DENSITY, DISTRIBUTION AND HUMAN CONSUMPTION OF SMALL MAMMALS AROUND A KAREN VILLAGE IN MAE HONG SON PROVINCE, THAILAND

NATTHA WATTANARATCHAKIT

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE
(ENVIRONMENTAL BIOLOGY)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2005**

ISBN 974-04-6235-9

Thesis
Entitled

DENSITY, DISTRIBUTION AND HUMAN CONSUMPTION OF SMALL MAMMALS AROUND A KAREN VILLAGE IN MAE HONG SON PROVINCE, THAILAND

…….
Miss. Nattha Wattanaratchakit
Candidate

…….
Assoc.Prof. Sompoad Srikosamatara,
Ph.D.(Zoology)
Major-Advisor

…….
Prof. Warren Y. Brockelman,
Ph.D.(Zoology)
Co-Advisor

……
Asst. Prof. John R. Milne,
Ph.D.(Entomology)
Co-Advisor

…….
Assoc.Prof. Rassmidara Hoonsawat,
Ph.D.
Dean
Faculty of Graduate Studies

……
Assoc.Prof. Prayad Pokethitiyook,
Ph.D.(Chemical Engineering)
Chair
Master of Science Programme
in Environmental Biology
Faculty of Science

Thesis
Entitled

DENSITY, DISTRIBUTION AND HUMAN CONSUMPTION OF SMALL MAMMALS AROUND A KAREN VILLAGE IN MAE HONG SON PROVINCE, THAILAND

was submitted to the Faculty of Graduate Studies, Mahidol University
For the degree of Master of Science (Environmental Biology)
on
16 May, 2005

…….
Miss. Nattha Wattanaratchakit
Candidate

……
Assoc.Prof. Sompoad Srikosamatara,
Ph.D.(Zoology)
Chair

…….
Prof. Warren Y. Brockelman,
Ph.D.(Zoology)
Member

……
Mr. Surapon Duangkhae,
M. Sc.(Environmental Biology)
Member

……
Asst. Prof. John R. Milne,
Ph.D.(Entomology)
Member

……
Assoc.Prof. Rassmidara Hoonsawat,
Ph.D.
Dean
Faculty of Graduate Studies
Mahidol University

……
Prof. Amaret Bhumiratana,
Ph.D.(Microbiology)
Dean
Faculty of Science
Mahidol University

ACKNOWLEDGEMENTS

For success of this thesis I wish to express my sincere gratitude and thanks to my major advisor, Assoc. Prof. Sompoad Srikosamatara. He is my nice teacher who has taught and given me good suggestions and opportunities since I was undergraduate student in Mahidol University. His suggestion and teaching make my thinking skills growing up.

My special thanks is to my co-advisor, Prof. Warren Y. Brockelman, my first foreigner teacher making me excited with my first course on general ecology. Thanks for his enjoyable course, invaluable knowledge and ideas in ecology and conservation which is very useful in this thesis. I would like to thank Dr. John R. Milne, my kindliness co-advisor, for helping me correcting this thesis and providing many helpful suggestions. Thanks for his encouragement and nice smile. My thanks also go to Mr. Surapon Duangkhae, Secretary General of Wildlife Fund Thailand, who was the external examiner of the thesis defense for his valuable advice and guidance in this research.

I would like to thank everybody in Room N505 especially my friend, Tae who share with me in learning, good feelings and accompanying me in the field since undergraduate periods. Thanks to P Tu and P Tao, for their helps in the field. Thanks to P Mattana for her help. Furthermore, the wonderful maps in this thesis could not occur without help and kindness of two persons, P Aon and Mr. Supagit Vinitpornsawan. Thanks Mr. Aung Phet Khan that taught me about basic GIS.

My special thanks go to Mr. Suwit Naosawat, Superintendent of Sun Pan Dean WS, for his kindness and supporting in the field including the rangers at Sun Pan Dean WS. Thank to nice Karen people in Muang Pham village for convenience in the field especially from the host family who take care about food, accommodation and manpower until my field work finished. Extra thanks to Pati Ngae, for his interest in my study and help me collecting some data.

Finally, I am grateful to my family, my loving grandmother and loving aunt for financial support, entirely care, and love especially my mother who understands and encourages me in long time period learning. It is hard to list all persons who supported and helped me during entire period of this thesis; however, I deeply thank them all for their valuable advice, guidance and kindness. The usefulness of this thesis, I dedicate to my father, my mother, my lovely grandmother and aunt and all teachers who have taught me since my childhood.

This research was supported partly by a grant from the ongoing project from BRT to Dr. Sompoad Srikosamatara grant BRT_341015 and supported directly by TRF/BIOTEC Special Program for Biodiversity Research and Training grant T_347014

Nattha Wattanaratchakit

DENSITY, DISTRIBUTION AND HUMAN CONSUMPTION OF SMALL MAMMALS AROUND A KAREN VILLAGE IN MAE HONG SON PROVINCE, THAILAND.

NATTHA WATTANARATCHAKIT 4336693 SCEB/M

M.Sc.(ENVIRONMENTAL BIOLOGY)

THESIS ADVISORS: SOMPOAD SRIKOSAMATARA, Ph.D., WARREN Y. BROCKELMAN, Ph.D., JOHN R. MILNE, Ph.D.

ABSTRACT

This research studied the relationship between small mammals and the lifestyle of Karen people in Muang Pham village, Mae Hong Son Province, North Thailand. Density, distribution and species diversity of small mammals around this Karen village were estimated. The status of their community was assessed to estimate the level of disturbance to wildlife communities. Hunting and trapping wildlife species by villagers was a major disturbance factor.

Ten species of small mammals were captured in this study. *Menetes berdmorei*, *Rattus rattus* and *Niviventer bukit* were the three most common species around Muang Pham village. *R. rattus* had high abundance in paddy fields, whereas *M. berdmorei* was captured often in corn fields. *N. bukit* was common in used forest area. However, in this study low numbers of captured animals were found, so estimates of their density are not conclusive. The greatest species diversity of small mammals was found in the communal forest, whereas the highest abundance of small mammals occurred in agricultural fields, but with low diversity. Most species that occurred in the agricultural area were pest species. *Maxomys surifer* had low density around the village but it was a delicious protein food for Karen villagers. Rat meat contributed about 7.2 kg / household and more than 300 kg of rat meat were consumed in Muang Pham village late in the trapping period. However, the consumption of this meat is tending to decrease in the new generation.

Disturbance from agriculture and timber and non-timber forest product harvesting around the village have caused a high abundance of pest species around this Karen village. Most species are tolerant of disturbed areas, whereas species that are sensitive to disturbance were rare near the village, including the food species of villagers such as *M. surifer*. The decrease in rat consumption in the new generation of villagers might cause the loss of a local skill inherited from their forefathers and might increase the cost of living of villagers.

KEY WORDS: HUMAN CONSUMPTION / SMALL MAMMALS / KAREN VILLAGE / DENSITY / MAE HONG SON

99 P. ISBN 974-04-6235-9

ความหนาแน่น การแพร่กระจาย และการบริโภคสัตว์เลี้ยงลูกด้วยนมขนาดเล็ก: กรณีศึกษาหมู่บ้านกะเหรี่ยง จังหวัดแม่ฮ่องสอน (DENSITY, DISTRIBUTION AND HUMAN CONSUMPTION OF SMALL MAMMALS AROUND A KAREN VILLAGE IN MAE HONG SON PROVINCE, THAILAND)

ณัฐฐา วัฒนรัชกิจ 4336693 SCEB/M

วท.ม. (ชีววิทยาสภาวะแวดล้อม)

คณะกรรมการควบคุมวิทยานิพนธ์ : สมโภชน์ ศรีโกสามาตร, Ph.D., วรเรณ บรอดเคลแมน, Ph.D., จอห์น มิลน์, Ph.D.

บทคัดย่อ

การศึกษานี้เป็นการศึกษาบทบาทของสัตว์เลี้ยงลูกด้วยนมขนาดเล็ก ต่อวิถีชีวิตของชนเผ่ากะเหรี่ยง หมู่บ้านหนึ่ง ในจังหวัดแม่ฮ่องสอน โดยได้ทำการสำรวจ ความหนาแน่น การแพร่กระจาย และความหลากชนิด ของสัตว์ในกลุ่มนี้ เพื่อประเมินถึงสภานภาพ และระดับความรบกวนของชาวบ้านที่มีผลต่อสังคมของสัตว์ป่า บริเวณรอบๆหมู่บ้าน โดยใช้ชุมชนของสัตว์เลี้ยงลูกด้วยนมขนาดเล็กเป็นตัวแทน ซึ่งปัจจัยการรบกวนต่อชุมชน สัตว์ป่าในครั้งนี้ จะรวมไปถึงการล่า และดักสัตว์เพื่อเป็นอาหารของชาวบ้านกะเหรี่ยงแห่งนี้ด้วย

ผลการศึกษาพบสัตว์เลี้ยงลูกด้วยนมขนาดเล็ก 10 ชนิดบริเวณรอบๆหมู่บ้าน กระจ้อน (*Menetes berdmorei*) หนูท้องขาว (*Rattus rattus*) และหนูขนเสี้ยนดอย (*Niviventer bukit*) เป็นชนิดที่พบบ่อยที่สุด ปริมาณ ของหนูท้องขาวจะมีมากที่สุดในพื้นที่นาข้าว ขณะที่กระจ้อนถูกพบมากในบริเวณไร่ร้าง และพื้นที่ใกล้เคียง ส่วน หนูขนเสี้ยนดอยมักจะดักได้ในพื้นที่ป่าใช้สอย ซึ่งเป็นพื้นที่ป่าที่มีระดับการถูกรบกวนจากชาวบ้านสูง ความหลาก ชนิดของสัตว์ถูกพบมากสุดในบริเวณป่าชุมชน ในขณะที่ในพื้นที่เพาะปลูกรอบๆหมู่บ้านแม้จะมีความชุกชุมของ สัตว์สูงสุด แต่กลับมีความหลากชนิดต่ำ กระจ้อน และหนูท้องขาว เป็นชนิดที่มักจะถูกพบในบริเวณเหล่านี้ ซึ่งทั้ง สองชนิดเป็นศัตรูที่สำคัญต่อการทำลายพืชไร่ของชาวบ้าน นอกจากนี้พบว่า ชาวบ้านกะเหรี่ยงแห่งนี้ยังคงบริโภค สัตว์เลี้ยงลูกด้วยนมขนาดเล็กเป็นอาหาร รวมถึงหนูด้วย หนูที่ชาวบ้านเลือกกินส่วนใหญ่เป็นหนูที่อาศัยในป่า หนู ฟานเหลือง (*Maxomys surifer*) เป็นหนูที่ชาวบ้านชอบบริโภคมากที่สุด ทั้งนี้พบว่าในระหว่างการศึกษา เนื้อหนู ชนิดนี้ถูกนำมาเป็นอาหารชาวบ้านแห่งนี้ ไม่ต่ำกว่า 300 กิโลกรัม อย่างไรก็ตามภูมิปัญญาในการดักหนูตามป่า และความนิยมบริโภคโปรตีนชนิดนี้กำลังลดลงในกลุ่มของคนรุ่นใหม่ ซึ่งส่วนใหญ่เลือกที่จะซื้อโปรตีนจาก ตลาด มากกว่าเข้าป่าหาอาหาร ส่วนการล่าสัตว์ป่าอื่นๆเพื่อเป็นอาหารยังคงพบในหมู่บ้านแห่งนี้ แม้ว่าประชากร ของสัตว์ป่าจะลดลงจนสังเกตได้

จากการศึกษาในครั้งนี้พบว่าการรบกวนที่เกิดจากการเพาะปลูก และการใช้ไม้รวมทั้งเก็บของป่ารอบๆ หมู่บ้าน ทำให้สัตว์เลี้ยงลูกด้วยนมขนาดเล็กที่อาศัยอยู่รอบๆหมู่บ้านมักเป็นชนิดที่ปรับตัวต่อการรบกวนของ มนุษย์ได้ดี และส่วนใหญ่จะเป็นศัตรูต่อผลผลิตทางการเกษตรของชาวบ้าน ขณะที่หนูที่ชาวบ้านเลือกเป็นอาหาร นั้นมักจะพบในบริเวณป่าที่อยู่ห่างไกลออกไปจากหมู่บ้าน เพราะเป็นชนิดที่อ่อนไหวต่อการรบกวนของมนุษย์ ส่วนการลดลงของความนิยมบริโภคเนื้อหนูของกลุ่มคนรุ่นใหม่ในหมู่บ้านนี้ นอกจากจะทำให้ทักษะในการหา อาหารจากป่าของคนรุ่นใหม่ลดลง แล้ว อาจจะส่งผลให้ชาวบ้านมีค่าใช้จ่ายมากขึ้นเพื่อแลกซื้ออาหาร และแหล่ง โปรตีนจากตลาดสด

99 หน้า. ISBN 974-04-6235-9

CONTENTS

CONTENTS (Continuous)

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

LIST OF ABBREVIATIONS

Abbreviations	Terms
NTFPs	Non-timber forest products
WS	Wildlife Sanctuary
m	Meter
cm	Centimeter
sq. m.	Square meter
g	Gram
kg	Kilogram

CHAPTER I
INTRODUCTION

Mae Hong Son Province is located in Northern Thailand. The enchantments of this province were elaborated by the wonderful natural environment and diversity of cultural landscape. Most of the areas of Mae Hong Son province are covered by forest area and about 70% of overall areas are high mountain (OEPP, 2000). This topography helps to protect its wonderful land from urbanization. The populations of Mae Hong Son province consist of various ethnic groups such as Shans or Thai Yai who live in the lowland area and several hill tribe people, who occupy approximate 50% of total population. There are more than 600 villages of Karen, Hmong, Lahu, Lua and Lisu, scattering among the mountain in Mae Hong Son province (OEPP, 2000). Both charming scenery of landscape and diversity of ethnic people make Mae Hong Son province an attractive place for tourists who love to go for adventure and ecotourism. Trekking, camping, cave tours, touring the hill tribe villages, nature study, gliding on rubber rafts, riding elephants, floating on bamboo rafts, etc are common activities in tourism programs of this province. Consequently, most of the income of Mae Hong Son province comes from tourism. Especially various ethnic people and hill tribe villagers seem to attract many tourists in each year, however, most of incomes go to the tourist agencies and guides more than hill tribe people.

The natural resources of Mae Hong Son province are still healthy and include high diversity of flora and fauna (Masuthon et al, 1999; Piluek et al, 1999; Sitasuwan et al, 1999; Vidthayanon et al, 1999; Srikosamatara et al, 1999a; OEPP, 2000). There are about 463 species of wildlife found in Mae Hong Son province (OEPP, 2000). However, it is not different from many areas in northern Thailand, the wildlife species were threatened from human activities (Bruver, 1973; Srikosamatara et al, 1999a; Tungittiplakorn et al, 1999; Pattanavibool & Dearden, 2002). Some species have disappeared from the area since 30 years ago, such as Wild water buffalo, Rhinoceros, Hog-nosed deer, Eld's deer and Mouse deer (Bruver, 1973). Some species were rare at that time and are absent in the present; for example, Elephant, Guar and Banteng

(Bruver, 1973; Srikosamatara et al, 1999a). Large mammals that are still found in Mae Hong Son include Rhesus Macaque, White-handed gibbon, small cat, Common palm civet, Wild boar, Serow and Hog Badger (Srikosamatara et al, 1999a; OEPP, 2000).

Hunting has been identified as a major cause of declining of wildlife species both in northern Thailand and Mae Hong Son province (Srikosamatara et al, 1999a; Tungittiplakorn et al, 1999; Pattanavibool & Dearden, 2002). Hill tribe people have a long history in hunting, not only for consumption but it is also a part of their culture (Bruver, 1973; Suwanbubpa, 1976; Dearden, 1995; Tungittiplakorn et al, 1999). They have many kinds of trap used in the forest, ranging from the large size to simple small traps for small mammals (Garrett, 1929). However, the level of threat to wildlife by hunting of each hill tribe group is different. Lahu or Muser people have been often associated with a high level of hunting while the Karen people have been less threat to wildlife communities (Santasombat, 2001; Chaekpimai et al, 2001).

In 1999, a biological diversity study project involving cooperation between Mae Hong Son Province and BRT (Biodiversity Research and Training Program) was conducted in Mae Hong Son province to provide a knowledge platform for the growing eco-tourism industry. The status of mineral licks and wildlife species has been studied including the potential of these resources for supporting ecotourism (Srikosamatara et al, 1999a). The results reported that the potential of many mineral licks in Mae Hong Son is still good but low abundance of wildlife might been from heavy hunting in the area. Furthermore, the research has also revealed that the cause of heavy hunting in Mae Hong Son province, not only come from the local people but include many hunters from other places such as Chaing Mai province (Srikosamatara et al, 1999a). Srikosamatara and his colleagues (1999b) are also training the local people and RFD rangers to monitor wildlife populations by track station survey in two hill tribe villages of northern Mae Hong Son. Both villages have low diversity of wildlife species in the area. Three groups of wildlife species were surveyed in these study areas: small carnivores, small mammals and birds (Srikosamatara et al, 1999b). Small mammals were highest abundant animal followed by birds; where as abundance of small carnivore was lowest.

Afterwards, during 2000-2002 the relative abundance of wildlife around some hill tribe villages in northern Mae Hong Son and including the two villages in the previous study were censuses using track station survey (Srikosamatara et al, 2000 & 2002; Chaekpimai et al, 2001). The studies reported low relative abundance and diversity of wildlife species around the hill tribe villages. Both abundance and species diversity of wildlife around two villages in the previous study was declining rapidly within 2-3 years except small mammals especially the rat (Srikosamatara et al, 2002). From the result of all study areas, the relative abundance of carnivore species was low while the small mammals were most abundant animals especially the rats.

This research was focused on small mammals around a Karen village, Muang Pham village to continue the previous wildlife study that show highest abundance of small mammals in the area. The density, distribution and species composition of these small animals were estimated around this Karen village.

Small mammals

Small mammals are non-flying mammals whose weight less than 2 grams to about 5 kg when they are adult. This group of animals covers the largest proportion (> 60%) of total terrestrial mammals (Barnett & Dutton, 1995; Bourliere, 1975). Small mammals play important role in ecosystem such as seed eaters, seed dispersers; especially they are major food items supporting many predators in the food web. The population of small mammals is numerous and widely distributed around the world. Most of them are highly adaptive to live in various habitats from natural habitats to disturbed areas including human settlements and urban areas. Furthermore, small mammals are good ecological indicators for the status of many terrestrial ecosystems due to they response rapidly to any disturbed factors. The basic data of small mammals help to better understand the status and tend to change in wildlife community’s structure and ecosystem.

Muang Pam village

Muang Pam village is a Karen village that relative abundance of wildlife species around the village has been studied (Srikosamatara et al, 2000; Chaekpimai et al, 2001). The results showed low relative abundance and diversity of large wildlife species and greatest abundance of small mammals, especially rats, around the village.

This village is located in Phang Ma Pha District in northern Mae Hong Son Province, the village is situated in the valley and surrounded by forest. The Karen people classify forest areas around their village into many types depending on their activities such as agriculture area, used forest, conserved forest, cemetery forest, and small areas of communal forest. The agricultural areas of Karen people are not located far away from the village. Most of forest areas around the village area are Used Forest where villagers can harvest both timber and non timber products (NTFPs) for use in their family. While the forest area acting as watersheds are defined to Conserved Forest. Karen people will not do any activity that threatens the Conserved Forest, they also help to protect the area to conserve water source and keep the forest for future use.

Historically, the people of Muang Pham village moved from Pai District to the location of Pa Mon village (south of the location of present Muang Pham village). They lived about 3 years before moving to Huai Nam Pong for about 3-4 years but the cultivation areas was not enough for villagers so they move again to the watershed of Nam Pham River but this was far away from the agricultural area and cultivation area was not enough for the people that increasing. Consequently, after 4 years they moved to settled down at the present location of the villagers (Santasombat, 2001). Muang Pham village is situated in present area approximately 40 years ago (Chaekpimai et al, 2001).

Karen people

The Karen people are the largest hill tribe group in Thailand and they have lived for more than 100 years in northern Thailand (Santasombat, 2001). They have numerous legends and tradition in their culture and maintain many traditional beliefs, especially a strong belief in sexual morality.

Livelihood of most Karen people are farmer who have good skills in practicing Rotational Swiddening cultivation in the valley and they are only ethnic group in northern Thailand that has a tradition of growing paddy rice in the valleys. Then, Karen people are the most productive farmers and cultivate rice both in dry area and in paddy field. Rice is the most important agricultural product of the Karen (UNDP, 2004).

The Karen people have less impact on forest area and wildlife animals compared with other hill tribe groups (Chaekpimai et al, 2001; Tungittiplakorn et al, 1999), they have high awareness of the valued of the environment, especially water and forest. Around their village both timber and non-timber resource are protected by local rules and many beliefs of the villagers. The wildlife animals around their village are not threatened especially gibbons and hornbills. The Karen people believe that most wildlife animals are homes of human spirits.

The food supply for Karen village is not different from the other villages in rural area of the country. Most of food supplies in their family come from the forest around the village. Their important protein sources are many species of insects, amphibians, reptiles and birds. They include many species of small mammals while the other larger mammals are taken opportunistically. Moreover, the Karen is one hill tribe people who consume rat meat. They will trap rats in the forest after harvest season. However, they do not consume every species of the rat and they also have some beliefs about the consumption the rats. For example they do not eat the Lesser Gymnure (*Hylomys suillus*) because they believe that this species of rat makes their life going down.

Generally, the small mammals are used as ecological indicators of the condition of terrestrial habitats (Kanchanasaka, 1992; Lynam, 1997; Hamarit, 1997) or role as seed dispersal, or seed predator. Many studies have focused on the role of rat or

squirrel as ecological pests. However, few studies have tried to link between the small mammals and the human community. After the preliminary study, the research found that there are some interesting relationships between small mammals and villagers in this Karen village. For example, the Karen people act as predators of small mammals but there are differences from the natural predators because the people capture them only in certain periods of time. Small mammals are food that might change the proportions of nutrient of villagers at that time, and they are also agricultural pests.

Consequently, to try to understand the relationship between small mammal around the village and villagers in this Karen village, data on the number of trapped rats by villages, the perceptions of villagers about these small mammals and the local wisdoms to catch or eradicate small mammal by villagers were studied. Moreover, biomass of small mammals in this village was compared with the other forest areas without human predation.

The study objectives

1. Estimate density and distribution patterns of small mammals around a Karen village.
2. Study the species composition of small mammal communities in different habitat types around a Karen village.
3. Try to understand the links between small mammals and the human community of Karen people.
4. Estimate the number of trapped rats by the villagers for local consumption of the village.
5. Compare biomass of small mammal between this Karen village and other forest areas without human hunting.

CHAPTER II
LITERATURE REVIEW

2.1 Abundance and distribution of small mammals

In 1981, Wiles studied abundance of small mammals in three types of forest in western Thailand, and found higher abundance of small mammals in Lowland bamboo forest than Upper bamboo forest and Dry dipterocarp forest (Wiles, 1981). He also mentioned that *Maxomys surifer* had the highest abundance both in Lowland and Upland bamboo forest (9.2% and 4.3%) while *Rattus rattus* was highest abundant species in Dry dipterocarp forest (4.4%). While other studies in western Thailand have suggested that Dry evergreen and Mixed deciduous forest (EV/MD) supported a greater abundance of small mammals than Mixed deciduous and Dry dipterocarp forest (MD/DD) (Walker & Rabinowitz, 1992). In second study, *Maxomys surifer* showed greatest abundance in both habitats. Next are *Tupaia belangeri* and *Menetes berdmorei* in MD/DD plot and *Leopoldamys sabanus* and *Tupaia belangeri* in EV/MD plot, respectively.

