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Some ecological aspects of dhole (*Cuon alpinus*) in the Huai Kha Khaeng Wildlife Sanctuary, Uthai Thani Province, Thailand

Khwanrutai Charaspet[1], Ronglarp Sukmasuang[1*], Noraset Khiowsree[1], Nucharin Songsasen[2], Saksit Simchareon[3], Prateep Duengkae[1]

[1]Forest Biology Department, Kasetsart University, Phaholyothin Road, 10900, Bangkok, Thailand
[2]Smithsonian's National Zoo & Conservation Biology Institute, 3001 Connecticut Avenue, NW, Washington, DC 20008, USA
[3]Department of National Parks Wildlife and Plant Conservation, Phaholyothin Road, 10900, Bangkok, Thailand

Abstract

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The dhole (*Cuon alpinus*) is one of the least frequent studied endangered canid species and many aspects of ecological knowledge about this species are lacking. The objectives of this study were to investigate the spatial movement of dholes, prey abundance, prey selection, and prey overlaps with other large carnivorous species in the Huai Kha Khaeng Wildlife Sanctuary, Thailand, during November, 2017 and October, 2018. Two adult female dholes were captured and fitted with GPS collars. Twenty camera trap sets were systematically used to survey the area. Scat collection was conducted along forest roads and trails. The home range sizes and activity radii of the two dholes were 3,151.63 ha. and 1,442.84 m, and 33.39 ha and 331.56 m, respectively. The sambar deer (*Rusa unicolor*) was the most abundant prey species (30.93%). However, dhole fecal analysis showed that the monitored dholes preferred red muntjac (*Muntiacus muntjak*) (57.1%). There was a high degree of prey overlap between dholes and leopards (98%), indicating very high prey competition. The dholes in this study represent movement patterns in richly abundant prey habitats, but with the presence of other predators that can affect prey selection and movement patterns of the dhole in the area.

Keywords

GPS-collar, large carnivores, prey species, scat analysis

Introduction

The dhole (*Cuon alpinus*), or Asian wild dog, is one of 37 species in the Canidae family and it has been classified as endangered since 2004 (Kamler et al., 2015). Historically, the dholes' distribution was throughout Asia. However, they have disappeared from most of their former ranges and now can only be found in some Asian countries, as a result of habitat reduction and fragmentation, hunting and reduction of their prey populations (Gopi et al., 2012). Another important factor is the negative attitude of some people towards dholes, regarding them harmful. In Thailand, some people have suggested elimination of dholes from Thai protected areas (Jenks et al., 2014). Naturally, the dhole is a predator species playing an important role in the ecosystem. As one of predator species, dholes can have a strong influence not only on their prey but also on one another, with cascading effects on many species and eco-

