopards generally live 21-23 years in captivity, with the oldest known individual reaching 27 years old. Wild leopards rarely live beyond 12 years, with the oldest known individual reaching 17 years.

Activity patterns

Leopards are very adaptable and can live close to human habitation causing limited conflict with people (Athreya and Belsare, 2007; McDougal, 1991; Seidensticker et al.,1990). In our study area, leopards utilized areas that are use for education and ecotourism activities, even moving between buildings in the educational complex and Bodogol Research Station even during times of the day with possible human activity. Our results reveal that leopards are active in the morning between 05:00 to 08:00 am and at dusk from 15:00 to 18:00 pm. This is possibly related to activity pattern of their prey. The peak leopard activity in Gunung Halimun National Park is from 06:00 to 09:00 am and at 15:00 to 18:00 pm (Syahrial and Sakaguchi, 2003) and in Gunung Malabar Protected Forest around 16:00 to18: 00 pm (Ario et al., 2014).

Leopards are dimorphic, with males being

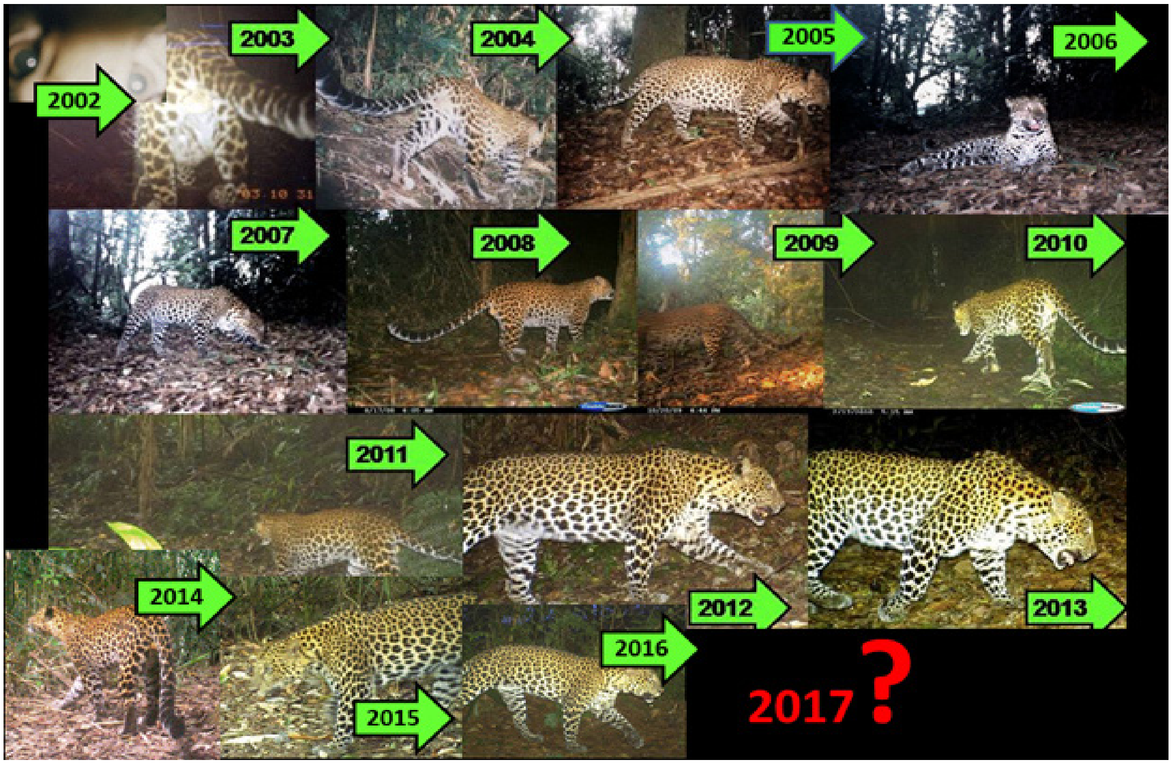

Figure 3. The male (M1) first recorded in 2002 and last recorded in 2016. He is believed to be the main breeding male in the study area and the father to M2, M3 and F3.

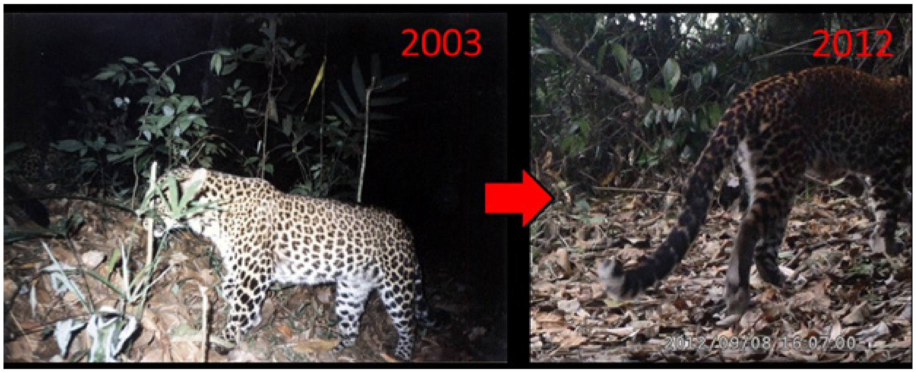

Figure 4. The female (F1) first recorded in 2003 likely died of old age in 2016. She is likely the mother of F3.

Figure 5. The melanistic female (F2) is believed to be the mother of M2 and M3. By 2017, she was still observed in the study area.

Figure 6. The young female (F3) is believed to be the product of M1 and F2. By 2017, she was still observed in the study area.

Figure 7. The melanistic male (M2) is believed to be the product of M1 and F2. By 2017, she was still observed in the study area.

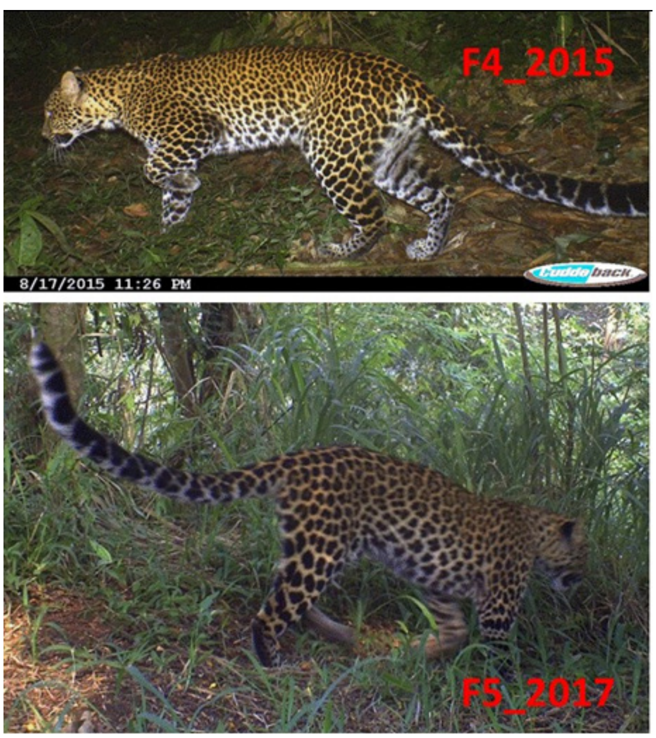

Figure 8. Two females were recorded in 2015 and 2017, respectively. We believe they were both immigrants from areas adjacent to our study site. Both females are still recorded in the area and may reproduce with M2.

bigger than females and, when possible, follow a polygynous breeding system (Skinner and Smithers, 1990). Therefore, males are expected to have larger home-ranges than females thereby increasing mating opportunities (Sandell, 1989). In contrast, if sufficient resources are available, females utilise smaller home-ranges, especially during breeding season and when rearing young (Bailey, 1993).

Our results show that male and female home ranges overlap each other significantly, with several individuals using the same path albeit at different times. Our study also suggests that M1's home-range included two female home-ranges (F1, F2) with M1's home range ± 17.35 km² (Minimum convex polygon), F1 ± 4.76 km², and F2 ± 6.98 km² (Fig. 9). A radio-tracking study in Gunung Halimun National Park recorded smaller home-ranges for both male and female at 7,81 km² and 3,48 km², respectively (Sakaguchi et al., 2003), whereas adult males used approx. 20-30 km² in Sri Lanka (Eiseberg and Lockhart, 1972) and approx. 25 km² in Thailand (Rabinowitz, 1989).

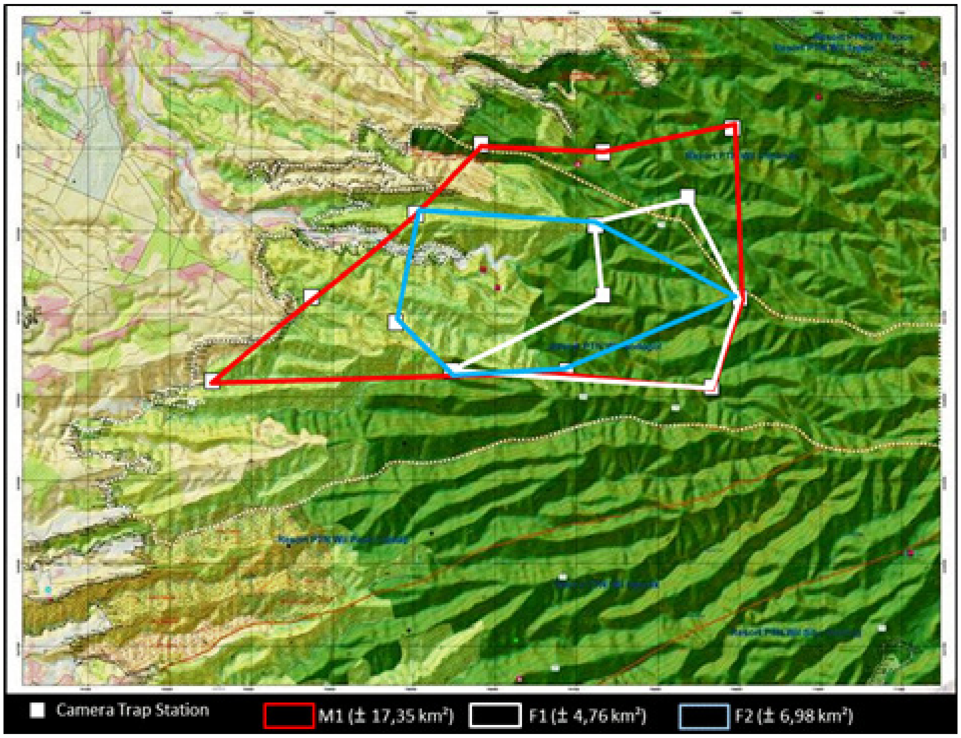

Figure 9. The home-range of male M1 (red line) spans over female F1 and F2 home-ranges (blue and white lines).

Leopard prey

Karanth and Sunquist (1995) reported that leopard prey consist of 89-98% ungulate and primates. In our study, wild boar (*Sus scrofa*) makes up the majority of prey (39,8%), followed by mouse deer (*Tragulus javanicus*) 25,9%, common-palm civet (*Paradoxurus hermaphroditus*) 19,1% and other mammals 15,2%. Primates often form a significant part of leopard diet, but we did not find any evidence of this despite the presence of e.g. grizzled leaf monkey (*Presbytis comata*), ebony leaf monkey (*Trachythecus auratus*) and long-tiled macaque (*Macaca fascicularis*). On several occasions, we recorded primate alarm calls when a leopard was discovered. In 2014, a photographer captured a leopard eating a leaf-monkey in Gunung Halimun National Park, where 10 prey species were identified from faecal analysis (Sakaguchi et al., 2003). In Gunung Malabar Protected Forest, Sunda flying lemur (*Petaurista petaurista*), Javan slow loris (*Nycticebus javanicus*) and Javan gibbon (*Hylobates Moloch*) was identified from faeces using DNA-extraction and analyses (Ario, 2017 unpublished).

In other west Javan national parks, Javan leopards are reported to prey on small to medium size animals, such as muntjac (*Muntiacus muntjak*), long-tailed macaque, wild boar, mouse deer and Javan gibbon (Santiapillai and Ramono, 1992). In Meru Betiri National Park in East Java, leopards prey on wild boar (65%), mouse deer (5.9%), Sunda pangolin (5.9%), civet (3.9%), Javan porcupine (3.9%), bats (3.9%), flying lemur (3.9%), squirrels (3.9%) and muntjac (2%) (Seidensticker and Suyono,1980), which is similar to the food composition as far away as in Ituri Forest, Zaire (53.5% ungulate and 25.4% primates) (Hart et al.,1996). In conclusion, our studies suggest the Javan leopard is an opportunistic and adaptable large predator that predates on a variety of available prey.

Acknowledgement

We would like to thank Conservation International Indonesia, Gunung Gede Pangrango National Park, Javan Gibbon Foundation, Semak Foundation, Eagle and Tepala Volunteers.

REFERENCES

Ario, A. (2007). Javan Leopard (*Panthera pardus melas*) Among Human Activities: Preliminary Assessment on The Carrying Capacity of Gunung Salak Forest Area, Gunung Halimun-Salak National Park. Scientific Report. Conservation International Indonesia.

Ario, A., Sunarto and J. Sanderson (2008). *Panthera pardus melas*. In IUCN 2008. IUCN Red List of Threatened Species. <www.iucnredlist.org>. Accessed 13 Jan 2009.

Ario, A., Hidayat, E. and Supian (2009). Protection and Monitoring of the Endangered Species of Javan Leopard (*Panthera pardus melas*) in Gunung Gede Pangrango National Park, West Java, Indonesia. Scientific Report. Conservation International Indonesia.

Ario, A., Supian, Hidayat, E., Ginanjar, M., and R. Gumilang (2013). Penilaian Awal Status Populasi Macan Tutul Jawa (*Panthera pardus melas*) di Taman Nasional Gunung Ciremai. Laporan Kegiatan. Conservation International Indonesia.

Ario, A., Hidayat, E., Agung, I., Misbah, Wahyudin, D. and Uas (2014). Survei Keberadaan Macan Tutul Jawa (*Panthera pardus melas*) Dengan Menggunakan Perangkap Kamera (Camera Trap) Di Hutan Lindung Gunung Malabar Jawa Barat. Laporan Kegiatan. Conservation International Indonesia-Yayasan Owa Jawa-Perum Perhutani.

Athreya, V.R. and A.V. Belsare (2007). Human-Leopard Conflict Management Guidelines. Maharashtra State Forest Department. Kaati Trust, Pune. India.

Bailey, T.N. (1993). The African leopard: a study of the ecology and behavior of a solitary felid. New York, Columbia University Press.

Bailey, T.N. (2005). The African Leopard: Ecology and Behaviour of a Solitary Felid. Columbia University Press, New York, USA.

Eisenberg, J.F. and M. Lockhart (1972). An ecological reconnaissance of Wilpattu National Park, Ceylon. *Smithsonian Contrib. Zool.* **101**: 1–108.

Griffiths, M. and C.P. van Schaick (1993). Camera-trapping: A new tool for the study of elusive rain forest animals. *Tropical Biodiversity* **1**: 131–135.

Gunawan, H., Prasetyo, L.B., Mardiastuti, A., and A.P. Kartono (2009). Habitat macan tutul jawa (*Panthera pardus melas* Cuvier 1809) di lanskap hutan produksi yang terfragmentasi. *Jurnal Penelitian Hutan dan Konservasi Alam* **6(2)**: 95-114.

Guggisberg, C. (1975). Wild Cats of the World. New York: Taplinger Publishing Company.

Hart, J.A., Katembo, M. and K. Punga (1996). Diet, Prey selection and ecological relations of leopard and golden cat in the Ituri Forest, Zaire. *African Journal of Ecology* **34(4)**: 364-379.

Hunter, L and G. Hinde (2005). Cats of Africa: Behavior, Ecology, and Conservation. United Kingdom: New Holland Publisher.

Kays, R.W. and K.M. Slauson (2008). Remote cameras. In: Long, R.A., MacKay, P., Zielinski, W.J., Ray, J.C (eds.), Non-invasive Survey Methods for Carnivores. Island Press, Washington DC. Pp. 110–140.

Karanth, K.U. and M.E. Sunquist (1995). Prey selection by tiger, leopard and dhole in tropical forests. *J. Anim. Ecol.* **64**: 439–450.

Kementerian Lingkungan Hidup dan Kehutanan (2014). Statistik Kementerian LHK. Pusat Data dan Informasi. KLHK. Jakarta.

McDougal, C. (1991). Man-eaters (In Great Cats. Majestic creatures of the wild. Eds. John Seidensticker, Susan Lumpkin, Frank Knight). Rodale Press, New York. 240pp.

Rabinowitz, A. (1989). The density and behavior of large cats in a dry tropical forest mosaic in Huai Kha Khaeng Wildlife Sanctuary in Thailand. *Nat. Hist. Bull. Siam Soc.* **37(2)**: 235-251.

Meijaard, E. (2004). Biogegraphic history of the Javan leopard, *Panthera pardus*, based on a craniometric analysis. *Journal of Mammalogy* **85(2)**:302–310.

Miththapala, S., Seidensticker, J., Philips L.G., Fernando, S.B.U. and J.A. Smallwood (1989). Identification of individual leopards (*Panthera pardus kotiya*) using spot pattern variation. *J. ZooL, Lond.* **218**: 527-536.

Sakaguchi, N., Sinaga, R.M. and A.H. Syahrial (2003). Food habits of the javan leopard *Panthera pardus melas* in Gunung Halimun National Park, Indonesia. In: Biodiversity Conservation Project. Research on Endangered Species in Gunung Halimun National Park, Research and Conservation of Biodiversity in Indonesia, vol. XI.

Sandell, M. (1989). The mating tactics and spacing patterns of solitary carnivores. In: Gittleman, J.L (ed). Carnivore behavior, ecology and evolution. Cornell University Press. Itacha. New York. Pp.164-182.

Santiapillai, C. and W.S. Ramono (1992). Status of the leopard (*Panthera pardus*) in Java, Indonesia. *Tigerpaper* **19**: 1-5.

Seidensticker, J., Sunquist., M.E. and C. Mc Dougal (1990). Leopards living at the edge of the Royal Chirwan National Park, Nepal. In Conservation in developing countries: problems and prospects. (Eds). Daniel J.C and Serrao, J.S. 415-423. Bombay Natural History Society and Oxford University Press.

Seidensticker, J. and Suyono (1980). Harimau di Taman Nasional Meru Betiri dalam: Ekologi, perilaku dan keuletan harimau serta perlunya usaha konservasi harimau.

Skinner, J.D and R.H.N. Smithers (1990). The mammals of southern African subregion. University of Pretoria Press. Pretoria.

