The Diversity of Small Mammals in Natural and Recovery Forests in Mae Rim District, Chiang Mai Province

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Abstract

Forest areas in Mae Rim District, Chiang Mai Province, have been converted to farmlands, causing the area to deteriorate and affecting wildlife habitats. Various organizations are working to restore the area. The effectiveness of the restoration program must then be monitored. The purpose of this study was to investigate and compare the diversity of small mammals and their frequency of detection (FD) in natural and restored forests in Mae Rim District, Chiang Mai Province. From February to August 2021, three camera traps were installed at each site to detect mammals that are active on the ground. There was in total 531 traps-night per forest. Nine mammal species from six families and two orders were discovered in the natural forest. The Large Indian Civet (*Viverra zibetha*) had the highest FD value of 4.14, followed by the Small Indian Civet (*Viverricula indica*) (FD = 2.82) and Leopard Cat (*Prionailurus bengalensis*) (FD = 1.13). There were five species from four families and one order recorded in the restored forest. The Leopard Cat (*Prionailurus bengalensis*) had the highest frequency of entering with an FD of 0.94, followed by the Small Indian Civet (*Viverricula indica*) with an FD of 0.56. Leopard Cats are carnivores, while civets are omnivores and potential seed dispersers. The similarity of mammal species found in both locations was 71%. The findings show that forest restoration provides habitats for local mammals, and the presence of seed dispersers implies the area's potential to undergo natural regeneration.

Keyword: Mammal diversity/ Camera trapping/ Forest restoration/ Chiang Mai

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1. Introduction

Based on Thailand's forest area data in 2020, Chiang Mai Province covers an area of 22,135.35 square kilometers, and the forest area is accounted for 15,337.97 square kilometers or 69.29 percent of the total area. It is the third-largest forest area in the northern provinces. On the other hand, the provincial forest area has continued to decline, from 75.62 percent in 1988 to 71.72 percent, 69.90 percent, and 69.29 percent in 1993, 2017, and 2020, respectively (Royal Forest Department, 2020).

Illegal logging, deforestation, forest fires, and encroachment on arable land contribute to Thailand's shrinking forest area. As a result, the soil surface at watershed areas has been destroyed. It also devastates plants and wildlife habitats, resulting in lower biological diversity (Ratchapruek Institute Foundation, 2021). Reduced forest cover impacts the area's ecosystem and increases greenhouse gas emissions into the atmosphere, exacerbating the problem of climate change. It is estimated that forest area loss from 2000 to 2010 accounted for 68.1Mt CO_2eq of greenhouse gas emissions (Global Forest Watch, 2021).

As a result of this issue, various environmental agencies and organizations are taking steps to restore forest areas that have been destroyed or disturbed by human activity. Forest restoration can be accomplished in a variety of ways. Conventionally, forest restoration was frequently used to select fast-growing plants, regardless of whether the seedlings were native or not. As a result, the cost of restoring such forests is often prohibitively high. In addition, seedlings take longer to grow because they are not native plants in rehabilitation areas. Furthermore, the biodiversity of recovery areas has decreased (FORRU, 2006).

The Forest Restoration Research Unit (FORRU), Faculty of Science, Chiang Mai University, restore forests through native plant structures. The Unit also carried out studies to compare various restoration techniques and processes. Following up on forest restoration is therefore critical. For example, to assess the study area's success in terms of biodiversity. In addition, the return of wildlife in recovery areas can be a good indicator of biodiversity. Additionally, local animal populations play different roles in ecosystems, particularly those that disperse seeds, which can help increase the area's biodiversity (FORRU, 2006). On the other hand, seed predators may destroy seeds that enter an area and thus act as a limiting factor in this regard.

This study investigates the diversity of mammals in natural forests and rehabilitation forests in Mae Rim District, Chiang Mai Province. The species richness and the frequency of detection between the two areas can be compared by installing automatic cameras.

