

FOREWORD: METHODS FOR DETECTING AND SURVEYING TROPICAL CARNIVORES

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Since 1996, global deteriorations in conservation status of 171 mammal species have been documented (Hoffmann et al., 2011). This rate of decline is even greater for terrestrial carnivore species, with almost 10% experiencing conservation status deteriorations during this same period (J. L. Belant, unpublished data). Of all terrestrial biogeographical regions, the greatest rate of extinction risk for mammals, including carnivores, occurs in Southeast Asia (Hoffmann et al., 2011). The tropical island of Borneo is the third largest island of the world and located in the centre of Southeast Asia. Borneo is divided among Brunei Darussalam, Indonesia (Kalimantan) and Malaysia (East Malaysia). Borneo harbors altogether 25 species of carnivores, including more endemic carnivores than any other island except Madagascar. Current threats to carnivores on Borneo include mainly the loss of suitable habitat and direct persecution by illegal hunting and trapping (Shepherd et al., 2011). Presently, about half of the carnivore species whose geographic ranges include Borneo have been classified by the *IUCN Red List of Threatened Species* as Threatened. Between the *IUCN Red List* assessments of 2002 and 2008, two of these carnivore species deteriorated in conservation status to Threatened and three were elevated to a higher category of threat (Shepherd et al., 2011).

Improving conservation of species requires in part our ability to understand their distributions and population trends. Consequently, numerous techniques have been developed to detect, survey, and monitor carnivores and other species worldwide. The suitability of these techniques, however, varies among species and their environments occupied (e.g., Wilson & Delahay, 2001; Davison et al., 2002; Gompper et al., 2006). Surveying carnivores is challenging because of their large areas traversed, typical occurrence at low densities, and elusive behavior (Sargeant et al., 1998; Mathai et al., 2010). This is particularly challenging in tropical areas due to typically dense vegetation, sometimes mountainous terrain, and the remoteness of many areas. There are several recent books that provide extensive reviews of wildlife monitoring

(e.g., McComb et al., 2010), more specifically of surveying carnivores (Long et al., 2008), non-invasive methods (Thompson, 2004), or camera-trapping (O’Connell et al., 2011)—the latter likely the most common method currently used to study carnivores (Sunarto et al., 2012). Although these books provide thorough references for students, scientists, and conservationists, the specific requirements and challenges of detecting and surveying wildlife, particularly carnivores, in tropical environments are rarely discussed. Of late, many of these methodologies have been applied, with often days, weeks or months spent in the field. However in many cases, despite thorough planning, the anticipated results could not be achieved, with only a minority of the project goals being fulfilled. Practical experiences—why approaches proved to be impractical to study many tropical carnivores—are seldom published and thus new projects often repeat these ineffective approaches. The constraints of many field techniques under tropical conditions were the motivation to synthesise and evaluate their efficacy for detection and surveying of tropical carnivores.

The need for a review of tropical carnivore techniques was addressed as a part of the 1st Borneo Carnivore Symposium (BCS): Road Towards Conservation Action Plans. The BCS was held in Kota Kinabalu, Sabah, Malaysia from 18–24 Jun.2011 and hosted by the Sabah Wildlife Department. The organising committee was chaired by Laurentius Ambu (Sabah Wildlife Department) and Andreas Wilting (Leibniz Institute for Zoo and Wildlife Research) and included Jerrold L. Belant (IUCN/Species Survival Commission [SSC] Small Carnivore Specialist Group), Christine Breitenmoser-Würsten (IUCN/SSC Cat Specialist Group), and Nicole Duplaix (IUCN/SSC Otter Specialist Group). The BCS was attended by about 200 people from almost 20 countries, with strong representation from the range states of Brunei Darussalam, Malaysia, and Indonesia. We divided the BCS into two parts: PART I titled ‘Science for conservation of Bornean carnivores’ and PART II ‘Developing conservation strategies

for Bornean carnivores'. During the first day of PART I, research techniques for studying Bornean carnivores were discussed in four sessions. Within these sessions seven important research techniques for detecting and monitoring tropical carnivores were presented by scientists, who reviewed existing information about these techniques and added their personal valuable experiences from their carnivore research on Borneo. During lively discussions following the presentations we recognised the need to publish these review papers and the Raffles Bulletin of Zoology provided us the opportunity to do so in this supplemental issue.

