CANID NEWS

Field Report

Camera trap records of dholes in Khao Ang Rue Nai Wildlife Sanctuary, Thailand

Kate E. Jenks*[1,2], Nucharin Songsasen[2] and Peter Leimgruber[2]

[1] Graduate Programs in Organismic and Evolutionary Biology, and Wildlife and Fisheries Conservation, University of Massachusetts, 611 N. Pleasant Street, Amherst, MA 01003, USA . Email: kate@katejenks.info

[2] Smithsonian Conservation Biology Institute, 1500 Remount Road, Front Royal, VA 22630, USA.

* Correspondence author

Keywords: Asian wild dog, *Cuon alpinus*, distribution, zero-inflation Poisson regression model

Abstract

In response to a lack of data on dholes *Cuon alpinus*, we initiated an intensive field study of dholes in Khao Ang Rue Nai Wildlife Sanctuary (KARN) in eastern Thailand to gather critical baseline information on the factors influencing dhole presence. Dholes have declined over time, are exposed to continued pressure from humans, yet are taking over the role of top-predator in many Thai protected areas with the extirpation of tigers *Panthera tigris*. During January 2008-February 2010, we obtained 67 independent photographs (n = 4,505 camera-trap nights) of dholes along with photos of 27 mammal species in KARN. To evaluate factors determining dhole presence we used a zero-inflation Posisson regression model. We did not detect any significant influence of human activity on dhole presence. However, our photos confirmed that dholes and domestic dogs use overlapping areas at KARN. The presence of domestic dogs could have implications for competition or disease spillover. The presence of wild pigs had a significant negative relationship to sites of dhole photos, while bait had a significant positive relationship. Based on camera trapping efforts, we found that the one reproducing dhole pack detected during our study was mostly crepuscular, and their minimum 1-day movement averaged 2,597m (n= 6 consecutive-day photos). Photo capture rates of dholes were highest in the cool season (Oct-Jan). While we confirmed that there was at least one healthy dhole pack in KARN, this is far from establishing the presence of a healthy population in this protected area.

Introduction

In October 2007, stakeholders from various governmental, non-governmental, and academic organizations participated in the first Wild Canid Conservation Workshop in Thailand with the aim of assembling all knowledge about dholes *Cuon alpinus* and Asiatic jackals *Canis aureus* in this country. For the endangered dhole (IUCN 2010), the main conclusions were straightforward; even considering the two previous field studies of dholes in Thailand (Austin 2002, Grassman et al. 2005), there was a serious lack of basic information on dhole ecology that is essential to understanding population status and conservation threats. Additionally, specialists recognized an urgent need to design and implement systematic studies to generate ecological and behavioural baseline data, with the expectation that findings will confirm the value of this carnivore to maintaining viable Thai ecosystems.

In response to this lack of data, we initiated a field study of dholes in Khao Ang Rue Nai Wildlife Sanctuary (KARN) in eastern Thailand to generate baseline information that will aid decision-makers in developing effective management plans for the species. Here we report on our camera trapping efforts, the aim of which was gather baseline data on dhole activity and movements in KARN and to elucidate factors influencing photo rates, and thus, presence of, dholes. The dhole is a Southeast Asian predator that preys on medium to large ungulates. The species has been associated with negative connotations, for which conflicts with humans were a leading cause of historical population decimation (Durbin et al. 2004). Therefore, we hypothesized that photo rates of dholes were (1) negatively correlated to human activity, and (2) positively correlated to prey availability and the presence of bait.

The following is the established format for referencing this article:
Jenks, K.E., Songasen, N. and Leimgruber, P. 2012. Camera trap records of dholes *Cuon alpinus* (Canidae, Carnivora) in Khao Ang Rue Nai Wildlife Sanctuary, Thailand. *Canid News* [online] URL: http://www.canids.org/canidnews/15/Camera_trap_records_of_dholes_in_Thailand.pdf.