The distribution patterns of small mammals vary along the elevation gradient. Langham studied the distribution pattern of small mammals at four elevations (150, 450, 750 and 1000 meters) in tropical rain forest of Malaysia (Langham, 1983). The result showed some species of small mammals disappeared or were replaced with increasing altitude. Only *Tupaia glis* was found in all elevation levels, while some species such as *Niviventer cremoriventer* and *Berylmys bowersii* were found only at the highest altitude. The research also pointed out that the total biomass of small mammals at lower elevations was larger than at the higher levels. Moreover, the other study conducted in Philippines along six elevation levels from 475 to 1,750 metes (Rickart et al, 1991). The habitat type varies from lowland dipterocarp forest (475, 900 meters) to montane forest (1,125, 1,350 meters) to mossy forest (1,150 and 1,750 meters). From the result, the numbers of species of small mammal in lowland forest

are lower than at higher levels and the most species were captured in mossy forest. In addition, the study also showed only *Rattus everetti* was most abundant and found in all habitat levels while the other native species were rare. In a study done in China, the species richness and relative abundance of small mammals were estimated along seven sites at elevation levels between 1600 and 3900 meters (Li et al, 2003). The researchers found that the highest abundance of small mammals was found at mid-elevation where several types of forest occur and primary productivity is high due to suitable rainfall and humidity.

2.2 Density, diversity and habitat preferences of small mammals

Species diversity of small mammals are depended on characteristics of habitat. Elliott and his colleagues found different small mammal communities between Deciduous and Evergreen forest in Doi Suthep-Pui National park, Chiang Mai province (Elliott et al, 1989). *Menetes berdmorei* and *Melogale personata* were common species in deciduous forest while the other five species of *Rattus rattus*, *Maxomys surifer*, *Niviventer bukit*, *Berylmys bowersi and Leopoldmys sabanus* were captured in Evergreen forest. *Leopoldmys sabanus* was the only species found in both habitats. *Rattus rattus* is the dominant species in Evergreen forest (3-23 individuals/ha) followed by *Maxomys surifer* and *Niviventer bukit*, 5-11 and 2-11 individuals/ha, respectively. The researchers also suggested that the Evergreen Forest in elevation gradient from 900 meters upwards in National Park is the most suitable habitat for small mammals.

In Bamboo forest, the small mammals show higher diversity of species than Dry dipterocarp forest in Southwest Thailand (Wiles, 1981). Only five species of eleven were captured in Dry dipterocarp forest but all of them were present in Bamboo forest. *Maxomys surifer* was the dominant species in Bamboo forest but it was absent from Dry dipterocarp forest. The research commented that the absence of *M. surifer* is due to competition with *R. rattus*. Morever, he also concludes that small mammals prefer lowland bamboo forest because the characteristics of this forest type provide many ecological niches for several types of small mammal. For example, the enlarged clump of *Bambusa arundinacea* provide abundant food for bamboo rats and its thorns can

help many small mammals escape from their predators. While the moist and dense ground benefits ground-dwelling small mammals and the thick soil is good for burrowing small mammals. Wiles also mentioned that the abundance of small mammals in dry dipterocarp forest is lower than in bamboo forest. He suggested that small mammals are uncommon in dry dipterocarp forest and referred to Wharton (1966) that it is a common phenomenon for Southeast Asia forest. Lacks of food and the open canopy of this forest are the main factors that limit these small animals in dry dipterocarp forest. These conclusions were also supported by a study near Blue River, Oregon, that the small mammals would be abundant in habitats that present the superior factors for them (Doyle, 1990). He refers to higher abundance of small mammals in riparian area than in upland forest because the former habitat can provide more available water and food to these animals.

However, one study from western Thailand showed equal numbers of species of trapped small mammals in Dry evergreen and Mixed deciduous forest (EV/MD) and Mixed deciduous and Dry dipterocarp forest (MD/DD) (Walker and Rabinowitz, 1992). Four species of *Maxomys surifer*, *Rattus rattus*, *Menetes berdmorei* and *Tupaia belangeri* were found in both habitat types. Where as *Leopoldamys sabanus*, *Niviventer bukit* and *Hylomys suillus* were captured only in EV/MD plot and *Brylmys berdmorei*, *Mus cervicolor* and *Crocidura fuliginosa* unique in MD/DD plot. *M. surifer* was found with the highest population density in rainy season in both plots. The study also showed total biomass of small mammals that higher in EV/MD plot than MD/DD plot in all season. Four most biomass species from this study were *M. surifer*, *Tupaia belangeri*, *Menetes berdmorei*, and *Leopoldamys sabanus*, respectively.

2.3 Small mammal communities in disturbed areas

Fragmentation is one disturbing factor to wildlife communities in Thailand (Lynam & Billick, 1999; Pattanavibool, 1999; Pattanavibool & Dearden, 2002). Lynam and Billick (1999) studied the effect of fragmented habitat to small mammal in a tropical forest of Thailand. They found the fragmentation affected both abundance and distribution of small mammal on island. The abundance of many native small mammals is less on island, particular in medium and small Island. Many disturbance-sensitive species such as *Mus whiteheadi*, *Leopoldamys sabanus*, *Tupaia glis*, *Maxomys surifer* were replaced by disturbance tolerant species, especially *R. rattus*. This species, however, possibly prefer disturbed habitat and it can take over other small mammals on the island rapidly (Lynam, 1997). The researchers also mention that although the abundance of many native species were declining but total abundance of small mammal in island was not significant depressed because some species such as *R. rattus* lead to increased population density. Besides, there is another study in Khlong Saeng wildlife sanctuary compared relative abundance of some wildlife species in disturbed and undisturbed area. However, the result showed that relative abundance of small mammals especially the rat species trends to increasing in disturbed area (Wattanaratchakit, 1999).

One study showed the distribution of small mammals in five urban habitats: residential gardens, woodlands, allotment gardens, scrub, and cemetery (Baker et al, 2003). The researchers pointed out that the habitat fragmentation is an important impact to some urban small mammals even if it is compensated by good quality gardens. Caro (2001) compared the species richness and abundance of small mammals inside and outside a protected area of African national park. The results showed the species diversity and abundance of small mammals was higher outside than inside the protected area. The researchers gave three reasons explaining his result, first is outside park may present a higher quality and available of food. While, the second one is the predator inside the park are higher than outside and the last one is competition between ungulates and small mammals inside park. For the last reason he referred to the studies of Kessing (1998, 2000). Furthermore, Jeffrey (1997) recommended that

the replacement of agriculture area and human settlement might support the increasing of diversity and abundance of small mammals although its evidence is also obscures.

Tourism and logging by local people are other factors affecting small mammal community (Stephenson, 1993). The study was set up in four sites of different disturbance levels in mid-altitude rain forest reserve of Analamazaotra, Madagascar. The study showed the species richness of endemic small mammal declining in disturbed area was correlated with human disturbance level. The researcher mentioned that the tourism is major disturb factor to this area. Moreover, *Rattus rattus* is common species that found all site and highest abundance in disturbed area (highest disturb level). However, the researcher also concluded that *R. rattus* species may be an indicator of disturbed area. Another study of *R. rattus* showed high density in melaleuca forest, which is disturbed forest (Kanchanasaka, 1992). Furthermore, this study showed greater diversity of small mammal species in an undisturbed area (peat swamp forest) than disturbed area (melaleuca forest) in both wet and dry seasons. Seven species were found in this study, five species of *R. annandali*, *R. whiteheadi*, *R. rattus*, *R. mulleri* and *R. losea* were captured in peat swamp forest and only two species (*R. rattus* and *R. losea*) were captured in melaleuca forest during the dry season and one more, *R. mulleri*, in melaleuca forest during wet season. *Rattus annandali* was the dominant species of peat swamp forest with its density was 9-12 individuals/ha in dry season and 6-7 individuals/ha in wet season. Next was *Rattus whiteheadi* which had a density of 3-4 individuals/ha in dry season, while in melaleuca forest, the density of *R. rattus* was 6-7 individuals/ha in dry season and 4-5 individuals/ha in wet season. However, the result also showed that *Rattus annandali*, *Rattus whiteheadi* have not been found in disturbed forest area (melaleuca forest).

The other one study reported the difference of the communities of small mammals (Murid rodents) in disturbed and undisturbed areas of natural forest and agriculture areas along the Mekong River (Hamarit, 1997). The study found eight species of small mammal. Seven species of *Rattus rattus*, *Bandicota indica*, *Rattus losea*, *Rattus exulans*, *Mus cervicolor*, *Mus caroli* are present in agriculture areas while only *Rattus rattus*, *R. Bukit* and *Vandeleuria oleracea*, were found in mixed deciduous forest. However, the results of this study were different from the previous study that the diversity of small mammal species in disturbed area should be less than

undisturbed area. The researcher pointed out that the species appeared in agriculture area are more adaptive to live in disturbed area than two last species in natural forest, while *R. rattus* appear in all habitat types. Anyhow, it is surprising that *Maxomys surifer* which is common species of natural forest areas in Thailand (Marshall, 1977) was not found in both last studies.

While one study compared populations of Muridae between two different disturbed habitats of forest plantation and grassland habitat in Bang Phra Reservoir Non-Hunting Area (Pinnoy, 1993). The results showed higher density and population size of animals in forest plantation than grassland. However, only three species of Muridae were found in this study and each species occupied specific habitat types. *Rattus rattus* was found in forest plantation and was absent in grassland (the density of animals *ranged* from 15.6 - 26.5 animals/ha., biomass 3.4 - 6.2 kg. and home range size is averaged 0.043 ha) while in grassland found only *Bandicota indica* (the density of animals was 8.2 -12.3 animals/ha., biomass 4.7 – 6.8 kg. and home range size averaged 0.032 ha) and *Mus cervicolor*. The researcher pointed out that *B. indica* seems restricted in ungrazed grassland whereas *M. cervicolor* tolerated the extremely grazed grassland.

Forest fire is other factor impacting rodent communities (Haim & Izhaki, 1994). Haim and Izhaki studied recovery stages of rodent community after forest fire in pine forest in Mount Carmel National Park, Israel. The researchers found that after the fire the original species were disappeared from the area. They mentioned that there are three stages of recovery of rodent in this area: first stage, the invader species come to the area and replaced the original species, 2nd stage the invader species will coexist with forest dwelling species and the end stage the original species will go back to the area. They also suggested that the habitat without any disturbance after burned from fire is fastest for recovery of rodent community.

2.4 Species interactions of small mammals

Predator-prey interaction is an important mechanism to control high abundance of small mammal population in ecosystem passing through trophic level interaction. Loss or low density of predators in a habitat may affect small mammals through the

trophic cascade (Dimond, 2001). After dam construction in Venezuela, only three trophic categories: herbivore, seed predators and predators of invertebrate found in medium and small island in the absence of large vertebrate predators (Terborgh et al, 2001). The consumers including small mammals on these two island size are higher than mainland and large islands. He also pointed out that hyperabundance of small mammal lead to bottom- up forces from plants. Many plants on island increase chemical-defense and become herbivore-resistant plants, after that carrying capacity of producer for consumer will decrease. Top-down regulation by leader of trophic level is necessary for control balancing in ecosystem. The study of Crook and Soule (1999) is other example of necessary of predators in trophic level. Loss of native sage-scrub habitat by urbanization in coastal southern California is affecting distribution of top predator (coyote). Then the mesopredator (domestic cat) are abundant in fragmented habitat where there are few coyotes. This process is followed by decreasing diversity of scrub-breeding birds that are prey for the mesopredators. The loss of predators affects relative abundance of small mammals showing in study at Khlong Saeng wildlife sanctuary in Surat Thani province (Wattanaratchakit, 1999). Several wildlife species are affected from human disturbance, most of them disappear in disturbed area including many predator of small mammal. So, the relative abundance of small mammals is high in disturbed area where their predators are absent. Moreover, the predators are another factor limiting distribution of small mammal in urban area (Baker et al, 2003)

The competition is an other factor affecting density of small mammals. There are some research showed the competition between *Maxomys surifer*, which is common species in natural habitat, and *R. rattus* who can live in many habitats and high adaptive to disturb areas. For example, the study by Wiles, found that the density of *R. rattus* tend to increase where that *R. surifer* is absent (Wiles, 1981). Not only intraspecific competition, but interspecific competition also occurs. There is some evidence of compettion between small mammal and ungulate for food in African Savanna (Kessing, 1998 & 2000). The researcher mentioned that the small mammal densities were low in the plot that ungulate are present while their densities decrease in a removal ungulate plot and also showed the effect of small mammals to plant

community when their densities are high. Total biomass of plants in plot without small mammal was 40% greater than the plot that small mammals can access when the end of first year of experiment. He suggested that they would have some impact on small mammals through food quality because expected density of small mammal are increasing while the body size of some mice are higher than the size with ungulate.

2.5 Ecological studies of small mammals in Thailand

The study on small mammals is still lacking in Thailand and South-east Asia (Bernett & Dutton, 1995). There have been seven studies on small mammal (excluding bats) in Thailand from 1891 to 1999 (Figure 1). Two researches have been conducted in south Thailand (Kanchanasaka, 1992; Lynam & Billick, 1999), two studies have been done in western forest complex (Wiles, 1981; Walker & Rabinowitz, 1992), and two studies have been made in the east region and northeast region (Pinnoy, 1993; Hamarit, 1997). Only one research has been conducted in northern Thailand (Elliott et al, 1989). The species composition of small mammals, the proportion of each species and the number of species were different in each habitat (Table 1 & Figure 2).

However, in most studies about the ecology of small mammals in natural habitat, no one has tried to link the relationship between the small mammals and human community. From the previous work on small mammals, *Rattus rattus* was the only species found in all studies and it showed high proportion in many habitat types especially in disturbed area (Elliott et al, 1989; Kanchanasaka, 1992; Pinnoy, 1993; Lynam & Billick, 1999; Hamarit, 1997) (Figure 3), while, *Maxomys surifer* showed highest abundance species in the relatively undisturbed Western forest complex (Wiles, 1981; Walker & Rabinowitz, 1992) (Figure 3).

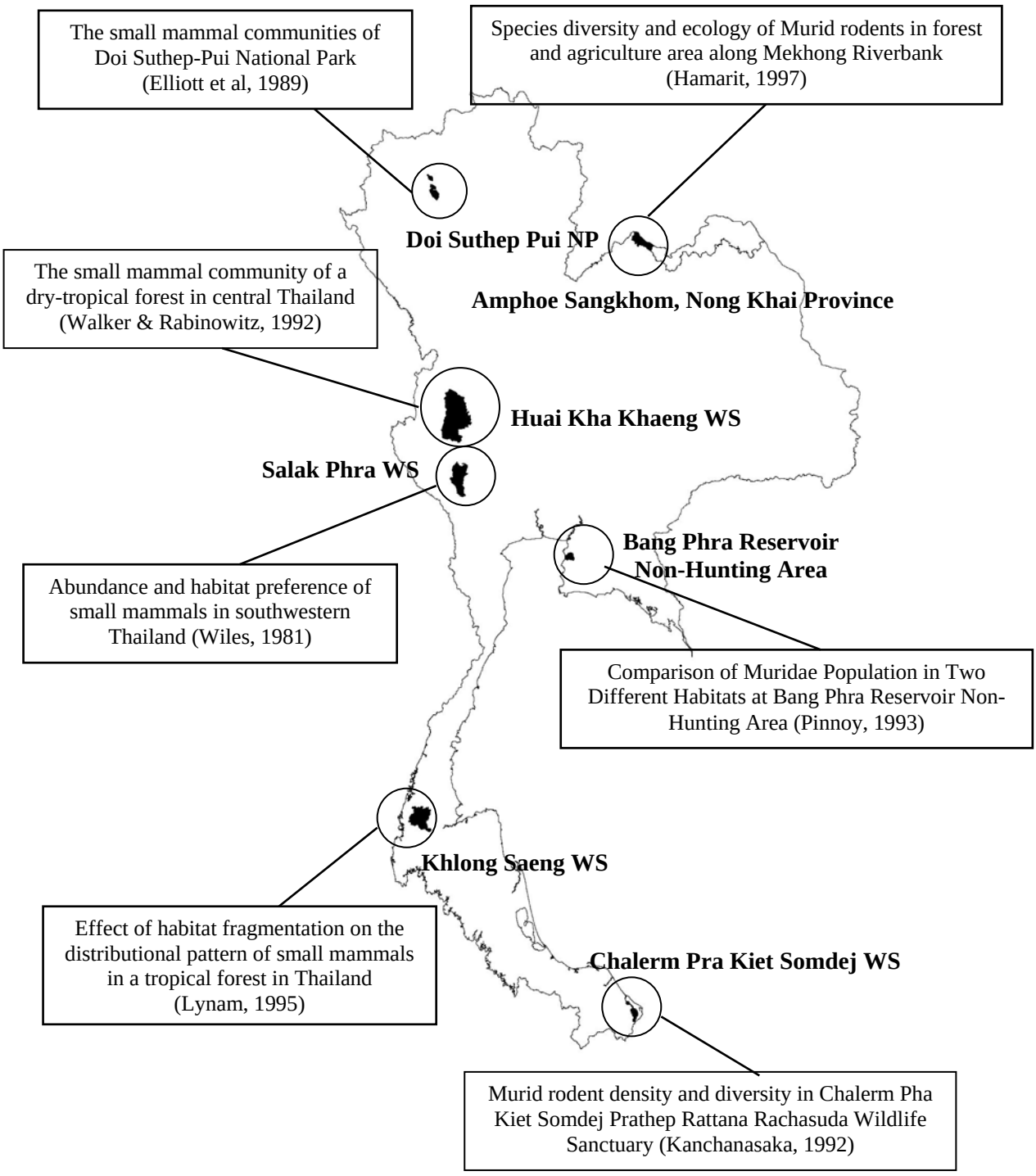


Figure 1. Locations of small mammal studies in Thailand.

Table 1. Proportion of captured small mammals, according to studies in Figure 1.

Species	Forest areas									Disturbed areas				Fragmented areas							
	DD[1]	DD[2]	MD[5]	MD/DD[3]	EV/DD[3]	EV[1]	Lowland bamboo forest[2]	Upland bamboo forest[2]	Peat swamp forest[4]	Melaeuca forest[4]	Agricultural area[5]	Abundoned field[5]	Banana field[5]	Mainland Year 5[6]	Mainland Year6 (Dry)[6]	Mainland Year6 (Wet)[6]	Mainland Year 7[6]	Island Year 5[6]	Island Year 6 (Dry)[6]	Island Year 6 (Wet)[6]	Island Year 7[6]
Rattus rattus	-	84.6	78.3	3.9	2	43.6	20.8	31.8	8.6	83.3	52.1	62.2	81.5	10.3	9.8	17.2	18.1	34.1	46.4	56.3	60.3
Rattus annandali	-	-	-	-	-	-	-	-	68.9	-	-	-	-	-	-	-	-	-	-	-	-
Rattus losea	-	-	-	-	-	-	-	-	6.9	13.3	4.2	-	-	-	-	-	-	-	-	-	-
Rattus exulans	-	-	-	-	-	-	-	-	-	-	1.7		-	-	-	-	-	-	-	-	-
Maxomys surifer	-	-	-	69	2	28.2	63.5	68.2	-	-	-	-	-	34.6	40	33.8	30.3	10.6	11.8	14.8	7.9
Maxomys whiteheadi	-	-	-	-	-	-	-	-	12.1	-	-	-	-	19.5	10.8	19.8	19.5	10.1	4.8	9.2	5
Niviventer bukit	-	-	13	-	1.5	25.6	-	-	-	-	-	-	11.1	0.5	3.1	1.7	4.2	1.0	2.1	1.1	5
Niviventer cremoriventer	-	-	-	-	-	-	-	-	-	-	-	-	-	2.8	1.4	1.7	0.3	1.9	0.3	0.8	0.4
Leopoldamys neilli	-	-	-	-	-	-	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leopoldamys sabanus	-	-	-	-	9.9	1.3	-	-	-	-	-	-	-	23.8	17.3	13.5	17.4	-	-	0.3	
Berylmys berdmorei	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Berylmys bowersi	-	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mus cervicolor	-	-	-	1.9	-	-	-	-	-	-	10.1	18.9	-	-	-	-	-	-	-	-	-
Mus caroli	-	-	-	-	-	-	-	-	-	-	19.3	5.4	7.4	-	-	-	-	-	-	-	-
Melogale personata	15.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hylomys suillus	-	-	-	-	2.5	-	-	-	-	-	-	-	-	-	0.6	-	1	-	-	-	-
Crocidura fuliginosa	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenomys mulleri	-	-	-	-	-	-	-	-	3.5	3.3	-	-	-	0.5	0.3	0.6	-	3.4	1.2	4.5	7.1
Batacota indica	-	-	-	-	-	-	-	-	-	-	12.6	12.2	-	-	-	-	-	-	-	-	-
Vandeleuria oleracea	-	-	8.7	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-
Chiropodomys gliroides	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	4.7	2.9	0.7	23.1	15.2	6.7	6.7
Echinosorex gymnurus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	1.5	1.4	1.3
Menetes berdmorei	84.2	-	-	10.4	1	-	2.1	-	-	-	-	-	-	2.2	1.7	-	0.7	4.8	3.3	0.8	2.9
Tupaia glis	-	15.4	-	13.5	5.9	-	10.5	-	-	-	-	-	-	4.3	9.2	8.6	7.3	11.1	13.3	4.2	3.3
Number of species	2	2	3	7	7	5	5	2	5	3	6	5	3	10	11	10	10	9	10	11	10

- MD= Dry mixed deciduous, DD= Dry deciduous dipterocarp forest, EV= Dry evergreen forest
- 1. Elliott et al, 1989 2. Wiles, 1981 3. Walker & Rabinowitz, 1992 4. Kanchanasaka, 1992 5. Hamarit, 1997 6. Lynam, 1995

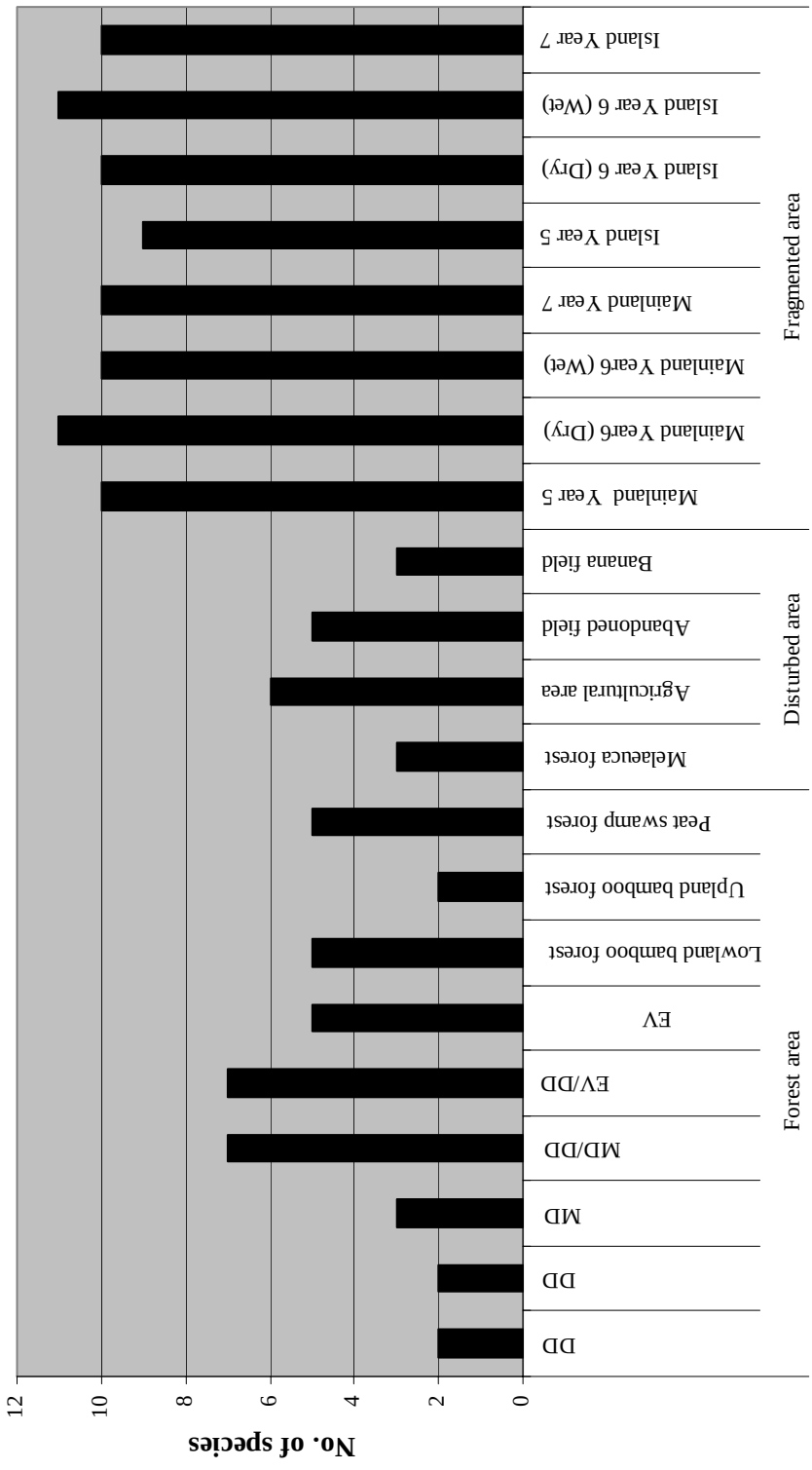


Figure 2. Total numbers of captured species in different habitat types (habitat types arranged as in Table 1)

