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**Research Article**

# Exploring the diversity and abundance of wildlife in human-dominated landscape in eastern Thailand

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## Abstract

The area around the Sanam Chai Khet Forestry Research and Training Station (SCKFRTS) has been declared a degraded forest. The remaining wildlife in the area is affected by habitat loss, conversion of natural areas to agricultural areas, human settlements, fragmentation, and human disturbance, resulting in the loss of species, populations, and genetic resources. However, there are no studies on wildlife diversity in this region. Therefore, we investigated the diversity, abundance, and activity period of mammals in the SCKFRTS region to provide guidelines for efficient conservation management. We conducted a study of the diversity, abundance, and activity period of wildlife species using camera trapping in the SCKFRTS, from July 2023 to May 2024, for 11 months, with 46 camera trap locations, totaling 1,668 trap nights. The results revealed 3 classes, 11 orders, and 22 species of wildlife species. The wildlife diversity index was 2.03. The highest species diversity index was observed for wild elephants (0.36), followed by that for red junglefowl (0.24) and large-spotted civets (0.20). The relative abundance index of all the recorded species was 15.95%. Wild elephants were the most abundant (7.31%) species. Species that were active at night included the large-spotted civet, small Indian civet, and long-tailed giant rat. Cathemeral species included the golden jackal, northern red muntjac, and wild elephant. Strongly diurnal species included the small Indian mongoose, northern pig-tailed macaque, and Indochinese ground squirrel. These findings indicate that various natural wildlife inhabits the area. Therefore, the impact of activities conducted in this area on wildlife should be considered. Management should be conducted as a model for conservation in the area, and the ecology of important wildlife in the area should be monitored.

**Keywords**: community forest, forest plantation, forest remnant, forest research station, wild mammals

## Introduction

The Sanam Chai Khet Forestry Research and Training Station (SCKFRTS), under the supervision of the Faculty of Forestry, Kasetsart University, was granted permission by the

Royal Forest Department to use the Kwae Rabom and Si Yat National Forest Reserves in Tambon Tha Kradan and Tambon Thung Phraya, Sanam Chai Khet District, Chachoengsao Province, covering an area of approximately 3.11 $km^2$, as a place for research, fieldwork, training, and management of economic forest plantations. This area has been an important habitat for various wildlife species because most of the terrain is the largest lowland dry evergreen forest in Thailand, connected to the boundary of the Khao Ang Rue Nai Wildlife Sanctuary, which was once connected to forests in Cambodia, an area with high wildlife species diversity (Menkham et al., 2019; Sukmasuang et al., 2020a; 2020b). The area around the SCKFRTS has been declared a degraded forest, with the Kitti Forest Park Co., Ltd. (https://www.kittiwanagroup.com/) occupying an economically important forest plantation. The area has been disturbed and divided into the forest patches such as Khao Chak Kam, Khao Nam Yot, and Khao Ta Pho. The remaining wildlife in the area is affected by habitat loss, conversion of natural areas to agricultural areas, human settlements, fragmentation, and human disturbance, resulting in the loss of species, populations, and genetic resources. This loss of biodiversity is difficult to assess, and its preservation and restoration are particularly important in this context.

In a study of wild mammals in a nearby conservation forest area (Sribuarod, 1999) in the Khao Ang Rue Nai Wildlife Sanctuary, nine species of carnivorous mammals were found by using the camera trap method. A study of the diversity of carnivorous mammals via installed camera traps (Ruengtik, 2019) found 14 species of carnivorous mammals, including the golden jackal (*Canis aureaus*), dhole (*Cuon alpinus*), Asiatic black bear (*Ursus thibetabus*), Malayan sun bear (*U. malayanus*), Norther red muntjac (*Muntiacus muntjak*), sambar deer (*Rucervus unicolor*), small Indian civet (*Viverricula indica*), small Indian mongoose (*Urva auropunctata*), crab-eating mongoose (*Urva urva*), leopard cat (*Prionailurus bengalensis*), and clouded leopard (*Neofelis nebulosa*).

Wildlife are sensitive to environmental changes (Karssene et al., 2017; Voigt et al., 2003). The main threats to wildlife are human activities (Ripple et al., 2014), including forest destruction, habitat degradation, and climate change. Some wildlife species are difficult to observe and have a low density, and most of them forage at night. Therefore, studying wildlife using cameras is a safe and non-invasive approach (Harmsen et al., 2009). Based on the species, day or night surveys (Azlan and Sharma, 2006; O'Connell et al., 2011; Rovero et al., 2013) are suitable for population or density studies (O'Connell et al., 2011). Image abundance (O'Brien et al., 2003) can be used to study the relationship between the presence of wildlife and environmental factors (Kitamura et al., 2008).

The problem of human–elephant conflict has become severe over the past 10 years in the areas

surrounding the Eastern Thailand Conservation Forest (Sukmasuang et al. 2024), including the area around SCKFRTS, where wild elephants use remnant forest patches as shelters during the day, come out to forage in agricultural and community areas at night, and do not return to the conservation area. This problem has caused violence and the deaths of people and wild elephants and remains a constant concern. As an educational institution, the SCKFRTS has attempted to find solutions by cooperating with government agencies, the private sector, communities, and research and development to prepare the SCKFRTS area to be a model for solving problems.

Camera trapping is an effective, non-invasive method for surveying wildlife in difficult-to-access areas and for rare species (Azlan & Sharma, 2006). The obtained data are useful for conservation planning. They are primarily used in wildlife population monitoring, species diversity, abundance, distribution, and habitat studies. The obtained data have also been used to analyze wildlife status and changes (van Schaik & Griffiths, 1996, Karanth & Sunquist, 1995; O'Brien et al., 2003), including prioritizing each wildlife species as an indicator of ecosystem conditions. They are a tool for conservation planning and spatial prioritization. Wildlife diversity in the SCKFRTS area, in the Kwae Rabom and Si Yat National Reserved Forests, Chachoengsao Province, has not been studied. Therefore, we aimed to investigate the diversity, abundance, and activity period of mammals in the SCKFRTS region to provide guidelines for efficient conservation management. Our findings form a basis for long-term wildlife studies and the use of the area to establish a research station and train forestry students in Sanam Chai Khet for research, teaching, and fieldwork.