*Corresponding author:
e-mail: mronglarp@gmail.com

system processes (Beschta et al. 2009; Glen and Dickman, 2014). Dholes can kill prey that is as large as that one of tigers and leopards, and they usually form relatively large packs to hunt the large prey efficiently (Lekagul and McNeely, 1977). In Thailand, the dholes' main prey is medium to large ungulates, ranging between 20–260 kg. However, the dholes also prey on small animals such as rodents, birds and reptiles (Austin, 2002; Slangsingha, 2012; Prayoon, 2014; Charaspet, 2015). At present, there are few studies on the ecology of dholes. Therefore, in order to better understand their ecology and to assist in conservation efforts, more research is needed for this species (Kamler et al., 2012). Specifically, limited knowledge on spatial ecology in association with prey relationships and competition with other large predators has hampered the ability to establish conservation or management action for the species. This study focused on the home range size, movement patterns, prey species and selection, as well as the overlap of the dhole's prey species with other large carnivores in the area. Normally, the knowledge of how animals distribute their activities in space and time is of central importance in any ecological study (Spensser, 2012). Thus, biologists track animals to estimate the sizes and shapes of their home ranges, movement patterns within the home ranges, home range overlaps among individuals, and time-dependent variability of the home-range boundaries (e.g. Fieberg and Borger, 2012; Fieberg and Kochanny 2005; Powell and Mitchell, 2012). The size of a dhole's home range varies with its habitat. Acharya et al. (2007) reported that the size of the home range varied from 26.0–202.8 km^2 in dry deciduous forest, at the Pench Tiger Reserve, India. Grassman et al. (2005) found that the size of the home range varied from 12.0–9.5 km^2 in the dry evergreen forest at the Phu Khieo Wildlife Sanctuary, Thailand. Austin (2002) studied the size of the area inhabited by dholes, using radio signals in the Khao Yai National Park, Thailand. This author found that the size of the area was 27.6 km^2, and the average daily distance traveled was 1.4 km. Home range formation is, thus, the result of dynamic processes. Both the habitat and internal situation of the animals may change with time, and cause the home range size to vary (Viana et al., 2018). Moreover, the home range size may depend on the method of data collection and analysis. Normally, the home range size depends on the quality of the habitat, with higher habitat quality allowing smaller home ranges. The home range size and movement in dhole can be determined using satellite radio signals. Although Huai Kha Khaeng Wildlife Sanctuary (HKK) is one of the most important dhole habitats in Thailand, these aspects have never been studied. The relative abundance of dholes and the characteristics of the prey they consume in the area have also never been investigated. An understanding of home range size, habitat used, and prey characteristics are fundamental for maintaining the dhole population and habitat management (Rechetelo et al., 2016). Advanced research data, including habitat use and prey species, are essential for the species conservation, not only in this area but throughout their distributed range. The objectives were to investigate the spatial movement of dholes equipped with Global Position System (GPS)-collars, to examine the abundance of dholes, their prey, and other carnivores, using camera traps and to study the prey species of dholes and prey overlaps with their competitors.

Methods

Study area

This study was conducted in an area of approximately 200 km^2 between the Klong Phlu Long-term Ecological Research Plot (KP) and the Khao Nang Rum Wildlife Research Station (KNR) in HKK. The sanctuary is located in the Banrai and Lansak Districts, Uthai Thani Province and Umpang District, Tak Province. The sanctuary is situated between latitude 15º 15' to 15º 45' and longitude 99º5' to 99º 25'. The Huai Kha Khaeng Stream and Tab Salao Stream are permanent water sources in the area (Faculty of Forestry, 1988). The topography in this area includes lowlands along the main streams as well as mountainous terrain. The altitude of the sanctuary ranges from 250–1,678 meters above the sea level (MSL) (Faculty Of Forestry, 1988) (Fig. 1).

Field data collection

Dhole trapping and radio collaring

The dhole trapping procedure was conducted from 25th June–4th July 2018, with using soft-catch traps, in the area between the HKK head office and Khao Nang Rum Wildlife Research Station, and from 28th–31st July 2018 in the area around the Khlong Phu Long-term Ecological Research Plot and Huai Kha Khaeng River. Five to eight soft catch trap stations were employed. This method was similar to that used by Jenks et al. (2015). The captured dholes were fitted with GPS radio collars and released at the capture site. All of the locations were downloaded via LOTEX website every 4 hours until the signal stopped. Regular ground checks were performed every month, during the study period, using diurnal VHF system tracking at hilltop sites and forest trails, to investigate the habitat characteristics of the collared animals.

Population abundance of dholes and their prey

The abundance of dholes, their prey and other large carnivorous mammals were determined by the camera trap method. Twenty camera trap sets were deployed randomly every month, each within a 1 km^2 grid cell covering the 200 km^2 study area from November 2017 through June 2018. The cameras were set to take 3 photographs within 10 seconds, after the infrared sensors were triggered (Charaspet, 2015). The camera traps were placed 30 cm above the ground along trails or suitable locations, such as water sources, with higher possibilities of capturing animal im-