Study area

Khao Ang Rue Nai Wildlife Sanctuary (KARN) in eastern Thailand (13°00'–13°32'N, 101°40'–102°09'E) encompasses 1,079km^2 (Fig. 1). The climate is monsoonal, with distinctive wet (Jun-Sep), cool (Oct-Jan), and dry (Feb-May) seasons. Average annual rainfall is 1,500mm, and temperature is 28°C (Thai Meteorological Department 2011). The majority of the vegetation is lowland rainforest at < 200 m elevation, although our study site, centered at Chachoengsao Wildlife Research Station, was within patches of secondary forest.

Human activity varies throughout the sanctuary and is influenced by ranger patrols, tourist groups, and villagers entering the protected area. Illegal hunting targeting birds and small mammals occurs occasionally throughout the sanctuary. Additionally, there have been cases of larger mammals such as gaur *Bos gaurus* and banteng *Bos javanicus* being injured by snares (K. Jenks unpublished data).

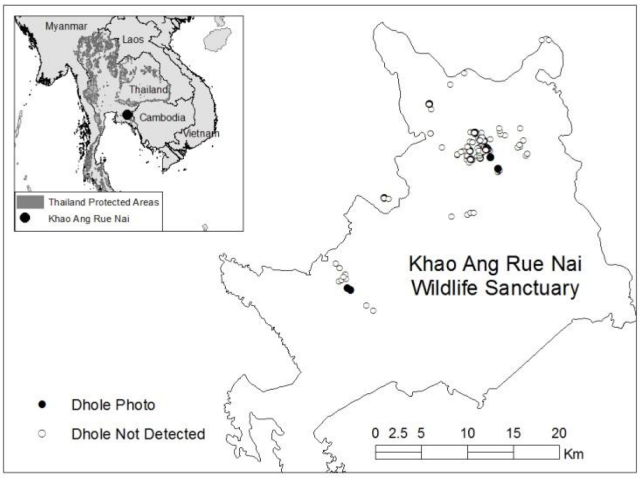

Figure 1: Camera trap (n=227) locations and dhole detection sites in Khao Ang Rue Nai Wildlife Sanctuary, Thailand.

Methods

Gathering Baseline Activity and Movement Data

We conducted surveys in KARN using camera traps (Moultrie Model MFH-I-40, EBSCO Industries, Inc., Birmingham, AL 35201-1943 USA) from 30 January 2008 through 2 February 2010 (e.g. Karanth et al. 2004). We used cameras to consistently monitor a dhole pack known to frequent a water reservoir near the Research Station, to examine daily movements, and provide insights for future capture and collaring. Cameras were placed at locations where dhole signs (prints or feces) were detected or along wildlife trails. As a result, the study area and camera trap site selection concentrated in a central location within the sanctuary, logistically close to the sanctuary Research Station. We undertook a continuous sampling effort of 4,505 trap nights, placing cameras at 227 sites >500 m apart (to maintain independence between sites and decrease the probability that the pack would be detected by multiple cameras in one day) and distributed within a core area of approximately 300km^2 (Fig. 1). We also monitored 13 sites further south (approximately 22km) in an effort to capture additional dhole packs (Fig. 1). Cameras were set approximately 50cm above ground, 1-5m from the targeted monitoring area, and camouflaged with foliage. Thirty-nine cameras were baited with sambar deer *Rusa unicolor* road kill and 24 were baited with commercial scent lures (Minnesota Trapline Products, Pennock, MN 56279 USA). Independent detections (recorded as photo counts) were calculated following the protocol of O'Brien et al. (2003) who defined independence as (a) consecutive photos of different individuals of the same species, (b) consecutive photos of different species, (c) consecutive photos of individuals of the same species taken > 30 minutes apart, and (d) nonconsecutive photos of individuals of the same species. If a group of animals was captured in one frame it was counted as one count of the species.