Soehartono, T and A. Mardiastuti (2002). CITES Implementation in Indonesia. Nagao Natural Environment Foundation. Jakarta.

Sunarto., Sollmann, R., Mohamed, A. M.J. Kelly (2013). Camera trapping for the study and conservation of tropical carnivores. *The Raffles Bulletin of Zoology* **28**: 21-42.

Syahrial, A.H. and Sakaguchi (2003). Monitoring research and the Javan leopard *Panthera pardus melas* in Gunung Halimun National Park, Indonesia. In: Biodiversity Conservation Project. Research on Endangered Species in Gunung Halimun National Park, Research and Conservation of Biodiversity in Indonesia, vol. XI

Activity pattern and habitat profile of small carnivores in an oil palm landscape

Inda D. Solina[1], **Wilson Novarino**[2], **Rizaldi**[1] and **Anthony J. Giordano**[3]

[1]Ecology, Department of Biology, Faculty Mathematic and Natural Sciences, Andalas University, West Sumatra, Indonesia
[2]Zoology, Department of Biology, Faculty Mathematic and Natural Sciences, Andalas University, West Sumatra, Indonesia
[3]S.P.E.C.I.E.S., Ventura, California, USA

Corresponding author: Inda D. Solina; *Email: solina.inda@gmail.com*

Abstract

As of 2010, approximately 55,000km^2, or 12% of Sumatra island, was subject to oil palm cultivation. This has resulted in the mass clearing of tropical forests, which has led to many isolated forest fragments, as well as the disruption of ecosystem functionality. While the impact of these activities on larger carnivores has been well-established, how they have impacted the ecology of smaller carnivores, including mustelids and viverrids, has been much less studied. Between June and December 2015, we conducted camera-trap surveys to investigate the activity patterns and habitat characteristics of small carnivores in Solok Selatan near Kerinci Seblat National Park, a region containing extensive oil palm plantations. We established a total of 15 camera-trap stations, including five cameras in each of three different habitats: fragmented forest, riparian zones and continuous forest. A statistical analysis was carried out using Generalized Linear Model (GLM) to assess the relationship between species richness among various habitat and covariates, then compared with Akaike Information Criterion (AIC) values to identify the most likely models were run in R statistic program. In general, the camera traps recorded seven species of small carnivore during monitoring, consists of one mustelid species exhibiting predominantly diurnal activity, and six viverrids that were largely active at night. Larger distances from the park edge were also associated with greater species richness at camera-traps, most likely because these species had become isolated in forest surrounded by completely unsuitable habitat. We conclude that this mixed oil palm landscape has negatively impacted small carnivore diversity and activity.

Pada tahun 2010, sekitar 55.292 km2 luasan perkebunan kelapa sawit mencapai 12% dari total pulau Sumatera itu sendiri. Pembukaan hutan menjadi perkebunan menimbulkan permasalah tersendiri, terutama timbulnya hutan terfragmentasi yang tidak terhubung dengan hutan sehamparan dan tidak berfungsinya riparian sebagai koridor penghubung. Dampaknya terhadap mamalia karnivora besar telah banyak diteliti, sementara untuk mamalia karnivora kecil belum diteliti, dengan demikian perlu dilakukan penelitian untuk mengetahui bagaimana pola aktivitas dari Mustelidae dan Viverridae di kawasan perkebunan kelapa sawit dan profil habitat yang mereka manfaatkan. Penelitian ini menggunakan metoda Camera trap. Sebanyak 15 camera dipasang pada tiga habitat; fragmentasi, riparian dan hutan sehamparan di dalam kawasan perkebunan kelapa sawit Solok Selatan, masing-masing habitat dipasangi 5 camera. Kamera dipasang dari bulan Juni-Desember 2015. Uji statistik menggunakan Generelized Linear Model (GLM) pada R statistic dilakukan untuk mengetahui hubungan antara keragaman spesies yang diperoleh dengan beberapa parameter lingkungan, kemudian diambil nilai Akaike Information Criterion (AIC) paling kecil dan sederhana untuk digunakan sebagai permodelan. Didapatkan total 7 spesies, satu Mustelidae yang memiliki aktivitas diurnal, dan 6 species Viverridae yang memiliki aktivitas nocturnal. Profil habitat dari kedua famili mamalia karnivora kecil ini menunjukkan bahwa tutupan kanopi dan jaraknya ke hutan Taman Nasional Kerinci Seblat mempengaruhi jumlah spesies yang ditemukan di kawasan perkebunan kelapa sawit tersebut.

Keywords: Mustelidae, Viverridae, activity patterns, habitat, forest fragmentation, oil palm, Carnivora, tropical forest

Introduction

Oil palm plantation is one of the most rapidly expanding commodity crops (Phalan et al., 2013)in Indonesia, with oil palm plantations mainly located on Sumatra and Kalimantan. Large monoculture plantations now dominate nearly 10-12% of Sumatra's 443,065.8 km^2 and more plantation development is expected in the near future (Rianto et al. 2012; Gunarso et al. 2013). Although oil palm plantation operations attempt to maximize the area they utilize, some areas are retained as

Submitted 1st August, 2018. Accepted 20th August, 2018

forest due to the presence of challenging terrain or land contours, infertile soil, or the occurrence of riparian, wetland, and/or conservation areas. Whereas the protection of high conservation value areas is positive, the practice frequently leads to increasing habitat fragmentation, ultimately resulting in species decline (Mudappa et al., 2007; Fitzherbert et al., 2008; Syamsi, 2011; Bernard et al., 2014; Yue et al., 2015).

All species respond to forest fragmentation differently. Despite being able to fly, many bird species perceive roads, monoculture and open areas as barriers to their movement and dispersal (Farina, 1998). Many mammals in Southeast Asia are heavily dependent on intact tropical forests, include many predators, such as the Sunda clouded leopard (*Neofelis diardi*) and marbled cat (*Pardofelis marmorata*) (Pusparini et al., 2014; Duckworth et al., 2014; Bernard et al., 2014; McCarthy et al., 2014; Hearn et al., 2016; Rustam et al., 2016). One exception appears to be the leopard cat (*Prionailurus bengalensis*) that is common even in oil palm plantations (Rajaratnam et al., 2007; Silmi et al., 2013; Bernard et al., 2014; Jennings et al., 2015; Yue et al., 2015).

Riparian forests could potentially serve as corridors between larger forest tracts in an otherwise fragmented landscapes. Many species, including felids and other small carnivores, can make use of original standing vegetation along watercourses thereby contribute to species persistence across larger landscapes (Karsai and Kampis, 2011). To what degree corridors are important to smaller mammalian carnivores in tropical Asian landscapes, however, has not been tested yet.

The activity patterns of small carnivores are determined by the distribution and/or behaviour of their food resources, as well as the presence of potential competitors and predators (Sunarto et al., 2014). For carnivores in tropical landscapes like Sumatra, many species may occur sympatrically across large regions and thus occupy the same areas or even habitat (McCarthy et al., 2014a, b). To facilitate coexistence and avoid direct competition, sympatric small felid species occupying potentially similar niches may be active at different times on Sumatra (Sunarto et al., 2014). Although this is probably also true for viverrids and mustelids, comparisons of activity patterns among these species have received less attention than felids and other mammals.

This study aims at assessing the importance of forest fragments in an oil-palm dominated landscape to small carnivores, as well as what role if natural riparian corridors and forest fragments play, if any, in their persistence. We also aimed at improving our understanding of species coexistence and competition in altered landscapes, as well as the importance of various forest microhabitat characteristics on carnivore species richness.

Methods

Study Area

We conducted this study in Solok Selatan (3346.20 km^2), a district of West Sumatra Province, Indonesia, which comprise 60% of Kerinci Seblat National Park (KSNP). Our study area included two of ten palm oil plantation operations in the region: Tidar Kerinci Agung company (TKA), and Kencana Sawit Indonesia Company (KSI). These two areas comprised a total area of 86,093 ha (Government District: Solok Selatan, 2014). Our study areas consisted of three habitat types within the oil palm concessions: continuous forest bordering the KSNP, riparian forest inside the oil palm concession area and fragmented forest with mixed forest habitat (Fig. 1). The elevation of the TKA (101’26”-101’40” E and 01’25”-01’40”S) varies between 250-700 above sea level, with most of the TKA’s total area (28.029 ha) dominated by secondary forest. All fragmented forest, hilly secondary forest, occurred in the conservation area of KSI.

Camera trapping

We deployed 15 Xenon-flash digital camera-traps (DTC-565) to conduct our surveys between June and December, 2015. Camera-traps were distributed evenly across each of the three habitat blocks: five

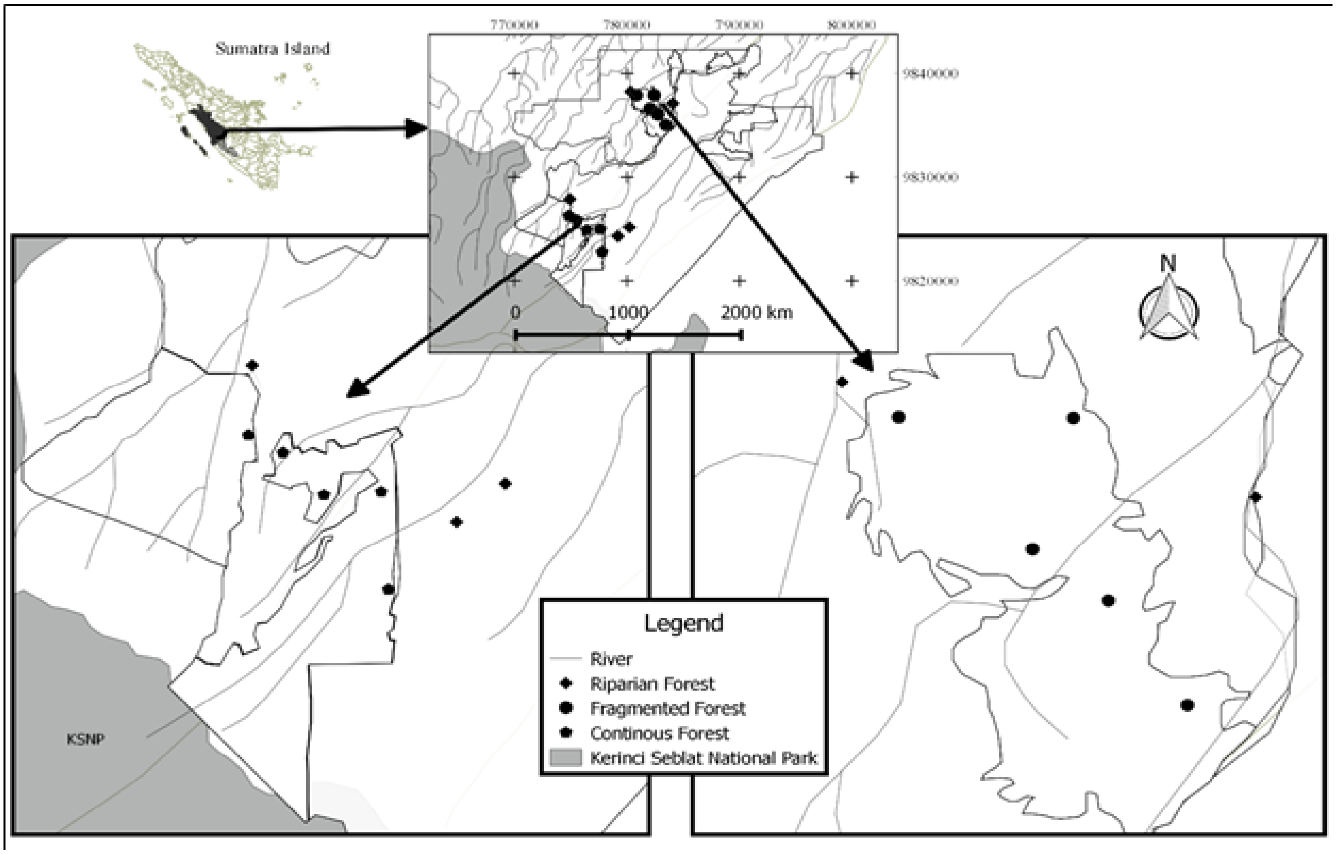

Figure 1. The study sites in a oil palm plantation landscape in Solok Selatan, West Sumatra, Indonesia, and the positions of the camera-traps. Left is continuous forest bordering the Kerinci Seblat National Park, and right is fragmented forest.

camera-traps were deployed in continuous forest adjacent to TNKS, five camera-traps were placed in riparian forest; and five camera-traps were put in the isolated forest fragment (KSI). To maximize spatiotemporal independence, no two camera-traps were <1 km apart. Camera-traps were affixed to tree trunks approximately 50 cm above the ground; trigger sensitivity was set to 'medium' and to take a single photograph at a time. All camera-traps operated 24-hours/day without the use of bait or lures and were each equipped with 2-4GB memory cards capable of storing more than 15,000 images per card. Cameras were checked monthly to change the batteries and memory cards. For ambiguous and unclear photos, we identified species using regional mammal field guides (Payne et al., 2000; Nowak and Paradisso, 1983) and through consultation with taxonomic experts (e.g, IUCN Small Carnivore Specialist Group).

Organization and preliminary analysis of photo data was assisted with software developed by Sanderson and Harris (2013). Lower values of interspecific comparison of activity suggest greater similarity between those patterns. To assess the relationship between species richness and various

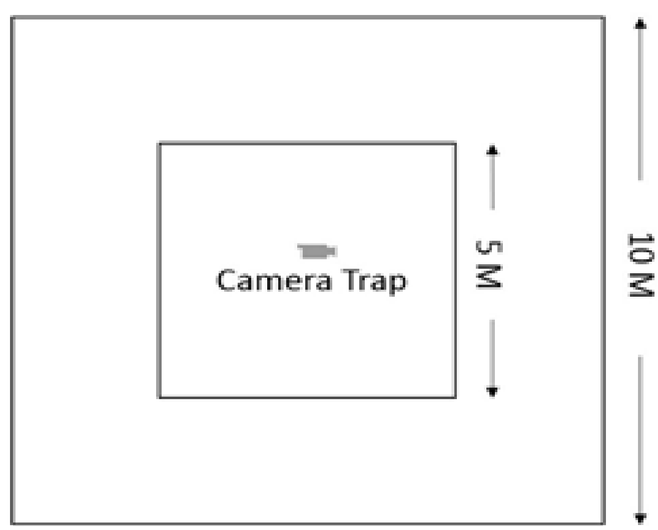

Figure 2. Vegetation analysis plots.

habitat characteristics and covariates, including relative sapling and tree density, canopy cover, distance to roads, distance to the KSNP forest, and distance to the nearest river, we used a Generalized Linear Model (GLM) with a stepwise backward function in R --- that is, variables with the highest Z values were reduced one by one until the most parsimonius models were identified. We then compared Akaike Information Criterion (AIC) values (sic. Anderson et al., 1998; Anderson and Burnham 1999) and contrasted relative evidence support among potential models.

Habitat characteristics

To characterize important habitat features surrounding camera-trap locations, we used a squared plot method (Fitri, 2012). Each camera-trap location constituted a central point encompassed by one 10x10m area plot to estimate tree number/density, and one 5x5m area sub-plots for counting saplings (Fig. 2). We estimated canopy cover using a densiometer consisting of a 24 x 4 grid of total points in 10 x 10 m quadrant (Fig. 2) at 1 m above ground level in the center of the plot vegetation survey. This was done with the observer facing the camera-trap and counting the number of dots, allowing us to calculate the percentage of closed/open canopy cover in areas immediately adjacent to camera-traps.

Results and Discussion

A total of 2,879 trap nights yielded 2,880 pictures of 23 mammal species. Of these, seven species (30.4%) were Mustelidae for which we obtained only 35 independent photos (Tab.1). Common palm civets (*Paradoxurus hermaphroditus*) were photographed most frequently (n=20, or 57% of all independent photo records of small carnivores) and were the only species detected in all three habitat types or more than one habitat. Surprisingly, we recorded more species (n=5) in the isolated forest fragmented, including the Binturong (Vu) (*Arctictis binturong*) and the Banded palm civet (NT) (*Hemigalus derbyanus*) not detected in other habitats. The small-toothed palm civet (*Arctogalidia trivirgata*) and the common palm civet were the only two species recorded in the riparian forest within the oil palm concessions.

Activity patterns

Of the seven small carnivore species we detected, only the yellow-throated marten (*Martes flavigula*) was recorded during the day (n=1; 09:00-10:00am); all six viverrids were recorded from around dusk through dawn (Fig. 3). Although we only recorded one photo of the yellow-throated marten, this species is known to be predominantly

Table 1. The species, English name and local name, number of independent photos, habitat and IUCN status for the small carnivores detected in the study site. Habitat - 'F' fragmentation, 'CF' - Continous Forest,' R - 'riparian'. IUCN status - 'VU' - vulnerable', 'LC' - least concern, 'NT' - near threatened.