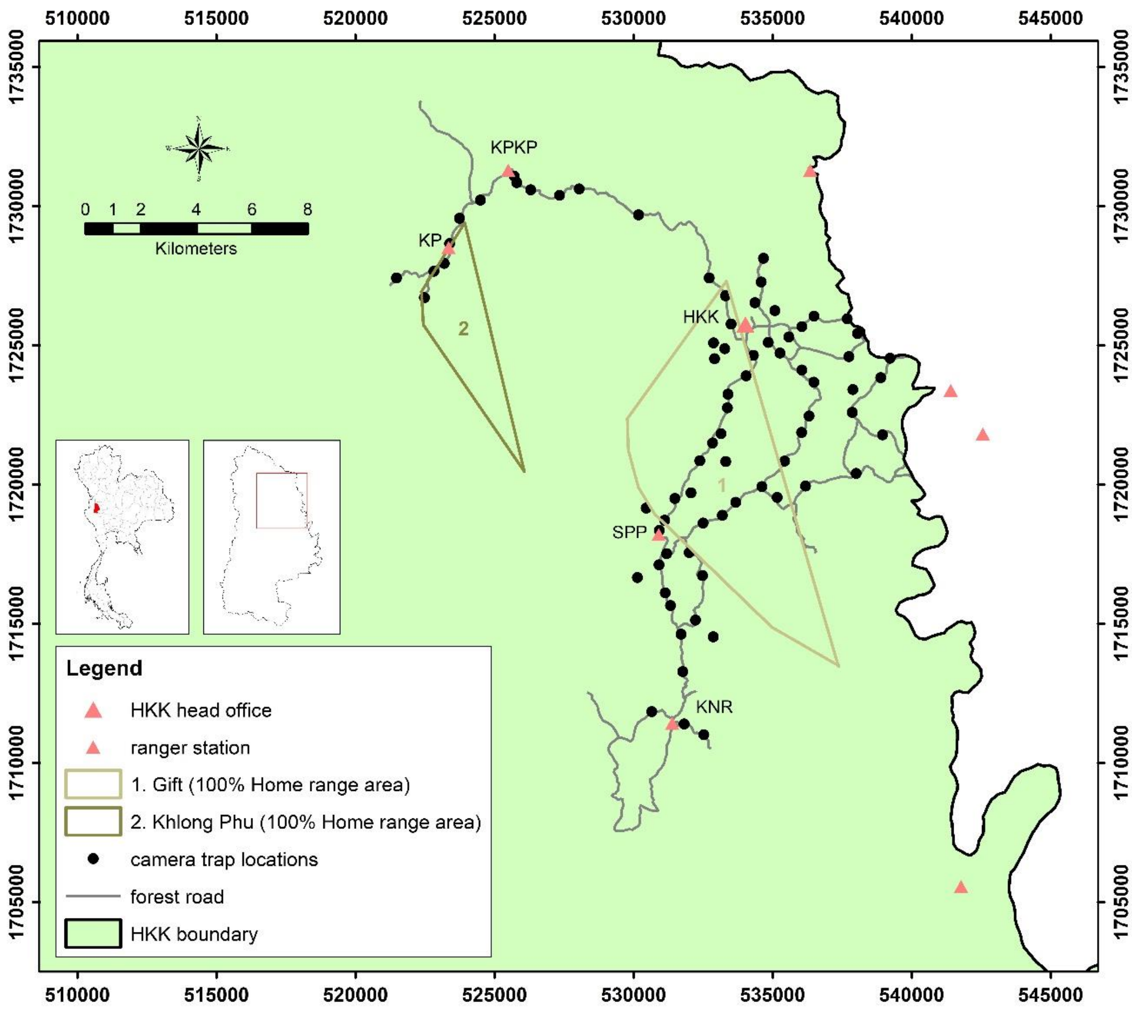

Fig. 1. Huai Kha Khaeng Wildlife Sanctuary and the study site location.

ages (Moruzzi et al., 2002; Charaspet, 2015). The animal photographs were then used for the relative abudance analysis, following the methodologies decribed below.

Prey species

Scats of dholes, tigers and leopards were collected regularly, every month, throughout the study period along forest roads within the study area. Differentiation between dhole's and the two large-felid's scats were determined based on the methods suggested by Phetdee (2000); Acharya (2007); Francis (2008); Kawanishi and Sunquist (2008); Simcharoen (2008); Kumaraguru et al. (2011) and Simcharoen et al. (2018). Found scats were kept in separate plastic bags and labeled. The species, collection date, forest type, scat condition, scat size, scat location, trace, and coordinates were recorded (Charaspet, 2015).

