STATUS, DIVERSITY AND RELATIVE ABUNDANCE OF SMALL CARNIVORES AND OTHER MAMMALS IN A SMALL PROTECTED AREA OF 50 KM^2 IN THONG PHA PHUM DISTRICT, WESTERN THAILAND

NOPPHADOL PRAYONG

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ABSTRACT

In this study, the status of small carnivores and other mammals in 57 km^2 of PTT Forest Reserves was studied in parallel with human activities in the area. The results show that there are at least 17 mammals present in this protected area (PAs) including 10 carnivore species. The Large Indian Civet (*Viverra zibetha*) was the most abundant (Relative Abundance (RA) = 6.39) followed by the Small Indian Civet (*Viverricula malaccensis*) and the Common Palm Civet (*Paradoxurus hermaphroditus*) with RA equal to 4.44 and 3.33, respectively. Along forest edges, percent visitations of the Large Indian Civet indicate that it is the dominant species. Abundance of Large Indian Civets was negatively and significantly correlated with distance to the forest edge ($r = -0.682$, $p = 0.043$). The times of presence in photo pictures from camera traps showed that most small carnivores were nocturnal.

There is a variety of human activity in this small PA. Frequencies of signs of Non-Timber Forest Products (NTFPs) collecting and of domestic animals were significantly negatively correlated with distance from villages ($r = -0.831$, $p = 0.006$ and $r = -0.685$, $p = 0.042$, respectively). In contrast, the relation of distance from villages and hunting was not significant. Domestic dogs (*Canis familiaris*) were abundant in this forest, especially in areas that were less than 1 km from the forest edge.

The result of this study on the status of small carnivores and other wildlife in this small protected area will be useful to motivate local participation in conservation. Wildlife conservation in the Integrated Conservation and Development Projects (ICDP) concept is briefly discussed in relation to local agencies in the area. Cooperation among local agencies and local people for conservation is now needed to start co-conservation management in this small protected area. The experience will be useful for improving wildlife conservation of the Western Thong Pha Phum Ecosystem on the larger scale.

KEY WORDS: SMALL PROTECTED AREA/ SMALL CARNIVORES/ RELATIVE ABUNDANCE/ HUMAN ACTIVITIES/ WILDLIFE CONSERVATION

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สถานภาพ, ความหลากหลายและความชุกชุมสัมพัทธ์ของสัตว์กินเนื้อขนาดเล็กและสัตว์เลี้ยงลูกด้วยนมอื่นๆในพื้นที่อนุรักษ์ขนาดเล็ก อำเภอทองผาภูมิ ประเทศไทย (STATUS, DIVERSITY AND RELATIVE ABUNDANCE OF SMALL CARNIVORES AND OTHER MAMMALS IN A SMALL PROTECTED AREA OF 50 KM^2 IN THONG PHA PHUM DISTRICT, WESTERN THAILAND)

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บทคัดย่อ

การศึกษาครั้งนี้เป็นการศึกษาสถานภาพของสัตว์กินเนื้อขนาดเล็กและสัตว์สัตว์เลี้ยงลูกด้วยนมอื่นๆ รวมทั้งกิจกรรมต่างๆของมนุษย์ในพื้นที่ 57 ตารางกิโลเมตรของป่าอนุรักษ์ 72 พรรษามหาราช ผลการศึกษาพบว่ามีสัตว์เลี้ยงลูกด้วยนมอย่างน้อย 17 ชนิดในพื้นที่นี้ ซึ่งประกอบด้วยสัตว์กินเนื้อ 10 ชนิด ชะมดแผงสันหางปล้อง (*Viverra zibetha*) เป็นสัตว์กินเนื้อขนาดเล็กที่มีค่าความชุกชุมสัมพัทธ์มากที่สุด คือ 6.39 รองลงมาได้แก่ ชะมดเช็ด (*Viverricula malaccensis*) และ อีเห็นธรรมดา (*Paradoxurus hermaphroditus*) มีค่าเท่ากับ 4.44 และ 3.33 ตามลำดับ ชะมดแผงสันหางปล้องจัดเป็นชนิดที่โดดเด่นในพื้นที่ขอบป่า อีกทั้งยังแสดงการเพิ่มขึ้นของความชุกชุมอย่างมีนัยสำคัญเมื่อระยะทางจากขอบป่ามีค่าน้อยลง ($r = -0.682$, $p = 0.043$) หลักฐานของเวลาที่แสดงในรูปจากกล้องดักถ่ายภาพสัตว์ป่าชี้ว่าสัตว์กินเนื้อทั้งหมดที่บันทึกได้เป็นสัตว์หากินกลางคืน

กิจกรรมรบกวนของมนุษย์ในพื้นที่ศึกษามีหลากหลาย โดยพบว่าการหาของป่าและสัตว์เลี้ยงจะมีมากขึ้นอย่างมีนัยสำคัญเมื่ออยู่ใกล้หมู่บ้าน ($r = -0.831$, $p = 0.006$ and $r = -0.685$, $p = 0.042$ ตามลำดับ) ขณะที่การล่าสัตว์ไม่มีความสัมพันธ์กับระยะทาง หมาบ้านเป็นสัตว์เลี้ยงที่พบทั่วไปในการศึกษาครั้งนี้ โดยเฉพาะในพื้นที่ไม่เกิน 1 กิโลเมตรจากขอบป่า

การนำข้อมูลสถานภาพของสัตว์กินเนื้อขนาดเล็กไปขยายผลเพื่อการขับเคลื่อนการมีส่วนร่วมของชุมชนท้องถิ่นได้มีการเริ่มดำเนินการ โดยขั้นแรกได้มีการพิจารณาร่วมกันถึงการนำรูปแบบของการบูรณาการระหว่างการอนุรักษ์และการพัฒนา (ICDP) มาประยุกต์ใช้ โดยการเริ่มดำเนินการในพื้นที่อนุรักษ์ขนาดเล็กและหวังว่าประสบการณ์ดังกล่าวจะมีประโยชน์ในการขยายผลสู่พื้นที่ที่ใหญ่ขึ้นของระบบนิเวศป่าทองผาภูมิตะวันตก

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CHAPTER I
INTRODUCTION

1.1 General Background

Western Thong Pha Phum (WTPP) Forest is one of interesting areas for learning biodiversity. Since, this area is a junction of three ecoregions including Tenasserim-South Thailand Semievergreen Rain Forest, Kayah-Karen Mountane Rain Forest, and Chao Phraya Lowland Moist Deciduous Forest, so that high diversity of life can be found in this ecosystem. Much research in WTPP Forest confirm this prediction. The progress reports on biodiversity such as fishes, stream benthic macroinvertebrate, stoneflies, aquatic bugs, amphibians and reptiles show high diversity in this ecosystem (BRT, 2004). For wildlife, especially small carnivores, very little is known. However, from the viewpoint of biogeography, we might assume that this ecosystem should contain high diversity of carnivores and be similar to the carnivore communities in nearby forests such as Huai Kha Khaeng Wildlife Sanctuary to the north and Kaeng Krachan National Park to the south. Although several activities of local people around Western Thong Pha Phom Forest may affect the carnivore community at the present time, based on interviews of local people, some carnivores are still present such as small and medium-sized cats, civets, bears, and otters etc.

To protect this ecosystem, Western Thong Pha Phum Forest has been under the process of establishing as a part of Thong Pha Phum National Park (TPPNP), which include in Western Protected Area Complex of Thailand (WPAC). Like many Protected Areas (PAs) in Thailand, forest areas and wildlife are still threatened by several activities. Previous research found that level of human activities in TPPNP were third highest when compare with other PAs in WPAC, especially because of socio-economic factors such as human population and land use size (Emphandhu, 2003). Historical, cultural and geographical reasons increase the complexity of the problem (see literature review). So, wildlife conservation in this area should involve

more than just strict law enforcement. Co-management with local community should be encouraged. However, due to inflexibility of Thai PA laws and negative feeling of local people toward PAs, small protected area co-management regimes should be tried so that learning experiences can be accumulated and help to scale up to a larger area. PTT Forest Reserves is a small PAs that suitable to develop this practice.

A Forest Reserve proposed by the Petroleum Authority of Thailand (PTT) since 1999 is a part of the post Environmental Impact Assessment (EIA) responsibility of PTT after Yadana natural gas pipeline construction from Myanmar. Officially, it is a forest reserve under the National Forest Reserve Act of 1964. It is a small protected area about 50 sq. km located in side of the boundary of WTPP Forest. Temporary boundary has been demarcated by PTT to designate as a protected area. PTT interests to conserve forest and wildlife, and to develop wellbeing of local community around the forest (PTT, 2002). However, a partnership project was made with Biodiversity Research and Training Program (BRT) in encouraging biodiversity research for maintaining the protected area.

Although this PA is small with an area about 50 sq. km or 30,000 rai, but it is big enough for a pilot project on biodiversity co-management. The importance of its location within the boundary of WTPP Forest is that it will be a part of Thong Pha Phum National Park (TPPNP) in the future. So, the accumulated experience will be helpful for buffer zone management of a larger protected area, TPPNP. Moreover, this PA is an area interconnecting link between natural and human ecosystems. So, local people around the forest can be positive or negative factors affecting the wildlife community and biodiversity conservation in this area.

At the present day, most people practice agriculture and collect non-timber forest products (NTFPs), such as bamboo shoots, mushrooms, etc, for selling. Since rainfall pattern is similar to Southern Thailand, agriculture like that in Southern Thailand can be found. They are, for example, rubber plantations, fruit plantations and some crops. Some wildlife lives in the agricultural areas such as civet, small cats and small mammals etc. While in forested areas, more complex wildlife communities are expected. These will be depended on distance from human settlements because close distance should be more disturbed by human, which will be hypothetically tested in this thesis.

Hunting is still being practiced in this ecosystem. From interviewing local people concerning non-timber forest products (NTFPs), the hunting of wild pigs, barking deer, primates, civets, young bears and young tapirs still occurs (Naruchaikusol, unpublished). Such activities are threatening wildlife communities at the present time and if the disturbances of human still occur, carnivores and other wildlife in this ecosystem may be extirpated. So, information on the wildlife community in this ecosystem will be helpful for assessing the status and impact of human disturbance on them. Local people are important stakeholders for wildlife conservation in this area. Therefore, for successful wildlife conservation, knowledge on wildlife status and their ecology should be developed in local contexts and integrated as a part of local knowledge accumulated within the local community. Important information are, for example, effect of local people lifestyle on wildlife communities. Predator-prey interaction and trophic cascade are good exercises for participatory learning and research. This kind of research is useful for local people to appreciate values of wildlife and encourage their involvement of them on wildlife conservation.

Currently, the question about role of ecologists in biodiversity conservation was addressed. In situation that tropical biodiversity continues to erode unabated, Ecologists should build knowledge, send to managers and or intervene in adaptive management strategies (du Toit, et. al., 2004). If the same questions were asked on wildlife conservation in Thailand, the answers may be diverse. One is that the capability of intervention may be limited by Protected Areas (PAs) regulation.

In Thailand, most threatened wildlife exists in PAs. So successful conservation is strongly depended on PA management. However, most ecologists who study wildlife or other biodiversity in previous times have only given knowledge to PA managers when the research was finished, if at all. It is considered sufficient. Although Thailand has a well developed PA system, but the strategy and management plans for wildlife conservation still need improvement. Variety of modification is essential for solving diverse problems in each area. Community-based conservation is a new and promising practice that has been accepted worldwide, but this is still less effective in Thai PAs due to the lack of flexibility of Thai laws on resources use in PAs (Srikosamatara and Brockelman, 2002) and it still requires high level of knowledge

and skill to handle the issue. However, in a specific PA such as small forest reserve and community reserve, this practice has been improving (UNDP, 2004).

In case of PTTF, both local agencies involved and focal areas set up seem to be ready for local co-management approach. With the collaboration with the Biodiversity Research and Training Program (BRT) biodiversity and local knowledge research have been done. However, although several projects have been carried out in the areas, local co-management for wildlife conservation is not improving due to little knowledge on wildlife in PTTF as a focal area. Actually, both local agencies and research aims are good enough to support Integrated Conservation and Development Projects (ICDP) for wildlife conservation. Although, there is much good will, practical aspects on the ground are still needed.

More studies should be done on the current status of wildlife in this area, especially small carnivores and other mammals. This information will not only be a part of a bigger set of data on biodiversity using area-based approach, it will be useful for collaborative wildlife conservation and restoration plans with local people, which is one of the aims of WTPP Project. Moreover, wildlife conservation as a core objective of ICDP in this area should be demonstrated.

Limitation of predator population by prey availability and the effect of predator on prey population are recognized as important ecological processes that affect carnivore conservation (Creel, 2001). However, there is less information about these processes in tropical carnivores and most comes from undisturbed habitat (Emmons, 1987; Ray and Sunquist, 2001; Rabinowitz and Walker, 1991). While in disturbed areas or areas where humans are involved, this knowledge is still unclear. In Thailand, the knowledge about relation and structure of carnivore community is limited and most come from Huai Kha Khaeng Wildlife Sanctuary where some intensive studies have been done (Rabinowitz and Walker, 1991, Conforti, 1996). Nevertheless, this information cannot be used to represent carnivore community in Western Thong Pha Phum ecosystem because each area has different characteristics. Moreover, changing of wildlife community by human disturbance in this area may affect relationships within the carnivore community.

In this study, the status of small carnivore and other mammals in PTT Forest Reserves were studied in parallel with human activities in the areas. The information

would be useful for understanding the current status of the wildlife community and effect of human disturbance on them. The study would be used for demonstrating the important role of small carnivores and other wildlife in an ecosystem to local people around the forest so that they will see how important it is to conserve and restore the wildlife community by themselves. In addition, for developing ICDP approach, this study will also set a base of wildlife monitoring and evaluation for local participatory management, which is a gap in the ICDP approach in present day (Hughes and Flintan, 2001). All information would also be discussed with other local agencies and the local community for wildlife management in the future.

1.2 Objective of study

- To assess current status of small carnivores and other mammals in a small protected area of PTT Forest Reserves
- To study the abundance and species composition within a small carnivores community in disturbed forest
- To study the pattern of human activities in a small protected area and its effect on small carnivores
- To motivate the participation of local people in wildlife conservation with other local agencies

CHAPTER II
LITERATURE REVIEW

2.1 Role of Carnivores to Healthy Tropical Ecosystem

Many current discussions about ecological interaction that determine diversity, abundance and complexity of trophic levels usually refer to top-down and bottom-up control. For bottom-up control dominants, the system controls upward from lower to higher trophic levels, thus species richness and diversity are determined by competition forces and defense of plants and herbivores. Since carnivores are at the top of the food chain, bottom-up control implies they have little ecological utility. Whereas in system with top-down regulation, carnivores have high importance in trophic structuring, they control herbivore density and continue to reduce overharvest on plants (Schmitz et al, 2000, Miller et al., 2001, Dyer and Letourneau, 1999). There are at least two conditions necessary for top-level carnivores to influence ecosystem structure. One is that the food web must be strongly linked, especially between carnivores and their prey, and the other is that the community must be under top-down control (Estes, 1995).

In previous days, the ecological role of carnivores on prey community and other lower trophic level were studied in several-undisturbed ecosystem. Their relations are important to control prey populations, decrease competition within the prey community and reduce seed predation (Duffy, 2002). In the Chilean semiarid zone, predator presence and small mammal exclusion had significant effects on many plant species. Some shrubs were higher covering in habitat where predators such as owls and culpeo fox can be found (Gutiérrez, et al, 1997). The study of Terborgh et al. (2001) shows impact of higher carnivores on lower trophic levels. In small islands where predators are absent, the study showed that densities of seed predators and herbivores were 10 to 100 times greater than on mainland where predators were

present. These also reduced densities of seedlings and saplings of canopy trees (Terborgh et al., 2001).

Many studies of predator – prey relations have been carried out previously but most have come from undisturbed forest. The temporal response of carnivore density in relation to various sizes of prey populations depended on different size of prey. Small carnivore feeding mostly on small sized prey show rapid functional response to prey more than large carnivore, which require a longer time in response to population change of large prey (Carbone and Gittleman, 2002). This study also indicates that the prey community is important to maintain the carnivore community. General models to predict carnivore density relative to resources show some inference of this relation that carnivore population are influenced by productivity rates of the prey population rather than by standing mass. Several studies on feeding ecology of carnivores in tropical forest show importance of size diversity of prey to structuring the carnivore community.