Species	Common name	Local name	#Photos	%	Location	IUCN
Mustelidae						
Martes flavigula	Yellow-throated marten	Musang leher kuning	1	2.86	F	LC
Viverridae						
Arctogalidia trivirgata	Small-toothed palm civet	Musang Akar	1	2.86	R	LC
Arctictis binturong	Bearcat/Binturong	Binturong	1	2.86	F	VU
Hemigalus derbyanus	Banded palm civet	Musang Belang	7	20	F	NT
Paguma larvata	Masked palm civet	Musang Galing	1	2.86	CF	LC
Paradoxurus hermaphroditus	Common palm civet	Musang Luwak	20	57.14	F,CF,R	LC
Viverra tangalunga	Malay civet	Musang Tenggalong	4	11.43	F	LC
		Total	**35**	**100**		

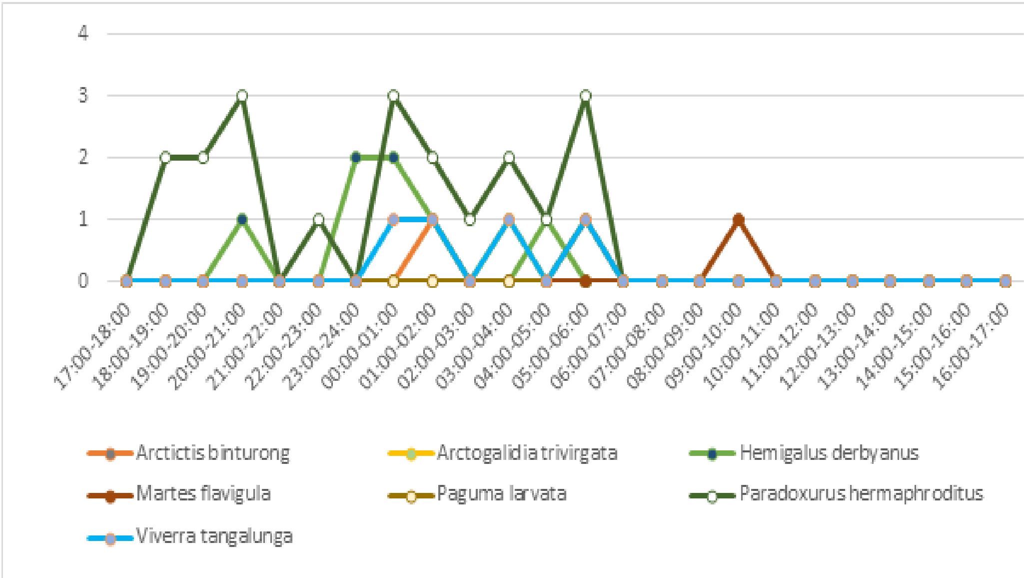

Figure 3. Comparative activity pattern of small carnivores in three forest types in western Sumatra.

diurnal, sometimes hunting at night during a full moon or shortly before sunrise (Grassman et al., 2005; Abramov et al., 2008; Cheyne et al., 2010; Mathai et al., 2010; Mccarthy and Fuller, 2014). Common palm civets (n=20) were active from dusk to dawn, with activity from 00:00 to 01:00am, 05:00-6:00am, and 20:00-21:00pm; conversely, lower activity rates were recorded between 02:00-03:00am, 04:00-5:00am and 22:00-23:00pm. We did not record common palm civet between 07:00am and 17:00pm and although it has adopted diurnal habits elsewhere (Cheyne et al., 2010), it is widely regarded as crepuscular and nocturnal (Azlan, 2003; Wilting et al., 2010). The banded palm civet appeared to be active between 19:00pm – 05:00am (n=7), whereas Malay civet occurred between 23:00pm – 05:00am. The Malay civet and Banded palm civet are known to be predominantly nocturnal and crepuscular (Azlan et al., 2008; Wilting et al., 2010; Brodie and Gioradano, 2011; Ross et al., 2015). Unfortunately, we only detected three of the six viverrid species once, including the binturong, small-toothed palm civet, and masked palm civet (Tab. 1). This prevented a better understanding of their diurnal activities at our study site. The ecology of Binturong is poorly understood and may vary between areas, as publications about diurnal activity and dispersal are conflicting (Wildmann et al., 2008). Grassman et al. (2005) noted the Binturong to be crepuscular and nocturnal, whereas Nettelbeck (1997) reports them as diurnal. Small-toothed palm civet is strongly nocturnal (Duckworth et al., 2008) and Masked palm civet is nocturnal with occasional diurnal activity (Duckworth et al., 2008b).

Despite our relative lack of detections, the activity of both Malay and common palm civets was comparable (Fig. 3). Direct competition between the two species may be reduced due to differences in the diet and behaviour. For example, the common palm civet is broadly omnivorous; it hunts rodents and other small vertebrates, insects and mollusks and also consume fruit in large quantities (Duckworth et al., 2008b). In contrast, the Malay civet is more terrestrial than the palm civet (Azlan et al., 2011; Eng, 2011), as well as relatively less frugivorous (Azlan et al., 2008). Although our data from this landscape is limited, it is possible that common palm civets are routinely active earlier in the day than Malay civets (Brodie and Giordano, 2011). Similarly, limited data on banded palm civets (n=7) suggest their activity is similar to common palm civets; both species were detected between 20:00pm and 01:00am (Fig.3). Banded palm civets are known to be more terrestrial than

Table 2. Quantitative measures of habitat features characterizing the three forest types in the study area.

	Sapling		Trees			Distance		
Forest	**Density**	**R. Density**	**Density**	**R. Density**	**Canopy**	**River(m)**	**KSNP(m)**	**Road(m)**
Fragmented	0.26	0.20	0.02	0.20	0.82	748.99	12405.6	284.49
Continuous	0.47	0.21	0.03	0.14	0.86	401.19	5252.68	199.41
Riparian	0.30	0.19	0.04	0.26	0.85	57.24	9454.63	19.00

Table 3. Results of a non-parametric Kruskall-Wallis test comparing microhabitat features of continuous forest, forest fragment and riparian forest.

	Sapling		Trees		
	Density	**R. Density**	**Density**	**R. Density**	**Canopy Cover**
X2	5.341	.383	1.426	1.673	.287
Df	2	2	2	2	2
Asymp. Sig.	.069ns	.826ns	.490ns	.433ns	.867ns

Table 4. Results of the GLM evaluating forest microhabitat features on the number of species detected

	Std. Error	z value	P value
(Intercept)	8.81	-2.615	0.00891 **
R. Density sapling	8.95	1.884	0.05955 .
Canopy Cover	7.29	2.579	0.00992 **
Distance to KSNP	0.0128	3.014	0.00258 **
AIC: 39.707			

palm civets, and consume smaller prey than Malay civets. A study based on stomach content analysis of banded civets on Borneo found no plant or fruit content of any kind, only insect parts (Hon et al., 2008).

Unfortunately, our data are not sufficient to evaluate and compare niche overlap for the small carnivore species detected in this study. Jennings and Veron (2011) recorded differences in habitat and elevation for the southeast Asian small carnivore community. They noted that, while niches might appear similar, they could be differentiated by how much each species utilized similar and very different habitat types, including tropical evergreen forest, deciduous forest, degraded forest, thick brush, plantation and marsh. More data from our site is needed to perform a rigorous analysis, however, it may not convey a meaningful picture, since the ongoing landuse change may impact the small carnivore populations in the area.

Habitat assessment

Sapling density was very similar for all three forest types (Tab. 2). Similarly, there was little variation in tree density or canopy cover between the study sites and there was no significant difference among habitats with respect to quantitative microhabitat features associated with camera-trap locations (Tab. 3). We tested the relationship between the number of species recorded and several micro and macro habitat variables, including relative density of saplings and trees; canopy cover; elevation; distance from the road; distance to natural forest (i.e., the KSNP) and distance to the river. The results of our generalized linear models (Tab. 4) yielded significant positive z scores for the canopy cover and distance to KSNP, suggesting that more closed canopy forest and greater distance from the KSNP were both associated with higher numbers of species detected at a camera-trap site. Results for the other covariates were not significant.

All of the photos that Wilting et al. (2010) recorded of banded palm civets occurred in forest with dense canopy cover. Another study reported that binturong were predominantly active during the day under dense canopy cover (Grassman et al., 2005). Eng (2011) concluded canopy cover was an important microhabitat variable for Malay and common palm civets. The proportion of total records consisting of common palm civets supports the suggestion that this species is more at home in fragmented landscapes than its conspecifics. Both species probably impacted the relatively large and significant positive z-score for the number of species recorded at each camera-trap, which indicated increased distance from the KSNP edge was important. This could be due to the impacts of forest edge effects and fragmentation. Although fragmentation leads to the isolation of plant and animal species (Mitchell et al., 2015), it may also benefit a select number of small carnivore species. There is evidence that common palm civets can persist in human-modified habitats, including plantations and logged forest. Similarly, Malay civets have also been recorded frequently in degraded and modified habitats although not as much as common palm civets (Jenning and Veron, 2011; Jenning et al., 2015; Wilting et al., 2010; Mathai et al., 2010). Mudappa et al. (2007) concluded that small carnivores (Mustelidae, Viverridae) in India were relatively abundant in fragmented forests of India surrounded by coffee plantations and where the edge to interior ratio was higher, possibly due to a greater abundance of small mammals and insects in the forest litter. Habitat conditions like these can be found in the mixed oil palm landscape of Solok Selatan of West Sumatra.

We recorded a total of seven small carnivore species in mixed oil palm and forest habitat adjacent to Kerinci Seblat National Park. Carnivore detections comprised only 35 of 2,880 photographs of mammals recorded. Of these, 24 belonged to two species, the common palm civet and Malay civet. Greater canopy closure values were associated with camera-traps recording more species and larger distances from the park edge were also associated with greater species richness at camera-traps, most likely because these species had become isolated in forest surrounded by less unsuitable habitat. We conclude that mixed oil palm landscape has negatively impacted small carnivore diversity and activity, which has led to the almost complete disappearance of four species (1 photo each out of 2,880 photos). These findings appear consistent with those from other studies regarding the adverse impact of this type of agricultural landscape on the diversity of small carnivores, other terrestrial mammals and biodiversity overall (Mudappa et al., 2007; Fitzherbert et al., 2008; Syamsi, 2011; Bernard et al., 2014; Yue et al., 2015).

Acknowledgement

This study was funded by Kemenristek DIKTI Program Penelitian Unggulan Perguruan Tinggi. We are grateful to Tidar Kerinci Agung Company and Kencana Sawit Indonesia Company for issuing a research permit. Thank you for all of field assistences; Nunu, Dani, Nando, Shobri, Ryan, TKA's team (Anton and friends), KSI's team (Hadi and friends), Fauzil, also many thanks to Aadrean and Reki.

References

Abramov, A., Timmins, R.J., Roberton, S., Long, B., Than Zaw and J.W. Duckworth (2008). *Martes flavigula*. The IUCN Red List of Threatened Species 2008: e.T41649A10528335. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T41649A10528335.en. Downloaded on 10 June 2016.

Aderson, D.R., Burnham, K.P. and G.C. White (1998). Comparison of Akaike information criterion and consistent Akaike information criterion for model selection and statistical inference from capture-recapture studies. *Journal of Applied Statistics* **25(2)**: 263-282. http://dx.doi.org/10.1080/02664769823250.

Anderson, D.R. and K.P. Burnham (1999). Understanding information criteria for selection among capture-recapture or ring recovery models. *Bird Study* **46(1)**:14-21. DOI 10.1080/00063659909477227

Azlan, M.J. (2003) The diversity and conservation of mustelids, viverrids, and herpestids in a disturbed forest in Peninsular Malaysia. *Small Carnivore Conservation* **29**: 8–9.

Azlan, M.J., Hon, J., Duckworth, J.W., Jennings, A. and G. Veron (2008). *Viverra tangalunga*. The IUCN Red List of Threatened Species 2008: e.T41708A10538140. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T41708A10538140.en. Downloaded on 10 June 2016.

Bernard, H., Fjeldsa, J. and M. Mohamed (2009). A case study on the effects of disturbance and conversion of tropical lowland rainforest on the non-volant small mammals in north Borneo: management implications. *Mammal Study* **34**: 85-96. doi: http://dx.doi.org/10.3106/041.034.0204

Bernard, H., Baking, E.L., Giordano, A.J., Wearn, O.R. and A.H. Ahmad (2014). Terrestrial mammal species richness and composition in three small forest patches within an oil palm landscape in Sabah, Malaysia Borneo. *Mammal Study* **39**: 1-14.

Brodie, J. and A.J. Giordano (2011). Small carnivore of the Maliau Basin, Sabah, Borneo, including a new locality for Hose's civet *Diplogale hosei*. *Small Carnivore Conservation* **44**: 1-6.

Cheyne, S.M., Husson, S.J., Chadwick, R.J. and D.W. Macdonald (2010). Diversity and activity of small carnivores of the Sabangau Peat-swamp forest, Indonesia Borneo. *Small Carnivore Conservation* **43**: 1-7.

Duckworth, J.W., Timmins, R.J., Roberton, S., Long, B. and A. Azlan (2008a). *Arctogalidia trivirgata*. The IUCN Red List of Threatened Species 2008: e.T41691A10517467. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T41691A10517467.en. Downloaded on 10 June 2016.

Duckworth, J.W., Wozencraft, C. and B. Kanchanasaka (2008b). *Paguma larvata*. The IUCN Red List of Threatened Species 2008: e.T41692A10517976. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T41692A10517976.en. Downloaded on 10 June 2016.

Duckworth, J.W., Lynam, A. and C. Breitenmoser-Wursten (2014). Introduction: Non-Panthera cat species in South-east Asia: presents knowledge and recommendations. *Cat News* **8**: 62-67.

Eng, I.S. (2011). Microhabitat analysis and population parameters of small carnivores in Sarawak Planted Forest, with emphasis on the Malay Civet Viverra tangalunga. Dissertation, Universiti Tunku Abdul Rahman.

Farina, A. (1998). Principles and methods in landscape ecology. Chapman and Hall Publisher, London.

Fitri, L.M. (2012). Komunitas dan Tingkah Laku Anti Predator (Mobbing) Burung Strata Bawah di Hutan Harapan Jambi. Dissertation, University of Andalas.

Fitzherbert, E.B., Struebig, M.J., Morel, A, Danielsen, F., Bruhl, C.A., Donald, P.F., B. Phalan (2008). How will oil palm expansion affect biodiversity? *Trends in Ecology and Evolution* **29 (10)**: 538-545. doi:10.1016/j.tree.2008.06.012

Government District Solok Selatan (2014). District Profile. Access in http://www.solselkab.go.id/post/read/88/perkebunan-investasi.html on 21 October 2015.

Grassman, L.I., Tewes, M.E., N.J. Silvy (2005). Ranging, habitat use and activity patterns of binturong *Arctictis binturong* and yellow-throated marten *Martes flavigula* in north-central Thailand. *Wildlife Biology* **11(1)**: 49–57 doi: http://dx.doi.org/10.2981/0909-6396(2005)11[49:RHUAAP]2.0.CO;2

Gunarso, P., Hartono, M.E., Agus, F., T.J. Killen (2013). Oil palm and land use change in Indonesia, Malaysia and Papua New Guinea. Reports from Technical Panels of the 2nd Greenhouse Gas Working Group of the Roundtable on Sustainable Palm Oil.

Hearn, A.J., Ross, J., Macdonald D.W. et al (2016). Predicted distribution of Sunda clouded leopard *Neofelis diardi* (Mammalia: Carnivora: Felidae) on Borneo. *Raffles Bulletin of Zoology* **33**:149-156.

Hon, J., Azlan, M.J., and J.W. Duckworth (2008). *Hemigalus derbyanus*. The IUCN Red List of Threatened Species 2008: e.T41689A10515759. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T41689A10515759.en. Access at 14October 2015

Jennings, A.P. and G. Veron (2011). Predicted distribution and ecological niches of 8 civet and mongoose species in Southeast Asia. *Journal of Mammalogy* **92(2)**:316-327. DOI: http://dx.doi.org/10.1644/10-MAMM-A-155.1

Jennings, A.P., Naim, M., Advento, A.D., Aryawan, A.A.K., Sudharto, Caliman, J., Verwilghen, A. and G. Veron (2015). Diversity occupancy of small carnivores within oil palm plantations in central Sumatra, Indonesia. *Mammal Research* **60**:181-188. Doi:10.1007/s13364-015-0217-1

Karsai I. and G. Kampis (2011). Connected fragmented habitats facilitate stable coexistence dynamics. *Ecological Modelling* **222**: 447-455. Doi:10.1016/j.ecolmodel.2010.11.002

Mathai, J., Hon, J., Juat, N., Peter, A. and M. Gumal (2010). Small carnivores in logging concession in the Upper Baram, Sarawak, Borneo. *Small Carnivore Conservation* **42**:1-9.

MaCarthy, J.L., Wibisono, H.T., McCarthy, K.P., Fuller, T.K. and N. Andayani (2014a). Assessing the distribution and habitat use of four felid species in Bukit Barisan Selatan National Park. *Global Ecology and Conservation* **3**:210-221. Doi: 10.10.16/j.geoco.2014.11.009

McCarthy, J. and T.K. Fuller (2014b). Records of small carnivores from Bukit Barisan Selatan National Park, southern Sumatra, Indonesia. *Small Carnivore Conservation* **51**:59-63.

Mitchell, M.G.E., Suarez-Castro, A.F., Martines-Harms, M., Maron, M., McAlpine, C., Gastron, K.J., Johansen, K. and J.R. Rhodes (2015). Reframing landscape fragmentation's effect on ecosystem services. *Trends in Ecology & Evolution* **30(4)**:190-198. Doi: 10.1016/j.tree.2015.01.011

Mudappa, D., Noon, B.R., Kumar, A. and R. Chellam (2007). Responses of small carnivores to rainforest fragmentation in the southern Western Ghats, India. *Small Carnivore Conservation* **36**:18-26.

Nettlebeck, A.R. (1997). Sightings of Binturongs *Arctictis binturong* in the Khao Yai National Park, Thailand. *Small Carnivore Conservation* **16**: 21–24.

Nowak, R.M. and J.L. Paradiso (1983). Walker's Mammals of The World 4th Edition. The John Hopkins University Press, Baltimore and London.

Payne, J., Francis, C.M., Phillipps, K. and S.N. Kartikasari (2000). Panduan lapangan mamalia di Kalimantan, Sabah, Sarawak dan Brunei Darussalam. Wildlife Conservation Society, Bogor Indonesia.

Phalan, B., Bertzky, M., Butchart, S.H.M., Donald, P.F., Scharlemann, J.P.F., Stattersfield, A.J. and A. Balmford (2013). Crop expansion and conservation priorities in tropical sountries. *PlosOne* **8**:e51759.

Pusparini, W., Wibisono, H.T., Reddy, G.V., Tarmizi and P. Bharata (2014). Small and medium sized cats in Gunung Leuser National Park, Sumatra, Indonesia. Cat news Special Issues **8**: 4-9.

Rajaratnam, R., Sunquist, M., Rajaratnam, L. and L. Ambu (2007). Diet and habitat selection of the leopard cat (*Prionailurus bengalensis*) in an agricultural landscape in Sabah, Malaysian Borneo. *Journal of Tropical Ecology* **23**: 209-217. doi:10.1017/S0266467406003841

Rianto, B., Mochtar, H. and A. Sasmito (2012). Overview of palm oil industry landscape in Indonesia. www.pwc.com. Access on 4 December 2014.

Ross, J., Brodie, J., Cheyne, S., Chutipong, W., Hedges, L., Hearn, A., Linkie, M., Loken, B., Mathai, J., McCarthy, J., Ngoprasert, D., Tantipisanuh, N., Wilting, A. and I.A. Haidir (2015). *Hemigalus derbyanus*. The IUCN Red List of Threatened Species 2015: e.T41689A45216918. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T41689A45216918.en. Downloaded on 10 June 2016

Sanderson, J. and G. Harris (2011). Automatic data organization, storage, and analysis of camera trap pictures. *Journal of Indonesian Natural History.* **1(1)**: 11-19. DOI: 10.1890/0012-9623-91.3.352

Silmi, M., Mislan, Anggara, S. and B. Dahlen (2013). Using leopard cats (*Prionailurus bengalensis*) as biological pest control of rats in palm oil plantation. *Journal of Indonesian Natural History* **1(1)**: 31-36.