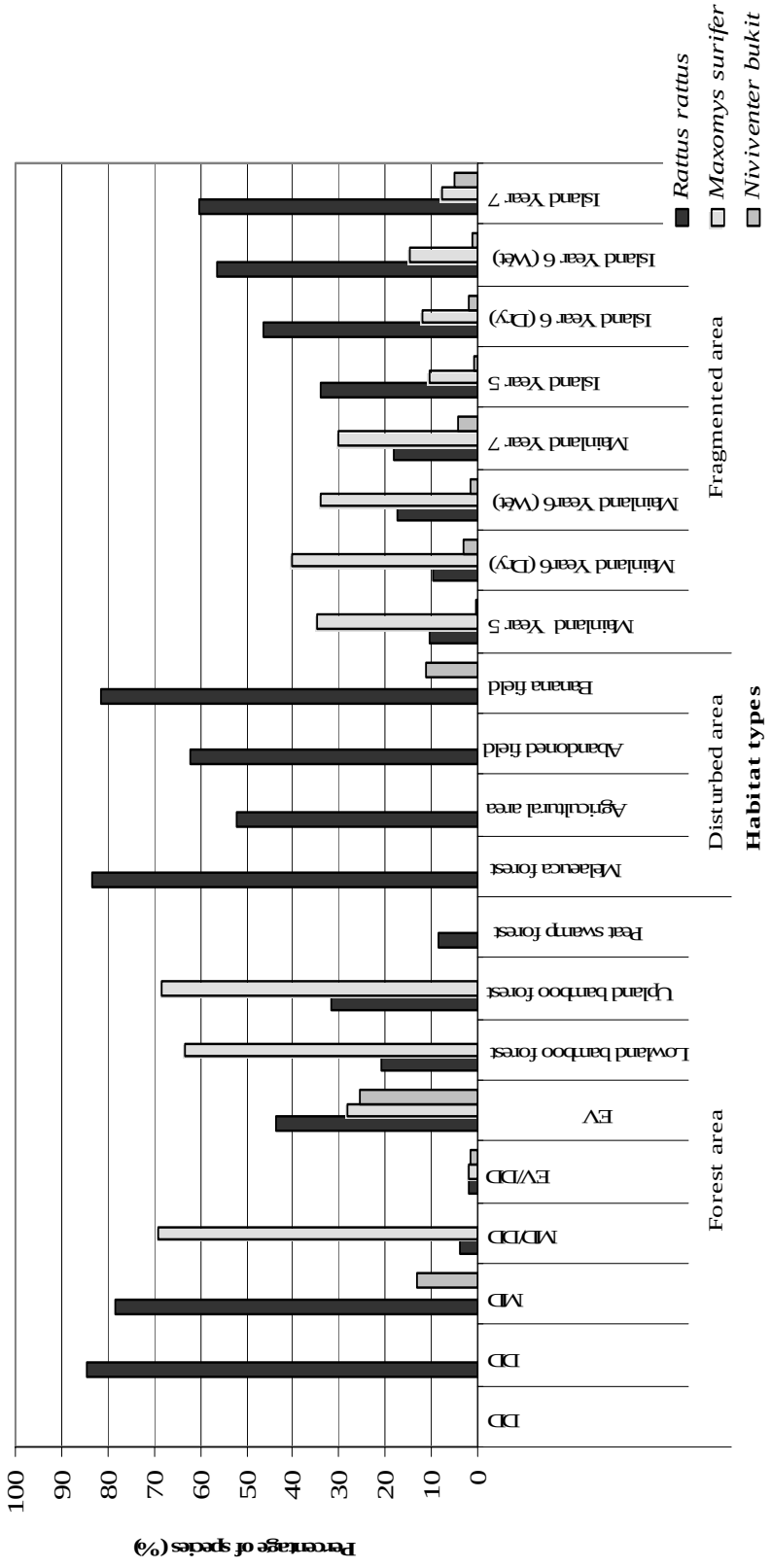


Figure 3. Proportions of *Rattus rattus, Maxomys surifer* and *Niviventer bukit* in different habitat types (habitat types arranged as in Table 1)

2.6 Small mammals as agricultural pests

Small mammals especially many species of rodents are important pest species in agriculture field. They destroy and compete with human. Rats and mice seem to be more serious pest than other small mammals. They have high reproductive rate, one female mouse can give birth 4 – 7 litters per year, yielding 2 – 13 young per litters (DOA, 2001). The rats directly compete with man for food in many parts of developing country, losses of approximate 5 – 17 % of rice in the Southeast Asia caused by the rats (Davidson, 2000). In Indonesia, about 15% of crops in each year were consumed by rat species before harvest. For Thailand, in each year more than 1,000 billion baht of the crop value were lost to the rats (DOA, 2001). It is not surprising, there are a lot of literatures about the role as pest of rats and many studies try to find the best way to control the population of them in agricultural areas.

The research from Malaysia developed a control method of rat population in oil palm plantations, the researchers suggested that even human predation was one control method but it could not get rid of a very high proportion of these agricultural pests. They also refer to human consumption to rat that it was one indigenous method to control rat population of some local area, however it was no result back up the argument (Wood & Fee, 2003).

In Thailand, many methods to get rid of these pests in the agricultural area are developed by local knowledge. At least 16 types of local traps were developed by indigenous people for eradicate the pest in rural area (DOA, 2001). However, nowadays the rodenticide have important role to eradicate agricultural pest in many cultivated area. Although, it seems to be powerful to control the pest population in the field, however, sometime not only the pest that unlucky but it also affects other animals species such as birds that are nature predators which were affected from the rodenticide that contaminate in the rats (Hamarit, 2001).

Furthermore, in some rural areas of Thailand the farmers exterminate the rat by consuming (Hamarit, 1997, DOA, 2001). A lot of numbers of rats are trapped from the agricultural area and sale in the fresh market of many provinces. Most of the people prefer to consume the rat meat during harvest season because they believe that the rat

will be clear and delicious more than other season in a year. The rat catcher becomes a good temporary job for some people in harvest season.

2.7 Small mammals as human food

Generally, the small mammals are good food supply for many people in rural area especially in several countries of developing country such as Africa and Asia.

In Africa, wild animals including rats have traditionally been used for people in due to the raising domestic animals for human consumption is difficult (Stein et al., 2002). These wild animals are important protein source supporting people in this region including many species of small mammal. For example, grasscutters or cane rats (*Thryonomys swinderianus* and *T. gregorianus*), giant pouched rats (*Cricetomys gambianus* and *C. emini*) and porcupines (*Atherurus africanus ssp*.) are most commonly hunting rodent species in bush meat market of Africa. Although the impact from harvest by human to small mammals is not great, but there are some case of some rodent species were threatened by local people such as locally exterminated of giant pouched rats occurred in eastern Democratic Repubic of Congo or the population of grasscutters become extinct because overexploitation by local people (Stein et al., 2002). Nevertheless, Stein and his colleague also reported that the people who prefered to consume the rodents still face health risks such as Lassa fever. This disease is a serious problem in some parts of tropical Africa and is transmitted by the multi-mammate rat in genus *Mastomys*.

In Asian region, small mammals are used as human food in many areas. There are a lot of information about people who love to eat rat meat in Asia. This information can be found in general publications or newspapers. For example, in rural area of Vietnam, the rat meats are good meat and popular in pubs and restaurants, some people believe that it has some medicinal properties and the cost of rat meat approximately $2 per kilogram. The information from Hanoi reported that some farmer may catch approximate 30 kilograms of rat in the paddy field by using electricity. So, extra from getting rid of rats in the field, these farmers also obtain food for family and get the money from selling the rat to pub and restaurant. In the same way, many people in China eat the rat meat for a long time in the same reason of

Vietnamese. Most Chinese believe that rat meat contains some medicine; they will preserve the rat babies in alcohol and drink as a drug. In addition, the brochure of one rat restaurant in China also presents that rat meat are healthy food that can prevent hair loss, revive the male libido, reduce phlegm and so on. Besides, the owner of this restaurant also recommended that it should not be eaten more because it will get a nosebleed and raises the body temperature. Therefore, this meat is considered as a winter food. Some owner restaurant in China claimed that it helps to eliminating the pests and helping some farmers to enrichment while one owner restaurant in this news presented that he serve only free range rats, the wild rat in their restaurant come from the far mountain and these rat feed on only fruit and vegetable (Stein et al., 2002). That means not only rat as pest were consumed but include the wild rat from the nature.

In other parts of Asia, there are some species of small mammal were produced to wildlife trade market of Southeast Asia in form of bush meat. There are at least 8 species of squirrel and flying squirrel include two species of Bamboo rat; Great Bandicoot and Bush-tailed Porcupine were sold in That Luang Fresh Food Market in Vientiane (Srikosamatara et al, 1992). It occupied 2.37% of total value of mammals sold in wet season of this market. In market of North Sulawesi estimate 50,000-75,000 forest rat were sold per year (Bennett & Rao, 2002). Rat–catchers are job for some villagers in Burma (Wemmer & Aung, 1998). These people support their family by selling the roast rats to others villagers. One rat-catcher could harvest 725 rats in three months (3-47 rats/night). The common captured animals in rice field are *Rattus rattus*, *Bandicota bengalensis*, *B. indica* and *B. savilei*.

In Thailand, small mammal is common food for rural people. Many small mammal species include the rat meat were sold often in fresh food market of many provinces of the country. For example, in some district of Udonratchatani Province the rats are bought in price of 40 baht per one. The rat-catcher is a job of some villager. The rats were bought at the market or sometime the villagers who love to eat rat will ask the rat trapper by themselves (information from woman who lives in this province). In other case, sometime when you travel to the countryside by car, you may see the roast rats are hanged for sale with other birds at the road site shack particularly in harvest season. However, from the information of some local people from northeast

Thailand, most of rat species that they prefer to eat are Bandicoot rat. They were trapped from the paddy field. The information on amount of small mammals consumed by human have not been collected in Thailand.

2.8 Karen people and conservation

Karen is a tribal group which has high awareness of conservation (Santasombat, 1999). Karen people do not concentrate in hunting like some hill tribe such as Lahu, Lisu and Hmong, but their hunting still occurs (Steinmetz & Mather, 1996). Some Karen people are vegetarians and do not hunt (Singhasakorn, 1996), however, this phenomenon is not universal among all Karen, it will be only local phenomenon in some areas (Tungittiplakorn et al, 1999). Steinmetz and Mather studied the impact of Karen village to the wildlife in western Thailand and pointed out that the forest area near Karen settlement supports viable wildlife population especially many species of primates (Steinmetz & Mather, 1996).

One elder Karen man, Joni Odochao, said that most remaining forest areas in Thailand are located where hill tribes live (UNDP, 2004). This elder man is one local philosopher with pride in his Karen blood and believes that a Karen person is a good nature conservationist (Promsao & Siraluk, 1999; UNDP, 2004). He also said that long-held traditions of Karen people come from harmonious co-existence of people and forest. There are many examples of conservation traditions of Karen people in the literature (Promsao & Siraluk, 1999; UNDP, 2004; Santasombat, 1999; Santasombat, 2001)

2.9 Small mammals around Muang Pam village

The results of previous wildlife studies in Muang Pam village showed highest relative abundance of small mammal species around the village. Small mammals are highly abundant in all line transects around the village in both wet and dry season (42.2% and 35.2%). The greatest abundance of them showed in communal forest where carnivores disappear. Rats are highest relative abundant and increase in wet season (Srikosamatara et al, 2000 & 2002).

Most villagers in Muang Pam are farmers. The agricultural products such as rice, corn, bean and vegetables are important crop for supporting their life. Doubtlessly, the small mammal such as squirrels and rats are important serious agricultural pest to their crops. However, the Karen people do not prefer to use rodenticide to eradicate these pests. Furtermore, the Karen people are one hill tribe group who consumes rat meat while other hill tribe group such as Lisu and Lahu (Musser) do not eat. The villagers in Muang Pam will trap the rats in the forest for support their families especially in cold season when the water too cold and they do not want to touch the water (information from preliminary study). So, the small mammals including the rats are common food and are one protein source for villagers in Muang Pam village.

CHAPTER III
METHODOLOGY

3.1 The study site

Mae Hong Son Province

Mae Hong Son province is located between 17º 38´ - 19º 48´ N and 97º 20´ - 98º 39´ E, covering an area of 12,672.26 sq km, in northern Thailand (Figure 4). More than 90% of the area consists of limestone mountain and high hills around various river basins, 71 % of the province is covered with forest (OEPP, 2000). Mae Hong Son lies next to Myanmar, separated by the Thanon Thong Chai and Dan Lao Mountain which are main mountains of the province. The main rivers in the province are the Salawin, Pai, and Yuam. The vegetation of Mae Hong Son province can be divided into 5 major categories; Tropical Mixed Deciduous Forest, Deciduous Dipterocarp Forest, Dry Evergreen Forest, Hill Evergreen Forest and Pine Forest (OEPP, 2000). The climate of Mae Hong Son seems to be perennially shrouded under misty air that is ground fog in the rainy season and winter, and smoke from slash-and-burn farming in the summer. Consequently, it is often called “the town of Three Mists”.

The people of Mae Hong Son consist of 2 major groups, Shans or Thai Yai who live in the city, and five hill tribe groups: Karen, Lisu, Hmong, Lahu, are Lua who live in villages on mountain tops of the province. Their lifestyles have changed little in hundreds of years. However, both Shans and hilltribe people have their own distinctive culture such as dialect, architectural lifestyles, customs and traditions, and cuisine. Consequently, Mae Hong Son province is one of the dream destinations for visitors who are attracted by cultural and natural wonder.

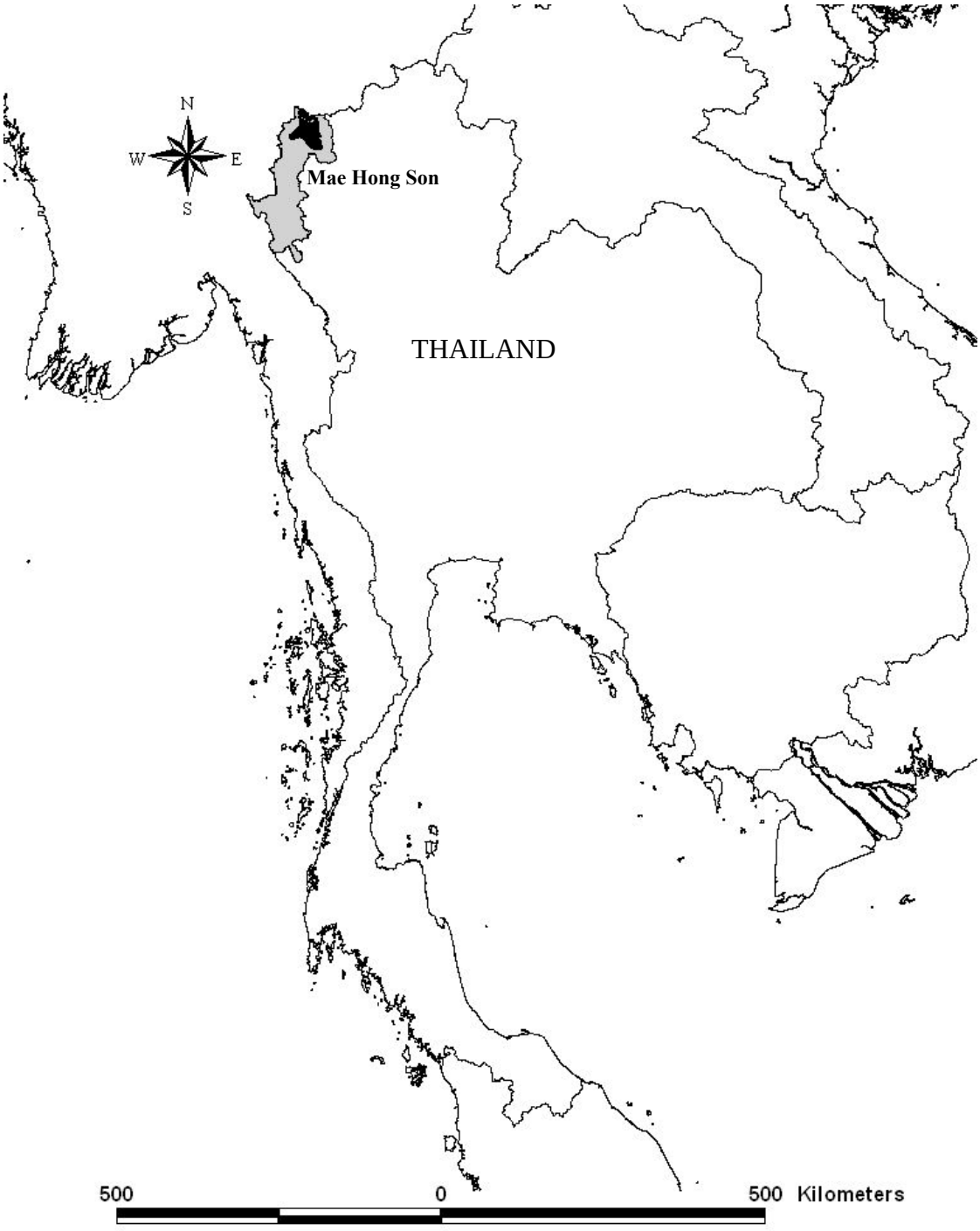


Figure 4. Location of Mae Hong Son province, the dark areas in province boundary is the area of Sun Pan Daen and Lum Nam Pai Wildlife Sanctuary.

Muang Pham village

Muang Pham village is located in Northern Mae Hong Son Province (Figure 5). The village is surrounded by the forest and still in the valley. The location of this village was excluded from the area of San Pun Duang WS when its boundary was announced. The village lies at an altitude of 800 – 1200 meters. The area of cultural landscape of villagers in Muang Pham village is approximately 59 square kilometers (Figure 6, 7). It includes the watersheds, the agricultural area and several forest types that were determined by villagers. The forest types around the village are dominated by Deciduous Forest, Dry dipterocarp Forest and Bamboo Forest. There are several major streams running through the area such as Huai Nam Pam, Huai Kut-on, Huai Pa Muang, Huai Rai and Huai Pong.

This village is about 40 years old and the population consists of about 120 households (Chaekpimai et al, 2001). Most villagers are farmers who still practice Rotational Swiddening in the valley. The areas for agriculture are situated not far from the village. The main plant of them is rice, which are planted both in dry field and paddy field, the other minor plant such as corn, bean, garlic and many vegetable.

Most Karen are classifying forest area around the village according to the exploitation of resources from the forest or their activity (Figure 8). The forest areas around Muang Pham village were classified into four use types (Santasombat, 2001).

Conserved Forest: It is a location of the watershed where many major rivers of the village originate. There are strict rules for protecting the forest; any human activities such as cutting wood and hunting are restricted in this area. However, nowadays most of the conserved forest area of Muang Pham village has been declared to Wildlife Sanctuary area by the government. The forest types contain Deciduous Forest and Dry Dipterocarp Forest.

Used Forest, this forest is located near the village. In this area the villagers can harvest both timber and non- timber forest products (NTFPs). Most of vegetation is Deciduous Forest and some area is dominated by bamboo.

Cemetery Forest is a small forest area, dominant by deciduous forest, near the village where dead people have been buried.

Communal Forest, small area in the south of the village where all villagers must help to take care. The dominant forest type is Deciduous Forest. There are two visiting place of village: Pong Laung* and Wang Pla**. In general, the villagers avoid doing any activities in this area especially hunting and cutting timber. The villagers have believed that this area is a holy place; most of the trees in this forest were ordained. However it may be a way of local people to protect the large trees. Moreover, everybody in the village must help to make firebreak to prevent forest fire in this area every year.

* **Pong Luang**, the largest mineral lick in Muang Pham village. Nowadays, mostly it was used by cattle, buffalo and birds (Appendix B).

** **Wang Pla**, an important place to conserve the fish of villager, it was small reservoir that has temporary dam to preserve water (Appendix B). There are strict rules to prohibit the people to catch fish in this area both villagers and outside people.

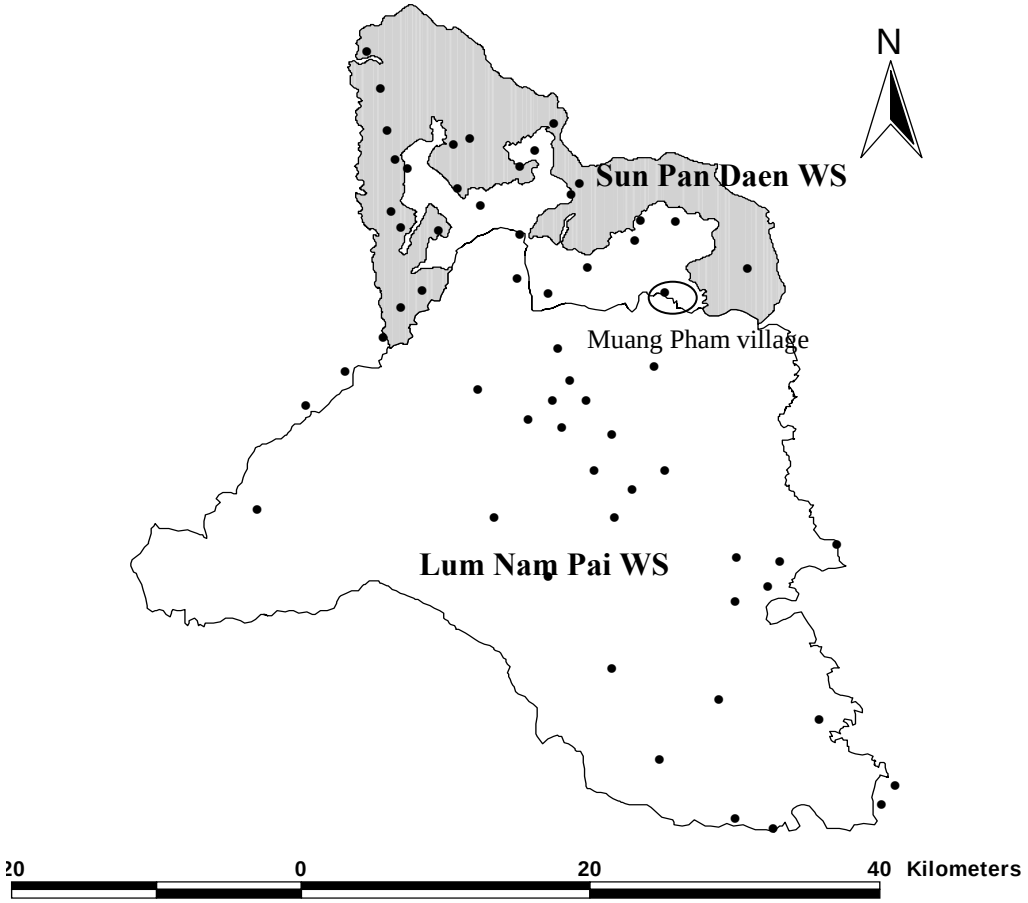


Figure 5. The numerous hill tribe villages that are located in the areas of Sun Pan Daen and Lum Nam Pai Wildlife Sanctuaries. The circle shows the position of Muang Pham village.