Laboratory procedure

Each animal scat collected in the area was placed in a 1-mm mesh nylon bag, rinsed in water and cleaned again with an ultrasonic cleaner to remove residual dirt (Charaspet, 2015). All the remains in the nylon bag of each scat, such as hair, teeth, feathers, bone and hooves were air dried and stored in paper bags (Ramesh et al., 2012). The remaining hair was prepared following the process recommened by Phetdee (2000) and Charaspet (2015). The characteristics such as color, length, cuticle pattern, medullar pattern and cross section pattern were compared with those in our reference collection (Phetdee, 2000) to identify prey species.

Data analysis

Spatial movement

Home range size has been calculated using minimum convex polygons (MCP). The MCP at 100%, 95%, 75% and 50% were calculated to determine the area covered and core areas, using RANGE 9 program.

Mean activity radii, the distances between centers of home ranges and all of the telemetry locations, were also calculated (Grassman et al., 2005) using the RANGE 9 program.

Population abundance
Species identification in each photo gained from camera trap was performed for dependent or independent occasions following O'Brien et al. (2003). Then relative abundance index (RAI) of species detections and computed the RAI as

$$\mathrm{RAI} = \frac{\mathrm{A} \times 100}{\mathrm{N}}$$

where A is the total number of detections of a species by all cameras and N is the total number of camera trap days by all the cameras throughout the study area following Jenks et al. (2011) and Kanchanasaka et al. (2010).

Prey species
Frequency of occurrence of mammalian prey species in carnivore scats is a commonly used parameter in predator diet studies. Frequency of occurrence (%FO) based on our scat samples and the identification process results were used to calculate %FO using the following formula (Kamler et al., 2012; Charaspet, 2015) as

$$\mathrm{FO} = \frac{\mathrm{ni} \times 100}{\mathrm{N}}$$

where ni is the number of scats of prey species i and N is total scat.

Electivity indices measure the utilization of food types (r) in relation to their abundance or availability in the environment (p) or the indices showing the degree of selection of a particular prey species by the predator being studied. Electivity index was calculated using the following formula (Jacobs, 1974) as

$$\text{Electivity index} = \frac{(\mathrm{r} - \mathrm{p})}{(\mathrm{r} + \mathrm{p}) - 2\mathrm{rp}}$$

where r is the proportion of the prey category in the predator's diet and p is the proportion of the availability of the prey category in the study area.

Dietary electivity index values range from –1 to +1. Index values near +1 indicate that the prey category is selected by the predator in much greater proportion than it is available in the habitat. Conversely, index values near –1 indicate that the prey category is selected much less than its abundance in the study area. Prey with index values near 0 are consumed in proportion to their availability (Kamler et al., 2012).

Investigations of resource utilization by predators, as well as their relationship with their prey and the environment, are important in understanding the mechanisms that influence vertebrate community structure (Vieira and Port, 2007). The three large carnivores' species are reported in HKK. However, resource utilization has never been studied. Overlapping of prey over utilization areas of dholes, leopards, and tigers was calculated using the following Pianka (1974) as

$$\text{Pianka's niche overlap index} = \frac{\sum P_{ij} \times P_{ik}}{\sqrt{(\sum i(P_{ij})^2 \times \sum i(P_{ik})^2)}}$$

where P_{ij} is the percentage of prey species i of predator j, P_{ik} is the percentage of prey species i of predator k.

Pianka's index varies between 0 (total separation) and 1 (total overlap). We used this index to enable comparisons with other studies on the diet similarity of South American foxes that used the same measurement of diet (e.g. Juarez and Marinho-Filho, 2002; Jacomo et al., 2004; Zapata et al., 2005).

Results and discussion

Spatial movement of dhole
Home range size
Two adult female dholes from different packs were captured. The first one was captured on the 4th of July 2018, near Sub Pah Pha Forest Ranger Station (SPP) and the second was captureed on the 31st of July 2018, near Huai Kha Khaeng River, Khlong Phu Long-term Ecological Research Station (KP). For the first dhole, 95 GPS locations were recorded between the 27th July, 2018 and 11th September, 2018. However, for the second dhole, only 31 GPS locations were recorded. The home range sizes at 100%, 95%, 75% and 50% for each dhole are shown in Table 1.