Sunarto, S., Kelly, M.J., Parakkasi, K. and M.B. Hutajulu (2014). Cat coexistence in central Sumatra: ecological characteristics, spatial and temporal overlap, and implications for management. *Journal of Zoology* **296**: 104-115. doi:10.1111/jzo.12218

Syamsi, F. (2011). Komunitas kelelawar Microciroptera di kawasan perkebunan kelapa sawit PT. Kencana Sawit Indonesia (KSI) Solok Selatan. Dissertation, University of Andalas.

Widmann, P., De Leon, J. and J.W. Duckworth (2008). *Arctictis binturong*. The IUCN Red List of Threatened Species 2008: e.T41690A10516645. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T41690A10516645.en. Downloaded on 10 June 2016.

Wilting, A., Samejima, H. and A. Mohamed (2010). Diversity of Bornean viverrids and other small carnivores in Deramakot Forest Reserve, Sabah, Malaysia. *Small Carnivore Conservation* **42**: 10-13.

Yue, S., Brodie, J.F., Zipkin, E.F. and H. Bernard (2015). Oil palm plantations fail to support mammal diversity. *Ecological Applications* **25(8)**: 2285-2292.

Predation accounts of translocated slow lorises, *Nycticebus coucang* and *N. javanicus*, in Sumatra and Java

Robithotul Huda, Richard Moore and **Karmele L. Sanchez**

IAR Indonesia. Jl. Curug Nangka Kp. Sinarwangi, RT. 04/05, Kel. Sukajadi, Kec. Tamansari, Bogor, West Java 16610

Corresponding author: Robithotul Huda; *Email: huda@internationalanimalrescue.org*

Abstract

Incidences of primate predation are seldom witnessed in the wild and even less so at night. The slow lorises (Genus: Nycticebus) are small-bodied nocturnal primates found across Southeast Asia. Here we provide accounts of predation events that occurred during behavioural monitoring in a seven-year translocation programme of radio-collared Javan (*N. javanicus*) and Sunda (*N. coucang*) slow lorises. From 2010 to 2017, a total of 30 Sunda slow lorises and 45 Javan slow lorises were fitted with radio collars and were released into their respective habitats. Seven Sunda slow lorises and four Javan slow lorises fell victim to predation during this period. Six were confirmed cases, and five were suspected. Predators included felids (leopard cats and Javan leopards), reptiles (reticulated pythons and common water monitors) and raptors (changeable hawk-eagles). With all the cases presented here, the backgrounds of the slow lorises (i.e. time spent in the illegal trade and rehabilitation) need to be taken into consideration as the animals' abilities to avoid predators may have been affected. Nevertheless, as predation accounts in nocturnal primate species are so rarely observed, this collection of observations involving slow lorises may help to provide additional information to better understand certain aspects of predator-prey relationships.

Abstrak

Kejadian pemangsaan pada primata sangat jarang terlihat di alam liar apalagi di malam hari. Kukang (Genus: Nycticebus) merupakan satwa nocturnal berbadan kecil yang bisa ditemukan di Asia tenggara. Laporan ini bertujuan untuk memberikan gambaran tentang peristiwa pemangsaan dari hasil pemantauan perilaku dalam program translokasi Kukang jawa (*N. javanicus*) dan Kukang sumatera (*N. coucang*) yang telah berjalan selama tujuh tahun. Sejak tahun 2010 hingga tahun 2017, sebanyak 30 Kukang sumatera dan 45 Kukang jawa dipasang radio transmitter sebelum dilepasliarkan ke habitatnya. Tujuh kukang sumatera dan empat kukang jawa menjadi korban pemangsaan pada periode ini. Enam kasus terkonfirmasi dan lima kasus masih pendugaan. Pemangsa tersebut adalah Felidae (kucing hutan dan macan tutul jawa), Reptil (ular sanca batik dan biawak) dan Raptor (Elang brontok). Kukang yang diteliti merupakan hasil perdagangan illegal dan pemeliharaan yang telah direhabiliasi, sehingga kemungkinan kemampuan untuk menghindari predator (anti predasi) telah berkurang. Namun demikian, karena kasus pemangsaan terhadap Kukang masih sangat jarang, maka informasi ini sangat penting dalam membantu memahami aspek-aspek tertentu dalam kaitanya antara Predator dengan mangsanya.

Key words: Indonesia, nocturnal primate, predation, slow loris, translocation

Introduction

Predation among wild primates by snakes, raptors and carnivores is a constant threat to their survival and is undoubtedly a powerful selection pressure in their life histories (Burnham et al., 2012). Quantifying the scale of predation is essential in determining and understanding certain aspects of primate ecology (Terborgh and Janson, 1986); however, incidences of primate predation are seldom witnessed in the wild (Cheney and Wrangham, 1987; Isbell, 1990) and even less so at night (Isbell, 1990; Bearder et al., 2002; Hart, 2007; Burnham et al., 2012). Indeed, when both the prey and the predator are nocturnal, direct observations of predation events are virtually unobtainable (Isbell, 1990) explaining why most reports are anecdotal (Peetz et al., 1992).

Slow lorises (Genus: Nycticebus) are small-bodied nocturnal primates found across South-east

Submitted 1st March, 2018. Accepted 31st July, 2018

Asia (Nekaris and Bearder, 2011). Owing to their cryptic and nocturnal nature, they are one of the least known primate taxa (Bearder, 1999; Nekaris, 2014). Not surprisingly, information regarding the predation of slow lorises is limited to a few actual accounts. Known predators of slow lorises include orangutans (*Pongo abelii*) (Utami and van Hoof, 1997; Hardus et al., 2012), changeable hawk eagles (*Nisaetus cirrhatus*) (Hagey et al. 2007), marbled cats (*Pardofelis marmorata*) (Streicher and Nadler, 2003) and pythons (*Python reticulatus*) (Wiens and Zitzmann, 1999). Another likely predator group is monitor lizards (*Varanus sp.*) (Kenyon et al., 2014). Despite being protected by Indonesian laws, slow lorises have been among the most commonly traded primate species for more than two decades (Nijman et al., 2015). International Animal Rescue (IAR) Indonesia, a primate rehabilitation centre in Bogor, West Java was established in 2006 and has received slow lorises rescued from the pet trade since 2008. In 2010, a systematic translocation programme for slow lorises was initiated. Here we provide accounts of predation on Javan (*N. javanicus*) and Sunda (*N. coucang*) slow lorises that occurred during the post-release monitoring phase of the translocation programme over a seven-year period. All the slow lorises in this study derived from the illegal pet trade and were almost certainly wild caught individuals.

Methods

Release protocol

Slow lorises selected for translocation were fitted with a radio collars and monitored post-release using R1000 Com-Spec receivers with Biotrack antennas for up to 13-months (mean = 3.5 months) at three study sites between 2010 and 2017. Data on ranging, behaviour and feeding ecology were collected during the monitoring period. The release programme followed the guidelines of the IUCN for the reintroduction of primates (IUCN/SCC, 2013). The lorises spent one month in a habituation cage at the release site prior to release.

Release sites

Sunda slow lorises were released in Batutegi Protected Forest, Tanggamus Regency, Lampung and Bukit Barisan Selatan National Park in Sumatra. Javan slow lorises were released in Mount Sawal Nature Reserve, Ciamis and Mount Salak in Halimun-Salak National Park, West Java. Batutegi Protected Forest consists of primary and secondary rain forest covering an area of 58,174 ha with elevations ranging from 200 – 1,750 m asl. Bukit Barisan Selatan National Park is located in the Bukit Barisan Mountains and crosses the provinces of Lampung, Bengkulu and South Sumatra. The park has an area of 356,800 ha and consists of a mix of montane, lowland tropical, coastal and mangrove forest ranging from 0 – 1800 m asl. Mount Sawal Nature reserve comprises secondary rain forest with elevations ranging from 600 – 1,764 m asl. Mount Salak covers an area of approximately 76,000 ha ranging from 400 – 2211 m asl. Primary forest is still present at higher altitudes, but secondary forest dominates the lower regions.

Predation records

When the predation of a slow loris occurred, the events and circumstances leading up to the predation were recorded in chronological order, along with the location, the habitat type, and any additional evidence found at the scene.

Results

A total of 30 Sunda slow lorises and 45 Javan slow lorises were fitted with radio collars and released into their respective habitats. The IAR Indonesia team recorded six Sunda slow lorises (20%) and six Javan slow lorises (13%) predations during the study period. In five of the cases, the predator could be confirmed, and in the remaining cases the predators were assumed based on evidence found at the scene of the event.

On 11th May 2012, a female Sunda slow loris was released from the habituation cage in Batutegi

Table 1. Incidences of slow loris predation observed at the Yayasan IAR Indonesia release programme from 2010-2018.

Case	Date	Species	Sex	Predator	Evidence	Location	Survival (days)
1	21.10.12	*N. coucang*	F	Reticulated python	Confirmed	Batutegi Protected Forest	150
2	28.1.13	*N. coucang*	M	Raptor	Suspected	Batutegi Protected Forest	330
3	11.4.13	*N. coucang*	F	Reticulated python	Confirmed	Batutegi Protected Forest	9
4	14.8.13	*N. coucang*	M	Reticulated python	Confirmed	Batutegi Protected Forest	3
5	18.7.15	*N. coucang*	M	Reticulated python	Confirmed	Batutegi Protected Forest	240
6	14.9.15	*N. javanicus*	M	Leopard cat	Suspected	Mount Sawal, Ciamis	330
7	15.8.15	*N. javanicus*	F	Leopard cat	Suspected	Mount Sawal, Ciamis	90
8	13.9.15	*N. javanicus*	F	Javan leopard	Suspected	Mount Sawal, Ciamis	0
9	12.8.17	*N. javanicus*	M	Javan leopard	Suspected	Mount Sawal, Ciamis	0
10	19.10.17	*N. coucang*	M	Chbl. hawk-eagle	Confirmed	Bukit Barisan Selatan NP	30
11	9.1.18	*N. coucang*	M	Water monitor lizard	Confirmed	Bukit Barisan Selatan NP	95

Forest, Lampung. On 21th October 2012 (150 days after release), the slow loris telemetry signal emerged from a python located on the ground in some bushes. At 6am the following day, the remains of the slow loris and the radio collar were retrieved after they were regurgitated from the python. The length of the python was 190cm and weighed approximately 13 Kg.

On 8th August 2012, a male Sunda slow loris was released from habituation cage in Batutegi Forest. On 13th June 2013 (330 days after release), the carcass of the slow loris was found. The head had been ripped off, the fur on the head had been plucked out and the muscle had multiple beak-sized holes. A raptor was the suspected predator.

Figure 1. The 1.9 m reticulated python that preyed upon a Sunda slow loris in Batutegi.

On 2nd April, 2012, a female Sunda slow loris was released from the habituation cage in Batutegi Forest. On 11th April 2013 (nine days after release), the telemetry-signal from the slow loris lead to a python located at the base of a bamboo thicket. The length of the python was 170 cm and weighed approximately 11 kg.

On 11th August, 2013 a male of Sumatran slow loris was released from the habituation cage on Talang Randai Island in Batutegi Forest. On 14th August, 2013 (three days after release), we found the signal coming from a python located in a hole in the ground. The following day, the python regurgitated the remains of the slow loris and the radio collar. The length of the python was 180 cm and weighed approximately 11kg.

On 10th November, 2014, a male Sunda slow loris was released from habituation cage in Batutegi Forest. On 18th July, 2015 (240 days after release), the signal from the slow loris came from a python located in some bushes on the ground. The length of the python was 350 cm and weighed approximately 15 kg.

On 5nd December, 2014, a male Javan slow loris was released from the habituation cage in the Mount Sawal Nature Reserve. On 14th September

2015 (330 days after release), the carcass of the slow loris was found. The remains included fur, the jaw bone and some internal organs. Footprints of a leopard cat (*Prionailurus bengalensis*) were identified in the mud near to the remains. Prior to the event, the monitoring team had observed a leopard cat in the same area as the slow loris' remains on numerous occasions.

On 16th May, 2015, a female Javan slow loris was released from the habituation cage in the Mount Sawal Nature Reserve. On 15th Augustus 2015 (90 days after release), the carcass of the slow loris was located. All that remained of the slow loris was some fur and what appeared to be the stomach of the animal. A leopard cat's footprints were found in the mud near to the remains.

On the 11th September, 2015 three Javan slow lorises (including 2 females and an infant) were placed inside a temporary habitation cage on Mount Sawal to await release. The habituation cage was 4.5 x 1.5 x 2 m, was half a metre off the ground and consisted of a wood frame and wire mesh. On the 13th September 2015, on arrival at the cage, the wire mesh of the cage had been ripped open and all three slow lorises had disappeared. The tears in the mesh appeared to have been made by the claws of a large animal. On a nearby tree, claw marks from a Javan leopard (*Panther pardus melas*) were identified and leopard hair was also found on the ground (Fig 2).

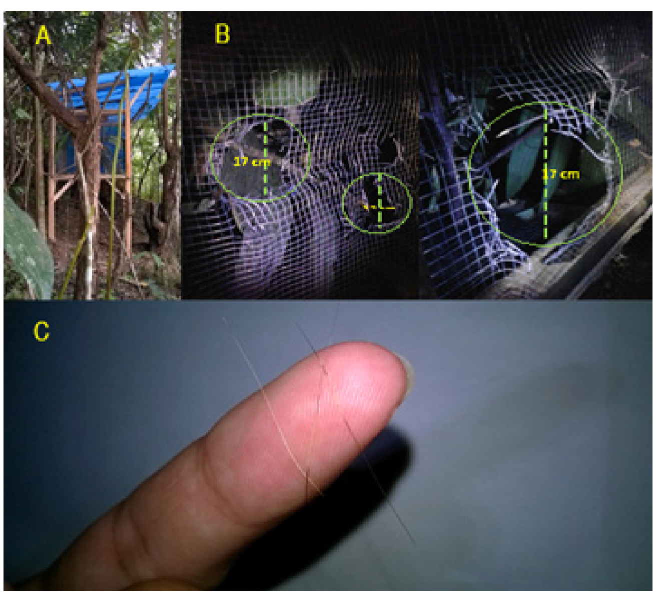

Figure 2. (a) the habituation cage; (b) tears in the wire mesh suspected to have been made by a Javan leopard; (c) hairs found on the ground near to the habituation cage.

On the 1st August 2017, one male Javan slow loris was placed inside a temporary habitation cage on Mount Sawal to await release. The cage was 3 x 3 x 2 m and made of bamboo and strong twine mesh. On 12th August 2017 at approximately 22:00, the monitoring team found the habituation cage had been ripped open and the slow loris had disappeared. Slow loris fur was found at the scene and fresh footprints made by a Javan leopard were identified (Fig 3).

On 18th September 2017, a male Sunda slow loris was released from habituation cage in Bukit Barisan Selatan National Park in Sumatra. On the 19th October 2017, the transmitter signal emerged from a changeable hawk eagle's nest (*Nisaetus cirrhatus*) in a tree approximately 20m above ground (*Dipterocarpus sp.*). At least one fledgeling

Figure 3. (a) Ripped mesh of the habituation cage. (b) Footprints of a Javan leopard was found next to the habituation cage.

remained in the nest. The team climbed nearby trees to confirm the collar was indeed in the nest.

On 29th August 2017, a male Sunda slow loris was released from habituation cage in Bukit Barisan Selatan National Park. On the 9th January 2018, we zeroed in on a the radio-collar signal emerging from a common water monitor lizard (*Varanus. s. salvator*) located in undergrowth next to a small body of water. The monitor lizard was 1.55m long and weighed approximately 5 kg.

Discussion

All predation events reported in this study occurred in the wild and could reflect natural levels of predation. Nevertheless, our study subjects may have been more susceptible to attacks owing to the varying amounts of time spent in captivity. Animals that have undergone periods of isolation away from predators can begin to lose the appropriate anti-predator behaviours necessary for survival in the wild (Griffin et al. 2000). The length of time spent in captivity and how much the animal was affected by this differed for each individual. When released into a new and unknown habitat, translocated animals typically have to contend with new types of predators, aggressive conspecifics defending their territories and finding suitable and adequate food (Beck 2010). Wild animals that naturally move into new habitats are known to be at higher risk of predation (Isbell 1990). Newly translocated animals, likely affected by a stint in captivity, are probably even more at risk of falling prey to predators, starvation and disease. Furthermore, some of the slow lorises may have originated from a habitat either void of predators or with a different predator composition and in such cases they may never have learnt area-specific anti-predator behaviour during their early stage of life.

Reticulated pythons were responsible for four of the 11 confirmed predation cases. Because snakes consume prey whole, the radio collars were swallowed along with the slow lorises, making it possible to track and verify the predation event. All of the python predations occurred at the release site in Batutegi Protected Forest and involved the Sumatran Sunda slow lorises as the prey. The dense rain forest in Batutegi is bordered by a large freshwater reservoir with lots of river tributaries that dissect parts of the forest providing an ideal habitat for this water-loving reptile (Das 2012; Mattison 2014).

Slow lorises are arboreal, but will take to terrestrial locomotion over short distances when canopy cover is absent (Rogers and Nekaris, 2011). Young pythons are good climbers and hunt in the lower branches of trees, but become increasingly terrestrial as they grow larger (Mattison, 2014). Based on the dense forest with closed canopy where the predation events took place and the pythons' smaller body sizes (body weights of all four pythons ranging from 11 to 15 kg), the slow lorises were most likely ambushed by juvenile pythons in the trees.

Mammals compose a large proportion of reticulated python diet, which includes rodents, monkeys, pangolins and wild pigs (Shine et al., 1999). Pythons predation on slow loris has been documented previously in West Malaysia and also involved a radio-collared wild slow loris (Wiens and Zitzmann, 1999). Python predation on tarsiers, a similar small-bodied nocturnal primate, have also been recorded on at least three occasions in Sulawesi, Indonesia and the Philippines (Gursky, 2002; Neri-Arboleda et al., 2002; Řeháková-Petrů et al., 2012).

There exists no previous published reports of pythons predation on Javan slow lorises. This lack of observation may be attributed to the difficulties associated with observing rare events involving two nocturnal, cryptic and arboreal species. Another possible explanation is that Javan slow lorises possess better anti-predator strategies, especially towards snakes, than Sunda slow lorises. Nekaris and Munds (2010) proposed that slow loris facemasks may have an aposematic function. However, the most likely reason for the different predation rates between the two species is the lower densities of pythons in the two mountainous release sites. The two release sites, Mount Salak and Mount Sawal in West Java, do not contain large bodies of water and are at higher elevations with cooler temperatures, making it a less attractive habitat for these large reptiles. Pythons are present at these sites, but are uncommon (Kurniati, 2003).