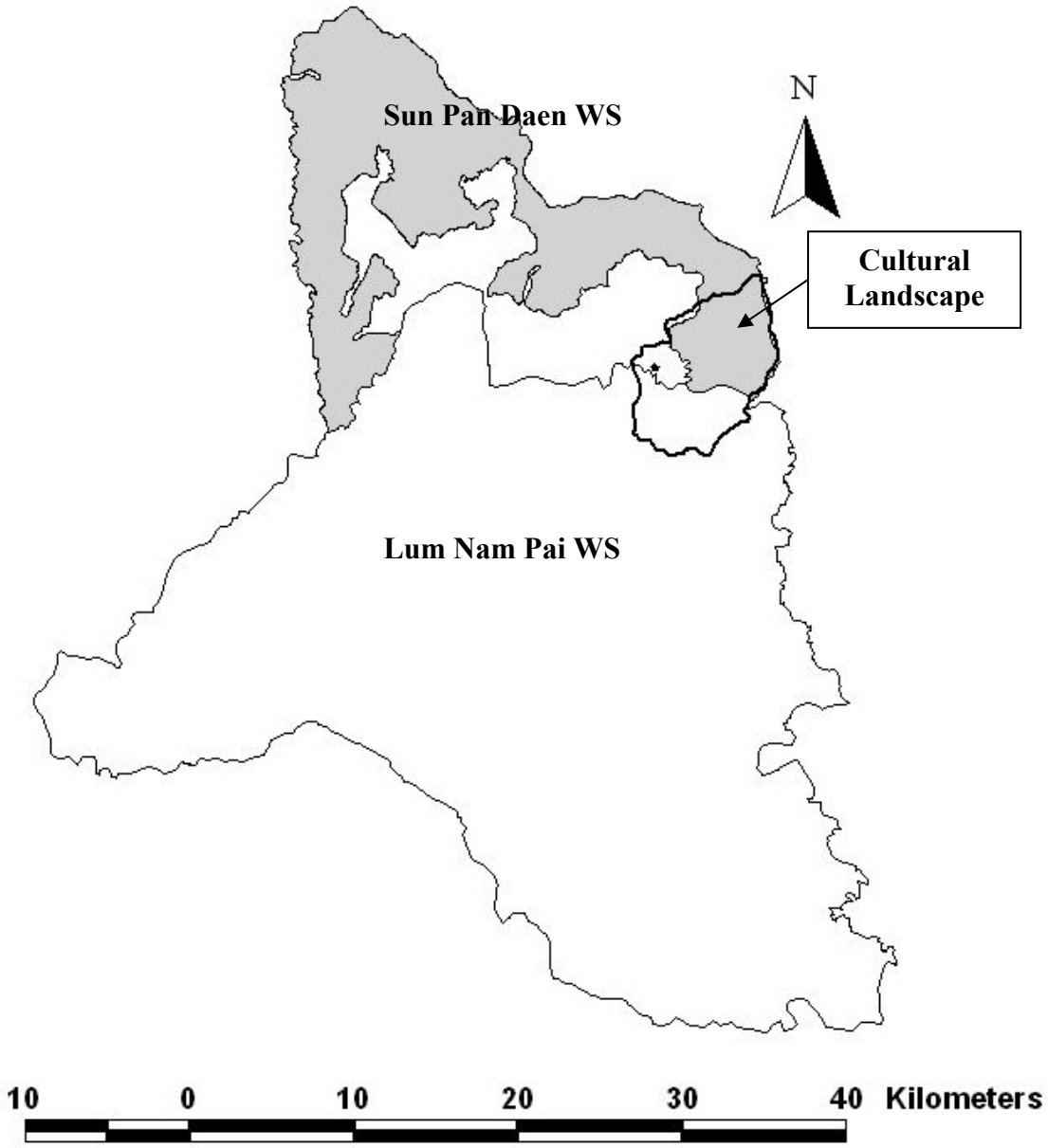


Figure 6. Showing cultural landscape determined by villagers, gray area is Sun Pan Daen WS

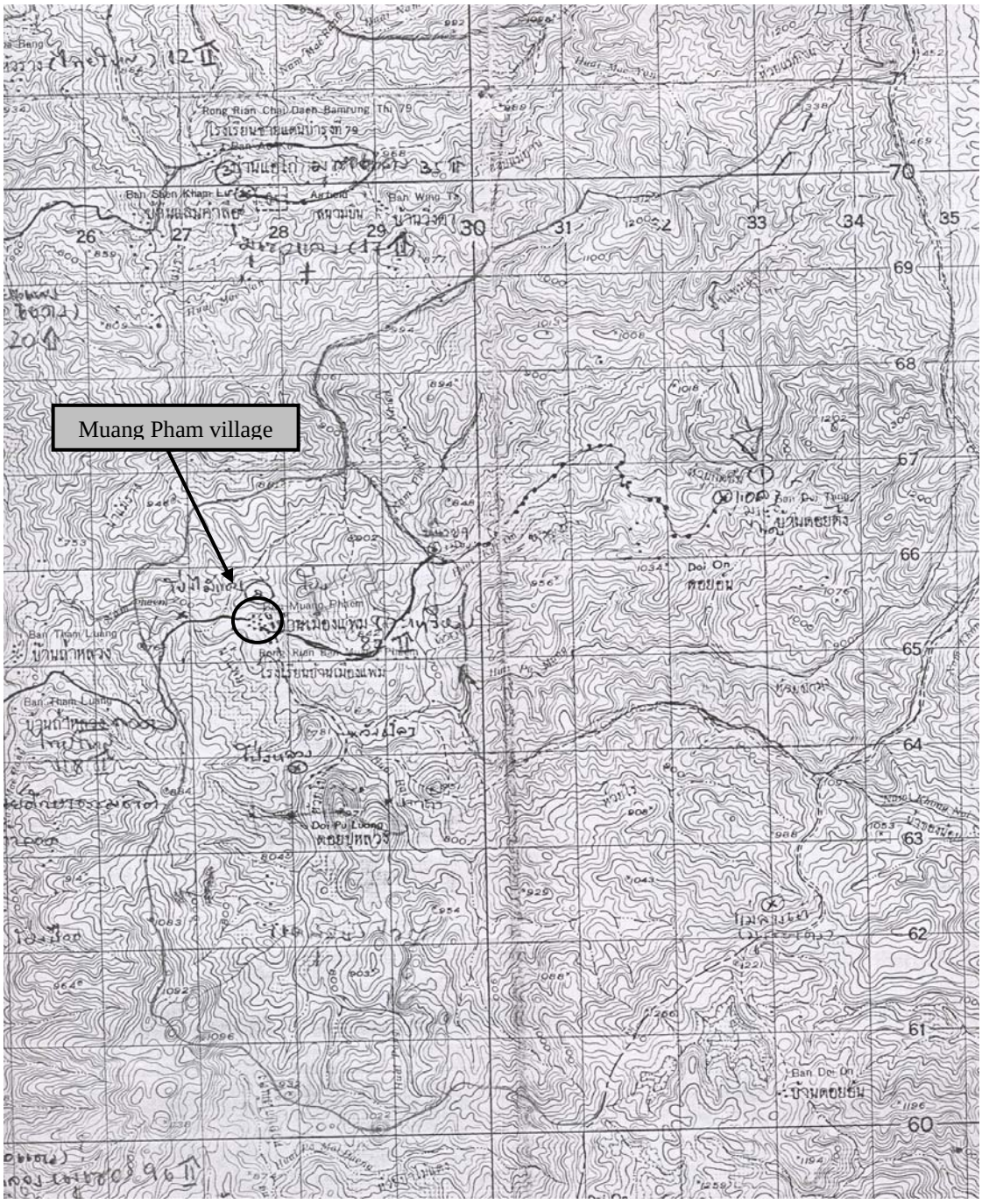


Figure 7. Topographic map showing the location of Muang Pham village, the cycle is the position of the village.

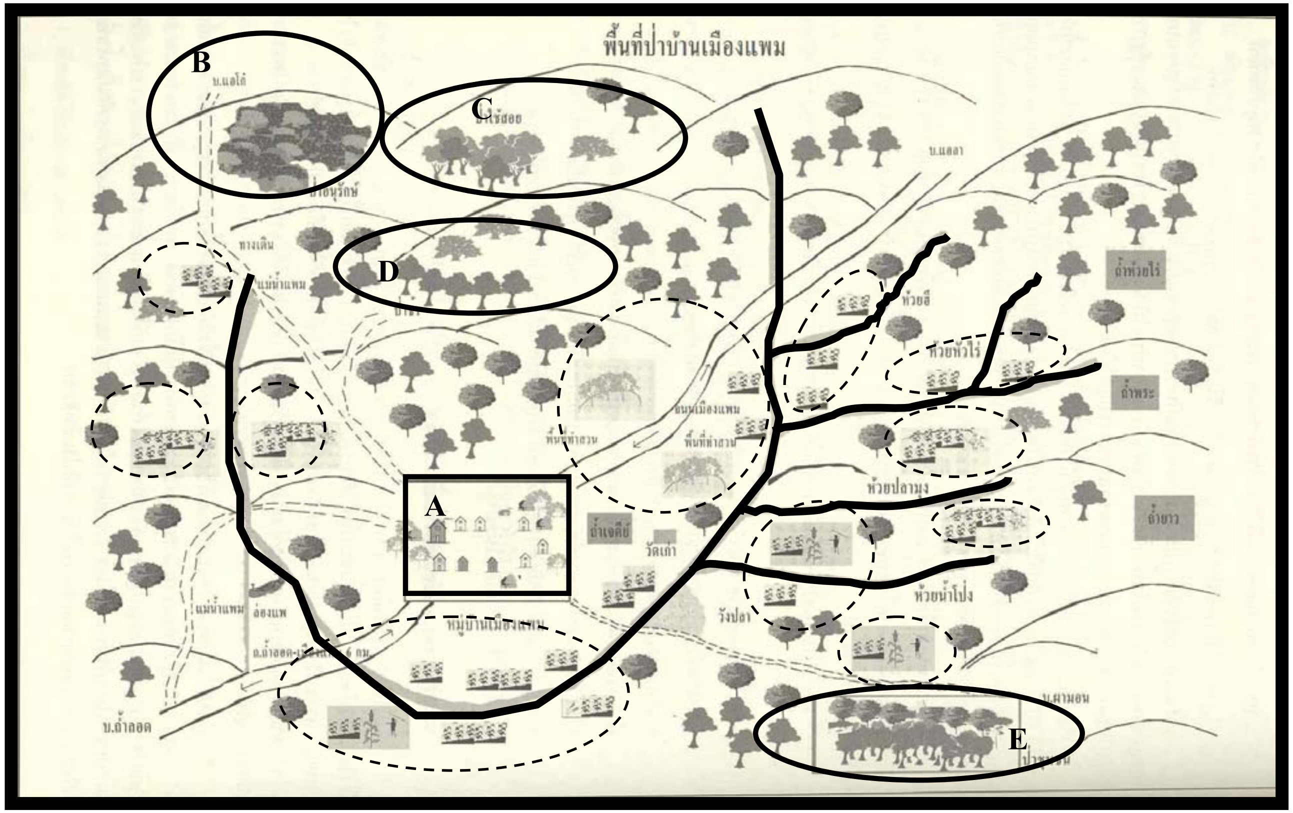


Figure 8. Local map of Muang Pham village showing the locations of the different forest types around the village; A= village, B= Conserved Forest, C= Used Forest, D= Cemetery Forest and E= Communal Forest. Dash cycles show the agricultural areas. (Source: Santasombat, 2001)

3.2 Trapping site

The trapping sites were located in different forest types and agricultural areas of villagers to compare species composition of small mammal.

During preliminary study, the Census lines with Assessment lines were set in three sites around the village where the line transects in previous study were laid (Srikosamatara et al, 2000) (Figure 9 and Table 2).

Site A was located inside the San Pun Daen Wildlife Sanctuary boundary. Site A occurred in Dry Dipterocarp Forest but was dominated by Pine and Fagaceae spp. Parallel census lines were lain along the ridge top, and six assessment lines were lain down on the slope from the top of the ridge to stream.

Site B was located in communal forest in the southern part of the village near Pong Luang, a large mineral lick. This area was disturbed by both the villagers and tourists. Most villagers use paths through this area to their agricultural areas, and tourists use these paths to walk from other villages to Muang pam village or to ride the domestic elephants. The forest area in this area is Deciduous Forest and there is the stream, Huai Pong, running parallel the census lines. Consequently, the forest in Site B will be moister than other two sites.

Site C was in the Used Forest, some trap stations are located in agricultural area. The forest type is Deciduous mixed Bamboo Forest. In this forest type the villagers will cut the wood and bamboo for use in their households.

After preliminary study, six square grids were laid around the village (Figure 10 and Table 2) for studying small mammals in the area.

Grid 1 and Grid 6 were set in agricultural area. But there are some different characteristics between these two grids. Both of them are abandoned fields but Grid 6 was abandoned in a longer time than Grid 1 where harvested in 4 – 5 month ago before the study done. So, in Grid 1 the agricultural products still remain in the area.

Grid 2, 3 and 4 are located in used forest in the north of the village. Grid 2 and 4 were situated near the road and Grid 3 was set near the Cemetery Forest. Moreover, the position of Grid 3 was placed in the same area of Site C in the preliminary study. For Grid 4, it was placed near the Nam Pham forest guard station of Sun Pan Daen Wildlife Sanctuary where the villagers escape to do the illegal activities. Around the area of Grid 3 and Grid 4, there are some villagers trapping the rat during grid trapping.

Grid 5 lied in the communal forest at the same location of Site B in preliminary study.

Table 2. Locations and forest types of trapping sites during preliminary study and grid trapping periods

Trap site	Location	Forest type
Trapping configuration sites (Preliminary study)		
Site A	Inside San Pun Daen WS boundary	Dry Dipterocarp Forest dominance by Pine and Fagaceae spp.
Site B	Communal Forest	Deciduous Forest
Site C	Used Forest	Deciduous Forest + Bamboo Forest
Grid trapping sites		
Grid 1	Agricultural area	Abandon corn field about 1 month ago (the agricultural product still remain the area)
Grid 2	Used Forest near the road	Deciduous Forest + Bamboo Forest
Grid 3	Used Forest near gibbon forest	Deciduous Forest (same location of Site C in preliminary period, some villager trap the rat near grid site during grid trapping period)
Grid 4	Used Forest near the road and San Pun Daen WS	Deciduous Forest (some villager trap the rat near grid site during grid trapping period)
Grid 5	Communal Forest	Deciduous Forest (Huai Pong running through grid site)
Grid 6	Agricultural area	Abandon corn field about 4-5 month ago (more of thorn plant in the area)

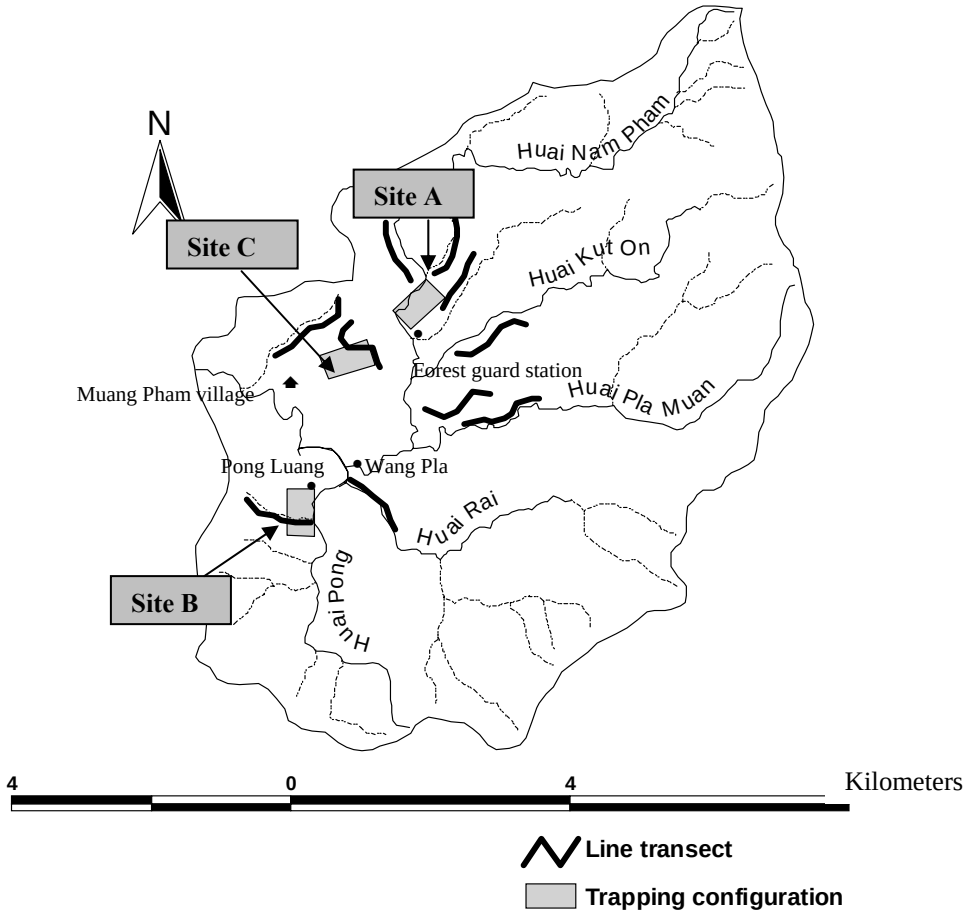


Figure 9. Locations of the three trapping configurations and line transects (previous study), the dark point in the map show the position of Num Pham forest guard station, Pong Luang and Wang Pla

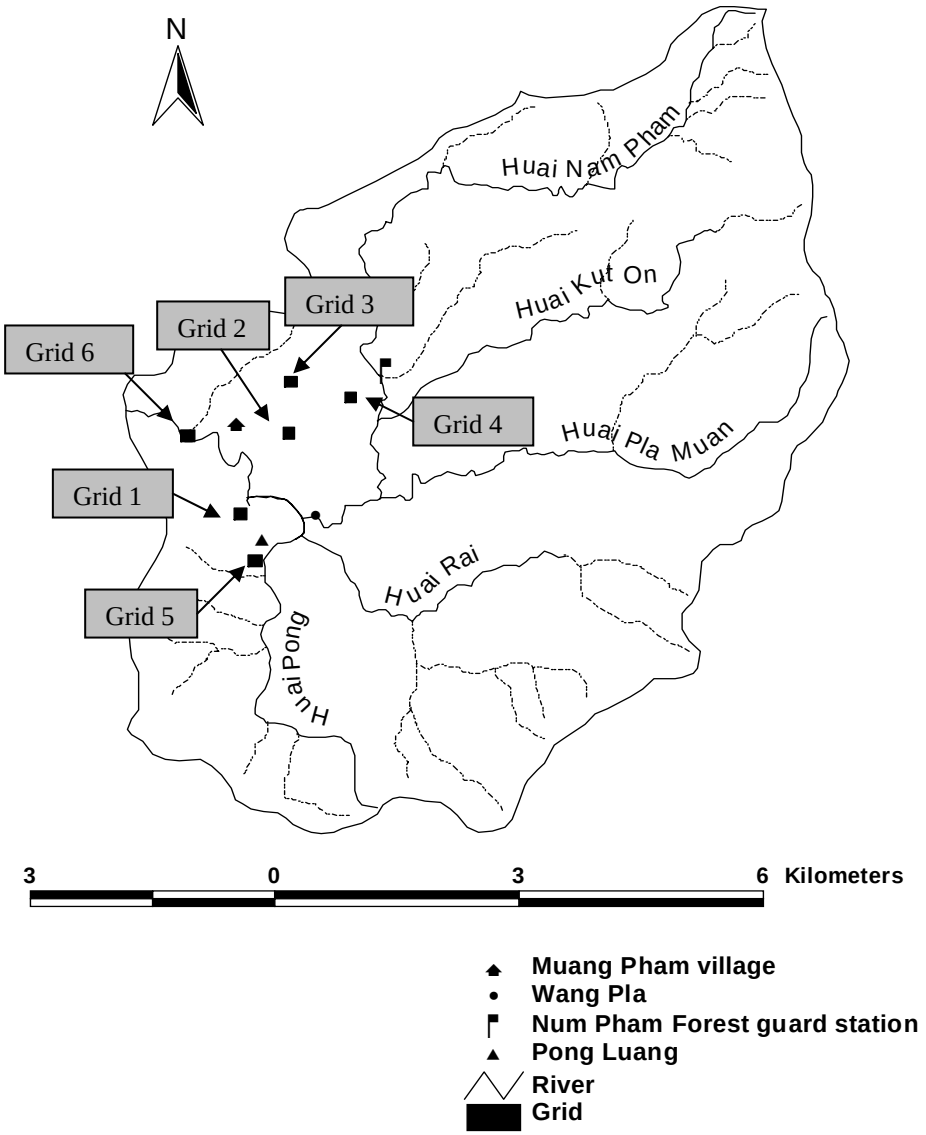


Figure 10. Locations of six square trapping grids around Muang Pham village.

3.3 Trapping method

Live trapping is the basic way for studying small mammals. This method provides the most information data about population numbers, determine differences between habitat types and monitoring population changes following disturbance.

To study the density of small mammals in this study, a mark- release-recapture technique was used within trapping configuration. Each trap station in both trap configurations, one wire live trap (14 x 14 x 24 cm) was placed only on the ground and they were opened to prebait in two or three days before trapping started. Traps were checked twice a day, between 08.00–10.00 and 16.00-18.00. After checking the traps were cleaned of old bait or feces, and new bait was added daily. The doors of the live traps were specially designed for supporting the long tail rats because the tails of Muridae spp. is one important character for identification.

Captured animals were marked by hair clipping in a different pattern on their body. Sex, weight and body length of them were recorded. To measure the animals' weight a 300 and 500 g Pesola were used. While the head plus body length (HB) and tail length (T) were taken with a meters wire. Identification of animal species followed the Mammals of Thailand (Lekagul & McNeely, 1977; Askin, 1977; Marshall, 1977). The other appearances such as sex, age class are also collected and then captured animals were released at the point of capture. The recaptured animals were recognized by a unique pattern of hair clipping.

3.4 Trapping configuration

Trapping configurations were laid to determine species diversity and density of small mammals around Muang Pham village. During preliminary study, three trapping configurations of the census lines with assessment lines were design to obtain the data of small mammals (Figure 9). The preliminary study was done during 23 May 2003 – 30 July 2003. However, although this trapping configuration technique covers the large area but some problems occurred during preliminary period, it taken a long trapping period and a lot of manpower including the assessed data were sensitive. Consequently, the square grid method was designed to collect the data of small

mammals. Grid trapping period was done in December 2004. Six square trap grids were placed around the village (Figure 10).

The census lines with assessment lines

This technique taken from O'Farrell et al. (1977) but spacing in trapping configuration was adapted from Walker & Rabinowitz (Walker & Rabinowitz, 1992). The trapping configuration consisted of two 585 meter long census lines in parallel (53 meters apart) containing 40 trap stations each and six 255 meter long assessment lines, which intersect the census line at a 45° angle, and contain 18 trap stations per line (Figure 11). The captured animals were marked by hair clipping and released at the point of capture. Trapping were operated along the census lines until new captures of animals were fewer than 10% of total captures. After that recovery period was followed about two or three days to recover the population of small mammals in trapping sites and then trapping was done again along the assessment lines for another four days. Trap-nights were different in each site because it is depended on the days that used in census lines.

The square grid

The square grids were designed to trap small mammals around Muang Pam village during December 2004. The layout of square grids consisted of six rows and six columns of traps and trap spacing was 20 meter (Figure 12). Each grid covered an area of 1 ha. The 36 trap stations were laid down in each grid. The traps were conducted over four consecutive nights. Each grid was baited for an average of 144 trap nights.