In Neotropical Forest, the feeding ecology of 3 small carnivores indicate that mammalian prey size of jaguar and ocelot were different. Most prey of jaguar have body weight more than 1 kg whereas prey of ocelot were mostly less than 1 kg (Emmon, 1987). Likely with African rain forest, the study indicated that the species richness of prey was not a key factor to structuring carnivore community more than size diversity and abundance of mammalian prey (Ray and Sunquist, 2001). In India, although rodents are the main prey of 3 small carnivores including jungle cat, caracal and golden jackal, but important of this prey were different between carnivore species. 70% of daily metabolizable energy of felids was obtained from rodents whereas only 45% were in jackal. These results indicate that important of rodents were more for felids than the jackal. The study also shows efficiency of small carnivores to control prey population. In one year, 5840 to 7300 rodents were eaten by one jungle cat, one caracal and one golden jackal (Mukherjee et al., 2004).

2.2 Carnivore Studies in Thailand

In Thailand, there are few studies on relationship between carnivore and prey community. There are at least 36 species in the order Carnivora in Thailand (Lekagul and MeNeely, 1977). Ecology of some carnivores have been studied several times, however most of them were conducted in undisturbed habitat and there are more than 50% of carnivores in Thailand with little information.

For large cats, the studying on the tiger and leopard show that both feed on at least 19 mammalian prey species. 88% of feces contains only a single prey item. Foods niche separation is a mechanism to reduce competition and allows co-existence between these two large cats. The main prey of both cats is barking deer, but in leopard feces primates and some small mammals can be found, but tiger take less. In addition, tiger is higher in the hierachy than leopard, so tigers usually displace leopards (Rabinowitz, 1989). In Kaeng Krachan National Park (KKNP), the study on ecology of leopard shows that they feed on at least 9 mammalian prey species and hog badger were their main prey. Prey selections were influenced by prey density. KKNP are dense rainforest where the density of barking deer or other medium and large sized prey is low. Leopards shift to take smaller prey as hog badger which is common in this national park (Grassman, 1999).

There is little information on the ecology of Clouded leopards. In Khao Yai National Park, the study showed that the density of this medium-sized cats were 0.06 individuals/km^2. Female and male's home ranges are 33.3 and 36.7 km^2, respectively (Austin and Tewes, 1999). Similarly, in Phu Khieo Wildlife Sanctuary range size of clouded leopards was 22.9 – 45.1 km^2 (Grassman, et al. 2005). In both studies the ranges were larger than those of male leopard elsewhere in Thailand (Rabinowitz, 1989; Grassman, 1999). Although, these reports show that clouded leopards prefer primary evergreen forest, some reports from other areas show that they also use disturbed forest such as selectively logged forest (Rabinowitz et al., 1987) and dipterocarp forest (Santiapillai and Ashby, 1988). The feeding ecology of this cat was studied in Phu Khieo Wildlife Sanctuary and prey species were the mean prey of two medium-sized cats (clouded leopard and golden cat), due to inability to identify feces of these carnivores. However, the results indicate that these carnivores consumed at

least 9 species. Muridae were most frequent of occurrence as 39.1% (Grassman, et al. 2005).

For small carnivores, leopard cats were studied in HKK and KKNP. Similarly, leopard cats mostly ate rats in both studies, Siamese hare and wild pig are largest prey in KKNP and HKK, respectively (Rabinowitz, 1990b; Grassman, 1997). For other felids, there are still less information. Although, some studies show status of them (Rabinowitz and Walker, 1991; Conforti, 1996), but the information on ecology of many small cats were limited. This may be due to the lack of suitable method to observe and study them. However, the study of sympatric felids presently at Phu Khieo Wildlife Sanctuary has added to ecological information of such wild cats in Thailand. The result found that Asiatic golden cat and marbled cat were ranged over 32.6 – 47.7 km^2 and 5.3 km^2, respectively (Grassman, et al. 2005).

In Huai Kha Khaeng (HKK) and Thung Yai Naresuan Wildlife Sanctuary (TY) near the forest of WTPP ecosystem, carnivores were studied for several times. There are at least 22 carnivores found in both wildlife sanctuaries (Conforti, 1996). 22 of 36 carnivores in Thailand indicate a high diversity of them in this ecoregion. It is expected that WTPP ecosystem should contain a high diversity of carnivores similar to these nearby forests. However, the effect of several human activities may change relation within carnivore-prey community in WTPP. In HKK, the intensive study on carnivore-prey community was conducted and showed that a diverse prey community and several habitat types are factors in maintaining a stable carnivore community in this area (Rabinowitz, 1991). The study shows at least 34 species of mammalian prey taken by these carnivores of which average body size ranged from 26 g of pencil-tailed tree mouse to 223 kg of sambar deer (Lekagul and MeNeely, 1977; Rabinowitz, 1991). For small carnivore community, the prey used by small carnivores are related to abundance of small mammal indicated by trapping. *Maxomys surifer* were found most frequently in both small carnivore's feces and by trapping (Rabinowitz, 1991).

The relationships between the carnivore community and habitat types have also been studied. In HKK and TY, species richness of carnivores was high in Mixed Deciduous and Dry Evergreen Forest. Twenty species found in these forest type indicated the importance of them to maintain diverse carnivore assemblage (Conforti, 1996). The study relationship between fire, Dry Dipterocarp Forest (DD) and

carnivore community in HKK found that DD affected carnivores both directly and indirectly. The comparison between post and pre fire trapping show a decrease of 56% in small mammals in post – fire trapping. This indicates that DD play a role to restrict distribution and population size of many carnivore, especially small carnivore that used small mammals as their main prey (Rabinowitz, 1990a). Forest characters also affect feeding behavior of some carnivore. In dense forest in Kaeng Krachan National Park (KKNP), primate have more benefits to avoid predators by travelling higher on trees resulting to low frequency of them in leopard feces, whereas primates is main prey in HKK leopard (Rabinowitz, 1989; Grassman, 1997).

2.3 Effect of Human Disturbance on Carnivores

Effects of human disturbance on wildlife community have been found in many studies and most show a negative trend. However, the pattern of disturbance and wildlife response were still need information in several ecosystem, especially in Tropical forest. In some area, the available information can not be explained and is difficult to apply in management plan due to variation of problems in each area. In Tropical forest, human activities in Protected Areas were still present. However, disturbance level of each activities types are not equal. The effect of some types of disturbance is more threatened than others and species may respond in different ways (Cuarón, 2000). Effects of some human disturbance on mammal community were studied several times in past decade such as habitat degradation and fragmentation, hunting and introduced species. Unfortunately, although result indicate importance of such activities on threatening wildlife information on the pattern and wildlife respond is still less in Tropical forest especially in Thailand. Moreover, the effects on some wildlife group such as small carnivores were little understood. Information about effect of disturbance on them can be seen more in larger wildlife groups such as effect on mammal or small mammal community, the main prey of them.

For large mammals, they are more responding to some specific human activities. In African forest, although elephants were negative relation with overall human disturbance signs but when looking specifically at relationship between hunting signs and elephants density there are no relationship (Blom, 2004). In Malaysia, small

forest area network (2-2744 ha) were distributed within landscape of logged area and protected as Virgin Jungle Reserves (VJRs). The study found that size of forest was the most important factor affecting mammal community. A sharp loss in species richness was appeared in forest that have size less than 164 ha. Moreover, carnivores were presented only in study site that classify as medium and large size (Laidlaw, 2000).

Hunting is an activity affecting mammal community. In Ecuador, hunting is most intense near human settlement and animal densities were positive relation with distance from settlement. Data in this study will be also used in decision making to established no-take area where densities of mammal are reduced but still enough to have potential to recover (Sirén, et al., 2004). The comparison between effect of vegetation disturbance and hunting on mammals in agroforestry area indicate that hunting has more impact on mammals > 2 kg in size (Naughton-Treves, 2003). In African rainforest, hunting is a main activity that affect to wildlife population. The study in Cameroon found that snare density decreased as distance from the village increase. The number of animals that rotted on snares was three times higher when compare with farthest hunting area (Muchaal, 1999).

Domestic dog is a current problem to natural environment in many part of the world. However, effect of domestic dog on wildlife community were little reported and most come from temperate ecosystem and Africa. In boundary of Communal Land and Wildlife Research Area of Zimbabwe, dogs were mostly owned but unrestricted. Free – ranging dogs were highly efficient to competition with wild animals. They are both diurnal and nocturnal resulting in more time to hunt and scavenge (Butler and du Toit, 2002). The results showed that there are less than 25% of average dog's diet is provided by their owners. In this area dogs were great competitor to wild scavengers such as vulture species, which is a problem in vulture conservation (Butler and du Toit, 2002). Domestic dogs in this area act as predators and prey. The recent study found that dogs ranged up to 6 km within wildlife research area and were common carnivores on communal land – wildlife research area boundary (Butler, et al., 2004). Although they are inefficient competitor with large carnivores but, because they are also prey of large carnivores such as lions, leopards and hyaenas, so they are important disease transmitters (Butler, et al., 2004).

In tropical forest of Kenya, domestic dogs act like top predators, which there are positive effect on nest predation because they have role to control meso – predators in edge areas (Maina and Jackson, 2003). However, for some wildlife, domestic dogs tend to threaten them. In tropical forest of Queensland Australia, clear - cutting caused forest fragmentation, which benefited to domestic dogs and dingoes to attack Lumholz's treekangaroo (Newell, 1999). There are same situation in On Kau Sai Chau, the fifth largest island of Hong Kong. There are at least 5 small Indian civet and 1 masked palm civet were killed by domestic dogs between 1998 -2001 and adding 5 small Indian civet were killed in 2002. However, they do not eat such civets (Dahmar, 2002). In Thailand, there is still no information about impact of dogs on wildlife.

Human-caused fires are an importance factor that affect wildlife community. In Tropical forest, forest fires can be classified as surface fires and deforestation fires. The effects of fires on fauna can be found in few in-depth studies (CBD, 2001). However, the study in Thailand and Indonesia show high impact on wildlife (Rabinowitz, 1990a, Kinnaird and O'Brien, 1998). In Thailand, the results showed that small carnivores tend to avoid burned over areas, due to decrease of small mammals, a main prey of them. However, fires are beneficial to some wildlife such as insectivorous birds that taken wood-eating insects (Rabinowitz, 1990a). The effects of wildfire were cascaded to wildlife at higher trophic level. Fire damage in Sumatra, Indonesia reduced fruit availability to omnivores such as rodent, squirrel and civet species. The reduction of such mammals affects food supply for small and medium size carnivores (Kinnaird and O'Brien, 1998).

The direct studies about effects of human disturbance on carnivore community were still little and most come from temperate forest. The study on the effect of fragmentation on carnivore in California indicated that landscape variable determined species composition of carnivores more than species richness of them, which is depended on adaptability of each species (Crooks, 2002). In India, where large prey such as the population of wild buffaloes, gaur and sambar deer were reduced since habitat modification, tiger switched to feed on medium-sized prey, which may compete with leopards and causing the change in feeding behavior of leopard (Ramakrishnan, *et al*., 1999). In agricultural habitat, Gehring and Swihart (2003) used 717 scent stations to examined response of generalist predators to fragmentation in an

agricultural landscape and found that, sensitivity was positively related to body size (coyote, (fox=opossum=domestic cat=striped skunk), raccoon and long-tailed weasel, respectively). This study indicates that different composition of carnivore species in each habitat may alter structure and distribution of prey community in fragmented landscapes in consistent with the prediction from the theoretical model (Swihart *et al*., 2001 referred in Gehring and Swihart, 2003). Adaptation of some species to human disturbance is one way for their survival. Diet of large Indian civet in rubber plantation in Southern Thailand were studied and showed that this species were capable to survive by feeding on diverse prey ranging from small mammals, reptile, amphibians, arthropods, and fruits etc. (Kanchanasaka, 2000). Ecological characteristic of each carnivore is one factor that determines response level to human disturbance. Badgers are omnivorous and capable to feed on diverse prey so that they are highly adaptable in habitat change, but the location of its dens determine their presence in routine movement in specific habitats (Virgos *et al*., 2002).

2.4 Western Thong Pha Phum Forest (WTPPF), history of local community and impact of mega-projects

Western Thong Pha Phum Forest (WTTPF) is a part of Western Forest Complex of Thailand (WEFCOM) and has been under process to establishing Thong Pha Phum National Park. WEFCOM management plan were classified this area as “Totally Protected Zone” that mean area that natural area where the land still has high degree of ecological integrity and could be returned to a condition which would be qualified for inclusion in zone 1 (Strict Nature Preservation and Protection Zone, which HKK and TY were included etc.) (Trisurat, unpublished). For wildlife, there is still no completed information. However, briefly monitoring survey of wildlife show that there are diversity of life in this ecosystem and increasing species number in every years indicate that it should be found more species than ones when intensive survey is conducted (Table 1).

Table 1: Species diversity of wildlife in Thong Pha Phum forest between 1997 – 2001 (Source: PTT, 2002).

Wildlife	**1997**	**1998**	**1999**	**2000**	**2001**
Amphibians	11	28	47	47	47
Reptiles	20	44	63	63	65
Birds	112	180	218	252	280
Mammals	24	30	59	62	66
Total	167	282	387	424	458

For large mammals, many endangered species are present such as elephants, tigers, serows, gaur etc. Moreover, 2 endemic species were also found including Kitti's hog-nosed bat (*Craseonycteris thonglongyai*) and Regal crab (*Demanietta sirikit*) (Sueb Nakhasatien foundation and IUCN, 2001).

However, the I - shape of this forest result to more contact with human community than other protected area in WEFCOM (see Fig. 1 in study area). Previous research found that there are at least 8829 people living around the forest, half of them is non-resident. This number is the highest comparing with other PAs in WEFCOM (Emphandhu, 2003).

Most local people in villages around forest practice agriculture, non-timber forest products (NTFPs) collecting and daily employed workers. In Huai Kayeng subdistrict, most villages were close to forest resources. There are at least 316 species of plant foods, 16 species of bamboos and rattans, 44 bird species and 29 mammal species were collected from the forest. These NTFPs were collected both for consumption and selling (Naruchaikusol, unpublished).

Historically, people in this area emigrated from Khao Laem Dam construction in 1984 and have settled in 8 villages in Huai Kayeng subdistrict. After that, other mega-projects were came including transporting way of timber when there are logging concessions in Myanmar in 1987 (Naruchaikusol, unpublished) and Yadana natural gas pipeline project in 1997 by Petroleum Authority of Thailand (PTT, 2002). In

addition, this area also had the settle of forest plantation by Forest Industry Organization (FIO) since 1978.

Although there are several mega-projects conducted in this area, the impact of them on natural ecosystem was not systematically studied. Nevertheless, the highly destruction on wildlife and forest in period of village settlement and logging concessions in Myanmar was expected, which still have sign in present day such as a lot of wood houses and carcasses in villages. In addition, Ban Pracham Mai and Ban Rai Pa are 2 villages in this area that were listed in top ten villages within Western Forest Complex with highest wood product used (Emphandhu, 2003).

In case of Yadana natural gas pipeline, this is one of project with widely public interests. This project have been approved by environmental impact assessment (EIA) with comments on environmental restoration. The assessment of people's satisfaction with the public hearing still show negative result (Ogunlana, 2001). However, after this project passed, responsibility of PTT on forest restoration and conservation were done in this area such as forest restoration and protected area establishing (PTT, 2002). But there are no assessment of such activities at present time.