Another confirmed predation event by a reptile species – the common water monitor - occurred in Bukit Barisan Selatan National Park. Water monitors are predominantly terrestrial but are excellent climbers. These large reptiles feed on a variety of prey including invertebrates and small vertebrates, such as fish, crabs, freshwater turtles, birds, lizards and rats (Das, 2015). Although never confirmed, a monitor lizard was suspected to have predated on a reintroduced pygmy slow loris in Vietnam (Kenyon et al., 2014). As carrion is also component of a water monitor's diet, there is a possibility that the slow loris was dead before the water monitor consumed the animal.

Among the remaining non-confirmed predation cases, leopard cats were potentially responsible for two of the kills (Cases 5 and 6). The diet of leopard cats consists predominantly of small mammals, specifically murids, but also includes herpetofauna and birds (Rajaratnam et al., 2007; Shehzad et al., 2012). Leopard cats are known to possess highly adaptable dietary behaviour (Xiong et al., 2016), only one case of primate predation (*Semnopithecus obscura*) by leopard cat has been documented (Grassman, 2000). Leopard cats are known to possess highly adaptable dietary behaviour (Xiong et al., 2016). Although only one case of primate predation (*Semnopithecus obscura*) by a leopard cat has been documented (Grassman, 2000), they remain opportunistic predators fully capable of capturing and killing slow lorises. Another similar larger felid, the marbled cat (*Pardofelis marmorata*), was observed preying on a pygmy slow loris in Vietnam (Streicher and Nadler, 2003). The evidence found at the scene, however, which included leopard cat footprints, regular sightings of leopard cats in the area, and clear kill signs of a small carnivorous mammal may be coincidental. In both cases, the leopard cats may have merely encountered the slow loris' carcasses after another predator had already killed the animal.

In another unrelated case that occurred during post-release monitoring, two adult leopard cats were observed rushing towards two Javan slow lorises that had fallen to the ground from a high branch during a loud territorial fight. The two cats appeared to be ready to pounce on the unsuspecting primates that were preoccupied with each other, but were scared off after noticing the monitoring team (B. Muhidin, personal observation). Conversely, Nekaris et al. (2013) reported a seeming ambivalence during encounters between slow lorises and leopard cats; an observation which had also been reported by the IAR Indonesia monitoring team on numorous occasions.

Another larger felid may also have been responsible for two additional predation cases involving four Javan slow lorises (two adult females and an infant); however, these events occurred in a setting that was not deemed representative of wild circumstances. In both cases, the slow lorises were still in habituation cages on Mount Sawal awaiting release. The habituation cages were found torn open and the slow lorises inside had disappeared. Unfortunately, the slow lorises had yet to be fitted with radio-collars making it impossible to track them. The team concurred that only a Javan leopard, known to be present on Mount Sawal (Iqbal 2017), has the power to rip open the wire mesh in such a destructive way. Other evidence found at the scene corroborated this assumption: fresh claw marks on a tree, a Javan leopard footprint and hair found on the torn mesh (Figs 2 and 3). While leopards have been known to prey upon a number of different primate species, it is generally assumed that they avoid arboreal primates in favour of easier terrestrial targets, such as ungulates (Henschel et al., 2005; Hayward et al., 2006). Nevertheless, there is one recorded case of a leopard eating a Potto (*Perodicticus potto*), a similar small-bodied and nocturnal strepsirrhine primate in the Democratic Republic of Congo (Hart et al., 1996).

With only a few of cases of felid predation on nocturnal primates available in the literature, it is possible that such events are rare and opportunistic. The lack of evidence for such events, however, does not always equate to evidence for absence. For example, single predation events may not always be deemed sufficient or suitable for refereed literature. Additionally, the continuous human presence required for the monitoring of translocated slow lorises post-release will undoubtedly scare away potential felid predators. Nonetheless, if the claim that nocturnal behaviour of primates is associated with reducing predation risks by felids or other mammalian carnivores is correct (Burnham et al., 2012), the absence of evidence for felid predation may not be coincidental.

Two further cases involved predation by raptors. Although the case in Bukit Barisan Selatan National Park was not witnessed directly, the evidence of the collar being located in a changeable hawk eagle's nest was deemed conclusive. In the unconfirmed case, the remains found at the scene and the kill wounds were characteristic of birds of prey (Hardey et al., 2006). Incidences of raptors predating on nocturnal primates are fairly common in comparison to reptiles, felids and other primates (Burnham et al., 2012). Furthermore, as the predation happened during the day, a diurnal raptor species was presumed responsible. The predation of a slow loris by a changeable hawk eagle had previously been reported (Hardey et al., 2006). Raptor species found in the Batutegi Protected Forest - potentially resonsible for the predation - include changeable hawk eagles (*Nisaetus cirrhatus*), black hawk eagles (*Ictinaetus malayensis*) and crested serpent eagles (*Spilornis cheela*).

Our study recorded eleven predation observations of translocated slow lorises over a seven-year period. As predation accounts of nocturnal primate species are rarely observed, our collection of observations involving slow lorises may help to provide additional information to better understand certain aspects of predator-prey relationships. We hope that our results can assist in maximising the survival chances of slow lorises and other nocturnal primate species in future reintroduction programmes, potentially through the development of anti-predator behavioural training against known predators.

Acknowledgment

We thank the monitoring team at Yayasan IAR Indonesia: Bobby Muhidin, Hilmi, Mursid, Itang, Ricky for their help in the field. We are grateful to the staff at Halimun Salak National Park (TNGHS), West Java Nature Conservation Agency (BKSDA Jawa Barat), Bukit Barisan Selatan National Park (TNBBS) and the Forest Management Unit in Batutegi (KPHL Batutegi) for providing permission and supporting us in our efforts in Indonesian slow loris conservation. Our gratitude goes to an anonymous donor, Wildlife Reserves Singapore, Pro Wildlife, Rufford Small Grants, Ocean Park Conservation Foundation Hong Kong, US Fish and Wildlife Services for generously supporting this work.

References

Bearder, S., Nekaris, K. and C. Buzzell (2002). Dangers in the night: Are some nocturnal primates afraid of the dark? Pages 21-43 in Miller L, editor. Eat or be eaten: Predator sensitive foraging among primates. Cambridge University Press., Cambridge.

Bearder, S.K. (1999). Physical and social diversity among nocturnal primates: a new view based on long term research. *Primates* **40**:267-282.

Beck, B.B. (2010). Chimpanzee orphans: sanctuaries, reintroduction, and cognition in Lonsdorf, E., Ross, S.R., Matsuzawa, T. and Goodall J, editors. The mind of the chimpanzee: ecological and experimental perspectives. University of Chicago Press.

Burnham, D., Bearder, S., Cheyne, S., Dunbar, R. and D. Macdonald (2012). Predation by mammalian carnivores on nocturnal primates: is the lack of evidence support for the effectiveness of nocturnality as an antipredator strategy? *Folia Primatologica* **83**:236-251.

Cheney, D. and Wrangham, R. (1987). Predation. Pages 227–239 in Smuts, B., Cheney, D., Seyfarth, R., Wrangham, R., and Struhsaker, T., editors. Primate societies. University of Chicago Press, Chicago.

Das, I. (2012). A Naturalist's guide to the snakes of Southeast Asia: including Malaysia, Singapore, Thailand, Myanmar, Borneo, Sumatra, Java and Bali. John Beaufoy, Oxford.

Das, I. (2015). A field guide to the reptiles of South-East Asia. Bloomsbury Publishing.

Grassman, L. (2000). Movements and diet of the leopard cat *Prionailurus bengalensis* in a seasonal evergreen forest in south-central Thailand. *Acta Theriologica* **45**:421-426.

Griffin, A.S., Blumstein, D.T. and C.S. Evans (2000). Training captive-bred or translocated animals to avoid predators. *Conservation Biology* **14**:1317-1326.

Gursky, S. (2002). Predation on a wild spectral tarsier (*Tarsius spectrum*) by a snake. *Folia Primatologica* **73**:60-62.

Hagey, L.R., Fry, B.G. and H. Fitch-Snyder (2007). Talking defensively, a dual use for the brachial gland exudate of slow and pygmy lorises. Pages 253-272 in Gursky, S. and Nekaris, K. editors. Primate anti-predator strategies. Springer, New York.

Hardey, J., Crick, H.Q.P., Wernham, C.V., Riley, H.T., Etheridge, B. and D.B.A. Thompson (2006). Raptors: a field guide to survey and monitoring. Scottish Natural Heritage and the Stationary Office Ltd, Edinburgh.

Hardus, M.E., Lameira, A.R., Zulfa, A., Atmoko, S.S.U., de Vries, H. and S.A. Wich (2012). Behavioral, ecological, and evolutionary aspects of meat-eating by Sumatran orangutans (*Pongo abelii*). *International Journal of Primatology* **33**:287-304.

Hart, D. (2007). Predation on primates: a biogeographical analysis. Pages 27-59. Primate anti-predator strategies. Springer.

Hart, J., Katembo, M. and K. Punga (1996). Diet, prey selection and ecological relations of leopard and golden cat in the Ituri Forest, Zaire. *African Journal of Ecology* **34**:364-379.

Hayward, M., Henschel, P., O'brien, J., Hofmeyr, M., Balme, G. and G. Kerley (2006). Prey preferences of the leopard (*Panthera pardus*). *Journal of Zoology* **270**:298-313.

Henschel, P., Abernethy, K. and L. White (2005). Leopard food habits in the Lope National Park, Gabon, Central Africa. *African Journal of Ecology* **43**:21-28.

Iqbal, D. (2017). Macan Tutul Ditemukan di Gunung Sawal Ciamis. Mongabay Available from http://www.mongabay.co.id/2017/04/26/macan-tutul-ditemukan-di-gunung-sawal-ciamis/ (Accessed January 2018)

Isbell, L.A. (1990). Sudden short-term increase in mortality of vervet monkeys (*Cercopithecus aethiops*) due to leopard predation in Amboseli National Park, Kenya. *American Journal of Primatology* **21**:41-52.

IUCN (2002). Guidelines for nonhuman primate reintroductions. Pages 29–57 in Soorae PS, and Baker LR, editors. Re-introduction news IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE.

Kenyon, M., Streicher, U., Loung, H., Tran, T., Tran, M., Vo, B. and A. Cronin (2014). Survival of reintroduced pygmy slow loris *Nycticebus pygmaeus* in South Vietnam. *Endangered Species Research* **25**:185-195.

Kurniati, H. (2003). Amphibians and Reptiles of Gunung Halimun National Park West Java, Indonesia. Research Center for Biology-LIPI. Cibinong.

Mattison, C. (2014). Nature Guide Snakes and Other Reptiles and Amphibians. Dorling Kindersley Limited.

Nekaris, K. (2014). Extreme primates: Ecology and evolution of Asian lorises. *Evolutionary Anthropology*: News, and Reviews **23**:177-187.

Nekaris, K.A.I, Moore, R.S., Rode, E.J. and B.G. Fry (2013). Mad, bad and dangerous to know: the biochemistry, ecology and evolution of slow loris venom. *Journal of Venomous Animals and Toxins including Tropical Diseases* 19:21.

Nekaris, K.A.I., Bearder, S.K. (2011). The lorisiform primates of Asia and mainland Africa: Diversity shrouded in darkness. Pages 24-45 in Campbell CJ, Fuentes A, MacKinnon KC, Bearder SK, and Stumpf RM, editors. Primates in Perspective. Oxford University Press, Oxford.

Nekaris, K.A.I., Munds, R. (2010). Using facial markings to unmask diversity: The slow lorises (Primates: Lorisidae: *Nycticebus spp*.) of Indonesia. Pages 383-396 in Gursky, S., and Supriatna, J., editors. Indonesian Primates. Springer New York, New York, NY.

Neri-Arboleda, I., Stott, P. and N. Arboleda (2002). Home ranges, spatial movements and habitat associations of the Philippine tarsier (*Tarsius syrichta*) in Corella, Bohol. *Journal of Zoology* **257**:387-402.

Nijman, V., Spaan, D., Rode-Margono, E.J., Wirdateti and K.A.I Nekaris (2015). Changes in the primate trade in Indonesian wildlife markets over a 25-year period: Fewer apes and langurs, more macaques, and slow lorises. *American Journal of Primatology*:10.1002/ajp.22517.

Peetz, A., Norconk, M.A. and W.G. Kinzey (1992). Predation by jaguar on howler monkeys (*Alouatta seniculus*) in Venezuela. *American Journal of Primatology* **28**:223-228.

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**:209-217.

Řeháková-Petrů, M., Peške, L. and T. Daněk (2012). Predation on a wild Philippine tarsier (*Tarsius syrichta*). *Acta Ethologica* **15**:217-220.

Rogers, L., Nekaris, K.A.I. (2011). Behaviour and habitat use of the Bengal slow loris *Nycticebus bengalensis* in the dry dipterocarp forests of Phnom Samkos Wildlife Sanctuary, Cambodia. *Cambod J Nat Hist* **2**:104-113.

Shehzad, W., Riaz, T., Nawaz, M.A., Miquel, C., Poillot, C., Shah, S.A., Pompanon, F., Coissac, E. and P. Taberlet (2012). Carnivore diet analysis based on next-generation sequencing: application to the leopard cat (*Prionailurus bengalensis*) in Pakistan. *Molecular ecology* **21**:1951-1965.

Shine, R., Ambariyanto, Harlow, P.S. and, Mumpuni (1999). Reticulated pythons in Sumatra: biology, harvesting and sustainability. *Biological Conservation* **87**:349-357.

Streicher, U. and T. Nadler (2003). Re-introduction of pygmy lorises in Vietnam. *Reintroduction News* **23**:37-40.

Terborgh, J. and C. Janson (1986). The socioecology of primate groups. *Annual Review of Ecology and Systematics* **17**: 111-136.

Utami, S. and J. van Hoof (1997). Meat-eating by adult female Sumatran orangutans (*Pongo pygmaeus abelii*). *American Journal of Primatology* **43**:159-165.

Wiens, F. and A. Zitzmann (1999). Predation on a wild slow loris (*Nycticebus coucang*) by a reticulated python (*Python reticulatus*). *Folia Primatologica* **70(6)**: 362-364.

Xiong, M., Shao, X., Long, Y., Bu, H., Zhang, D., Wang, D., Li, S., Wang, R. and M. Yao (2016). Molecular analysis of vertebrates and plants in scats of leopard cats (*Prionailurus bengalensis*) in southwest China. *Journal of Mammalogy* **97**: 1054-1064.

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

Robithotul Huda, **Namrata B. Anirudh** and **Karmele L. Sanchez**

IAR Indonesia. Jl. Curug Nangka Kp. Sinarwangi, RT. 04/05, Kel. Sukajadi, Kec. Tamansari, Bogor, West Java 16610

Corresponding author: Robithotul Huda; *Email: huda@internationalanimalrescue.org*

Abstract

The Batutegi 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 Batutegi 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 captures 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 Batutegi Protected Forest to adjacent conservation areas.

Abstrak

Hutan Lindung Batutegi 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 Batutegi. KPHL Batutegi bekerjasama dengan Yayasan IAR Indonesia (IARI) telah melakukan kegiatan konservasi di HL Batutegi 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 Batutegi ke kawasan konservasi sekitarnya.

Key words: Carnivore, Biodiversity, Conservation, Camera-trapping, Batutegi, 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

Submitted 21st June, 2018. Accepted 31st July, 2018

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 Batutegi. 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, Batutegi 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 Batutegi 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; 1040.436-1040.894 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; 1040.658 – 1040.806 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

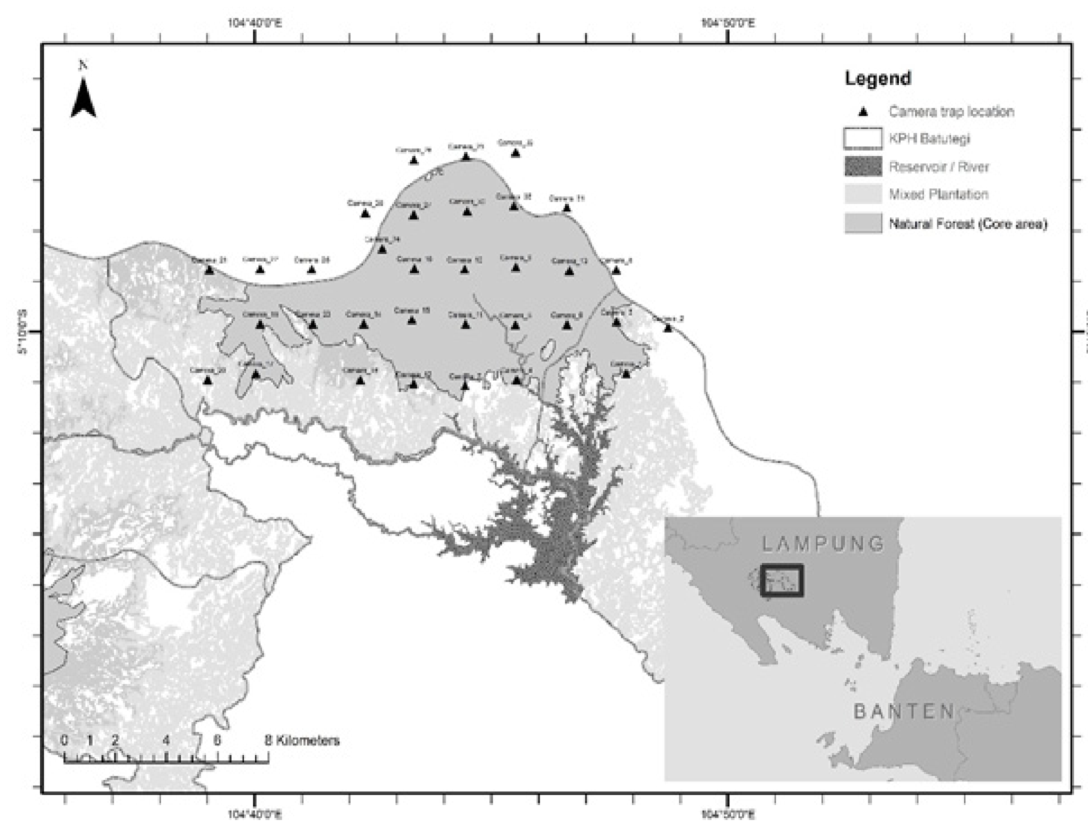

Figure 1. Map of study location and placement of 33 camera traps in the core area of BNR.