The home range size of the first dhole at 95% core area was 31.5 km^2 which was slightly larger than that of an adult female dhole (26.7 km^2) reported by (2002) using

Table 1. Home range size of the collared dholes in the Huai Kha Khaeng Wildlife Sanctuary, Thailand, during July and October 2018, using satellite radio collars

Dhole	The first dhole (Gift)	The second dhole (Khlong Phu)
Number of telemetry locations	95	31
100% core area (ha)	4,474.23	157.71
95% core area (ha)	3,151.63	33.39
75% core area (ha)	214.83	13.24
50% core area (ha)	6.05	3.38

a VHF radio collar in the Khao Yai National Park (KY). This may be due to the latter dhole being solitary, thus using a smaller area than a dhole pack. Jenks et al. (2015) studied dhole using GPS-collars in the Khao Ang Rue Nai Wildlife Sanctuary, and reported the home range to be 33 km^2, similar to the size of the first dhole in this study. The author also suggested that in the dry season, the dhole concentrated more around water sources. However, the size of the home range of the first dhole was smaller than that reported by Durbin et al. (2004) who studied an adult male dhole in India, with an average home range size of 55.0 km^2. The period of this study was reported to be during the breeding season and the dhole pack were taking care of their pups.

As for the second dhole in this study, the data received from the GPS collar was much less abundant than that of the first dhole, and the home range was significantly smaller. This may be due to different factors affecting the signal transmission from the collar, such as the density of the forest, the time schedule for satellite connection or other factors restricting the movement of the dhole. Further continuous monitoring and adding other means, e.g ground radio tracking will be conducted in order to get a better understanding of the home range of the second dhole.

Movement

The movement of the first dhole, based on the 95% core area of the GPS locations, showed an activity radius (average distance from the center of the animal's home) of 1,442.84 m (median = 450.00 m, range 0–8,312.60 m). The second dhole had an activity radius of 331.56 m (median = 209.11 m, range 0–3,476.56 m). Based on regular ground checks within the animal's home range, concentrated especially in locations with intense activity that had appeared via satellite and radio transmissions, it was found that the home range of the first dhole mostly covered dry dipterocarp, mixed deciduous, and small areas of dry evergreen forests, with proportion in descending order, near the Huai Song Thang River. The area of median terrain ranges between 200–500 m above the sea level. The concentrated area found in the dry dipterocarp forest had no forest fires occurring at an elevation of 267 m above the sea level. A small water source was also found in the area.

The second concentrated area identified through the ground check was an area 1 km from the forest road, where the animal was captured, 388 meters above sea level. This area is covered with lower dry dipterocarp forest, <10 m high, at the ridge of the mountain. Stone yards were distributed in this area; the lower area had forest trails used by large ungulates. This area was used by the collared dhole as a resting site. The third area identified was covered with dry evergreen forest near the Huai Song Thang River. The carcass of the first collared dhole was found at this location. Skeletal examination of the dhole carcass revealed a fractured rib and hip, which may be a result of the dhole's hunting activity. Regular ground checks also found that the first dhole traveled between the Khao Nang Rum View Point to the north part of the HKK Head Office with a span of 14,292.29 meters.

On the other hand, the home range area of the second collared dhole mostly covered dry evergreen and mixed deciduous forests, with the proportion in descending order, near the Huai Kha Khaeng River. The home range of the animal also covered a hot spring saltlick (Pru Nam Ron) where ungulate species were very abundant, especially sambar deer (*Rusa unicolor*), red muntjac (*Muntiacus muntjak*), gaur (*Bos gaurus*) and smaller wild animals.

The span of the home range was smaller than that of the first collared dhole, with the largest span of 3,920.69 m, but with a higher density of the prey base. The areas utilized by the two dholes in this study were similar to the areas reported by Jenks et al. (2015) within the primary and secondary forest. Supported by the ground check, many animal trails were found, indicating a high density of prey. One of the collared dholes that Grassman (2005) captured was located in a closed forest. This author also suggested that two of their prey species, sambar and red muntjac, were solitary and widely dispersed.

Prey abundance

During November 2017 to June 2018, 20 camera traps (a total of 3,172 trap days) were used to survey the prey species and their relative abundance in order to evaluate large predators and their prey's abundance. A total of 4,940 animal occasions were investigated.

