DISTRIBUTION, BEHAVIOR AND THREAT OF RED-SHANKED DOUC LANGUR *PYGATHRIX NEMAEUS* IN HIN NAMNO NATIONAL PROTECTED AREA, KHAMMOUANE PROVINCE, LAO PDR

Phaivanh Phiapalath

A Thesis Submitted in Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy in Environmental Biology

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การแพร่กระจาย พฤติกรรม และ ภัยคุกคามของค่างห้าสี ในพื้นที่อนุรักษ์แห่งชาติหินนามนอ แขวงคำม่วน ประเทศสาธารณรัฐประชาธิปไตยประชาชนลาว

นายไพวัน เพียปะลัด

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรดุษฎีบัณฑิต
สาขาวิชาชีววิทยาสิ่งแวดล้อม
มหาวิทยาลัยเทคโนโลยีสุรนารี
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DISTRIBUTION, BEHAVIOR AND THREAT OF RED-SHANKED DOUC LANGUR *PYGATHRIX NEMAEUS* IN HIN NAMNO NATIONAL PROTECTED AREA, KHAMMOUANE PROVINCE, LAO PDR

Suranaree University of Technology has approved this thesis submitted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

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ไพวัน เพียปะลัด : การแพร่กระจาย พฤติกรรม และ ภัยคุกคามของค่างห้าสี *PYGATHRIX NEMAEUS* ในพื้นที่อนุรักษ์แห่งชาติหินนามนอ แขวงคำม่วน ประเทศสาธารณรัฐประชาธิปไตยประชาชนลาว อาจารย์ที่ปรึกษา : ดร.พงศ์เทพ สุวรรณวารี, 168 หน้า.

ค่างห้าสี เป็นสัตว์ที่ใกล้สูญพันธุ์ตามบัญชีขององค์การสากล เพื่อการอนุรักษ์ธรรมชาติ จำนวนประชากรของค่างห้าสีพบมากที่สุดในประเทศสาธารณรัฐประชาธิปไตยประชาชนลาว โดยเฉพาะอย่างยิ่งในพื้นที่อนุรักษ์แห่งชาตินากาย - น้ำเทิน และหินนามนอ แต่ข้อมูลการศึกษาประชากรในธรรมชาติยังมีอยู่น้อยมาก การสำรวจตามเส้นทาง การติดตามพฤติกรรมสัตว์ และการสัมภาษณ์ชาวบ้าน ได้ถูกนำมาใช้ เพื่อศึกษาค่างห้าสี ในพื้นที่อนุรักษ์แห่งชาติหินนามนอ ในแขวงคำม่วน บริเวณตอนกลางของประเทศลาว ซึ่งมีสภาพเป็นเขาหินปูน ระหว่างเดือนกุมภาพันธ์ พ.ศ. 2550 ถึงมิถุนายน พ.ศ. 2551 ผลการศึกษาพบว่า ความหนาแน่นของประชากรค่างห้าสีเท่ากับ 5.8±4.7 กลุ่มต่อตารางกิโลเมตร จากการสำรวจ รวมระยะทางทั้งสิ้น 142.8 กิโลเมตร จำนวน 25 เส้นทาง ใน 10 พื้นที่ โดยมีประชากรทั้งหมดประมาณ 17,765 ตัว ในพื้นที่อนุรักษ์แห่งชาติ หินนามนอ ค่างห้าสีไม่ได้อาศัยเฉพาะบริเวณเทือกเขาหินปูน แต่จะพบมากบริเวณป่าดิบเขา (48.12%) ป่าดิบ (35.5%) และป่าผสม (14.0%) ในช่วงฤดูฝนค่างห้าสีจะถูกพบมากบริเวณป่าดิบ (42%) และหากินในพื้นที่ราบที่ต่ำกว่า ส่วนในฤดูแล้งพบอยู่ในที่สูงถึง 653 เมตรจากระดับน้ำทะเล จากการติดตามพฤติกรรมของค่างห้าสี 2 กลุ่ม (จำนวน 19 และ 39 ตัว) โดยใช้เทคนิคการกวาดสุ่ม พบว่า ค่างห้าสีใช้เวลาในการหาอาหารมากที่สุด (39.5%) บริเวณเรือนยอดต้นไม้ รองลงมาคือ การหยุดนิ่ง (18.9%) เพื่อจ้องมองภัยคุกคาม และการนอน (13.8%) แต่ใช้เวลากับพฤติกรรมทางสังคมน้อยที่สุด (5.0%) ซึ่งเวลาที่ค่างใช้ ทำกิจกรรมต่างๆ เป็นผลมาจากฤดูกาลและความกดดันจากมนุษย์ พืชอาหารที่ค่างห้าสีกินมี 112 ชนิดจากทั้งหมด 189 ชนิดที่จำแนกได้ โดยค่างจะชอบกินผลไม้มากกว่าใบอ่อนในฤดูฝน ภัยคุกคามหลักของค่าง ลิง และสัตว์ป่าชนิดอื่นๆ ในพื้นที่นี้ คือ การถูกล่าโดยมนุษย์ ซึ่งพบหลักฐานสูงถึง 0.3 ชิ้นต่อกิโลเมตร การศึกษาครั้งนี้แสดงให้เห็นถึงพื้นที่ที่อยู่ติดชายแดนประเทศลาว เวียดนาม และ ชุมชนเวียดนาม มีจำนวนของภัยคุกคามสูง ความสัมพันธ์ระหว่างการล่าสัตว์ป่า และการค้าสัตว์ป่ามีความเกี่ยวข้องกับฤดูกาลเพาะปลูก โดยพบว่า การล่าสัตว์ป่าจะพบมากในช่วงที่ชาวบ้านว่างเว้นจากการทำนา

สาขาวิชาชีววิทยา ลายมือชื่อนักศึกษา_____

ปีการศึกษา 2552 ลายมือชื่ออาจารย์ที่ปรึกษา_____

ลายมือชื่ออาจารย์ที่ปรึกษาร่วม_____

ลายมือชื่ออาจารย์ที่ปรึกษาร่วม_____

PHAIVANH PHIAPALATH : DISTRIBUTION, BEHAVIOR AND THREAT OF RED-SHANKED DOUC LANGUR *PYGATHRIX NEMAEUS* IN HIN NAMNO NATIONAL PROTECTED AREA, KHAMMOUANE PROVINCE, LAO PDR. THESIS ADVISOR : PONGTHEP SUWANWAREE, Ph.D 168 PP.

DOUC LANGUR/ *PYGATHRIX NEMAEUS*/ LIMESTONE, HIN NAMNO NATIONAL PROTECTED AREA/ PRIMATE

The Red-shanked Douc Langur is an endangered species according to IUCN Red List. The largest population of the species has been reported in Lao PDR especially in Nakai-Nam Thuen and Hin Namno National Protected Area but no study of a wild population is currently undertaken. A combination of transect walks, animal observation and villager interviews were conducted in Hin Namno NPA, a limestone habitat in central Lao, PDR., from February 2007 to June 2008. The group density of Red-shanked Douc Langur was 5.8±4.7 group km^{-2} from a total survey of 142.8 km, 25 line transects in 10 study camps. This gave an estimate of 17,765 individuals in Hin Namno NPA. They were not restricted to limestone habitats but frequently found in hill evergreen forest (48.12%), evergreen forest (35.5%) and mixed deciduous forest (14.0%). During the wet season, they used mostly evergreen forest (42%) at low elevation and flat ground especially for feeding. In contrast, they lived at higher elevation ranging up to 653 m above sea level during dry season. In addition, the observations of two groups (19 and 39 individuals) of the animal through scan sampling method revealed that Red-shanked Douc Langur spent the highest proportion

of time feeding (39.5%), followed by inactive (18.9%) for monitoring threats and sleeping (13.8%), while social activity was the lowest (5.0%). The time budget and activity of this animal were influenced by season and human pressure. The food plant species which the animals used are as many as 112 out of 189 plant species identified in the area. They preferred fruits over young leaves during the wet season. The main threat to the population of Red-shanked Douc Langurs in Hin Namno NPA was hunting and the level was very high (0.3 individual threat per km). The site closed to Lao-Vietnam border and any Vietic community had the highest number of threats. Finally, wildlife hunting and trade were related to cropping season, while hunting being much more pronounced when villagers were not engaging in farming.

School of Biology

Academic Year 2009

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Advisor's Signature_____

Co-advisor's Signature_____

Co-advisor's Signature_____

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Phaivanh Phiapalath

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LIST OF ABBREVIATIONS

A.M.	=	ante meridian
a.s.l.	=	above sea level
°C	=	Degree of Celsius
CITES	=	Convention on International Trade in Endangered Species of Wild Fauna and Flora.
CL	=	Confidence Limits
DBH	=	Diameter at Breast Height
GPS	=	Global Positioning System
ha	=	hectare
hr	=	hour
ICEM	=	International Centre for Environmental Management
IUCN	=	International Union for Conservation of Nature (The World Conservation Union – ex name)
km	=	kilometer
Lao PDR	=	Lao People' Democratic Republic
m	=	meter
Max ROD	=	Max Reliable Observer to animal Distance
Max RTD	=	Max Reliable Transect to animal Distance
MLTS	=	Modified-line transect sampling
mm	=	millimeter

LIST OF ABBREVIATIONS (Continued)

NPA	=	National Protected Area
P.M.	=	post meridian
sp.	=	species (singular)
spp.	=	species (plural)
S.E.M	=	Standard error of mean
STDEV	=	Standard deviation
UNESCO	=	United Nations Educational, Scientific, and Cultural Organization
US$	=	US dollar
WCS	=	Wildlife Conservation Society
WWF	=	World Wildlife Fund for Nature

CHAPTER I

INTRODUCTION

1.1 The significance of Red-shanked Douc Langur

Red-shanked Douc Langur belongs to the group of Old World Monkeys, in the family **Cercopithecidae**, sub-family **Colobinae** (leaf-eating monkeys), genus *Pygathrix* and species *Pygathix nemaeus*. It is an endangered species for conservation according to the IUCN Red List, and classified in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1975). Therefore, any trade of this species is prohibited.

Red-shanked Douc Langur is endemic to Southeast Asia and found only in Laos, Vietnam and Cambodia (Timmins and Duckworth, 1999). The population of this langur has remarkably declined since the Indo-China War (1970s), in which the animals were killed by defoliation bombs and targeted for shooting practice by army. Hunting and habitat loss are major threats to the population of this species, especially hunting for bush meat and medicinal purpose, as well as catching infants for pets and exportation to Western countries' zoos (Lippold and Vu, 1995). In the late 1960s, douc langurs were widely imported into the United States and European zoos. The exhibitions were up from 8 to 15 zoos around the world from 1968 to 1973 (Kavanagh, 1987). In Vietnam, primates including douc langurs are on the menu in Vietnamese restaurants (Lippold and Vu, 1995).

The main population of Red-shanked Douc Langur can be found in tropical forests, in primary and secondary forests (Lippold, 1995), ranging from 200 to 1,500 m above sea level (Timmins and Duckworth, 1999). This langur has been reported in Laos, Vietnam, Cambodia, and Southern China (Figure 1.1).

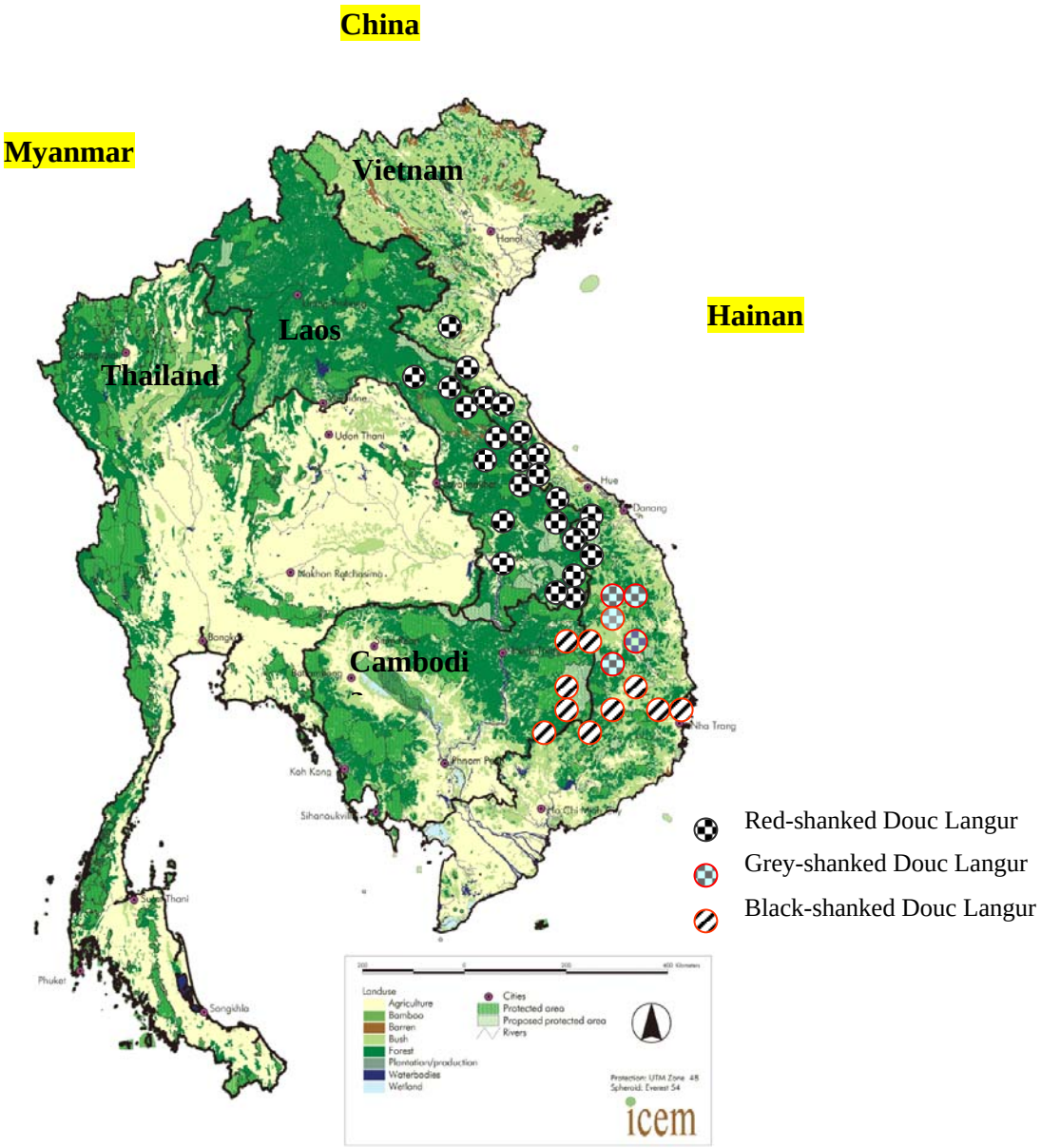

Figure 1.1 Distribution of Douc Langurs in Indochina

(Timmins and Duckworth, 1999; ICEM, 2003; Nadler, 2008).

However, it can no longer be found in China (Fooden and Feiler, 1988; Timmins and Duckworth, 1999). It has recently been confirmed in Cambodia (Rawson and Roos, 2008). In Vietnam, the species was reported in central highland areas (Lippold, 1995) while in Lao PDR it is distributed from the Center, beginning at Nam Chat catchment in Bolikhamxay Province to the southern province, the Attapeu Province, at the border of Cambodia (Timmins and Duckworth, 1999). At present, the largest population of Red-shanked Douc Langur in the world is in Nakai-Nam Theun and Hin Namno National Protected Areas (NPA), which lie mainly in Khammouane Province including Nam Chat Provincial Protected Area of Bolikhamxay Province in the northern Annamite Mountain Range (Duckworth *et al.*, 1999; Timmins and Duckworth, 1999).

Excitingly, Red-shanked Douc Langur populations found in Hin Namno are considered unique groups since they live in limestone forest (Timmins and Duckworth, 1999). However, no-one knows whether the limestone habitat provides some good refuge place for this species or not since none study in this area has been done before. While, a cousin as White-headed Langur in Fusui, China uses limestone hills as an important refuge area (Li and Rogers, 2005).

Very little is known about Red-shanked Douc Langur in Lao PDR (Timmins and Duckworth, 1999) as no study on the species has been undertaken so far. Only some studies of Red-shanked Douc Langurs have been conducted in Vietnam (Lippold, 1998; Pham *et al.*, 2000) about only the diets and general distribution (Pham, 1993; Lippold and Vu, 1995). The first field survey on douc langurs was carried out in Son Tra Nature Reserve in 1977 (Lippold, 1977). The field surveys began again in 1993 and more studies on the distribution were conducted between

1985 and 1995 (Lippold and Vu, 1995) and some work continued up to 1998. The social behavior of the species has been described in captivity (Kavanagh, 1978). In Cambodia, a study on douc langurs has also just started and the presence of Red-shanked Douc Langur has been recently confirmed (Rawson and Roos, 2008).

Primates, especially endangered species, are commonly used as flagship species for wildlife conservation (Mittermeier, 1988). Therefore, the loss of any endangered species may indicate a severe decline of the forest and ecosystem status. In this regard, information on distribution, ecology and threats of Red-shanked Douc Langur are urgently needed for its conservation in the future.

1.2 Research Objectives

The objectives of this study are:

1) To investigate the distribution of Red-shanked Douc Langur in Hin Namno National Protected Area, Khammouane Province, Lao PDR.
2) To assess general activity budget of Red-shanked Douc Langur in the wild.
3) To identify the main threats to the population of Red-shanked Douc Langur and their magnitude.

1.3 Scope and Limitations of the Study

1) Distribution study: the study sites were in Hin Namno National Protected Area. Ten study camps were selected in the north and the central parts of Hin Namno NPA. Twenty five transect lines of total 47.6 km were designed with an average length of 1.9 km (range 1.2–2.7 km). Each transect was walked three times between February and December 2007 for a total of 142.8 km.

2) Behavior study: two groups (G1 and G2) of Red-shanked Douc Langur were selected and observed each month throughout the year. The behavior study started in March 2007 for G1 and July for G2, and all were completed in June 2008. The observation schedule for each group was 5 to 7 days per month. Behavior activities, "activity budget" were recorded and compared in different seasons. Data on any activity were recorded by scan sampling of all visible group members every 30 minutes.

3) Threat identification: through the same transect walks, evidences of hunting such as a man with a gun or cross bow, gunshot, human artifacts (camps or camp fire), snare lines, and habitat destruction by logging were recorded. In addition, interviews with local hunters on wildlife hunting and trade were conducted twice in February 2007. A series of informal discussions were conducted periodically up until March 2008.

1.4 Expected Results

This investigation will provide information on the distribution of Red-shanked Douc Langur in Hin Namno National Protected Area, threats to the population and some basic behavioral activity patterns of Red-shanked Douc Langur in "the limestone habitat". The findings will be useful as baseline data for conservation and management of this species in the future.

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CHAPTER II

LITERATURE REVIEWS

2.1 Red-shanked Douc Langur

2.1.1 Taxonomy

According to Groves (2001), the order of primate is reclassified from the "traditional system" to the new "cladistic system" (Figure 2.1). The cladistic system is recently recognized by scientists as it is based on similarities in traits due to common ancestry (Strier, 2003). There are two groups in the sub-order of the traditional system, Prosimii and Anthropoides (Campbell and Loy, 1996). It is now restructured to two new sub-order named Strepsirhini and Haplorhini (Groves, 2001). Red-shanked Douc Langur belongs to the group of Old World Monkeys, in the family **Cercopithecidae**, sub-family **Colobinae** (leaf-eating monkeys), genus *Pygathrix* and species *Pygathix nemaeus* (Figure 2.2).

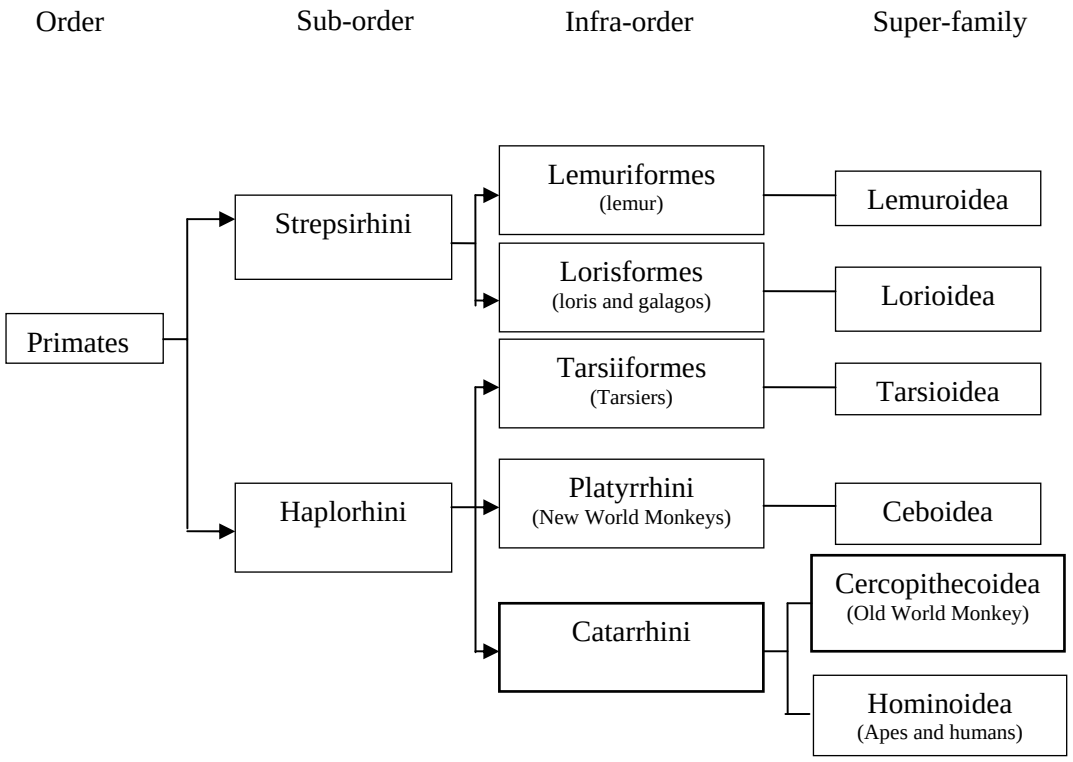

Figure 2.1 Cladistic system classification of primate (Groves, 2001)

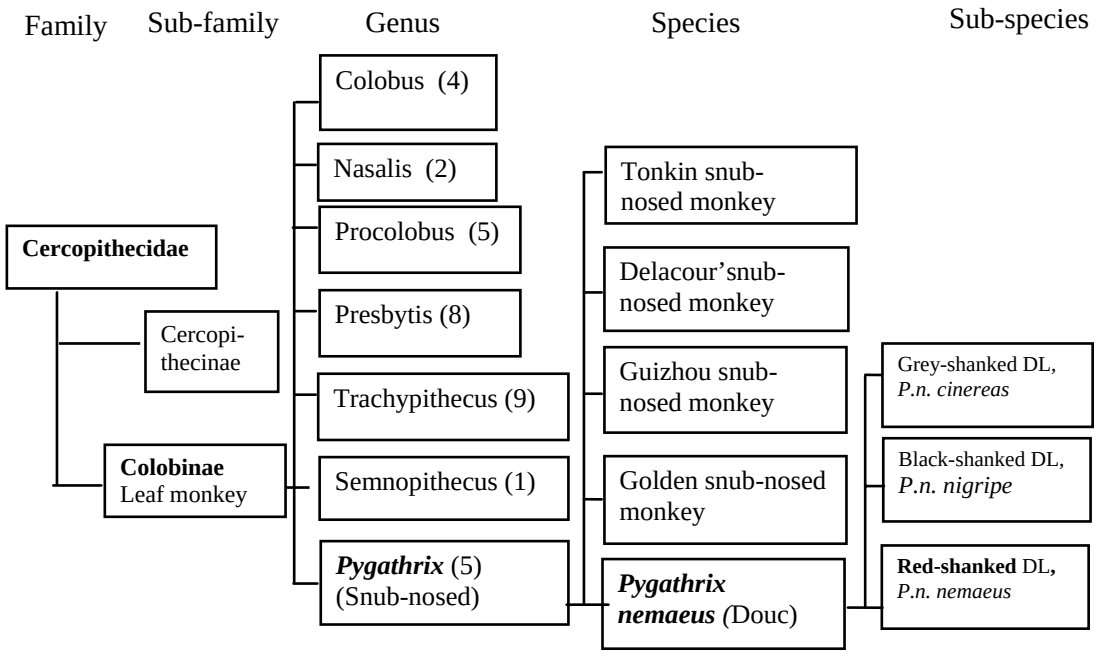

Figure 2.2 Classification of Cercopithecidae (Groves, 2001)

2.1.2 Anatomy

Lippold (1998) described Red-shanked Douc Langur as a man-like monkey with long white whiskers, reddish yellow face, wearing a grey shirt, and black pants. Over the grey shirt, the shoulders are black and the upper neck down to the chest is white. Red-shanked Douc Langur has deep maroon legs from the knees to the ankles and lower arms. Both feet and hands are black while a face is yellowish with white whiskers, and a tail is white. A newborn is in orange, its face is black with dark brown eyes surrounded by a black ring (Figure 2.3).