## Martial and methods

### Field data collection

A systematic survey plot with a size of 250 × 250 m was used to cover the study area on a 1:50,000 topographic map. One camera trap was installed per sample plot (Fig. 1) (Gupta et al., 2009; Jenks et al., 2012; Siripattaranukul et al., 2015) to ensure the independence of image acquisition in each grid and reduce the possibility of imaging the same animal using multiple cameras (Jenks et al., 2012). Camera trap locations were selected based on their suitability in each area, such as animal checkpoints, animal tracks, and recording information. The surrounding areas included plant communities, roads, trails, and agricultural licks (Lynam et al., 2013; Siripattaranukul et al., 2015; Wongchoo et al., 2013). Camera traps were installed approximately 30–40 cm above the ground, 3–4 m from the target area (Chutipong et al., 2014), or as appropriate. The camera traps were set to capture images when the sensor system detected movement, capturing three images 10 s apart for 24 h (Network, 2008). Camera traps were set up

for 30 days and then removed. The method of moving camera traps involved studying the appropriate location for the area because the systematic survey plot designation determined the size of the plot to cover the distribution of both small and large mammals. Therefore, the proposed method provided accuracy and precision according to the specified objectives.

**Data analysis**

We identified the species of animals from the images by using the Southeast Asian Mammals Handbook (Francis, 2008). Common and scientific names were used according to the literature (Lekagul & McNeely, 1988). We selected images with clear animal details, along with the date and time information specified in the image, which are images or events independent of each other. The criteria used to separate independent animal events or images (criterion for independence of animal images) were obtained from O'Brien et al. (2003): 1) consecutive images of different animals, which may be of the same or different species; 2) consecutive images of the same animal of the same species, which are more than 30 min apart; and 3) non-consecutive images of the same animal of the same species.

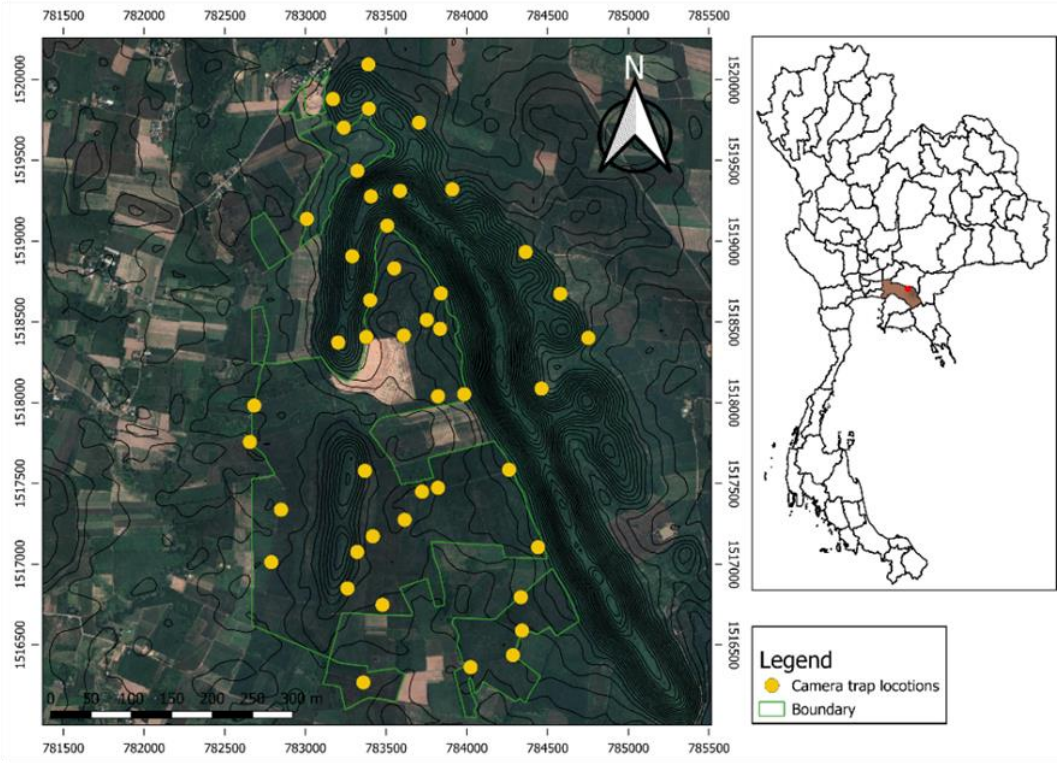



**Figure 1.** Location of the study sites, red star (right), yellow dots, and camera trap locations in the SCKFRTS area (left), Chachoengsao Province, Eastern Thailand, Source: Google Earth (2024)

The diversity indices of the mammalian species were calculated using the Shannon–Wiener index (Shannon & Weaver, 1949) according to the following formula:

$H' = - \sum pi \ln pi$

where H is the Shannon–Wiener index (Shannon & Weaver, 1949), and *pi* is the ratio of the number of images of wildlife species *i* to the total number of images.