CHAPTER III
METHODOLOGY

3.1 Study Area

3.1.1 The overview of Western Thong Pha Phum Forest

Western Thong Pha Phum Forest (WTPPF), is situated in Thong Pha Phum District, Kanchanaburi Province. The forest is situated in the North-South direction of Tenasserim Mountain. WTPPF has been under a process of establishing as a part of Thong Pha Phum National Park (TPPNP) combining with other protected areas in Western Forest Complex (Fig. 1). Several types of forests such as Tropical Rain Forest, Tropical Dry Forest, Mixed Deciduous Forest and Dry Dipterocarp Forest etc. are present in this ecosystem. The elevations of the area are between 100-1,249 m. from sea levels. There are average rainfall/year about 1,775 mm and temperatures range between 13.25^{o} C and 31.75^{o} C (Wannasri, 2002). WTPPF is a source of several streams flow to Khao Laem Dam and Khaew Noi River. In addition, location and shape of forest increase the value of this forest. WTTF were connected with Thung Yai Narasuen Wildlife Sanctuary and Khao Leam Dam National Park in the North and Sai Yok National Park in the South. So, WTPPF act as forest corridor (Fig. 1). Mining were operated in the forest resulting fragmentation with clear-cut area distributing within forest remaining at present day.

Since the forest is located in Thai-Myanmar boundary, several ethnic groups are distributing around the forest such as Thai, Burmese, Karen and Mon etc. Such people have closed relationship with forest resources. Wildlife hunting both for foods and sales could be found. Cattle herding passing forest area from Myanmar to Thailand is a commonly seen activity.

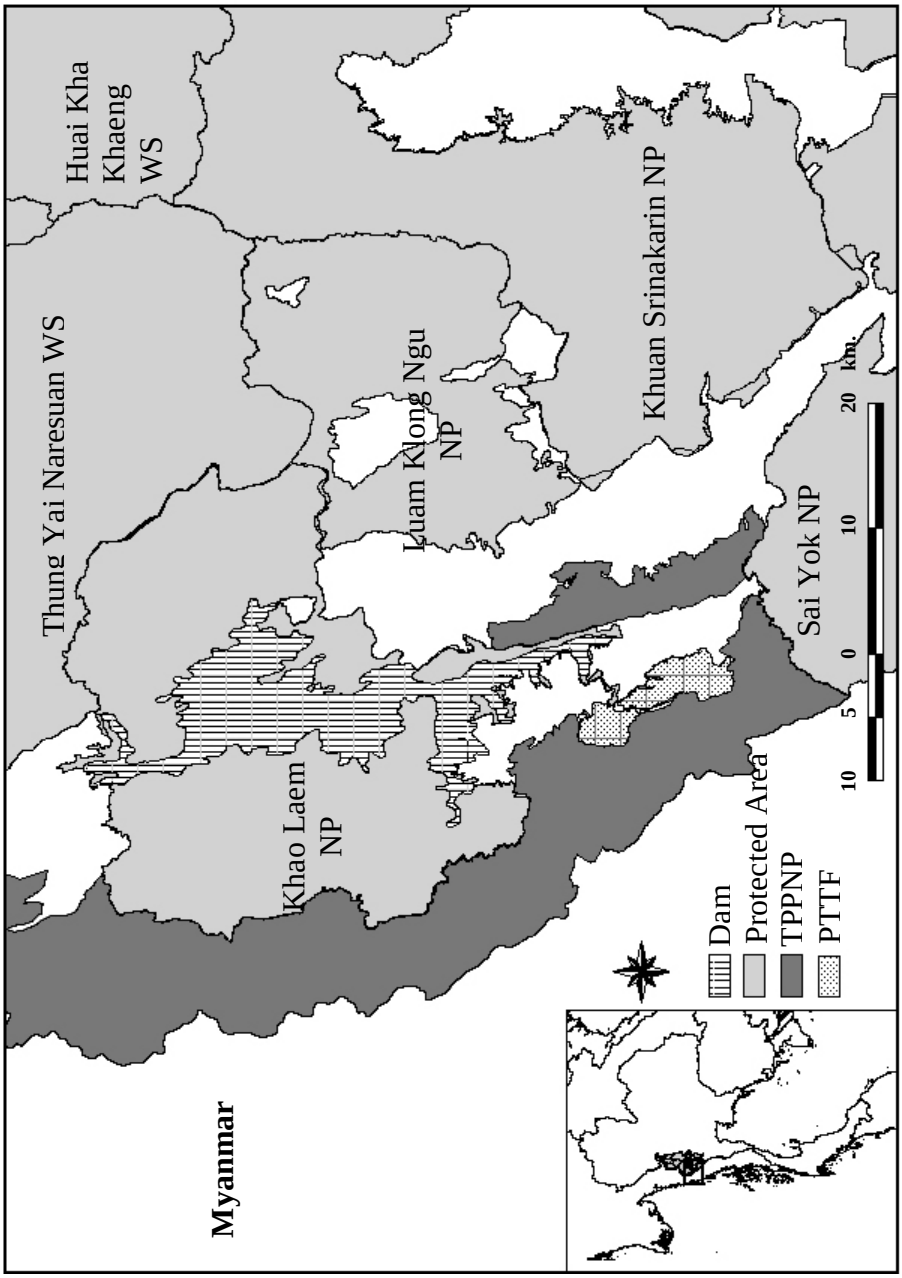


Figure 1: Location of PTT Forest Reserves (PTTF) and Thong Pha Phum National Park (TPPNP) in Western Protected Area Complex

In this study, wildlife observation was conducted in various habitats within 57 km^2 of PTT Forest Reserves (PTTF), which co-operately established by Biodiversity Research and Training Program (BRT) and Petroleum Authority of Thailand (PTT). This forest was covered by 3 watersheds: Huai Ban Rai Watershed, Huai Pracham Mai Watershed, and Huai Khayeng Watershed (Fig. 2).

3.1.2 Habitat characteristic of PTT Forest Reserves (PTTF) and study sites

PTTF is located at the boundary of WTPP Forest covering 57 km^2. This PA is separating to 2 parts, lower PTTF and upper PTTF by dirt road and some crop such as corn and cotton.

Lower PTTF covers an area of about 37.7 km^2. The elevation range in this area is between 180 – 945 m from sea levels. Slope degree and elevation were high in south and west of the forest. The ridge in this forest area cover 2 watersheds: Huai Khayeng watershed in the east of area and Huai Pracham Mai Watersheds in the west of area. This forest comprises of 3 main forest types such as Mixed Deciduous Forest, Dry Dipterocarp Forest and Tropical Dry Forest. The disturbance levels in this part of PTTF were higher than upper PTTF due to more areas are closely contacted to human settlement area and there are lower slope. In this part there are 4 study sites conducted: A, B, C and D.

Upper PTTF covers an area of about 19.5 km^2. Slope in this area is higher than lower PTTF. The elevation range in this area is between 160 – 740 m from sea levels. Two watersheds can be found: Huai Ban Rai watershed and Huai Pracham Mai Watersheds. This area comprise several forest types such as Mixed Deciduous Forest around the forest boundary, Tropical Dry Forest around the streams and valleys and Dry Dipterocarp Forest distributing on ridge between 500 – 760 m from sea levels. The disturbance level from human were higher in east of this reserved forest that contact to agricultural and settlement area than the west that contact to Thong Pha Phum National Park. In this part there are 3 study sites: E, F and G.

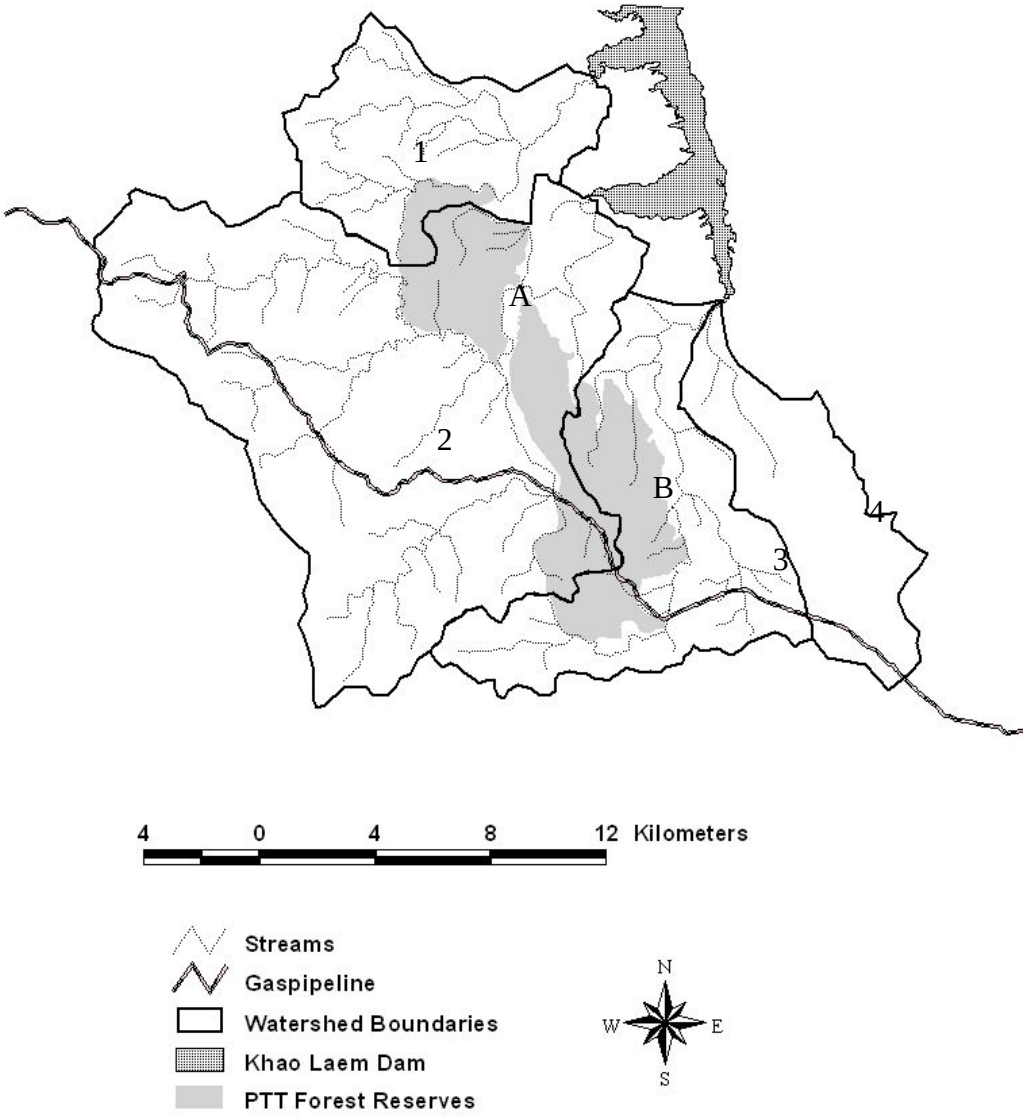


Figure 2: Watersheds classification in study area; 1 = Huai Ban Rai Watershed, 2 = Huai Pracham Mai Watershed, 3 = Huai Khayeng Watershed and 4 = Huai Tuem Watershed; A = Upper PTTF, B = Lower PTTF.

Survey was done in 7 sites within PTTF and 2 sites in TPPNP, covering 4 forest types include Mixed Deciduous Forest (site B, C, D and G), Dry Dipterocarp Forest (site A and E), Tropical Dry Forest (site F and H) and old mine in site I (Fig. 3). However, most habitats were disturbed forest, due to different human activities in each habitat.

Site A: site A is covered mainly by Dry Dipterocarp Forest. Elevation is between 400 – 700 m. from sea level. Dry Dipterocarp Forest community is mainly in narrow ridge and high slope degree in elevation between 500 – 700 m. from sea level. While, Mixed Deciduous Forest is present in lower elevation. This site is far from nearest village (Ban Pracham Mai) about 4.93 km. and from forest edge (gas pipeline) about 1.92 km. Line survey was conducted in human trail and elephant trail on narrow ridge.

Site B: site B is covered mainly by Mixed Deciduous Forest. Forest community is mainly bamboo plants and some trees such as *Lagerstroemia* sp. and *Ficus* sp. were found. Elevations in this site were between 400 – 500 m. from sea level and slope degree between 0 – 40 degree. This site is far from nearest village (Ban Huai Khayeng) about 2.97 km. and from forest edge about 1.13 km. Line survey was conducted in elephant trails.

Site C: forest community is similar with site B. Elevation is between 300 – 500 m. from sea level. This site is closed to forest edges. The distance from nearest village (Ban Huai Khayeng) is about 1.63 km. and distance from forest edge is about 0.27 km. Line survey was conducted in human trails on ridge.

Site D: this study site is closed with Pong Pu Ron Guard Station. Habitat is mainly Mixed Deciduous Forest and there are small areas of tropical dry forest in closed to limestone area. Elevations are between 400 – 600 m. from sea level. This site is far from nearest village (Ban Huai Pak Khok) about 3.10 km. and from forest edge about 0.87 km.

Site E: this site is closed to forest edge in upper part of PTTF. Elevations are between 300 – 700 m. from sea level. Slope degree in this area is high. There are narrow ridge whereas beside is a high slope valley. Habitat is mainly Dry Dipterocarp Forest at elevation between 500 – 700 m. from sea level. This site was far from nearest

village (Ban Huai Pak Khok) about 2.62 km. and from forest edge about 0.48 km. Line survey was conducted in human trails on ridge and this trail is also used by elephants.

Site F: habitat in this site is mainly disturbed tropical dry forest and there are small areas of dry dipterocarp forest in high elevation. *Dipterocapus* sp. and *Calamus* sp. were found in this area. In this area, many trees of *Dipterocapus* sp. were harvested for oil. Elevations were between 300 – 600 m. from sea level. Line survey were done on elephant trails on the ridge far from nearest villages (Ban Huai Pak Khok) about 3.91 km. and from forest edge about 2.23 km.

Site G: site G was set in a forest edge of northern part of upper PTTF. The forest is mainly Mixed Deciduous Forest. Elevations are between 300 – 400 m. from sea level. This site is far from nearest village (Ban Rai) about 3.24 km. and from forest edge about 0.57 km. even this site was far from local community but closely to roads and forest edges resulting in high human disturbance.

Site H: site H was set up in tropical dry forest in TPPNP. Even there are less sign of human disturbance in this area however, gun sounds were frequency heard. Elevation in this site was between 600 – 800 m. from sea level. The line survey was conducted in old trails near source of Huai Pracham Mai stream. The study site is far from nearest village (Ban Huai Pak Khok) about 9.1 km.

Site I: this site was set in old mine area. Line survey was done on old road. Elevations were between 700 – 800 m. from sea level. Habitat is covered mostly by some grasses, *Musa* sp. and bamboos. This site was from nearest village (Ban Huai Khayeng) about 9 km.