Conducting interviews is a common technique in tropical regions for assessing distribution and sometimes trends of carnivores and other species. However, several shortcomings are associated with this method, mainly how to separate accurate from inaccurate interview data and thus how to validate the data. Mohd-Azlan et al. (2013) provided a balanced view on the value of secondary data synthesising the utility of these surveys, but also addressing many of the sources of errors associated with these data.

A number of non-invasive methods have been developed for carnivore detection and monitoring. One of these techniques are the use of line transects, a widely-used method for detecting wildlife. But are line-transect surveys a valuable method to study secretive and often nocturnal tropical carnivores? Mathai et al. (2013) reviewed the use and application of transects surveys for studying tropical carnivores, highlighting their limitations but also presenting examples in which transect surveys provided valuable data which might not otherwise be obtainable using alternate techniques.

Camera trapping is one of the most rapidly expanding techniques in wildlife investigations. What started with attaching a camera to a tree to obtain the first glimpse of secretive wildlife species is today one of the most complex survey methods during all stages of implementation. Camera surveys require careful planning and study design, well considered placement in the field, and complex knowledge of advanced statistical tools to analyse data obtained. Sunarto et al. (2013) provided a detailed review of the applications of camera-trapping for surveying tropical carnivores, guiding the reader through considerations at all the stages of a camera-trapping project.

As with camera trapping, the use of molecular tools to understand carnivore ecology and to improve their conservation has made considerable advances in recent years. Nevertheless, molecular studies on tropical carnivores, especially those using field samples collected non-invasively, are extremely limited. Goossens & Salgado-Lynn (2013) describe the importance of using non-invasive techniques to obtain genetic samples, particularly for endangered species, but also emphasised the challenges of these studies under tropical conditions and for secretive carnivores.

Tropical carnivores often occur at low densities; consequently, non-invasive and secondary survey approaches may be

unsuitable in some circumstances to achieve research or monitoring objectives. McCarthy et al. (2013) summarised the approaches used for live capture of tropical carnivores, a task which can prove to be extremely challenging. The authors discussed reasons for the difficulties in trapping carnivores and provided an overview of how detailed study planning, knowledge of species ecology, appropriate selection of trap type and attractants (e.g., lures and baits), as well as trap location can be used to increase trapping success.

Radiotelemetry has become one of the most useful tools in studying the ecology of a species because of its ability to obtain numerous kinds of data on a tagged animal. Information on movement and home range, and habitat use and selection is prerequisite for conservation management of threatened species. However, only a few Bornean carnivores have ever been studied using radiotelemetry techniques and these studies faced great challenges. Gitzen et al. (2013) summarised these challenges and provided an overview of various techniques, technical developments, and data analyses suitable for carnivores in the tropics.

Knowledge of species' distributions and factors that influence their distributions is fundamental to wildlife conservation and management. Data derived from many of the techniques discussed in this supplement can be used in several different statistical frameworks to model species distribution and their habitat associations. Kanagaraj et al. (2013) provided an overview of several established techniques available to model species distribution and their application to tropical carnivore conservation. The authors highlighted the numerous benefits of these models, but also emphasised their limitations and the requirements of independent data to for model development.

It is readily apparent that the appropriateness of techniques presently available for studying tropical carnivores will vary based on species investigated and programme objectives. Belant et al. (2013) summarised the reviews of carnivore research techniques, categorising the advantages and disadvantages of each technique in a framework to guide investigators in the selection of approaches most suitable to their research and survey needs. Costs of several techniques, including live capture, radio telemetry, and genetic-based methods, may be prohibitive in some circumstances. However, these approaches can be invaluable and are sometimes the only techniques currently available to quantify some aspects of carnivore distribution and ecology (e.g., survival, dispersal).

This supplement to the Raffles Bulletin of Zoology provides the first synthesis of research and monitoring techniques for tropical carnivores. Although many advancements in the development of techniques for detection and monitoring carnivores has occurred, knowledge of the efficacy of techniques specific to tropical carnivores is limited. We acknowledge the need for additional efforts to further refine these methods. We trust this initial effort will serve as a foundation for tropical carnivore ecologists developing research and surveying projects and serve as a catalyst for sharing of future advancements and improvements to the

techniques reviewed here, as well as new methods developed. Finally, we thank the numerous authors for their contributions to articles in this supplemental issue of the Raffles Bulletin of Zoology.