The relative abundance index of mammals was calculated by multiplying the number of images of each wildlife species from independent camera traps by 100 and dividing by the number of camera traps. The number of days remaining for each camera was calculated by classifying each camera trap set (Azlan & Sharma, 2006). The activity period of the mammals (activity period) was classified based on the number of images of each animal. Subsequently, the activity period of the animals was divided into two periods: daytime, 06:01–17:59, and nighttime, 18:00–06:00. The percentage of images acquired during both periods was determined for each animal. Next, the animals were classified into five groups based on the percentage of the total images captured: more than 85% at night, strongly nocturnal; between 61% and 84% at night, mostly nocturnal; between 40% and 60% at night and during the day, Cathemeral; between 61% and 84% during the day, mostly diurnal; and more than 85% during the day, strongly diurnal.

## Results

### Species diversity

We found 22 species of wild animals and divided them into 3 classes: 11 orders, 16 families, 22 genera, and 22 species. Mammalia was divided into five classes, eight families, nine genera, and nine species, including large-spotted civet *(Viverra megaspila*), small Indian civet (*Viverricula indica*), small Asian mongoose (*Herpestes javanicus*), golden jackal (*Canis aureus*), northern pig-tailed macaque (*Macaca leonine*), northern red muntjac (*Muntiacus vaginalis*), Asian elephant (*Elephas maximus*), Indochinese ground squirrel (*Menetes berdmorei*), and long-tailed giant rat (*Leopoldamys sabanus*). Aves was divided into 5 classes, 7 families, 12 genera, and 12 species, including red junglefowl (*Gallus gallus*), red-wattled lapwing (*Vanellus indicus*), Oriental honey-buzzard (*Pernis ptilorhyncus*), black bazar (*Accipiter virgatus*), little egret (*Egretta garzetta*), great egret (*Casmerodius albus*), Chinese pond heron (*Ardeola bacchus*), Black-crowned night heron (*Aycticorax nycticorax*), Malay night heron (*Gorsachius melanolophus*), Blue-winged pitta (*Pitta moluccensis*), white-rumped shama (*Copsychus malabaricus*) and greater racquet-tailed drongo (*Dicrurus paradiseus*). In the case of reptiles, one order, one family, one genus, and one species were identified, namely, a common water monitor (*Varanus salvator*). The total wildlife diversity index in the SCKFRTS area as part of the Khwae Rabom-Siyat Reserved Forest (H') was 2.03. The species with the highest diversity indices were wild elephants (0.36), red junglefowls (0.24), and large-spotted civets (0.20) (Table 1).

**Table 1.** Shannon–Weiner Diversity Index of wildlife species using camera trapping in the area of SCKFRTS, Chachoengsao Province, Eastern Thailand

| Common name | Number of events | Pi = $n_i$/N | H = - ($P_i$ ln $P_i$) |
|---|---|---|---|
| **Class Mammalia** | | | |
| Large-spotted civet | 21 | 0.079 | 0.20 |
| Small Indian civet | 2 | 0.008 | 0.04 |
| Small Asian mongoose | 2 | 0.008 | 0.04 |
| Golden jackal | 17 | 0.064 | 0.18 |
| Northern pig-tailed macaque | 6 | 0.023 | 0.09 |
| Northern red muntjac | 7 | 0.026 | 0.10 |
| Asian elephant | 122 | 0.459 | 0.36 |
| Indochinese ground squirrel | 1 | 0.004 | 0.02 |
| Long-tailed giant rat | 1 | 0.004 | 0.02 |
| **Class Aves** | | | |
| Red junglefowl | 28 | 0.105 | 0.24 |
| Red-wattled lapwing | 1 | 0.004 | 0.02 |
| Oriental honey-buzzard | 1 | 0.004 | 0.02 |
| Black bazar | 1 | 0.004 | 0.02 |
| Little egret | 17 | 0.064 | 0.18 |
| Great egret | 8 | 0.030 | 0.11 |
| Chinese pond heron | 16 | 0.060 | 0.17 |
| Black-crowned night heron | 2 | 0.008 | 0.04 |
| Malay night heron | 5 | 0.019 | 0.07 |
| Blue-winged pitta | 1 | 0.004 | 0.02 |
| White-rumped shama | 2 | 0.008 | 0.04 |
| Greater racquet-tailed drongo | 1 | 0.004 | 0.02 |
| **Class Reptilia** | | | |
| Common water monitor | 4 | 0.015 | 0.06 |
| **Sum** | **266** | **1** | **2.03** |

## Relative abundance

Wild elephants had the highest relative abundance (7.31%), followed by the large-spotted civet (1.26%) and golden jackal (1.02%). The red junglefowl (1.68 %), little egret (1.02 %), and Chinese pond heron (0.96 %) were in the bird class. In the reptile class, a common water monitor was found with a relative abundance of (0.24%). Wild Asian elephants had the highest relative abundance (7.31%), indicating that the SCKFRT area, as part of the Khao Rabom-Si Yat National Forest Reserve, is an important habitat for wild Asian elephants, consisting of flat areas, water sources, and forest patches that are food sources; this area is also safe for them to rest and sleep while avoiding human activity. The order of predators with high relative abundance was large-spotted civets followed by golden jackals; both species can feed on various prey, including small mammals, reptiles, insects, and fish, indicating the suitability and completeness of the study area.