The prey species with the highest relative abundance percentage was *Rusa unicolor* (30.93%), followed by birds (e.g. *Pavo muntiacus* and *Gallus Gallus*, 17.02%), *Canis aureus* (15.86%), and *Muntiacus muntjak* (12.96%) (Table 2). These results are similar to those obtained in the Salak Pra Wildlife Sanctuary (SLP), Thailand, where in the same forest complex, *Rusa unicolor* was found to be the most common species (Charaspet, 2015).

The above results show that there were more prey animals than predators. This finding is consistent with the theory of predator and prey interaction (Abrams, 2000). Furthermore, the camera traps detected dhole within the same locations as the two felid species at the area approximately 2 km from the HKK head office heading towards Kra- Pook Kra-Piaeng (KPKP), KP, SFP and KNR. These data indicate that the high diversity and abundance of prey is sufficient to support the 3 large predators within the same area. Notably, this study also found domestic dogs in the same area where the three large predators were found. This location is approximately 10 km from the forest edge or the nearest village. This finding was similar to that in Khao Yai National Park. Jenks et al. (2011) found a domestic dog in the central area of the park, 7 km from the park boundary. Domestic dogs may be a threat factor to wild species such as sambar deer, muntjac, civets or dholes. Moreover, domestic dogs may carry diseases harmful to the wild mammal populations (Jenks et al. 2011), such as rabies, canine distemper, etc. (Alexander and Appel, 1994; Sabeta et al., 2018). Strict enforcement of regulations regarding domestic dogs in the area is much needed.

Table 2. Prey species and % relative abundance gained by camera trap technique in the Huai Kha Khaeng Wildlife Sanctuary, Thailand, during November 2017 to June 2018, a total of 3,172 trap days

No.	Scientific name	Common name	No. of pictures	% RA
1	*Rusa unicolor*	Sambar deer	981	30.93
2	–	Peafowl and birds	540	17.02
3	*Canis aureus*	Asiatic jackal	503	15.86
4	*Muntiacus muntjak*	Red muntjac	411	12.96
5	*Sus scrofa*	Wild pig	361	11.38
6	*Viverra zibetha*	Large Indian civet	325	10.25
7	*Bos javanicus*	Banteng	303	9.55
8	–	Unknown rodent	284	8.95
9	*Hystrix brachyura*	Malayan porcupine	269	8.48
10	*Elephas maximus*	Wild elephant	258	8.13
11	*Paradoxurus hermaphroditus*	Common palm civet	231	7.28
12	*Prionailurus bengalensis*	Leopard cat	99	3.12
13	*Lepus peguensis*	Hare	62	1.95
14	*Herpestes urva*	Crab-eating mongoose	40	1.26
15	–	Unknown primate	23	0.73
16	*Ursus thibetanus*	Asiatic black bear	18	0.57
17	–	Unknown mammal	15	0.47
18	*Paguma larvata*	Masked palm civet	13	0.41
19	*Macaca faccicularis*	Long-tail macaque	12	0.38
20	*Viverricula indica*	Small Indian civet	10	0.32
21	*Bos gaurus*	Guar	8	0.25
22	*Tapirus indicus*	Tapir	7	0.22
23	*Macaca nemestrina*	Southernpig-tail macaque	7	0.22
24	*Ursus malayanus*	Sun bear	6	0.19
25	*Martes flavigula*	Yellow-throated marten	5	0.16
26	*Viverra megaspila*	Large-spotted civet	5	0.16
27	*Macaca mulatta*	Rhesus macaque	4	0.13
28	*Manis javanica*	Malayan pangolin	3	0.09
29	*Arctonyx collaris*	Hog badger	2	0.06
30	*Canis familiaris*	Domestic dog	2	0.06

Table 3. Number of dhole pictures and % relative abundance of dholes compared with leopards and tigers in the study area

No.	Scientific name	Common name	No.pictures	% RA
1	*Cuon alpinus*	Dhole	30	0.95
2	*Panthera pardus*	Leopard	246	7.76
3	*Panthera tigris*	Tiger	103	3.25

During the study period, 30 dhole photographs were recorded with a % RA of 0.95. Among the large predators, the relative abundance of leopard was the highest, followed by tiger, and dhole (Table 3). This result is similar to that of Simcharoen et al. (2018) who reported that, in HKK, the density of leopards is more than twice the density of tigers. Dholes had the lowest abundance when compared with tigers and leopards, probably due to the density of those two felids or spatial avoidance (Selvan et al. 2013; Stainmetz et al. 2013).