"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 temminicki*) 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	*Arctictis binturong*	15	0.43	12	Vulnerable
Banded palm civet	*Hemigalus derbyanus*	56	1.60	19	Near Threatened
Masked palm civet	*Paguma larvata*	27	0.77	11	Least Concerned
Small-toothed palm civet	*Actogalidia trivirgata*	2	0.06	2	Least Concerned
Yellow-throated marten	*Martes flavigula*	6	0.17	3	Least Concerned
Short-tailed mongoose	*Herpestes brachyurus*	1	0.03	1	Near Threatened
Sun bear	*Helarctos malayanus*	16	0.46	9	Vulnerable
Sunda stink badger	*Mydaus javanensis*	108	3.08	24	Least Concerned
Banded linsang	*Prionodon linsang*	29	0.83	13	Least Concerned
Golden cat	*Catopuma temminckii*	22	0.63	10	Near Threatened
Marbled cat	*Pardofelis marmorata*	10	0.29	5	Near Threatened
Sumatran tiger	*Panthera tigris sumatrae*	7	0.20	2	Critically Endangered
Leopard cat	*Prionailurus bengalensis*	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.

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

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

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 determined 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.

Acknowledgements

We would like to thank The Michael Uren Foundation for providing financial support for this project. The project was undertaken in cooperation with KPHL Batutegi, Dinas Kehutanan Provinsi Lampung and BKSDA, Lampung. We thank our field staff and members of our Survey Release Monitoring team based in Lampung and West Java and volunteers who helped set up cameras and retrieve data in challenging field conditions in BPF, Lampung, Sumatra. Permits for this research were issued under the conditions of the Memoradum of Understanding (MoU) signed between IAR Indonesia and KPHL Batutegi, valid from 2014 to 2017 (522/590/III.16/2014) and 2018 to 2022 (522/023/V.23/K.VIII.1/2018).

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., Traeholt, 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.

Lessons learned from the tiger translocation and release in Tambling, Lampung, Indonesia

Ani Mardiastuti

Department of Forest Resources Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University

Corresponding author: Ani Mardiastuti; *E-mail: ani_mardiastuti@ipb.ac.id*

Abstract

Tiger translocation and release is considered an option to resolve human-tiger conflicts. This paper describes the process of translocation of Sumatran tigers (*Panthera tigris sumatrensis*) from Banda Aceh to Bandar Lampung and release in Tambling Wildlife Nature Reserve, Bukit Barisan Selatan National Park. Following a rehabilitation process, five tigers were translocated of which two males were equipped with radio-collared transmitters. All five tigers were successfully released into their new habitat. From this study, we learned that (1) a strong collaboration of various stakeholders is crucial, (2) translocation and release program required a huge amount of funding, (3) experienced tiger handlers during transport and rehabilitation are extremely important, (4) support in scientific research for practical application in the field is essential (5) tiger release need to be accompanied by an awareness program to the surrounding community, (6) guidelines and protocols of transportation, rehabilitation, release, and post-release must be in place before release.

Abstrak

Salah satu opsi untuk mengatasi konflik manusia dan harimau adalah dengan memindahkan (translokasi) harimau bermasalah dan melepasliarkannya ke lokasi lain. Tujuan makalah ini adalah untuk mencatat proses pemindahan harimau Sumatra (dari Banda Aceh ke Bandar Lampung) dan pelepasliaran (di Tambling Wildlife Nature Reserve, Taman Nasional Bukit Barisan Selatan), serta menarik pembelajaran dari studi kasus tersebut. Setelah melalui rehabilitasi, dari lima ekor harimau yang dipindahkan, dua ekor harimau jantan yang dilengkapi dengan radio-collared transmitter telah berhasil dilepasliarkan. Beberapa pembelajaran penting dari studi kasus ini adalah: (1) diperlukan kolaborasi yang kuat antar pada pemangku-kepentingan, (2) proses pemindahan dan pelepasliaran harimau memerlukan dana yang besar, (3) dibutuhkan sumberdaya manusia terlatih dalam proses pemindahan dan rehabilitasi, (4) sangat diperlukan dukungan penelitian ilmiah untuk diterapkan secara praktis di lapangan, (5) pelepasliaran harimau perlu didampingi dengan program penyadar-tahuan kepada masyarakat sekitar, (6) panduan dan protokol untuk transportasi, rehabilitasi, pelepasliaran dan pasca pelepasliaran perlu segera diadakan.

Keywords: *Bukit Barisan Selatan National Park, human-tiger conflict, relocation, Sumatran tiger, Tambling Wildlife Nature Conservation*

Introduction

Wildlife translocation is defined as the deliberate human-mediated movement of wildlife between populations (Tenhumberg et al., 2004). Translocation is a common management intervention used to mitigate carnivore-human conflicts (Griffith et al., 1989; Linnell et al., 1997; Massei et al., 2010). Translocation of large carnivores can also help conservation by reducing mortality, supplement small vulnerable populations and re-establish wild populations (Griffith et al., 1989; Wolf et al., 1997).

The reasons for conducting translocations have changed over time (Massei et al., 2010). In the late 1980s, 90% of wildlife translocations were carried out for hunting purposes and only 7% for conservation (Griffith et al., 1989). in 2000 Fischer and Lindenmayer (2000) reviewed 180 studies on wildlife translocations and concluded that 57% were undertaken specifically for conservation, whereas 5% was conducted to resolve human–wildlife conflicts.

Submitted 1st March, 2018. Accepted after revision 31st October, 2018

In Indonesia, Sumatran tigers that are considered "problem tigers" are translocated from conflict areas to areas with suitable habitat, such as certain national parks like Bukit Barisan Selatan and Leuser. Unfortunately, translocation actions and lessons learnt are rarely recorded systematically and in many cases not reported at all.

This paper describes the process of translocation and release of Sumatran tigers and the lessons learned from rehabilitation processes and long-distance transportation

Methods

The case study

In June 2008, five tigers (4 males, 1 female) were translocated from Banda Aceh to Bandar Lampung, from where they were brought to and released into the Tambling zone, part of Bukit Barisan Selatan National Park (BBSNP). Tambling is currently privately managed and collaborate with the national park's authorities in boosting ecotourism. The private organisation funded the entire translocation process that was initiated and coordinated by the Ministry of Environment and Forestry (MEF).

After a successful rehabilitation, two male tigers were released into selected sites. Of the remaining three tigers, two were kept for release at a later date, after assessing the results of the first two releases, whereas the fifth tiger, a known man-eater, was deemed too risky and kept in captivity for breeding purposes.

Long-distance air transportation

The five tigers that need to be translocated had been kept in small cages in Banda Aceh for 20 months (June 2007-October 2009) under poor husbandry standards. Due to the compromised health conditions, the MEF concluded that land transportation would pose an elevated mortality risk for the tigers. Instead, MEF decided that to reduce mortality risk during transportation direct air-transfer from Banda Aceh to Tambling was the best option. This necessitated plane charter, because there is no direct commercial flight service between the two cities. Previous tiger translocation activities, for example Goodrich and Miquelle (2005) and Basak et al. (2015) did not mention the mode of transportation, but tigers were most likely transported by land.

In our project, the Indonesian airforce agreed to make available a Lockheed Hercules C-130 to transport the tigers approximately 2000km from Banda Aceh to Bandar Lampung, while the Indonesian navy contributed with a smaller Casa NC-212 aircraft from Lampung to Tambling. Experienced staff from Indonesian zoos familiar with transporting various wild species, including tigers offered expert advice and zoo standards were followed concerning transport cages (2x0.6x1m) protocols for transporting animals.

The entire exercise involved a range of stakeholders e.g. MEF, the private sector, Indonesian air force and navy, head of national park, Banda Aceh and Bandar Lampung airport authorities, Regional Office of the Ministry of Forestry (Balai Konservasi Sumber Daya Alam) of Lampung Province and Aceh Province (Nangroe Aceh Darussalam), safari park manager – along with a veterinarian and tiger keeper. Many other stakeholders were involved in enclosure design, tiger handling, researchers, NGOs with a special attention to tiger, GIS specialist, habitat surveyor, community awareness specialist, farmer who provide 'prey' food for tigers during rehabilitation process to mention some of the key players.

Enclosure design and construction

Before the tigers were transported from Banda Aceh to Bandar Lampung, a rehabilitation enclosure was constructed at the release site in Tambling. All tigers needed rehabilitation to be at full health and to revive as much of their natural hunting instinct that may have dwindled during the 20 months in captivity in Banda Aceh. Designing and constructing the Tambling release enclosure was the first and - until now - the only one in Indonesia. Taman Safari Indonesia designed the enclosure, which essentially consisted of four standard cages (6x6x3 m) connected to 1ha "natural" area for roaming exercise. Goodrich and Miquelle (2005) also used 1ha enclosures at Utes Wildlife Rehabilitation Center in Khabarovski Krai Province, Russian Far East, to rehabilitate Amur tigers.

Following Forman et al (2001), enclosures were built to simulate as closely as possible tigers' natural habitat to reinvigorate natural instincts and abilities as much as possible before release. It took ten people four months complete the enclosures.

Tiger rehabilitation

In Indonesia, rehabilitation experiences arise mainly from work with orangutan, gibbons and birds of prey. Many zoos and safari parks have tigers in their species collection and many are involved in international breeding programmes to help develop a secure *ex-situ* population. Rehabilitating and rewilding tigers is new in Indonesia and guidelines were unavailable.

Rehabilitation was necessary to improve the tigers' health and fitness and to restore as much of their natural instinct as possible. Veterinarians, tiger keepers and tiger experts worked together to device exercise regimes and challenges to maximise the chances of successful rehabilitation. Therefore, live prey were provided during rehabilitation to maintain hunting skills and regular health checks were undertaken along with monitoring for unusual and/or abnormal behaviour.

Based on the assessment of the team's tiger experts, two male tigers recovered to full health within 27 days, whereas for the remaining three, the recovery was longer than the observation period, and thus the data was not reported here. Goodrich and Miquelle (2005) reported 388 and 162 days used for two Amur tigers in the Russian Far East.

The entire exercise from designing transport cages, tiger handling en route and managing the rehabilitation process requires dedication and expertise that is currently only represented in a few Indonesian staff. It is therefore important that Indonesia ensure more training on tiger handling for translocation and rehabilitation in the future.

Surveying and identifying suitable habitat

The IUCN guidelines for reintroduction was completed and published in 2013 (IUCN/SSC 2013). This provide guidance to the process rather than a specific species. The species specific adjustments need to be carried out in a case by case situation. For example, "matching habitat suitability and availability to the needs of candidate species is central to feasibility and design" is a reminder of the importance of proper planning. In our case study, detailed information about tiger habitat requirement relied entirely on literature review concerning habitats in BBSNP and other parts of Sumatra. Furthermore, information about practical application of tiger release is essential and, consequently, there is a need for more dedicated publishing of experience and lessons learned in Indonesia, when such activities take place. Information about tiger habitat requirement and preference, options for prey, home-range requirements for males and females, male and female interaction in the wild, possible interaction between resident tiger(s) and tigers to be released, is essential to maximise the chances of successful release.

Prior to release, field surveys were conducted to select the best release sites within and around Tambling. We focused on the availability of prey, as well as the possible existence of resident tigers, because these parameters are critical to tiger survival and/or staying within the release area. The field surveys were conducted on foot, by motorcycles, by 4x4 car, as well as from a helicopter in the mountainous areas and other difficult-to-reach sites.

Sumatran tiger habitat is generally considered as forested areas with high densities of large ungulate prey, with a minimum of human disturbance (Mitchell and Hebblewhite, 2012; Wikramanayake et al., 2004). When prey density is too low, tigers will resort to attacking livestock and, in rare cases, humans (Reza et al., 2002). In Tambling, forested areas and ungulates were abundant, such as sambar deer, *Cervus unicolor*, Greater mouse deer, *Tragulus napu*, and mouse deer, *Tragulus* *javanicus* and in the periphery Asian water buffalo, *Bubalis bubalis*.

After potential release sites were identified, Tambling's manager, the head of BBSNP, tiger researchers, NGOs and MEF staff assessed the review and selected the most appropriate release site. An awareness program was conducted for the local community to inform them about the decision to release tigers in Tambling and how to prepare mitigation activities for livestock and safety, especially during the early release period.

Release and post-release planning

Next stage was related to release and post-release. It was necessary to decide:

(1) which of the five tigers and how many individuals should be released?
(2) were the identified individuals indeed ready for release and what criteria are used to determine release readiness?
(3) how to maximise the probability that the released tiger will survive?
(4) how to ensure that released tigers will not become problem tigers (i.e. attack livestock and human)?
(5) what will happen to the tigers that are unfit for release?
(6) what would be the plan to utilize the expensively-made enclosure?

None of these questions were readily answered at the time of the project and the choice of individuals for release, the number and area were made based on the team's combined expertise from the field and in captivity. There are not yet any guidelines and protocols ready to guide managers and practitioners through the process and decisions remain on an ad hoc basis, when needed and relevant. At the moment, there are too many tigers in *ex-situ* facilities to readily absorb addition wild tigers into breeding programmes. Furthermore, many of these are wild and not ready to be introduced to captive bred individuals, because the risk of severe injury resulting from fighting is too high.

In one case, our field surveys revealed the presence of one female tiger with a cub near the release site. This was a very positive observation that confirms the presences of both males and females in the area. Against normal practice, we decided to release two males (Male 1: 8 years old, 119 kg / Male 2: 4 years old, 74 kg) for phase 1. This was a very risky decision, due to the males' habit of infanticide and their poor contribution to overall breeding capacity. The risk that these two male tigers pose, either by being displaced by a resident male or by killing the female's cub, is very high. Had the option been available, the team would have preferred to release two females or, at least, one additional male only. The two released tigers were equipped with radio-transmitters (Sirtrack "Argos" and FollowIt "Tellus GPS").

Of the three unreleased tigers, one male (9 year) was kept in captivity, because of a history as a man-eater. The two remaining tigers (3-year old female and 6-year old male) were kept temporarily in Tambling for release at a later date, if the first release was successful.

After the release, the movement of two male tigers were monitored along with their feeding habits. Considering their movements combined with lack of human/livestock conflict (e.g. home-range did not overlap human settlements), the release was considerably a success.

Conclusion

Based on study by Fischer and Lindenmayer (2000), of 116 reintroductions cases of various wildlife species, 30 cases (26%) were classified as successful, 31 cases (27%) failed, while the rest of 55 cases (47%) was classified as unknown. For tigers, a reintroduction is considered a success if it leads to a self-sustaining population (Griffith et al. 1989). For translocations of problem tigers, criteria such as level of conflicts with people and domestic animals are also important (Goodrich and Miquelle, 2005). Not all translocated tigers in Indonesia are equipped with radio transmitter, mainly due to the prohibitive high cost of transmitters combined with the bureaucratic difficulties in importing transmitters and permits to use it. The experience gained in this study considered tiger translocation monitored with radio transmitters. Unfortunately, the translocated tigers described in this study could only be monitored for one month after release , due to battery failure. Extended battery-life for long-term monitoring will be essential in future translocation projects (Fischer and Lindenmayer, 2000), which will also provide information about the long-term survival of the released tigers.

Acknowledgement

I would like to thank Tony Sumampau and Hariyo T. Wibisono for sharing invaluable information about tiger ecology and *ex-situ* management. I am also grateful to Tonny Soehartono, who gave me the opportunity to be part of the translocation team. Last but not least, I would like to express my gratitude to Tomy Winata, for his hospitality and assistance every time I travelled to and stayed in Tambling Wildlife Nature Conservation.

References

Basak, K., Singh, A.K., Choudhury, B., Chauhan, D., Ashraf, N.V.K. and P.K. Boro (2015). Translocation as a Management Option for Tigers (*Panthera tigris tigris*) that Move Out of Source Areas: Case Studies from India. Proceeding on International Workshop on Rehabilitation and Reintroduction of Large Carnivores, Moscow, Russia.

Fischer, J. and D.B. Lindenmayer (2000). An assessment of the published results of animal relocations. *Biological Conservation* **96**: 1-11.

Fontúrbel, F.E., and J.A. Simonetti (2011). Translocations and human-carnivore conflicts: problem solving or problem creating? *Wildlife Biology* **17**: 217–224.

Forman, J.M., Claude, L.N., Albright, A.M. and M. Lima (2001). The design of enriched animal habitats from a biological engineering perspective. *Transactions of the American Society of Agricultural Engineers* **44**: 1363–1371.

Goodrich, J.M. and D.G. Miquelle (2005). Translocation of problem Amur tigers *Panthera tigris altaica* to alleviate tiger-human conflicts. *Oryx* **39**: 1–4.

Griffith, B., Scott, J.M., Carpenter, J.W. and C. Reed (1989). Translocation as a species conservation tool: status and strategy. *Science* **245**: 477-480.

IUCN/SSC (2013). Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. IUCN Species Survival Commission, Gland, Switzerland.

Linnell, J.D.C., Aanes, R., Swenson, J.E., Odden, J. and M.E. Smith (1997). Translocation of carnivores as a method for managing problem animals: a review. *Biodiversity and Conservation* **6**: 1245–1257.

Mardiastuti A., and T. Soehartono (2009). Hunian Baru untuk Harimau Sumatra: Kisah Pemindahan Harimau Sumatra dari Aceh ke Lampung. Tambling Wildlife Nature Conservation, Jakarta, Indonesia.

Massei, G., Quy, R.J., Gurney, J. and D.P. Cowan (2010). Can translocations be used to mitigate human-wildlife conflicts? *Wildlife Research* **37**: 428–439.

Miller, C.S., Petrunenko, Y.K., Goodrich, J.M., Hebble-White, M., Seryodkin, I.V. and D.G. Miquelle (2011). Translocation a success, but poaching remains a problem for Amur tigers. *Cat News* **55**: 22-25.

Ministry of Environment and Forests (2011). Guidelines For Human-Leopard Conflict Management. Ministry of Environment and Forests, India.

Ministry of Forestry (2007). Strategi dan Rencana Aksi Konservasi Harimau Sumatera (Panthera tigris sumatrae) 2007 – 2017. Ministry of Forestry, Jakarta, Indonesia.

Mitchell, M.S. and M. Hebblewhite (2012). Carnivore Habitat Ecology: Integrating Theory and Application for Conservation. In Carnivore Ecology and Conservation: A Handbook of Techniques (eds R.A. Powell & L. Boitani). Oxford University Press, Oxford, UK.

Reza, A.H.M.A., Feeroz, M.M. and M.A.Islam (2002). Man-tiger interaction in the Bangladesh Sundarbans. *Bangladesh Journal of Life Science* **l4**:15-82.

Tenhumberg, B., Tyre, A.J., Shea, K. and H.P. Possingham (2004). Linking wild and captive populations to maximize species persistence: optimal translocation strategies. *Conservation Biology* **18**: 1304–1314.

Wikramanayake, E., Mcknight, M., Dinerstein, E., Joshi, A., Gurung, B. and D. Smith (2004). Designing a conservation landscape for tigers in human-dominated environments. *Conservation Biology* **18**: 839–844.

Weise, F.J., Stratford, K.J. and R.J. Van Vuuren (2014). Financial costs of large carnivore translocations – accounting for conservation. *PLoS ONE* **9**: e105042. doi:10.1371/journal.pone.0105042.