Each photograph was printed with date and time so we made use of this information to document the activity level of dholes at KARN. Since cameras were operational 24hr per day, we assumed that the more active dholes were in the area, the more frequently they would come into contact with cameras, and the more photographs would be taken. Thus, we pooled time periods into one-hour intervals and measured the activity level of dholes by the percentage of the total photographs. We also measured minimum daily distance travelled between camera locations when dholes were captured on consecutive days. We assumed that consecutive photos were of the same pack based on the locations being within their estimated home range and consistent with previous movement patterns of this pack observed by field workers. We also performed a Kruskal-Wallis test to evaluate the effect of season on dhole photograph counts.

Evaluating Factors Determining Dhole Presence

A zero to represent dhole absence was assigned to photos with no animals or those that included other non-target species. Our spatial count data exhibited a high number of zeros (85%), representing pictures with no dholes. To address this problem we employed a zero-inflation Poisson regression model (ZIP) that allowed for complex sets of hypotheses involving species counts given site suitability (Lambert 1992, Welsh et al. 1996). ZIP has been applied to model the number of sightings of a rare possum species (Welsh et al. 1996) and to herbivore responses to water and bomas (Ogutu et al. 2010). The ZIP model also allows for two different kinds of zero counts; those due to unsuitable sites and those due to the observed counts (Kery 2010). The coefficients in the zero-inflation model are included as predictors of excess zeros (i.e. the probability that no dholes are present at a site because it is not suitable). The coefficients in the count model are usually used to determine abundance for a species. In this case, our counts were equivalent to the frequency of site use (how many times we detected dholes at certain areas). The majority of our camera trap sites were concentrated in the northern portion of the sanctuary and we do not know if all covariates (e.g. prey abundance) were similar to the rest of the sanctuary. Extrapolation to the entire park beyond our study area was inappropriate; therefore, for the ZIP analysis, we removed 13 southern sites and used a subset (n=214) to characterize only the core area of use (approximately 100km^2) for one dhole pack.

We explored covariates for their impact on predicting site suitability for dholes and counts. A total of seven environmental variables was measured at each camera site. An offset (similar to a weight) was included to compensate for the variation in the response resulting from differing search effort (number of camera trap nights). Five covariates were taken from camera photo detections (number of sambar deer, barking deer *Muntiacus muntjak*, wild pigs *Sus scrofa*, humans, and domestic dogs *Canis familiaris*). We assumed that the following covariates were indicators of human activity: counts of humans, dogs, and nearest distance to the headquarters. All distance measures were obtained in ArcGIS 9.2 (ESRI, Redlands, CA, USA). The final covariate was a baited or non-baited camera site. We formulated one global model to explore hypothesized effects of site variables with no interaction between explanatory variables. Before running the model we scaled continuous explanatory variables to improve convergence in the model.

The ZIP analysis was performed using a Monte-Carlo Markov Chain Bayesian framework in WinBUGS 14.3. We used the program R (version 2.11.1) with the package R2WINBUGS (Sturtz et al. 2005) to relay the data to WinBUGS.

Results

Baseline Data

In 4,505 trap nights we recorded a total of 1,906 independent photographs; these included 31 "unidentified mammal" photos. Of the total photos, 18% (n=350) were of carnivores, 52% (n=991) were of non-carnivore mammals, 10% (n=186) were of birds, 2% (n=34) were of reptiles, 3% (n=61) were of domestic dogs, and 13% (n=253) were human traffic photos including park staff, tourists, poachers, villagers, and vehicles.

We captured 27 mammal species (17 carnivore species and ten non-carnivore species; Table 1). The carnivores included five mustelids, four viverrids, three felids, three canids, and two ursids. Of these species, six were documented ten times or less. Large-spotted civets *Viverra megaspila* (n=73) and dholes (n=67) were the most common carnivores. Elephants *Elephas maximus* (n=361) and sambar deer (n=218) were the most common non-carnivore mammals recorded by cameras.