2. Methodology

2.1 Study site

This study was carried out in a natural forest area (latitude 18.937, longitude 98.819) and a 9-year-old reforestation area (latitude 18.938, longitude 98.821) in Doi Suthep-Pui National Park, Chiang Mai Province (Figure 1). The area is known for its moist evergreen forest (1,300 – 1,420 m), with an average year-round temperature of around 23.0 degrees Celsius and an annual rainfall of 1,312 mm. The natural forest study plot area was 3,277.57 square meters, and the reforestation plot area was 1,178.90 square meters.

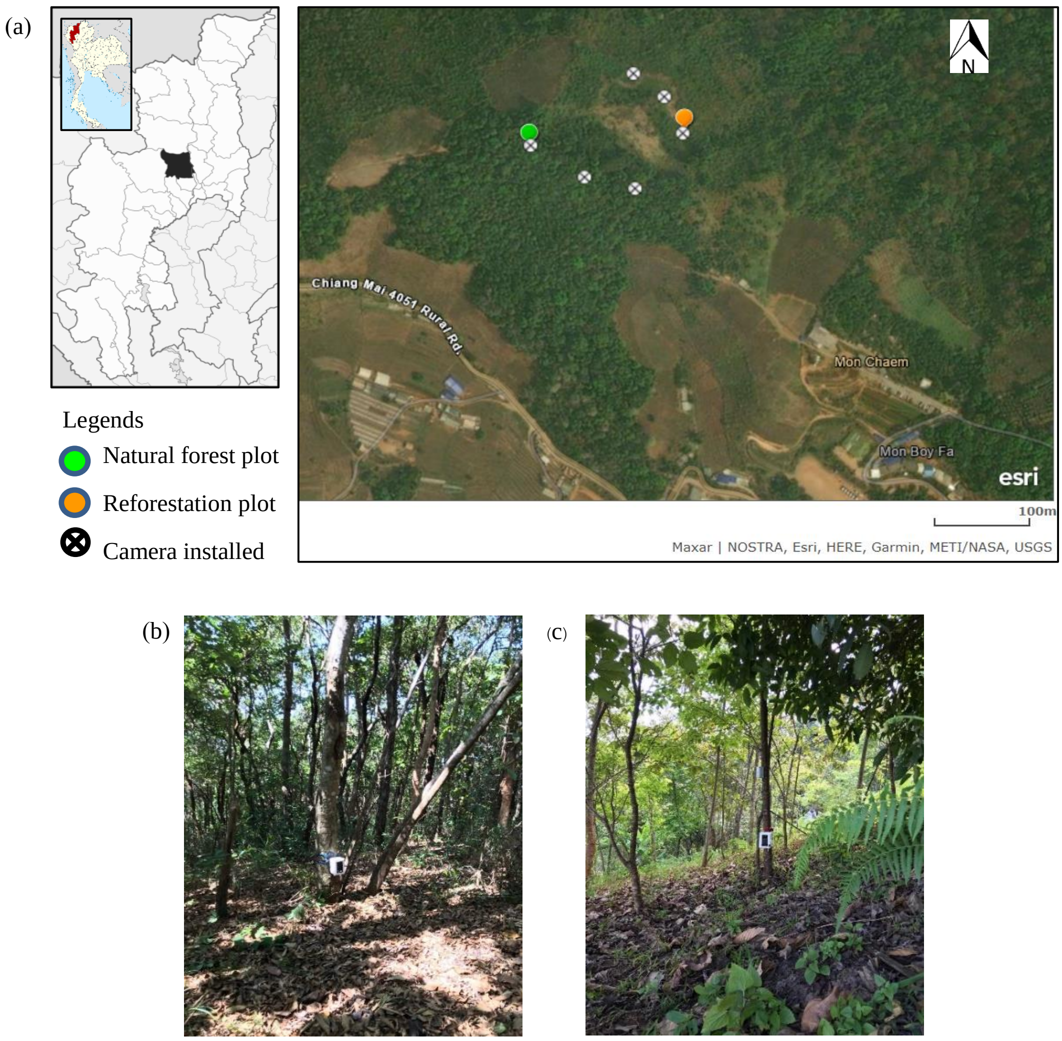

Figure 1. Study area. (a) map of the study area, (b) natural forest plot, and (c) reforestation plot.