**Table 2.** Abundance of wildlife species found in the area of SCKFRTS, Chachoengsao Province, Eastern Thailand, based on 46 camera trap locations with a total of 1,668 trap nights

| Class/Order/Family/ | Scientific name | IUCN | No. of | No. of | %RAI |
|---|---|---|---|---|---|

| **Common name** | | **(2024)** | **independent images** | **location found (%)** | |
|---|---|---|---|---|---|
| Class Mammalia<br>Order Carnivora<br>Family Viverridae<br>large-spotted civet | *Viverra megaspila* | EN | 21 | 6(13.04) | 1.26 |
| small Indian civet | *Viverricula indica* | LC | 2 | 2(4.35) | 0.12 |
| Family Herpestidae<br>small Asian mongoose | *Herpestes javanicus* | LC | 2 | 2(4.35) | 0.12 |
| Family Canidae<br>golden jackal | *Canis aureus* | LC | 17 | 11(23.91) | 1.02 |
| Order Primate<br>Family Cercopithecidae<br>Northern Pig-tailed macaque | *Macaca leonine* | VU | 6 | 4(8.70) | 0.36 |
| Order Artiodactyla<br>Family Cervidae<br>northern red muntjac | *Muntiacus vaginalis* | LC | 7 | 4(8.70) | 0.42 |
| Order Proboscidea<br>Family Elephantidae<br>wild elephant | *Elephas maximus* | EN | 122 | 27(58.70) | 7.31 |
| Order Rodentia<br>Family Sciuridae<br>Indochinese ground squirrel | *Menetes berdmorei* | LC | 1 | 1(2.17) | 0.06 |
| Family Sciuridae<br>long-tailed giant rat | *Leopoldamys sabanus* | LC | 1 | 1(2.17) | 0.06 |
| | | **sum** | **179** | **sum** | **10.73** |
| Class Aves<br>Order Galliformes<br>Family Phasianidae<br>Red junglefowl | *Gallus gallus* | LC | 28 | 7(15.22) | 1.68 |
| Order Charadriiformes<br>Family Charadriidae<br>Red-wattled lapwing | *Vanellus indicus* | LC | 1 | 7(15.22) | 0.06 |
| Order Accipitriformes<br>Family Accipitridae<br>oriental honey-buzzard | *Pernis ptilorhyncus* | LC | 1 | 7(15.22) | 0.06 |
| Black baza | *Accipiter virgatus* | LC | 1 | 7(15.22) | 0.06 |
| Order Pelecaniformes<br>Family Ardeidae<br>Little egret | *Egretta garzetta*<br>*Casmerodius albus*<br>*Ardeola bacchus* | LC | 17 | 3(6.52) | 1.02 |
| Great egret | *Aycticorax nycticorax* | LC | 8 | 1(2.17) | 0.48 |
| Chinese pond heron | *Gorsachius* | LC | 16 | 2(4.35) | 0.96 |
| black-crowned night heron | *melanolophus* | LC | 2 | 2(4.35) | 0.12 |
| Malay night heron | | LC | 5 | 1(2.17) | 0.30 |
| Order Passeriformes<br>Family Pittidae<br>Blue-winged pitta | *Pitta moluccensis* | LC | 1 | 1(2.17) | 0.06 |
| Family Muscicapidae<br>White-rumped shama | *Copsychus malabaricus* | LC | 2 | 1(2.17) | 0.12 |
| Family Dicruridae<br>Greater racquet-tailed drongo | *Dicrurus paradiseus* | LC | 1 | 1(2.17) | 0.06 |
| **Sum** | | | **83** | **Sum** | **4.98** |
| **Class Reptilia**<br>Order Squamata<br>Family Varanidae<br>Common water monitor | *Varanus salvator* | LC | 4 | 3(6.52) | 0.24 |
| **Sum** | | | **4** | **Sum** | **0.24** |

**Note:** LC = Least concern, VU = Vulnerable, EN = Endangered

When considering the conservation status of wildlife species according to the IUCN (2024), per camera trap data in the area of SCKFRTS, two wildlife species were classified as endangered species: large-spotted civets and wild Asian elephants. One wildlife species was likely to be vulnerable. There was also a northern pig-tailed macaque. Nineteen wildlife species were classified as least concerned species, including the small Indian civet, small Asian mongoose, golden jackal, northern red muntjac, Indochinese ground squirrel, long-tailed giant rat, red junglefowl, red-wattled lapwing, Oriental honey-buzzard, little egret, great egret, Chinese pond heron, black-crowned night heron, Malay night heron, blue-winged pitta, white-rumped shama, greater racquet-tailed drongo, and common water monitor (Table 1). When comparing the results of this study with the species diversity of carnivores reported by Jenks et al. (2012) in the Khao Ang Rue Nai Wildlife Sanctuary between January 2008 and February 2010, there were 67 camera traps on 4,505 trap nights. Sixteen carnivorous mammalian species were found within six families and thirteen genera. They included golden jackal, Dhole, Asiatic black bear, Malayan sun bear, northern red muntjac, smooth-coated otter, small Indian civet, large-spotted civet, common palm civet, small Asian mongoose, crab-eating mongoose, leopard cat, and clouded leopard.

The carnivores found were similar to those found in this study, namely, golden jackal, large-spotted civet, and small Asian mongoose. The results of this study demonstrated the diversity of wildlife species found in this area. The largest mammal was the wild elephant, a keystone species that influences the environment. Four predators were found, Golden Jackal, large-spotted civet, small Indian civet, and small Asian mongoose, indicating the abundance of habitats and prey species in the study area.