Species		Nights to 1st Photo	Total Number of Photos
Asian Elephant	*(Elephas maximus)*	1	361
Sambar Deer	*(Rusa unicolor)*	1	218
Barking Deer	*(Muntiacus muntjak)*	1	94
Crab-eating Mongoose	*(Herpestes urva)*	183	12
Domestic Dog	*(Canis familiaris)*	222	61
Gaur	*(Bos gaurus)*	225	20
Banteng	*(Bos javanicus)*	227	52
Large Indian Civet	*(Viverra zibetha)*	230	26
Malayan Porcupine	*(Hystrix brachyura)*	230	163
Large-spotted Civet	*(Viverra megaspila)*	395	73
Lesser Mouse-Deer	*(Tragulus javanicus)*	458	9
Dhole	*(Prionailurus bengalensis)*	466	67
Hog Badger	*(Arctonyx collaris)*	701	33
Pig-Tailed Macaque	*(Macaca nemestrina)*	807	15
Smooth-coated Otter	*(Lutrogale perspicillata)*	817	10
Small Indian Civet	*(Viverricula indica)*	848	14
Common Palm Civet	*(Paradoxurus hermaphroditus)*	1089	22
Eurasian Wild Pig	*(Sus scrofa)*	1099	29
Leopard Cat	*(Prionailurus bengalensis)*	1217	22
Small Asian Mongoose	*(Herpestes javanicus)*	1258	10
Yellow-throated Marten	*(Martes flavigula)*	1290	8
Asiatic Black Bear	*(Ursus thibetanus)*	1356	12
Sunda Pangolin	*(Manis javanica)*	2847	2
Malayan Sun Bear	*(Helarcots malayanus)*	3616	3
Clouded Leopard	*(Neofelis nebulosa)*	3910	3
Asiatic Jackal	*(Canis aureus)*	3993	9
Golden Cat	*(Pardofelis temminckii)*	4178	1
Unidentified Mammals			84

Table 1: Camera trap (n=227) records at Khao Ang Rue Nai Wildlife Sanctuary, Thailand from January 2008 to February 2010, including mammal species detected, sampling time required to obtain the first photograph, and number of independent pictures obtained (n=1,906).

We photographed a dhole pack of six individuals, and dholes and domestic dogs using overlapping areas of the sanctuary. We confirmed that dholes were breeding in KARN; two pups were first photographed in May 2008 when approximately six months old (estimated based on size) and young adults were recorded near the same location in June 2009. Dholes have similar pelage, which makes it difficult to identify individuals. However, we were able to identify the pups based on their size proportions from one year to the next and because they were photographed with the same adult female who was identified by her "docked" tail (Fig. 2).

Figure 2: Camera trap photo of adult female with docked tail, 3 adult dholes, and 2 pups taken in Khao Ang Rue Nai Wildlife Sanctuary, Thailand. Arrows point to individual dholes and the visible eye-shine of the pups.

Activity and Movement Data

Dholes were mostly crepuscular, exhibiting peaks in their daily activity in the early morning and the late afternoon (Fig. 3). The mean

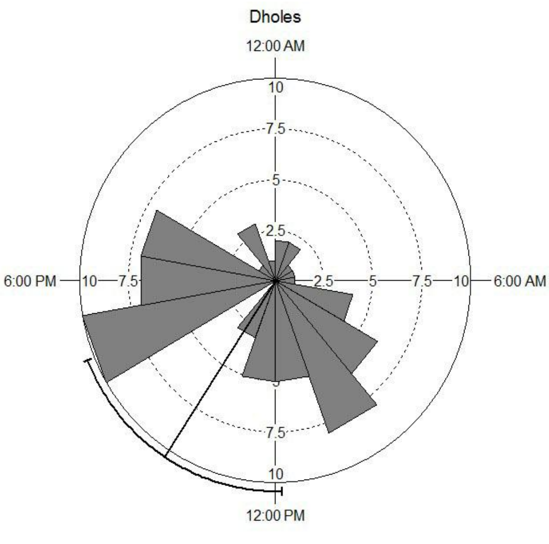

Figure 3. Times of dhole activity based on pooled camera trapping records in Khao Ang Rue Nai Wildlife Sanctuary, Thailand (January 2008 to February 2010). Numbers on concentric circles represent sample sizes. Bold line represents mean vector (14:11 h). Arc outside the circle represents 95% CIs of the mean vector.