Figure 2.3 Adult female and an infant of Red-shanked Douc Langur

2.1.3 Age Class

Based on captivity observation, Red-shanked Douc Langur is classified into four age classes: infant (<1.5 year), juvenile (1.5–3 years), sub-adult (3–4 years) and adults. They can live up to 25–30 years in the wild but their life is shorter in captivity (Kavanagh, 1978).

2.1.4 Distribution

In Vietnam, Red-shanked Douc Langur was found in Bach Ma National Park (Pham, 1993b), Phong Nha Ke Bang National Park (Pham *et al*., 2000), Phu Mat Nature Reserve (Lippold, 1998), Kong Cha Rang Nature Reserve, Kon Khi Kinh Nature Reserve (Lippold, 1995), and Son Tra Nature Reserve (Lippold, 1977; 1995). These places are mainly in Vietnam's Central Highlands with altitude between 500–1,000 m above sea level (Timmins and Duckworth, 1999).

In Lao PDR, their habitats lie between 14˚25´ and 18˚25´ N. They can be found along the Vietnam border in the east, from Nam Chat catchment to the Cambodian border in the south (Timmins and Duckworth, 1999). Recently, the species has been recorded and confirmed at 12 locations (Figure 2.4) ranging from 200 to 1,500 m a.s.l., (Timmins and Duckworth, 1999).

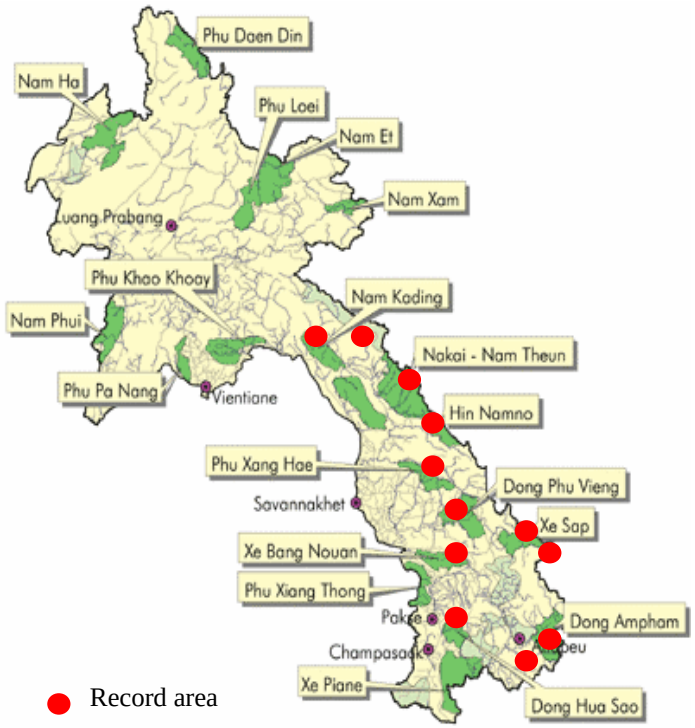

Figure 2.4 Distribution of Red-shanked Douc Langur in Lao PDR (from Duckworth *et al*., 1999; Timmins and Duckworth, 1999).

Nakai-Nam Theun National Protected Area and Hin Namno National Protected Area support the largest population of the species in the world (Duckworth *et al.*, 1999; Timmins and Duckworth, 1999). A small to medium population of Red-shanked Douc Langur has also been reported at other eight sites in Laos including Nam Kading National Protected Area in Bolikhamxay Province, Phou Xang He and Dong Phouvieng in Savannakhet Province, Xe Bang Nuan and Sesap in Saravanh Province, Dong Hua Sao in Champasak Province, Dong Ampham and Nam Kong in Attapeu Province, and Phou Ahyon in Sekong Province (Duckworth *et al*., 1999; Timmins and Duckworth, 1999). Red-shanked Douc Langur is found in similar habitats to Vietnam including limestone habitats (Duckworth *et al*., 1999; Timmins and Duckworth, 1999; Walston and Vinton, 1999).

The Red-shanked Douc Langur is mainly found in primary forests but also in secondary forests. They can adapt to variety of forest types including semi-evergreen, hill evergreen, sub-montane evergreen, mixed deciduous, mixed evergreen and closed broad-leaved tropical forests (Lippold, 1998).

2.1.5 Behavior

Red-shanked Douc Langur is diurnal and arboreal, as is normally found in the group of colobids, spending a major proportion of their daytime for feeding in the wild (Lippold, 1995). Also, the species mainly lives in the mid to upper levels of the forest canopy.

Groups of Red-shanked Douc Langurs reportedly move through the forest canopy along established routes. An adult male is the group leader and all group

members follow when he moves. Females and infants are often found in the center and juvenile males bring up the rear during their locomotion (Lippold, 1995; 1998).

Group size of Red-shanked Douc Langur varies depending on habitat and human disturbance. In the past, they lived in groups of 30–50 individuals (Lippold, 1995). Groups as large as 50 individuals have been reported in Kong Cha Rang Nature Reserve and Kon Khi Kinh Nature Reserve (Lippold, 1995). Nevertheless, in areas with high pressure of human activity, the group size is much smaller, with as few as 4–5 individuals (Lippold, 1998).

Groups consist of mostly multi-male and multi-female with a sex ratio of 2.5 females for each male (Lippold, 1998). In captivity, females reach sexual maturity at about 4 years, at which time she can mate, while the males reach it at 4–5 years. Mating characteristics and sexual invitation start when the jaw thrust forward and the head shaken sideways with eyebrows raised and lowered several times in rapid succession (Kavanagh, 1978). The mean interbirth interval was 22 months and the gestation period was between 180 and 190 days (Brockman and Lippold, 1975; Lippold, 1989). Most births in captivity occurred between January and August, just before fruiting season of some favorite foods in the wild (Lippold, 1977; 1989). When giving birth, the female grasps the infant as it emerges and pulls it out. The newborn, with eyes wide open, grasps hold of the mother's fur. In the meantime, the mother licks its newborn immediately after birth (Brockman and Lippold, 1975).

Similar to all primates, social grooming in the wild occurs most frequently in the afternoon before the napping or resting period (Brockman and Lippold, 1975, Lippold, 1977). Also, adults spend more time for grooming compared to juveniles and infants (Dorian, 2002). During sleeping time, females sleep with their offspring, while

males spend time in rough play. Some females also spend time grooming (Lippold, 1998). Some observations showed that females prefer to groom males (Lippold, 1995).

2.1.6 Feeding

Red-shanked Douc Langur is a leaf-eating monkey. Pham (1993a) revealed the diet from the stomach content of dead langur to contain as many as 50 species of food types. The main food types were young leaves, unripe fruits, ripe fruits, leaf buds and flowers. Eighty two percent of intake consisted of leaves (75% of the leaves used are young leaves), 14% were fruits and seeds (mainly unripe but some over ripe) and 4% were flowers (Pham, 1993a). Hoang and Baxter (2006) also showed that the species consumed 84 plant species, consisting mostly of leaves (66%) and fruits (13%).

Red-shanked Douc Langur can consume some toxic food types because it has a large stomach partitioned with a number of sacks, allowing some toxic breakdown of leaf compounds (Pham, 1993a; Sterling *et al*., 2006).

2.1.7 Threats

The population of this langur has declined remarkably both in Vietnam and Lao PDR. They were killed by defoliation bombs, targeted for shooting practice by the army during Indochina War, have been hunted for sale and food, and the infants have been caught for pets (Lippold and Vu, 1995).

In Vietnam, douc langurs are occasionally eaten, for example as special dishes for the Vietnamese New Year (Lippold and Vu, 1995). They are also sold for

traditional medicine. The central highlands in Vietnam support most important habitats of douc langurs whereas the government policy of moving people from the North is likely to increase deforestation (Lippold and Vu, 1995). Moreover, forest loss in Vietnam originates from the expansion of fruit tree plantations, illegal logging, and firewood collection, which seriously affects the population of douc langurs in Vietnam (Lippold and Vu, 1995 and Mittermeier *et al*., 1988).

In Lao PDR, Red-shanked Douc Langur is also threatened by hunting, habitat degradation, and human disturbance. Although the species is on the National Protected Species List accordingly to the Lao Law on Wildlife and Aquatic Resources 2008 (MAF, 2008), the species has still been hunted for food and sale. The level of hunting has declined slightly after homemade guns, normally used for wildlife hunting in Laos, have been handed over in the last ten years. However, the population of Red-shanked Douc Langurs found close to the Lao-Vietnam border still receive high pressure from Vietnamese poachers (Walston and Vinton, 1999).

In the late 1960s, douc langurs were frequently imported to the United States and European zoos; the exhibition was up from 8 to 15 zoos from 1968 to 1973 (Kavanagh, 1987). It is difficult to raise douc langurs in captivity and often fail resulting for a need to import more animals from the original countries i.e Vietnam and Laos. Currently successful colonies exist only at the San Diego Zoo in the US (Kavanagh, 1987), Dusit Zoo in Thailand (Kulcharoen and Utara, 2008), the Cologne Zoo in Germany, and also in Singapore Zoo (Yeong *et al*., 2008).

2.1.8 Conservation

According to IUCN, nearly a third of all primate taxa are currently considered endangered, and 82% of primates in Lao PDR are highly threatened (IUCN, 2008). *Pygathrix nemaeus* is one of eight critically threatened species during last two decades (Jones, 1997). Specifically, the Grey-shanked Douc Langur, *Pygathrix nemaeus cinereas,* is classified as one of 25 most endangered species in the world (Mittermeier *et al*., 2005) and still retains a most endangered primate status up to date (IUCN, 2008). Many primates are listed as protected species in many other nations, and conservation projects have been implemented. For example, the Endangered Primate Rescue Center at Cuc Phuong in Vietnam and many primate research projects have been funded in Vietnam. Some projects focus on raising awareness through developing educational materials for different target groups, working with school children/villagers around conservation areas (Marsh, 2004). Others developed ecotourism projects to provide alternative incomes for local people who help protecting a species (Bettinger and Lehnhardt, 2004).

2.2 Primate Census Methods

There are many techniques designed for primate census sampling. However, four most popular methods for non-vocalized primates study are Effective Distance or **Whitesides method** (Whitesides *et al*., 1988), **Max ROD**: Max Reliable Observer to animal Distance (Struhsaker, 1981), **Max RTD**: Max Reliable Transect to animal Distance (Struhsaker, 1981), and **Distance Transan** (**D**–**Transan**) Computer software program (Johnson and Routledge, 1985).

Whitesides method $\text{Group Density} = \dfrac{N_t}{2(S/2+D)L_t}$

While $D = (FD)\ (N_t/N_f)$

N_t = Number of group encounters

D = Effective distance equal to FD

S = Mean group spread in km

L_t = Sum length of all census combined

FD = Fall off distance

N_f = Number of sightings of group at distance less than the fall off distance

Max. ROD method $\text{Group Density} = \dfrac{\text{Sum of group sightings}}{2\ (\text{length x width of 1 side of transect in km})}$

Max RTD method $\text{Group Density} = \dfrac{\text{Sum of group sightings}}{2\ (\text{length x width of 1 side of transect in km})}$

D – Transan Group Density = a PC program using a non-parametric, Shape-restricted estimator

Max ROD and Max RTD are very similar, the difference is only the Max ROD based on distance from an observer to an animal while Max RTD based on a perpendicular distance from line to an animal (Figure 2.5).

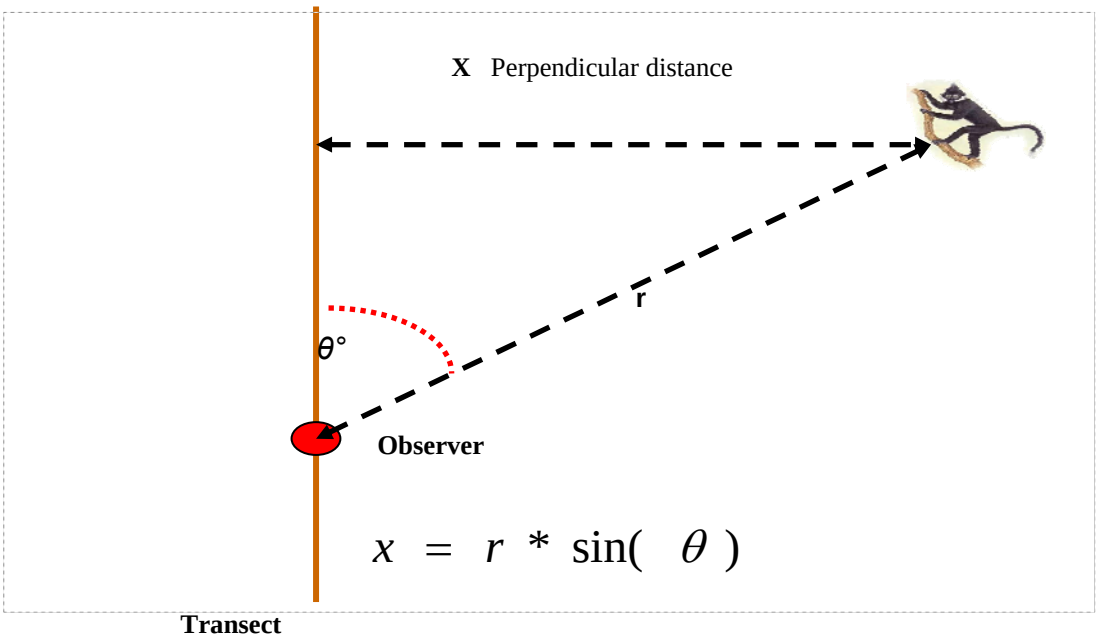

Figure 2.5 Measurement of perpendicular distance to an animal

Fashing and Cords (2000) tested these methods of identifying diurnal primate density in the Kakamega Forest in Kenya. They concluded that the Whitesides method had more accuracy of estimating the density of primates comparing to known densities, calculated with long-term data on home range size and overlap. Nijman and Menken (2005) also had the same conclusion. However, this method may not be appropriate for studying species with low density or rare species in homogeneous habitats.

Occupancy and Encounter rates are also used for census study of primates where a straight line cannot be made; however, these two methods cannot estimate species density. For limestone karst, there is no suitable methods to study the density of species accurately since it is not possible to make straight transects. Only rough estimate per km walk or an Occupancy method (MacKenzie *et al.*, 2002) can be used.

Occupancy method

$$\mathbf{E(C) = pN} \qquad \textit{while} \quad \mathbf{N = \frac{C}{p}}$$

E = Encounter

N = Abundance,

C = Count Statistic of N relationship

p = Detection probability; P (member of N appears in C)

When detection is 100% ($p = 1$), the count statistic provides an accurate estimate of N. However, if $p < 1$, the count statistic provides a biased estimate of N. N and C is in function of relationship, when N increase, C increase and *vice versa*.

Nevertheless, the MacKenzie method is very labor intensive and unaffordable for student research. It is suitable for funded projects that conduct in long-term monitoring.

Finally, Li and Rogers (2007) used a modified-line transect sampling method to census White-headed Langurs on limestone in China. Therefore, it is considered the most recent and appropriate method for censusing Red-shanked Douc Langurs in Hin Namno National Protected Area because bearing is not required for curve lines.

$$N = G * Mg$$

$$G = Dg * A$$

$$Dg = \frac{m \pm CL}{a}$$

$$m = \frac{X_1 + X_2 + ...X_i}{n}$$

$$cl = t_{0.05}(n-1) * \frac{S}{\sqrt{n}}$$

$$\%\, precision = \frac{CL}{m} * 100$$

$$s = \sqrt{\frac{\sum x^2 - \frac{\left(\sum x\right)^2}{n}}{n-1}}$$

Legends

N	=	Estimate of population size
G	=	Total number of groups
Mg	=	Mean group size
Dg	=	Group density estimate
A	=	Total area
m	=	Mean frequency of group encounters
CL	=	95% confidence limits
a	=	Sample area
n	=	Number of repeated surveys of transects
X	=	Number of groups encountered on a single transect
S	=	Standard deviation of group encounters frequency

i ranges from 1– x where $t_{0.05}$ was the 2 tailed value of it in students' distribution when $p < 0.05$ and the degree of freedom (df) is $n - 1$.

2.3 Hin Namno National Protected Area

Hin Namno National Protected Area (Figure 2.6) is situated at latitude 17°15´–40´ N and longitude 105°43´–106°09´ E, about 174 km from Khammouane Province to the east or 450 km from Vientiane. It connects with the international border of Phong Nha Ke Bang Natural World Heritage in Vietnam and is closed to Nakai Nam Theun NPA on the southeast. It lies entirely within the Boulapha district of Khammouane Province, has total area of 820 km^2 and an altitude ranging from 200 to 1,000 m a.s.l., (Timmins and Khounboline, 1996). Hin Namno is one of only two limestone areas that have been declared as National Protected Areas in the country.

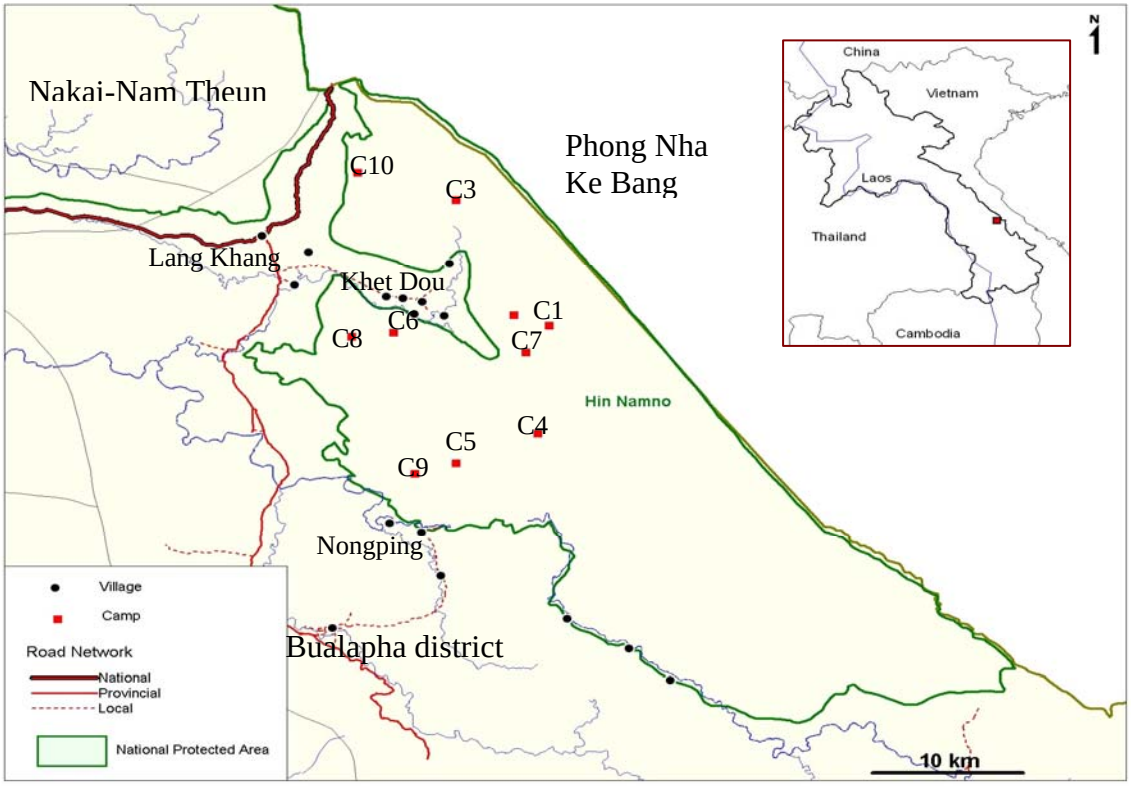

Figure 2.6 Hin Namno National Protected Area

2.3.1 Geography

The Hin Namno NPA is mainly dominated by steep slope mountains and limestone karst (Figure 2.7). Most outcrops are found in top mountains. However, besides the top, it has many forests, and more dense forests are found between mid levels of limestone mountains to foothill areas. The area has one main river, Xe Bangfai, lying outside the area, which forms the boundary along an 18 km stretch. The river runs underground in a “long cave river” for 6 km. Paxong and Houy Talee are the permanent and small streams, located in the northwest, while the seasonal streams, Nam Huck, Houy Pakha and Houy Ngor mainly drain into the Xe Bangfai River. Fifty percent of the area is 200–500 m a.s.l., whereas 45% is 500–1000 m a.s.l., (Berkmuller *et al*., 1995).

Figure 2.7 Geography of Hin Namno National Protected Area

2.3.2 Climate

Hin Namno NPA is not completely affected by monsoons from Vietnam and is considered quite dry compared to Nakai-Nam Thuen NPA. Nakai-Nam Theun NPA has been affected by monsoons from the Tonkin Gulf of Vietnam, which has a high average annual rainfall of 2,500–3,000 mm. In Hin Namno NPA, especially Phou Chuang, which is closest to Nakai-Nam Theun, there are some similar habitat types to southeastern Nakai-Nam Theun. Geographically, Hin Namno is part of the Northern Annamite Mountain Range. However, the major areas of Hin Namno NPA are not well considered as monsoon ranges because the rain does not precipitate all year round as in Nakai-Nam Theun NPA. The climate and precipitation in Hin Namno NPA is different from Nakai-Nam Thuen due to different altitudes. On the other hand, Hin Namno NPA, probably has similar climate conditions to the Vilabouly district of Savannakhet Province in the south or Yommalat district in the northwest.

Unfortunately, no official data of these areas are available from the National Meteorology Department.

Alternatively, the rainfall and temperature records at Savannakhet station can be used as references to the study area. It is understood that Savannakhet is considered dry compared to Hin Namno NPA. The average monthly temperature and rainfall at Savannakhet station in 2007 and 2008 are shown in Figure 2.8 and 2.9.