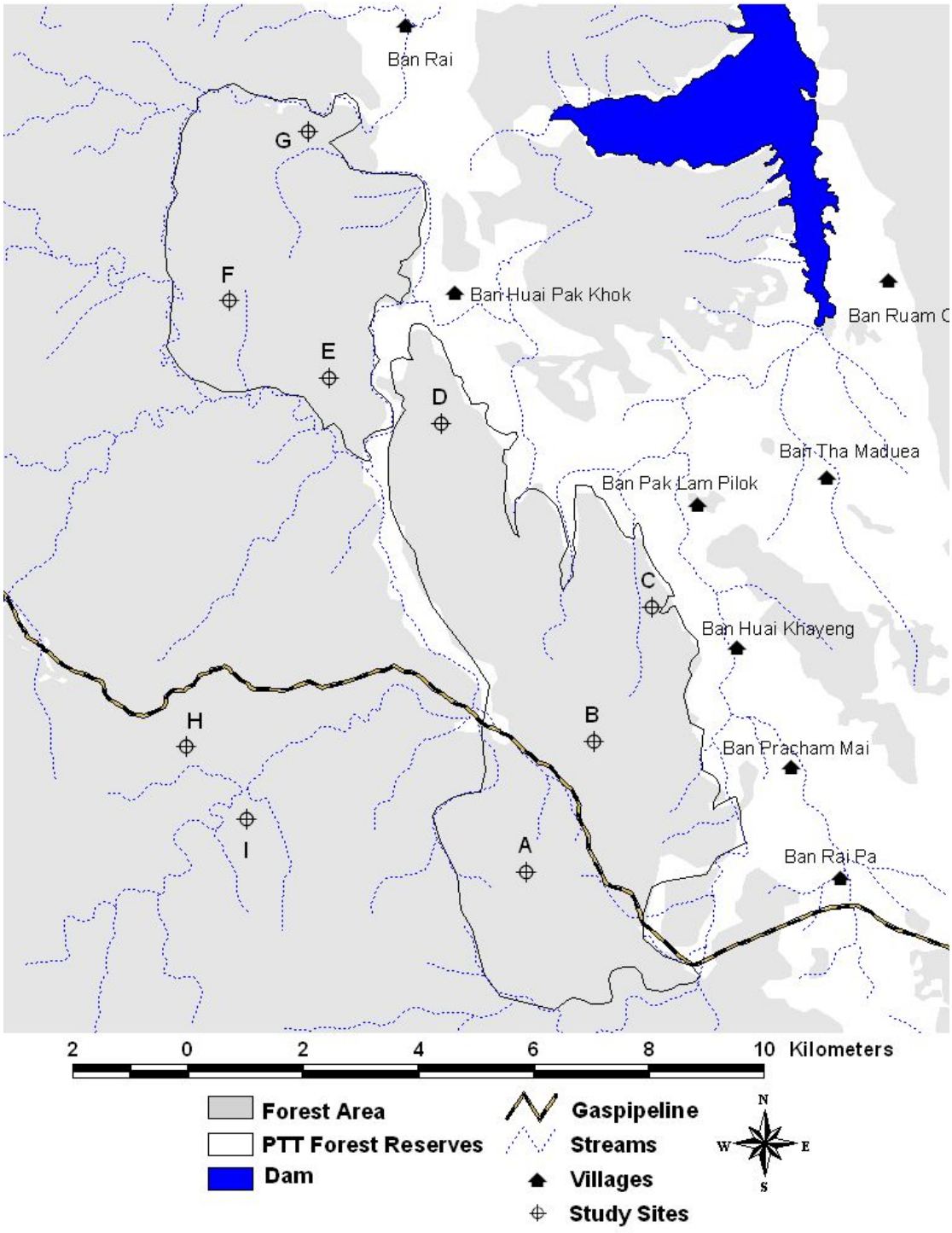


Figure 3: Area of PTT Forest Reserves, villages around forest and study sites.

3.2 Methodology

3.2.1 Observation of small carnivores and other mammals

During March 2004 – January 2005, Wildlife surveys were conducted in 9 study sites, 7 sites in PTTF and 2 sites in TPPNP. Simple methods were used in this study by focusing on small carnivores. However, other mammals were also observed. Although the methods were simple but it was enough for assessing status and abundance of small carnivores. Moreover, the simple method will be more useful for monitoring planning by local agencies in participating with local people for wildlife conservation management in the future. So, three methods were conducted including track station survey focusing on small carnivore community, walking trail survey and camera traps survey for briefly assessing status of wildlife in PTTF.

3.2.1.1 Track Station Survey

Track stations were conducted for assessing abundance and diversity of small carnivores. So, in this study, one 2 km line transect was set up in each of 9 study sites distributing in PTTF and some area of TPPNP cover all habitat types such as Mixed Deciduous Forest, Dry Dipterocarp Forest and Dry Evergreen Forest. One m^2 of track stations were made along transect and each station was 100 m. apart. The surface of each station was made smooth and soft by sieving soil. Banana and freshly fishes that are available in the area were baited on the stations. Bananas suitable to used even it is fruits because of strong smell and from previous research show that small carnivores in tropical forest like to eat fruits, not only fresh meat (Rabinowitz and Walker, 1991, Grassman, 1997 and Ray and Sunquist, 2001).

In 2 day period, animal tracks were checked everyday in the morning and recorded in data sheet (see in appendix A), then tracks in soil surface were fixed. Species were identified using tracks. Two main field guides were used: The Mammal Tracks of Thailand (Green World Foundation, 1997), and Carnivores of mainland South East Asia (Kanchanasakha, et al., 1998). Since some small carnivores have

similar size and characteristic of tracks, camera traps were set up at various stations to determine species of unknown tracks.

Overall, 360 station-night (40 station-nights/site) were conducted, 280 in PTTF and 80 in TPPNP. Although some studies show more trap-night will affect the reliability of data but most conducted in large area. In this study, size of Protected Area were about 57 km^2, therefore it is enough for representing status of small carnivores in this small PA.

Relative abundance is calculated using trap success/ trap night x 100. Trap success was derived from number of track station that animals were visited.

3.2.1.2 Walking Trail Survey

Intensive survey of wildlife was done within PTT Forest Reserves. Signs of wildlife in human trails and wildlife trails within study areas were observed. The presence of carnivores and other mammals signs such as scats, scrapes and tracks etc. were identified and recorded. Points of carnivore signs (record by GPS), species names and other details were also noted in data sheet. Information were analyzed and marked in 1:50,000 topographic maps to assess distribution and diversity of carnivores. In same period, signs of human activities and habitat characteristic in each area were recorded.

Although this method is rough, but the results can show general picture of diversity and status of mammals in this PA. In addition, information on habitat characteristic within PTTF can be obtained and used for making management plan in the future.

3.2.1.3 Camera Trap Survey

Camera trap in this study system is Passive CamTrakker (CamTrack South, Inc., U.S.A). Six camera traps were set distributing within PTTF. The camera were programmed to take a photograph every 30 second. The date of the photo was automatically recorded on each photograph. However,this method was not suitable in this area due to high human disturbance. Camera traps could not be set up for long

resulting in less trap success. Moreover, there are 2 times that some people tried to destroy cameras. Camera traps were set for the total of 95 trap-night.

3.2.2 Human Disturbance Survey

During track station survey, signs of human disturbance were observed in 2 km. line surveys in each study sites. Human signs in each site were classified into 3 main activities include hunting signs, domestic animals and non-forest timber products collecting. Each sign within and beside line were counted. Frequency of each activities among study sites were compared.

3.2.2.1 Hunting Signs

Old signs of fire, camping sites, hunting points and gun sounds were classified as hunting signs. In 2 km lines, such signs were counted and recorded. For camping sites, there are both semi-permanent and temporary sites. semi-permanent camping sites mean site that is constructed for mining in the past and used for staying when people travel to hunting in near forest. Most hunting points were near wildlife trails and some fruit trees such as figs. This study classified old signs of fire as hunting signs because most of them were occurred in dry seasons when there are less other resources available in forest. For gun sounds, this study was counted as number of sound/ day in each line survey.

3.2.2.2 Non- Timber Forest Products (NTFPs) collecting

NTFPs collecting was one of major activities occurring in this forest reserves. Previous study found that there are about 316 food plants, 16 species of bamboos and rattans and 4 species of dipterocarp oils were available in this forest (Naruchaikusol, unpublished). However, most sign that found in the survey are bamboo products collecting, *Curcuma parviflora* collecting and dipterocarp oils. This study counted number of signs every 100 m. distance for avoiding error of same collecting.

3.2.2.3 Domestic Animals

There are two groups of domestic animals that found in study area including domestic cattle and domestic dogs. Counting were different between 2 groups. For cattle, tracks of them were counted as one count in 100 m. distance, whereas dogs capable to count number of individuals in line survey by camera traps.

3.3 Data Analysis

Data of species were analyzed by program Excel for presence track station success, species composition and relative abundance of small carnivores. Habitat characteristic such as size of area, percent area of each slope degrees, elevations and distance of study sites from villages and forest edges were analyzed by program ArcView GIS. SPSS version 7.5 for analysis of the relationship between each factor such as disturbance levels and distance from village and forest edge, abundance of small carnivores and disturbance levels etc.

CHAPTER IV
RESULTS

4.1 Status of small carnivores and other mammals in PTT Forest Reserves (PTTF) and some areas of Thong Pha Phum National Park (TPPNP)

Eighteen mammal species were observed in this study including 10 carnivore species (Table 2). Ten mammal species were observed by walking on trails, 9 species from the track station survey and 2 from camera traps. However, some animals were confirmed to be present by local people such as Fea' Muntjac, Golden Cat, Banded Palm Civet, Banded Linsang, Ferret Badger and Yellow-Throated Marten.

From walking trail survey, Elephant is a large mammal distributed all over the area of PTTF. In year 2004, most of them immigrated to this area in the end of September and they moved to inside TPPNP in February of 2005. Track signs of Sambar Deer were found on the ridges of Upper PTTF. Size measurement confirm only one individual presented. Common Muntjac were distributed in both part of PTTF, however track signs showed low density. One individual were observed directly near forest edge of below PTTF. Serow is still present in this area. Signs of them such as feces and tracks were found in limestone area with high slope degree in Lower PTTF.

That highest abundance of large mammal in this forest is wild pigs. Their signs were found in every line of walking trail survey. Whereas lesser mouse deer were found only in dense forest near source of Huai Khayeng stream south of forest reserve.

Hog Badger and porcupine are only 2 species observed by camera traps setting in Upper PTTF. They were detected in dry evergreen forest near source of Ban Rai stream. Feces of small clawed otter were found along Huai Pracham Mai and Huai Kayeng streams.

Table 2: Species of Mammals were observed by 3 methods in study area

Species	**Method***	**Study Area****
Sun Bear	1	A
Elephant	1	A,B,C
Sambar Deer	1	A,C
Red Muntjac	1	A
Wild pig	1	A,B,C
Serow	1,2	B
Jackal	2	B
Binturong	1,2	B,C
Large Indian Civet	2	A,B,C
Small Indian Civet	1,2	A,B,C
Common Palm Civet	2	A,B,C
Masked Palm Civet	2	A
Leopard Cat	2	A,B,C
Small-Clawed Otter	1	C
Hog Badger	3	A
Lesser Mouse Deer	1	B
Porcupine	2,3	A,C
Domestic Dog	1,2,3	A,B

* 1 = Walking Survay, 2= Track Station, 3= Camera traps

** A = Upper PTT Forest Reserves, B = Lower PTT Forest Reserves,
C = Thong Pha Phum NP

4.1.1 Track station success, Species Presence and Composition of Small Carnivores and some mammals

From 360 station-nights of track station survey, 85 track stations were visited by small carnivores and some mammals, indicating 23.61 % trap success. Study sites D, G and C showed high trapping success as 42.5%, 35% and 32.5%, respectively. Study sites A and I have lower trap success as 10% both. 10 mammal species include 7 carnivores, 2 other mammals and domestic dogs were observed in 7 sites of PTTF and 2 sites of TPPNP (Table 3). From 9 study sites, 3 civet species such as Small Indian Civet, Common Palm Civet and Large Indian Civet were mostly present as 8, 7 and 7 study sites, respectively. Whereas Masked Palm Civet, Binturong and Asiatic Jackal were rarest species that only visited in one site.

Dog is a domestic animal found in several study sites. From camera traps, there are at least 9 individuals within 5 track station line surveys. Serow were large mammal found only at visiting track stations in site D. Even no serow tracks inside track stations but they were detected by camera traps. Camera traps were also benefit to separated domestic dogs at individual level and Asiatic Jackals.

The relationship between species presence and habitat types were shown in Table 4. The results indicate that Mixed Deciduous Forest is forest types that have most species presence as 8 species followed by Dry Evergreen Forest, Dry Dipterocarp Forest and Old mines as 6, 5 and 3 species, respectively. Common Palm Civet and Small Indian Civet were found in all habitat types, while masked Palm Civet, Binturong and Jackal were carnivores that visited only one habitat types. Masked Palm civets were found only in Dry Evergreen Forest whereas jackal and binturong were found in Mixed Deciduous Forest and Disturbed forest of old mines, respectively. Domestic dogs were presented 3 sites in Mixed Deciduous Forest and 2 sites in Dry Dipterocarp Forest. The result also show old mines in TPPNP were sites that had less species, only 3 species were visited in track pads and all were civet species.

Table 3: Species and number of track station visits in 9 track station line surveys;

Line	No. of trap visits										Total Trap Night	**% Trap Success**
	Common palm civet	Small Indian civet	Masked palm civet	Large Indian civet	Binturong	Leopard cat	Jackal	Serow	Porcupine	Domestic dog		
A*	1	0	0	0	0	2	0	0	0	1	40	**10**
B*	3	3	0	3	0	1	0	0	0	0	40	**25**
C*	2	1	0	6	0	0	0	0	0	4	40	**32.5**
D*	2	2	0	2	0	0	1	1	0	9	40	**42.5**
E**	0	3	0	2	0	0	0	0	0	1	40	**15**
F**	2	1	1	1	0	1	0	0	1	0	40	**17.5**
G**	0	2	0	6	0	0	0	0	1	5	40	**35**
H***	1	2	0	3	0	3	0	0	1	0	40	**25**
I***	1	2	0	0	1	0	0	0	0	0	40	**10**
Total	**12**	**16**	**1**	**23**	**1**	**7**	**1**	**1**	**3**	**20**	**360**	**23.61**

* = line surveys in Lower PTT Forest Reserve

** = line surveys in Upper PTT Forest Reserve

*** = line surveys in Thong Pha Phum National Park.

Table 4: Number of survey sites in each habitat type with each mammal species.

Species	Habitat types (9 survey sites)				
	DD (N=2)	MD (N=4)	DE (N=2)	SF (N=1)	**Total**
Common palm civet	1	3	2	1	**7**
Small Indian civet	1	4	2	1	**8**
Masked palm civet	0	0	1	0	**1**
Large Indian civet	1	4	2	0	**7**
Binturong	0	0	0	1	**1**
Leopard cat	1	1	2	0	**4**
Asiatic Jackal	0	1	0	0	**1**
Serow	0	1	0	0	**1**
Porcupine	0	1	2	0	**3**
Domestic dog	2	3	0	0	**5**

DD = Dry Dipterocarp Forest

MD = Mixed Deciduous Forest

DE = Dry Evergreen Forest

SF = Secondary Forest (Old mine)

Small carnivore community in this area consisted of mainly civet species. 5 civet species were observed from 9 overall wild mammals. Overall, percent visitation of Large Indian Civet were highest as 27% followed by Small Indian Civet, Common Palm Civet and Leopard Cat as 19%, 14% and 8%, respectively (Fig. 4). In this study, percent visitation of domestic dogs was very high, about 24% of overall station visitation. The species composition of wild mammals among 9 study sites indicate that species richness in site F were highest (6 species) followed by site D and H (5 species), site B (4 species), site C, G and I (3 species) and site with lowest richness is site A and E (2 species), respectively (Table 5).

The table also indicates that, even common palm civet were visited in 7 of 9 study sites but with low percent visit. In contrast, percent visitation of large Indian civet and small Indian civet showed dominant species in some study sites such as large Indian civet in site C (46%) and site G (43%) and small Indian civet in site E (50%) and site I (50%).

Domestic dogs were present in several sites. 5 of 9 track stations line survey were visited by dogs. There are 3 sites with high visited rates such as site D, G and C (52%, 36% and 31%, respectively). Most sites were located at forest edges less than 1 km. from agriculture areas.