photo time was 14:11 h (95% CI 11:52-16:31). The capture rates of dholes differed significantly among seasons (Kruskall-Wallis: 19.778, p<0.001), with the majority of detections (77.6%) occurring in the cool season (Oct-Jan). Dholes were photographed on consecutive days six times for a mean minimum 1-day movement of 2,597 m (range = 969 – 4,682 m).

All of the posterior distributions for covariates included in the zero-inflation model overlapped zero (Table 2). This indicated that we did not detect any covariates impacting site suitability for dholes. Posterior distributions for wild pigs and bait in the count model did not overlap zero (Table 2) indicating these covariates did impact the dhole count. We found a negative association between wild pig photos and frequency of site count by dholes and a positive association between baited sites and dholes (Table 2). We did not detect any significant influence of human activity on dhole presence (Table 2).

Factors Determining Dhole Presence

	Mean (SD)		2.5% Credible Interval	97.5% Credible Interval
Count model coefficients:				
(predicting dhole frequency of site use)				
intercept	-3.073 (1.867)	*	-6.607	-0.241
sambar deer	0.460 (0.583)		-0.683	1.147
wild pig	-0.792 (0.391)	*	-1.595	-0.092
barking deer	0.149 (0.375)		-0.612	0.675
domestic dog	1.176 (1.227)		-1.180	2.902
human	-0.029 (0.730)		-0.995	1.440
distance from headquarters	0.185 (0.382)		-0.638	0.735
bait	1.596 (0.662)	*	0.304	2.799
Zero-inflation model coefficients:				
(predicting site suitability)				
intercept	0.884 (5.894)		-9.515	9.680
sambar deer	-2.381 (3.982)		-7.977	5.413
wild pig	2.275 (2.672)		-2.466	8.550
barking deer	-1.922 (2.171)		-5.440	2.306
domestic dog	-2.904 (4.215)		-9.639	4.907
human	4.918 (4.584)		-5.810	9.874
distance from headquarters	-1.984 (2.236)		-5.774	1.985
bait	-3.789 (3.593)		-9.518	2.345

*posterior distribution does not overlap zero

Table 2. Mean, standard deviation (SD), and 95% credible interval of posterior distributions of parameters for zero-inflated Poisson regression model (n=214).

Discussion

Our aim was to gather baseline data on activity and movement patterns for dholes at KARN and evaluate factors determining dhole presence at individual camera sites. We hypothesized that photo rates of dholes were (1) negatively correlated to human activity, and (2) positively correlated to prey availability and the presence of bait. The relatively high number of dhole photos we obtained was not an indication of population density, but probably a reflection of the fact that we set up camera traps with the intention of consistently monitoring our target pack. Additionally, the pack size of six was a minimum as it is highly possible that not all members of the group were in the one photo frame; it was difficult to identify individuals and thus confidently estimate how many total individuals we photographed. Observer sightings of packs were extremely uncommon during our study due to dense forest vegetation and the elusive nature of the species.

Dhole mean daily distance traveled was similar to distances observed in telemetry studies of Thailand dholes in Phu Khieo Wildlife Sanctuary (PKWS; 2.6km; Grassman et al. 2005) and in Khao Yai National Park (KYNP; 1.4km; Austin 2002). Dhole crepuscular activity patterns in KARN were also similar to dholes observed in PKWS and KYNP (Austin 2002, Grassman et al. 2005). While Karanth and Sunquist (2000) believed that dholes synchronized their activity with diurnal prey, we observed three dholes hunting sambar deer diurnally (ca. 16:00h) by chasing the deer into a water reservoir. In the same week, our team found a fresh sambar kill, the remains of a dhole hunt that was observed by one of the sanctuary rangers at 22:00h.