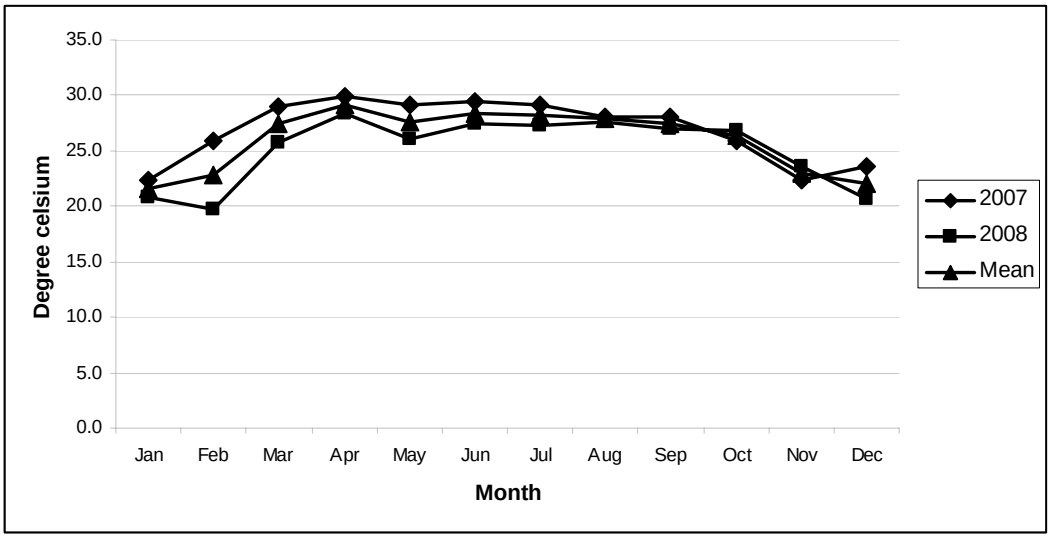

Figure 2.8 Average monthly temperature at Savannakhet station in 2007 and 2008 (Meteorology Department, 2008)

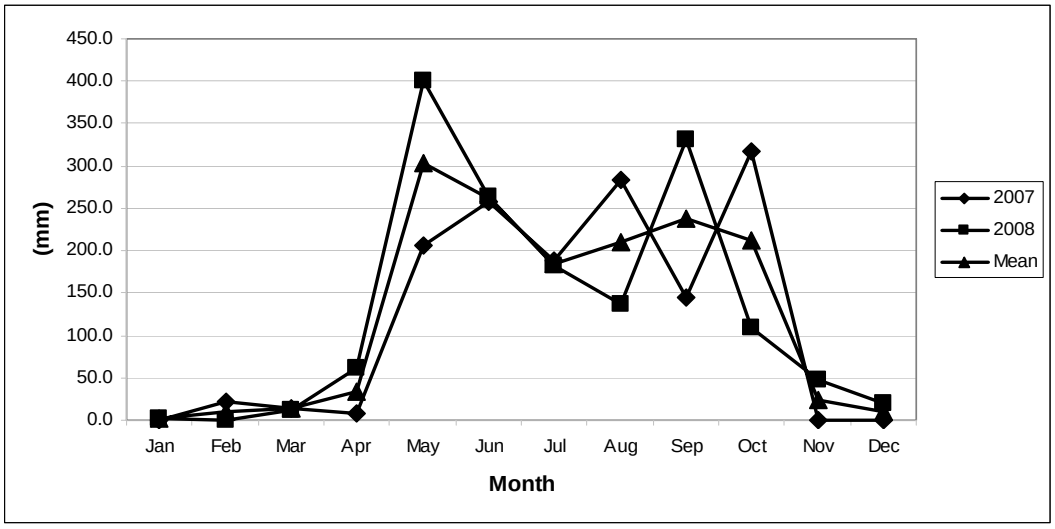

Figure 2.9 Average monthly rainfall at Savannakhet station in 2007 and 2008 (Meteorology Department, 2008)

The average annual temperature was 26°C (minimun 21°C in January and maximun 31°C in April). The average annual rainfall was 1,503 mm, highest in May (316.3 mm) and lowest in January (1.1 mm). Similar to that in Savannakhet, Hin Namno NPA has two main distinct seasons (rainy and dry seasons). The rainy season is from June to October and the dry season from November to May. The cold season runs from December to March. It is considered hot during the daytime in March.

Data from Ban Vangmaneu (17° 31´ 05 N–105° 49´ 52 E), the village research base in Hin Namno NPA between March 2007 and February 2008, showed that the annual temperature was 25.0°C with minimum monthly average of 19.8°C in February and maximum monthly average of 30.2°C in April (Figure 2.10). The daily temperature ranged from 11°C in January to 40°C in April, with an annual rainfall of 1,480 mm (monthly rainfall ranging from 1.1 mm in February to 297.4 mm in October, with similar figures in June (Figure 2.11).

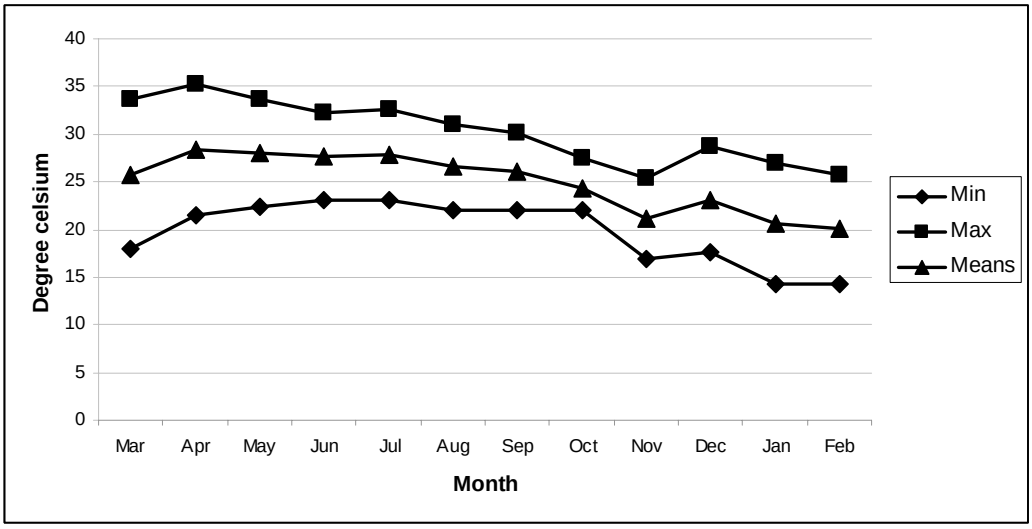

Figure 2.10 Monthly average temperatures at Ban Vangmaneu in Hin Namno NPA from March 2007 to February 2008

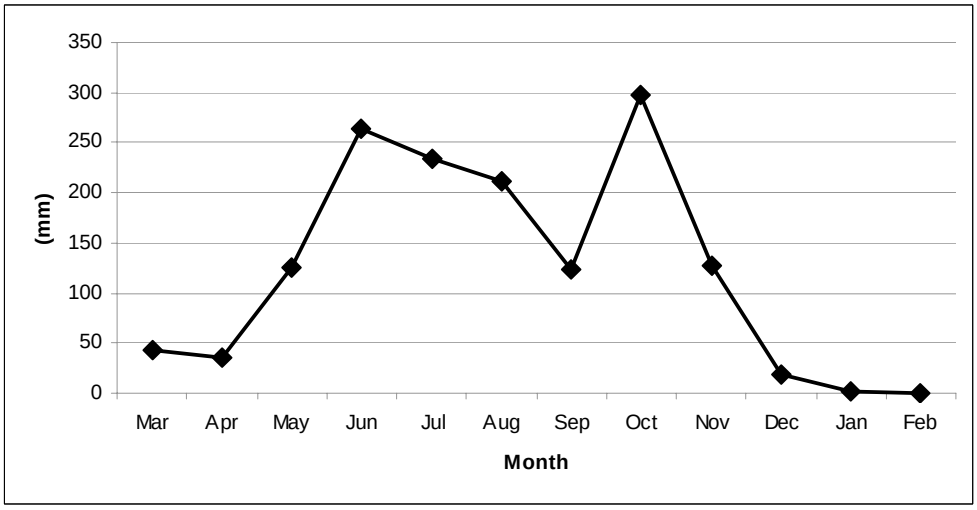

Figure 2.11 Monthly rainfall records at Ban Vangmaneu in Hin Namno NPA from March 2007 to February 2008

2.3.3 Flora and Fauna

Hin Namno NPA has two biogeographic zones, the central Indochinese limestone and a part of the Annamite Mountain region, which would have endemic species (Timmins and Khounboline, 1996).

Habitats: the majority of the area is limestone karst with a range of vegetation cover from bare rock to shrubby forest, containing flat lowlands broken by sporadic karst outcrops.

The limestone mountains, especially the central and some northern parts of the area, are covered with tall closed canopy evergreen forest, semi-evergreen forest, and mixed deciduous forests. Nonetheless, patches of secondary forest are found in the area. Because some tribal inhabitants (*Salang*) used to live and cultivate inside the area 40 years ago; some scattered areas are covered with old fallows. In addition, the flat lowland areas are found in central area such as in Nam Khoum, Nam Masai, and riparian habitats along the Xe Bangfai River (Timmins and Khounboline, 1996).

Flora: little is known by scientists about the flora of the area. So far, Walston and Vinton (1999) have noted 536 species of plants in the area. They also classified habitat types of Hin Namno NPA into seven forest types such as evergreen, mixed deciduous, deciduous, secondary, bamboo, limestone forest and cultivated area. The dominant tree species were in *Agavaceae, Arecaceae* and *Poaceae* families. However, the study has not mentioned percentage of these families.

Fauna: Hin Namno NPA provides suitable habitats for various animals, especially birds. For example, Large-Antlered Muntjac *Muntiacus vuquangensis*, Crested Argus *Rheinardia ocellata*, Siamese Fireback *Lophra diardi*, Clouded Leopard *Neofelis nebulosa*, Marble Cat *Pardofelis marmorata*, Black Giant Squirrels *Ratufa bicolar*, and four hornbill species, known as Great Hornbill *Buceros bicornis*, Wreathed Hornbill *Aceros leucocephalus*, Brown Hornbill *Anorrhinus tickelli*, and Rufous-necked Hornbill *Aceros nipalensis* (Timmins and Khounboline, 1996).

There are 18 primate species known in Laos (Ruggeri and Timmins, 1996). Nine species were found in Hin Namno NPA, including the Southern White-cheeked Gibbons *Nomascus siki*, Red-shanked Douc Langur *Pygathrix n. nemaeus*, Stripe-headed Black Langur *Trachypithecus hatinhensis*, Assamese macaque *Macaca assamensis*, Stump-tailed macaques *Macaca arctoides*, Rhesus macaque *Macaca mulatta*, and two species of Loris: Pygmy Loris *Nyticebus pygmaeus* and Slow Loris *Nyticebus bengalensis*. However, the presence of Phayre's Langurs *Trachypithecus phayrei* is still questionable (Timmins and Khounboline, 1996).

2.3.4 Threats to the Biodiversity in the Area

The major threats to wildlife population in the area are hunting and disturbances by human (Timmins and Khounboline, 1996). Habitat clearance for shifting cultivation practice was a major problem in the past 35 years ago, while recent problems are non-timber forest product (NTFP) extraction (Timmins and Khounboline, 1996; Walston and Vinton, 1999), selected value tree chopping for timber, and primate hunting, as well as trapping for species like serows *Naemorhedus sumatraensis*, porcupines *Atherurus macrourus* and Stripe-headed Langur *Trachypethecus hatinhensis*. These threats may lead to severe reduction of many key species in Hin Namno NPA for the long run.

2.3.5 Conservation Status

Wildlife inventories were conducted in Hin Namno NPA in 1995 and 1996 through cooperation of the Wildlife Conservation Society (WCS) and the Department of Forestry/Ministry of Agriculture and Forestry (Timmins and Khounboline, 1996).

The World Wildlife Fund for Nature (WWF) did a complete survey in 1999. The WWF Lao Program introduced some management intervention, including land use planning activities to some villages in the area. So far, through a series of dialogue for cooperation, the Agreement and Management Framework with Vietnam for Trans-boundary conservation was made in 2004 for a Cooperative Action Plan 2005–2010. However, the implementation is slow. Right now, the dialogue on establishing International Trans-boundary Natural World Heritage Site, joining Hin Namno and Phong Nha Ke Bang, has been held infrequently. Lastly, IUCN, with funding from UNESCO, has been working with the government of Lao PDR to raise some awareness among decision-makers on the importance of designation and preparation for Hin Namno NPA as a Natural World Heritage Site (NWHS). The designation for NWHS is still in the process, while IUCN Lao has a small project (2009–2010) to develop a co-management of Hin Namno NPA.

2.3.6 Local Community

Approximately 7,240 inhabitants of 22 villages live along the borders of Hin Namno National Protected Area (Table 2.1). They comprise four main ethno-linguistic groups, including the Brou, Makong, Tri, Vietic and Tai-Kadai along with the Phuthai and Salang (Timmins and Khounboline, 1996). Groups of people are mixed, as up to three languages are used in some villages. Based on the characteristics of people and languages, these villages can be classified into two main communities. The first community consists of Ban Dou and Nong Ping, Kha Nyou, Langkhang and Pak Phanang. Most people use Phuthai and Laolum languages with some using Kaluang, Yoy, Makong and Viet. The livelihoods of these villagers rely on paddy

cultivation. The second community includes Thaplao and Nongma located in the southern part of Hin Namno NPA or upper Xebangfai River. People belong mainly to Tri or So ethnic group, Laotheung. Their livelihoods rely on shifting cultivation. The villagers around Hin Namno NPA gain incomes from collecting forest products, hunting wildlife, and collecting and selling scrap metals.

The access to most of these villages is difficult, but all can be reached by land during the dry season and by boat during the wet season (because there are mostly no bridges available for crossing rivers).

Table 2.1 Villages and population in Hin Namno NPA

No	Village	Sub-district	House	HH	pop	Female	Sub-ethnic
1	Tong xang	Ban Dou	54	61	301	157	Yoy
2	Vangmaneu	Ban Dou	58	60	287	154	Phuthai and salang
3	Ban Dou	Ban Dou	86	88	430	225	Phuthai
4	Nong No	Ban Dou	53	56	285	174	Phuthai
5	Nongseng	Ban Dou	44	46	237	129	Phuthai
6	Nongbua	Langkang	82	90	494	272	Yoy
7	Phanob	Langkang	83	88	405	203	Yoy
8	Vangkhon	Langkang	26	25	116	56	Laotheung, Phouthai
9	Seanphan	Kha Nyou	50	52	295	159	Pouthai
10	Kha You	Kha Nyou	130	140	669	366	Kaleung
11	Sa-ang	Kha Nyou	144	128	657	326	Kaleung
12	Nya-wai	Papha-nang	49	56	229	128	Kaleung
13	Nya-wet	Papha-nang	31	41	227	120	Soh
14	NaKha-yom	Nongping	48	54	248	110	Laoloum, Vietic
15	Thasa-at	Nongping	44	48	253	169	Kaleung and Tri
16	Nongping	Nongping	36	42	247	117	Makong
17	Thaplao	Thaplao	49	59	307	162	Tri
18	Ka-I	Thaplao	59	69	293	154	Makong/Tri
19	Thangbeng	Thaplao	42	50	249	105	Makong /Tri
20	Namchala	Nongma	58	70	224	154	Makong/Tri
21	Labouy	Nongma	41	44	267	142	Makong/Tri
22	Nongma	Nongma	92	103	528	273	Makong
	Total		1,359	1,470	7,248	3,855	

Remarks: HH = Household (some house has two or three households), pop = population

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CHAPTER III

RESEARCH METHODOLOGY

3.1 Field Research Procedures

The fieldwork started with village interviews, site selection and transect design (Figure 3.1). The transect walks were designed based on the possibility to make some line transects in different directions–at least two lines per study camp.

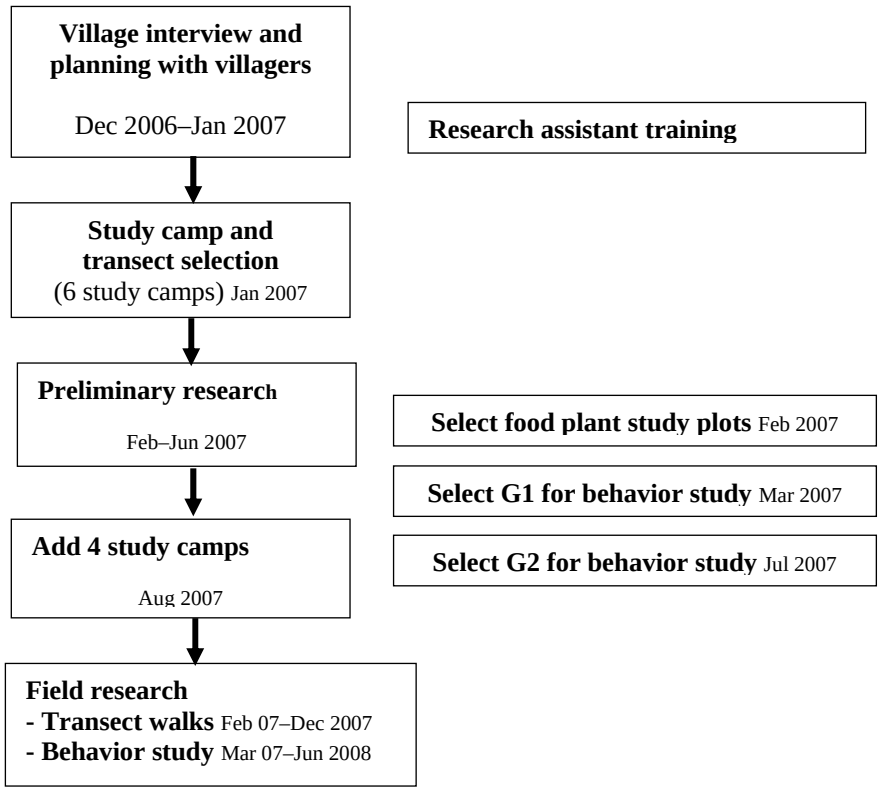

Figure 3.1 Field research procedures

3.2 Village Interviews

Two formal interviews and series of informal interviews were conducted in 10 selected villages of Hin Namno NPA. The villages were Ban Dou, Nongno, Thongxam, Nongseng, Phanob, Nongboua, Vangmaneu, Ban Salang, Nongping, Phathoung and Thaplao. The first eight villages were located in the northern part of the Hin Namno border with Vietnam, and were visited frequently. Preliminary visiting was done in December 2006 to discuss the possibility of transect design and to get some information on primates in the area. The first informal village interviews were conducted in January 2007 to find the status of primates in the area, including their presence and absence, using *A Photographic Guide to Mammals of Thailand and South-East Asia* (Francis, 2000) to help identify animals during the discussions. Also, wildlife threat and current status of wildlife trade in the area were questioned. Key informant hunters were chosen by the village chief for the interviews. The second interview focused on specific information of certain primate species on presence, location, wildlife hunting and trade status, local community use of the site and their opinions on the Hin Namno NPA management. The eight villages close to the Lao – Vietnam border were visited every month for over one and a half year. Other villages adjacent to Hin Namno NPA were visited only at the beginning of the project.

3.3 Description of Study Camps

Ten study camps were selected to study Red-shanked Douc Langur distribution in Hin Namno NPA. These study camps were selected in central and northern part of Hin Namno NPA (Figure 3.2–3.4).

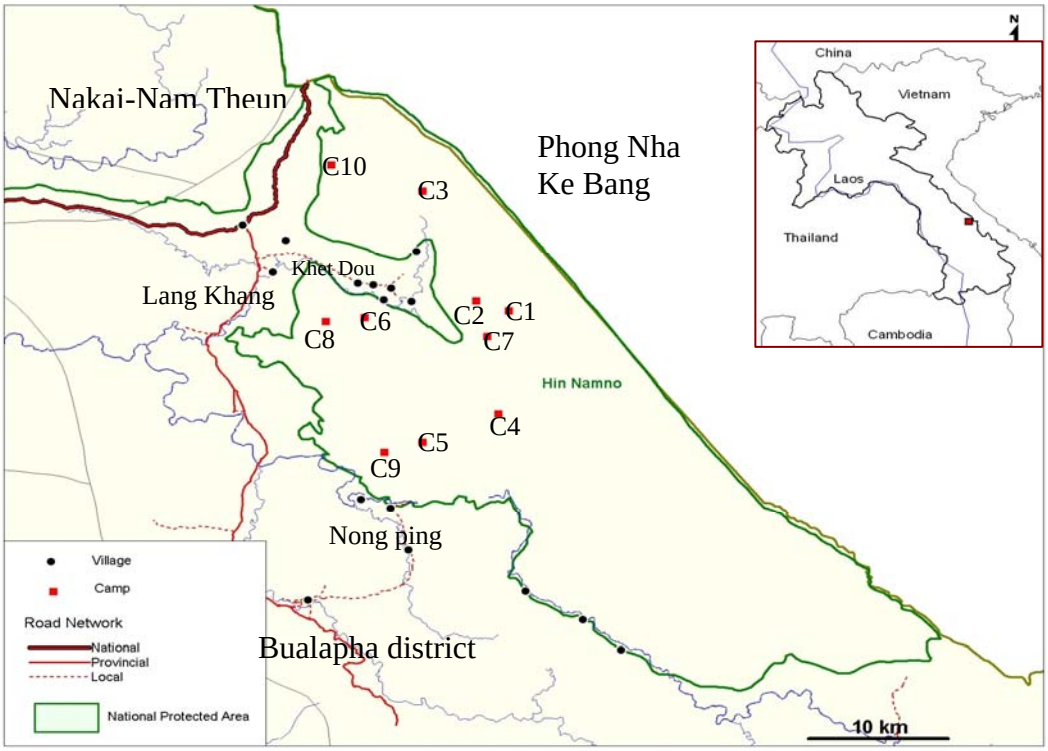

Figure 3.2 Map of the study camps in Hin Namno NPA

Figure 3.3 Study camp no. 5 for Group 1 at Nam Masai in Hin Namno NPA

Figure 3.4 Study camp no. 4 for Group 2 at Nam khoum in Hin Namno NPA

The study camps were selected in areas where transects could be established, with at least two transects of 1 km long (Table 3.1). There were various sub–forest types from the transects (Table 3.2) and the definitions of these forest types are as follow given.

Table 3.1 Description of study camps and transects

No	Name	Longitude	Latitude	Elevation (m)	No. of Lines	Length (km)	Total walk (km)
C1	Kuan Nong	105º50´ 60´´	17º 35´ 69´´	525	2	4.5	13.5
C2	Nong Boun	105º53´ 07´´	17º 30 ´45´´	523	3	6.3	18.9
C3	Kuane Thalee	105º 51´ 05´´	17º 35´ 23´´	384	2	4.3	12.9
C4	Nam Khoum	105º 53´ 62´´	17º 26´ 18´´	362	3	5.9	17.7
C5	Nam Masai	105º 50´ 58´´	17º 24´ 99´´	299	3	5.7	17.1
C6	Kuane Thoun	105º 48´ 24´´	17º 30´ 29´´	364	2	3.5	10.5
C7	Kuane Khing	105º 53´ 18´´	17º 29´ 48´´	506	3	5.2	15.6
C8	Nong Luang	105º 46´ 67´´	17º 30´ 12´´	319	3	5.0	15.0
C9	Nong Ban Na	105º 49´ 05´´	17º 24´ 57´´	247	2	3.2	09.6
C10	Phou Chuang	105º 46´ 91´´	17º 36´ 80´´	727	2	4.0	12.0
	Total				25	47.6	142.8

Table 3.2 Percentage of sub-forest types in transects

Sub-forest type	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Evergreen	67.8	42.9	30.2	58.9	46.8	54.3	92.7	57.9	40.6	23.0
Hill Evergreen	20.0	35.7	48.8	16.1	8.1	40.0	11.5		59.4	
Dry Evergreen								42.1		
Semi-Evergreen				3.6	14.5		5.8			
Moist Evergreen				5.4						
Mixed Deciduous	12.2	11.1	4.7	10.7	25.8					45.0
Montane forest										33.0
Bamboo		8.7	4.7	1.8		5.7				
Secondary forest		1.6	11.6	3.6	4.8					

Definitions of sub-forest types

- *Evergreen forest*: multi–storied, 80% evergreen, growing on gentle slopes with dominant tree families of Padocarpaceae, Myrtaceae, Arecaceae and Fagaceae.
- *Hill evergreen forest*: small and medium trees have green leaves and grow in hills and on higher slopes.
- *Dry evergreen forest*: most trees loose their leaves at the end of the dry season; dominant species are mainly *Lagerstroemia* spp. (Lythraceae).
- *Semi-evergreen forest*: the sub–forest type in which only some trees loose their leaves during the end of dry season while other trees have green leaves year–round.
- *Moist evergreen*: short trees, green and bright leaves located in dampened areas.
- *Mixed Deciduous forest*: less than 70% of tree species are deciduous (some of the trees loose their leaves during the end of dry season or before spring season).