Prey species identification by fecal analysis

Fourteen dholes' scats, 20 leopards' scats and 9 tigers' scats were found and collected during November 2017 to September 2018 along the forest roads in the study area. Fecal analysis results are shown in Fig. 2.

Scat analysis revealed that 50% of the dhole scats contained only 1 species of prey, whereas 43% contained 2 prey species and the remaining 7% contained 3 species of prey. At least 6 prey species were confirmed by scat analysis with some hair (21%) that could not be identified. The highest frequency of occurrence of prey consumed by dholes was *Muntiacus muntjak* (57%), followed by *Rusa unicolor* and *Axis porcinus* (21%). This result is similar to two previous studies of dhole diets in Southeast Asia, Nam Et-Phou Louey National Protected Area (NEPL) (Kamler et al., 2012) and Phu Khieo Wildlife Sanctuary (PK) (Grassman, 2005), which found that dhole preyed primarily on Muntiacus muntjak and Rusa unicolor (Grassman, 2005; Kamler et al., 2012). These results contrast with those of the studies in Kao Yai National Park, Tap Lan National Park (TL), and SLP, which found that the highest prey selection of dholes were *Sus scrofa* (Austin, 2002; Prayoon, 2014; Charaspet, 2015). Reasons for the differences in dhole diet in different protected areas may depend on prey diversity and their abundance, the study areas and especially the interaction between the dhole and other large carnivores in the area. In the case of HKK, the dholes need to reduce their pack size to reduce their competition with leopards and tigers, so smaller prey species were selected. However, in the other protected areas with no large carnivores, larger prey species were hunted by a larger pack of dholes. This finding agrees with Karanth and Sunquist (1995) who reported dhole feeding on small bodied prey such as the black-naped hare (*Lepus nigricollis*) and porcupine (*Hystrix indica*), whereas tigers did not, because of the competition between the predators and the success of the pack hunting strategy used by wild canids (Aryal et al., 2015). In this study, the highest % frequency of occurrence in the leopard scat was *Muntiacus muntjak* (40%) and the highest frequency of occurrence from tiger scat analysis was the Rusa unicolor (33%). The above results contrast with Simchareon (2008) who studied leopard scats in the same area and reported 26 prey species, with *Rusa unicolor* having the highest frequency of occurrence (26%). Two previous studies of tigers in HKK showed that *Muntiacus muntjak* (42%) and *Bos javanicus* (31%) were the most common prey in 1987–1988 and 1996–1998, respectively (Rabinowitz, 1989; Phetdee, 2000). In this area, ungulates were the primary prey of the three predators. The prey species changed over time, perhaps because previous studies employed long-term scat-collecting covering many years, as well as because in this period, there was a fluctuation in the density of or the population structure of ungulate species, which caused the results to differ.