**Figure 2.** Example of setting up a camera trap in the area of SCKFRTS, Chachoengsao Province, Eastern Thailand


Large-spotted civet


Small Indian civet


Small Asian mongoose


Golden jackal


Northern pig-tailed macaque


Northern red muntjac



Wild elephant Indochinese ground squirrel

**Figure 3.** Example of wildlife species found in the area of SCKFRTS, Chachoengsao Province, Eastern Thailand

**Activity patterns**

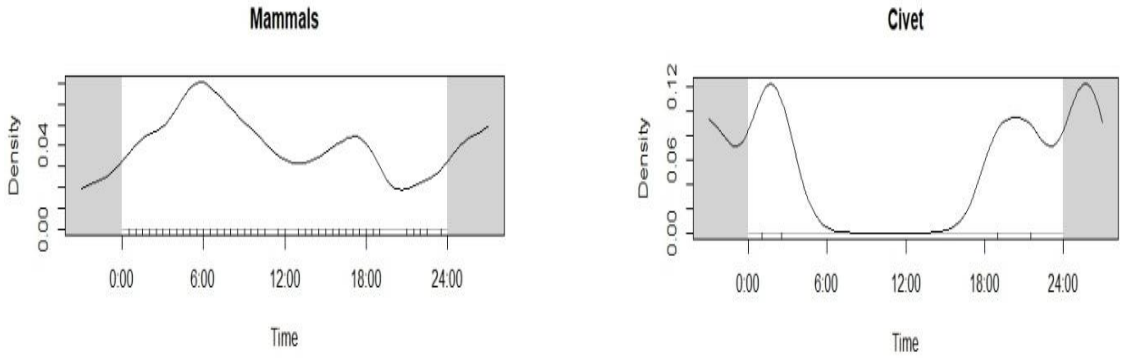
We studied the daily activity time of mammals from wildlife camera trap surveys and classified images independent of the time and date recorded. The daily activity time was divided into two main periods: daytime 06:01–17:59 and nighttime 18:00–06:00 (Azlan & Sharma, 2006; van Schaik & Giffiths, 1996). The results of dividing the daily activity time into more than two main periods included the period of high activity only at night (strongly nocturnal). The number of images captured during this period for each species was more than 85% and included the large-spotted civet, small Indian civet, and long-tailed giant rat. The period of nocturnal activity (mostly nocturnal) and the number of images captured during this period for each species ranged between 61% and 84%, and no wildlife species were found. The period of nocturnal activity was equal to the day (cathemeral). The number of images captured during this period for each species ranged from 40% to 60%, and included golden jackal, northern red muntjac, and wild Asian elephants, and the activity period was strongly diurnal. More than 85% of images were captured for each species, including small Asian mongooses, northern pig-tailed macaques, and Indochinese ground squirrels. The number of images captured during the daytime was between 61% and 84%, which was classified as the group with the most diurnal activity pattern (Table 3). Mammals in the SCKFRTS area exhibited the highest activity period between 05:00 and 06:00 and the lowest activity period between 20:00 and 21:00 (Fig. 4). The large-spotted civet showed the highest activity period between 02:00 and 03:00 and the lowest activity period between 06:00 and 16:00, which is consistent with the findings of previous studies (Sribuarod, 1999; Than Zaw, 2008; Ruengtik et al., 2019; Gray et al., 2020) (Fig. 4). Golden Jackal had the highest activity between 04:00 and 05:00 and the lowest activity between 12:00 and 14:00 and 20:00 and 22:00, which differs from the findings of Ruengtik et al. (2019), Charaspet et al. (2019), and Jenks et al. (2015), who reported that golden jackal had the highest activity period at night (Fig. 4). The northern red muntjac had the highest activity between 10:00 and 11:00 and the lowest activity

between 05:00 and 06:00 and 14:00 and 19:00. Northern pig and tailed macaques has the highest activity during 06:00–07:00 and 14:00–16:00, whereas their lowest activity was during 08:00–12:00 and 18:00–04:00, which is consistent with the findings of Mohd Azlan et al. (2017), who reported that northern pig and tailed macaques had their highest activity periods during the daytime (Fig. 4). Wild elephants had highest activity during 05:00–06:00 and 17:00–18:00, and their lowest activity was during 01:00–02:00, which differs from the results of Menkham et al. (2019), who reported that wild elephants were most active during the day at night. From 18:00 to 05:59 (strongly nocturnal) (Fig. 4). Domestic dogs were found to be strongly diurnal in their activity, with more than 85% of the captured images showing the highest activity between 07:00 and 12:00 and the lowest activity between 19:00 and 05:00 (Fig. 4).

**Table 3.** Camera trap data of wild mammal species, encounter rate of images, and activity patterns, found in the SCKFRTS area, Chachoengsao Province, Eastern Thailand

| Common name | Total of daytime | %Observation of daytime | Total of nighttime | %Observation of nighttime | Activity pattern |
|---|---|---|---|---|---|
| **Class Mammalia** | | | | | |
| Large-spotted civet | 0 | 0 | 21 | 100 | SN |
| Small Indian civet | 0 | 0 | 2 | 100 | SN |
| Small Asian mongoose | 2 | 100 | 0 | 0 | SD |
| Golden jackal | 7 | 41.18 | 10 | 58.82 | CM |
| Northern Pig-tailed macaque | 6 | 100 | 0 | 0 | SD |
| Northern red muntjac | 4 | 57.14 | 3 | 42.86 | CM |
| Wild elephant | 68 | 55.74 | 54 | 44.26 | CM |
| Indochinese ground squirrel | 1 | 100 | 0 | 0 | SD |
| Long-tailed giant rat | 0 | 0 | 1 | 100 | SN |
| **sum** | 88 | | 91 | | |