- *Montane forest*: evergreen forest found at over 700 m a.s.l. in non-limestone habitats.
- *Bamboo forest*: primarily made up of bamboo, predominantly *Bambusa* species.
- *Secondary forest*: regrowth of trees after shifting cultivation, with more dense understories.

3.4 Population Estimate

Ten study sites were selected in the study area, especially in the more-accessible central and north Hin Namno NPA. Each study site had 2 or 3 line transects. The length of each transect ranged from 1.2–2.7 km. A total of 25 transects were designed with a total length of 47.6 km. The average number of transect lines and transect lengths per camp was 2.5 lines and 4.76 km (ranging from 3.2–6.3 km).

Each transect was walked three times every two to three months resulting in total 142.8 km of transect walks (Table 3.1). Since the study sites were difficult to access and it was often impossible to make a straight line due to limestone dominance, neither Whitesides method (Whitesides *et al*., 1988) nor Struhsaker method (Struhsaker, 1981) were appropriate for this study. The Occupancy method (Mackenzie *et al.*, 2002) was possible, but it did not provide a density and it required a great quantity of labor. Therefore, the modified-line transect sampling (MLTS) method for censusing primate on limestone by Li and Rogers (2007) was applied for this study because bearing was not required for curve lines. Details of the equation are below.

$$N = G * Mg$$

$$G = Dg * A$$

$$Dg = \frac{m \pm CL}{a}$$

$$m = \frac{X_1 + X_2 + ...X_i}{n}$$

$$cl = t_{0.05}(n-1) * \frac{S}{\sqrt{n}}$$

$$\%\, precision = \frac{CL}{m} * 100$$

$$s = \sqrt{\frac{\sum x^2 - \frac{\left(\sum x\right)^2}{n}}{n-1}}$$

Legends

N	=	Estimate of population size
G	=	Total number of groups
Mg	=	Mean group size
Dg	=	Group density estimate
A	=	Total area
m	=	Mean frequency of group encounters
CL	=	95% confidence limits
a	=	Sample area
n	=	Number of repeat surveys of transects
X	=	Number of groups encountered on a single transect
S	=	Standard deviation of group encounters frequency

i ranges from 1 – x where $t_{0.05}$ was the 2 tailed value of it in students' distribution when $p < 0.05$ and the degree of freedom (df) is $n - 1$.

All line transects were marked every 50 m. Each transect was designed in different directions from the study camp crossing different habitats, starting at least 500 m from the camp. Due to the hilly terrain, curve transect lines were accepted but each transect would keep an approximate direction throughout. The transect walks were conducted in the morning between 7.30 A.M. and 11.30 A.M., in good weather with walking speed at 0.7–1 km/hr. During the walk, data were recorded, including time of animal encounters, primate species, number of animals seen, estimates and location. At each encounter, the number of animals recorded included the number of unseen animals which was estimated based on the sight of moving trees and the given form was used for this (Appendix A–A1). Rangefinder was used to find distance from

an observer to animals, and a compass and GPS were used to determine the location of the animals. Observations were discontinued after a maximum of 10 minutes (Altmann, 1974).

The transect walks were carried out between February and December 2007, mostly by one team and occasionally by two teams in different transects at the same time each morning. Each team consisted of 2–3 people having one principal researcher or one trained staff. The total time spent for transect work was 81 days or 276 man-days. Four new study camps (C7 Kuane Khing, C8 Nong Luang, C9 Nong Banna and C10 Phou Chuang) were added in August 2007 after the preliminary research was completed. Still, all these transects were conducted three times.

3.5 Behavior Study

Two Red-shanked Douc Langur groups were selected and observed every month at the study camp 4 and 5. Group 1 (G1) lived near study camp 5–Nam Masai and Group 2 (G2) near study camp 4–Nam Khoum (Figure 3.5 and 3.6). The distance between the study camp 5 and 4 is 5 km apart from each other. The two study camps have a large flat ground and only some limestone hills found in scatter. Therefore, we had followed the study animals easier in these camps.

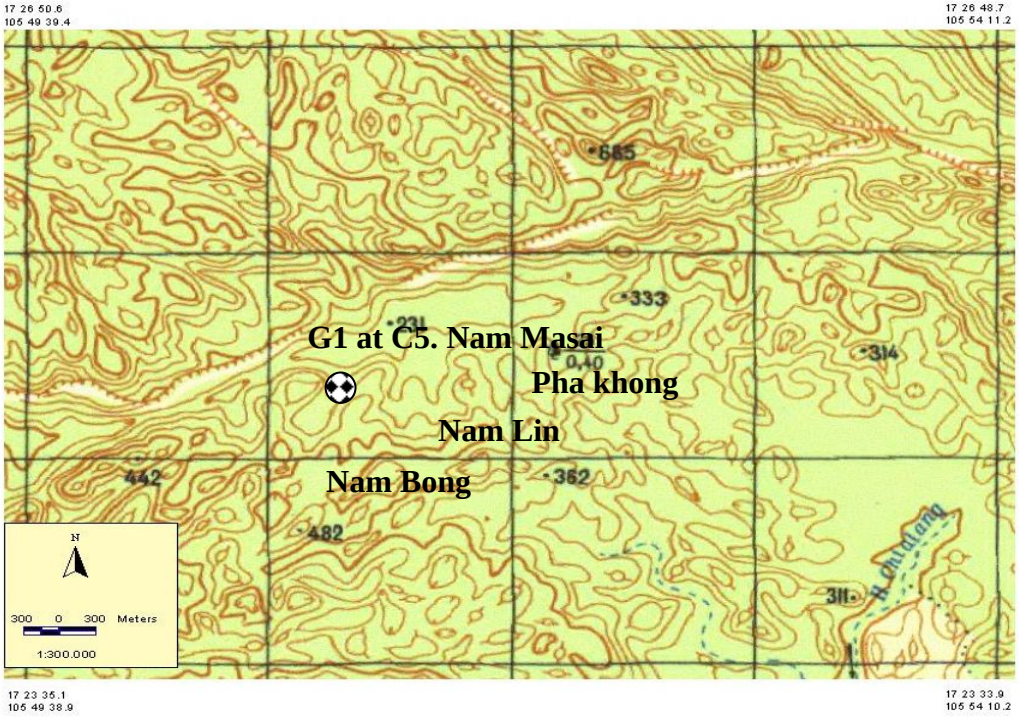

Figure 3.5 Location of G1 at C5 Nam Masai study camp

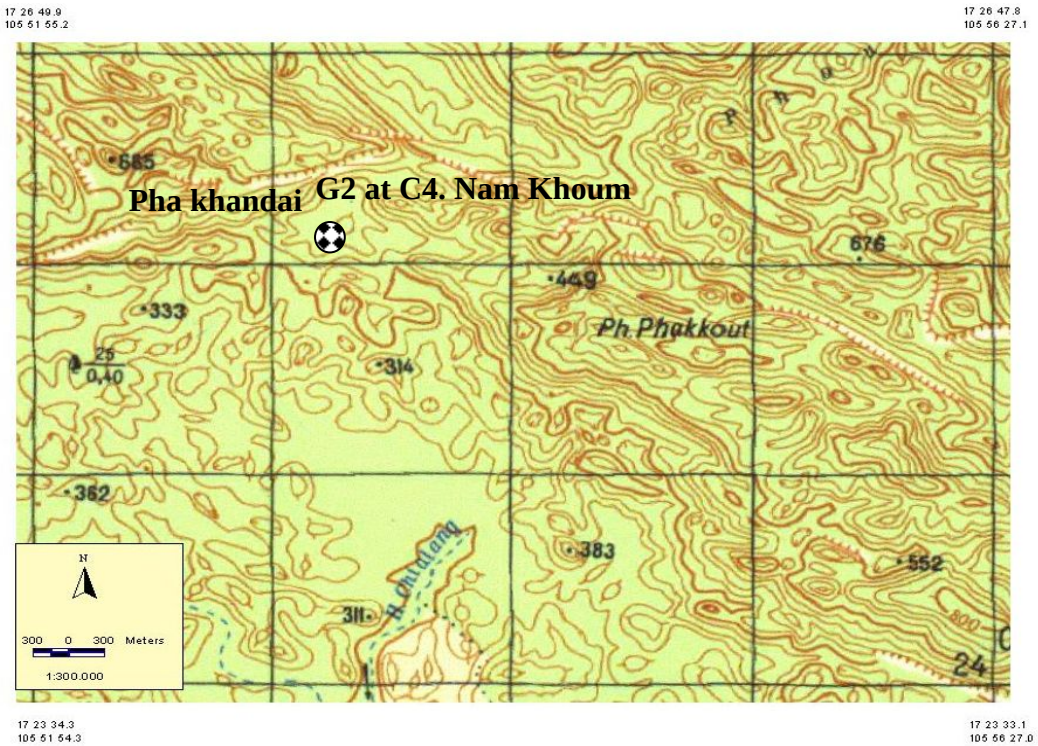

Figure 3.6 Location of G2 at C4 Nam Khoum study camp

The study groups were not habituated because of the ongoing hunting activity in the areas; therefore the observations could be conducted as long as the observers were not detected. Scan sampling (Altmann, 1974) was used from March 2007 through June 2008 at an average distance of 27 m. Sometimes, the animals were observed as close as 10 m during the wet season. They were not so afraid after the research team had followed the groups for weeks. When the animals detected the research team, they moved only 100 m away.

Observations usually took place from 7.30 A.M. to 5 P.M. and from dawn to dusk for the days that the group home range was examined. The scan sampling technique was used and lasted 10 minutes for every 30 minutes (Appendix A–A2, A3)

Definitions of animal behavioral activity

The following definitions are modified from Koenig *et al*. (2007).

- *Foraging*: animal is searching, selecting, pulling and processing food.
- *Feeding*: putting food from hand to mouth or chewing.
- *Monitoring*: animal is looking or staring in one direction, the body appears tense.
- *Vocalizing*: animal produces a call that is heard at some distance.
- *Grooming*: cleaning the fur of a group member with the hands or the mouth.
- *Social*: behavior in an individual due to its interaction with other members of the group.
- *Inactive*: animal pauses from feeding as to listen to something (particularly be aware of danger, sleep is excluded from this category).
- *Sleeping*: an animal is sitting with eyes closed with hands grasping trees.
- *Traveling*: locomotion including jumping.

Group composition, home range and group marks

The animals were classified into 5 age-sex classes: Infant (IF), juvenile (JU), sub-adult (SA), adult female (AF) and adult male (AM). The infant is the animal with an age less than 1.5 year old.

Group 1 had 19 individuals in March 2007. The group consisted of 5 males and 10 females with 4 infants (Table 3.3). The infants were excluded from sex identification because it was difficult to distinguish. There were 2 adult males, 4 adult females, 5 sub-adults, 4 juveniles and 4 infants. The group home range was in upper Ban Na flat ground around Houy Han Xang and Phou Pha Khong during wet season. Phou Pha Khong was the limestone place where they escaped when faced with threats. During the dry season, they lived in Houy Nam Lin and Nam Bong. The most important identification of this group was one adult female with a birth mark on left cheek. In March 2007, she was pregnant and gave birth in June 2007.

Group 2 had 39 individuals in July 2007. This group consisted of 13 males and 20 females and 6 infants. The group had 4 adult males, 7 adult females, 10 sub-adults, 12 juveniles and 6 Infants. This group increased from 39 animals in July 2007 to 47 individuals in July 2008. The main area that the group lived was 500 m from the C4–Nam Khoun study camp. During the dry season, they mainly lived around Phou Pako valleys, while in the wet season they descended to lower areas. For identification, one adult male had long white whiskers and another adult male had a red spot on his chin. It is quite easy to remember this group because it is only the largest group found in the area.

Table 3.3 The age class composition of Group 1 and 2 from March 2007–July 2008

	Group 1							Group 2						
	Total	AM	AF	SA	JU	IF	New born	Total	AM	AF	SA	JU	IF	New born
2007														
Mar	19	2	4	5	4	4								
Apr	19	2	4	5	4	4								
May	19	2	4	4	4	5	1							
Jun	19	2	4	4	4	5								
Jul	17	2	3	4	3	5		39	4	7	10	12	6	2
Aug	17	2	3	2	4	6	1	41	4	7	9	13	8	2
Sep	18	2	3	2	4	7	2	44	4	7	10	13	10	1
Oct	18	2	3	2	4	7		45	5	9				
Nov	17	2	3	2	4	6		27	3	5	6	8	5	1
Dec	17	2	3	2	4	6		26	3	6	7	4	6	
2008														
Jan	17	2	3	2	4	6		19	2	5	5	4	3	
Feb	16	2	3	2	4	6		21	2	5	4	4	6	1
Mar	16	2	3	2	4	6		22	3	5	5	4	5	
Apr	17	1	3	3	4	6		25	3	6	5	5	6	1
May	17	1	3	3	4	6		25	3	6	5	5	6	
Jun	21	2	3	5	5	6		36	4	7	8		9	3
Jul	20	2	4	3	4	7	1	47	5	9	10	12	10	2
							5							13

AM = adult male, AF = adult female, SA = sub-adult, JU = juvenile, IF = Infant

Remarks: infant number here, including the newborns, was recorded during the study.

3.6 Food Plant Study

A total of six 50x50 m^2 plots were designed at C1 (plot 1), C2 (plot 2), C6 (plot 3), C4 (plot 4), C5 (plot 5 and 6) in February 2007. Each plot was divided into 25 smaller 10x10 m^2 blocks and all trees with 10 cm or more diameters at breast height (DBH) were measured. The measurements included tree size, height and canopy, which were determined with a rangefinder and measuring tape. Tree specimens were collected and labeled with the tree number and local name. The specimens were coded, then sent to identify at Kasetsart University in Thailand. Phenology of three plant plots at study camp 4 and study camp 5 were monitored for flowering and fruiting, especially for trees used by Red-shanked Douc Langurs. The

food plants were monitored based on the plant species previously observed being used by the animals. Where possible, leaves and fruits were photographed.

3.7 Climate Study

Both temperature and rainfall data were collected at Vangmaneu village. A barometer was used for min/max temperature recording and a 90 mm rain gauge was used for rainfall collection. One villager was hired for recording the data throughout the year from March 2007 to February 2008. Thermometer was checked every day in the morning at 7 A.M. to record the minimum and maximum temperature. The rain gauge was installed in the open area nearby; however, if heavy rain occurred, more frequent checking was conducted.

3.8 Threat Study

During the transect walks, evidence of hunting, such as man with a gun or cross bow, and camps were noted as human disturbance (including people, camp fire, and snare lines). Habitat loss was recorded when finding logs/logging or finding people felling trees. Villager interviews on wildlife use and wildlife trade status in the area, as well as the Hin Namno management practice of local villagers, were also carried out during the first two weeks of the preliminary research in December 2006 and January 2007. Discussions focusing on wildlife hunting and trade took place with local hunters and village chiefs. Guidebooks were used to identify mammals (Francis, 2000), birds (Svengsuksa *et al*., 2003) and turtles (Stuart *et al*., 2001). Any evidence of wildlife threats found in the village were recorded, especially the number of wildlife traders, wild animals caught and wildlife products such as bones and organs.

Meanwhile, logbooks were recorded secretly by contact persons in the selected villages from February 2007 to March 2008. Ten villages were involved in this practice, but only 6 villages completed it.

3.9 Research Participants

In this research, Thirty–six Government officials and villagers were involved with 26 village assistants (mainly village militia and hunters), 3 officials and 7 logistic assistants (Appendix B). About 2–3 villagers per time were assigned by their village chief in rotation. One villager from Ban Vangmaneu was hired full-time for collecting climatic data throughout the year from March 2007 to February 2008.

3.10 Time Used for the Research Activity

Total research time, including photographing and additional work, was 1.8 years from December 2006 to August 2008. Total days used for the entire project was 321 days or 1,168 man–days. Time spent in the forest was 238 days (74.14% of all time engaged in the research). The rest of the time was used to work in villages, districts, traveling and photographing. The time used for distribution study was 81 days (25.23%), with 128 days (50.46%) for behavior study and 78 days (24.29%) for other studies. Additional time was used to interview local hunters. The remaining time was used for plant plot study and traveling in the forest.

Two groups 0f Red-shanked Douc Langur were studied for 128 days (717.5 hours) for the behavior study, with 162 days of effort. The observations took 2.5–9.3 hours per day (average 5.4 hour per day), for 3–7 days a month per group (average 4.6 days per month). However, it was less in April and May due to the increased

sensitivity of the animals to people. For the total 128 days used for the behavior study, 97 days (59.9%) were used for G1 while 65 days (40.1%) were used for G2. Number of detection days was 73, out of 97 total effort days for G1 (382.5 hours) and 54 days out of 65 total effort days for G2 (338 hours).

3.11 Materials and Equipments

Equipments included a topography map (1:50,000), two Garmin *E-trek* Global Positioning System (GPS) units, three "Nikon and Discovery" binocular units, one 10x50 and two 7x18 capacity units, a rangefinder (Bushnell), a compass (Suunto), a video camera (Sony), a regular camera (canon), a digital camera (Fiji), a tape recorder (Sony), film (Kodak), batteries (Panasonic), tents, hammocks and sleeping bags. Additional items included flash lights, candles, lighters, an alarm clock, plastic bags, tapes (50m and 5m), a ruler (30cm), line transect markers, strings, a thermometer (Min/Max), rainfall data logger, newspapers for plant specimen collection, plastic bags, medicine and rubber bands. As well as data recording forms, plastic sheets, notebooks, waterproof pens, were used.

3.12 Data Analysis

Data for distribution study were calculated using the modified-line transect sampling (MLTS) method by Li and Rogers (2007) for censusing primate on limestone. Data of the species were shown in group density per km^2, number of a total group and population estimates especially in the central and northern Hin Namno NPA. In order to obtain the density there is a need to identify the sample area (a value) and the potential habitat. The sample area (a = 2.66 km^2) for the equation

which was identified from the cutting point of the group encounters with the accepted detection width of the transect (= 0.056 km) and for the transect length (= 46.7 km). The potential habitat of the species (206 km^2) was identified and that mostly located in the central and northern Hin Namno NPA. The potential habitat was determined based on the criteria (i) habitat type suitability; (ii) distance from human settlement/threat pressure, (iii) animal encounters and (iv) hill slope. Then, calculation for population of the species requires to have a group size average based on the total population estimates (14.96 animals). The population was shown in minimum and maximum values.

Meanwhile, density of the species among the study camps was calculated in group per km^2. The comparison of the species between the wet and dry season was shown based on the number of encounter during each season period. In addition, the analysis was to compare a distance in kilometers from the nearest villages and the Lao-Vietnam border as the parameter influencing the density of the Red-shanked Douc Langur.

Also, the comparison of group density of 6 primate species found in the same transects with Red-shanked Douc Langur study was reckoned per km walk because the encounter rate of some primate species was low which is not applicable for the equation of Li and Rogers (2007).

The behavior observation data was estimated for time budget of the animals in dry and wet season to find the differences between the two study groups. Although, the study examined 5 age-classes of the animal, only behavior of adults (adult male, adult female and sub-adult) was used for this analysis. A time count period of 30-minute intervals was used as one unit number and one time for one animal. *t*-test was

used for analysis using SPSS program version 12 for Windows when p value < 0.05 is significant.

Six plant plots were studied in order to understand the density of food trees associated with the habitats in the area. Frequency and density were analyzed. In addition, food plants used most by the animals were recorded from direct observation and shown in percentages.

Evidence of threats were recorded from the same transect walk, arranged and shown. Information of study camps, such as distance from the study camps to Lao – Vietnam border and local communities, were also obtained if the numbers found from each camp reflected the distance. In addition, the relationships of wildlife hunting, trade and crop season were analyzed using SPSS version 12 for Windows and analyzed in Spearman correlation. It was found to be significant $p<0.05$ of 2-tailed significance.

3.13 References

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CHAPTER IV

POPULATION AND DISTRIBUTION OF RED-SHANKED DOUC LANGUR IN HIN NAMNO NATIONAL PROTECTED AREA, LAO PDR

4.1 Abstract

The line transect survey of Red-shanked Douc Langurs was conducted over a total walked length of 142.8 km in Hin Namno National Protected Area between January and December 2007. It is a limestone habitat, an area of 820 km^2 located in Bualapha district, Khammouane Province. We found a total of 46 groups, 450 animals seen with 668 estimated animals. The group density is 5.8±4.7 group km^{-2} with a total of 17,765 individuals in the Hin Namno NPA. The species found was not specific to limestone, they were found most in hill evergreen forest (48.15% of the total group encounters), evergreen forest (35.5%) and mixed deciduous forest (14%). During the dry season, they spent most time in hill evergreen forests (58.8%) at an average elevation of 464 m above sea level, ranging up to 653 m. During the wet season, they used evergreen forest for 42% in lower areas or around foothills at an average elevation of 380 m a.s.l. The study camps located as far as 10 km from any settlement, especially from the Lao-Vietnam border, as well as in areas supporting larger flat grounds, have higher group densities. The group density per km^{-2} ranged from 1.3–14.0 and was highest at the study camp C4 (14.), C7 (9.7) and C5 (9.0).

4.2 Introduction

Hin Namno National Protected Area (NPA) connects to Phong Nha Kebang Natural World Heritage Site in Vietnam. The connection makes the largest limestone karst in Southeast Asia under protection (Timmins and Khounboline, 1996). This place is significant for primate conservation, especially for the Red-shanked Douc Langur *Pygathrix nemaeus* and the Stripe-headed Black Langur *Trachypithecus hatinhensis.* (Timmins and Khounboline, 1996; Timmins and Duckworth, 1999; Walston and Vinton, 1999; Duckworth *et al*., 1999).

Red-shanked Douc Langur *Pygathrix nemaeus* is considered high priority for conservation need. It is classified in the Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1975) and endangered species of IUCN Red list (IUCN, 2008) and Category I status in Laos. However, hunting of this species is still observed today in Lao PDR. Human pressures through hunting and over-harvesting of forest products by outsiders encroaching is highly alarming for its impact on the population of Red-shanked Douc Langur in Hin Namno NPA (Timmins and Khounboline, 1996; Walston and Vinton, 1999). Only a few studies of Red-shanked Douc Langurs have been conducted in Vietnam (Lippold, 1998; Pham *et al*., 2000), mainly only about the diets and general distribution of the species (Lippold and Vu, 1995; Pham, 1993).