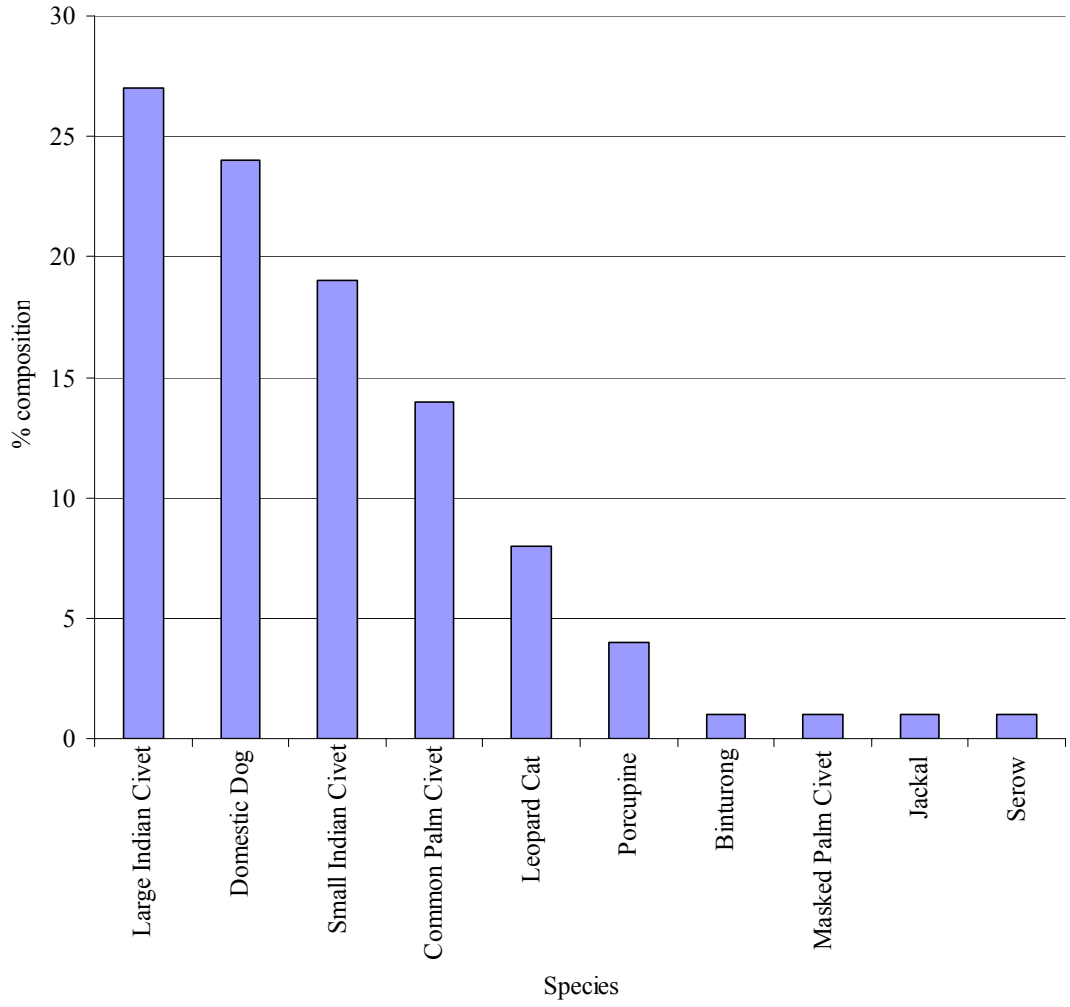


Figure 4: Species composition of small carnivores and some mammals in PTTF and some area of TPPNP based on track station visits, N=85.

Table 5: Percent visitation of small carnivores and other mammals among study sites by track station method

Species	% visitation of mammals in 9 study sites (N=85)									Average
	A, 1.92* (n=4)	B, 1.13* (n=10)	C, 0.27* (n=13)	D, 0.87* (n=17)	E, 0.48* (n=6)	F, 2.23* (n=7)	G, 0.57* (n=14)	H, 2.49* (n=10)	I, 3.85* (n=4)	
Common palm civet	25	30	15	12	0	30	0	10	25	14
Small Indian civet	0	30	8	12	50	14	14	20	50	19
Mask palm civet	0	0	0	0	0	14	0	0	0	1
Large Indian civet	0	30	46	12	33	14	43	30	0	27
Binturong	0	0	0	0	0	0	0	0	25	1
Leopard cat	50	10	0	0	0	14	0	30	0	8
Jackal	0	0	0	6	0	0	0	0	0	1
Serow	0	0	0	6	0	0	0	0	0	1
Porcupine	0	0	0	0	0	14	7	10	0	4
Domestic dog	25	0	31	52	17	0	36	0	0	24

* represent distance of each study sites from forest edges

4.1.2 Relative Abundance of small carnivores and some mammals

Overall, large Indian civet is the most abundant small carnivore, relative abundance is 6.39, followed by small Indian civet (4.44) and common Palm civet (3.33). Other species with low abundance were masked palm civet, binturong and jackal with relative abundance as 0.28. In addition, dog is a domestic animal with high abundance in this forest, relative abundance is 5.56 (Fig. 5).

Relative abundance of small carnivores in each study site was shown in Table 6. The results show that large Indian civets were highest abundant in site C and G, both are 15, both sites were mainly Mixed Deciduous Forest at the forest edge. Common palm civet were highest abundant in site B as 7.5 and small Indian civet were highest in site B and E. Leopard cat were low abundant in many site, except in site H where mainly by Dry Evergreen Forest in TPPNP, there are highest as 7.5. For domestic dogs, there are most detected in site D, G and C where closely with forest edge, relative abundance are 22.5, 12.5 and 10 respectively.

4.1.3 Activities of some mammals

Six mammals were detected by camera traps, including Large Indian civets, hog badger, Asiatic jackal, serow, porcupine and domestic dogs. Domestic dogs were mostly detected in this study. 4 species include large Indian civet, Asiatic jackal, serow and domestic dogs were detected from camera traps set together with track stations, and 3 species were detected by camera traps set alone are hog badger, porcupine and domestic dogs. The time presence in photo pictures indicate that most small carnivores were active in the night. Activities times of wild mammals were between 21:30 to 7:40. While activities time of domestic dogs were between 6:53 to 15:11. Frequencies of detected domestic dogs were most peaks in time between 3:00 – 4:00 pm. Large Indian civets were detected in time between 24:00 to 05:00. Serow is only species that were detected both in day and night times (Fig. 6).

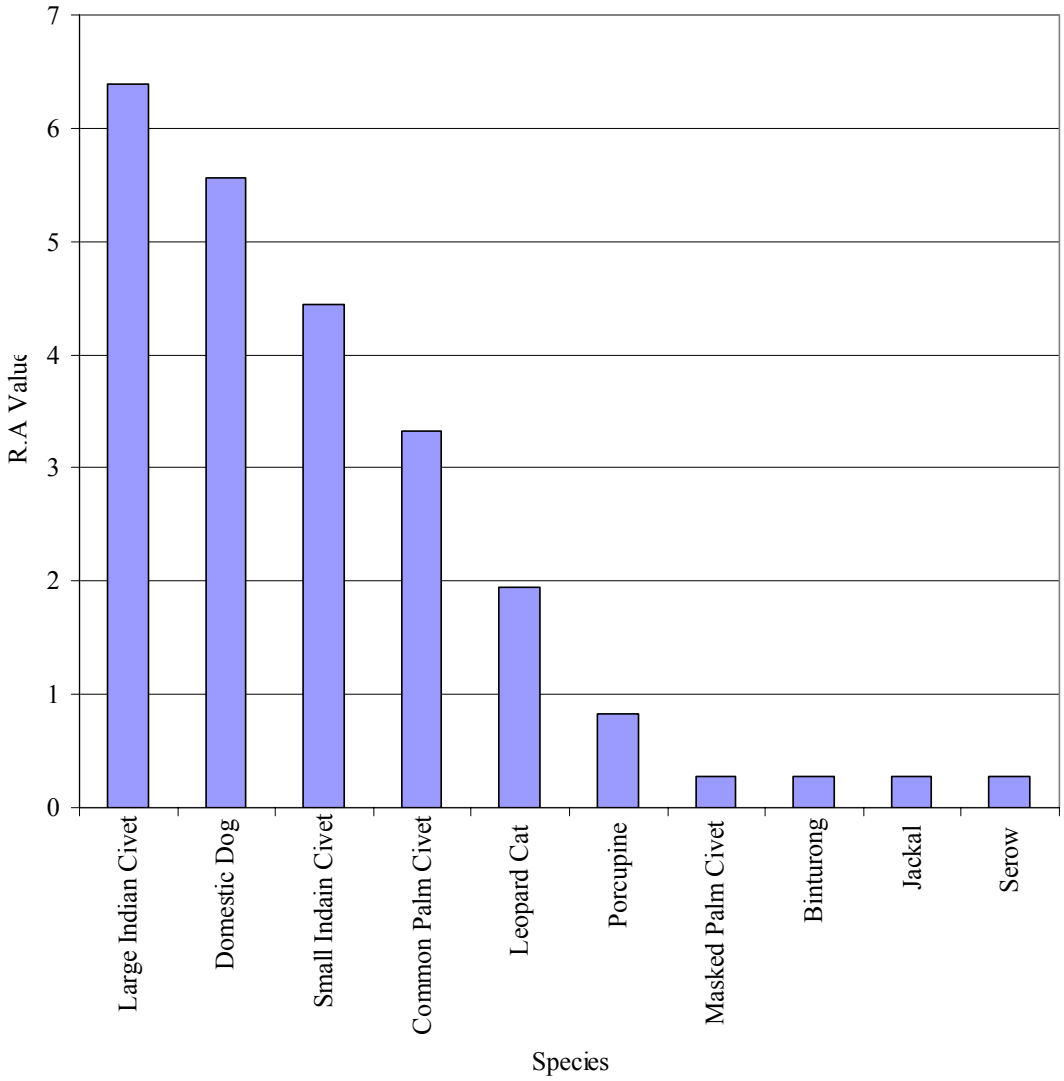


Figure 5: Relative abundance of small carnivores and some mammals in PTTF and some area of TPPNP

Table 6: Relative abundances of small carnivores and other mammals in 9 study sites.

Species \ Study sites	Relative Abundance (R.A)									
	A (DD)	B (MD)	C (MD)	D (MD)	E (DD)	F (DE)	G (MD)	H (DE)	I (SF)	**Average**
Common palm civet	2.5	7.5	5	5	0	5	0	2.5	2.5	**3.33**
Small Indain civet	0	7.5	2.5	5	7.5	2.5	5	5	5	**4.44**
Masked palm civet	0	0	0	0	0	2.5	0	0	0	**0.28**
Large Indian civet	0	7.5	15	5	5	2.5	15	7.5	0	**6.39**
Binturong	0	0	0	0	0	0	0	0	2.5	**0.28**
Leopard cat	5	2.5	0	0	0	2.5	0	7.5	0	**1.94**
Jackal	0	0	0	2.5	0	0	0	0	0	**0.28**
Serow	0	0	0	2.5	0	0	0	0	0	**0.28**
Porcupine	0	0	0	0	0	2.5	2.5	2.5	0	**0.83**
Domestic dog	2.5	0	10	22.5	2.5	0	12.5	0	0	**5.56**

DD = Dry Dipterocarp Forest, MD = Mixed Deciduous Forest, DE = Dry Evergreen Forest,

SF = Secondary Forest (Old mine)

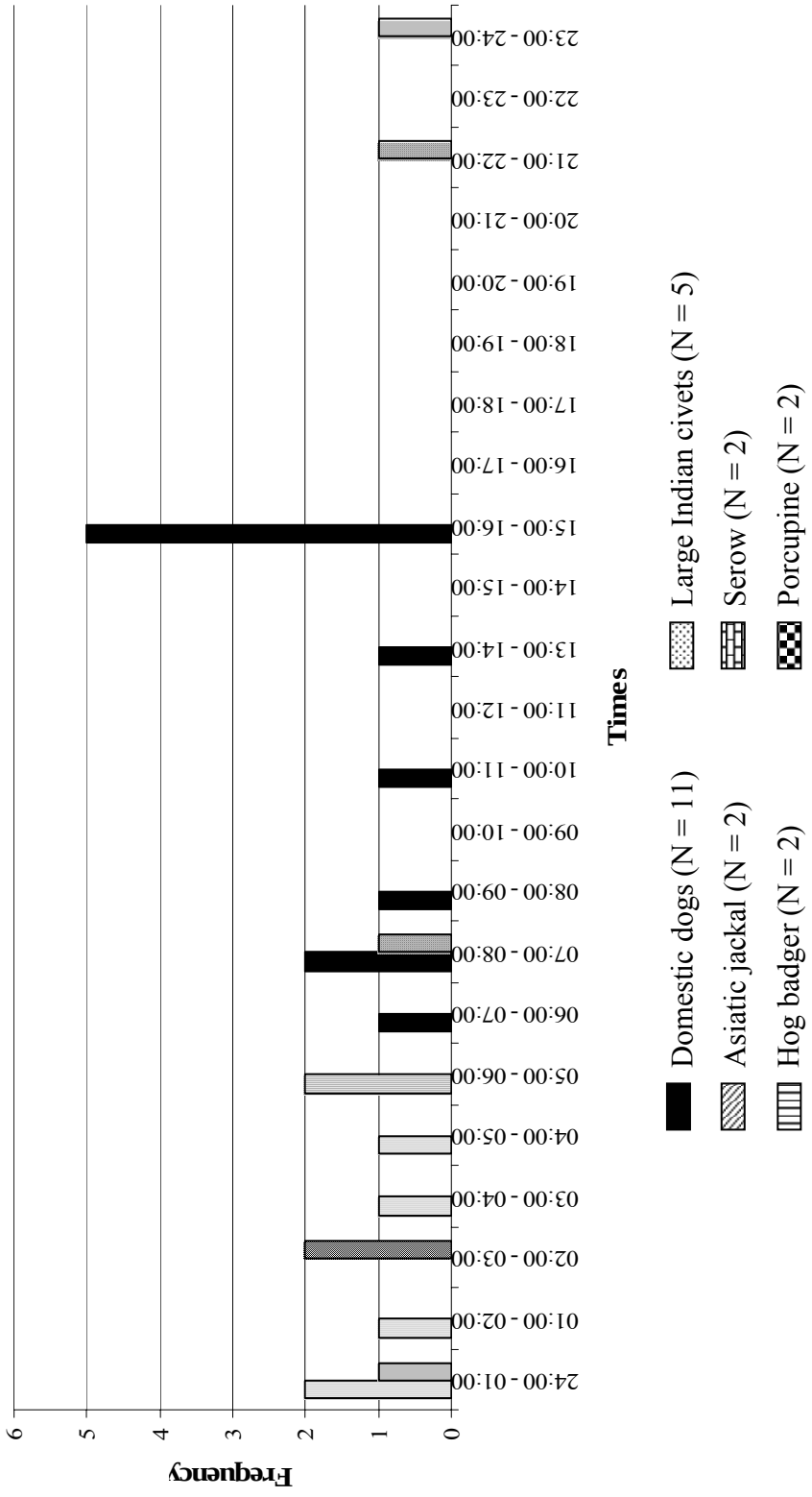


Figure 6: Activities times of 6 mammals detected by camera traps

4.2 Human activities and some disturbance factors in PTTF

There are three main activities of local people in PTTF include hunting, Non-Forest Timber Products (NTFPs) collecting (most signs is a piece of bamboo) and domestic cattle herding from Myanmar. Moreover, domestic dogs were also abundant in this forest. Total of disturbance activities show that study site A and C were found most frequent signs as 10 counts/ 2 km line. However, frequency of each activity signs were different among study sites (Table 7).

The results indicating that dominant activities in each area were different. Hunting signs represented by gun sounds, camping sites and fire points in site A, F and H have more frequency than other sites as 9, 6 and 6 counts/line, respectively. In contrast, in study site C, D, E and G where close more to villages, frequency of NTFPs collecting and domestic animal signs were high, but there are lower signs of hunting.

This study, fire signs were found in most study sites, while old camping sites were found only 3 sites include site A, H and I where far from villages than other sites. Six study sites, gun sound were heard, especially in site A (4 counts/ 2 km/ day) and H (3 counts/ 2 km/ day) that far from village and National Park guard station. Moreover, old hunting places on trees were found together in these areas.

Signs of domestic cattle were found in study sites near to forest edges and villages. In addition, there are signs and direct observation of herd of cattle on gas-pipelines which most were herded from Myanmar. During this study, there are 2 times that cattle were seen traveling along the gas-pipeline. There are more than 30 individuals counted in each times.

4.2.1 Relationship between the distance of villages and pattern of human activities

Distance of 9 study sites from nearest villages and forest edges were analyzed by program ArcView GIS. Five villages were close to the study areas include Ban Huai Kayeng, Ban Huai Pak Khok, Ban Rai and Ban Pracham Mai (Fig. 3). The distance of study sites from villages is between 1.630 - 9.133 km. While, the distance of study sites from forest edges is between 0.275 - 3.848 km. The nearest study site to

a village is site C which distance about 1.630 km. from Ban Huai Kayeng, while site H in TPP National Park were most far from village about 9.133 km. from Ban Huai Pak Khok (Table 7).

Pattern of human activities were related with distance from villages. Overall, although, the frequency of disturbance signs was not significantly correlated with distance from villages, r = - 0.295 (p = 0.441). However, there are different correlations among each type of human activity and distance from villages. The negative correlation of NTFPs collecting and domestic animals with distance indicated that there tended to increase in forest close to villages, r = - 0.831 (p = 0.006) and - 0.685 (p = 0.042), respectively (Fig. 7a,b). In contrast, hunting activities were tended to increase in area that far from villages, r = 0.552 (p = 0.124), however this correlation were non significant.