2.2 Camera Trapping

From February to August 2021, images of small mammals were captured using the HC-801A Infrared trail camera in six locations, divided into three locations at the natural forest area and three at the reforested area. This equates to 531 trap nights per area. The camera installation location was chosen by surveying the animal tracks to determine the area that represented the forest—using a Line transect survey. Automatic cameras were installed at three locations at least 50 meters apart. The cameras were installed around a strong tree by positioning the camera about 40 centimeters above the ground (Jiménez et al., 2010). Thus, the camera should face toward an open, grass-free area. If the grass grows, mow it down to keep the camera's sensor from capturing unwanted motion. Next, insert an SD card, 8 AA alkaline batteries into the camera, and set the camera to continuous mode (three snapshots per detection). The SD card and batteries were replaced once a month. Data in the SD card were taken for analysis.

Small mammals are classified according to their species and genus. "A Naturalist's Guide to the Mammals of Thailand and Southeast Asia" (Shepherd and Shepherd, 2012) was used. When a single species appeared in photographs taken more than 30 minutes apart, the two subjects were treated as separate individuals (O'Brien et al., 2003). Data were examined for the Frequency of Detection, Species Richness, and Similarity Index. For each parameter, the calculation method is described as follows.

- Frequency of Detection (FD) was calculated using the same formula as in the Relative Abundance Index (RAI) = (E/TN) * 100, where E is the number of events or photographs taken and TN is the total number of trap nights. The relative abundance reveals how common or rare a species is relative to other species in a defined location or community. However, in this study, the term frequency of detection is used instead of relative abundance to avoid misleading the audience as the data may not conclude the abundance of a species. Although popular among wildlife camera trapping studies, the calculation of RAI is influenced by sampling-related factors that can bias the results and thus their interpretations (Sollmann et al., 2012). Those sampling-related factors include the home range of animals, the size of the sampling area, the location of the camera installed, etc.
- Species Richness (S) is the number of species recorded within a defined area.
- Similarity index was calculated based on the Sorensen index for presence-absence data (Krebs, 1999) where Ss = (2Wx100)/(A+B). In this equation, W is the number of species present in both study sites, A is the number of species present only in the natural forest plot, and B is the number of species found only in the reforestation plot.

3. Results and Discussion

3.1 Species richness and detection frequency

Ninety-three images were captured by camera traps, with 72 percent (n=67) from the natural forest plot and 28 percent (n=26) from the reforestation plot. There were 90 percent (n= 84) of these that could be identified. Due to inadequate focus, lighting, or angle, the remaining shots were unidentifiable. Mammals and birds were among the animals taken.

In the natural forest, nine mammal species were found from two genera of the six families (Table 1). With a frequency of detection (FD) of 4.14, the Large Indian Civet (*Viverra zibetha*) had the highest frequency. The FD values of the Small Indian Civet (*Viverricula indica*) and the Leopard Cat (*Prionailurus bengalensis*) were 2.82 and 1.13, respectively. As for the reforestation area, five mammal species were found from one genus and four families (Table 2). The Leopard Cat (*Prionailurus bengalensis*) had the highest detection frequency, with an FD of 0.94. The second highest FD of 0.56 was of Small Indian Civet (*Viverricula indica*). Figure 2 depicts a photograph of mammals detected in this study. The limitation in analyzing camera trap data is that the data obtained can determine the number of species discovered. Still, it cannot be used to calculate the population density of the animals. The animals photographed at different times may be the same individual and cannot be distinguished from the photographs.

3.2 Similarity between sites

The study found mammals such as Large Indian Civet, Small Indian Civet, Leopard Cat, Crab-eating Mongoose, Hog Badger, Masked Palm Civet, Shortridge's Mouse, Small Asian Mongoose and squirrel in the natural forest area. While in the reforestation plot, the study found Large Indian Civet, Small Indian Civet, Hog Badger, Leopard Cat, and Crab-eating Mongoose. The similarity of mammal species found in the natural forest and reforestation area equals 71%. The result demonstrated the return of mammals to the degraded forests. Furthermore, the presence of seed dispersal species in the reforestation area suggests that seeds from the natural forest may be dispersed into the area. In addition, some of the predator species such as Leopard cat and Crab-eating mongoose found in the reforestation plot may also help control the population of seed predators, thus promoting the regeneration of forest area.