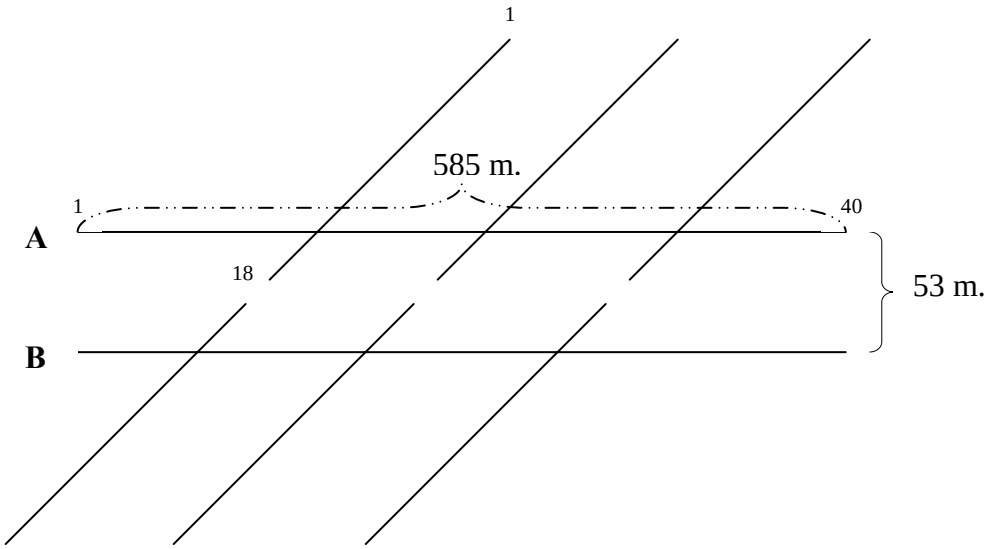


Figure 11. Trapping configuration consisting of two census lines (A, B) with six assessment lines.

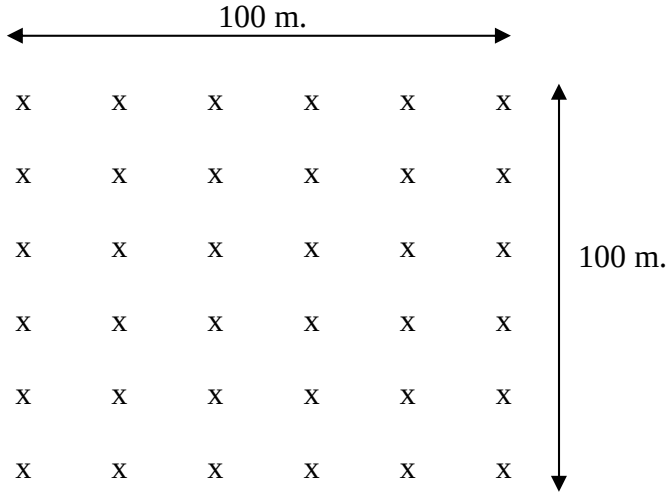


Figure 12. Configuration of square trapping grid consisting of six rows and six columns (x = trap station)

3.5 Baits

Bananas were used as bait during both trapping periods. In Grid 1, they was set in agricultural area, the remains agricultural products in area such as bean and cassava also were used as bait too. Moreover, to attract animals the milled rice mixed with turmeric was added to banana. Milled rice mixed with turmeric is extract bait for trap the rat of villagers in Muang Pham village.

3.6 Data analysis

- **Abundance analysis**

Abundance of each species of captured small mammal was measured as individuals captured per 100 trap-nights (the number of individual captured animals divided by the number of trap nights x 100).

- **Density analysis**

- Preliminary study

The density of each species of captured animals during preliminary study was estimated by the method of O'Farrell et al (1977, 1978).

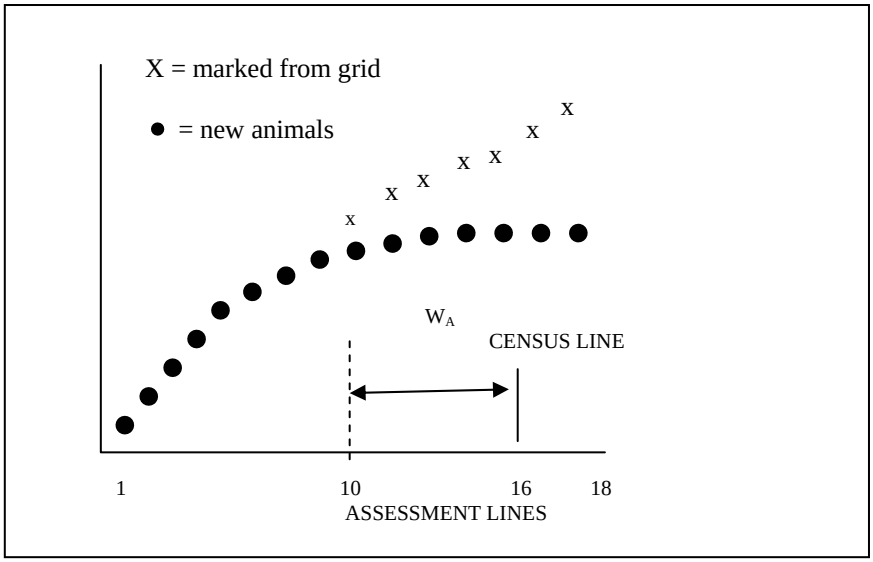
Density (D):

$$\mathbf{D = N_A/A}$$

To calculate A (Area of Effect)

$$\mathbf{A = L_W L_L + 2 L_W W_A + \pi r^2}$$

where L_W equal the width of the plot, L_L equal the length of the plot and r equal W_A plus half the distance between the census lines. W_A or the width of the area can be estimated by using the midpoint between the two stations where the break in the slope occurred as seen graphically.



Trap interval = 15 m.

W_A = midpoint between the two stations were the break in the slope occurred as seen graphically

For example:

W_A = (15) (6) + ½ (15)

= 97.5 m

To calculate N_A (The number of animals within the area of effect)

The proportion of animals removed from the Area of Effect (A):

$$\mathbf{R_P = M / T}$$

M = the number of captured animals in the area of effect that already marked in the census trapping period

T = the total (unmarked and marked) animals caught within the area of effect on assessment lines.

$$\mathbf{N_A = N_G / R_P}$$

N_G = the total number marked during census trapping period

- Grid trapping

The densities of captured animals during grid trapping period were true number of captured individuals in grid sites. Due to population of each captured species were small.

- **Biomass Analysis**

The biomass of each species in the area was estimated average weight of animals. The average weights of each species were calculated separating the different age class of adult and juvenile. The average weights of each age level in the same species were added together and divided by the total area in unit of ha.

3.7 Rat trapping by villagers

The data of trapping the rats by villagers in year 2003 were collected in August 2004 by interviewing the villagers. The Karen assistants who can speak Thai help to translate the language. The data on amount of trapped rats by villagers in 2004 were collected during the trapping season. Some data were collected by participation of villagers who are interested in this study.

3.8 Signs of predators of small mammals

During trapping period, the sign of all predators of small mammals such as carnivores, reptiles, birds including human that appeared around the village were collected.

CHAPTER IV
RESULTS

4.1 Preliminary study

During preliminary survey, nine species of small mammals were captured around Muang Pham village by trapping configuration of census lines with assessment lines. It consisted of *Bandicota savilei*, *Leopoldamys sabanus*, *Rattus rattus*, *Rattus koratensis*, *Niviventer bukit*, *Maxomys surifer*, *Mus cervicolor*, *Menetes berdmorei* and *Tupaia belangeri*. *R. rattus* was the most abundant captured species which comprised 43% of all captured individuals, and next were *N. bukit* and *M. berdmorei* (Table 3). Where as *B. savilei*, *L. sabanus*, *R. koratensis* and *M. cervicolor* were represented by only one captured individual from the total of 3,856 trap nights.

The greatest number of individuals and species were captured in Site B (Table 4). Only three species of *R. rattus*, *N. bukit* and *M. berdmorei* were trapped in all three trapping configurations. *B. savilei*, *B. berdmorei R. koratensis* and *M. surifer* found only in Site B. Only one *M. caroli* was found in Site A while *L. sabanus*, *T. belangeri* were captured in Site C. *M. berdmorei* showed highest abundance in Site C but there is only one captured in Site A and Site B. However, captured *M. berdmorei* in Site A and B have higher weight than the *M. berdmorei* in Site C (Appendix A). Two pregnant animals were trapped during preliminary study that are one *M. berdmorei* in Site A and one *M. surifer* in Site B.

However, density of captured small mammal in Site A could not be estimated by the equation in the method because only one individual was trapped in assessment trapping period. Density of *R. rattus* and *N. bukit* in Site B were 1.87 individuals/ha and 1.25 individuals/ha respectively (Table 5). And the density of *M. berdmorei* in Site C was 1.95 individuals/ha. The methodology used for determining the density of those three species followed that of O'Farrell et al (1977). However, the sample sizes of other captured species were too small for this method.

Table 3. Total number and relative abundance of each small mammal species in the preliminary study and grid trapping stu
Relative abundance of animals was measured as individuals captured per 100 trap nights.
(numbers exclude recaptured animals)

Species	Common name	Preliminary study	Grid trapping
Bandicota savilei	Lesser bandicoot rat	1(0.03%)	1(0.12%)
Leopoldamys sabanus	Noisy rat	1(0.03%)	-
Berylmys berdmorei	Lesser white-toothed rat	-	1(0.12%)
Rattus rattus	Roof rat	28(0.73%)	13(1.5%)
Rattus koratensis	Sladen's rat	1(0.03%)	-
Niviventer bukit	Bonhote's rat	16(0.41%)	13(1.5%)
Maxomys surifer	Yellow rajah rat	4(0.1%)	3(0.35%)
Mus caroli	Ryukyu mouse	1(0.03%)	-
Menetes berdmorei	Indochinese ground squirrel	10(0.26%)	14(1.62%)
Tupaia belangeri	Northern treeshrew	3(0.08%)	4(0.46%)
No. of individuals		65	49
No. of species		9	7
No. of total trap nights		3,856	864

Table 4. Total number and relative abundance of small mammals in three trapping configurations of census lines with assessment lines

Species	Trapping area		
	Site A	Site B	Site C
Bandicota savilei	-	1 (0.1%)	-
Leopoldamys sabanus	-	-	1 (0.09%)
Rattus rattus	7 (0.4%)	20 (2.02%)	1 (0.09%)
Rattus koratensis	-	1 (0.1%)	-
Niviventer bukit	1 (0.05%)	6 (0.5%)	7 (0.65%)
Maxomys surifer	-	4 (0.4%)	-
Mus caroli	1 (0.05%)	-	-
Menetes berdmorei	1 (0.05%)	1 (0.1%)	8 (0.74%)
Tupaia belangeri	-	-	3 (0.27%)
No. of individuals	10 (0.55%)	33 (3.32%)	20 (1.86%)
No. of species	4	6	5
No. of trap nights	1,792	992	1,072

4.2 Grid trapping and species composition

By grid trapping, total of 49 individuals of animals were captured by 864 trap nights of grid trapping. Seven species of small mammals were found in grid trapping period. *M. berdmorei* was greatest relative abundance and followed by equal percentages of *R. rattus* and *N. bukit* (Table 6). The other four species were trapped in a few individuals. The largest numbers of small mammal's species were presented in Grid 5. Average density of small mammals around Muang Pham village were 8.21 individuals/ha and their average biomass was 1.37 kg/ha.

However, *Leopoldamys sabanus*, *Rattus koratensis* and *Mus cervicolor* that were trapped during preliminary study period were not captured by grid trapping. The other small mammal species found during study period: Variable squirrel (*Callosciurus finlaysoni*) and Burmese striped tree squirrel (*Tamiops mcclellandi*) were frequently observed in the tree around the village, but not captured.

Menetes berdmorei

M. berdmorei was the most abundance species around Muang Pham village (Table 3). A total of 14 individuals were captured during grid trapping. The density of *M. berdmorei* varied from 1-8 individuals/ha and an average biomass was 536.3 g/ha. The greatest numbers of *M. berdmorei* were captured in Gird 6. However, this species were not found in Grid 2, 4 and 5. All of captured animals were found when traps checking in evening. None of them were captured during the night. Seven individuals were recaptured, four from seven were found three times with average minimum movement area of 349.3 sq m. The minimum possible movement area calculated by distance from station to station of all stations that each recaptured individual was found. Mean weight of captured *M. berdmorei* was 212.9 gram that higher than the captured animals during preliminary period (Table 8). All of captured of this species were adult animals with equal of sex ratio of 1:1 (Table 7). This small mammal species seem more awake than Muridae species when they were trapped.

Tupaia belangeri

Only four individuals of *T. belangeri* were captured by grid trapping around the village, no individuals of this species were captured in Grid 1, Grid 4 and Grid 5. Population density varied from 1-2 animals/ha. Similar with *M. berdmorei*, this common treeshrew seem agitated when it was found in the trap. All of captured animals were adult female and found only in the day. Mean weight of *T. belangeri* by grid trapping higher than the captured animals during preliminary study.

Rattus rattus

R. rattus was most abundance species during preliminary study and still high abundant in grid trapping period. Thirteen individuals of *R. rattus* were captured by grid trapping. This species were captured in almost all grid sites except in Grid 3. The density of *R. rattus* varied from 1 to 4 individuals/ha with average biomass of this species was 383.4 g/ha. There are only two individuals of them were recapture twice times. Most of captured *R. rattus* were juvenile (N=8) and most of them were female (N=11) (Table 7).

Niviventer bukit

N. bukit were found in almost all grid sites except in Grid 6 with 13 individuals were captured. It is other one small mammal species that high abundance around Muang Pham village. Density of *N. bukit* around the village was 2-4 individuals/ha with average biomass of 224 g/ha. Two from five recaptured were trapped every day in Grid 5 that moved in the average minimum area of 1.21 sq km. The average weight of animals in grid trapping was less than the captured individuals in preliminary period (Table 8). Ten individuals of captured animals were adults and nine of them were female.

Maxomys surifer

Three individuals of *M. surifer* were found at Grid 5. All of them are matured females. The position of Grid 5 was only one area of study sites that found *M. surifer*. During preliminary study all of this species were captured in Site B which located in the same area of Grid 5. The population density was about 3/ha at Grid 5. The average

weight of captured animals was 129 g which range from 105-153 g. The average body size of *M. surifer* during grid trapping were greatest than the captured animals in preliminary study.

Rattus koratensis

The general appearance of *R. koratensis* was not quite different from *R. rattus.* However, the tail length of this species was longer than head-body length. Only one adult female was captured in Site B during preliminary study. The captured animals in this study have tail length was 21.5 cm while head-body length was 19 cm. Moreover, the black hair at the middle of its black will longer than the hair of other parts.

Brylmys berdmorei

By grid trapping, one individual of *B. berdmorei* was captured. It was trapped three times in same trap station in Grid 5.

Mus caroli

M. caroli was captured during preliminary study. Only one of this species was found in Site A. It was smallest small mammal species that found in this study. Its weight was 19 g. The head-body length and tail length were 9.5 and 8.5 cm.

Bandicota savilei

Only one individual of *B. savilei* was captured during grid trapping in Grid 5. The animal was captured three times in Grid site with minimum movement area of 0.2 sq km. This species was more aggressive than other Muridae species.

Leopoldamys sabanus

During preliminary study, one *L. sabanus* was trapped in trap station on assessment line of Site C. *L. sabanus* is giant rat with long prominent trail (Marshall, 1977). The captured *L. sabanus* in this study was sub-adult female with weight was 233 g. with head-body and tail length of 22 cm. and 25 cm.

Table 5. Density and biomass of captured small mammals around Muang Pham village

Species	Density (individuals/ha)		Biomass (g/ha) on grid trapping
	Preliminary study	Grid trapping	
Rattus rattus	1.87*	1-4	333.4
Niviventer bukit	1.25*	2-4	224
Maxomys surifer	-	3***	387
Menetes berdmorei	1.95**	1-8	536.3
Tupaia belangeri	-	1-2	-
Total			1480.7

* Data from Site B

** Data from Site C

*** Data from Grid 5

Table 6. Total numbers and relative abundance of small mammals in each grid sites around Muang Pham village, 36 trap stations were placed with 144 trap nights in each grid sites.

Species	Grid Sites						All Grids
	Grid 1	Grid 2	Grid 3	Grid 4	Grid 5	Grid 6	
Bandicota savilei	-	-	-	-	1(0.7%)	-	1(0.1%)
Berylmys berdmorei	-	-	-	-	1(0.7%)	-	1(0.1%)
Rattus rattus	1(0.7%)	4(2.8%)	-	1(0.7%)	3(2.1%)	4(2.8%)	13(1.5%)
Niviventer bukit	2(1.4%)	2(1.4%)	2(1.4%)	4(2.8%)	3(2.1%)	-	13(1.5%)
Maxomys surifer	-	-	-	-	3(2.1%)	-	3(0.3%)
Menetes berdmorei	1(0.7%)	-	5(3.5%)	-	-	8(5.6%)	14(1.6%)
Tupaia belangeri	-	1(0.7%)	1(0.7%)	-	-	2(1.4%)	4(0.5%)
No of total individuals	**4(2.8%)**	**7(4.9%)**	**8(5.6%)**	**5(3.5%)**	**11(7.7%)**	**14(9.8%)**	49(5.7%)
No of species	**3**	**3**	**3**	**2**	**5**	**3**	

Table 7. Age class and sex ratio of captured small mammals around Muang Pham village; AD = adult, JV = Juvenile, F = Female, M = Male (Data from grid trapping).

Species	Age class ratio (AD:JV)	Sex ratio (F:M)
Rattus rattus	0.6 : 1	11 : 1
Menetes berdmorei	14 : 0	1 : 1
Niviventer bukit	5 : 1	3 : 1

Table 8. Average measurements of adult captured small mammals in the study area sites both preliminary period and grid trapping period (W= weight (gm), HB= head-body length (cm), Tail= tail length (cm)).

Species	Preliminary study			Grid trapping		
	W (Range)	HB (Range)	Tail (Range)	W (Range)	HB (Range)	Tail (Range)
Bandicota savilei	225	20	21	198	20	23.5
Leopoldamys sabanus	233	22	25	-	-	-
Berylmys berdmorei	-	-	-	228	18	22
Rattus rattus	110(78-164)	15.8(14-18)	16.4(14-19)	94.4(78-116)	15.4(15-16)	16(15-18)
Rattus koratensis	131	19	21.5	-	-	-
Niviventer bukit	88.67(66-108)	15.2(13.5-17)	15.9(12.5-17.5)	83.3(73-104)	15.2(14-17.3)	17.57(17-19)
Maxomys surifer	105.5(99-111)	16.3(15-17.5)	17(16.5-18)	129(105-153)	17.25(16-18.5)	18.25(16.5-20)
Mus caroli	19	9.5	8.5	-	-	-
Menetes berdmorei	171.1(108-230)	18.65(16.5-21.5)	15.7(14-19)	212.9(131-163)	20.2(17.5-23)	14.5(11-17)
Tupaia belangeri	111(110-112)	18.3(17-19.5)	16.75(17-16.5)	150(137-163)	18.25(17.5-19)	18(17-19)

4.3 Predator species of small mammals around Muang Pham village

During preliminary survey, civet is common carnivore species found in the study area. The footprints of one civet appeared in the corn field near the village that not far from location of Site C, it came to eat the hens of owner field twice a time. The other sign of civet found at one trap station on Site C, the trap which has one ground squirrel were moved from its position. Moreover, civet's feces have been found in Site A. The other predator of small mammals is domestic cat which there are a lot of number in the village, these cats often feed in the forest near the village.

In grid trapping period, there are two Spot-bellied Eagle Owls lived in the cemetery forest near the location of Grid 3. Where as the feces of civet found on the road near the location of Grid 2, there are a lot of rat's hair contaminate in the feces. Moreover during trapping period in Grid 2 the one ripped rat's tail which may cause the hunting from predator were found under the tree.

4.4 Nutrition and protein sources of the villagers

Since February the villagers in Muang Pham village would prepare the agricultural area for cultivate their agricultural product. Corn and sesame are two first crops cultivated and followed by upland rice in different areas. The other crops such as pumpkin, taro, beans, chili, cucumber and other vegetables were mixed in the cultivated field. About August, the villagers started to harvest, the ripe corns were harvested for family and livestock and follow by other crops. After the harvest season in dry field agricultural products finish, the paddy rice was planted and it was harvested around November. After that the cultivation of garlic was followed in paddy field. The period of harvest season of Karen people will cover about 5 - 6 month. Furthermore, the arrivals of the rain have been influenced to cultivation period of villagers.

Rice, chili and salt are the principal food in Karen life. The villagers give first priority to rice they would take a lot of rice in the meal. The savories of some meals in Karen family may have only vegetable curry and chili paste with fresh vegetable especially in pre- harvest period.

The food supplies in form of NFTPs have been influence to Muang Pham villagers during dry season until harvest season (Figure 13), because their stocks of agricultural products have been gone. In rain season, pre-harvest, most of the villagers' food in Muang Pham village concentrated in mushrooms, bamboo shoot and wild vegetables because during this period the travel to the town was difficult by the rain. Some days they could not leave from the village except by foot.

Most of protein of Karen people was numerous fishes in the river that was general protein source support the Muang Pham villagers. They will catch the fish in the river all the year. Interviewing with some villagers found that catching the fish in the river of villagers were reduced in cold season because some villagers avoid the touch the cool water in river. The other protein sources such as insects, reptiles, small animals and others wild meat were taken opportunistically. Furthermore, nowadays the villagers favor to buy protein from the market such as pork, chicken, egg including the fish. Moreover, Karen people prefer to consume the placenta of large animals such as cow, buffalo and domestic elephant as they believe that it is a tonic.

Generally, Karen people have many livestock such as pig, chicken, cow and buffalo. Nevertheless, pig is a heritage of Karen woman while cow and buffalo are a property of family. Chicken have important in sacrifice ceremonial. Consequently, it is not often that they will kill and consume their livestock except the importance ceremony such as wedding ceremony or New Year party or sacrifice ceremony.

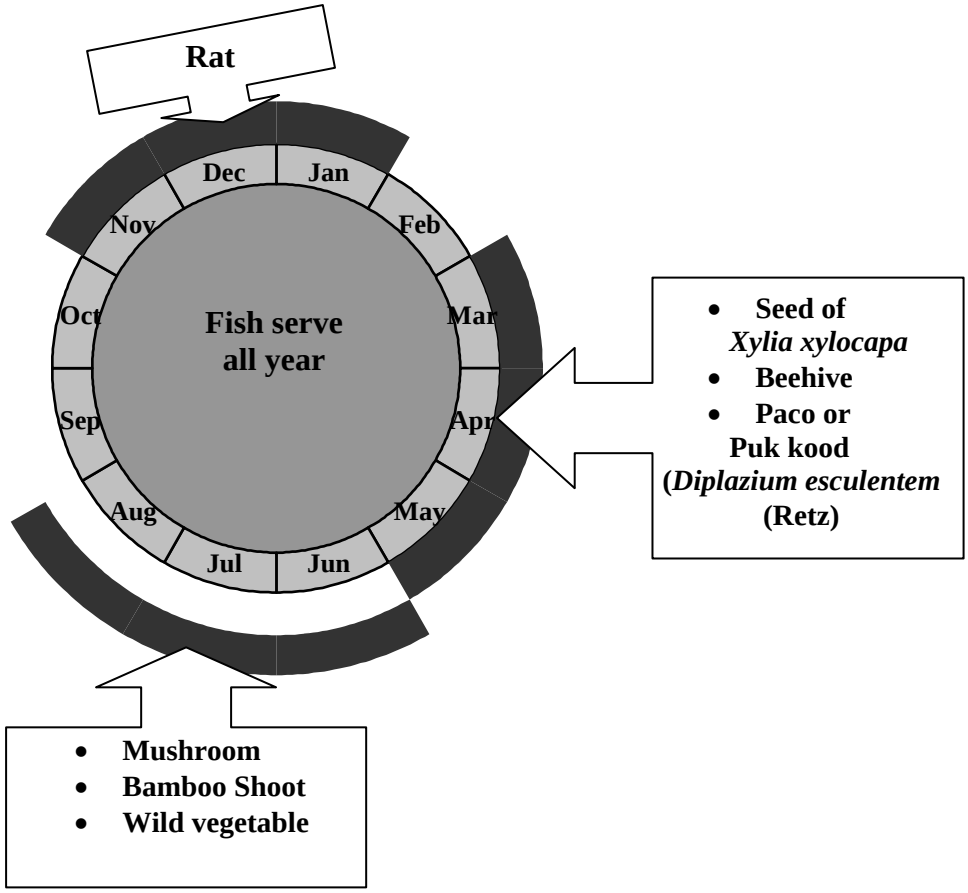


Figure 13. Cycle of NFTPs and protein sources of Muang Pham villagers in a year.

4.5 Small mammals as protein sources for villagers

The Karen people have a certain time to trap the rat in a year. They will trap rats during dry season during November – January. From the interview of 103 households who trapped the rat, there are only 26 households trapped the rat in year 2003 for consumption. There were 4 households trapping only 1-2 times, 9 households trapping less than 10 times while 13 households trapping more than 10 times (Figure 14). However, this number might be less than true number because some villagers could not remember. The information from the villagers referred to at least 1,500 – 2,000 rats were trapped by villagers.