4.2.2 Forest Fire

Forest fires in PTTF occurred every year and most were burned by local people. Forest fire usually spread from crop area near the forest edges where local people burned their crops in dry season. Moreover, sometimes they burned forest directly to clear dry leaves in the ground, it is useful for decreasing sound when they walk to hunting. In 2004, forest fire were started in the end of November and it was expected to be present for all dry season. The analysis and estimated affecting area from forest fire on December 2004 – January 2005 by using GIS show that forest that closed to edges were mostly disturbed (Fig. 8). Burning area about 4 km^2 was estimated. However, from interviewing local people about forest fire last year, there are more affected areas and continue to cover most of PTTF area before wet season.

Table 7: Some disturbance factors in 9 study sites

Line	Nearest village	Distance from nearest village (km)	Distance from nearest forest edge(km)	Hunting signs*				Domestic Animals*		NTFPs*	**Total**
				Fire point	Camping sites	Gun sound	Shooting sites	Dogs**	Cattle	collecting sign	
A	PM	4.930	1.918	2	1	4	2	1			**10**
B	HK	2.969	1.133	1					1	2	**4**
C	HK	1.630	0.275	2				2	2	4	**10**
D	HPK	3.102	0.875	1		1		3		2	**7**
E	HPK	2.615	0.482	2				1		2	**5**
F	HPK	3.915	2.229	3		2	1			1	**7**
G	BR	3.237	0.574	2		2		2		2	**8**
H	HPK	9.133	2.492	1	1	3	1				**6**
I	HK	9.008	3.848	1	2	2					**5**

* data were colleted from counting in 2 km. line survey

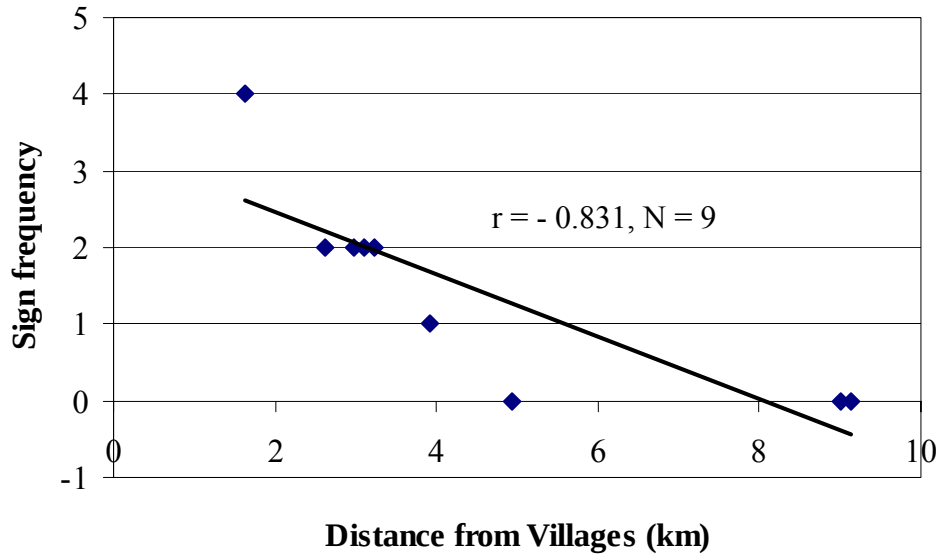
** the number show individuals were detected by camera traps in 2 km. line survey

PM = Ban Pracham Mai

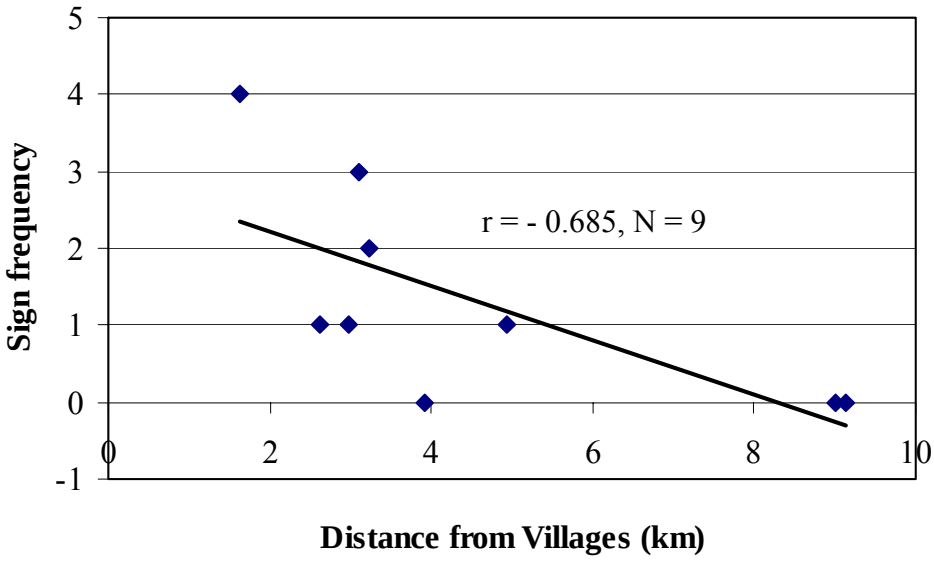
HK = Ban Huai Kayeng

HPK = Ban Huai Pak Khok

BR = Ban Rai



a. NTFPs collecting



b. Domestic animals (dogs and cattle)

Figure 7: Relationship between human activities and distance from village.

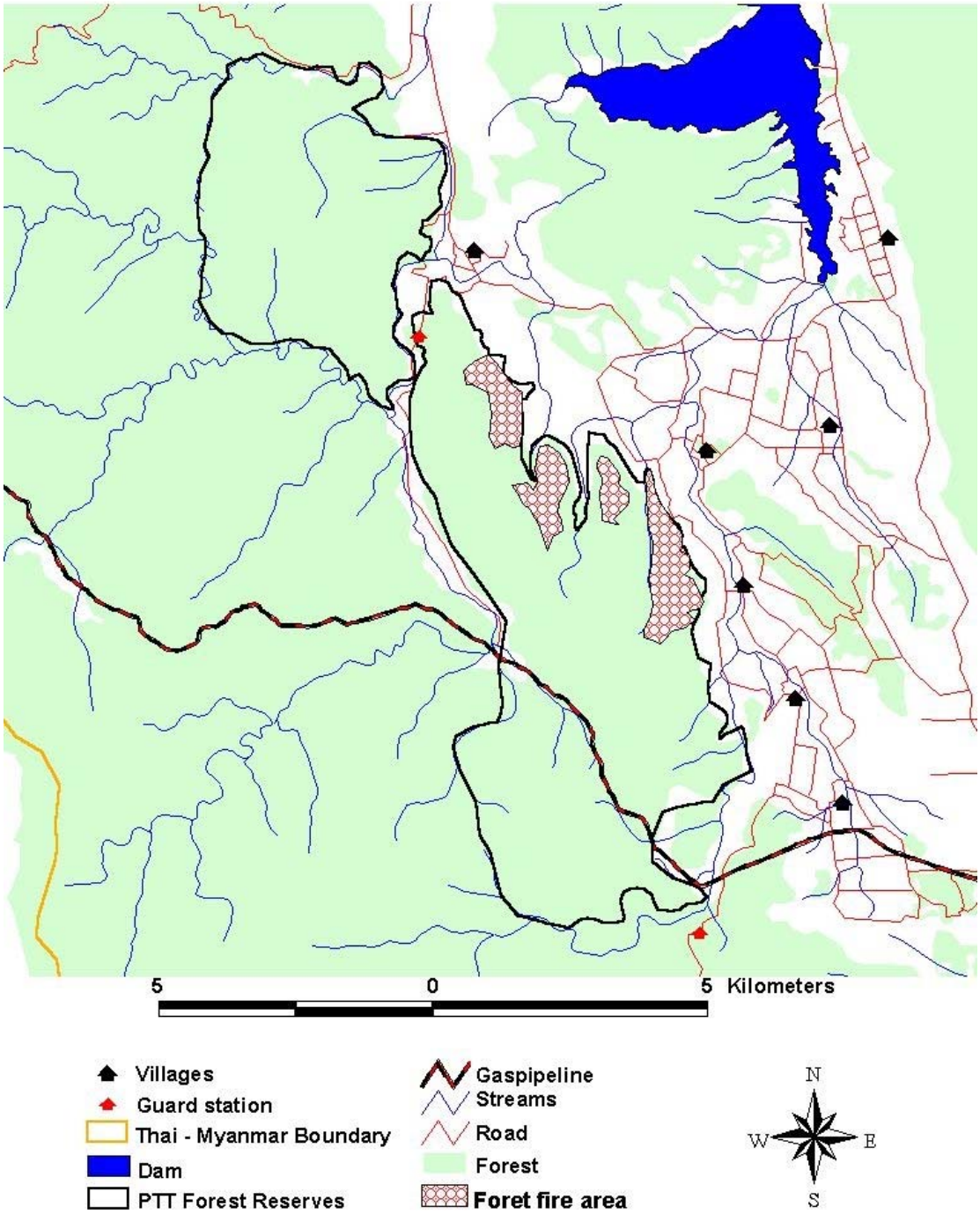


Figure 8: Forest fire areas in PTT Forest Reserves occurred on December 2004

4.2.3 Domestic Dogs

Domestic dogs were found in 5 of 9 track station line surveys. They were detected by camera traps in 4 line surveys and one line were only found track signs. Most sites were located in PTT forest reserves. From camera traps that setting together in track station lines were identified to 9 individuals of dogs. Moreover, other camera traps setting in Upper PTTF also detected dogs and identified to 3 individuals (Table 8). From most pictures, the owners of dogs were not detected. In addition, only in site A that dog were detected alone. While other sites there are at least 2 dogs travel together (Fig. 9).

The results show that most domestic dogs were detected in study sites less than one km from forest edge. The comparison of dog abundance among different area from forest edge found that domestic dogs tend to be less abundant in area far from forest edge. Relative abundance is 11.87 in area of less than 1 km from forest edge (4 line surveys), 1.25 in area between 1 – 2 km from forest edge (2 line surveys) and not detected in area more than 2 km from forest edge (3 line surveys).

Table 8: Domestic dogs detected by camera traps, ranging by date of detected

Dog Names	**Date**	**Time detected**	**Study sites detected**	**Nearest distance from**	
				village(km)	**forest edge(km)**
W1	20/7/04	unknown	C	1.63	0.275
B1	6/8/04	15:04	445488, 1623736*	4.587	0.507
B2	6/8/04	15:02	445488, 1623736*	4.587	0.507
W3	6/8/04	15:04	445488, 1623736*	4.587	0.507
W2	17/9/04	6:53	C	1.63	0.275
Br1	17/9/04	6:53	C	1.63	0.275
B3	23/10/04	7:08	D	3.102	0.875
Br2	23/10/04	unknown	D	3.102	0.875
W4	23/10/04	unknown	D	3.102	0.875
B4	27/10/04	13:51	G	3.237	0.574
B5	28/10/04	10:13	G	3.237	0.574
W5	5/12/04	15:02	A	4.93	1.918

* is site of camera trap setting out of track station line survey.

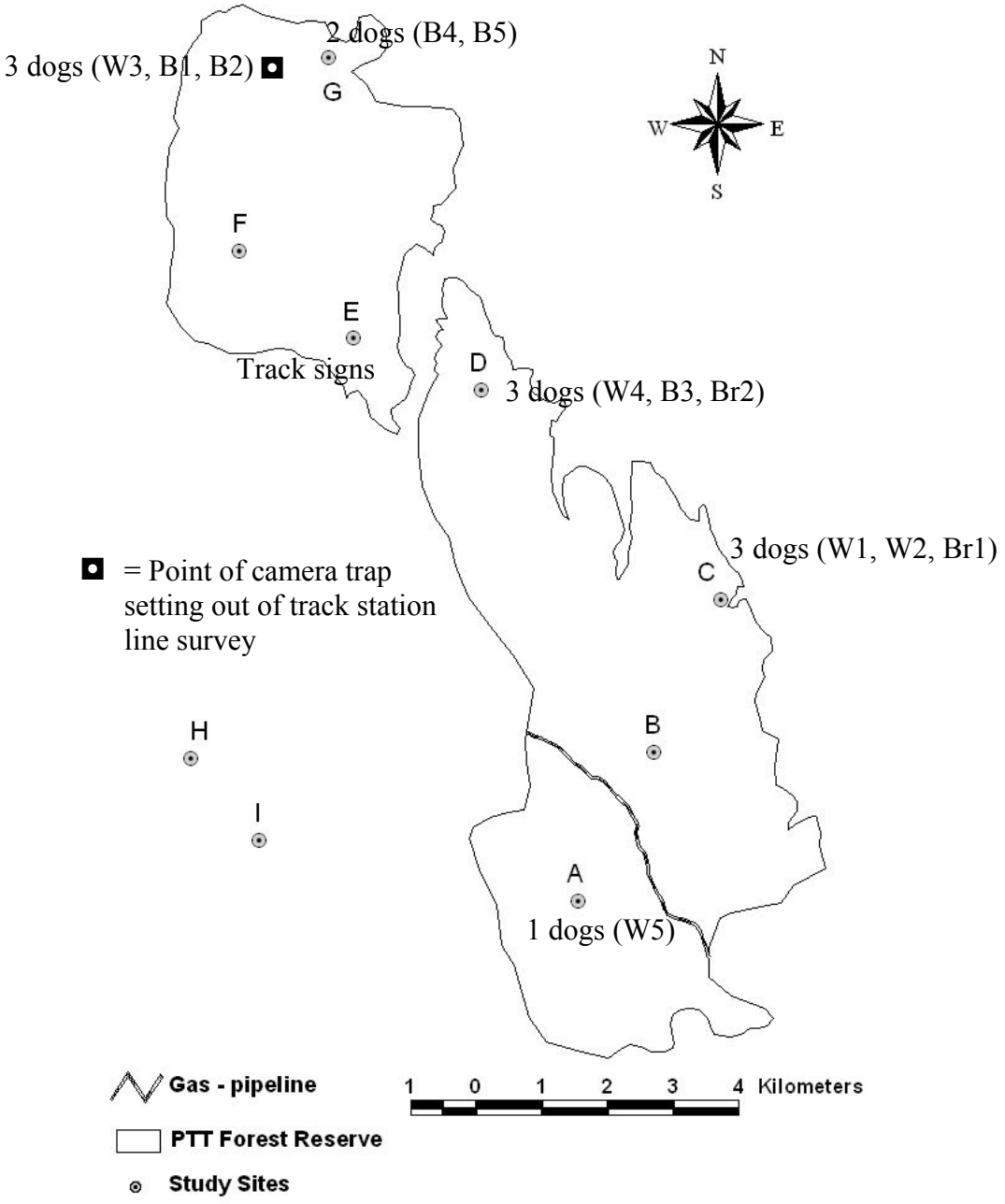


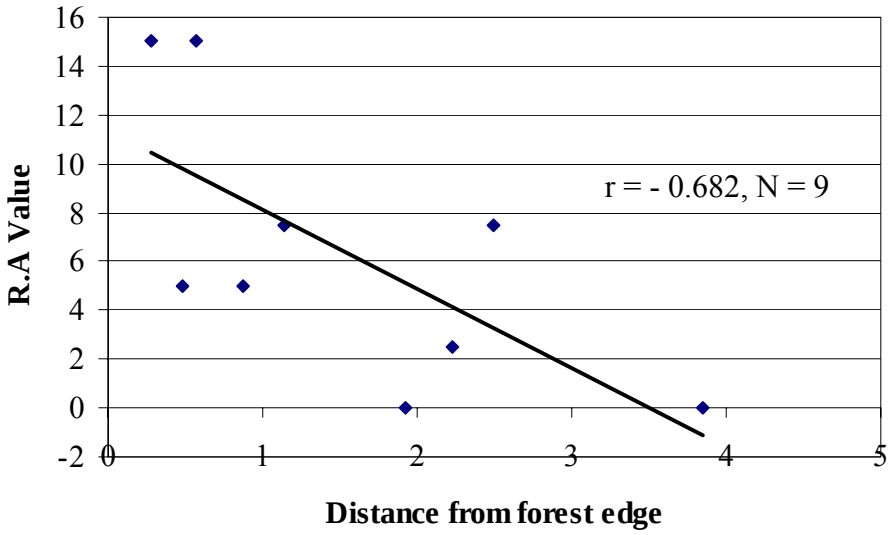
Figure 9: Number and distribution of domestic dogs that detected by camera traps and track signs in each study sites

4.3 Relationships between human activities and abundance of small carnivores

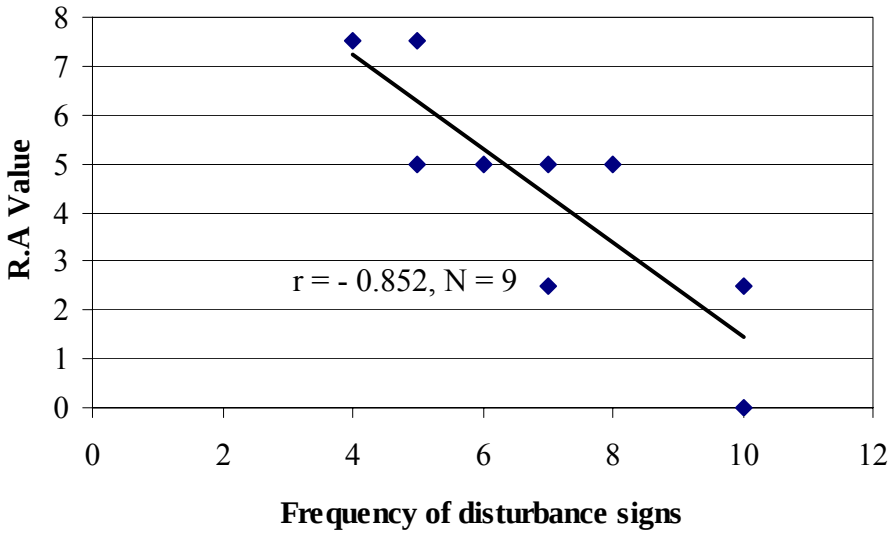
Overall, the study indicated that human activities as a whole in the forest and mammal abundance were not significant correlation due to the similarly of disturbance level among study sites. This relation were tended to negative ($r = - 0.128$, $p = 0.743$).