**Note:** SN: Strongly nocturnal; CM, catheter; SD, strongly diurnal; MN: Mostly nocturnal; MD: Mostly diurnal.



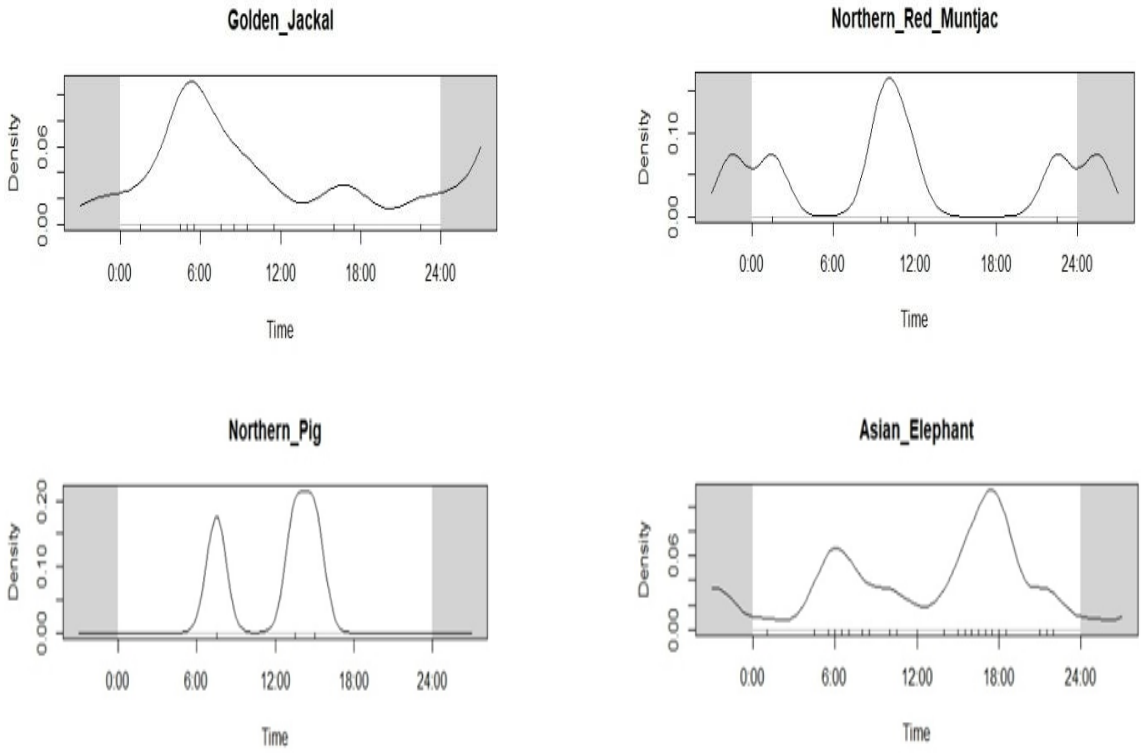



**Figure 4.** Example of activity patterns of some mammal species in the SCKFRTS area, based on camera trap data, Chachoengsao Province, Eastern Thailand

**Wild elephant**

Based on the camera trap data, we classified the age class of the wild elephants using 70 images. Per the camera trap data, the size of the wild elephant herd ranged from 1 to 11 individuals. In this study, we identified one adult male elephant with a mark on the right hind leg and a scar from being strangled by a hard object. Per the data collection, this wild elephant was found at 5 of the 46 camera trap locations (Fig. 5). The population structure of wild elephants was divided into adults (91.23%), subadults (14.04%), juveniles (12.28%), and calves (5.26%) (Table 4).


**Figure 5.** Male wild elephant was found a scar on its right hind leg

The proportion of the population structure of adults, subadults, juveniles, and calves was 17.33:2.66:2.33:1.00, respectively. When we compared our results to those of Menkham et al. (2019), the population structure of wild elephants in the Khao Ang Rue Nai Wildlife Sanctuary was 11.1:0.8:1.3:1, respectively. Further, the proportion of adults to calves was 17:1; thus, elephants in the study area have the potential to give birth to young ones to replace deaths from natural causes or accidents due to human activities in cases where wild elephants leave the conservation area (Table 4).

**Table 4.** Population structure of wild elephants in the SCKFRTS area, Chachoengsao, Province, Eastern Thailand

| Age class | Adult | Sub-adult | Juvenile | Calf |
|---|---|---|---|---|
| No. of individuals | 52 | 8 | 7 | 3 |
| Ratio | 17.33 | 2.66 | 2.33 | 1.00 |
| Percentage | 91.23 | 14.04 | 12.28 | 5.26 |

**Threat factors**

+

Snare

Live trap


A hunter with a gun that can capture images

Hunting gun shells

Artificial nest for white-rumped shama (*Copsychus malabaricus*)


Domestic dogs for hunting activities

**Figure 6**. Hunting activities by local residents threaten wildlife and natural habitats in the area

## Discussion

In this study of wildlife species diversity in the SCKFRTS area, Chachoengsao Province, Eastern Thailand, 22 species of wildlife were found and divided into 3 classes: 11 orders, 16 families, 22 genera, and 22 species. Mammals (Class Mammalia) were divided into 5 classes, 8 families, 9 genera, and 9 species. Birds (Class Aves) were divided into 5 classes, 7 families, 12 genera, and 12 species. Reptiles (Class Reptilia) were divided into 1 class, 1 family, 1 genus, and 1 species. The overall wildlife diversity index (H) was 2.03. The wildlife species with the highest diversity indices were wild elephants (0.36), red junglefowls (0.24), and large-spotted civets (0.20). The relative abundance of wildlife in the SCKFRTS area was based on 22 species of wild animals identified. This study found a total relative abundance of 15.95%. The mammal class showed that wild elephants had the highest relative abundance (7.31%). Thirteen terrestrial birds were found, the most important being red junglefowl with the %RAI of 1.68%. One reptile species (water monitored) was captured, with %RAI of 0.24%. The activity period was strongly nocturnal. The percent of images captured during this period for each species, including the large-spotted civet and small Indian civet, was more than 85%. The activity was mostly nocturnal. The percent of images captured for each species during this period ranged from 61% to 84%. No wild animals were observed in this study. The activity period was nocturnal and equal to that of the day (catheter). The number of images captured during this period for each species was between 40% and 60%, including the golden jackal, northern red muntjac, and wild elephants. The activity period was strongly diurnal. The number of images captured during this period for each species was greater than 85%, including small Indian civets, northern pig-tailed macaques, and northern tree squirrels. The number of images captured during the daytime was between 61% and 84%, classified as a group with mostly diurnal activity patterns. No other