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LITERATURE CITED

- Belant, J. L., H. Hofer & A. Wilting, 2013. Comparison of methods for detecting and surveying tropical carnivores. *Raffles Bulletin of Zoology*, Supplement, **28**: 109–113.
- Davison, A., J. D. S. Birks, R. C. Brookes, T. C. Braithwaite & J. E. Messenger, 2002. On the origin of faeces: Morphological versus molecular methods for surveying rare carnivores from their scats. *Journal of Zoology (London)*, **257**: 141–143.
- Gitzen, R. A., J. L. Belant, J. J. Millspaugh, S. T. Wong, A. J. Hearn & J. Ross, 2013. Effective use of radiotelemetry for studying tropical carnivores. *Raffles Bulletin of Zoology*, Supplement, **28**: 67–83.
- Gompper, M. E., R. W. Kays, J. C. Ray, S. D. LaPoint, D. A. Bogan & J. R. Cryan, 2006. A comparison of noninvasive techniques to survey carnivore communities in northeastern North America. *Wildlife Society Bulletin*, **34**: 1142–1151.
- Goossens, B. & M. Salgado-Lynn, 2013. Advances and difficulties of molecular tools for carnivore conservation in the tropics: A guideline. *Raffles Bulletin of Zoology*, Supplement, **28**: 43–53.
- Belant, J. L., H. Hofer, A. Wilting, 2013. Comparison of Methods for detecting and surveying tropical carnivores. *Raffles Bulletin of Zoology*, Supplement, **28**: 109–113.
- Hoffmann, M., J. L. Belant, J. S. Chanson, N. A. Cox, J. Lamoreux, A. S. L. Rodrigues, J. Schipper & S. N. Stuart, 2011. The changing fates of the world's mammals. *Philosophical Transactions of the Royal Society B*, **366**: 2598–2610.
- Karnagaraj, R., T. Wiegand, A. Mohamed & S. Kramer-Schadt, 2013. Using landscape modeling to map the road towards carnivore conservation in the tropics. *Raffles Bulletin of Zoology*, Supplement, **28**: 85–107.
- Long, R. A., P. MacKay, W. J. Zielinski & J. C. Ray, 2008. *Noninvasive Survey Methods for Carnivores*. Island Press, Washington, D.C. 385 pp.
- Mathai, J., J. Hon, N. Juat, A. Peter & M. Gumal, 2010. Small carnivores in a logging concession in the Upper Baram, Sarawak, Borneo. *Small Carnivore Conservation*, **42**: 1–9.
- Mathai, J., D. Jathanna & J. W. Duckworth, 2013. How useful are transect surveys for studying carnivores in the tropical rainforests of Boreno? *Raffles Bulletin of Zoology*, Supplement, **28**: 9–20.
- McCarthy, J. L., J. L. Belant, C. Breitenmoser-Würsten, A. J. Hearn & J. Ross, 2013. Live trapping carnivores in tropical forests – tools and techniques to minimise efficacy. *Raffles Bulletin of Zoology*, Supplement, **28**: 55–66.
- McComb, B., B. Zuckerman, D. Vesely & C. Jordan, 2010. *Animal Populations and their Habitats: A Practitioner's Guide*. CRC Press, Boca Raton, Florida. 282 pp.
- Mohd-Azlan, J., J. L. Belant & E. Meijaard, 2013. Using secondary survey information to study carnivores in Borneo. *Raffles Bulletin of Zoology*, Supplement, **28**: 1–8.
- O'Connell, A. F., J. D. Nichols & K. U. Karanth, 2011. *Camera Traps in Animal Ecology: Methods and Analyses*. Springer, New York, New York. 271 pp.
- Sargeant, G. A., D. H. Johnson & W. E. Berg, 1998. Interpreting carnivore scent-station surveys. *Journal of Wildlife Management*, **62**: 1235–1245.
- Shepherd, C. R., J. L. Belant, C. Breitenmoser-Würsten, N. Duplaix, L. N. Ambu & A. Wilting, 2011. Conservation challenges and opportunities for Borneo's carnivores. *TRAFFIC Bulletin*, **23**: 89–91.
- Sunarto, R. Sollmann, A. Mohamed & M. J. Kelly, 2013. Camera trapping for the study and conservation of tropical carnivores. *Raffles Bulletin of Zoology*, Supplement, **28**: 21–42.
- Thompson, W. L., 2004. *Sampling Rare or Elusive Species*. Island Press, Washington, DC. 413 pp.
- Wilson, G. J. & R. J. Delahay, 2001. A review of methods to estimate the abundance of terrestrial carnivores using field signs and observation. *Wildlife Research*, **28**: 151–164.