However, different types of human activity had different relationships with distance, some factors and human activities showed significant relation with specific small carnivores. The result indicates that forest edge was a habitat preference of large Indian civet. The correlation test between the distance from forest edges and this species show that abundance of this species increased when closed to forest edge, $r = - 0.682$, $p = 0.043$ (Fig. 10a).

Hunting is an activity that affects species presence of some small carnivores. This activity was negatively, but insignificantly related with overall mammal abundance in this study ($r = - 0.511$, $p = 0.160$). However, hunting level affected abundance of small Indian civet. The abundance of small Indian civet was tended to decrease in area in which hunting signs were high, $r = - 0.726$, ($p = 0.027$). Small Indian civet was also negatively related to disturbance level. They tended to be less abundant in study sites with high level of human disturbance, $r = - 0. 852$, $p = 0.004$ (Fig. 10b). There was no significant correlation between disturbance level and other small carnivores.



a. Large Indian civet



b. Small Indian civet

Figure 10: Relationship between some disturbance factors and abundance of 2 civet species

CHAPTER V
DISCUSSION

5.1 Status and diversity of small carnivores and other mammals in PTT forest reserves

Most large carnivores were absent in this small forest reserves. Only two species of bears is large carnivores present in this area. Whereas large cats such as tiger (*Panthera tigris*) and leopard (*Panthera pardus*) were absent. However, the presence of medium –sized cats as clouded leopard (*Neofelis nebulosa*) were confirmed by local hunters in upper part of PTT forest reserves about 3 year ago. These large carnivores were present inside Thong Pha Phum National Park (TPPNP) but with very low density. Although, this small reserve was connected with National Park but the using area of large carnivores were less because there are less density of large and medium size mammals such as sambar deer, primate and muntjac, which are main prey of large carnivores (Rabinowitz, 1989, Grassman, 1997). The low density of such prey is resulting from concentrated hunting in the past and these mechanisms were continuing to TPPNP at present day.

Both species of bear were still present in this reserve because feeding ecology of them was flexible. They are omnivores which capable to eat a wide range of food, therefore, food supply in this area is enough. *Salacca wallichiara* (Rakam in Thai) and bee nests are preferred food of them (Wong, 2002) and such foods still abundance in this area. However, Rakam and bee nests are NTFPs available of local people in the area (Naruchaikusol, unpublished) and may result to competition between these carnivores and local people if these foods become scarce.

5.1.1 Small carnivores

Small carnivore community in this forest reserves were mainly civets. 5 of 7 small carnivores observed by track station survey were member in family Viveridae. In nearby forest, Huai Kha Khaeng (HKK)/Thung Yai Naresuan (TY) Wildlife Sanctuaries, current research have shown that there are 8 viverrid species distributing in the area includes Large Indian civet, Large spotted civet, Small Indian civet, Common palm civet, Masked palm civet, Three-striped palm civet, Banded linsang and Binturong (Conforti, 1996). From that list, there are 3 species not found in this study include Large spotted civet, Three-striped palm civet and Banded linsang. However, the presence of banded linsang was confirmed inside Thong Pha Phum National Park by hunters. Distribution and abundance of 5 civet species in these reserves were explained as following

Large Indian civet (*Viverra zibetha*): Among 5 viverrid species that were observed in this study, large Indian civet was mostly abundant. Only 2 of 9 sites were not found this species include site A and I located at narrow ridge and high slope degree. In study sites closed to forest edges, these species were mostly abundant and showed dominated small carnivore community, especially in site C and G, which located at forest edge of both Lower and Upper part of PTT forest reserves. This species can eat a wide range of food and adapt to habitat change (Lekagul and McNeely, 1977), resulting in their presence in several habitat types such as Mixed Deciduous, Dry Evergreen, Dry Dipterocarp (Rabinnowitz,1991), and rubber plantation (Kanchanasaka, 2000). In this study, Mixed Deciduous near forest edges were high abundance of this species may be due to variety and abundance of animal foods. In edge area, even there are less of fruits trees but some animals was abundant such as bamboo rats, which confirm by usually capture success of local people in this area. In some site, Large Indian civet abundance was low and can not be observed in this study such as site A and I. For site A, forest type were mainly Dry Dipterocarp Forest on narrow ridges, low abundance of this species were likely with previous study at HKK that showed lowest habitat use of large Indian civet on dry dipterocarp forest (Rabinnowitz, 1991).

Small Indian civet (*Viverricula malaccensis*): Although, the abundance of this species was lower than large Indian civet but they were found in all forest types including old mines that large Indian civet were not found. Although, small Indian civet was secondly most abundant species, however relative abundance in each study sites did not show as dominant species. This result differed from large Indian civet that showed dominant in some area such as forest edges and low abundance in some habitat types such as dry dipterocarp forest. Small Indian civets were observed in dry dipterocarp forest where few small carnivores such as site E and grassy area of old mine, which similar with other studies. In HKK, small Indian civet used dry dipterocarp more than other forest types (Rabinnowitz, 1991) while secondary forest had highest abundance of them in study of Conforti (1996).

Common palm civet (*Paradoxurus hermaphroditus*): Like small Indian civets, common palm civets distributed all habitat types. However, this civet has low abundance in upper part of forest reserves. 2 of 3 study sites that conducted at this part were not visited by common palm civet. Both unfound sites were located near forest edges. The low abundance of them in such area may result from less food available. Although common palm civet was classified in Order carnivora that means meat eater but their behavior like omnivores and more like fruits than animals (Lekagul and McNeely, 1977, Rabinnowitz, 1991, Grassman, 1997). Nevertheless, study sites E and G in upper part reserves were less available of fruit trees; figs for example, while in core of lower part of forest reserves figs trees were more abundant and result to higher abundance of common palm civet in site B where near core of lower part of protected area.

Masked palm civet (*Paguma larvata*): there is very low abundance of masked palm civet in this forest reserves. Only one time they visited track station of site F where dominated by dry evergreen forest. Masked palm civet is omnivorous like common palm civet. However, whereas common palm civet were present in most sites, masked palm civet was very rare. These may be due to interspecific competition. In HKK/TY Wildlife Sanctuary, the study showed that abundance of Masked palm civet was very low when the abundance of Common palm civet are high (Conforti, 1996). In this forest reserves, Common palm civet were common elsewhere. In limited food resources situation, they may be great competitor for other palm civets.

Binturong (*Arctictis binturong*): there is only one track station visited in old mine inside TPPNP, whereas there is no station visited in PTT forest reserves. However, there is one time of direct sighting in the core of below forest reserves near site B confirm the presence of this species. This study found that most of fruit eating civets such as common palm civet and binturong prefer area of site B because there are more fig trees around this area which benefit to these civets. In old mine of site I there are some fruit trees that introduced by workers in mining period such as lemon, pomelo, mangoes etc. which may benefit to binturong.

Other small carnivores in this forest reserves were less abundant. One felid that still common is leopard cats (*Prionailurus bengalensis*). This species found distributed in all forest reserves but low abundance elsewhere, except in site H covering by evergreen forest inside TPPNP. At study sites near forest edge, leopard cats were not found in track station. The results may be due to avoidance of this species to large Indian civets or domestic dogs which is dominant species in these areas. Not only leopard cat that low abundance in forest edges, other true carnivores were also low abundant. While, some civets such as common palm civets and small Indian civet capable use same area more because more wide range of foods result to food niche which less overlap with other species.

Asiatic jackal (*Canis aureus*) is one of small carnivores that visited track station line near forest edges. Asiatic jackal is one of 2 canids that found in Thailand and this species were more adaptable to habitat disturbance than dhole. In forest reserves, jackal was detected by camera trap setting within track stations. This method was benefit to separate them from domestic dogs which high visitation rate in this area.

Hog badger (*Arctonyx collaris*) were not observed by track station but were detected by camera trap setting in upper part of forest reserves. This species was still common in forest reserves, particularly upper forest reserves. There is also one direct sighting of this species beside roads near upper part of forest reserves. Ecology of this carnivore was still unclear. They feed on variety of insects, small animals roots etc. (Lekagul and McNeely, 1977). In addition, small clawed otters (*Aonyx cinerea*) are species that still common in the area. Many feces sites were found on the rock beside streams. Other otter species were not found in this study because there are only small

streams in forest reserves which less food supply for other otters which most were larger than small clawed otters. Small clawed otters like to eat small crabs, mollusks and small size animals which available in small stream, while, others eat mostly fishes (Kruuk, et al. 1994). This is reason that why there are only small clawed otter in this area. However, inside TPPNP with more large streams, especially within Huai Pracham Mai Watershed, other species are possible to present.

For other small carnivores, there are confirming the presence such as golden cat (*Felis temminicki*), banded linsang (*Prionodon linsang*), Burmese ferret badger (*Melogale personata*) and yellow-throated marten (*Martes flavigula*). Even not found them in the study but this confirm show that small carnivores in this small reserve are still diverse, but may live in low density.

- Community characteristics of small carnivore in disturbed forest of a small protected area

Ten carnivores found in this small PAs is half of carnivores documented present in near forest at HKK and TY (Conforti, 1996). Although, this result may not be a true species diversity due to the other species that confirm the presence by hunter still not included, however the low diversity and characteristic of small carnivore community in this area indicate influence of human disturbance on them. Overall, small carnivore community in this PAs was mainly generalized carnivores, especially viverrid species. This result confirms adaptability of these species in disturbed forest (Lekagul and McNeely, 1977, Heydon and Bulloh, 1996). Very high abundance of large Indian civet in this forest indicates the successfulness of this species to survive in disturbed forest. While, other strongly predators such as some felids were less abundant.

Microhabitat may also influence small carnivore community in this area. In edge area where habitat mainly by bamboos and there are less trees, dominant carnivore community are large Indian civets whereas, common palm civets and mask palm civet show very low abundant, even they are very common species in several area (Rabinnowitz and Walker, 1991, Conforti, 1996, Heydon and Bulloh, 1996, Grassman, 1997). While, in more complex forest, abundance of each species is likely

to equal. There are 2 study sites that have less diversity of carnivores as only 2 species, both were mainly by dipterocarp forest on narrow ridges. The result indicates less preference of small carnivores on this habitat type, similarly with previous study in HKK (Rabinnowitz, 1990a) and HKK/TY (Conforti, 1996) that found less diversity in this habitat. The less using of small carnivores in this area may result from less prey availability. In HKK, dry dipterocarp have low abundance and biomass small mammal, the main prey of small carnivores than other habitat types (Walker and Rabinowitz, 1992). Moreover, high slope degree in both dipterocarp habitats in this study may also result to very low diversity of small carnivores.

5.1.2 Other mammals

Large mammals in this forest reserves live in low density. Sign of large mammals that mostly found in this reserve is elephants (*Elephas maximus*). The population of them is still unclear, however there are notice of local people that they are increasing every year. PTT forest reserves are an important area for elephants. From walking trail survey sign of elephants foraging were covered all area, especially within Lower PTT forest reserves. Bamboo is important foods for them which high abundant in this reserves. Moreover, saltlick at Pong Pu Ron Guard Station is important sites that elephants frequently visited.

Both species of barking deer include common muntjac (*Muntiacus muntjak*) and Fea's muntjac (*Muntiacus feae*) were present in this area. However, sign of these species were difficult to separate. Local people call Fea's muntjac as "khaeng dam". Some people said that they usually hunted this endangered species near forest edges in the last few years. However, from walking survey both species have low density in this area.

There is one time that track signs of sambar deer (*Cervus unicolor*) were found on ridge of upper part PTT forest reserves. This finding is a surprise for local people that survey together because they had not been found in this area for a long time. However, this sambar deer may just move from inside TPPNP for eating fresh grasses that there is abundant on the ridge in rainy season and go back when feeding finished.

Serow (*Capricornis sumatraensis*) is one large mammal that still common in this area. From camera trap, reddish legs of them confirm subspecies in this area is *C. s. milneedwardsi* which they range from Tenasserim north to China (Lekagul and McNeely, 1977). In this reserve, sign of them were mostly found around limestone area of "Khao Dang" in lower part of reserves. Trail and feces of them were also frequently found in area lower elevation near site D. The survival of this large mammal in this area is high because their habitat were closed to guard station resulting in difficulty of illegal hunting. However, if opportunity opened, hunters can hunt them so easily.

In addition, some endemic species such as Regal crab (*Demanietta sirikit*) also found within PTTF. Most sign of them is a piece of crab shell that found in source of small streams. The sign indicated that they are prey of some small carnivores. For other endemic species, Kitti's hog-nosed bat (*Craseonycteris thonglongyai*) there are no sign of them within this PAs, however, their caves with low population of them were found in small limestone mountain outside PAs.

5.2 Pattern of human activities in a small protected area of PTT Forest Reserves

The results indicate that there are diverse activities in PTTF. This was not surprise when consider the number and characteristic of local community around the forest. There are 6 villages around this forest reserves, 3 villages located within 1 km from forest edges and 3 villages located within 1 – 2 km from forest edges. So, local people within such villages used forest resources both direct and indirect. For wildlife, previous study on NFTPs using in this area found that there are more than 40 bird species, about 30 mammal species and 10 amphibians/reptiles species listed as food (Naruchaikusol, unpublished).

This study briefly classified activities in PTTF to 3 types include hunting, collecting of NFTPs and domestic animals. These activities have different pattern and disturbed level related with distance from villages/forest edges and resources availability. Moreover, some current disturbance from forest fire was also discussed.

5.2.1 Hunting

In tropical forest, there are 5 main factors affecting hunting including physical, biological, social, cultural and economics (Bennett and Robinson, 2000). In this study there are no significant relation between distance of forest from villages and hunting frequency. However, results indicated that level of hunting were high in area that far from villages. Other studies in tropical forest were different. For example, in an Amazonian community the hunting is mostly intense near human settlement (Sirén, et al., 2004) and snare density was decreased as distance from the village increase (Muchaal, 1999). Difference of result in this study compared with hunting pattern in other tropical forest may be due to density of wildlife and protected area system.