wildlife species were identified in this study. The age classification of wild elephants, based on 70 wild elephant images, showed that the herd size of the wild Asian elephant herd ranged from 1 to 11 individuals. This study identified one male elephant with full-grown tusks, marks on his right hind leg, and scars from struggling in a large-wire snare trap. This wild Asian elephant was found at 5 of the 46 camera trap locations. The population structure of wild elephants was divided into adults (91.23%), sub adults (14.04%), juveniles (12.28%), and calves (5.26%). Threats were found to occur in various forms in this area, including direct hunting with guns, setting traps to catch wild animals, using cages to catch mammals, and using artificial nests to catch wild birds. Furthermore, conflicts occur between people and wild elephants, which must be resolved in conjunction with conservation efforts. The information presented in this study can be used in resolving conflicts between humans and wildlife in the area, in preparing conservation guidelines, and for impact reduction and restoration. These measures can aid in developing a management plan for economic forest plantations appropriate for the area and public relations for a better understanding of conservation, resource utilization, and wildlife diversity in the area, among communities, students, and university students. The results of this study serve as a milestone for data collection for use in area management, both in the area of responsibility and in cooperation with surrounding communities for conservation and resolving conflicts between humans and wildlife, especially wild elephants, in the area to ensure sustainability.

**Conclusion**

This study found wildlife living in the remaining forest areas to be both endangered and potentially extinct species. The area was also a habitat for herds of wild Asian elephants, which seems to have caused fear among the public and led to violence in human–elephant conflicts. However, disturbance activities in the area and illegal exploitation remain ongoing, particularly the trapping of small animals. Management approaches to make the area a model for environmental management, maintenance, and restoration at this forestry research and training station include disseminating knowledge and promoting understanding of the importance of environmental conservation, conserving species, and numbers of wildlife in the area as a model for the community. Simultaneously, actions to promote economic crop cultivation, increase yield per unit area, or breed certain wildlife for household or economic use to improve the quality of life of people should be conducted in conjunction with various agencies around the area to achieve common goals. Furthermore, conflicts between humans and wildlife, especially wild Asian elephants, should be addressed in conjunction with measures to protect agricultural crops, lives, and property, according to the guidelines proposed by the IUCN (2024). Finally, studies on human–wildlife interactions and wildlife epidemics in the area should be conducted.

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## References

Azlan, M.J. & Sharma, D.S.K. (2006). The diversity and activity patterns of wild felids in a secondary forest in Peninsular Malaysia. Oryx 40(1): 36-41. https://doi.org/10.1017/S0030605306000147

Chutipong, W., Lynam, A.J., Steinmetz, R., Savini, T. & Gale, G.A. (2014). Sampling mammalian carnivores in western Thailand: Issues of rarity and detectability. Raffles Bulletin of Zoology 62: 521-535. https://doi.org/10.5281/zenodo.5354365

Charaspet, K, Sukmasuang, R., Khiowsree, N., Pla-ard, M., Songsasen, N. & Simchareon, S. (2019). Movement, home range size and activity pattern of the golden jackal. (*Canis aureus*, Linneaus, 1758) in Huai Kha Khaeng Wildlife Sanctuary, Thailand. 20 (11): 3430-3438.https://doi.org/10.13057/biodiv/d201141

Francis, C.M. (2008). A Guide to the Mammals of Southeast Asia. Princeton University Press. Gupta, S., K., Mondal, Sankar, K. & Qureshi, Q. (2009). Estimation of striped hyena *Hyaena hyaena* population using camera traps in Sariska Tiger Reserve, Rajasthan, India. Journal of the Bombay Natural History Society 106(3): 284-288. www.biodiversitylibrary.org/part/201589

Gray, T.N.E., Chanrattana, P. & Chanrattanak, P. (2020). Status and ecology of Large-spotted *Viverra megaspila* in eastern Cambodia. Small Carnivore Conservation 43: 12–15.

Harmsen, B.J., Foster, R.J., Silver, S., Ostro, L. & Doncaster, C.P. (2010). Differential use of trails by forest mammals and theimplications for camera trap studies, a case study from Belize. .Biotropica 42(1):126-133. https://doi.org/10.1111/j.1744-7429.2009.00544.x

IUCN (2023). The IUCN Red List of Threatened Species. Version 2019-3. International Union for Conservation of Nature and Natural Resources. IUCN, Gland. https://www.iucnredlist.org.

Jenks, K. E.,Songsasen, N. & Leimgruber, P. (2012). Camera trap records of dholes in KhaAng Rue Nai Wildlife Sanctuary, Thailand. Canid Specialist Group: 1-5.

Jenks, K.E., Aikens, E.O.,Songsasen, N., Calabrese, J., Fleming, C., Bhumpakphan, N. & Leimgruber, P. (2015). Comparative movement analysis for a sympatric dhole and golden Jackal in a human-dominated landscape. Raffles Bulletin of Zoology 64:546-554.

Karanth, K.U. & Sunquist, M.E. (1995). Prey selection by tiger, leopard and dhole in tropical forests. Journal of Animal Ecology 64(4): 439-450. https://doi.org/10.2307/5647

Karssene, Y., Chammem, M., Khorchani, T., Nouira, S. & Li, F. (2017). Global warming drives changes in carnivore communities in the North Sahara Desert. Climate Research 72(2): 153-162. https://www.jstor.org/stable/26394304

Kitamura, K., Judkewitz, B., Kano, M., Denk, W. & Häusser, M. (2008). Targeted patch-clamp recordings and single-cell electroporation of unlabeled neurons in vivo. Nat Methods. 5(1):61-7. https://doi.org 10.1038/nmeth1150.

Lekagul, B. & McNeely, J.A. (1988). Mammals of Thailand. Bangkok: Darnsutha Press, Thailand.