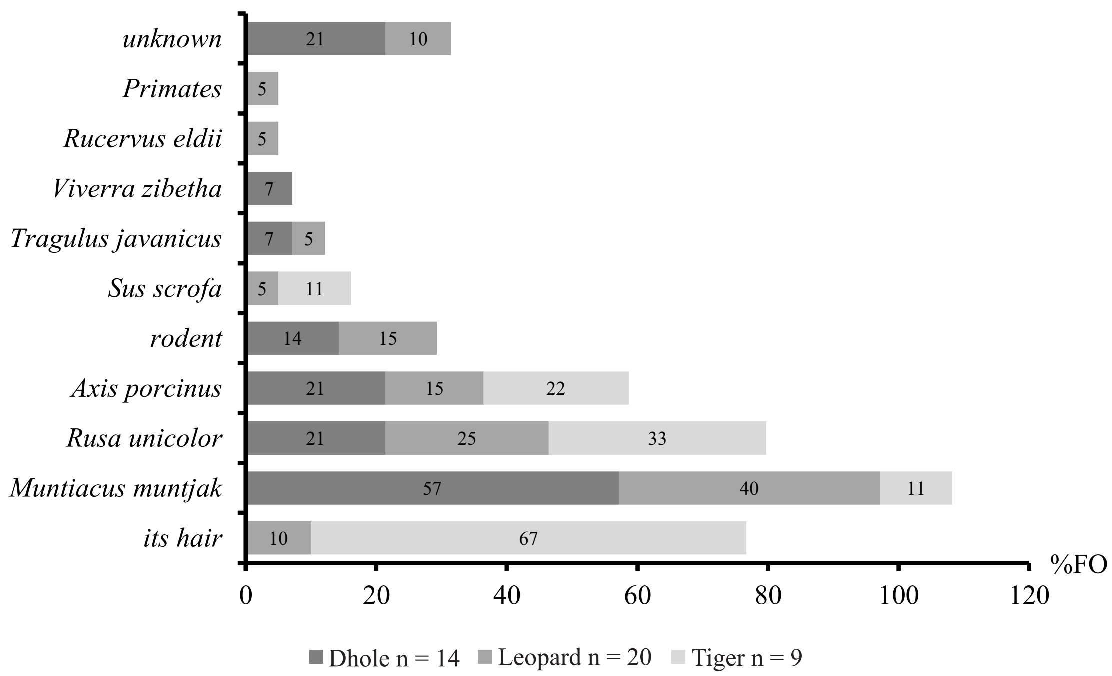

Fig. 2. Frequncy of occurrence of dhole prey species in comparison with leopards and tigers within the study site.

Electivity index

Based on the Electivity index for measuring the preferred prey, the surveyed dholes mostly preferred smaller prey, *Muntiacus muntjak*, at a rate greater than its availability. Leopards preferred primates and *Muntiacus muntjak* more than their rate of availability. Tigers mostly preferred larger prey (i.g. *Rusa unicolor* and *Sus scrofa*), with the exception of *Muntiacus muntjak* based on their availability. This finding supports the concept of niche overlap with dholes and leopards consuming smaller ungulates and with tigers consuming larger ungulates.

Prey overlap

Both interference and exploitation competition have long been recognized as important factors in shaping the ecological relationships of large carnivores (Kruuk, 1972). Based on the Pianka's index used for measuring the diet overlap between dholes and leopards, and between dholes and tigers, the results showed a very high degree of overlap (0.98) between the dholes and leopards, and somewhat high degree of overlap (0.68) between the dholes and tigers. This result is similar to the results reported by Ramesh et al. (2012) in India, who reported that the prey overlap between dholes and leopards was 0.99 and between dholes and tigers was 0.62.

This indicates that there are interspecific competitions in large predators' guilds (Ramesh et al., 2012). From the combined data, we found that ungulate species, consisting of red muntjac, sambar deer, wild boar, and hog deer, were the main prey of the three large predator species in HKK. The results from camera traps in this study showed that the *Rusa unicolor* was the highest in abundance, but the dominant prey of dholes and leopards was small ungulates (*Muntiacus muntjak*). In comparison, tigers tended to consume large ungulates (*Rusa unicolor* and *Sus scrofa*). Perhaps the large body size of the tiger permits the safe capture of large and dangerous prey (Andheria et al., 2007), whereas the leopard's body size is more than five times smaller than *Rusa unicolor* (Ramesh et al., 2012). Moreover, for efficient coexistence, they have to partition their diet through resources to reduce competition with the tiger (Karanth and Sunquist, 1995; Ramesh et al. 2012).

Conclusions

Spatial distribution studies are of great importance in understanding the ecology of ~~a~~ species and these studies can also contribute very much to the species management planning for future conservation activities. This study is the first report on the home range and movement of dhole in HKK, one of the richest and most diverse protected areas in Thailand. The distribution and home range of the dholes in this study represent the movement and behaviour of dholes in rich abundance prey habitats, but also overlapping with other predators. The presence of other predators can play an important role in prey selection and movement patterns of the dhole in the area. As shown in this study, the dholes' prey preferences are different from that of dholes reported in other protected areas.

Distribution and home range of the dhole in this study differ due to the difference in the number of points and the time for data collection. Continuous monitoring using various techniques and increasing the number of dholes monitored and the length of the monitoring to cover all seasons will help to increase knowledge on the habitat choice, behaviour and movement patterns of the dholes in the study area. Furthermore, an increase in the number of dholes monitored within the same pack can improve the understanding of the pack dimension, social behavior, movement patterns and pack distribution; knowledge that is still lacking in this species.

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