Wolf, C.M., Griffith, B., Reed, C. and S.A. Temple (1997). Avian and mammalian translocations: update and reanalysis of 1987 survey data. *Conservation Biology* **10**: 1142–1154.

10 years on - The diversity and activity of small carnivores of the Sebangau peat-swamp forest, Indonesian Borneo

Susan M. Cheyne[1,2], **Adul**[1], **Ici Piter Kulu**[3] and **Karen A. Jeffers**[1]

[1]Borneo Nature Foundation, Central Kalimantan, Indonesia
[2]Oxford Brookes University, Oxford, UK
[3]LLG CIMTROP, University of Palangka Raya

Corresponding author: Susan M. Cheyne; *E-mail: s.cheyne@borneonature.org*

Abstract
The distribution and population status of Bornean small carnivores in Indonesian Borneo is very poorly understood. Since 2008, Borneo Nature Foundation has collected 7,145 images of mammalian wildlife in the Sebangau peat-swamp forest, Central Kalimantan. This represents 29,418 trap nights until end March 2018. We have data on 11 species of small carnivores including the endemic collared mongoose (*Herpestes semitorquatus*) and the first information on the Critically Endangered Sunda pangolin (*Manis javanica*) in peat-swamp forests. Data are presented on species diversity and activity patterns including overlap with felids at all locations where small carnivores were photographed. Distribution and activity data on this guild of small carnivores in Indonesian Borneo is very poor and we advocate for more camera trapping studies to work to provide data on small carnivores.

Abstrak
Status distribusi dan populasi satwa karnivora kecil di Kalimantan sangat kurang dipahami. Sejak 2008, Borneo Nature Foundation telah mengumpulkan 7.145 gambar satwa liar mamalia di hutan rawa gambut Sebangau, Kalimantan Tengah. Ini mewakili 29.418 perangkap malam hingga akhir Maret 2018. Kami memiliki data tentang 11 spesies karnivora kecil termasuk luwak berkerah endemik (Herpestes semitorquatus) dan informasi pertama tentang binatang yang Terancam Punah paling tinggi yaitu Sunda pangolin (Manis javanica) di hutan rawa gambut. Data disajikan pada keanekaragaman spesies dan pola kegiatan termasuk tumpang tindih dengan kucing liar di semua lokasi di mana karnivora kecil difoto. Data mendistribusi dan aktvitas binatang karnivora kecil di Kalimantan ini sangat kurang dikenal dan kami menganjurkan agar lebih banyak studi perangkap kamera berfungsi untuk menyediakan data tentang karnivora kecil.

Keywords: Carnivores, Peat-swamp forest, Borneo, diversity

Introduction

An often overlooked feature of Asian tropical forest communities is the high diversity of sympatric carnivores. The Asian Region supports a total of 80 species in the order Carnivora, and the intact lowland forests support 15-25 species especially in sites with extensive closed-canopy forest (Corlett, 2007). Different forest types support up to six sympatric cats, six civets (plus Prionodon), three mongooses, eight mustelids (including otters), two canids and two bears (Austin et al., 2007; Grassman Jr et al., 2005; Grassman et al., 2005; Veron et al., 2006). In many sites this diversity exceeds that of the Neotropics which support carnivore communities ranging from 15 recorded in western Amazonia and <15 in Central America. African forests are reported to have even smaller numbers: some areas have no dogs or bears and only two cats (Corlett, 2007).

Despite this diversity, the paucity of data on the various small carnivores, and the guilds they function is widespread. Camera traps and the presence of more long-term research projects are addressing this

Submitted 1st March, 2018. Accepted 12th October, 2018

issue and lending more insight into the lives of the smaller carnivores (Mathai et al., 2016).

An earlier paper on these species from Sebangau (Cheyne et al., 2010) focused on some of the small carnivores found in this area and highlighted that the activity patterns of the small carnivores in Sebangau demonstrate activity patterns similar to those reported at other sites. However, the common palm civet (*Paradoxurus hermaphrodites*) demonstrates behavioural flexibility to a diurnal activity pattern. Following the Borneo Carnivore Symposium held in Sabah, Malaysia in 2011 (http://www.fwrc.msstate.edu/borneocarnivoresymposium/) data for several of the small carnivores were modelled to predict distribution. Table 1 indicates whether these species were predicted to occur in the peat-swamp forests of Sebangau. We note the caveats implicit in modelling as discussed during this modelling process (Kramer-Schadt et al., 2013) and that otters and the pangolin were not included in these models.

Borneo Nature Foundation and the Wildlife Conservation Research Unit (WildCRU), University of Oxford initiated the Sebangau Felid Project in May 2008 (Adul et al., 2015; Cheyne et al., 2010; Cheyne and MacDonald, 2011).

Methods

Study Site

This study was conducted in the Natural Laboratory for the Study of Peat Swamp Forest, Sebangau catchment, Central Kalimantan, Indonesia 2º19' S; 113 º 54' E (Fig. 1). The area is peat-swamp forest (Mixed-Swamp Forest sub-type) and was logged under a concession system from 1991-1997, followed by illegal logging from 1997-2004. The site is at an altitude ca. 10m a.s.l. The area

Table 1. Status of small carnivores in Sebangau based on camera trap data and predicted distribution. Bold indicates species confirmed in Sebangau.

Species	Latin name	Y/N	Predicted probability	Reference
Sunda Pangolin	*Manis javanica*	Y	Not assessed	NA
Borneo Ferret Badger	*Melogale everetti*	N	Not expected	Wilting et al., 2016
Hairy-nosed Otter	*Lutra sumatrana*	N	Not assessed	NA
Sunda Otter Civet	*Cynogale bennettii*	Y	High	Cheyne et al., 2010; Cheyne et al., 2016
Asian Small-clawed Otter	*Aonyx cinerea*	Y	Not assessed	NA
Binturong	*Arctictis binturong*	Y	Medium	Semiadi et al., 2016
Hose's Civet	*Diplogale hosei*	N	Low	Mathai et al., 2016
Collared Mongoose	*Herpestes semitorquatus*	Y	Low	Honet al., 2016
Banded Civet	*Hemigalus derbyanus*	N	Low	Ross et al., 2016
Banded Linsang	*Prionodon linsang*	Y	Medium	Duckworth et al., 2016
Common Palm Civet	*Paradoxurus hermaphroditus*	Y	Medium	Duckworth et al., 2016
Malay Civet	*Viverra tangalunga*	Y	Medium	Ross et al., 2016
Malay Weasel	*Mustela nudipes*	N	Low	Meijaard et al., 2016
Masked Palm Civet	*Paguma larvata*	N	Low	Semiadi et al., 2016
Short-tailed Mongoose	*Herpestes brachyurus*	Y	Medium	Duckworth et al., 2016
Small-toothed Palm Civet	*Arctogalidia trivirgata*	Y	Medium	Duckworth et al., 2016
Sunda Stink Badger	*Mydaus javanensis*	N	Low	Samejima et al., 2016
Yellow-throated Marten	*Martes flavigula*	Y	Low	Hon et al., 2016

was significantly affected by the forest fires which impacted Indonesia in 2015 (Wich et al., 2016).

Since 2008 a total of 160 cameras have been set in fixed forest areas. A combination of camera models were used including Cuddeback Expert®, Cuddeback Capture IR® (Cuddeback Digital, Non-Typical Inc, WI, USA) Maginon, Crenova and Bushnell. Camera traps were placed along human-made trails (>4 years old) and, where possible, watering areas, located to maximise the success rate of photographic 'captures'. Activity times were collated as 06h00-12h00, 12h00-18h00, 18h00-00h00 and 00h00-06h00 to account for average dawn and dusk times in Sebangau, which is situated almost on the equator (see (Adul et al., 2015; Cheyne et al., 2013; Cheyne et al., 2016) for more information on the study site).

Results

Small carnivores comprised 313 photographs (4.38% of total wildlife photos (n = 7145)) and represent 11 species (Fig. 2). The most commonly represented species were short-tailed mongoose (37.06% n = 116), Malay civet (25.88%, n = 81) and common palm civet (15.02, n = 47). The least common species were binturong, (0.32%, n = 1), small-clawed otter (0.96%, n = 3), collared mongoose (1.6% n = 5) and Sunda pangolin (1.6%, n = 5).

Sunda Pangolin

Pangolins are highly under-represented in the camera trap data, with only 5 independent images in 10 years. Four images were captured in 2010 and a further single image in 2014 (Fig. 3).

Activity

The active time for the small carnivores shows a clear split between species' active times (Fig. 4 and 5). Short-tailed mongoose, small-clawed otter and yellow-throated marten predominantly active from dawn to dusk. Banded linsang, Malay civet, Sunda otter civet, small-toothed palm civet, common palm civet active predominantly from dusk to dawn and

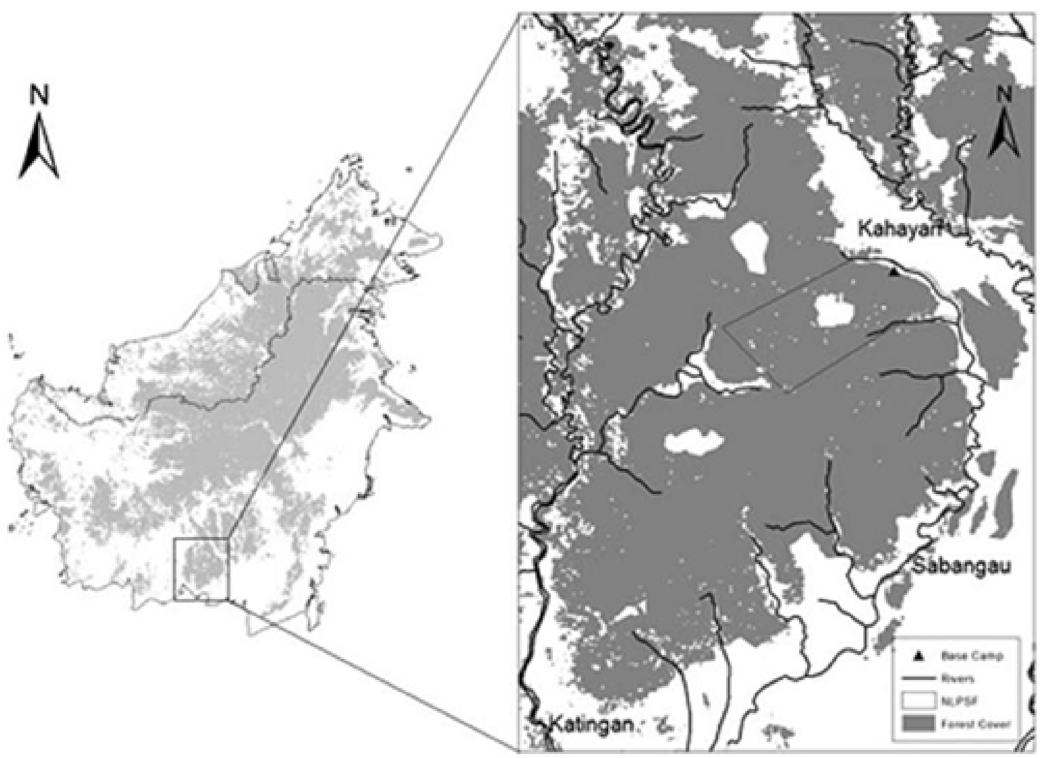

Figure 1. Study site in north-east Sebangau catchment in Central Kalimantan, Indonesia.

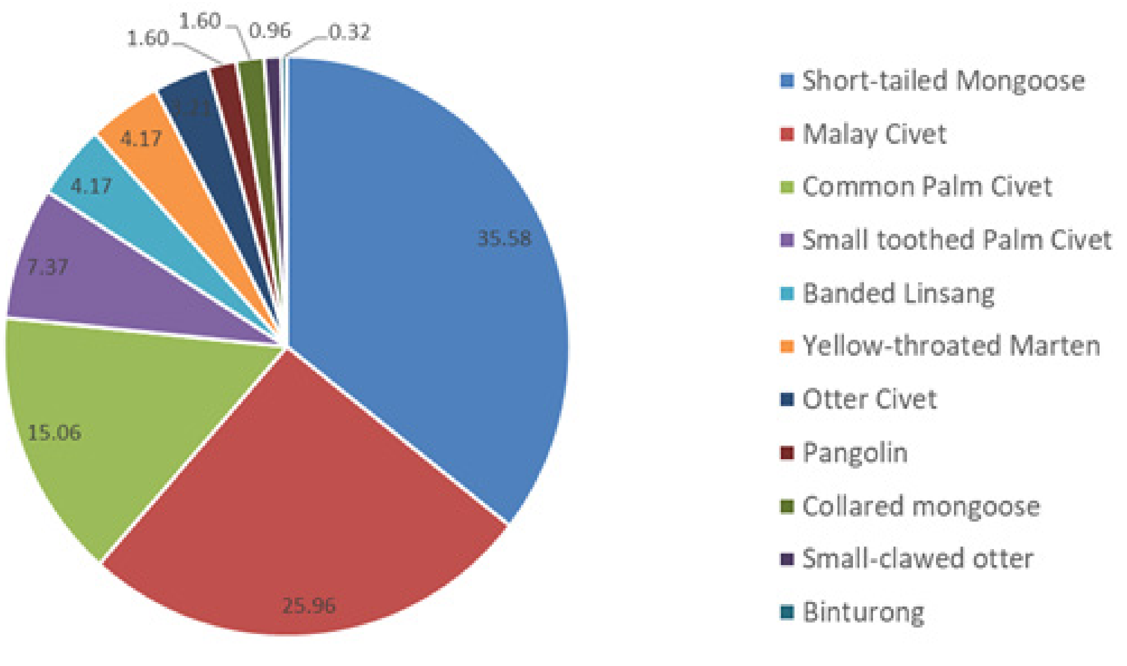

Figure 2. Representation of small carnivore species found in Sebangau as % of total carnivore images.

the Sunda pangolin only active at night. Binturong are not included as the number of photographs is too small to draw reasonable conclusions.

Species sighted but not photographed

Hairy-nosed otter (*Lutra sumatrana*) and the Malay weasel (*Mustela nudipes*) have reportedly been seen in the same area as the cameras by local people (Husson et al., 2009; Page et al., 1997) dating from 1993-2008. Masked palm civet, Sunda stink badger and Hose's civet have a low probability of occurring in this habitat (Tab. 1).

Figure 3. Sunda pangolin, *Manis javanica*, on camera trap.

Discussion

The long period of time required to obtain photographs of small carnivores highlights the importance of long-term data and monitoring to avoid false-negative presence data.

Banded linsang are frequently thought to not appear on ground-based camera traps due to their arboreal and nocturnal activity (Azlan, 2003). These data highlight that long-term camera trapping studies are often required to obtain photo captures of elusive animals and to avoid reporting the false absence of these animals. Hairy-nosed otter are perhaps more likely to be present than not, but their ecology makes it difficult to get sightings/photos. Interestingly, the IUCN Red List does not have Sebangau as a location where hairy-nosed otters occur (IUCN 2015).

Data from Malaysian Borneo support the findings of the Malay civet as a nocturnal animal with activity times in Danum Valley ranging

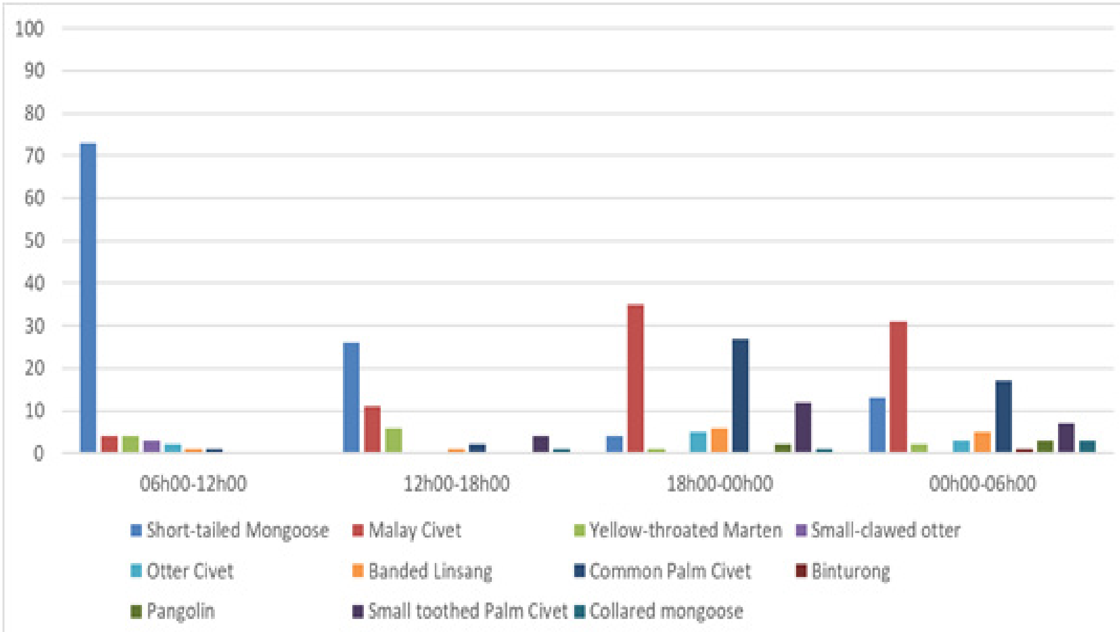

Figure 4. Activity times of small carnivores split into 6h blocks.