The numbers of rats trapped by villagers in year 2004 was collected directly from the villagers who trapped the rats. This data was collected from 54 villagers. There were only 6 persons that got more than 120 rats while most of trapper could harvest less than 40 individuals (Figure 15). One old villager who prefers to trap could trap 308 rats during November to mid December. The numbers of trapped rat were increasing from November to January; about 3,000 rats were trapped for consumption in the village (Figure 16). The average number of trapped rats per person was 59.5 individuals, the highest number was 308 individuals and lowest was 3 individuals. Each rat trapper came from a different family, so there are about 52 families that trap the rat in this year (2 rat trapper are child).

During December 2004, one professional rat catcher had been injured and could not trap since middle December while another professional trapper went to other province. Consequently, lack of two professional trappers might lower the number of trapped rats in this year. So, this total number is considered minimum number of trapped rats by villagers.

Why villagers choose to trap the rats in dry season? Because the rat trails in the forest are easy to find. Some villagers told that the rat in this period will be bigger and more delicious than other period. The rat species that Karen people prefer to consume is *Maxomys surifer*. The Karen people do not like to eat *Rattus rattus*. The Karen people have been divided the rat into many species in Karen language so that the scientific name of these rats could not be identified by the interview. However, for Thai language, the villagers could tell you of only two kinds of rats that are black rat

or they call “Nu Dum” and red rat or “Nu Daeng”. Red rat means red or brown body rat species such as *M. surifer* and *N. bukit* while black rat refer to *Rattus* spp.

Most of villagers do not consume black rats because they feel these kinds of rats are dirty and taste bad. During this study, I found that almost all of the rats from the forest trapped by villagers were *M. surifer*. The other small mammals that the villagers prefer to consume are *Bandicota savilei*, *Leopoldamys sabanus*, *Menetes berdmorei* and *Tupaia belangeri*. These species have a large body size, so it might be less cost to cook and consume. Moreover, the rat species that they do not eat is Pig-tailed Shrew (*Hylomys suillus*), the short tail rat, and all small size rats, it might be refer to *Mus* sp., because they believe that if they eat these rat species it will make their life go down in the future. Furthermore, the Karen people do not eat the rats in village area although they are same species that they consume because they think that these rats might eat the dirty food. However, some villagers like to eat squirrel more than the rats because they feel that the rat are dirty because it feeds on the ground while squirrel feed on the tree.

The trapped rats were split to get the entrails out and roast to get rid of the hair. Afterward, the rat meat can cook many menus like other meats such as to fry or curry. The remaining meats were roast until dry to preserve in next meals. There are no rat meats sold in Muang Pham village like other rural area of country. If the large numbers of rat are harvested, they will give to their relatives or neighbors. Nowadays, there are many protein source that are easy access such as chicken or pork in the market. Consequently, although these small animal meats are protein source with no cost but the rat meat consumption for new generation villager is declining because some villager have job that get salary enough to pay for the protein source. However, some villagers are still afraid of Leptosterosis and stop to eat the rat meat. Moreover, in the present, many teenage villagers must leave the village for education or getting job in urban area. Even though, they will return to the village but most of them will loss skills for trapping. However, during this study, there are some teenagers and children who still live in the village went trapping rats in the forest.

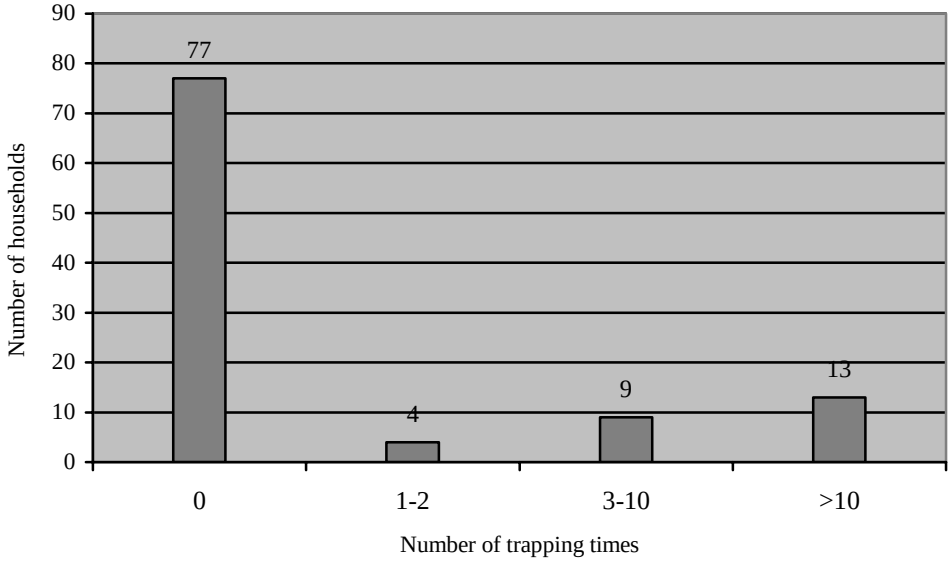


Figure 14. Numbers of households that trapped rats in the year 2003 of Muang Pham village, total households (N=103)

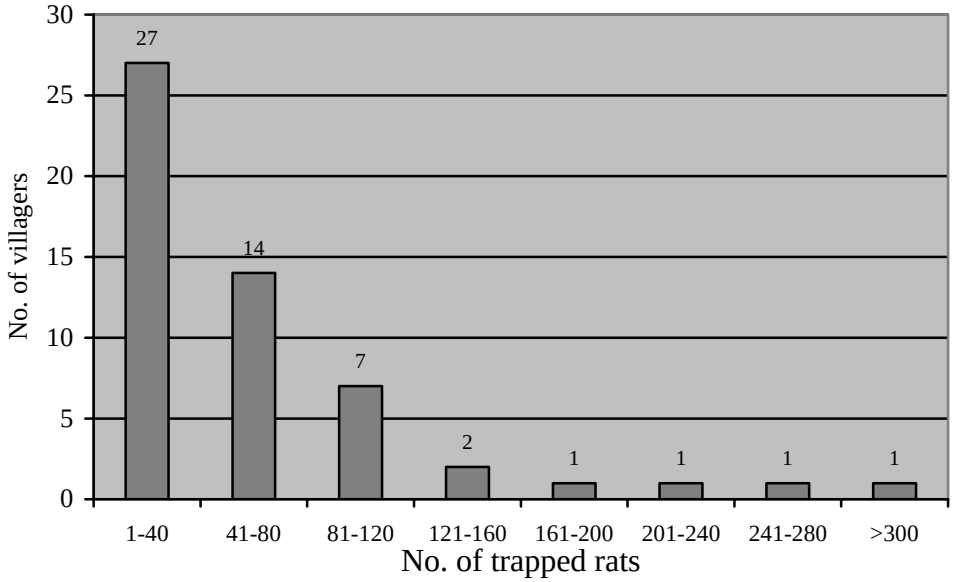


Figure 15. Relation between number of villagers that trapper rats and number of trapped rats.

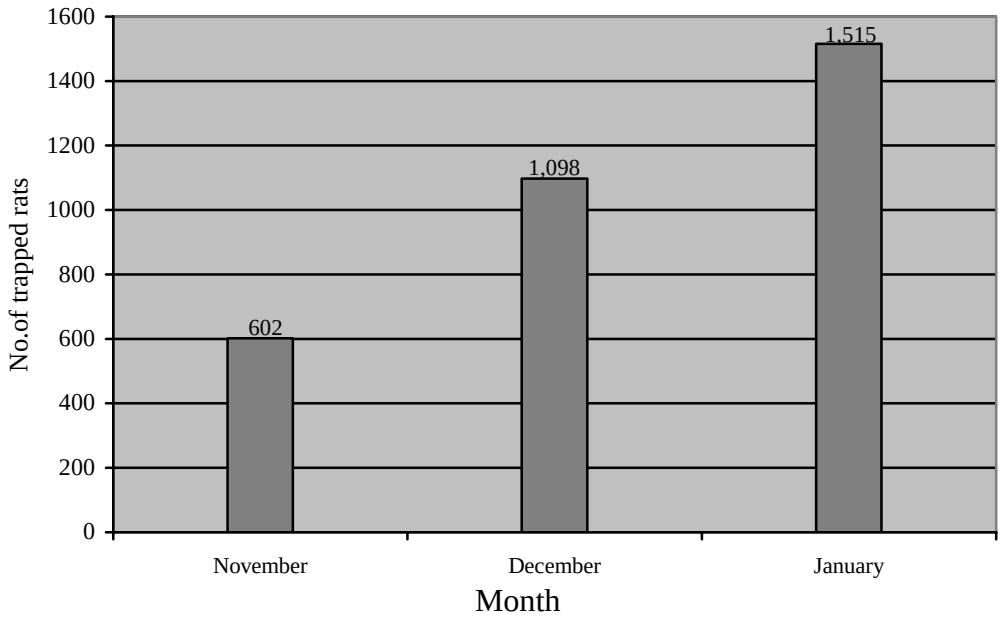


Figure 16. Numbers of rats trapped by villagers during three months (Nov. – Dec.) in the year 2004. Total number (N=3,215).

4.6 Capture and eradication of pest rodents by villagers

The data of eradicating rats in the paddy field by villagers were record during December 2004, one owner field got rid of the rats in his field two times, 93 and 78 rats were caught, respectively. Both two times, only one individual of *Maxomys surifer* was captured from the field.

During preliminary study, a lot of evidence of damaging corn products by squirrel and rat species were found in cone fields. Some corn fields, almost all of the products were damaged. Although, the field owner will laid trapping equipments around their field to protect their agricultural products, however, it is not successful as large agricultural products are still loosed in each year. The villagers just only speed up harvesting before they will loss huge products.

In paddy field, rats seem as more serious pest than squirrels but the villagers in Muang Pham village do not strict to eradicate these pest by rodenticide. *Rattus* spp. is an important pest species who most distribution in the paddy field. The villagers will eradicate these pests from their field by the nest. The owner paddy field will persuade

the neighbors and used the nest to catch the rat in their field in the night which they can harvest a large number of rats in one night. After that, some people may eat these captured rats, they will roast the captured rats and cooking for eat with liquor.

4.7 Trapping equipment used by villagers

The villagers use a simple trap to trap the rats in the forest. This kind of trap is simple, low cost but high powerful moreover it is easy to make by local material, bamboo wood. This kind of trapping has a light weight, so the villagers can carry a huge number of traps for trapping by themselves, approximately 20 - 30 traps/time (Figure 17).

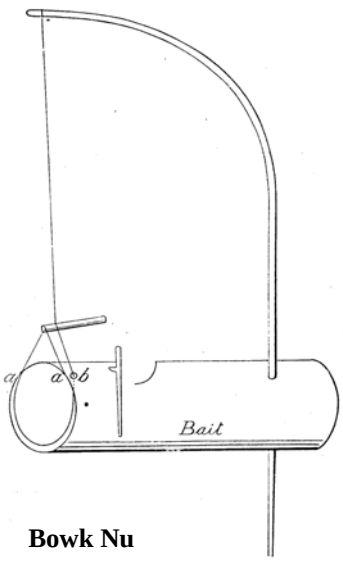
The villagers prefer to lay the traps near the rat trail, mostly along the stream or moist area in the forest (Figure18). The traps will be laid down one night and were picked up in the morning. The mechanism of this local trap is a loop of rope which strangles the rat when it visits the trap (Figure 17). Milled rice mixed with turmeric is extract bait for trap the rat of villagers in Muang Pham village (Figure 19). The advantage of this local trap type is the body of trapped rat was not damaged, so it is easy to keep and cooking.

The location of Grid 3, Grid 4 and Grid 5 of this study located in the prefer trapping area of some villagers. During trapping period in Grid 4, there is one villager put the traps near grid area, however, he got seven rats from 14 local traps where as there is only one captured rat in Grid 4.

However, for the kind of trap that has used around the field to protect the agricultural areas differ from the traps that are used in the forest (Figure 20). The mechanism of this trap is a big log will release to strike the animals when they visit (Figure 20).

(A)

(B)



Bowk Nu **(C)**

a, string is attached at these points.

b, string passes through hole in bamboo.

Entrance of game disturbs the lower peg.

(Source: Garrett, 1929)

Figure 17. The local rat trap used in the forest, and made from bamboo wood.

(A) The number of traps that use in each times

(B) The method to use the trap

(C) The structure and mechanism of traps

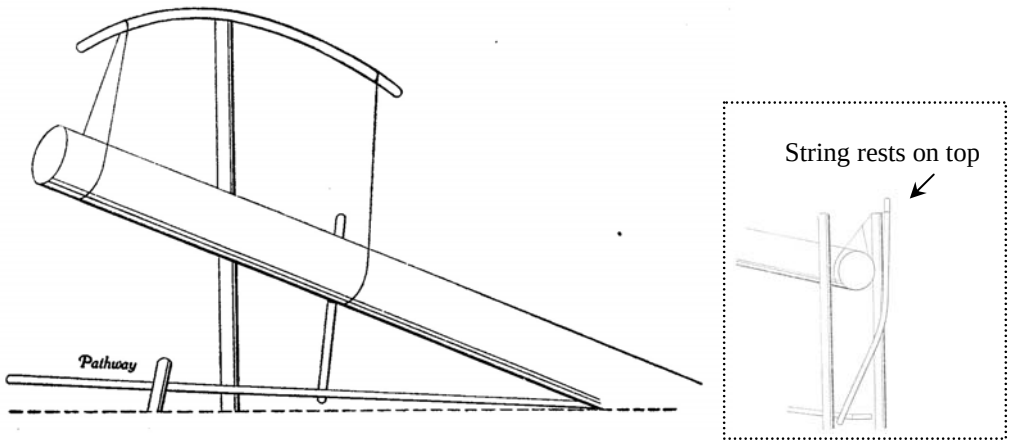
(A)

(B)

Figure 18. The characteristics of habitats preferred by villagers for trapping rats (A) along the river, (B) rat trail

Figure 19. Bait used by villagers for trapping rats, milled rice mixed with turmeric.

(A)



Ka Tam **(B)**

(Source: Garrett, 1929)

Figure 20. The local trap used in agricultural areas to protect the agricultural product.
(A) The trap was laid among the wall of vegetation.
(B) The structure and mechanism of traps.

CHAPTER V
DISCUSSION

5.1 Problems of the trapping configuration technique

The preliminary study on small mammals around Muang Pham village was done during April – July 2003. The trapping configuration of two parallel census lines with assessment lines was conducted to estimate density of small mammal in study area. This trapping configuration was suggested to estimate the true values of small mammal (O'Farrell et al, 1977; O'Farrell & Austins, 1978), however, during preliminary study, some problems have been occurred.

First, there are a few number of recaptured animals found on trapping sites. Although, the low recapture rate of animals is a common problem of small mammal study by captured-recapture method (Hamarit, 1997) but it will take a long time for trapping on census lines until new captured animals fewer than 10 % of total captured individuals. During preliminary study, seventeen days were spent trapping on census lines on Site A while seven days were spend on Site B and eight days on Site C. Second, if none or low number of captured animals on assessment lines the density of captured animals could not be estimated due to the area of effect (A), one factor in formula, could not be estimated and then the formula could not run. For example, only one captured individual was appeared on assessment lines at Site A, consequently the density of animals in this site could not be estimated. Finally, although this trapping configuration could cover the large area but it used a lot of live traps, 80 traps in census lines and 108 traps in assessment lines. So, a lot of manpower were used for transported these live traps to study sites include carrying back.

5.2 Abundance, density and biomass of small mammals

Three dominant species of small mammal around Muang Pham village were *Menetes berdmorei, Rattus rattus* and *Niviventer bukit*, all of them are widespread species in Thailand (Marshall, 1977). Due to all live traps in trapping configuration were set only on the ground, so none arboreal small mammals were found in this study. The small mammals in this study mostly forage on the ground (Askins, 1977; Lekagul & McNeely, 1977; Marshall, 1977; Par, 2003). All of them are common species in the deciduous forest of Thailand (Wiles, 1981; Elliott et al, 1989; Walker & Rabinowitz, 1992; Hamarit, 1997).

There are some evidences showed impact of disturbance factor to abundance and distribution of small mammal community including the benefit of disturbed area to these small animals (Jeffrey, 1977; Lynam & Bilick, 1999). Moreover, Jeffrey (1977) mentioned that replacement the forest area by agricultural area and human community were major cause to increasing in number and biomass of rodent. Then the agricultural area might influence the abundance of small mammal around this Karen village. Except food availability from the agricultural field, low abundance of predators and competitor are important factors to abundance of small mammal species (Caro, 2001). Nevertheless, even though the previous study (Srikosamatara et al, 2000; Chaekpimai et al, 2001) showed low abundance of predators of small mammals in this area but it is difficult to conclude the relationship between predator – prey without experimentation.

Lynam and Bilick (1999) referred that *Rattus rattus* was good adaptor who favored and successes to living in disturbed habitat. This species was most ubiquitous species Southeast Asia who found in almost all habitats vary form natural area to domestic habitats (Marshall, 1977; Pantuwatana, et al, 1969; Wiles, 1981; Elliott et al, 1989; Walker & Rabinowitz, 1992; Kanchanasaka, 1992; Pinnoy, 1993; Lynam, 1995; Hamarit, 1997; Wood & Chung, 2003). Nevertheless, Marshall (1977) also pointed to low abundance of *R. rattus* in natural habitat. The evidence of this suggestion may confirm the low abundance of this species in western forest complex of Thailand, See chapter II (Wiles, 1981; Walker & Rabinowitz, 1992). Not only be a good adaptor *R. rattus* also be disturbance tolerant species with high power to replace the disturbance

sensitive species and invade the endemic species in disturbed habitats (Stephenson, 1993; Lynam, 1995; Lynam & Bilick, 1999). In this study *R. rattus* showed high abundance around the Muang Pham village especially in paddy field and abundance field. At all the condition of high disturbance level, a lot of agricultural products in the field and rare predators around the village might be support high population of this species.

Meanwhile, *Maxomys surifer* who are sensitive species to disturbed area showed low captured rate in this study. Although *M. surifer* was referred to widely distribution throughout the country, however, Marshall (1977) mentioned that mostly this species was widespread species in wild habitats. This species showed high abundance in nature forest areas at Huai Kha Khaeng and Salak Phra Wildlife Sanctuary (Wiles, 1981; Walker & Rabinowitz, 1992). While Lynam and Billick, 1999, showed decreasing of this species in fragment habitats at Khlong Saeng Wildlife Sanctuary (See chapter II). Moreover, no appearance of *M. surifer* in agricultural area near Mekhong River and Melaeuca forest, disturbed forest in Southern Thailand (Kanchanasaka, 1992; Hamarit, 1997). Low captured individuals of *M. surifer* around Muang Pham village might be as the results of habitat types and disturbance level. Even with low captured rate around the village but the villagers still trap a lot of number of this species from the forest area far away the village.

Nevertheless, some evidences indicated interspecific competition between *R. rattus* and *M. surifer*, and *R. rattus* tended to increase where *M. surifer* decreasing (Wiles, 1981; Walker & Rabinowitz; 1992; Lynam & Billick, 1999). However, this study concentrated in forest area around the village, so it can not supply the information on the abundance of *M. surifer* in forest area far away the village.

The number of captured animals in this study was low, so the density of animals was probably lower than the true population density. For the density of each species, the density of *Menetes berdmorei* in this study close to the study in deciduous forest at Doi Suthep-Pui National park (Elliott, 1989) but greater than the study in Huai Kha Khaeng Wildlife Sanctuary (Walker & Rabinowitz, 1992). Nevertheless, high abundance of these ground squirrels around Muang Pham might be from the attraction of agricultural products. Moreover, it was found often in the traps that use banana as baits (Askins, 1977). Where as the density of *R. rattus* in this study lower

than the other study in disturbed area of Thailand (Kanchanasaka, 1992; Pinnoy, 1993; Hamarit, 1997; Lynam & Bilick, 1999). The densities of other species in this study have not been reported in any studies except *Niviventer bukit* that has been reported in Doi Suthep-Pui National park (Elliott, 1989) but they were found only in evergreen forest habitat.

The biomass of small mammals has been reported in few studies, not only in Thailand but also other countries in South-East Asia (Fleming, 1975; Walker & Rabinowitz, 1992). Biomass of small mammal in this study (1.4 kg/ha) was higher than the study in Huai Kha Khaeng Wildlife Sanctuary (Walker & Rabinowitz, 1992). However, this might be due to the many captured *M. berdmorei* which are bigger than rat species, whereas this species was few in the study in Huai Huai Kha Khaeng WS. Moreover, the study of Hanney (1965) showed higher biomass of small mammal than this study in wet plateaus and lower than in dry areas of Malawi (Fleming, 1975).

5.3 Distribution and species composition of small mammals

Most of the areas around Muang Pham village are agricultural area and used forest of village where several human activities occurred such as cultivation, harvest both timber and non-forest timber product (NFTPs). The agricultural areas always attracted changing some species of small mammal especially rodent species (Jeffrey, 1977). In this study, corn field seem to attract *M. berdmorei* more than rice field. Askins (1977) referred that *M. berdmorei* were found often to dig up and eat crops in rice and corn field. Meanwhile *Rattus rattus* were dominant species in paddy field though few individuals were captured by grid trapping but high abundance of this species was confirmed by the information from villagers who eradicated the rat in their paddy field. The other widespread species, *Niveventer bukit* (Marshall, 1977), were high captured in used forest around Muang Pham village.

Species composition of small mammal around Muang Pham village consisted of few dominant species with many rare species like the most small mammal community in tropical forest area (Fleming, 1975). Greatest diversity of small mammals appeared in Communal Forest near Pong Luang (biggest mineral lick of the village), location of Site B in preliminary study and Grid 5 of grid trapping. Some rare

species appeared only in this area during study done. Both of the results from preliminary study and grid trapping showed the same with highest diversity of small mammal in these areas. However, the forest area in Communal Forest is more humid than other area around the village because one main river of the village passes through this area. This condition of Communal Forest area and low disturbed level by villagers, no cultivation area, might be factors support the diversity of small mammals. Furthermore, the predators' small mammals were not reported in Communal Forest (Srikosamatara et al, 1999; Chaekpimai et al, 2001).

R. rattus and *N. bukit* are two species that were trapped almost all grid sites. *R. rattus* absented in Grid 3 and *N. bukit* was not appeared in Grid 6. However, the absence in traps of these two species in one grid was not likely because of the lack of these species in those areas but might be that the animals were not captured by the live traps. Low number of captured animals in Grid 1 might be due to plenty agricultural products that still remain in the area. During trapping period in Grid 1, signs of small mammals were found in many points e.g. on the ground, from the rest of agricultural product. So the area that rich in food of the animals might be the reason of trapping failure. The total captures of animals were low in grid sites with a high level of human disturbance. Such as in Grid 1 that there are villagers still planted the agricultural products near the area while Grid 2 and Grid 4 located near the road where motorcycles and villagers passed all day.

Most of forest areas around Muang Pham are high disturbed by human activities and domestic animals, captured of *R. rattus* in almost all grid sites and their high abundance confirm the successful of living of this species in many forest habitats particular the disturbed area (Wiles, 1981; Elliott et al, 1989; Hamarit, 1997; Kanchanasaka, 1992; Pinnoy, 1993; Lyman and Billick, 1999).

Menetes berdmorei dominated in grid where located in abandon corn field. This kind of habitat still has seed or crops support their food. However, the banana or bait in the trap might be strong influence to these species. Askins (1977) mentioned high success in trapping this species by banana. Furthermore, another species who was found in the same habitat of *M. berdmorei*, *Tupaia belangeri*, is common treeshrew that spent much of their time on the ground. Par (2003) referred to their food that mostly are insects, fruit and small mammals and he also pointed to difficult to identify

separate from *T. glis* but their colors are lighter than *T. glis.* Nevertheless, they do not find the evidence of competition for food between rat and squirrel. It might be caused by the time separation for foraging of them that most of captured rate of *M. berdmorei* and *T. belangeri* occurred in the day while all of captured rats found in the night.