However, although there are little hunting signs in forest area closed to villages. But in reality, hunting occurred. In forest area near villages, most of hunters did not travel for few days, only one night period were visited to hunt small animals such as civets, palm civets, slow loris etc. that are available in the area. This hunting pattern results in less sign of camping sites, shooting sites and gun sound. Most of them are fire signs. In contrast to more distance forest, hunting activities occurred both day and night periods as they feel safe from park rangers. So, some signs were more frequently observed such as gun sound and shooting sites, and since they traveled for many days, many camping site were found. The study also showed that there was re-using old semi-permanent camping sites that conducted in mining period by hunters.

Most of hunters were minority people who had no land for providing certain livelihoods. For example, in Ban Huai Khayeng village, most of hunters are Mon and Karen, which they used free time from temporary worker to travel in the forest, which, some people have free time along the week. Such people hunted wildlife aim for consumption within household more than for sale. Hunting for sale is also present in this forest, however there is less information as it is safer to keep it secret in order to protect themselves.

5.2.2 Non-Timber Forest Products (NTFPs) collecting

Less data on NTFPs collecting activities in this study make it difficult to analyze effect of them on small carnivore community. NTFPs collecting signs in the study were mostly come from sign of bamboo products. Even though, there are other resources utilization in this PAs, but there are less signs in the field. However, the strongly relation between distance from villages and frequency of signs indicate that there are higher of this activities near villages than other areas. This activity may indirectly affect on small carnivores in this forest when local people travel to collect NTFPs in forest that far from villages and camping in the forest. Most collectors have guns and hunted wildlife in a night, especially civet species.

There are 3 patterns of NTFPs using of villagers around the forest including consumption within village, buying by local investors for sending to Thong Pha Phum market and buying by local industry within villages. For example, there is a large “Khao Lahm” (sticky rice baked in a bamboo cylinder) industry at Ban Rai village near the forest where a lot of bamboo woods from villagers were bought.

5.2.3 Forest fires

Most forest fires in this PAs were made from man. There are 2 main reasons, one was that fires were extended from crop burning near forest, and one was direct forest burning by local people making easier to hunting. In dry season, dry leaves fall to the forest ground and this was problem for hunters because sound was made when they walked to hunt. So, they usually resolved this problem by burning dry leaves on the forest ground. The post-fire was also useful for hunters to hunt some wildlife such as barking deer, which they usually travel to eat young fresh grass that grow after fired.

Forest fires in this PAs occur every year and this factor should affect low density and diversity of small carnivore in this area. In HKK, this factor is important to small carnivore community. This factor reduces small mammals which the main prey of carnivores and is also a direct cause of death in terrestrial small carnivores. So, many carnivores avoid forest area (Rabinnowitz, 1990a).

5.3 Domestic Dogs is a current problem on wildlife in a small protected area

The high relative abundance of domestic dogs (*Canis familiaris*) in this study indicated the importance of this animal on wildlife threatened in small forest reserves. Although most of them were high abundant in area between 0 – 1 km. from forest edges, however they were capable to travel more. The distance of study sites is minimum distance of starting point of 2 km. line survey, whereas in reality, signs of domestic dogs were also found in some track station that more distance from starting points. In Africa, domestic dogs are capable to travel within forest up to 6 km from edge of forest reserve (Butler, et al., 2004). However, strong negative relation between abundance of dogs and distance from forest edges indicate that there are more dogs traveling near forest edges than sites that more distant. This study, sign of owners in line survey were not found and not detected with camera traps. So, there are both possibility that they traveled with owners and free-traveling. Although, this study not confirm specific pattern, but both pattern endangered wildlife. If they traveled with owners, they are capable to increase ability of owner to hunted wildlife. In the same time, if they traveled like as free-ranging dogs, they are capable to be predators and competitors on wildlife, especially with carnivores. Recent research confirmed these threatened processes by domestic dogs such as in Africa (Butler and du Toit, 2002, Butler, et al., 2004) and Asia (Dahmer, 2002). In Hong Kong, they direct killed on small Indian civets and masked palm civets. This report shows efficiency of dogs as predators to other small carnivores, especially civet species (Dahmer, 2002).

The relation of dogs abundance and distance of edge ($r = - 0.752$) were more strong than distance of villages ($r = -0.685$) because there are many households that separate from villages and set near forest edges. Most of these households have dogs. In addition, some area are high abundant for example, in the area of crops located between 2 part of forest reserves. Brief counting show that there are at least 12 dogs in 3 households or average 4 dogs/ houses. This situation may have fewer problems if they are located in villages. However, in this case, problems may occur. There are less possible of these dogs for sterilization as it is far from villages and the ignorance (or less knowledge) of owners to this process. So, in the case that poor peoples must raise dogs that increase every year, food for them may not enough and may result to

increase free-ranging dogs in this area. In Zimbabwe communal lands, average density of dogs is 21 dogs/ km^2. This study found that there are less than 25% of average dog's diet provide by their owners (Butler and Bingham, 2000 referred in Butler and du Toit, 2002). In the present study, although there is no study about density of dogs but from the result we expected that there are high densities of them around the forest.

From camera traps it is shown that dogs did not travels alone in several times. 2-3 dogs packing were detected in same trips. This behavior should increase efficiency of them to threaten wildlife.

In this forest, the effect of domestic dogs on wildlife should be studied more for good management on them around the forest. This topic should not be only more interesting in this area, but it should be searched more in several protected area in Thailand.

5.4 The recommendation on wildlife conservation in local context: the beginning at small scale protected area of PTT forest reserve

The result show that there are low density and diversity of carnivores in this forest, and because carnivores is wildlife group that is located at higher level of food webs, so status of them will also reflect the status of other wildlife group in lower trophic levels. However, since the status of wildlife is still not so bad and forest area that connecting to a larger forest of TPP National Park benefits wildlife for moving between areas. So, there are still hopeful to restore wildlife in this forest. Using status of wildlife and effect of human activities on them to encourage people in wildlife conservation is a good practice in the future.

Even qualification of some wildlife that are present in this area were appropriated to set as local flagship species when examined with criteria for selecting "locally appropriate" flagship species by Bowen – Jones and Entwistle (2002) such as Regal crab, Kitti's hog-nosed bat and elephants and in reality most of them were promoted in the past time and still address in conservation issue in present day. However, there are less impact to wildlife conservation at a community level. The interesting of local people on conservation still specific to promoted species whereas other species were still threatened. So, wildlife conservation in this area should be practiced in several way rather than with local flagship issue only.

In this area, 6 villages were involved in this small protected area (see in study area). Before conservation planning, who are involved in wildlife threatened and who have efficiency to help in wildlife conservation should be identified at the same time. This study, brief taking with people and local agencies found that most people that travel in the forest is ethnic groups such as Karen, Mon and Burmese. Most livelihoods of them are temporary worker. Unsecure livelihoods result in having more free time. Someone use only holiday for hire, while 5 days in week were free. So, they usually used this time to travel in the forest for hunting and NFTPs collecting both for sale and consumption. These people should be more interested because they are high population in community, for example half of household in Ban Huai Kayeng is minority such as Mon, Karen and Burmese. Understanding their time using pattern should be first step for good management plan. This step confirm useful for

conservation agencies to provide conservation plans in Indonesia (Colfer, et al., 1999). Interestingly, not only local people that are involved in wildlife threatened in this protected area. Domestic dogs are also factor that will create problem. Similarly, understanding about their use of time, population and their ecology should be more.

Finding more people who can help in wildlife conservation should be motivated. For this area, young generation group is ready and suitable for participatory wildlife conservation. Although they are less involved in wildlife used (however, someone began involved) but characteristic of them such as having more time, active and the opening to learned new knowledge are suitable qualification for conservation program, especially in part of communication and conservation study. Actually, network of young generation groups in villages began in few years ago, but there are still less activities that are involved wildlife conservation. Most of activities such as sport competition, party etc. aim to increase strong network, there are no specific objective. However, if capable to introduce them in conservation study, they should be useful for wildlife conservation in this forest. Moreover, young generation group capable to use some ready tool for contacting with other local people more than outsider such as local radio and direct communication with local languages. Local radio may be important tool in conservation plan with young generation. Present day, they talked, made newspaper report and local news in every morning with some helping of local agencies such as BRT and PTT. Villagers have good response for them. However, this tool of conservation is underused. It should be added as a tool for conservation in the near future.

- Linking local people and local agencies on wildlife conservation in a small protected area

The application of Integrated Conservation and Development Projects (ICDP) model to wildlife conservation is appropriate practice because there are local agencies that already develop this model. BRT and PTT are 2 local agencies in this area that are involved in biodiversity conservation and development with local community. The first briefly discussion on situation of disturbance activities and status of wildlife in a small PAs of PTT forest reserve induce them to motivate wildlife conservation in this

PAs as a pilot area for co-management among 4 groups include BRT, PTT, local people and ecologist or researchers in the way of ICDP project. Since the idea and knowledge base of each group about conservation were different. The finding suitable point that is an overlapping knowledge of each groups were benefit for conservation plan. There is a simple theory in GIS model, which capable to apply in co-management conservation between local people and conservation experts (Balram, et al., 2004).

However, in the way of co-conservation management with local people, how can local people benefits should be addressed because this will result in willingness of people in conservation. For resolving this problem, communication practice about benefit of biodiversity conservation should be designed and accumulated knowledge should be used in this area, for example, the value of NTFPs and what effect of overharvest on them, the importance of wildlife on forest resource and the effect on their livelihood when wildlife are absent etc. Although, this practice were accepted the usefulness worldwide (Leisher and Peters, 2004). It may be more difficult in practical aspects on the ground because each area has different characteristic of people and problems. However, experience and understanding people are importance to design flexible practice. This is the challenge for agencies and conservationist to overcome the burden and become succeeded on wildlife conservation.

CHAPTER VI
CONCLUSION

There are at least 10 carnivores in a small protected area of PTT forest reserve. Carnivores in family Viverridae were most diverse and abundance. 5 species of civets were observed in this study include Large Indian Civet (*Viverra zibetha*), Small Indian Civet (*Viverricula malaccensis*), Common Palm Civet (*Paradoxurus hermaphroditus*), Masked Palm Civet (*Paguma larvata*) and Binturong (*Arctictis binturong*). Most of them were common in this study except Masked Palm Civet and Binturong that are specific in some habitat. There are only one species of family felidae observed in the study: leopard cats (*Felis bengalensis*), one species in family canidae was Asiantic jackal (*Canis aureus*) and two species in family mustelidae were hog badger (*Arctonyx collaris*) and small clawed otter (*Aonyx cinerea*). Habitat characteristic were affected to species composition of small carnivore community in this forest. Most small carnivores in this study were generalist carnivores and may tend to have feeding as omnivorous. While more truly carnivores such as felids species has very low diversity and abundant. This community characteristic may result from food available in disturbed habitat of this reserve. Microhabitats also affected carnivore community. In forest edges dominated mainly by bamboo forest, large Indian civet abundance are high and show as a dominant species in carnivore community. While in more complex forest, abundance of carnivores tends to be equal. Activities times show carnivore communities in this forest are nocturnal. The ranges of time were 23.00 – 6:00.

Human activities in PTT forest reserve were varied mainly by hunting, NFTPs collecting, timbers cutting and cattle herding routes etc. Hunting is still high in this PAs, even though most of professional hunting usually travel to hunt more within Thong Pha Phum National Park. No significant relation between distance from villages and hunting frequency, although they tend to do more hunting in area

far from forest. While, NTFPs collecting shows significant and more abundant in forest near villages.

The results show that domestic dogs are a current problem in this area. Second abundance and only lower than large Indian civet indicate high level of using forest of this animal. 12 individuals of dogs were detected by camera traps and no signs of owners both in pictures and line surveys. Pictures also show that only one sites in site A that they travel alone, whereas most sites they travel in pack 2-3 dogs. These information reflected important of this animals on wildlife threatening. However, more study on population, forest utilization and ecology of domestic dogs were need in the future. Not only in this area, but they may be a big problem in several PAs in Thailand.

The effect of human activities on small carnivore community were not assessed directly due to high disturbance level in the forest distributing widely in all forest reserves and even within Thong Pha Phum National Park. However, low diversity and low abundance of small carnivores in this PAs indicate the effect of human disturbance comparing with high diversity of them in similar forest types of other study.

Wildlife conservation by using status of small carnivores and effect of human disturbance on them were just begun. Brief taking about situation of wildlife threatened were done with other local agencies after the study is almost finished and local agencies are already. Integrated Conservation and Development Projects (ICDP) model were discussed on how it can be applied at small scale in this area. Efficiency of 2 local agencies in this area has already been co-managed. BRT is capable to provide knowledge and monitoring system for biodiversity conservation, while PTT have efficiency to develop well being of local people and separate them from wildlife threatened. The first discussion concluded that status of wildlife in this study will combine with other existing knowledge and will be used to secondly discussed with ecologist, BRT, PTT and local people in the pilot villages to motivate participatory wildlife conservation.

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APPENDIX

Appendix A: Datasheet for recording wildlife data gathered from track station survey

Surveyor: **Date:**

Weather Condition: **Start Time:** **, and End**

Name of area: **Forest type:**

No. of station/ Bait	Distance from start point	Species or taxa	Size (Width/Length)	Sketch picture	Remarks

Appendix B: List of mammals that present in Western Thong Pha Phum Forest.

Species Name	**Scientific Names**	**Sources***
Elephant	*Elephas maximus*	A
Tapir	*Tapirus indicus*	B
Gaur	*Bos gaurus*	B
Sambar Deer	*Cervus unicolor*	A
Common Muntjac	*Muntiacus muntjac*	A
Fea' Muntjac	*Muntiacus feae*	A*
Serow	*Naemorhedus sumatraensis*	A
Wild pig	*Sus scrofa*	A
Lesser Mouse Deer	*Tragulus javanicus*	A
White - handed Gibbon	*Hylobates lar*	A
Macaque sp.	*Macaca sp.*	B
Langur sp.	*Semnopithecus sp.*	B
Slow loris	*Nycticebus coucong*	A
Sunda Colugo	*Galeopithecus variegates*	B
Porcupine	*Hystrix brachyura*	A
Pangolin	*Manis javanica*	B
Large Bamboo Rat	*Rhizomys sumatrensis*	B
Bay Bamboo Rat	*Cannomys badius*	B
Tiger	*Panthera tigris*	B
Clouded Leopard	*Pardofelis nebulosa*	A*
Golden Cat	*Felis temminicki*	A*
Leopard Cat	*Prionailurus bengalensis*	A
Asiatic Black Bear	*Ursus thibetanus*	B
Sun Bear	*Ursus malayanus*	A

Appendix B (Cont.)

Species Name	**Scientific Names**	**Sources**
Asiatic Jackal	*Canis aureus*	A
Hog Badger	*Arctonyx collaris*	A
Burmese ferret badger	*Melogale personata*	A*
Yellow - throated Marten	*Martes flavigula*	A*
Small-Clawed Otter	*Aonyx cinerea*	A
Masked Palm Civet	*Paguma larvata*	A
Common Palm Civet	*Paradoxurus hermaphroditus*	A
Large Indian Civet	*Viverra zibetha*	A
Small Indian Civet	*Viverricula malaccensis*	A
Binturong	*Arctictis binturong*	A
Banded Linsang	*Prionodon linsang*	A*

A = data from survey of this study

A* = data from interview of this study

B = data from wildlife using list of Naruchaikusol (unpublished)

Appendix C: Mammals detected by camera traps

a. Hog Badger (*Arctonyx collaris*)

b. Asiatic jackal (*Canis aureus*)

Appendix C (Cont.)

c. Malayan Porcupine (*Hystrix brachyura*)

d. Serow (*Capricornis sumatraensis*)

Appendix C (Cont.)

e. Large Indian civet (*Viverra zibetha*)

Appendix D: 12 Domestic dogs detected by camera traps

a. B3

b. W4 (left), Br2 (right)

c. B4

e. W5

f. B5

g. B2

Appendix D (Cont.)

h. W3 (left), B1 (right)

i. Br1 (left), W2 (right)

j. W1

BIOGRAPHY

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