Understanding the distribution and density of Red-shanked Douc Langur is important for the species conservation and a need to use the species as flagship species for making a zone for biodiversity conservation. Therefore, the objective for this study is to determine the distribution and densities of Red-shanked Douc Langur in Hin Namno NPA, Khammouane Province in Lao PDR. The results would be

baseline data for over-time monitoring of changes in distribution and density of the species in Hin Namno NPA.

4.3 Methodology

4.3.1 Study Area

Hin Namno National Protected Area (820 km^2) is located in Bualapha district, Khammouane Province, which joins with Phong Nha Ke Bang Natural World Heritage Site in Vietnam (Figure 4.1). It is situated at latitude 17º15'–40' N and longitude 105° 43'–106° 09' E, with altitude ranging from 200 m to over 1,000 m above sea level (a.s.l.). The climate data of the study area recorded from March 2007 to February 2008–the annual rainfall is 1,480 mm, with the rainy season extending from the end of May to the end of October. The average annual temperature is 25.7°C (average ranged from 11–40°C). Total human population living adjacent to the area consists of 7,240 inhabitants from 22 villages.

The majority of the area is limestone karst on the top of hills and mountains, which covers about 90% of the entire Hin Namno NPA and is mostly considered as type I limestone (Li and Rogers, 2007). The area has a range of vegetation and is covered from bare rock to shrubby forest, with flat lowlands broken by sporadic karst outcrops and scattered areas of large rock piles. The flat lowlands, especially found in central and some northern Hin Namno NPA, are covered with tall closed canopy evergreen forest, hill evergreen forest and mixed deciduous forests (Timmins and Khounboline, 1996).

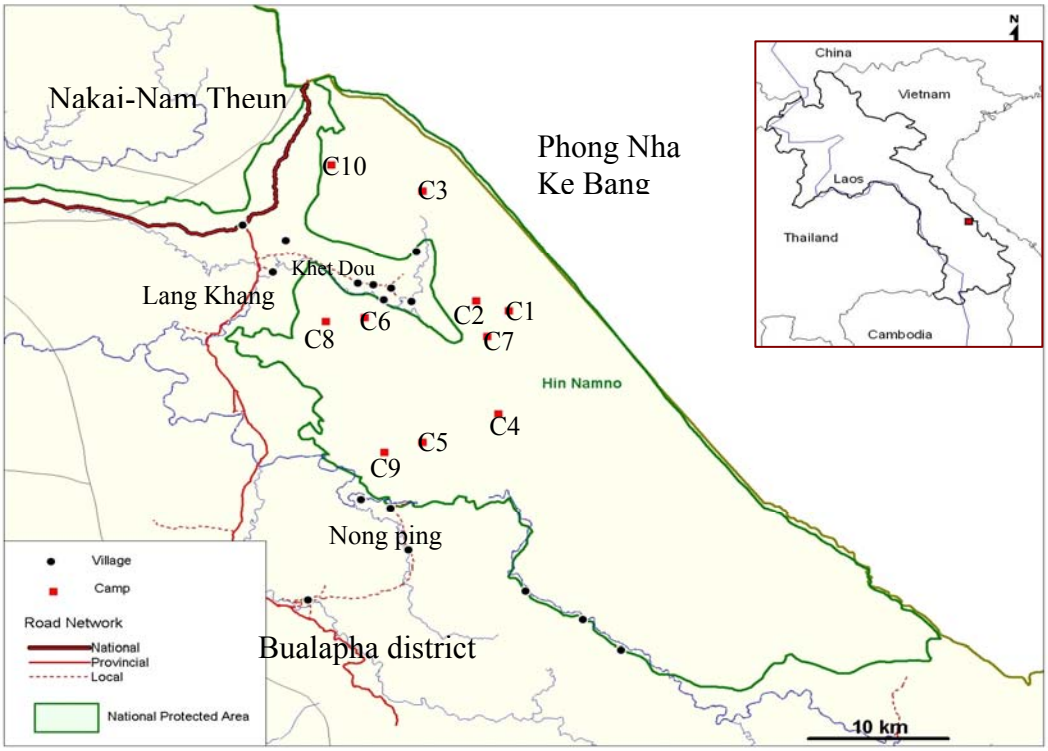

Figure 4.1 Location of study camps and transects in Hin Namno NPA

4.3.2 Transect Design

Ten study camps were selected only in the northern and central parts of Hin Namno NPA becausethe research was not allowed in southern Hin Namno NPA. Each study camp had 2 or 3 line transects at an average altitude of the study camp, (Figure 4.1 and Table 4.1).

Each transect direction headed to the west, south and north from the study camp crossing different habitats, starting at least 500 m away from the camp. Due to the hilly terrain (type I), curve transect lines were accepted, but each transect would keep an approximate direction throughout. The length of each transect ranged from 1.2–2.7 km. A total of 25 transects were designed with a total length of 47.6 km (average transect length 1.9 km). Average number of transect lines and transect length per study camp were 2.5 lines and 4.8 km (ranging from 3.2–6.3 km). The data were

also analyzed to see how animal density differed between distance to the study camp and the distance from the local communities or the Lao-Vietnamese border.

Table 4.1 Description of study camps and transects for distribution study

No	Name	GPS Coordinates		Dist. from nearest settlements (km)		Avr Elev	No. Line	km walk
		Latitude	Longitude	Village	Viet.			
C1	Kuane Nong	17º 35´ 69´´	105º50´ 60´´	7.4	3.9	525	2	13.5
C2	Nong Boun	17º 30 ´45´´	105º53´ 07´´	5.0	5.6	523	3	18.9
C3	Thalee	17º 35´ 23´´	105º 51´ 05´´	5.5	3.5	386	2	12.9
C4	Nam Khoum	17º 26´ 18´´	105º 53´ 62´´	9.0	10	362	3	17.7
C5	Nam Masai	17º 24´ 99´´	105º 50´ 58´´	5.2	21	299	3	17.1
C6	Kuane Thoun	17º 30´ 29´´	105º 48´ 24´´	3.5	15.5	364	2	10.5
C7	Kuane King	17º 29´ 48´´	105º 53´ 18´´	4.8	7.0	506	3	15.6
C8	Nong Luang	17º 30´ 12´´	105º 46´ 67´´	5.0	14.7	319	3	15.0
C9	Nong Ban Na	17º 24´ 57´´	105º 49´ 05´´	4.5	18	247	2	9.6
C10	Phou Chuang	17º 36´ 80´´	105º 46´ 91´´	5.4	5.8	727	2	12.0
	Total					420.6	25	142.8

These transects were walked three times 2 to 3 months apart from February to December 2007, resulting in a total of 142.8 km walked. The transect walks were conducted in the mornings between 7.30 A.M. and 11.30 A.M. in good weather, with walking speed at 0.7 to 1 km/hr.

During the walk, data including time of animal encounters, primate species, number of animals seen, number of animal estimates and locations of those encounters were recorded. Animals were presumed when movement in trees occurred. The number of animal estimates for each encounter was therefore the total animal estimate added to the animals actually seen. A Rangefinder was used to find the distance from an observer to the animals, and a compass and GPS were used to determine the location of the animals. The team stopped at every 200 meters to look

for animals, and observations were discontinued after 10 minutes before restarting another period (Altmann, 1974). The transect walks were carried out mostly by one team, but occasionally by two teams in different transect lines. Each team consisted of 2–3 people, with one principal researcher or one trained staff. Total time spent for transect work was 81 days or 276 man-days.

Since the study area is difficult to access and impossible to make a straight line due to hilly limestone dominance, neither Whitesides (Whitesides *et al*., 1988) nor Struhsaker methods (Struhsaker, 1981) were appropriate for primate study on limestone. The Occupancy method does not show a density (MacKenzie *et al*., 2002). Therefore, the modified-line transect sampling (MLTS) method for censusing primate on limestone (Li and Rogers, 2007) was applied for this study because this method bearing was not required for curve line transect. A sample area and the data analysis were slightly modified, in which the sample area used based on the accepted detection width of transect times the total lengths of the transect walks.

4.3.3 Population and Density Calculation

Data for the distribution study of Red-shanked Douc Langur were analyzed using the modified-line transect sampling (MLTS) method by Li and Rogers (2007) for censusing primate on limestone. Obtaining a density group (*Dg)* of the study animal required to have the mean frequency of group encounter (*m*), the value of confidence limits (*CL*) and the sample area (*a*). The sample area was quantified based on the total number of km walked and a width of the line transect of animal detection. The confidence limits (*CL*), were calculated where $t_{0.05\,(n-1)}$ was the 2-tailed value of *t*

in Student's distribution when $p \leq 0.05$ and the degrees of freedom were n –1. Details of the equation by Li and Rogers (2007) are below.

$$N = G * Mg$$

$$G = Dg * A$$

$$Dg = \frac{m \pm CL}{a}$$

$$m = \frac{X_1 + X_2 + \ldots X_i}{n}$$

$$cl = t_{0.05}(n-1) * \frac{S}{\sqrt{n}}$$

$$\%\, precision = \frac{CL}{m} * 100$$

$$s = \sqrt{\frac{\sum x^2 - \frac{\left(\sum x\right)^2}{n}}{n-1}}$$

Legends

N	=	Estimate of population size
G	=	Total number of groups
Mg	=	Mean group size
Dg	=	Group density estimate
A	=	Total area
m	=	Mean frequency of group encounters
CL	=	95% confidence limits
a	=	Sample area
n	=	Number of repeat surveys of transect
X	=	Number of groups encountered on a single transect
S	=	Standard deviation of group encounters frequency

i ranges from 1 – x where $t_{0.05}$ was the 2 tailed value of it in students' distribution when $p < 0.05$ and the degree of freedom (df) is $n - 1$.

The Standard deviation (STDEV) of encounter frequency of the douc langur was required for *CL* figuration, and was calculated where x was the number of douc langur groups encountered at a single study camp. Then the *Dg* value was used to calculate the total group number of the animals studied by multiplying by the total area of Hin Namno NPA (820 km^2). However, only 206 km^2 in the central and northern Hin Namno NPA as suitable habitat for the animal (Figure 4.2).

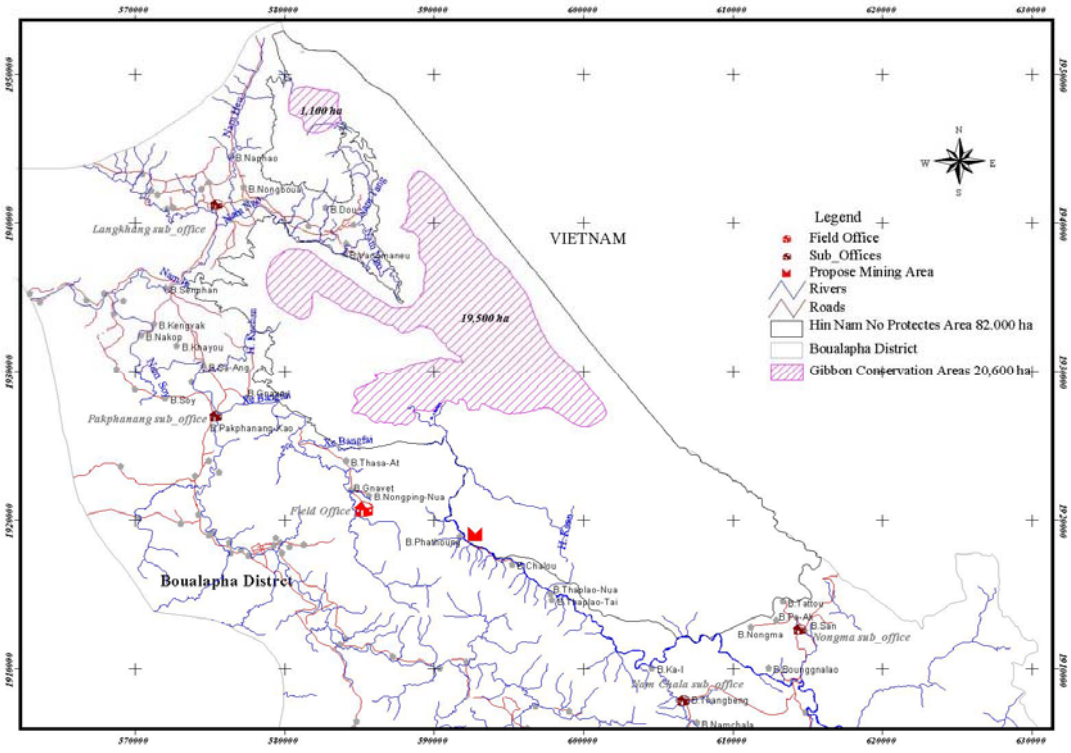

Figure 4.2 Potential habitat of Red-shanked Douc Langur in Hin Namno NPA.

The potential habitat was determined based on the criteria (i) habitat type suitability; (ii) distance from human settlement/threat pressure; animal encounters and (iv) hill slope. Therefore the total population (*N*) of the study animal was quantified the suitable area by the total group number (*Dg*). For this purpose, the sample area (a = 2.66 km^2) for the equation which was identified from the cutting point of the group encounters with the accepted detection width of the transect (= 0.056 km) and for the transect length (= 46.7 km).

For an average group size (*Mg*), the number of animal estimates was calculated based on the group size 14.96 groups km^{-2} from population estimates (ranged from 3–45 douc langurs per group, n = 46) because the research team was unable to count all animals at each encounter.

Meanwhile, density of the species between the study camps was found in accordance with the value of group density km^2. Also, comparison of the species found between the wet and the dry season was shown based on the number of encounters found during each season period. Habitat used by the Red-shanked Douc Langur was based on the number of encounters found from the transect and per season months. In addition, qualitative assessment was made on parameter for obtaining which the density influenced the Red-shanked Douc Langur.

4.4 Results

As much as 142.8 km were walked, 46 groups of 450 animals were seen with 688 total animal estimates. From the application of the modified-line transect sampling (MLTS) method by Li and Rogers (2007) the result of the group density of Red-shanked Douc Langur was 5.8±4.7 group km^{-2} (mean = 1.53, STDEV = 1.29) (Table 4.2). The density value was used to compute a total group of the species in Hin Namno (1,187±968 groups, ranging 219–2,155 groups), and then the total population in Hin Namno NPA was estimated 17,765±14,481 animals, ranging 3,276–32,238 animals. The number of encounters and population of the species found in each study camp were different. The group density km^{-2} ranged from 1.3 – 14.0 and was highest at the study camp C4 (14.0), C7 (9.7) and C5 (9.0).

Table 4.2 Population of Red-shanked Douc Langur in different study camps

Study camp	Line no	Grp by repeats			Variable					Per line	Per study camp
		1	2	3	a (km^2)	s (STDEV)	m	CL	% precision	*D*g (g km^{-2})	*D*g (g km^{-2})
C1											4.1±
	1	2	0	0	0.16	1.15	0.70	2.90	340.3	3.90	
	2	1	0	0	0.08	0.58	0.30	1.40	430.0	4.17	
C2											3.0±
	3	2	0	1	0.11	1.00	1.00	2.50	248.0	9.10	
	4	0	0	0	0.07	0.00	0.00	0.00	0.0	0.00	
	5	0	0	0	0.17	0.00	0.00	0.00	0.0	0.00	
C3											4.3±
	6	1	0	1	0.17	0.60	0.70	1.40	215.2	3.92	
	7	1	0	0	0.07	0.60	0.30	1.40	430.0	4.76	
C4											14.0±
	8	2	2	2	0.07	0.00	2.00	0.00	0.0	28.60	
	9	0	0	2	0.15	1.15	0.70	2.90	430.0	4.44	
	10	0	1	2	0.11	1.00	1.00	2.50	248.0	9.09	
C5											9.0±
	11	0	1	3	0.13	1.15	1.30	3.80	284.6	10.03	
	12	3	0	1	0.11	1.15	1.30	3.80	285.0	12.10	
	13	0	0	1	0.07	0.58	0.30	1.40	430.0	4.76	
C6											5.7±
	14	0	1	0	0.11	0.58	0.30	1.40	430.0	3.03	
	15	0	1	1	0.08	0.58	0.70	1.40	215.0	8.33	
C7											9.7±
	16	0	1	0	0.07	0.58	0.30	1.40	430.0	4.76	
	17	3	1	1	0.14	1.15	1.70	2.90	172.0	11.90	
	18	2	1	0	0.08	1.00	1.00	2.50	248.0	12.50	
C8											2.8±
	19	1	0	0	0.07	0.58	0.30	1.40	430.0	4.76	
	20	1	0	1	0.1	0.58	0.70	1.40	215.2	6.67	
	21	0	0	0	0.11	0.00	0.00	0.00	0.00	0.00	
C9											2.1±
	22	0	0	0	0.1	0.00	0.00	0.00	0.00	0.00	
	23	1	0	0	0.08	0.58	0.30	1.40	430.00	4.17	
C10											1.3±
	24	0	0	0	0.09	0.00	0.00	0.00	0.00	0.00	
	25	0	1	0	0.13	0.58	0.30	1.40	430.00	2.56	
Total	25	20	10	16	2.66	1.29	1.53	1.52	133.62		
Density *D*g (g km^{-2})											5.8±4.7
Total group (G)											1,187±968
Total population (N)											17,765±14,481

Only a few groups of Red-shanked Douc Langur were found near the study camps, which were close to the Lao-Vietnam border (Table 4.1). From three visits to these areas, a low group density per km^2 were noted, such as C10 (1.3), C9 (2.1), C2

(2.8) and C3 (3.0). However, in most of the study camps far from the border, except C9, the highest density of the Red-shanked Douc Langur was found including C4 (14.0), C7 (9.7), C5 (9.0) and C6 (5.7). In particular, C7 just 4.5 km away from the Ban Salang had the second highest density of the Red-shanked Douc Langur in Hin Namno NPA. C9, close to the Vietic community of Ban Nave, had the lowest density.

Although transect walks were carried out in almost the same distance as 72.5 km for wet season (June to October) and 70.5 km for dry season (January to May and, December), the group encounter was as different as 27 and 19 groups found during wet and dry season, respectively (Table 4.3). From transect walks, Red-shanked Douc Langur was found most in hill evergreen forest (48.2% of the total group encounters, n = 46) and at average elevation of 442 m a.s.l. The species also used forest habitat differently between the wet season and the dry season.

Red-shanked Douc Langur was found in evergreen forest in accordance with the number of group encounters found in the transect during the wet season (42% of the total group encounters), hill evergreen (37.5%) and 17% for deciduous and dry evergreen forest at an average elevation of 380 m a.s.l. During the wet season, the species was found most in flat grounds for feeding and in upper areas for sleeping. The lowest altitude they were found at the study camp 8 was around 200 m a.s.l. During the dry season, the species was found in hill evergreen forest (58.8%), evergreen forest (29.4%), and deciduous and dry evergreen forest (11.8%) at an average elevation of 464 m a.s.l., ranging up to 653 m a.s.l. In the early dry season, the species was occasionally observed in foothills and old fallows and rarely found in the flat grounds, especially between March and May.

Table 4.3 Encounter number of Red-shanked Douc Langur recorded in the transect

Camp	Line	km	Feb	Mar	May	Jun	Aug	Oct	Dec	by line
C1	1	3	2		0		0			2
	2	1.5	1		0		0			1
C2	1	2	2		0		1			3
	2	1.3	0		0		0			0
	3	3	0		0		0			0
C3	1	3					1	1	0	2
	2	1.3					1	0	0	1
C4	1	1.2		2	2		2			6
	2	2.7		0	0		2			2
	3	2		0	1		2			3
C5	1	2.4		0	0		3			3
	2	2		3	1		0			4
	3	1.3		0	1		1			2
C6	1	2		1		0		0		1
	2	1.5		0		1		1		2
C7	1	1.2					0	1	0	1
	2	2.5					2	1	1	4
	3	1.5					2	1	1	4
C8	1	1.2					1	0	0	1
	2	1.8					1	0	1	2
	3	2					0	0	0	0
C9	1	1.8					1	0	0	1
	2	1.4					0	0	0	0
C10	1	1.6					0	0	0	0
	2	2.4					1	0	0	1

4.5 Discussion

Red-shanked Douc Langur in Hin Namno NPA is considered high population, even the potential area is small (206 km^{-2}). The potential habitat was determined based on the criteria of habitat type suitability, encounter of the animals, distance from human settlement/threat and hill slope. The habitat that the animal use today is smaller than in the past since more hunting and habitat disturbance. The density of douc langur is 5.8±4.7 groups km^{-2}, with a total of 1,187±968 groups and population of 17,765±14,481 animals in the Hin Namno NPA, however, some groups of the animals are reported in the southern Hin Namno NPA at Khoun Ka-arn area but we

had no opportunity to visit this area during the study. The estimated standard deviation is large for all the group density, group number and population because of few survey replications. Anyway, this study would be considered a roughly estimate of the species in Hin Namno NPA. The findings show that Hin Namno NPA still has healthy population of the species, even they have been decreased a lot from 2007 due to the high level of hunting and high market demands on primate bones in Vietnam and China for medicinal purpose. Wildlife hunting and trade was obviously increased when Hin Namno NPA had no funding support from World Wildlife Fund for Nature (WWF) in early 2006.

Red-shanked Douc Langur is distributed widely from central to southern Lao PDR. Outside of Nakai-Nam Theun and Hin Namno the population is small (Timmins and Duckworth, 1999; Duckworth *et al*., 1999). The densities are different between the sites. For Hin Namno NPA, study camp C4, C7 and C5 had the highest group densities whereas camp C2, C8, C9 and C10 had low densities. The study camps that held the highest group density have larger flat ground with evergreen forest. Therefore, these characteristics are the most important for Red-shanked Douc Langur. Another parameter is probably the distance from the Lao-Vietnam border. In Vietnam, the species has been reported mainly in evergreen forests (Pham, 1993). However, *Pygathrix nemaeus* is not always restricted to a primary forest, they can adapt to other forest types as well (Lippold, 1995). Some studies in Phuoc Binh Province of Vietnam have claimed that Black-shanked Douc Langur is found most in mixed bamboo forest and broadleaf (Hoang and Baxter, 2006). Although, bamboo forest is presented in Hin Namno NPA but we never found Red-shanked Douc Langur in such a habitat. The average altitude that the species was found 422 m above sea

level, which is considered low compared to that in Vietnam (Hoang and Baxter, 2006).

Density of group encounters and population is somewhat different, based on the quality of habitat types and level of human impact. Good habitat quality is usually found around foothills, which is mainly evergreen forest supporting a variety of wild food plants. White-headed Langur in Fusui limestone in China usually descends to foothills and flat grounds for feeding (Li and Rogers, 2005). Red-shanked Douc Langur was found mostly in evergreen and hill evergreen forests, not specific to limestone mountains. They mainly used limestone for crossing and as an escape area from hunting.

We found a higher number of Red-shanked Douc Langur in the camps, far from human settlement, and in large flat ground areas. A lower number of group encounters was found in the camps closed to the Lao-Vietnam border and Vietic community. Since mid 1980s, Vietnamese poachers have been entering Laos to harvest forest products illegally (Nooren and Claridge, 2001) as well as to purchase wildlife and wild plants. It became obvious that any camp close to the Lao-Vietnam border or Vietic community has a low group density of Red-shanked Douc Langur because of Vietnamese poachers crossing the border to hunt wild animals. This situation has also been found in other national protected areas along the Lao-Vietnam border, such as Nakai-Nam Theun NPA (Robichaud and Stuart, 1999) and Xesap. Generally, all protected areas in Laos within 10 km from the border have been disturbed by Vietnamese people (Robichaud and Stuart, 1999).