Cameras documented the presence of at least three prey species that dholes are known to consume (Grassman et al. 2005): sambar deer, barking deer, and wild pig, but we found a negative relationship between wild pig and frequency of site use by dholes. This was surprising as wild pigs have been well documented as a target prey for dholes (Austin 2002, Grassman et al. 2005). Perhaps this result was biased by the low sample size of wild pig photos (n = 29), but on the other hand we did not find any information on whether or not wild pigs actively avoid areas with high dhole activity. We did find that baited sites were positively correlated with frequency of site use by dholes, and this matched our hypothesis and was expected because the majority of bait used was sambar deer, a preferred food of dholes.

Dholes (and potentially domestic dogs) are likely the carnivores with the largest impact on medium to large-sized prey species in KARN. Tigers *Panthera tigris* and leopards *Panthera pardus* were not documented in KARN by our camera surveys and thought to be extirpated there (S. Wanghongsa, head of Chachoengsao Wildlife Research Station at KARN, pers. comm.). Additionally, our camera trap photos confirmed that dholes and domestic dogs use overlapping areas at KARN. The presence of domestic dogs in the sanctuary could also have implications for direct competition with dholes and with native scavengers (Butler and duToit 2002). Furthermore, direct and indirect contact (via urine, fecal, or other body fluids) was likely. This is significant because domestic dogs can be an important reservoir for diseases that may spillover to threatened species. For example, Daszak et al. (2000) classified canine distemper virus as an emerging infectious disease due to spillover from domestic dogs that greatly reduced African wild dog *Lycaon pictus* and black-footed ferret *Mustela nigripes* populations. This situation should be monitored closely. We photographed a solitary dhole that appeared in poor health, possibly due to disease, and was never photographed with the rest of the pack.

Dholes are highly social pack hunters that live in extended family packs averaging eight individuals (Johnsingh 1981), and we documented a pack of six dholes in KARN. In camera trap photographs, all members appeared well-fed with sleek coats, and the pack was reproducing. While we confirmed that there was a healthy dhole pack in KARN, this is far from establishing the presence of a healthy population in this protected area. For example, if a typical pack range is 50-100km^2, three to six packs should range over about 1/3 of the sanctuary. Although we did not detect any significant impact of humans or domestic dogs on dhole counts, our camera sites were in the core of the sanctuary. Dhole packs with home ranges closer to the forest edges may be more greatly impacted by human presence. To sustain viable populations of canids, the availability of forest cover and prey species are important (Humphrey and Bain 1990). Information gaps surrounding dhole prey and spatial requirements must be bridged, and further information on dhole mortality threats must be gathered to facilitate plans for their future survival.

Acknowledgements

We thank S. Panda for his expert knowledge and dedication in the field. This study was supported by the Department of National Parks, Wildlife and Plant Conservation and the National Research Council of Thailand, S. Wanghongsa, K. Boonkird, N. Bhumparkpan, and N. Sisuruk. Funding for surveys was provided by the Association of Zoos and Aquariums Conservation Endowment Fund, Smithsonian Endowment Fund, and a Fulbright U.S. Student Scholarship. B. Kekule graciously provided extra camera traps and advice on elephant-proofing them. Earlier versions of the manuscript were edited by M. Akresh, T.K. Fuller, C. Kennedy, B.H. Letcher, K.M. Sakrejda-Leavitt, and two anonymous reviewers.

References

Austin, S.C. 2002. Ecology of sympatric carnivores in Khao Yai National Park, Thailand. Ph.D. dissertation, Texas A&M University-Kingsville and Texas A&M University, College Station, Texas. 153p.