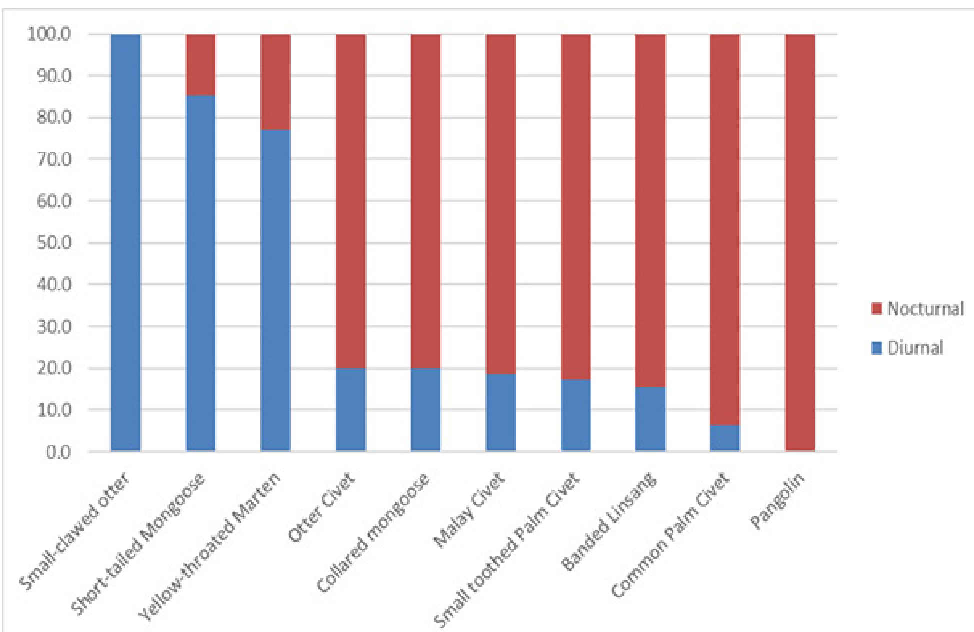

Figure 5. Active split of small carnivores (only species with >3 photos are included).

from 18h00 to 07h00 (Colon, 2002). Van Schaik and Griffiths (1996) concluded that viverrids in Borneo are generally nocturnal as is the carnivore ancestral condition (Martin, 1990). Studies of other forest civet species reveal consistently nocturnal patterns (Dhungel and Edge, 1985; Joshi et al., 1995; Macdonald and Wise, 1979; Rabinowitz, 1991). The common palm civet is confirmed as predominantly nocturnal in Sebangau, not diurnal as presented in (Cheyne et al., 2010). The yellow-throated marten is primarily diurnal (Duckworth, 1997; Grassman Jr et al., 2005), a behaviour pattern which is supported by data from Sebangau. Mongooses are also reported as diurnal with 85% of Sebangau sightings being between 06h00 and 18h00 (Belden et al., 2007).

Of the species for which there are too few photos to draw concrete conclusions, the Asian small-clawed otters are reported as nocturnal and crepuscular (Foster-Turly, 1992), though all 3 photos from Sebangau were taken after dawn. Eight of ten photos of the otter civet were nocturnal, concurring with data from Sarawak (Sebastian, 2005), though the same author also suggests that it is also occasionally active during the day (Sebastian, 2005). Of 13 photos of the banded linsang, 11 were between dusk and dawn, agreeing with other data that this animal is nocturnal (Azlan, 2003).

For all these species, bar the Malay civet, the data from Borneo are poor and from Indonesian Borneo are almost non-existent (IUCN, 2016). The data presented here highlight the value of camera traps and offer new information on the activity and distribution of the Bornean small carnivore guild.

Acknowledgements

SMC was funded through a grant to David W. Macdonald from the Kaplan family and by the Clouded Leopard Project. SMC and DWM's work on Bornean felids is part of the WildCRU/Panthera collaboration and was carried out within the BNF-CIMTROP multi-disciplinary research project in the northern Sebangau forest, Central Kalimantan, Indonesia. SMC gratefully thanks the Centre for the International Cooperation in Management of Tropical Peatlands (CIMTROP) for sponsoring her research and providing invaluable logistical support. We gratefully acknowledge the contribution of all the researchers who assisted with the project. SMC thanks the Indonesian Ministry for Science and Technology for providing research permissions for this work.

References

Adul, Ripoll, B., Limin, S.H. and S.M. Cheyne (2015). Felids of Sebangau: Camera trapping to estimate activity patterns and population abundance in Central Kalimantan, Indonesia. *Biodiversitas* **16(2)**: 151-155. doi:10.13057/biodiv/d160208

Cheyne, S.M., Husson, S.J., Chadwick, R.J. and D.W. Macdonald (2010). Diversity and activity of small carnivores of the Sebangau Peat-swamp Forest, Indonesian Borneo. *Small Carnivore Conservation* **43**: 1–7.

Cheyne, S.M., Husson, S.J. and D.W. Macdonald (2010). First otter civet photographed in Sebangau Peat-swamp Forest, Indonesian Borneo. *Small Carnivore Conservation* **42**: 25–26.

Cheyne, S.M. and MacDonald, D.W. (2011). Wild felid diversity and activity patterns in Sebangau peat-swamp forest, Indonesian Borneo. *ORYX* **45(1)**: 119-124. doi:10.1017/S003060531000133X

Cheyne, S.M., Mohamed, A., Hearn, A.J., Ross, J., Samejima, H., Heydon, M., et al. (2016). Predicted distribution of the otter civet *Cynogale bennettii* (Carnivoreia: Carnivora: Viverridae) on Borneo. *Raffles Bulletin of Zoology* **33**: 126-131.

Cheyne, S. M., Sastramidjaja, W. J., Muhalir, Rayadin, Y. and D.W. Macdonald (2016). Carnivoreian communities as indicators of disturbance across Indonesian Borneo. *Global Ecology and Conservation* **7**: 155-173. doi:10.1016/j.gecco.2016.06.002

Cheyne, S.M., Stark, D., Limin, S.H. and D.W. Macdonald (2013). First Estimates of Population Ecology and Threats to Sunda Clouded Leopards (*Neofelis diardi*) in a Peat-swamp Forest, Indonesia. *Endangered Species Research* **22**: 1–9.

Duckworth, J. W., Fredriksson, G., Heydon, M., Alfred, R., Boonratana, R., Eaton, J., et al. (2016). Predicted distribution of small-toothed palm civet *Arctogalidia trivirgata* (Carnivoreia: Carnivora: Viverridae) on Borneo. *Raffles Bulletin of Zoology* **33**: 103-110.

Duckworth, J. W., Hearn, A. J., Ross, J., Samejima, H., Mohamed, A., Cheyne, S. M., et al. (2016). Predicted distribution of short-tailed mongoose *Herpestes brachyurus* (Carnivoreia: Carnivora: Herpestidae) on Borneo. *Raffles Bulletin of Zoology* **33**: 131-142.

Duckworth, J. W., Samejima, H., Semiadi, G., Hearn, A. J., Ross, J., Fredriksson, G., et al. (2016). Predicted distribution of banded linsang P*rionodon linsang* (Carnivoreia: Carnivora: Prionodontidae) on Borneo. *Raffles Bulletin of Zoology* **33**: 71-77.

Hon, J., Hearn, A. J., Ross, J., Mohamed, A., Alfred, R., Samejima, H., et al. (2016). Predicted distribution of the collared mongoose *Herpestes semitorquatus* (Carnivoreia: Carnivora: Herpestidae) on Borneo. *Raffles Bulletin of Zoology* **33**: 142-148.

Hon, J., Hearn, A. J., Ross, J., Samejima, H., Augeri, D. M., Mathai, J., et al. (2016). Predicted distribution of the yellow-throated marten *Martes flavigula* (Carnivoreia: Carnivora: Mustelidae) on Borneo. *Raffles Bulletin of Zoology* **33**: 42-49.

Kramer-Schadt, S., Niedballa, J., Pilgrim, J. D., Schröder, B., Lindenborn, J., Reinfelder, V., et al. (2013). The importance of correcting for sampling bias in MaxEnt species distribution models. *Diversity and Distributions* **19(11)**: 1366–1379 doi:10.1111/ddi.12096

Mathai, J., Brodie, J., Giordano, A., Alfred, R., Belant, J. L., Kramer-Schadt, S. and A. Wilting (2016). Predicted distribution of Hose's civet *Diplogale hosei* (Carnivoreia: Carnivora: Viverridae) on Borneo. *Raffles Bulletin of Zoology* **33**: 118–125.

Mathai, J., Duckworth, J. W., Meijaard, E., Fredriksson, G., Hon, J., Sebastian, A., et al. (2016). Carnivore conservation planning on Borneo: Identifying key carnivore landscapes, research priorities and conservation interventions. *Raffles Bulletin of Zoology* **33**: 186-217.

Meijaard, E., Hearn, A. J., Ross, J., Fredriksson, G., Mathai, J., Nakashima, Y., et al. (2016). Predicted distribution of the Malay weasel *Mustela nudipes* (Carnivoreia: Carnivora: Mustelidae) on Borneo. *Raffles Bulletin of Zoology* **33**: 50–54.

Ross, J., Hearn, A. J., Macdonald, D. W., Alfred, R., Cheyne, S. M., Mohamed, A., et al. (2016). Predicted distribution of the Malay civet Viverra tangalunga (Carnivoreia: Carnivora: Viverridae) on Borneo. Raffles Bulletin of Zoology, 2016.

Ross, J., Hearn, A. J., Macdonald, D. W., Semiadi, G., Alfred, R., Mohamed, A., et al. (2016). Predicted distribution of the banded civet *Hemigalus derbyanus* (Carnivoreia: Carnivora: Viverridae) on Borneo. *Raffles Bulletin of Zoology* **33**: 111–117.

Samejima, H., Meijaard, E., Duckworth, J. W., Yasuma, S., Hearn, A. J., Ross, J., et al. (2016). Predicted distribution of the Sunda stink-badger *Mydaus javanensis* (Carnivoreia: Carnivora: Mephitidae) on Borneo. *Raffles Bulletin of Zoology* **33**: 61–70.

Semiadi, G., Ross, J., Hearn, A. J., Heydon, M., Samejima, H., Mathai, J., et al. (2016). Predicted distribution of the binturong *Arctictis binturong* (Carnivoreia: Carnivora: Viverridae) on Borneo. *Raffles Bulletin of Zoology* **33**: 96-102.

Semiadi, G., Ross, J., Hearn, A. J., Macdonald, D. W., Mathai, J., Auger, D. M., et al. (2016). Predicted distribution of the masked palm civet *Paguma larvata* (Carnivoreia: Carnivora: Viverridae) on Borneo. *Raffles Bulletin of Zoology* **33**: 89–95.

Wich, S. A., Singleton, I., Nowak, M. G., Utami Atmoko, S. S. uci, Nisam, G., Arif, S. M. hd, et al. (2016). Land-cover changes predict steep declines for the Sumatran orangutan (*Pongo abelii*). *Science advances* **2(3)**: e150078. doi:10.1126/sciadv.1500789

Wilting, A., Hearn, A. J., Eaton, J., Belant, J. L., and S. Kramer-Schadt (2016). Predicted distribution of the Bornean ferret badger *Melogale everetti* (Carnivoreia: Carnivora: Mustelidae) on Borneo. *Raffles Bulletin of Zoology* **33**: 55–60.

Guidelines for Authors

The Journal of Indonesian Natural History will publish original work by:

- Indonesian or foreign scientists on any aspect of Indonesian natural history, including fauna, flora, habitats, management policy and use of natural resources
- Indonesian or foreign scientists on any aspect of regional natural history, including fauna, flora and habitats

Preference is given to material that has the potential to;

- Improve conservation intervention and management in Indonesia
- Enhances understanding of conservation needs in Indonesia
- Enhances the understanding of Indonesia's natural history

The Journal language will be in English with abstracts in Bahasa Indonesia as well as English. Authors of full papers are encouraged to provide a Bahasa Indonesia/English translation of their abstract. Submissions in Bahasa Indonesia will be accepted and translated into English only if accepted for publication.

Papers and Short Communications
Full Research Papers (2,000-7,000 words) and Short Communications (200-2,000 words) are invited on topics relevant to the Journal's focus, including:

- The conservation status, ecology or behaviour of wild species
- Status or ecology of habitats
- Prehistoric and extinct species and new findings
- Checklists of species, nationally or for a specific area
- Discoveries of new species records or range extensions.
- Biodiversity value associated with land use change, plantation development and forestry
- Biodiversity in High Conservation Value areas
- Reviews of conservation policy and legislation
- Conservation management plans for species, habitats or areas
- The nature and results of conservation initiatives, including case studies
- Sustainable use of wild species
- Community use and management of natural resources
- Abstracts of unpublished student theses (Short Communications only)

The Journal will not accept descriptions of new species, subspecies or other taxa.

How to Submit a Manuscript
Manuscripts should be submitted by e-mail to the Editor at:

editorjinh@jinh.org

In the covering e-mail, the Lead Author must confirm that:

- The submitted manuscript has not been published elsewhere,
- All of the authors have read the submitted manuscript and agreed to its submission,
- All research was conducted with the necessary approval and permits from the appropriate authorities

Review and editing
All contributors in English are strongly advised to ensure that their spelling and grammar is checked by a native English speaker before the manuscript is submitted to the Journal. The Editorial Team reserves the right to reject manuscripts that are poorly written.

Submission in Bahasa Indonesia is also accepted and the Journal secretariat will undertake a preliminary review of all manuscripts for suitability of content and format. Manuscripts that are rejected at this stage will not be sent for peer review and translation.

Manuscripts that pass through the preliminary review will be sent for translation and peer review by a minimum of two reviewers. Authors are welcome to suggest appropriate reviewers.

Proofs will be sent to authors as a portable document format (PDF) file attached to an e-mail note. PDF-readers can be downloaded free of charge from http://www.adobe.com and http://www.nitropdf.com for viewing PDF files. Corrected proofs should be returned to the Editor within 3 days of receipt. Minor corrections can be communicated by e-mail.

The Editorial Team also welcomes contributions to the other sections of the journal:

News
Concise reports (<300 words) on news of general interest to the study and conservation of Indonesia's natural history. News reports may include,

- Announcements of new initiatives; for example, the launch of new projects, conferences or funding opportunities.
- Announcements of important new reports or other publications related to Indonesian natural history.
- Summaries of important news from an authoritative published source; for example, new Indonesian species described in other journals, a new research technique, or a recent development in conservation.
- Summaries and analysis of new policies, decrees and laws relevant to the conservation of Indonesian natural history.

Letters to the Editor
Informative contributions (<650 words) in response to material published in the Journal.

Preparation of manuscripts
Full papers follow the style and format of papers published in the journal Conservation Biology. Authors should consult examples in Conservation Biology for guidance on general style.

Contributions should be in Bahasa Indonesia and/or UK English, double-spaced and in 'doc, 'rtf' or 'wpd' format, preferably as one file attached to one covering e-mail.

The cover page should contain;
The title and full mailing address, e-mail address and address of the Lead Author and all additional authors.

Contributing Papers should contain the following sections and be arranged in the following order: Abstract, Introduction, Methods, Results, Discussion, Acknowledgments, Literature Cited. Tables, Figures and Plates (including legends), if included, should follow the Literature Cited.

All pages should be numbered consecutively. Do not number section headings or subheadings.

Title: This should be a succinct description of the work, in no more than 20 words.

Abstract: Abstracts should only be submitted for Full Papers. This should describe, in 100-300 words, the aims, methods, major findings and conclusions. It should be informative and intelligible without reference to the text, and should not contain any references or undefined abbreviations. Authors are encouraged to submit an English translation of Indonesian text and an Indonesian translation of an English text.

Keywords: From five to eight pertinent words, in alphabetical order.

Literature cited in text: Enclose citations in text in parentheses e.g. “Asian tapirs are no elephants when it comes to seed dispersal (Campos-Arceiz et al., 2011).”

Use an ampersand (&) between author surnames when the citation is parenthetical: (Traeholt & Idris, 2011).

When a citation is not parenthetical, use "and": “Our results agree with the predictions of Wolf and Rhymer (2001).”

For citations with more than two authors, use et al.: (Campos-Arceiz et al., 2011). Do not italicize et al.

List parenthetical citations in alphabetical order and chronologically from oldest to most recent and separate entries with a semicolon: (Campos-Arceiz et al., 2011; Geissman, 2009, 2010).

Separate the years with commas when citing multiple papers by the same author: (Corlett, 2007, 2010; Geissman, 1984, 1995, 1999, 2000).

“**In press**” means the cited paper has been accepted unconditionally for publication. Provide the year of publication in the text (Bird, 2010) and in Literature Cited section provide the volume number, and substitute “in press” for page numbers (Bird, I.M. 2010. Nesting success in arid lands. Conservation Biology 24: in press.).

Papers in review must be cited as unpublished and should not appear in the Literature Cited section.

Use an initial for the first (given) name and spell out the last name (surname) for other sources of unpublished data or information: (R. Fowler, unpublished data; M.E. Soulé, personal communication).

Software: capitalize the first letter only if the name of the program is a word (e.g., Vortex, ArcGIS). If the name of the program is not a word, use all capital letters (e.g., SAS).

The following are examples of Literature Cited house style:
Campos-Arceiz, A. and R.T. Corlett (2011). Big animals in a shrinking world—studying the ecological role of Asian megafauna as agents of seed dispersal. Innovation 10: 50–53.

Campos-Arciez, A., Larringa, A.R., Weerasinghe, U.R., Takatsuki, S., Pastorini, J., Leimgruber, P., Fernando, P. and L. Santamaria (2008). Behavior rather than diet mediates seasonal differences in seed dispersal by Asian elephants. Ecology 89: 2684–2691.

MacArthur, R.H. & Wilson, E.O. (1967). The Theory of Island Biogeography. Princeton University Press, Princeton, USA.

Sutherland, W.J. (ed.) (1998). Conservation Science and Action. Blackwell Science, Oxford, UK.

Beck, B.B., Rapaport, L.G. & Stanley Price, M.R. (1994). Reintroduction of captive-born animals. In Creative Conservation: Interactive Management of Wild and Captive Animals (eds P.J.S. Olney, G.M. Mace & A.T.C. Feistner), pp. 265-286. Chapman & Hall, London, UK.

Traeholt, C., Bonthoeun, R., Rawson, B., Samuth, M., Virak, C. and Sok Vuthin (2005). Status review of pileated gibbon, *Hylobates pileatus* and yellow-cheeked crested gibbon, *Nomascus gabriellae*, in Cambodia. Fauna & Flora International, Phnom Penh, Cambodia.

Sun H. (2000). Status of the tiger and its conservation in Cambodia. MSc thesis, University of Minnesota, Minneapolis, USA.

IUCN (2010). 2010 IUCN Red List of Threatened Species. Http://www.redlist.org [accessed 1 February 2011].

Biography: This should describe the main research interests of all authors (<150 words total), apart from what is obvious from the subject of the manuscript and the authors’ affiliations.

Tables, figures and plates: These should be self-explanatory, each on a separate page and with an appropriate caption. Figures can be submitted in colour as well as in black and white. The Editorial Team may decide to convert coloured figures into black and white should it be necessary due to printing cost and without diluting the message. Plates (black and white only) will only be included in an article if they form part of evidence that is integral to the subject studied (e.g., a photograph of a rare species), if they are of good quality, and if they do not need to be printed in colour.

Appendices: Lengthy tables, and questionnaires are discouraged. In special circumstances these may be made available for viewing online.

Species names: The first time a species is mentioned, its scientific name should follow in parenthesis and in italics: e.g., Asian elephant (Elephas maximus). English names should be in lower case throughout except where they incorporate a proper name (e.g., Asian elephant, Cookson's wildebeest, long-billed vulture).

Abbreviations: Full expansion should be given at first mention in the text.

Units of measurement: Use metric units only for measurements of area, mass, height, etc.

Contents

ISSN: 2338 865x