4.6 Conclusion

Red-shanked Douc Langurs were found at every study camp and are considered widely distributed in Hin Namno NPA. However, the density of this species is different from camp to camp, depending on the distance from any settlements, especially from the Lao-Vietnam border. The camps closed to the Lao-Vietnam border had fewer groups of Red-shanked Douc Langur and lower density. By contrast, we found a higher density in the study camps far from the border. The douc langurs prefer hill evergreen forest and usually stay in low land during wet season. They move to higher ground for sleeping and avoid the danger from hunting.

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CHAPTER V

DENSITY AND CONSERVATION SIGNIFICANCE OF PRIMATES IN HIN NAMNO NATIONAL PROTECTED AREA, LAO PDR

5.1 Abstract

Primate distribution in Hin Namno NPA was estimated from a 142.8 km transect walk using a modified-line transect sampling methods for censusing primate on limestone from January to December 2007. Direct observations were made from the study camp areas and villager interviews were conducted. Ten primate species were found and reported, of which 6 species were found from the transect walk. A group density per km walk of Stripe-headed Black Langur *Trachypithecus hatinhensis* was 0.42, Red-shanked Douc Langur *Pygathrix n. nemaeus* was 0.32, Assamese Macaque *Macaca assamensis* was 0.27, Stump-tailed Macaque *Macaca arctoides* was 0.03, Southern White-cheeked Gibbon *Nomascus siki* was 0.03. One group of another form of Striped-headed Black Langur *Trachypethecus hatinhensis* was once spotted. Red-shanked Douc Langur is a flagship species for Hin Namno NPA which the study camp found high encounter rate of the species was also other primate species. The uniqueness of limestone functions as an important refuge area for primate species and makes this area the place for primate conservation in Lao PDR.

5.2 Introduction

Primate species are little known in the Lao PDR (Timmins and Duckworth, 1999), only a few short surveys have been conducted in each proposed and National Protected Areas (NPAs) to assess wildlife species through the last decade. Hin Namno NPA was investigated in 1996 and 1999 and it was revealed that this area was important for the conservation of primates, especially Red-shanked Douc Langurs *Pygathrix nemaneus* and Stripe-headed Black Langur *Trachypithecus hatinhensis* (Timmins and Khounboline, 1996; Thewlis *et al*., 1998; Walston and Vinton, 1999 and Timmins and Duckworth, 1999). The site is home to 9 primate species (Timmins and Khounboline, 1996; Walston and Vinton, 1999) of 18 known primate species (Table 5.1) in the Lao PDR (Ruggeri and Timmins, 1996). Some source just mentions only 15 species in Lao PDR (Nadler, 2008). However, recent information claims an additional of 6 gibbon species found in Lao PDR (Duckworth, 2008). Therefore, 18 primate species have been still reconfirmed in the country.

Table 5.1 List of primate species in Lao PDR

No	Common name	Scientific names	Legal status
1	Northern White-cheeked Gibbon	*Nomascus leucogenys*	CITES I, IUCN – CR, Lao Category I
2	Southern White-cheeked Gibbon	*Nomascus siki*	CITES I, IUCN – EN, Lao Category I
3	Yellow-cheeked Gibbon	*Nomascus gabriellae*	CITES I, IUCN – EN, Lao Category I
4	Black crested Gibbon	*Nomascus concolor*	CITES I, IUCN – CR, Lao Category I
5	Pileated Gibbons	*Hylobates pileatus*	CITES I, IUCN – EN, Lao Category I
6	White-handed Gibbon	*Hylobates lar*	CITES I, IUCN – EN, Lao Category I
7	Red-shanked Douc Langur	*Pygathrix nemaeus*	CITES I, IUCN – EN, Lao Category I
8	Stripe-headed Black Langur	*Trachypithecus hatinhensis*	CITES I, IUCN – EN, Lao Category I
9	Lao Langur	*Trachypithecus laotum*	CITES I, IUCN – VU,
10	Indochinese Lutung/leaf Langur	*Trachypithecus germaini*	CITES II, IUCN – EN, Lao Category I
11	Phayre's Langur	*Trachypithecus phayrei*	CITES I, IUCN – EN, Lao Category I
12	Long-tailed Macaque	*Macaca fascicularis*	CITES II, IUCN – LC, Lao Category II
13	Northern Pig-tailed Macaque	*Macaca leonina*	CITES II, IUCN – VU, Lao Category II
14	Stump-tailed Macaque	*Macaca arctoides*	CITES II, IUCN – VU, Lao Category II
15	Assamese Macaque	*Macaca assamensis*	CITES II, IUCN – NT, Lao Category II
16	Rhesus Macaque	*Macaca mulatta*	CITES II, IUCN – LC, Lao Category II
17	Pygmy Loris	*Nycticebus pygmaeus*	CITES II, IUCN – VU, Lao Category I
18	Slow Loris	*Nycticebus bengalensis*	CITES II, IUCN – VU, Lao Category I

Remarks: CR = Critical Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern

5.3 Methodology

5.3.1 Study Area

Hin Namno NPA (total area of 820 km^2) is located in Bualapha district, Khammouane Province, bordered by the Phong Nha Ke Bang Natural World Heritage Site in Vietnam (Figure 5.1). It is situated at latitude 17°15´–40´ N and longitude 105° 43´–106º 09´ E, with altitude ranging from 200 m to over 1,000 m above sea level. From climate data area recorded from March 2007 to February 2008, the annual rainfall is 1,480 mm. The average annual temperature is 25.7ºC (average ranges from 11–40°C). The total human population living adjacent to the area is 7,240 inhabitants from 22 villages.

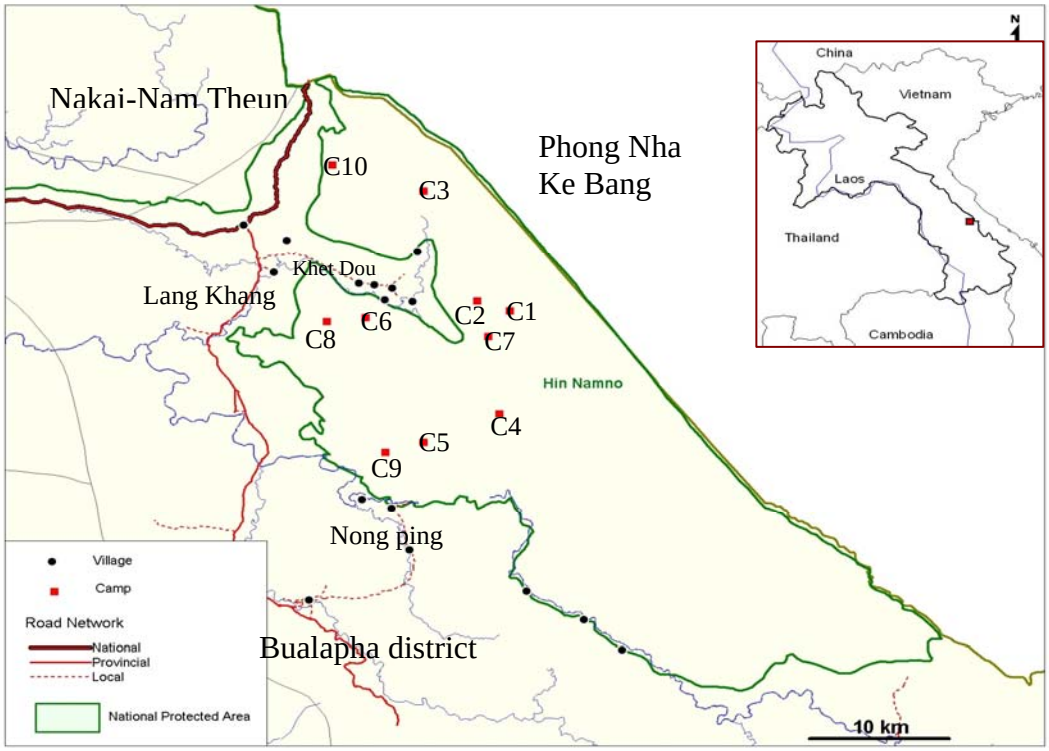

Figure 5.1 Map of transect walks in Hin Namno NPA

The majority of the area is limestone karst, covering 90% of the entire Hin Namno NPA. It consists mostly of type I limestone (Li and Rogers, 2007). The area, with ground cover ranging from bare rock to shrubby forest and flat lowlands, is broken by sporadic karst outcrops and scattered areas of large piles of rocks. The limestone mountains, especially at the central and some northern areas of Hin Namno NPA, are covered with tall-closed canopy evergreen forest, hill evergreen forest and mixed deciduous forests. Patches of secondary forest or old fallow of over 40 years are also found in the area (Timmins and Khounboline, 1996).

5.3.2 Transect Design

Ten study camps were selected in the central and northern Hin Namno NPA. The southern part was excluded due to the entry restriction. Each study camp had 2 or 3 line transects (Table 5.2). Each transect direction headed to the west, south or north from the study camp, crossing different habitats started at least 500 m from the camp. Due to the hilly terrain, curve transect lines were accepted but each transect would keep an approximate direction throughout. The length of each transect ranged from 1.2 to 2.7 km. A total of 25 transects were designed with a total length of 47.6 km (average transect length 1.9 km). The average number of transect lines was 2.5 and average transect length per study camp was 4.8 km (ranging from 3.2 to 6.3 km).

These transects were walked three times with two to three months apart from February to December 2007, resulting in 142.8 km of total walks. The walks were conducted in the morning between 7.30 A.M. and 11.30 A.M. in good weather with a walking speed at 0.7 to 1 km/hr. During the walk, data including time of animal encounters, primate species, number of animals seen, number of animal estimates and

locations of those encounters were recorded. The animal estimates were noted when movement was seen in trees, so that the number of animal estimates for each encounter was the total animal estimate added to the total animals seen. A rangefinder was used to find the distance from an observer to the animals, and a compass and GPS were used to determine the location of the animals. The team stopped every 200 meters to look for animals. Observations were discontinued after 10 minutes before restarting another interval (Altmann, 1974). The transect walks were carried out mostly by one team, but occasionally by two teams, in each study camp on different transect lines. Each team consisted of 2–3 people, with one principal researcher or one trained staff along with one or two village assistants. In addition, forest types were identified in every 200 m of transect walks. The total time spent for transect work was 81 days or 276 man-days.

Table 5.2 Description of study camps for primate distribution study

No	Name	Longitude	Latitude	Elevation. (m)	No. of Line	Length (km)	Total walk (km)
C1	Kuan Nong	105º50´ 60´´	17º 35´ 69´´	525	2	4.5	13.5
C2	Nong Boun	105º53´ 07´´	17º 30 ´45´´	523	3	6.3	18.9
C3	Kuane Thalee	105º 51´ 05´´	17º 35´ 23´´	384	2	4.3	12.9
C4	Nam Khoum	105º 53´ 62´´	17º 26´ 18´´	362	3	5.9	17.7
C5	Nam Masai	105º 50´ 58´´	17º 24´ 99´´	299	3	5.7	17.1
C6	Kuane Thoun	105º 48´ 24´´	17º 30´ 29´´	364	2	3.5	10.5
C7	Kuane King	105º 53´ 18´´	17º 29´ 48´´	506	3	5.2	15.6
C8	Nong Luang	105º 46´ 67´´	17º 30´ 12´´	319	3	5.0	15.0
C9	Nong Ban Na	105º 49´ 05´´	17º 24´ 57´´	247	2	3.2	09.6
C10	Phou Chuang	105º 46´ 91´´	17º 36´ 80´´	727	2	4.0	12.0
	Total				25	47.6	142.8

Since the study area is difficult to access and impossible to make a straight line due to hilly limestone dominance, neither Whitesides (Whitesides *et al*., 1988) nor Struhsaker methods (Struhsaker, 1981) were appropriate for primate study on

limestone. The Occupancy method does not show a density (MacKenzie *et al*., 2002). Therefore, the modified-line transect sampling (MLTS) method for censusing primate on limestone (Li and Rogers, 2007) was applied for the species that have high encounter rate. However, comparison a density of these primate species can be only possible by km walk due to low encounter rate of some primate species.

5.3.3 Villager Interviews

Initial village interviews on current information of primate species and the possibility to make transects were conducted in 8 villages in northern Hin Namno NPA (Figure 5.2). Secondary interviews focused on the information of specific primate species, their presence and location, as well as wildlife hunting, trade and village perspectives on conservation and site management. More frequent visits and informal interviews were conducted during the research period in Ban Nongbua, Ban Dou, Nong No, Thongxam, Nongseng, Pha Nob, and Vangmaneu/Salang. An average of the formal focus group discussions was 3.7 people from 40 interviewees (11 village heads and 29 hunters) in these villages).

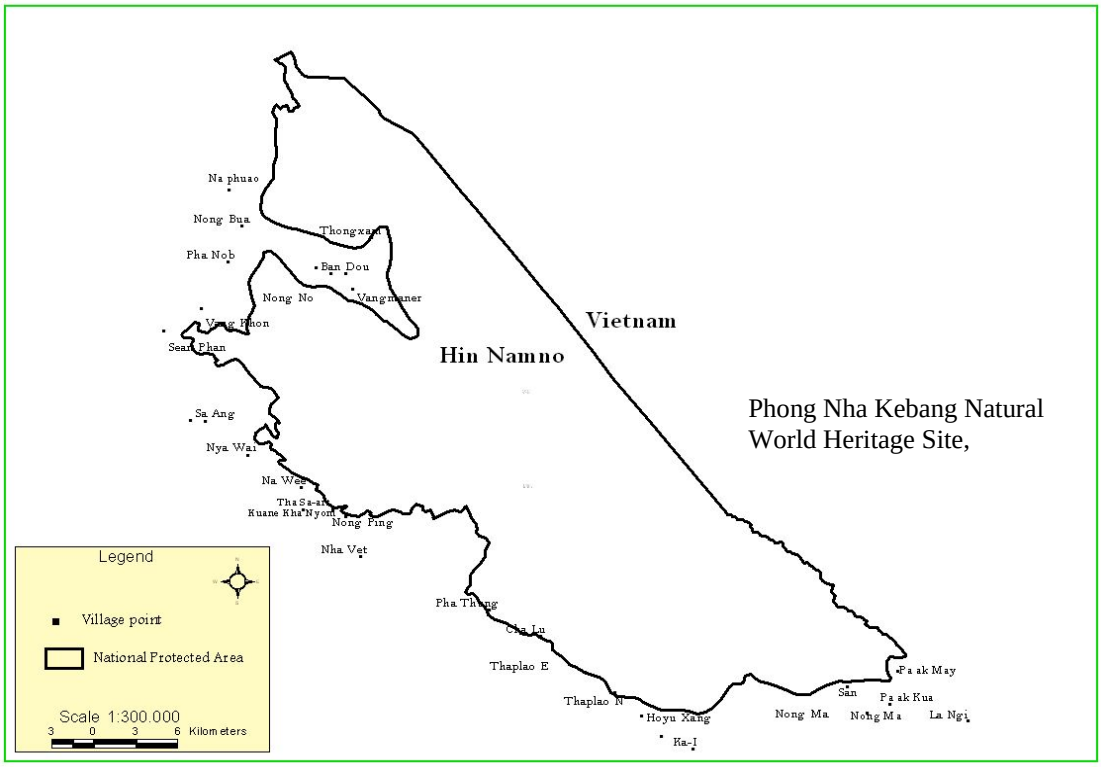

Figure 5.2 Map of villages in Hin Namno National Protected Area

5.4 Results

A total walk of 142.8 km from 25 transects was carried out. From the census study, 6 primate species were recorded (Table 5.3). The largest group size was found in Stump-tailed macaque (37.8, *n* = 4, a group size ranging from 10–40), whereas the lowest was found in Southern White-cheeked Gibbon (3.8, *n* = 5, a group size ranging from 2–5). Red-shanked Douc Langur had a group size of 14.9 animals (*n* = 46, group size ranging from 3–40 individuals), while the group size of Striped-headed Black Langur was 9.4 animals (*n* = 60) and Assamese macaque had 19.1 animals per group (*n* = 39).

Table 5.3 Density of primate species encounters from transect walk

Study camps	Red-shanked Douc Langur		Stripe-headed Black Langur		Assamese Macaque		Stumped-tailed Macaque		White-cheeked Gibbon	
	Group	Number	Group	Number	Group	Number	Group	Number	Group	Number
C1.	3	24	8	62	3	28	1	10	2	6
C2.	3	19	3	17	1	5				
C3.	3	26	9	71	7	77				
C4.	11	135	11	46	3	24	1	40		
C5.	9	92	6	29	5	32	1	30		
C6.	3	18	4	31	3	29			2	9
C7.	9	89	7	47	9	99	1	15		
C8.	3	30	9	57	5	57				
C9.	1	12	2	13	2	24			1	4
C10.	1	5	1	3	1	8				
Total	46		60		39		4		5	
Average		14.96		9.40		14.10		37.75		3.8

Using the modified-line transect sampling (MLTS) method for censusing primate on limestone, the group per km walk of primate species in Hin Namno NPA, was 0.42 for Stripe-headed Black Langur, 0.32 for Red-shanked Douc Langur group, 0.27 for Assamese Macaque, 0.03 for Stump-tailed Macaque *Macaca arctoides*, 0.03 for Southern White-cheeked Gibbon *N. siki*, and only one group for another sub-species of Stripe-headed Black Langur (white-eared form). Other species were found beyond the transects and from villager reports including Rhesus Macaque *Macaca mulatta*, Pig-tailed Macaque *Macaca leonina* and Long-tailed Macaque *Macaca fascicularis* (certified by village interviews). Two more species of nocturnal prosimians *N. pygmaeus* and *N. bengalensis* were also seen (Figure 5.3).

Assamese macaque

Pig-tailed macaque

Rhesus macaque

White-cheeked gibbon

Stump-tailed macaque

Pygmy loris

Long-tailed macaque

Slow loris

Figure 5.3 Pictures of other primate species found in Hin Namno NPA

Habitat distribution

Habitats in the area, according to the records from transects, were mainly evergreen forest (48.7%), hill evergreen (23.7%) and other habitats, including mixed deciduous forest, mixed dry evergreen forest and bamboo forest. Primates used hill evergreen forest for 48.2%, evergreen forest for 35.5% and mixed deciduous and dry evergreen forest for 14.4%. During the dry season, they used evergreen forest in low flat ground (42%) rather than hill evergreen (37.5%). In contrast, they used hill evergreen forest (58.8%) more than evergreen forest (29.4%) in the wet season.

Wildlife threat and local conservation effort

Wildlife threat was high in Hin Namno NPA, due especially to hunting and wildlife trade (Table 5.4). Hunting is conducted by both Lao hunters and Vietnamese poachers, while wildlife trade was observed in the survey villages and mostly by Vietnamese traders (15 people).

Table 5.4 Records of primates harvested in 8 villages from March 2007 to February 2008

Month	Douc Langur	Black Langur	Assamese Macaque	Stump-tailed Macaque	Gibbon sp.	Loris sp.
Mar	12	9	3	1		
Apr	3	12	1	2		
May		9	1			
Jun	3	18	2			
Jul	2	11		1		
Aug	7	9	1	0		
Sep	14	7	6	1		
Oct	85	24	21	7	1	
Nov	97	37	12	9		
Dec	83	55	19	11	2	3
Jan	98	45	2	1		
Feb	91	39	5	2	1	2
Total	495	275	73	35	4	5

In the past, the regular patrols by local people were well implemented. However, when wildlife product demands increased, especially for primate bones, some groups of local villagers became hunters instead of patrollers. The villages now lack visits by officials since the end of the World Wildlife Fund for Nature (WWF) project in early 2006. Consequently, the local villagers also mentioned that they received insufficient support from the local government. The existing laws and regulations were not seriously enforced for illegal hunting in the area. This situation discouraged local villagers from working against the poachers. Therefore, the number of local hunters in 8 villages had increased to 92 by the end of 2007. In this regard, one head of a village cluster group, Mr. Chanpheng, urged for the help to stop wildlife hunting and trade in the area. He suggested that the wildlife hunting and trade was highly increased during dry season 2007/2008 and that hunting was mostly done for sale. If the trends of this issue are not curbed, some primate species in the Hin Namno NPA will be gone soon.

5.5 Discussion

The current number of primates species found in Hin Namno NPA is surprising. Although it is a small area, 10 species of primates live in the area is abnormal in this region. In this connection, Hin Namno NPA is only a single area that supports a high number of primate species in the country and is very important for the conservation of primate communities, especially for Red-shanked Douc Langur and Stripe-headed Black Langur (Walston and Vinton, 1999; Duckworth *et al*., 1999; Timmins and Khounboline, 1996). The reason that many primates still remain in the area is probably due to the limestone, which has restricted human access so that the

animals have a secure place from human persecution. A discussion of each primate species found from inside and outside the transect walk as below.

5.5.1 Primates found in transect walk

Red-shanked Douc Langur is distributed widely from the central to southern parts of Lao PDR (Timmins and Duckworth, 1999; Duckworth *et al*., 1999). Hin Namno NPA can contain 0.32 group/km walk. The average group size from total estimated population was almost in double larger than the average group size directly seen. It is because the animals are hiding behind leaves in the trees. In comparison, the group encounter was higher in the central area (C4 and C5), far from local communities. In contrast, the other parts, especially the area close to the Lao-Vietnam border, has very low density of this animal.

The species was found mostly in hill evergreen and evergreen forest from mid-limestone mountains to foothill limestone, where some flat ground is available. It is similar to White-headed Langur living in similar habitats in Fusi, China (Li and Rogers, 2004; 2005). Red-shanked Douc Langur stays in these forests because these habitats provide a variety of food, especially in wet season.

Stripe-headed Black Langur lives in the same habitat of Red-shanked Douc Langur. This species was understood as Francois' langur from the previous surveys (Timmins and Khounboline, 1996; Walston and Vinton, 1999). However, it is now argued among primatologists as it is Stripe-headed Black Langur *T. hatinhensis* or Indochinese Black Langur *T. ebenus*. It likely disagreed among various resources. Anyway, this study we just consider as Black Langur. During the transect walks, we found the species once used bamboo forest at C6 Kuane Thoun. A loud call of this

species was heard frequently in the early morning starting around 5.30 - 7.00 A.M. They also usually call out at anytime when they encounter dangerous threats e.g people or fighting each other. The total group density of this species per km walk is 0.47, it is considered good density. Although, Stripe-headed Black Langur has more group number than Red-shanked Douc Langur, the population is lower because of a smaller group size.

Stripe-headed Black Langur with white ears is claimed to be a sub-species. It is extremely rare in Hin Namno NPA. We had only two encounters during the field surveys; one in the transect at C7 Kuane Khing, and another outside the transect at C4 in July 2008. It was also reported in Ban Nong Ping and Pha Thoung. There were no sightings from previous surveys (Timmins and Khounboline, 1996; Walston and Vinton, 1999).

Assamese Macaque is widely distributed in the central region of Lao, PDR (Duckworth *et al*., 1999). It is also common to Hin Namno NPA as found in the same habitat as Red-shanked Douc Langur. The study camps of C7 Kuane Khing, C5 Nam Masai and C4 Nam Khoum, have a good record of this species. Current population of this species in the wild remains quite good. Although a smaller number of groups were found from the study plots, it generates the same number of population as Stripe-headed Black Langur.

Stump-tailed Macaque has also been recorded in the central region of Lao, PDR (Duckworth *et al*., 1999) and partly in the north. In Hin Namno NPA, the number of group encounters is low. However, its group size is the largest, as many as 60 individuals found at C4–Nam Khoum in 2007, compared to other primate species

in Hin Namno NPA. It is estimated that the species would have three to four groups in each sample site.