Table 1. List of species captured and frequency of detection of wild mammals in the natural forest plot.

Scientific name	Common name	No. of photo taken (pictures)	Frequency of Detection
Viverra zibetha	Large Indian Civet	22	4.14
Viverricula indica	Small Indian Civet	15	2.82
Prionailurus bengalensis	Leopard Cat	6	1.13
Herpestes urva	Crab-eating Mongoose	5	0.94
Arctonyx collaris	Hog Badger	4	0.75
Paguma larvata	Masked Palm Civet	2	0.38
Mus shortridgei	Shortridge's Mouse	2	0.38
Herpestes javanicus	Small Asian Mongoose	2	0.38
Sundasciurus sp.	Squirrel	1	0.19
Total photographs		59	

Table 2. List of species captured and frequency of detection of wild mammals in the reforestation plot

Scientific name	Common name	No. of photo taken (pictures)	Frequency of detection
Prionailurus bengalensis	Leopard Cat	5	0.94
Viverricula indica	Small Indian Civet	3	0.56
Arctonyx collaris	Hog Badger	1	0.19
Viverra zibetha	Large Indian Civet	1	0.19
Herpestes urva	Crab-eating Mongoose	1	0.19
Total photographs		11	

3.3 Ecological roles

We discovered one Large Indian Civet (*Viverra zibetha*), an omnivore listed as Near Threatened on The IUCN Red List of Threatened Species (Bista et al., 2012). The Large Indian Civet is an essential species for secondary seed dispersal (FORRU, 2006). In addition, we discovered small mammal species that live in a variety of habitats, such as the Leopard Cat (*Prionailurus bengalensis*) (Ross et al., 2015), hog badger (Arctonyx collaris) (Ross et al., 2015; Duckworth et al., 2016) Table 3 summarize ecological roles of each species detected.