Butler, J.R.A. and duToit, J.T. 2002. Diet of free-ranging domestic dogs (*Canis familiaris*) in rural Zimbabwe: implications for wild scavengers on the periphery of wildlife reserves. *Animal Conservation* 5: 29–37.

Daszak, P., Cunningham, A.A., and Hyatt, A.D. 2000. Emerging infectious diseases of wildlife --Threats to biodiversity and human health. *Science* 287: 443–449.

Grassman, L.I., Tewes, M.E., Silvy, N.J., and Kreetiyutanont, K. 2005. Spatial ecology and diet of the dhole *Cuon alpinus* (Canidae, Carnivora) in north central *Thailand. Mammalia* 69: 11–20.

Humphrey, S.R. and Bain, J.R. 1990. Endangered animals of Thailand. Sandhill Crane Press, Inc. Gainesville, Florida, USA. 480p.

IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 30 March 2010.

Johnsingh, A.J.T. 1981. Ecology and behaviour of the dhole or Indian wild dog - *Cuon alpinus pallas* 1811, with special reference to predator-prey relations at Bandipur. Bangalore, India, World Wildlife Fund-Indian and International Appeals.

Karanth, K.U., and Sunquist, M.E. 2000. Behavioural correlates of predation by tiger (*Panthera tigris*), leopard (*Panthera pardus*) and dhole (*Cuon alpinus*) in Nagarahole, India. *Journal of Zoology* 25: 255–265.

Karanth, K.U., Chundawat, R.S., Nicholes, J.D., and Kumar, N.S. 2004. Estimation of tiger densities in the tropical dry forests of Panna, Central India, using photographic capture-recapture sampling. *Animal Conservation* 7: 285–290.

Kery, M. 2010. Introduction to WinBUGS for Ecologists: A Bayesian Approach to Regression, Anova, Mixed Models, and Related Analyses. Academic Press, Amsterdam, The Netherlands.

Lambert, D. 1992. Zero-inflated Poisson regression, with an application to defects in manufacturing. *Technometrics* 34:1–14.

O'Brien, T.G., Kinnaird, M.F., and Wibisono, H.T. 2003. Crouching tigers, hidden prey: Sumatran tiger and prey populations in a tropical forest landscape. *Animal Conservation* 6: 131–139.

Ogutu, J.O., Piepho, H., Reid, R.S., Rainy, M.E., Kruska, R.L., Worden, J.S., and Nyabenge, M. 2010. Large herbivore responses to water and settlements in savannas. *Ecological Monographs* 80: 241–266.

Sturtz, S., Ligges, U., and Gelman, A. 2005. R2WinBUGS: A Package for Running WinBUGS from R. Journal of Statistical Software 12: 1–16.

Thai Meteorological Department. 2011. <http://www.tmd.go.th/en/index.php> Downloaded on 2 April 2011.

Welsh, A. H., Cunningham, R.B., Donnelly, C.F., and Lindenmayer, D.B. 1996. Modeling the abundance of rare animals: statistical models for counts with extra zeros. *Ecological Modeling* 88: 297–308.

Biographical sketches

Kate Jenks is a Conservation Biologist who has conducted research on carnivore ecology in Thailand since 2004. She is currently focusing her dissertation work on dhole ecology and is interested in exploring the effects of spatial movement and group interactions on disease in wild canids.

Nucharin Songsasen is a Research Biologist. Her research focuses on wild canid conservation. In addition to studying reproductive biology of canids kept ex situ, she is collaborating with governmental and non-governmental organizations in range countries in studying dholes and South American canids.

Peter Leimgruber, a Research Scientist at the Smithsonian, uses geospatial technology (e.g. GPS tracking, satellite remote sensing) to study extinction-prone species, such as Asian elephant and tiger. He is especially interested in the challenge of conserving highly mobile species that spend most of their life outside protected areas.