Southern White-cheeked Gibbon is widely recorded in the central region of Lao PDR, along northern Annamites (Duckworth, 2008; Duckworth *et al*., 1999). It is one of six gibbon species recently reported in Lao PDR and considered as *Nomascus siki* (Duckworth, 2008). During the transect walk in Hin Namno NPA, only 5 groups were found so that the population number was low. One group of only two animals was also found. The population of this species became fragmented in the area. Sometimes only one female was found, one male or just two individuals per encounter found outside of the transects. Two groups of 4 and 5 individuals were seen only twice; at C1 Kuane Nong in January 2007 and at C6 Kuane Thoun in June 2007. Also, one group of 6 individuals was observed in January 2008 at Ang-sang – the east of Kuane Ke but lies outside the transect.

5.5.2 Primates found or reported beyond transect walk

Five primate species were found or reported outside of transects as below.

Rhesus Macaque was reported along Xebangfai River, since its main habitat is in riparian zone. One young Rhesus macaque (locally known as *Ling nam*) was seen in captivity in Ban Nongping in January 2007 and one group was seen in Phou Vangmone limestone; the location nearby Ban Phanob (17º 32´ 24´´ N 105º 54´ 54´´ E) in November 2007. Also, this species was reported in the area by World Wildlife Fund for Nature (WWF) in 1999 (Walston and Vinton, 1999). This species is found in all parts of Lao, PDR (Duckworth *et al*., 1999).

Northern Pig-tailed Macaque was reported in some villages especially Ban Nongbua (17º 33´ 59´´ N 105º 45´ 08´´ E), Ban Phanob, Ban Dou and Nongping. The last two surveys of the Wildlife Conservation Society (WCS) (Timmins and Khounboline, 1996) and WWF (Walston and Vinton, 1999; Duckworth, 1999) had no records of this species. In January 2007, one group of 9 animals was found in Kuane Khing (C7). Although this species has been reported in all parts of Lao, PDR (Duckworth *et al*., 1999), it was rare in Hin Namno NPA.

Slow Loris was widely reported and common in Hin Namno NPA, according to the village interviews. However, no nocturnal survey has been conducted so far from the previous reconnaissance of WCS and WWF. In December 2007, one slow loris was seen in Ban Dou that villagers captured from Phou Chuang area. This species has also been reported as common in Lao, PDR (Duckworth *et al.*, 1999). Hin Namno NPA is in the range of the species distribution in South-east Asia (Rowe, 1996).

Pygmy Loris was reported to be found in similar habitats to Slow Loris, but its abundance is likely low. No nocturnal surveys have been conducted so far from the previous surveys of WCS and WWF (Timmins and Khounboline, 1996; Walston and Vinton, 1999). This species was quite frequently reported in the area. In December 2007, three living animals were seen in Ban Dou which they were captured from the Lao-Vietnam border.

Long-tailed Macaque is very rare in the Hin Namno NPA, it was reported in Ban Nongbua area. The hunters estimated that only two groups of about 15 individuals each remained in the Northern Hin Namno area. They were occasionally seen during crop harvest season around November. This species is usually recorded in

the southern parts and some part in the north and south of Lao, PDR (Duckworth *et al*., 1999). However, Hin Namno NPA is in the range of the species distribution in South-east Asia (Rowe, 1996). More field investigation is needed to prove the presence of this species.

Phayre's Langur was believed to be present in Hin Namno NPA by the previous surveys and that the potential habitat is along the Lao-Vietnam border (Timmins and Kounboline, 1996). Although it was not mentioned by the local hunters, Hin Namno NPA is in the range of the species distribution in South-east Asia (Rowe, 1996). More field investigation is also needed to prove the presence of this species.

In conclusion, Hin Namno NPA has a unique landscape for primates. There are at least 10 primate species found and there are likely more to discover. Some species mentioned, such as Phayre's Langur, is still not confirmed on the primate list of the Hin Namno NPA.

5.5.3 Better primate conservation and management in Hin Namno NPA

The population of primates in Hin Namno NPA has declined, particularly since 1990 because of high market demands for primate products in Vietnam and China. Wildlife trade crossing from Lao to Vietnam was frequently reported (Compton *et al*., 1998). Local villagers had conducted more than a dozen patrols per year to prevent Vietnamese poachers. However, patrol efforts declined to zero in 2008 due to a lack of funding and government staff support. In 8 villages of Northern Hin Namno, after the WWF project ended the number of local hunters increased from 15 hunters in early 2006 to around 50 in early 2007 and was up to 92 at the end of 2007

because of easily wildlife access and good wildlife market. The price of wildlife had been increased dramatically from 2007. However, only a small number of hunters in each village does wildlife hunting, the hunters are mainly village militia and mid-class citizen. A group of 2 and 3 Vietnamese traders kept regularly visiting the villages on bicycles for selling Vietnamese goods while, on their returns, they collected wildlife products.

More recently, the major proportion of local villagers are still interested in conservation and continue patroling. More education and awareness for children and local communities, as well as more support from the local government for law enforcement, is needed. In any case, the local villagers still do not understand how to deal with endangered and non-endangered primate species; therefore, the clarification is important for species management (Dorian, 2002).

In brief, village discussions showed the needs of local regulations for natural resource management to be prepared and accepted by everyone in the communities (Dorian, 2002) as the regulation would be formulated from the existing regulations of Hin Namno NPA. Zoning for restricted protection and multiple use areas is also necessary, and with clarification on rules for each zone. Local networking, local coordinators and coordination mechanisms should be in place. Some incentives for local patrol, as well as recognition for persons who do a good job for conservation, need to be established. Perhaps a good incentive is not always in cash, but in rice, clothes/uniform, and study tour opportunities. The boundary and territory of each village need to be clear and well understood so villagers can protect their own natural resources. Many villages have many different “Kuane” zones, which are possibly to assign someone frequently using the area as an information collector. He has to report

to his village chief whenever he receives information of illegal activities in his area of responsibility; then an enforcement team needs to take action immediately. These ideas are practical and cheap to operate. However, at village cluster level, a biodiversity and threat monitoring survey should be conducted by a monitoring team. In addition, the development of ecotourism activity in some zones and can change hunters to be conservationists, as well as to ensure benefit sharing amongst communities.

5.6 Conclusion

Hin Namno NPA is small but contains a high number of primate species, making it a significant place for primate conservation. Red-shanked Douc Langur is the most important species and can be considered as a flagship species in the area and remains at good population in the Hin Namno NPA. The second most important species is Stripe-headed Black Langur, then Assamese macaque, Stump-tailed macaque and Southern White-cheeked Gibbon. The first three species were distributed widely, while Stumped tailed Macaque and Southern White-cheeked Gibbon had low density and distribution. In addition, other primate species found outside the transect were considered low.

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CHAPTER VI

ACTIVITY BUDGET OF RED-SHANKED DOUC LANGUR IN HIN NAMNO NATIONAL PROTECTED AREA, LAO PDR

6.1 Abstract

Two unaccustomed groups of Red-shanked Douc Langur *Pygathrix nemaeus* were studied in Hin Namno National Protected Area, Khammouane Province in Lao PDR. Group 1 of 19 individuals had more human pressure while group 2 with 39 individuals had lower human pressure. The activity every 30-minutes were recorded via scan sampling from March 2007 to June 2008. Time budget of the species was examined, depending upon seasons. Only data for adults were used for this analysis. Results show that feeding (39.5%) was the highest proportion of time used; then inactivity (18.9%), which mostly consisted of listening for threats, sleeping (13.8%) and social activity (5.0%). was lowest The significant difference activity between groups was feeding, inactivity and traveling. The differences between dry and wet seasons were inactivity, sleeping, feeding and social activities. In addition, the species has certain home range (292 ha) and overlap with other groups, with a larger home range in dry season.

6.2 Introduction

Hin Namno National Protected Area connects to Phong Nha Kebang Natural World Heritage Site in Vietnam. The connection marks the largest limestone karst under legal protection in Southeast Asia (Timmins and Khounboline, 1996). This area is significant for the conservation of Red-shanked Douc Langur *Pygathrix nemaeus* and Francois' Langurs *Trachypithecus* spp. (Timmins and Khounboline, 1996; Timmins and Duckworth, 1999; Walston and Vinton, 1999; Duckworth *et al*., 1999). This area also holds unique and beautiful limestone-forest landscapes.

Red-shanked Douc Langur is considered a high priority of conservation need. It is classified in the Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and as an endangered species on the IUCN Red list (IUCN, 2008). However, human pressure on this species through hunting and over-harvesting of forest products by outside encroachers is highly concerning in the area (Timmins and Khounboline, 1996; Walston and Vinton, 1999). A lack of information on the distribution and ecology of Red-shanked Douc Langurs in the wild is of concern for conservation, especially in limestone habitats. Hin Namno NPA is a single area under legal protection in the Lao PDR where Red-shanked Douc Langurs are found in a limestone habitat.

Apart from the necessity of understanding douc langur distribution and threats, it is also essential to understand the time budget and activity of the species. Obtaining this kind of data can provide baseline for monitoring changes of the species behavior. Changes in animal activity may indicate a change in habitat quality, temperature, level of human disturbance and other factors (Brockelman and Srikosamatara, 1993; Li and Rogers, 2004; 2005).

6.3 Methodology

6.3.1 Study Area

Hin Namno National Protected Area (total area of 820 km^2) is located in Bualapha district, Khammouane Province, which joins the international borders with Phong Nha Ke Bang Natural World Heritage Site in Vietnam (Figure 6.1). It is situated at latitude 17º15´–40´ N and longitude 105º 43´–106º 09´ E, with altitudes ranging from 200 m to over 1,000 m above sea level. The annual rainfall in 2008 is 1,480 mm, with the rainy season extending from the end of May to the end of October. Also, the average of annual temperature is 25.7ºC (11–40ºC). Total human population living adjacent to the area is 7,240 inhabitants from 22 villages.

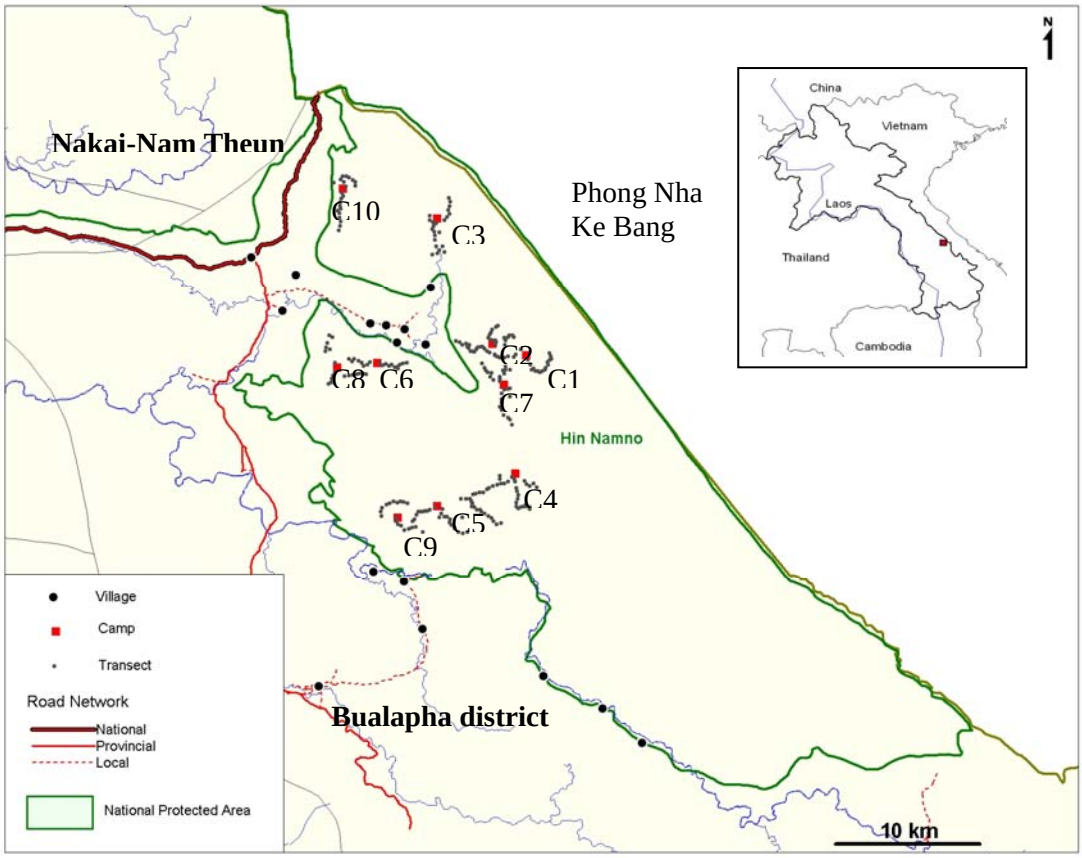

Figure 6.1 Map of the study camps and location of two behaviour study groups in Hin Namno NPA.

The majority of the area is limestone karst, with ground cover ranging from bare rock to shrubby forest and flat lowlands, broken by sporadic karst outcrops and scattered areas of large piles of rocks. The limestone mountains, especially at the central and some northern Hin Namno NPA, are covered with tall closed canopy evergreen forest, hill evergreen forest and mixed deciduous forests. Nonetheless, patches of secondary forest or old fallow of over 40 years are found in the area (Timmins and Khounboline, 1996).

Two study groups G1 and G2 were selected at C5 and C4 respectively. These two study camps were approximately 5 km apart from each other. There have similar habitats with no hilly limestone.

6.3.2 Study Groups

Two groups of Red-shanked Douc Langur were selected for behavior study. Group 1 (G1), in study camp 5 Nam Masai, received higher human pressure (6.5 individual threat/km) and Group 2, (G2) in study camp 4 Nam Khoum received lower human pressure (3.2 individual threat/km). These two groups were observed every month, from March 2007 to June 2008 for G1, and from July 2007 to June 2008 for G2. The animals were classified into five age-sex classes: adult female (AF), adult male (AM), sub-adult (SA), juvenile (JU) and infant (IF). Group 1 (G1) had 19 individuals, consisting of 2 adult males, 4 adult females, 5 sub-adults and 4 infants. G2 had 39 individuals, consisting of 4 adult males, 7 adult females, 10 sub-adults, 12 juveniles and 6 infants.

6.3.3 Group Observation

The study groups were not habituated because of the ongoing hunting activity in the area. However, observations were conducted as long as the observers were not detected. Scan sampling (Altmann, 1974) was conducted every 30-minute intervals at an average distance of 27 m from animals. Sometimes, the animals were observed from as close as 10 m during the wet season. They were less afraid of the research team after being followed for weeks. When they detected the research team, they just moved about 100 m away. During the group observations, data on the animals' sleeping time and home ranges were also recorded. The quantity data collected were based on the time count recorded.

Total time spent for behavior study was 128 days (717.5 hours) from 162 days of effort. The observation took 4–5 hours per day, 5–7 days a month per group. It was less in April and May due to the animal's fear of people, making them difficult to follow. From a total of 128 days used, 97 days (59.87%) were used for G1 and 65 days (40.12%) were used for G2 (Figure 6.2).

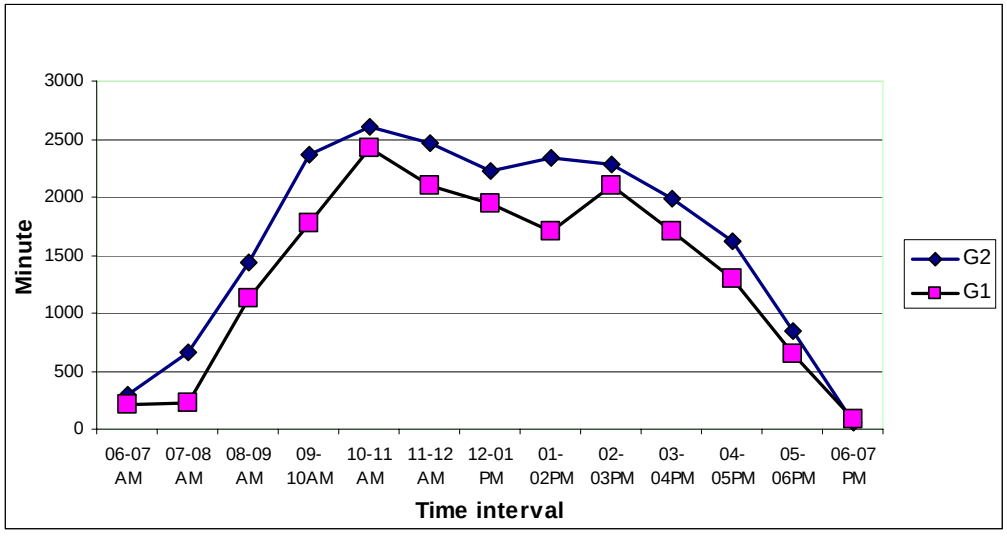

Figure 6.2 Comparison of daily time detection of Group 1 and Group 2.

The number of detection days was 73 (382.5 hrs) for G1 and 54 (338 hrs) for G2. On average, time spent per day was 4.95 hrs for G1 and 5.97 hrs for G2. Daily, animals were mainly detected after 9 A.M. and during sleeping time, at which time we could hear the calls of infants.

6.3.4 Data Analysis

Data from records at 30-minute intervals was counted as one unit. Total count time of adults only (adult male, adult female and sub-adult) was used for this analysis and was shown in percentages. The adult time recordings of each study group were prepared in months and separated by activity category. SPSS program Version 12 for Windows was used to test the comparison between the two study groups and between the dry and the wet season. Data recordings of the same month period from July 2007 to June 2008 were used for the group comparison. Paired *t*-test was used for this analysis, where p value < 0.05 indicates significance. In addition, the data on sleeping time of the animals and home ranges were presented in number and percentages.

6.4 Results

6.4.1 Time Activity

Five main activities of Red-shanked Douc Langur's behavior were identified as inactive, sleeping, feeding, social and travel (Table 6.1and 6.2). The records of the species' time budget and activity (Figure 6.3), based on the adults, shows that feeding accounts for 39.6% of their time (n = 2,360), which was the highest proportion of their time used. Following were inactivity (17.93%), mainly for monitoring threats

(predator vigilance), sleeping (13.8%) with the lowest proportion for social activity (5.02%).

Table 6.1 Count number of adults in Group 1 and Group 2 by month

Month/activity	inactive		Sleep		Feeding		Social		Travel		Other	
	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2
Mar-07	17				24		5		8		7	
Apr-07	30				43		4		13		13	
May-07	30				44		3		22		10	
Jun-07	38		24		114		6		12		24	
Jul-07	47	49	26	44	91	138	10	13	24	20	30	33
Aug-07	37	38	28	54	89	137	9	12	18	20	18	35
Sep-07	39	34	27	38	73	124	8	10	19	19	22	33
Oct-07	47	42	34	38	77	120	9	11	20	16	29	32
Nov-07	33	41	18	19	41	58	10	7	29	15	20	29
Dec-07	36	35	24	24	48	48	10	9	25	15	16	27
Jan-08	32	22	12	26	56	59	12	7	22	9	12	25
Feb-08	29	24	16	27	36	57	7	6	19	13	18	24
Mar-08	32	17	18	11	46	69	10	6	23	18	15	21
Apr-08	24	21	14	10	36	37	7	2	15	17	16	12
May-08	23	17	18	8	46	56	8	7	16	9	13	9
Jun-08	36	24	23	45	85	90	12	16	15	19	29	21
	530	364	282	344	949	993	130	106	300	190	292	301

G1 *n* = 2,483; G2 *n* = 2,298

Table 6.2 Number and Percent of adult times by groups and seasons

Activity		Inactive	Sleeping	Feeding	Social	Travel	Others	Total
G1		415	258	724	112	245	292	2,046
	%	20.28	12.6	35.39	5.47	11.97	14.27	100
G2		364	344	993	106	190	301	2,298
	%	15.84	15	43.21	4.61	8.26	13.1	100
Wet season		357	43.4	1024	110	190	210	1,970.4
	%	17.21	15.6	44.83	4.82	8.31	9.19	100
Dry season		386	243	693	108	245	383	2,058
	%	18.76	11.8	33.67	5.25	11.9	18.61	100

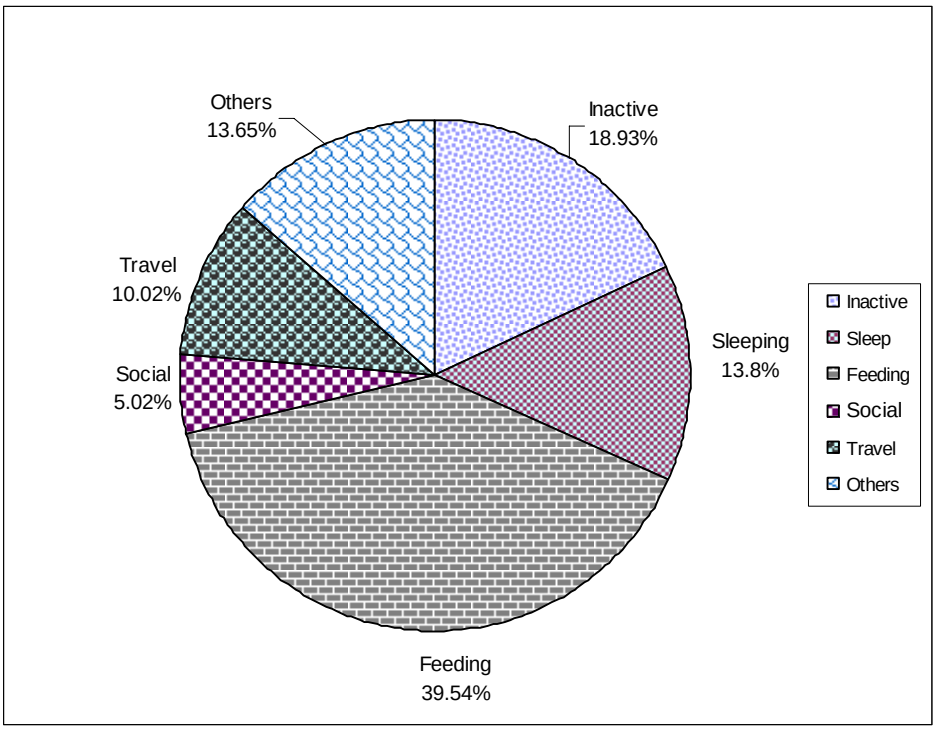

Figure 6.3 Diagram of activity budget of Red-shanked Douc Langur

6.4.2 Description of the Animals' Activity

For feeding (n = 858), the species ate similar proportions of leaves (41.6%) and fruits (40.1%). Different proportions of leaves and fruits were consumed by the animals between the wet and the dry seasons (Figure 6.4). The category "others" signifies that the animals ate other things, including leaf buds, flowers and figs. During their feeding or traveling time period, the animals used the upper level of the canopy rather than any other levels of forest canopies.