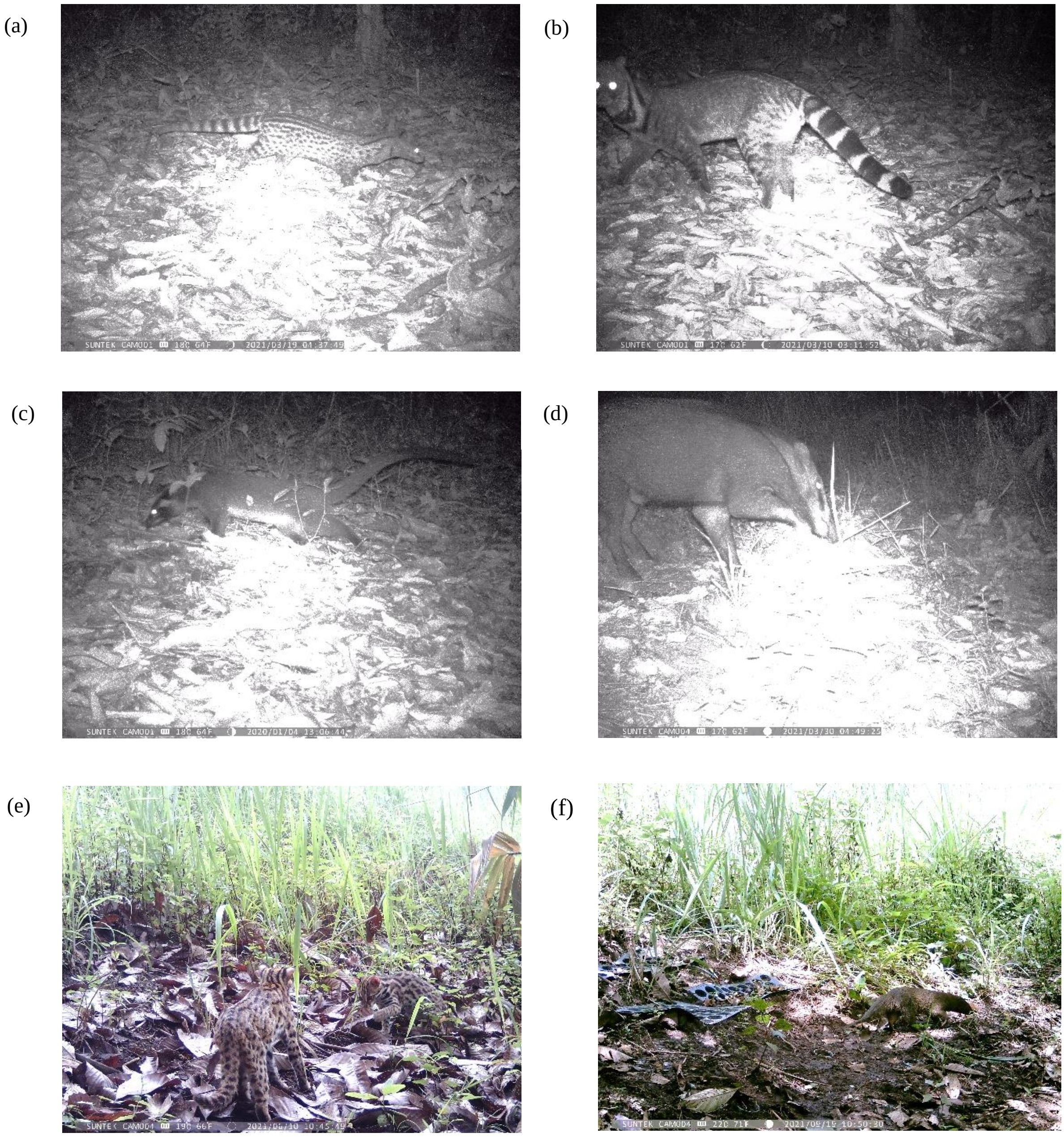

Figure 2. Examples of small mammal photos taken from the study sites. (a) Small Indian Civet (*Viverricula indica*), (b) Large Indian Civet (*Viverra zibetha*), (c) Masked Palm Civet (*Paguma larvata*), (d) Hog Badger (*Arctonyx collaris*), (e) Leopard Cat (*Prionailurus bengalensis*), and (f) Small Asian Mongoose (*Herpestes javanicus*)

4. Conclusions

Based on the research findings, the number of animal species found in natural and rehabilitated forest areas can be determined. The study demonstrates the advantages of forest restoration in terms of increasing ecosystem biodiversity. The findings of this study can be used to gather information about mammals that play an essential role in ecosystems and aid in forest restoration efforts to increase biodiversity in the long run. Further study of factors affecting forest regeneration, such as seed predation and seed dispersion, can also be studied.

Table 3. Summary of species' ecological roles.

No.	Species	Conservation Status	Sites found	Ecological roles
1	Large Indian Civet (Viverra zibetha)	Near Threatened	Both	Secondary seed dispersal species
2	Shortridge's mouse (*Mus* sp.)	Least concerned	Only in natural forest	Seed predator
3	Small Indian Civet (*Viverricula indica*)	Least concerned	Both	Secondary seed dispersal species, control rodent populations
4	Leopard cat (*Prionailurus bengalensis*)	Least concerned	Both	Predator species, control rodent populations which are seed predators.
5	Crab-eating mongoose (*Herpestes urva*)	Least concerned	Both	Control rodent populations
6	Masked palm civet (*Paguma larvata*)	Least concerned	Only in natural forest	Secondary seed dispersal species
7	Small Asian mongoose (*Herpestes javanicus*)	Least concerned	Only in natural forest	Control rodent populations
8	Hog badger (*Arctonyx collaris*)	Near Threatened	Both	Secondary seed dispersal species creates habitat soil aeration
9	Squirrel (*Sundasciurus sp.*)	-	Only in natural forest	secondary seed dispersal species

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