5.4 Predators of small mammals in Muang Pham village

Low abundance of natural predators of small mammal such as carnivore species around Muang Pham village were found in previous study (Srikosamatara et al, 2000 and Chaekpiami et al, 2001). Although, low predators present affected both abundance and behavioral patterns of small mammal (Caro, 2001 and Pye et al, 1999) but it is hard to know the impact of low predators to small mammals in this area due to none experiment support. However, civet is one carnivore species that still found away around Muang Pham village. The population of predators might be declining as a result of hunting by villagers.

Loss of wildlife species in this area might be due to hunting of local people same as other areas in Northern Thailand (Srikosamatara et al, 1999a; Tungittiplakorn et al, 1999; Pattanavibool & Dearden, 2002). Although there are some documents pointed out that Karen people threaten less to forest and wildlife than other hill tribe groups (Tungittiplakorn et al, 1999; Chaekpimai et al, 2001; Santasombat, 2001) but this Karen village were surrounded by Lahu village whose favor and expert in hunting. Consequently, the large forest areas that have been shared to use can not be conserved just by only one village. Furthermore though the Karen people are not concentrated in hunting, this activity seems to be just one culture of them like other hill tribe people (Bruver, 1973; Tungittiplakorn et al, 1999), so the wildlife species still were taken opportunistically in this village. For example dhole, bamboo rat, pangolin, porcupine, Slow Loris or monkeys were reported to be hunted.

Not only natural predators but villagers in Muang Pham villagers also act as predator of small mammals. The crossbow, local weapon, was used to kill the small animals such as birds and squirrel. These animals were taken sometime around their village when they go to the field or forest. Moreover, the Karen people in this village will trap the rat in the forest for consumption in family. However, the Muang Pham

villagers seem to prefer consuming *M. surifer* more than others species, so trapping success of rat in the forest far from the village might be higher than in undisturbed area.

Some evidences from Huai Kha Khaeng Wildlife Sanctuary showed that *M. surifer* was major food of some small carnivores (Rabinowitz, 1990a, b). However, it can not conclude that predators prefer this species more than the other rat species. Due to *M. surifer* was most abundant species in the area than those studies before (Walker & Rabinowitz, 1999). Furthermore, the preference to consume *M. surifer* of predators might be from the large size of this species. Walker & Rabinowitz (1999) showed high level in size gradient of *M. surifer* in small mammals' community in Huai Kha Khaeng Wildlife Sanctuary. So *M. surifer* may be prey that predators take less cost in hunting. However, it may be the same reason for the Karen, the large size of *M. surifer* may worth to cook. Except for *M. surifer*, the species that the Karen people choose to consume are *Leopoldamys sabanus*, the giant rat, *Menetes berdmorei* and *Tupaia belangeri*. In the same time they denied *Niviventer bukit* and *Mus caroli* with small size and *Banicota savilei* and *Rattus* spp. that are black body rat considering dirty. Then the condition to consume of villagers might from the feel, taste and disgust to each species of small mammal.

5.5 Nutrition and protein sources of Muang Pham villagers

The nutrition of Karen people was lowest during pre-harvest season (Omori & Greksa, 2002). Generally, Karen people concentrate more in carbohydrate in the meals than other nutrients. They could eat only rice mixed water without any savories. The ecological service from the forest served food for Muang Pham villagers all a years but it have strong influence during dry season before harvest period. Omori and Greksa (2002) referred to sources of protein of eight Karen villagers in Mae Sariang district, Mae Hong Son Province mostly are Marine food such as small fish, small shrimp, small crab, tadpole and Eggs. However, it should be more useful in term of Aquatic food than Marine food because Mae Hong Son province has no area connecting to the sea, so most of these foods likely come from the river. Except for those protein, Muang Pham villagers got protein from insects, frogs, snakes, rats and

other wild animals that they could take sometime e.g. bamboo rat, slow loris, jackal (during this study done). The pattern of these protein sources of Karen people were confirmed by the study from Thung Yai Naresuan Wildlife Sanctuary (Steinmetz & Mather, 1996).

Protein seems to be important to families that have children of Karen people more than the family without children. It was served to children before adult, although the proportion of protein was not too much in the meal of Karen people. In the past, most of proteins of hill tribe people come from the wild animals in the forest around their village. However, nowadays the decreasing of wildlife population and road available include the changing in cultivation style to cash crop of some hill tribe groups have been resulted to most of hill tribe people buy the proteins from the market (Tungittiplakorn et al, 1999). No difference in Muang Pham village, some villagers come to town everyday for working or roaming, so the transportation of everything include the food to the village is not hard like the past. Consequently, many villagers have chosen to exchange the protein source with the money from the town.

Generally, the Karen people are shy and the trade is not inherited like other hill tribe groups. Most agriculture products of Karen people were produced for consuming in the family while the other ethnic group cultivated the crops for sale. So, the economic of Karen people have been poorer than other hill tribe people. This reason might be due to the reason that the Karen people still look for the protein from the forest to support their family and reduce the cost of living.

Several fishes and other aquatic food from the rivers are important ecological service support food to the Muang Pham villagers all year. Furthermore, the pattern of protein source of villager was added by mushrooms in rain season and rats about 3 months in the cold season (Figure 1). During cold season some villagers would not rather to catch the fishes because they avoid touching the cold water in the river.

Generally, rodents such as rats are common protein source to many rural people especially in developing country including Thailand (Tungittiplakorn et al, 1999, DOA, 2001, Stein et al, 2002, Wood & Cheng, 2003). There are some studies referred to rat consumption by local people as agricultural pest control but none of them gave any details (DOA, 2001, Wood & Cheng, 2003). Some people in Asia such

as Chinese and Vietnamese believe that there are some medicinal properties in rat meat. However, for Karen people the rat just as a food for support their life.

The rat meat has played as one kind of NTFPs of villagers in Muang Pham village that has a certain period to harvest in cycle of a year. Although the population of the rat are scattering in the forest throughout the year but only three months in dry season (November-January) that they have been harvested because the villagers believe that rats meat will have high quality and taste in this period and the rat trail also easy to found.

It is hard to know how long that Karen people have been consumed the rat meat and in the past when the others wildlife species are still abundant around the Karen village, they choose or ignore this kind of protein source. However, from the interview one old man with age of about 84 years old, he has been trapped the rat since he was 8-9 years old so it can conclude that the Karen people trap the rat for consume more than 70 years ago. Furthermore there is one old Karen man who was birth in World War II time mentioned to the consumption the rat of Karen people since he was young (Promsao & Siraluk, 1999).

M. surifer was a preferred species that villagers in Muang Pham favor to eat. All the time that I found the villagers, who return from picking the trapped rats, all of them were *M. surifer*. Consequently, it be estimated that this year about 3000 individuals of *M. surifer* was consumed by Muang Pham villagers. However, if those trapped rat were estimated by average weight of 117.3 g/individual (from the result), about 351.8 kg of rat meat were consumed. The average mass of rat meat that was consumed per household was 7.2 kg.

Although, the consumption of rats is one method to control the population of agricultural pest in some area (Wood & Cheng, 2003), but it is not in Muang Pham village. Due to the villagers consume only the rat in the forest and do not eat the rats that have a black color such as *R. rattus* because they feel disgust. *R. rattus* is one species that is a serious pest and numerous in cultivation areas around their village but the villagers deny to eat them. They do not think that their rat consumption is to control the agricultural pest. However, most of the rats that villagers consumed have come from the forest while around their village especially the paddy field was high abundance by *R. rattus* who was only pest for villagers. That mean the rat around the

village mostly just a pest but if they want to get protein from the rat meat they must take a long time to go to the forest.

Not only the people in Muang Pham village that eat the rat, but there are many people in rural of Thailand also eat this meat, especially in the central plains and northeast region of Thailand. The price of rat is about 80 Baht / 1 kg (Buranakhet, 2004). If calculate total number of rats that were consumed in Muang Pham villager to economic value, it was approximate 28,000 Baht for this year. However, the Karen people do not sell the rat, if they harvest a lot of number of trapped rats they will share to their relatives or neighbors. So, there are no villagers supporting their livelihood as rat trapper by selling rat meat. It is different from the other areas that some people can earn by trap the rat for sale. For example, one study mentioned to one Burmese man who have job in rat trapper, however that study showed the results that different from the rat trapping in Muang Pham village such as the species that Burmese rat trapper catch (*R. rattus, Bandicota bengalensis, B. indica* and, *B. savilei*) are species the Karen people deny include the method and equipments to trap the rat (Wemmer & Aung, 1998). However, the number of trapped rat per one night by that rat trapper Burmese (3-47 rat/night) was higher than Muang Pham village that was highest about 15-20 individuals. It is probable that the Karen villagers trap the rat only for consumption in the family so they are not serious in the number of trapped rats while more number of trapped rats mean more income for rat trapper. This fact may refer to other wildlife that if the local people hunt only for consumption, the hunting may not be major effect to the population of wildlife. Nowadays, although the villagers in Muang Pham village still consume the rat but both trapping skill and favorite in rat consumption have been declining in new generation. From the result there are 52 household that trap the rat, it approximately 43 % of total household in Muang Pham village (Chaekpimai et al, 2001) still trap the rat. Most of the young Karen must leave from the village for education or get a job in the town. These young people would invest the time to learn the skill from their parents. Moreover, at present, most of villagers try to work to get more money. The Karen life in this village tends to change from producing for consumption to produce for economic reasons and have tried to expand their cultivation area to forest area.

However, if the villagers expand their agricultural fields by change the forest area the habitat area of *M. surifer* may be disturbed and move far away from the village. So, if they want to harvest this food they must take more energy to walk to habitat of *M. surifer*. In addition, new generation of Karen people tend to spend more money exchanging the food than get the food from the forest like their presents.

The other interesting questions are what happens, if the villagers stop to eat the rat and what advantage that villager give to ecosystem by eating the rat? *Maxomys surifer* is major species that should been focused because it is main species the villagers prefer to consume. This muridae species never have been reported as agricultural pest in Asia and Thailand (DOA, 2001; Aplin et al, 2003). So, if the number of *M. surifer* increase when villager ignore to eat, the increasing of their population may not affect to agricultural products of villagers because generally this species never found in agricultural area. In the other hand, there are some reports referred to a role as seed predator for *M. surifer* in forest habitat both in Moist Evergreen Forest and Dipterocarp Forest (Curran & Webb, 2000; Kitamura et al, 2004). Consequently, consuming rat of Muang Pham's villagers may help to decrease the number of seed predators in ecosystem.

5.6 Small mammals as pests

The ricefield rat as species of *Rattus argentiventer* is main culprit in paddy field of South East Asia (Wood & Cheng, 2003). However, this species was not appeared around the Muang Pham village. Marshall (1977) mentioned that the distribution of *R. argentiventer* is locally common on the Central Plains and Peninsula of Thailand, so it may be rare species on the North of the country. However, no reports about this species in other small mammals studies in natural habitat of Thailand (Wiles, 1981; Elliott et al, 1989; Walker & Rabinowitz, 1992; Hamarit, 1997; Kanchanasaka, 1992; Pinnoy, 1993; Lynam & Billick, 1999). Furthermore, the other species that were captured in agricultural area near Mekhong River such as *Mus cervivolor*, *Rattus exulans*, *R. losea* (Hamarit, 1997) were not captured in agricultural area around Muang Pham village. While *R. rattus* was most abundant species in those agricultural areas like Muang Pham village (Hamarit, 1997). The dominant pest

species in the paddy field around Muang Pham village was *R. rattus*. Meanwhile *M. berdmorei* play more role as agricultural pest in corn field than in paddy field.

Although Karen people in Muang Pham village have been serious with these pests but the reason that the villagers do not use the rodenticide in their field might be from the increasing of the cost. In addition, most of agricultural products of Karen people were not produced for cash as others hill tribe groups. However, many villagers also mention the increasing of *R. rattus* population in their field.

5.7 Local traps

Hill tribe people have many kinds of local traps that are commonly used in the forest ranging from big size trap for large animals to simple one to small mammals or birds (Garrett, 1929). Generally, the Karen people in Muang Pham village use trap for small mammals.

Around agricultural areas in Muang Pham village a lot of big traps were laid to protect the agricultural products. The information about this trap or “Ka Tam” was not focused on in this study. However, one study mentioned that the Karen people in Doi Angka laid this kind of trap at about 3 meter intervals around their agricultural area (Garrett, 1929).

Another kind of trap that Muang Pham villagers used to trap the rats in the forest was common and widespread trap in rural area of Thailand. Garrett (1929), referred to the used of this kind of trap of hill tribe people and called this trap “Bowk Nu”. This kind of trap has been preferred to trap the rat for consumption because the body of captured animals still complete and suitable for cooking whiles the other kind of traps may damage the body of animals such as Ka Tam that will strike the unlucky animals (Buranakhet, 2004). Buranakhet (2004) also mentioned that the people do not prefer to eat the rat during rain season because the rat meats have a musty odor. Moreover during rain season the fish in the river also numerous.

5.8 Small mammals as a measure of conservation success around Muang Pham village

The result that showed high abundance of invasive species as *Rattus rattus* and rare of disturbance sensitive small mammal such as *Maxomys surifer* in this study may indicate the impact of disturbance around Muang Pham village to wildlife species. The status of wildlife species around this Karen village have been face to declining. The species that still found mostly are good adaptive species to human activities e.g. civet and small mammals. The other wildlife species that found in the forest around Muang Pham village are gibbons and hornbills whose are amicable species of Karen people, however, these species who still live in this area have been protected by beliefs of Karen people. In the meantime many species of wildlife still are special food of Karen people in this village. Although, Karen people are not concentrate in hunting (Steinmetz & Mather, 1996), however, it seem to be hard to stop hunting in this area because hunting seem to deeply rooted in culture of hill tribe people including Karen people.

Along the history, Karen people are one hill tribe that not threatens to wildlife. They would hunt the wildlife just for consume and not hunt more than enough for collecting or sale. However, the other reason that hunting is not widespread activity of Karen people. They spend more time for cultivating than other hill tribe groups. The Karen will produce rice both during dry and wet cultivation, so they will have only 1-2 month that free from cultivation in a year.

Even though many document referred to the conservationist of Karen people (Promsao & Siraluk, 1999; Puginnier, 2001; Santasombat, 2001; Buergin, 2003) but in my opinion the conservation of them seems to focus on the important nature resource in their life. For example, they have high awareness to protect the water and forest (Preechpanya & Jirasuktaveekul, 2001) because the Karen people is one ethnic group that cultivate both in dry field and paddy field while the other hill tribe group plants only in dry field.

Furthermore, Karen people seem more serious in decreasing of fish in the river than the wildlife in the forest. Due to fishes are their major protein foods while the other wild meats just benefit that they may take opportunistic. So, the declining of

fishes directly affects their life while the effect of wildlife loss may not cause any effect in their life. So, even most of the villagers recognize to decreasing of wildlife population in the village but hunting still occurred. Moreover, rare of wild meat seem to increase the wonderful of this kind of food to villagers.

However, the culture and beliefs of Karen people still take more benefit to environment and wildlife species than the other ethnic groups. For example, even though the Karen people still hunting but they hunt only for consumption and they are not harvested and keep the wildlife in a lot of number while the other hill tribe hunt for sale. Hunting with the aim for consumption seems to affect to wildlife population less than the aim for trade. This advantage covers to other natural resource because the Karen do not harvest NTFPs for sale in the market.

Tungittiplakorn and her colleagues (2001), mentioned that the strength of leadership have important role to encourage the conservation in hill tribe village. Even the present headman of Muang Pham village are aware in decreasing of wildlife but the general characteristic of Karen people that is not aggression and the hunting seem a common activity, so it hard to mediate or give an actually punish to villagers who still hunting. Furthermore, not only Muang Pham village that located in this area but there is one Lahu village, Ae La village, also situated and use the same forest area. Lahu is one hill tribe group who love in hunting. This Lahu village always has conflicted about natural resource especially water resource with Muang Pham village because this village is located near watershed of Muang Pham village. Then, it should not to mention only Muang Pham village about any impact to forest area including the decreasing of wildlife species.

The products of civilization are attracting this village, the villagers must pay more to maintain their lives. Santabombat (2001) mentioned that the society of Muang Pham village are becoming in crisis of head over heels in debt because the civilization that has come to the village. The simple livelihood and clemency to share everything in the community seem to decrease because of the increasing cost of living. Everybody strive to earn the income. Incomes of villagers in Muang Pham village mostly come from employment and sale of handicrafts to tourist. Some people are government officer but too few. However, each family collect the property in terms of livestock, these animals are sold when they need money. However, the financial status of most of

people in Muang Pham village is still poor because the incomes from their job such as employment or sold handicrafts are just subsidized. Sometime a lot of villagers who have job in employment must be in a waiting list to work. The loans from the governments that support for poor people in rural area seem to make disadvantage to them. Although, the aim of this loan was invested for job but from my experience during this study the villagers used this loan in a wrong aim, for example they bought the motorcycle, mobile phone, build the new house like a town style that they could not get anything return for this investment. Moreover, when they must repay the loan, many villagers solved the problem by looking for the new loan to get the money and actually the interest of new loan higher than the old one.

The traditions and culture of Karen people are a good benefit to environment. Their culture and beliefs suitable for taking care and protecting the nature. However, the civilization has direct effect on Karen society. The increasing in cost of living at present day press them to struggle to earn more income. New generation wish to live in urban area because they believe that they can earn more income than live in the village. The local knowledge seems to decrease from forefather to next generation. Although in the future they can adapt to globalization but no one can confirm that the nice culture will still remain in their community.

CHAPTER VI
CONCLUSION

Total of 10 species of small mammals were captured in this study. It consisted of eight Muridae sp., one ground squirrel and one treesherw. *Menetes berdmorei*, *Rattus rattus* and *Neviventer bukit* were dominant small mammal species around Muang Pham village. The species composition of small mammals around Muang Pham village consisted of few dominant species with many rare species. *Rattus spp*. dominate in rice field both dry field and paddy field while *M. berdmorei* is mostly concentrated in corn field and *N. bukit* were found often in used forest around the village. The other species such as *M. surifer* are rare around the village but high number of this species also found in the forest area far away the village. The density and biomass of animals in this study might be lower than the true value due to the low number of captured animals. However, most species diversity of small mammal species appeared in the communal forest.

The signs of natural predators of small mammals such as civets, birds still found around the village but low frequency, so it could not be estimated the relation between predator and prey interaction in this study. Nevertheless except those predators, the Karen villagers also act as predator of these small mammals in this area. *M. berdmorei* and *Tupaia belangeri* were taken opportunistic by crossbow and gun while rats were trapped in certain time of a year. The rat trapping by villagers might be affected to population of *Maxomys surifer* because it was species preference for consumption. However, *M. surifer* was not strong in role of agricultural pest equal as *R. rattus*, none of them was captured in agricultural area.

About nutrition of Karen villagers, carbohydrate is major nutrient in meals of them while proportion of protein has been lack. Numerous fishes in the rivers serve protein support Muang Pham villagers all years and where added by the mushrooms during rain season and the rat meat in cold season during November – January. The other protein sources such as wild meat were taken opportunistic. The livestock of

villagers such as pig, chicken, cow and buffalo are not direct protein source in Karen life. The consumption of those animals will occur only in important ceremony. In addition, nowadays, the protein from the fresh market in the town is other choice for villagers, especially for new Karen generation. However, this kind of protein source requires money for exchange.

The skill of trapping the rat, one villagers' protein source, and favor to eat the rat meat seem to decline in new generation villagers in Muang Pham village. Only the old villagers still love to trap the rat. That means, this choice of protein source may be gone in next generation meanwhile the protein from the market has high impact to their life. However, the income of villagers in Muang Pham village are low, most of them are in debt. Then loss of protein source may cause the increasing of cost of living to Karen villagers.

The situation of small mammal community in this study may point to the effect of disturbance around this village to sensitive wildlife species. Nevertheless, the villagers also give indirect advantage to ecosystem because the best favorite rat species of villagers is *M. surifer*. Although this species is not major agricultural pest but it is referred to as a seed predators in forest.

Generally, the Karen people are not a threat to wildlife but they are also not aware of the decrease of wildlife species around their village. They do not think that their hunting affect wildlife community and knowledge about impact of wildlife extinction also lack. Furthermore the beliefs about protect wildlife species occur for few species such as gibbon and hornbill while not prominent for other species. Nevertheless, the traditions and cultures of Karen people are better to environment and nature than the other ethnic people. Moreover, the leadership who strong and care about conservation is important component to successful in conservation for this Karen village.

REFERENCES

APLIN, K.P., P.R. BROWN, J. JACOB. C.J. KREBS, AND G. R. SINGLRTON. 2003. Field methods of rodent studies in Asia and the Indo-Pacific. BPA Print Group, Melbourne, Austalia. 223 pp.

ASKINS, R.A. 1977. Family Sciuridae. Pages 337-387 in B. Lekagul, and J.A. McNeely (eds.), Mammals of Thailand. The Association for the Conservation of Wildlife Press, Bangkok. 758 pp.

BAKER, P.J., R. J. ANSELL, P.A.A. DODDS, C.E. WEBBER, AND S. HARRIS. 2003. Factors affecting the distribution of small mammals in an urban area. Mammal Rev. 3(1): 95-100.

BENNETT, E. L. AND M. RAO. 2002. Sustainability and impacts of wild meat harvests- regional overiews. in S.A. Mainka, and M. Trivedi (eds.), Links between Biodiversity Conservation, Livelihoods and Food Security: The sustainable useof wild species for meat. IUCN, Gland, Switzerland and Cambridge, UK. Vi+ 135 pp.

BERNETT, A. AND J. DUTTON.1995. Expedition field techniques small mammals (excluding bats). Royal Geographical Society, London, 126 pp.

BOURLIERE, F. 1975. Mammals, small and large: the ecological implications of size. Pages 1-8 in F.B. Golley, K. Petrusewicz, and L. Ryszkowski (eds.), Small mammals; their productivity and population dynamics. Great Britain at The Pitman Press, Bath, UK. Xxv+451 pp.

BRUVER, W. 1973. Fauna of north Thailand. Nat. Hist. Bull of Siam Society. 24: 463-466.

BUERGIN, R. 2003. Shifting frames for local people and forests in a global heritage: the Thung Yai Naresuan Wildlfie Sanctuary in the context of Thailand's globalization and modernization. Geoforum. 34: 375-393.

BURANAKHET, S. 2004. Doung Nu: eradicate the agricultural pest. Art & Culture. 25(8): 43-44.

CARO, T.M. 2001. Species richness and abundance of small mammals inside and out side an African National Park. Biological Conservation. 98: 251-257.

CHAEKPIMAI, T., W. SAWANGPROH, S. DITYHAM, AND S. SRISOMBOONLERT. 2001. The effect of Sgaw Karen and Lahu Nyi people on Wildlife communities around San Pan Daeng Wildlife Sanctuary, Mae Hong Son province, Thailand. Senior Project in Faculty of Science (Biology). Mahidol University, Bangkok, Thailand.

CROOKS, K.R. AND M.E. SOULE. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Nature. 400: 563-566.

CURRAN, L.M. AND C.O. WEBB. 2000. Experimental tests of the spatiotemporal scale of seed predation in mast-fruiting Dipterocarpaceae. Ecological Monographs. 70(1): 129-148.

DAVIDSON, S. 2000. Rat cunning. Ecos. 103: 12-16.

DEARDEN, P. 1995. Development and biocultural diversity in northern Thailand. Applied Geography. 15: 325-340.

DIAMOND, J. 2001. Dammed Experiments!. Science. 294: 1847-1848.

DOA. 2001. Rodent Pests and Their Control. Agricultural Zoology group. Insect and Zoology Division. Department of Agriculture, Bangkok, Thailand. 136 pp. (Thai)

DOYLE, A.T. 1990. Use of riparian and upland habitats by small mammals. Journal of Mammalogy. 71(1): 14-22.

ELLIOTT, S., S. UA-APISITWONG, AND O. BEAVER. 1989. The small mammal communities of Doi Suthep-Pui National Park. Seminar of Wildlife in Thailand. 10: 2-1 – 2-12.

FLEMING. T.H., 1975. The role of small mammals in tropical ecosystems. Pages 269-298 in F.B., Golley, K. Petrusewicz, and L. Ryszkowski, (eds.), Small mammals: their productivity and population dynamics. The Pitman Press, Bath,UK. XXV+451 pp.