Lynam, A.J., Jenks, K.E., Tantipisanuh, N., Chutipong, W., Ngoprasert, D., Gale, G.A., Steinmetz, R, Sukmasuang R., Bhumpakphan, N., Grassman, L.I., Jr., Cutter, P., Kitamura, S., Reed, D.H., Baker, M.C., McShea, W., Songsasen, N. & Leimgruber, P. (2013). Terrestrial activity patterns of wild cats from camera-trapping. Raffles Bulletin of Zoology 61(1): 407-415.

Menkham K, Sukmasuang R, Pla-Ard M, Charaspet K, Panganta T, Trisurat Y, & Bhumpakphan N. (2019). Population and habitat use of Asian elephants (*Elephas maximus*) and five ungulate species in Khao Ang Rue Nai Wildlife Sanctuary, Chachoengsao Province, Thailand. Biodiversitas 20: 2213-2221. https://doi.org/10.13057/biodiv/d200815

Mohd-Azlan, J., Messerli, Z. & Cheok, K.Y.M. (2017). Habitat occupancy and activity patterns of the long-tailed macaques and pig-tailed macaques in Sarawak, Borneo. Malayan Nature Journal 69(4): 277 - 285

Network, T. (2008). Terrestrial Vertebrate (Camera trap) Monitoring Protocol Implementation Manual. U.S.A.: Arlington, VA.

O'Brien, T.G., Kinnaird, M.F. & Wibisono, H.T. (2003). Crouching tigers, hidden prey:Sumatran tiger and prey populations in a tropical forest landscape. Animal Conservation 6: 131-139. https://doi.org/10.1017/S1367943003003172

O'Connell, L.A., Hofmann & H.A. (2011). The vertebrate mesolimbic reward system and social behavior network: a comparative synthesis. J Comp Neurol. 519(18):3599-639. https://doi.org 10.1002/cne.22735.

Phillips, S.J. & Dudík, M. (2008). Modeling of species distributions with Maxent: New extensions and a comprehensive evaluation. Ecography 31: 161-175. https://doi.org/10.1111/j.0906-7590.2008.5203.x

Ruengtik, J., Sukmasuang, R., Charaspet, K., Pla-ard, M., Panganta, T., Duengkae, P., & Bhumpakphan, N. (2019). Diversity and Abundance of Carnivorous Mammals in Khao Ang Rue Nai Wildlife anctuary, Chachoengsao Province. Thai Journal of Forestry. 38 (2): 1-15. www.li01.tci-thaijo.org/index.php/tjf/article/view/245836

Ripple, W.J., Estes, J.A., Beschta, R.L., Wilmers, C.C., Ritchie, E.G., Hebblewhite, M., & Wirsing, A.J. (2014). Status and ecological effects of the world's largest carnivores. Science 343(6167): 1241484. https://doi.org/10.1126/science.1241484

Rovero, F., Zimmermann, F., Berzi, D. & Meek, P. (2013). "Which camera trap type and how many do I need?" A review of camera features and study designs for a range of wildlife research applications. Hystrix, the Italian Journal of Mammalogy 24 (2): 148–156. https://doi.org 10.4404/hystrix-24.2-6316

Shannon, C.E. & Weaver, W. 1949. A Mathematical Theory of Communication. University of Illinois Press, Urbana.

Sribuarod, K. (1999). Diversity, distribution and abundance of mammals in the order Mammalia, Khao Ang Rue Nai Wildlife Sanctuary. Kasetsart University, Bangkok.

Siripattaranukul, K., Bhumpakphan N. & Sukmasuang R.. (2015). Diversity and abundance of carnivorous mammals in Salakphra Wildlife Sanctuary, Kanchanaburi Province. Journal of Wildlife in Thailand 22: 127-140.

Sukmasuang, R., Charaspet, K., Reontik, J. & Pla-ard, M. (2020a). Temporal overlap of carnivorous mammal community and their prey in Khao Ang Rue Nai Wildlife sanctuary, Chachoengsao Province, Thailand. Biodiversitas 21: 922-932. https://doi.org/10.13057/biodiv/d210310

Sukmasuang, R., Charaspet, K., Panganta, T., Pla-ard, M., Khiowsree, N., &Thongbantum, J. (2020b). Diversity, abundance, activity period, and factors affecting the appearance of wildlife around the corridors between Khao Yai- Thap Lan National Parks, Thailand by camera trapping. Biodiversitas 21 (5): 2310-2321. https://doi.org/10.13057/biodiv/d210563

Sukmasuang, R., Bhumpakphan, N., Deungkae, P., Chaiyarat, R., Pla-Ard, M., Khiowsree, N., Charaspet, K., Paansri, P. & Noowong, J. (2024). Review: Status of wild elephant, conflict and conservation actions in Thailand. Biodiversitas 25: 1479-1498. https://doi.org/10.13057/biodiv/d250416

Than Zaw, H.S., Htoo, S., Po, T., Maung, M., Lynam, A., Latt, K.T. & Duckworth, J.W. (2008). Status and distribution of small carnivores in Myanmar. Small Carnivore Conservation 38: 2-28.

Van Schaik, C.P. & Griffiths, M. (1996). Activity periods of Indonesian rain forest mammals. Biotropica 28: 105-112. https://doi.org/10.2307/2388775

Voigt, W., Perner, J., Davis, A.J., Eggers, T., Schumacher, J., Bährmann, R., & Sander, F.W. (2003). Trophic levels are differentially sensitive to climate. Ecology 84(9): 2444-2453. https://doi.org/10.1890/02-0266

Wongchoo, K., Chimchome, V., Simcharoen, S. & Duangchantrasiri S. (2013). Abundance and distribution of some viverrid species in Huai Kha Khaeng Wildlife Sanctuary. Thai Journal of Forestry 32: 1-9. https://li01.tci-thaijo.org/index.php/tjf/article/view/260294