GARRETT, H.B. 1929. Note on some traps made by the hill tribe people of Siam. Nat. Hist. Bull of Siam Society. 9: 23-24, 17 pls.

HAIM A. AND I. ZHAKI.1994. Changes in rodent community during recovery from fire: relevance to conservation. Biodiversity and Conservation.3:573-585.

HANNEY, P. 1965. The Muridae of Malawi (Africa: Ayasaland). Proceedings of the Zoological Society of London. 146: 577-633.

HAMARIT, K. 1997. Species diversity and ecology of Murid rodents in forest and agriculture area along Mekhong Riverbank, Amphoe Sangkhom, Changwat Nhongkai. M.S. Thesis. Kassetsart University, Bangkok,Thailand. (Thai)

HAMARIT, K. 2001. Effect of rodenticide to birds of prey. Journal of Wildlife Thailand. 10(1): 42-46. (Thai)

JEFFREY, S.M. 1977. Rodent ecology and land use in western Ghana. Journal of Applied Ecology. 14: 741-755.

KANCHANASAKA, B. 1992. Murid rodent density and diversity in Chalerm Pha Kiet Somdej Prathep Rattana Rachasuda Wildlife Sanctuary. Journal of wildlife in Thailand. 2(1): 53-60. (Thai)

KEESING, F. 1998. Impacts of ungulates on the demography and diversity of small mamamls in central Kenya. Oecologia. 116 (3): 381-389.

KEESING, F. 2000. Cryptic consumers and the ecology of an African savanna. BioScience. 50(3): 205-215.

KITAMURA, S., S. SUZUKI, T. YUMOTO, P. POODAWAD, P. CHUAILUA, K. PLONGMAI, N. NOMA, T MARUHASHI, AND C. SUCKASAM. 2004. Disersal of *Aglaia spectabilis*, a large-seeded tree species in a moist evergreen forest in Thailand. Journal of Tropical Ecology. 20: 421-427.

LANGHAM, N.1983. Distribution and ecology of small mammals in three rain forest localities of Peninsula Malaysia with particular references to Kedah Peak. Biotropica. 15(3): 199-206.

LEKAGUL, B. AND J.A. MCNEELY. Mammals of Thailand. The Association for the Conservation of Wildlife Press, Bangkok. 758 pp.

LI J.S., Y.L. SONG, AND Z.G. ZENG. 2003. Elevational gradients of small mammal diversity on the northern slopes of Mt. Qilian, China. Global Ecology & Biogeography. 12(6): 449-459.

LYNAM. A.J. 1995. Effects of habitat fragmentation on the distribution patterns of small mammals in a tropical forest Thailand. Ph.D. Thesis. University of California, Sandiego, USA. XIV+120 pp.

LYNAM. A.J. 1997. Rapid decline of small mammal diversity in monsoon evergreen forest fragments in Thailand. in W.F. Laurance, and R.O. Bierregaard (eds.), Tropical Forest Remnants: Ecology, Management and Conservation of Fragment Communities. University of Chicago Press, Chicago. 222-240 pp.

LYNAM, A.J. AND I. BILLICK. 1999. Differential responses of small mammals to fragmentation in a Thailand tropical forest. Biological Conservation. 91: 191-200.

MARSHALL, J.R. 1977. Family Muridae. Pages 397-487 in B. Lekagul, and J.A. McNeely. Mammals of Thailand. The Association for the Conservation of Wildlife Press, Bangkok. 758 pp.

MASUTHON, S, P. THAICHAROEN, AND Y. NIMRAKSAA. 1999. The diversity of ferns at ecotourism sites in Mae Hong Son province. Pages 805-811 In V. Baimai et al (eds.), Research reports on biodiversity on Thailand. Biodiversity Research and Training Program, Bangkok.

MC GREGOR, J. 1991. Waiter, There's a Rat in My Soup, and It's Delicious! A Restaurant in China Serves Rat 30 Different Ways; We Suggest the Kabobs. Wall Atreet Journal. Dow Jones & Company, Inc, USA. http://www.wsjbooks.com/page-excerpt1.htm#

MERODE, E., K. HOMEWOOD, AND G. COWLISHAW. 2003. Wild resources and livelihoods of poor households in Democratic Republic of Congo. Odi Wildlife Policy Briefing. No 1.

OEPP, 2000. Biological Resources Values in Mae Hong Son Province. Ministry of Science, Technology and Environment., Bangkok. 92 pp.

O'FARRELL, M.J., D.W. KAUFMAN, AND D.W. LUNDAHL. 1977. Use of live-rapping with the assessment line method for density estimation. Journal of Mammalogy. 58(4): 575-582.

O'FARRELL, M.J. AND G.T. AUSTIN. 1978. A comparison of different trapping configuration with the assessment line technique for density estimation. Journal of Mammalogy. 54(4): 866-868.

OMORI, K. AND L.P. GREKSA. 2002. Seasonal variation in the dietary adequacy of highland Pwo and Sgaw Karen (Thailand). American Journal of Human Biology. 14: 519-531.

PANTUWATANA, S., S. IMLARP, AND J.T. MARSHALL. 1969. Vertebrate ecology of Bang Phra. Nat. Hist. Bull. Saim Soc. 23(1-2): 132-183.

PAR, J. 2003. Mammal in Thailand. Sarakadee Print, Bangkok. 216 pp.

PATTANAVIBOOL, A. 1999. Wildlife responses to habitat fragmentation and other human influences in tropical montane evergreen forests in northern Thailand. Pages 715-720 in V. Baimai et al (eds.), Research reports on biodiversity on Thailand. Biodiversity Research and Training Program, Bangkok.

PATTANAVIBOOL, A. AND P. DEARDEN. 2002. Fragmentation and wildlife in montane evergreen forests, northern Thailand. Biological Conservation. 107: 155-164.

PILUEK, C., P. TRIBOON, C. TAPSAN, AND D. TONPAYOM. 1999. Investigation of wild orchids and research for development of ecotourism in Muang and Pangmapa district, Mae Hong Son province. Pages 812-817 in V. Baimai et al (eds.), Research reports on biodiversity on Thailand. Biodiversity Research and Training Program, Bangkok.

PINNOY, J. 1993. Comparison of Muridae Population in two different habitats at Bang Phra Reservoir Non-hunting Area. M.S. Thesis. University of the Philippines Los Banos, Philippines.

PROMSAO, K AND B. SIRALUK. 1999. Seven level forest: learned man knowledge. Knowledge Foundation. Amarin Printing & Publishing Public Company Limited, Bangkok, Thailand.190pp. (Thai)

PREECHAPANYA, P. AND W. JIRASUKTAVEEKUL. 2001. Karen knowledge about the sustainability of Forested Watershed and Agoforestry. Ecosystems.3(10): 8-17.

PUGINIER, O. 2001. Facilitating better linkages between Hill-tribe communities and government agencies with digitized land use maps in Mae Hong Son Province, Thailand. Peer-reviewed for scientific content. Pages 171-178 in D.E. Stoot, R.H. Mohtar, and G.C. Steinhardt (eds.), Sustaining the Global Farm, Berlin.

PYE, T., R. SWAIN, AND R.D. SEPPELT 1999. Distribution and habitat use of the feral black rat (*Rattus rattus*) on subantarctic Macquarie Island. J. Zool. Lond. 247: 429-438.

RABINOWITZ, A. 1990a. Research of the carnivore community in a dry tropical forest mosaic in Huai Kha Khaeng Wildlife Sanctuary, Thailand. Scientific report. Wildlife Conservation International. New York Zoological Society, Bronx Zoo, Bronx, New York.

RABINOWITZ, A. 1990b. Note on the behavior and movements of Leopard Cats, *Felis bengalensis*, in Dry Tropical forest Mosaic in Thailand. Biotropica. 22 (4): 397-403.

RICKART, E.A., L.R. HWANEY, AND R.C.B. UTZURRUM. 1991. Distribution and ecology of small mammals along an elevational transect in southeastern Luzon, Philippines. Journal of Mammalogy. 72(3): 458-468.

SANTASOMBAT, Y. 1999. Biodiversity and indigenous knowledge for sustainable development. Biodiversity and Indigenous Knowledge Studies Center for Research and Sustainable Development, Sociology and Anthropology Department, Faculty of Social Science, Chiangmai University. 308 pp. (Thai)

SANTASOMBAT, Y. 2001. Ecotourism, cultural diversity and natural management. Biodiversity Research and Training Program (BRT). Nopburee Press. Chiang Mai. 234 pp. (Thai)

SINGHASAKORN, N. 1996. Karen and Thung Yai Naresuan, How people and forest coexist, In Krungthep Thurakit, 3 September, p.1. (Thai)

SITASUWAN, N., S. CHOMDEJ, AND T. SUPHAHAN. 1999. A bird survey and the potential development of model communities for ecotourism in Mae Hong Son province. Pages 818-821 in V. Baimai et al (eds.), Research reports on biodiversity on Thailand. Biodiversity Research and Training Program, Bangkok.

SRIKOSAMATARA, S., B. SIRIPHOLDEJ, AND V. SUTEETHORN. 1992. Wildlife trade in Lao P.D.R. and between Lao P.D.R. and Thailand. Nat. Hist. Bull. Siam Soc. 40: 1-47.

SRIKOSAMATARA, S., S. NAOSAWAT, S. LAOYEEPA, AND V. SUTEETHORN. 1999a. Status of mineral licks and wildlife in Mae Hong Son province and their potential for ecotourism industry. Pages 826-831 in V. Baimai et al (eds.), Research reports on biodiversity on Thailand. Biodiversity Research and Training Program (BRT), Bangkok.

SRIKOSAMATARA, S., S. NAOSAWAT, AND T. BIDAYABHA. 1999b. Involving local people in monitoring population and communities of wildlife in Mae Hong Son. Pages 832-836 in V. Baimai et al (eds.), Research reports on biodiversity on Thailand. Biodiversity Research and Training Program (BRT), Bangkok.

SRIKOSAMATARA, S., N. WATTANARATCHAKIT, T. CHAEKPIMAI, W. SAWANGPROH, S. DITYHAM, AND S. SRISOMBOONLERT. 2000. Relative abundance of wildlife species around Muang Pham village, Mae Hong Son, Thailand. Unpublished report. Biodiversity Research and Training Program (BRT), Bangkok.

SRIKOSAMATARA, S., N. WATTANARATCHAKIT, T. BIDAYABHA, AND ET AL. 2002. Relative abundance of wildlife species around some hill tribe village, Mae Hong Son, Thailand. Unpublished report. Biodiversity research and training program (BRT), Bangkok.

STEIN, J.T., N.D. BAILEY, D.L. WADE AND BCTF. 2002 BCTF Fact Sheet: African Rodents and the Bushmeat Trade. Bushmeat Crisis Task Force. Washington, DC. 2 pages.

STEINMTEZ, R. AND R. MATHER. 1996. Impact of Karen villages on the fauna of Thung Yai Naresuan wildlife sanctuary: a participatory research project. Nat. Hist. Bull.Siam Soc. 44: 53-40.

STEPHENSON, P.J. 1993. The small mammal fauna of Reserve Speciale d' Analamazaotra, Madagascar: the effects of human disturbance on endemic species diversity. Biodiversity and Conservation. 2: 603-615.

SUWANBUBPA, A. 1976. Hill tribe development and welfare programmes in Northern Thailand. Regional Institute of Higher Education and Development. Times Printers, Sdn Bhd, Singapore. 93 pp.

TERBORGH, J., L. LOPEZ, V. P. NUNEZ, M. RAO, G. SHAHABUDDIN, G. ORIHUELA, M. RIVEROS, R. ASCANIO, G.H. ADLER, T.D. LAMBERT, AND L. BALBAS. 2001. Ecological meltdown in predator-free forest fragment. Science. 294: 923-1926.

TUNGITTIPLAKORN, W., P. DEARDEN, AND C. WITTAYAPAK.1999. Biodiversity conservation in the Thai highlands: human use of wildlife. Page 778-784 in V. Baimai et al (eds.), Research reports on biodiversity on Thailand. Biodiversity Research and Training Program, Bangkok.

UNDP. 2004. Community Forest in Thailand. United Nations Development Programme, Bangkok, Thailand. 144 pp.

VIDTHAYANON, C AND E. CHAROENSIRIWONGTHANA.1999. Fish biodiversity and potential for ecotourism in Mae Hong Son province and a Conservation Masterplan. Page 822-825 in V. Baimai et al (eds.), Research reports on biodiversity on Thailand. Biodiversity Research and Training Program, Bangkok.

WATTANARATCHAKIT, N. 1999. The effect of human disturbance to relative density of some wildllifes in Klong Saeng Wildlife Sanctuary, Suratthani Province. Senior Project in Faculty of Science (Biology): Mahidol University. V+29 pp.

WALKER, S. AND A. RABINOWITZ. 1992. The small mammal community of a dry-tropical forest in central Thailand. Journal of Tropical Ecology 8: 57-71.

WEMMER, C and M. AUNG. 1998. A year in the life of a village rat catcher: an example of subsistence hunting in rural Burma. in abstract in International Meeting of Society for conservation Biology, Macquaric University, Sydney.

WHARTON, C.H. 1966. Man, fire and wild cattle in north Cambodia. Proc. Ann. Tall Timbers Fire Ecol. Conf. 5: 23-65.

WILES, G.J. 1981. Abundance and habitat preferences of small mammals in southwestern Thailand. Nat. Hist. Bull. Siam Soc. 29: 44-54.

WOOD, B.J. AND G. F. CHENG. 2003. A critical review of the development of rat control in Malaysian agriculture since the 1960s. Crop Protection. 22: 445-461.

APPENDIX

APPENDIX A

1. Relative abundance of wildlife species around Muang Pham village in dry and wet season (*Srikosamatara et al., 2000 and **Chaekpimai et al., 2002)

Species	Relative Abundance (%)	
	*Dry Season	**Wet Season
Medium cat	0.8	-
Leopard Cat	0.4	-
Civet	2	3.1
Pangolin	0.4	-
Bird	5.7	3.5
Squirrel	4.9	3.5
Bamboo rat	0.4	1.3
Rat	29.5	37.4

2. Data of captured small mammals

2.1 Preliminary study

Site A (23 May 2003 – 12 June2003)

Census line	Date	Sex	Weight (g)	HB (cm)	T (cm)	Age
Rattus rattus	25-May	M	50	10	8	J
Rattus rattus	1-Jun	M	59	8.5	10	J
Rattus rattus	2-Jun	-	58	10.5	10	J
Rattus rattus	3-Jun		(escape before measure and weigh)			
Rattus rattus	6-Jun	-	32	10	10.5	J
Rattus rattus	7-Jun	M	84	15	17	S
Niviventer bukit	3-Jun	M	69	14.5	16.5	J
Mus caroli	3-Jun	M	19	9.5	8.5	J
Menetes berdmorei	2-Jun	F	230	21.5	10	A
Assessment line		**Sex**	**Weight (g)**	**HB**	**T**	**Age**
Rattus rattus	12-Jun	-	108	14	16	A

(Continuous)

Site B (25 June 2003 – 8 July 2003)

Census line	**Date**	**Sex**	**Weight(g)**	**HB (cm)**	**T(cm)**	**Age**
Rattus rattus	25-Jun	M	58	14	14	J
Rattus rattus	27-Jun	M	63	14	14	J
Rattus rattus	28-Jun	F	61	14	14.5	J
Rattus rattus	29-Jun	M	130	18	18.5	A
Rattus rattus	29-Jun	F	104	18	19	A
Rattus rattus	29-Jun	F	57	13	13.5	J
Rattus rattus	30-Jun	M	79	15.5	15.5	J
Rattus rattus	1-Jul	F	94	14	14	J
Rattus rattus	25-Jun	M	95	16	14.5	J
Rattus rattus	27-Jun	F	142	20	20	A
Rattus rattus	28-Jun	M	145	20	20	A
Rattus rattus	28-Jun	F	149	20	20.5	A
Rattus rattus	1-Jul	M	86	21.5	19	J
Rattus koratensis	25-Jun	F	131	19	21.5	A
Bandicota savilei	25-Jun	M	225	20	21	A
Maxomys surifer	27-Jun	F	111	16	16.5	A
Maxomys surifer	26-Jun	M	109	17.5	18	A
Maxomys surifer	28-Jun	M	103	16.5	16.5	A
Maxomys surifer	1-Jul	F	99	15	17	A
Niviventer bukit	26-Jun	F	91	15.2	9.4*	A
Niviventer bukit	26-Jun	M	60	14	16.5	J
Niviventer bukit	27-Jun	M	54	12.5	14.5	J
Niviventer bukit	29-Jun	F	64	15	17	J
Niviventer bukit	30-Jun	M	45	13	13.5	J
Menetes berdmorei	25-Jun	F	207	18	17	A
Assessment line	**Date**	**Sex**	**Weight(g)**	**HB (cm)**	**T(cm)**	**Age**
Rattus rattus	5-Jul	M	57	14	14.5	J
Rattus rattus	5-Jul	M	89	-	-	J
Rattus rattus	6-Jul	M	78	15.5	16	J
Rattus rattus	7-Jul	M	63	14.5	14.5	J
Rattus rattus	8-Jul	M	56	13.5	13.5	J
Rattus rattus	8-Jul	M	164	19.5	20.5	A
Rattus rattus	8-Jul	F	84	15	17.5	A
Niviventer bukit	6-Jul	M	48	12.5	13	J

* the tail of animal was not compete

(Continuous)

Site C (17 July 2003 - 30 July 2003)

Census line	**Date**	**Sex**	**Weight(g)**	**HB (cm)**	**T(cm)**	**Age**
Rattus rattus	23-Jul	F	81	15.5	16.5	J
Niviventer bukit	20-Jul	M	100	16.5	17	A
Niviventer bukit	20-Jul	F	62	13	14.5	J
Niviventer bukit	20-Jul	F	66	13.5	16	S
Niviventer bukit	23-Jul	M	91	15	17	A
Niviventer bukit	24-Jul	M	99	17	17	A
Menetes berdmorei	18-Jul	M	180	20	14	A
Menetes berdmorei	19-Jul	M	108	16.5	14	A
Menetes berdmorei	19-Jul	F	189	20	19	A
Menetes berdmorei	19-Jul	F	112	16.5	14.5	A
Menetes berdmorei	21-Jul	F	213	20	17	A
Menetes berdmorei	22-Jul	F	143	17	15	A
Tupaia belangeri	18-Jul	F	110	19.5	17	A
Tupaia belangeri	19-Jul	F	86	17	16.5	J
Tupaia belangeri	20-Jul	M	112	16.5	18	A
Assessment line	**Date**	**Sex**	**Weight(g)**	**HB (cm)**	**T(cm)**	**Age**
Leopoldamys sabanus	28-Jul	F	233	22	25	S
Niviventer bukit	27-Jul	M	108	15	12.5	A
Niviventer bukit	30-Jul	M	90	15.5	14	J
Menetes berdmorei	29-Jul	M	188	19.5	15	A
Menetes berdmorei	30-Jul	M	141	17.5	15.5	A

(Continuous)

2.2 Grid trapping

Grid 1 (3 Dec. 2004 – 6 Dec. 2004)

Species	Date	Sex	Weight(g)	HB (cm)	T(cm)	Age
Rattus rattus	5-Dec	-	65	13.5	13.5	J
Niviventer bukit	5-Dec	-	-	-	-	
Menetes berdmorei	5-Dec	M	183	20	14	A
Niviventer bukit	6-Dec	F	38	12	13	J

Grid 2 (7 Dec. 2004 – 10 Dec. 2004)

Species	Date	Sex	Weight(g)	HB (cm)	T(cm)	Age
Rattus rattus	7-Dec	F	26	9.5	9.5	J
Rattus rattus	8-Dec	F	70	14	15	J
Rattus rattus	8-Dec	F	87	15.5	15.5	J
Rattus rattus	9-Dec	F	78	15	15	J
Niviventer bukit	10-Dec	F	31	10.5	13.5	J
Niviventer bukit	10-Dec	F	73	14	19	A
Tupaia belangeri	10-Dec	-	-	-	-	

Grid 3 (10 Dec. 2004 – 13 Dec. 2004)

Species	Date	Sex	Weight(g)	HB (cm)	T(cm)	Age
Menetes berdmorei	10-Dec	M	170	19	15	A
Menetes berdmorei	10-Dec	F	249	23	15	A
Menetes berdmorei	10-Dec	M	169	20	15	A
Menetes berdmorei	11-Dec	M	211	21	14	A
Menetes berdmorei	11-Dec	M	230	22	14	A
Niviventer bukit	11-Dec	F	85	15	17	A
Tupaia belangeri	13-Dec	F	163	19	19	A
Niviventer bukit	13-Dec	F	75	14	17	J

Grid 4 (14 Dec. 2004 – 17 Dec. 2004)

Species	Date	Sex	Weight(g)	HB (cm)	T(cm)	Age
Niviventer bukit	15-Dec	F	55	13	16.5	J
Niviventer bukit	16-Dec	F	66	14	6.5	J
Niviventer bukit	16-Dec	F	77	15	19	J
Rattus rattus	16-Dec	F	46	11	12.5	J
Niviventer bukit	17-Dec	M	86	16	17	A

(Continous)

Grid 5 (18 Dec. 2004 – 21 Dec. 2004)

Species	Date	Sex	Weight(g)	HB (cm)	T(cm)	Age
Rattus rattus	18-Dec	F	64	14	15	J
Niviventer bukit	18-Dec	F	71	14.5	17	A
Niviventer bukit	18-Dec	M	104	17.3	17	A
Bandicota savilei	18-Dec	M	198	20	23.5	A
Maxomys surifer	18-Dec	F	84	15	14	J
Rattus rattus	19-Dec	F	90	15.5	15	A
Maxomys surifer	19-Dec	F	153	18.5	20	A
Brylmys berdmorei	19-Dec	F	228	18	22	A
Maxomys surifer	20-Dec	F	105	16	16.5	A
Niviventer bukit	21-Dec	M	83	15	17	A
Rattus rattus	21-Dec	M	101	16	16.5	A

Grid 6 (22 Dec. 2004 – 25 Dec. 2004)

Species	Date	Sex	Weight(g)	HB (cm)	T(cm)	Age
Rattus rattus	22-Dec	F	41	11.5	12	J
Menetes berdmorei	22-Dec	F	237	20	14.5	A
Menetes berdmorei	22-Dec	F	257	20	14	A
Menetes berdmorei	22-Dec	F	219	20	11	A
Menetes berdmorei	22-Dec	M	299	21	15.5	A
Menetes berdmorei	22-Dec	F	217	20	15	A
Tupaia belengeri	23-Dec	-	-	-	-	A
Tupaia belengeri	23-Dec	F	137	17.5	17	A
Menetes berdmorei	23-Dec	F	131	17.5	17	A
Menetes berdmorei	23-Dec	M	200	19	15	A
Rattus rattus	23-Dec	-	-	-	-	A
Menetes berdmorei	23-Dec	F	208	20	14	A
Rattus rattus	24-Dec	F	116	15	18	A
Rattus rattus	24-Dec	F	237	20	15.5	A
Rattus rattus	25-Dec	F	39	10.5	13	J
Rattus rattus	25-Dec	F	48	11	14	J

APPENDIX B

Picture 1: A lot of manpower to carry the traps to trapping sites
(about 25-30 traps / person). A live trap was laid on the ground in trap station.

(Feces) (Tracks)

Picture 2: Signs of carnivores around Muang Pham village.

Picture 3: Agricultural products were damaged by some small mammals.

Picture 4: *Rattus rattus* who high abundance in the agricultural field especially in paddy field.

Picture 5: Hair clipping, the captured animals were mark and identified by the difference position of hair clipping

(A) the place for conserve fish

(B) numerous fish in small reservoir.

Picture 6: Wang Pla

Picture 7: Pong Luang, largest mineral lick in Muang Plam village.
(Source: Peechanit Ketsuwan)

BIOGRAPHY

NAME Miss. Nattha Wattanaratchakit

DATE OF BIRTH 7 June 1978

PLACE OF BIRTH Bangkok, Thailand

INSTITUTIONS ATTENDED Mahidol University, 1996-1999:

Bachelor of Science (Biology)

Mahidol University, 2005:

Master of Science (Environmental Biology)

RESEARCH GRANT Biodiversity Research Training (BRT)

In the year 2004-2005

Tel. (6 66) 9098008
E-mail: nattha007@yahoo.com