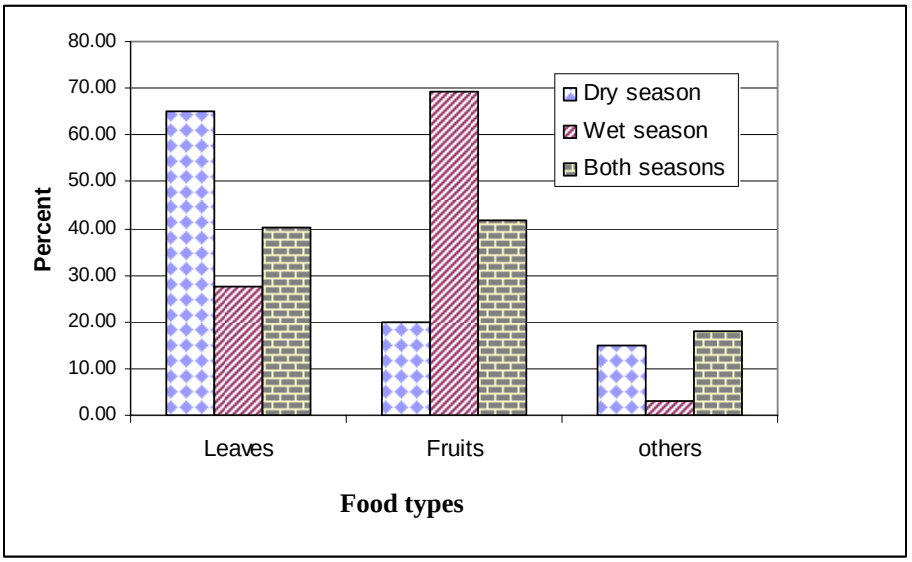

Figure 6.4 Proportion of food types of Red-shanked Douc Langur by seasons

For sleeping, douc langur selected a nearby high tree or a tree growing in rocky areas. On average, Red-shanked Douc Langurs began taking a nap at 13:03 and woke up at 15:05 while sleeping in the evening started at 18:17. However, it started earlier during the dry season, but sometimes they started at around 11:40 for napping and woke up at 13:30 during wet season. Sub-adults slept motionlessly while adults stayed alert overtime. Often, adult males stayed at higher levels than others during sleeping time or sometimes at similar level as adult females. Adult males functioned well to manage their groups to sleep together in a selected tree and to keep the group from dangerous threats. Calling out for the group members toward the sleeping site was observed during wet season, particularly in July and August.

For inactive mode, four categories were distinguished during the observation as normal, monitor, unclear monitor and unknown. Monitoring for threats accounted for 65.6%, which happened during feeding time. Normally, this was 23.3%.

Whenever they heard the sound of footsteps, they were reluctant to stay. The sound of footsteps was the most important clue that the animals had to watch out.

The social activity of adults was mainly for grooming (57.7%). Grooming was only observed in adult males and adult females during resting time. Other social activities included agonistic (22.2%), chase play (13.23%) and rough play (3.17%). Antagonism was rarely observed in the group of Red-shanked Douc Langurs. Occasionally, we observed an adult male chasing sub-adult male away from an adult female (one without infant). However, no fighting was observed because the sub-adult always escaped and never fought back. Occasionally, the chased sub-adult males failed down onto the ground.

Travel of the species was mainly by jumping and quadrupedalism. Other travel or moving modes used included brachiation, occasionally observed in the beginning of escape, shifting up or down on tree trunks and also using two legs to jump when descending onto the ground (n = 7).

Although, travel time of G1 was higher than G2, the home range of G1 was smaller than G2. Therefore, in this regard, travel time did not affect the home range size of Red-shanked Douc Langurs. Red-shanked Douc Langur travels around certain mountain clusters rather than leaving far away from home.

The category “other” (n = 593) was excluded in the main activities, and included activities such as auto-groom, solitary play and sex, body contact, nipple contact etc. The auto-groom of adults was 38.9% (n = 251) and solitary play was 9.3% (n = 55).

6.4.3 Comparison of Time Budget of two Groups and Seasons

Based on the time count of adults from the same month period, the significant differences between the study groups were inactive (G1>G2) and feeding (G1<G2). There were not significant differences for social activity, traveling and sleeping (Table 6.3).

Table 6.3 Comparison of adult time budget between G1 and G2

Activity	Group 1		Group 2		STDEV±S.E.M	n	*p*-Value
	Count	Mean	Count	Mean			
Inactive	414	35	364	30	6.34±1.83	12	0.04
Sleep	258	22	344	29	11.62±3.35	12	0.56
Feeding	724	60	993	83	19.83±5.72	12	0.02
Social	112	9	106	9	3.26±0.94	12	0.60
Travel	245	20	190	16	5.86±1.69	12	0.20

The significant differences of time budget between the dry and wet seasons were inactive (Dry season>wet season), sleeping (Dry season<wet season), feeding (Dry season<wet season) and social activity (Dry season<wet season). Traveling was not different between the seasons (Table 6.4).

Table 6.4 Comparison of adult time budget between dry and wet seasons

Activity	Dry season		Wet season		STDEV±S.E.M	n	*p*-Value
	Count	Mean	Count	Mean			
Inactive	386	55.1	393	32.75	19.80 ± 8.85	12	0.01
Sleep	245	35	357	29.75	10.78 ± 4.82	12	0.00
Feeding	693	99	1024	89.33	23.01 ± 10.2	12	0.00
Social	108	15.4	110	9.16	3.42 ± 1.25	12	0.02
Travel	245	35	190	15.83	7.50 ± 3.35	12	0.91

6.4.4 Home Range

For their home range, although the two group sizes were different but their home ranges were not. The year round home range of Red-shanked Douc Langur was 292 ha as G1 was 282 ha while G2 was 303 ha (Table 6.5; Figure 6.5 and 6.6).

Table 6.5 Home range of Red-shanked Douc Langur G1 and G2

Season	Group 1 (19 animals)	Group 2 (39 animals)	Average
Dry season	229 ha	277 ha	253 ha
Wet season	70 ha	156 ha	113 ha
Both season	282 ha	303 ha	292 ha

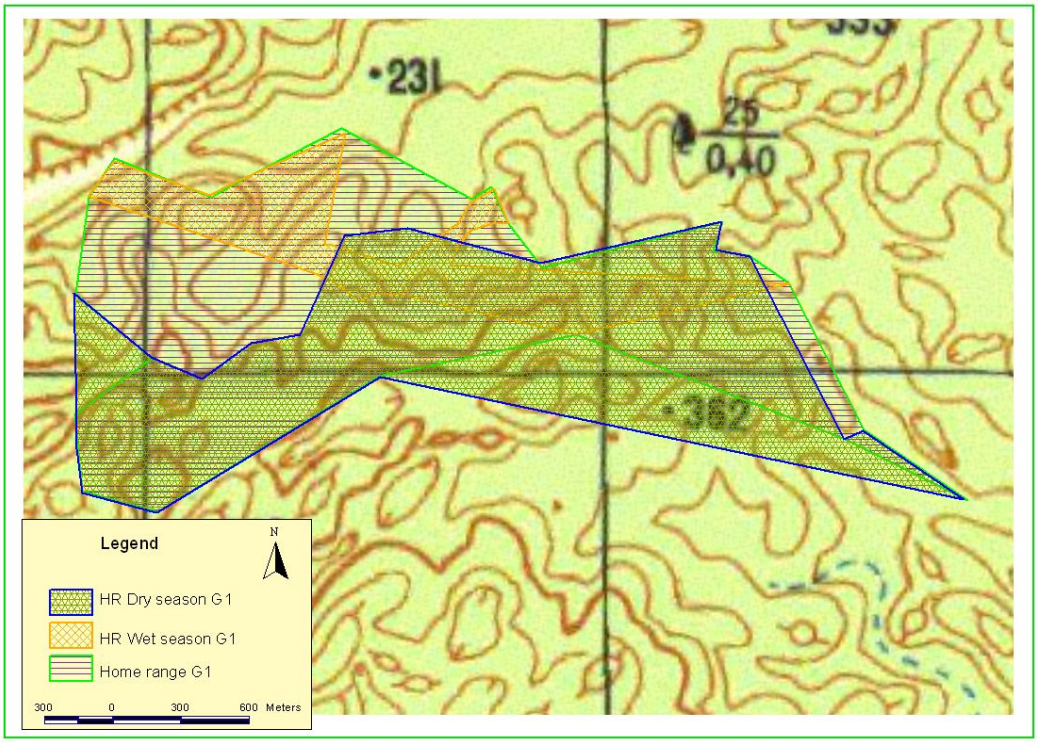

Figure 6.5 Home range of Red-shanked Douc Langur G1

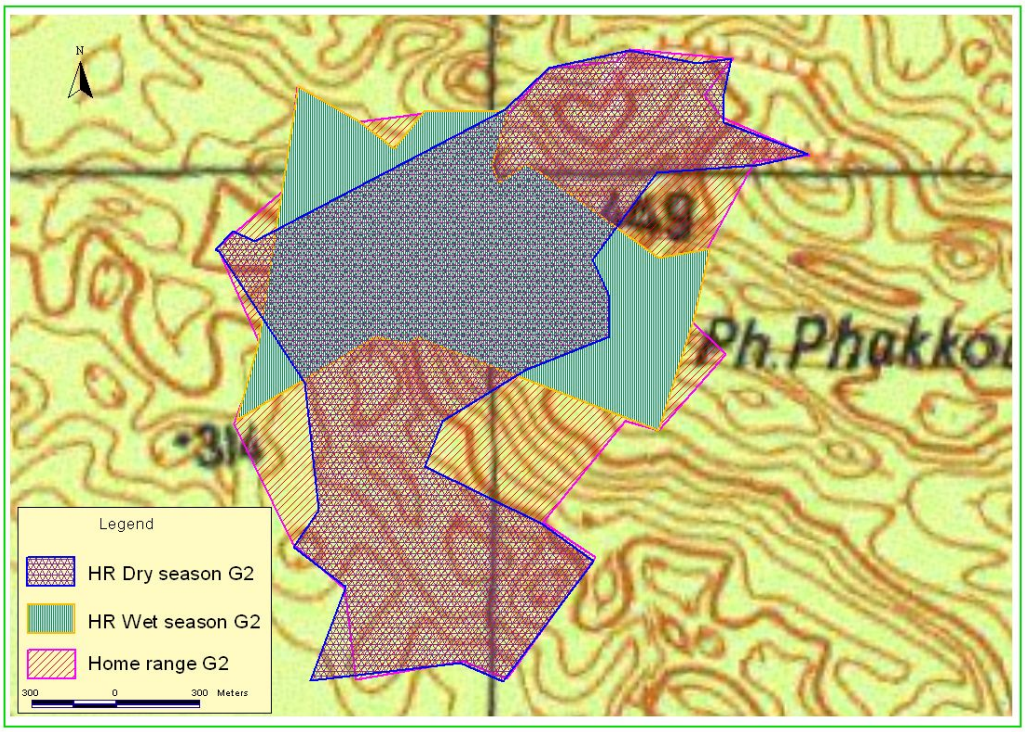

Figure 6.6 Home range of Red-shanked Douc Langur G2

6.5 Discussion

Feeding time accounted for as much as 39.5% of this species, exactly the same as the feeding time of Silvered Langur *Trachypithecus auratus sondiacus* in Indonesia (Kool, 1993). Some activity budgets of Black-shanked Douc Langur in Cambodia (Rawson, 2006). are different, particularly a resting proportion of 62% is very high compared to our study group We did not use and record “rest” for the Red-shanked Douc Langurs in Hin Namno NPA. In stead, we prefer to record “inactive” because our study site faces with ongoing hunting activity which makes the animals be always aware of predator vigilance. Therefore, we found that the animals stayed inactive accounts for 19% particularly for monitoring threats, or sleeping at noon (14%) along with other categories, consisting mostly of auto-grooming (14%).

The significant differences between the study groups in Hin Namno NPA were inactivity and feeding while the differences between the dry and wet seasons were all activities except traveling. The inactive mode is considered an important indication of threats between the study groups and between the seasons, because inactivity in this context indicates the animal awareness of dangerous threats. The higher percentage of inactive mode (predator vigilance), the more time that the animals used for monitoring threats. G1 has higher proportion of time of inactive mode since its location was in a higher threat area, receiving more pressures from hunting and human disturbance (5.6 individual threats per km). During the dry season, they were proactive monitoring for threats and feeding carefully because the number of hunters and people entering the forest increased during that time. Human disturbance also affected the proportion of animals' time and population fragmentation (Mbora and Keikle, 2004).

Although traveling time was not significantly different between seasons, traveling time was an important indicator for measuring the degree of threat and food availability, which is related to home range and group size (Li and Rogers, 2004). The traveling time of Red-shanked Douc Langurs is likely different from other monkeys and langurs because they have their established routes (Lippold, 1998) and always follow the first animal.

There were several types of traveling, depending on conditions and external factors. Jumping and quadrupedalism are two main traveling modes. Sometimes they can jump as high as 15–20 m from the high canopy to the lower canopy. The quadrupedalism was used where trees supported open branches while brachiating was occasionally noticed when they were facing humans immediately before they started

leaping. From observations, when their travel closed to a human track, they were very careful and moved faster. In this regard, it is very similar to the reports of the White-headed Langur in China (Li and Rogers, 2005).

Travel direction of Red-shanked Douc Langur differs between the wet season and dry season. During the wet season, the groups travel toward flat ground, and back to the limestone when they come across human. During the dry season, they travel in parallel with contour lines and at mid-limestone hills, especially between March and May (Figure 6.7). Interestingly, the travel system of the species for the group with high human pressure G1 is “move-monitor-forage-monitor-feed-monitor-move-monitor”. In monitoring mode, they often look underneath and backwards. This observation made the team understand their habits better. The observation of the unaccustomed animals from the sidelines or in front of their direction was much more successful than following the group.

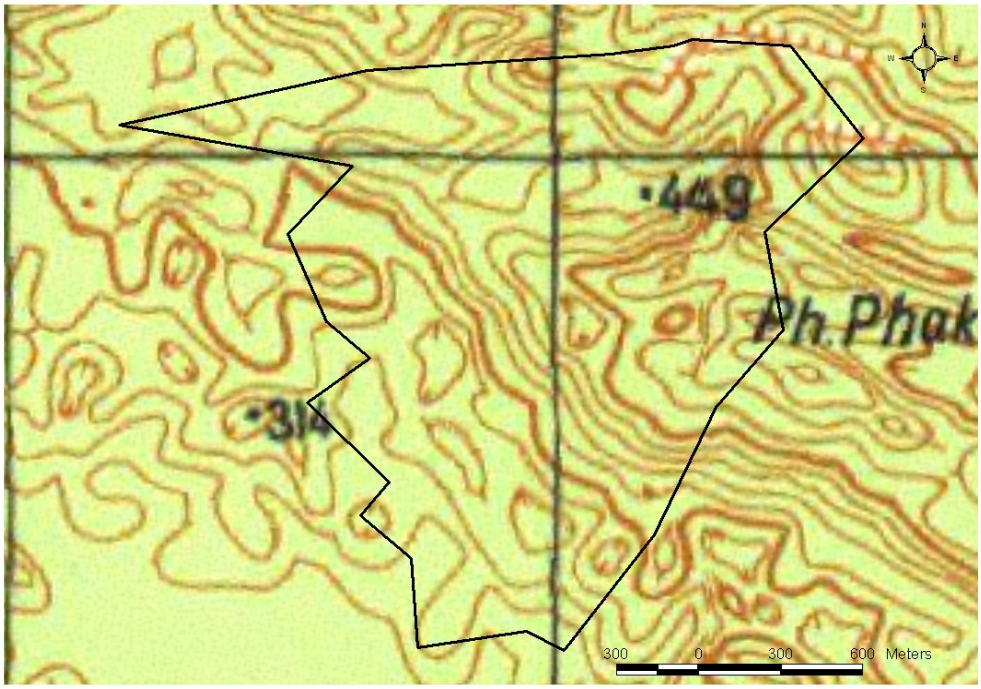

Figure 6.7 Map of travel direction of Douc Langur in Hin Namno NPA

Despite the different group size between G1 and G2, group size did not affect Red-shanked Douc Langur home range. Both study groups had similar home range size. In reality, G1 spent more time in traveling than G2, but the group moved around certain mountain clusters, rather than going far away from their central home range. In this regard, the need to travel long distances to search for food, resulting in a larger home range, is opposite of other primates (Fashing and Cords, 2000). Some primate species have to travel faster and longer for certain purposes, such as Phayre's Langur, which travels to a saltlick area as a need of mineral intake, resulting in a larger home range (Pages *et al*., 2004). The Red-shanked Douc Langur has never been observed using mineral licks.

G1, the smaller group, had less time feeding than the larger group G2 because G1 spent time traveling around a few mountain clusters in foothills and on flat ground during the wet season when more fruits are available. At this time, it was easier to detect the animals because they paid more attention to feeding than to being afraid of people. During the dry season, the animals preferred to live in upper hills where some new young leaves and shoots are available. During wet season, the animals mainly eat fruit pulp and seeds or both. They also ate major parts of some food trees including leaf buds, young leaves and fruits. For example, they fed on Dok khamma, *Paranephelium spirei,* Lecomte (Sapindaceae), *Ficus* sp. and Khoypha. *Ficus* is considered a stable food for primates because it provides fruits over the entire year (Yimkao and Srikosamatara, 2006; Bhumpakphan, 2008).

Due to threats, they did not like to stay long for feeding in certain areas. The sound of footsteps was critical for the species to be aware of dangers. Red-shanked Douc Langur had no alarm call. The calls were often made by other animals (squirrels

and small black birds). Human disturbance and hunting activity are major problems in Hin Namno NPA. The long-term impacts on the populations of animals are foreseeable. When habitat changes, scarcity of food is another problem. For example, White-headed Langurs in China is a group in a low quality habitat that has a high proportion of feeding time and a low proportion of playing time (Li and Rogers, 2004).

Seasonal change had no impact on time budgets of Red-shanked Douc Langur in Hin Namno NPA and the social activity occurred only in trees. There are similar to the study on White-headed Langurs, where limestone formations are used only for refuge (Li and Rogers, 2005), as whenever there is an absence of humans, the animals descend to the flat ground. However, Black-shanked Douc Langurs in Vietnam prefer to take a rest as a major activity (62%) (Rawson, 2006) and the resting place and social activity takes place on rocks (Nadler, 2008), which is incomparable to the Red-shanked Douc Langur in Hin Namno NPA.

Time budget is different for species, location and season. Many primates use the highest proportion of their time for feeding and resting (Qihai *et al*., 2007). In accordance with Lippold (1995), diurnal and arboreal animals, including colobid groups, spend at least 50% of the day feeding in the wild. However, studies do not indicate if feeding in this context includes foraging.

6.6 Conclusion

Red-shanked Douc Langurs spend the majority of their time for feeding (39.5%) and inactivity (18%). The differences between the two study groups were in inactive mode, traveling time and feeding while not different in social and sleeping

activity. Human pressure and season can change its behavior. For all age classes, grooming was considered low. Adults, especially adult males, spent the highest amount of time for inactivity – monitoring for threats and taking care of the group. In this connection, inactivity is a likely indicator of the level of threat or human pressure. For examples, G1 suffered from threats more, and spent more time for inactivity, especially during the dry season. During the wet season, they preferred to live in foothills and on the flat ground, away from limestone, whereas during the dry season they resided at mid to upper limestone hills. whatsoever, differences in habitat and geographic conditions may generate some differences in relation to animal behavior, particularly between limestone and non-limestone habitats or between habituated and unaccustomed groups.

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CHARPTER VII

FOOD PLANTS OF RED-SHANKED DOUC LANGUR IN HIN NAMNO NATIONAL PROTECTED AREA, LAO PDR

7.1 Abstract

Foods of Red-shanked Douc Langurs were identified from plot study and during the observation of two study groups in Hin Namno National Protected Area from March 2007 to June 2008. A total of 189 tree species were identified, of which 146 were located in the research plots, with 112 species used by Red-shanked Douc Langur. The distribution of food plants is not random; some food trees were abundant while some were not. The families with more number of food plants were Sapindaceae, Fagaceae, Meliaceae, Moraceae, Ebenanceae and Euphorbiaceae. Many food plants identified provided only fruits (36.6%), only leaves (25.89%) and both fruits and leaves (9.87%). The fruit season is mostly from May to August and this period is considered masting fruit period for the douc langur. There were 24 plants considered favorite foods for Red-shanked Douc Langurs, including Mak dang in Flacourtiaceae, Ko Namtao (*Quercus aliena* Blue) in Fagaceae and Dok khama (*Paranephelium spirei* Lecomte) in Sapindaceae. The fruits of all plants, except Mai Kean Luang (*Nauclea orientalis* (L.) L.) were eaten. Ripe fruits were mostly chosen while pulp and seeds of some unripe fruits, and some young fruits were also

consumed. In addition, the fruits that the animal likes most were sour taste of unripe fruits and then sweet.

7.2 Introduction

Food resources are essential to living wild animals, and mark the carrying capacity of habitats. Understanding food plants of Red-shanked Douc Langur is important to obtaining knowledge on its distribution. Food availability depends on habitat quality, which can shape changes in primate activity budget, notably social activities (Li and Rogers, 2004). Also, Martin (1982) reported the proportion of time used for playing of animals decreased when food availability declined. In addition, higher numbers of food plants used and large home range is an indicator of species that have eaten a large quantity of fruits (Martin, 1982).

So far, very few scientific studies on Red-shanked Douc Langur in the wild have been undertaken. Although some of its diet was studied in Vietnam (Pham, 1993) and field observations were conducted in the last decade, the food of this langur, especially in limestone habitat, has not been studied before. In the meantime, understanding the feeding ecology of wildlife, particularly primates, is important for their conservation. Food pattern findings reveal level of habitat quality, diversity of plant used for diet and level of threat (Strier, 2003). Therefore, the aims of this study were to examine the food plants Red-shanked Douc Langur used and the relationship of food availability and the presence of the animal.

7.3 Methodology

7.3.1 Study Area

Hin Namno National Protected Area (NPA), located at 17°15´–40´ N and 105˚43´–106˚09´ E has an area of 820 km^2 with an average elevation of 421 m above sea level, ranging from 200 m to over 1,000 m (Timmins and Khounboline, 1996). It connects with the international borders of Phong Nha Ke Bang Natural World Heritage site in Vietnam (Figure 7.1). This NPA lies entirely within the Bualapha district of Khammouane Province.

Figure 7.1 Locations of plant study plots in Hin Namno NPA

Human population in Hin Namno NPA is considered low, with a little over 7,000 people in 22 villages. However, no villages are located inside the area. The Hin

Namno NPA is mainly dominated with steep slope mountains and outcrops in upper hills with outstanding scenic values. A range of vegetation covers from bare rock to shrubby forest, and flat lowlands broken by sporadic karst outcrops. Lower areas around foothills are mostly evergreen forest, where tall trees can be found. The limestone mountains, especially the central and some northern parts of the area, are covered with tall closed canopy evergreen forest, semi-evergreen forest and mixed deciduous forests. Nonetheless, patches of secondary and degraded forest are also found in the area (Timmins and Khounboline, 1996). Because some tribal inhabitants (*Salang*) used to live and cultivate inside the area; some scattered areas are covered with old fallow more than 40 years old.

Between February 2007 and March 2008, the current records at Ban Vangmaneu, the village research base in Hin Namno, showed that the annual average temperature was 25.0°C and the daily temperature ranged from 11°C in January to 40°C in April. The annual rainfall recorded was 1,480 mm while the monthly rainfall ranging from 1.1 mm in February 2008 to 297.4 mm in October 2007.

7.3.2 Field Study

Two data collecting techniques, plant plots and direct animal observations through scan sampling (Altmann, 1974), were conducted to identify food plants of Red-shanked Douc Langurs in Hin Namno NPA.

Plant plot: A total of six 50x50 m^2 plots were selected at C1 (plot 1), C2 (plot 2), C6 (plot 3), C4 (plot 4), C5 (plot 5 and 6) in February 2007 (Figure 1). Each plot was divided into 25 smaller 10x10 m^2 blocks, and all trees with 10 cm or more diameters at breast height (DBH) were measured. The measurements included tree

size, height and canopy by a rangefinder and tape. Habitat structure of each plot was sketched. Where possible, leaves and fruits were photographed. Tree specimens were collected and labeled with the tree numbers and local names then sent to Kasetsart University in Thailand for identification.

Three plant plots at C 4 (plot 4) and C 5 (plot 5 and 6) were monitored for their flowering and fruiting times, especially for trees that Red-shanked Douc Langurs used. Phenology observations were conducted regularly each month by using binoculars to scan each identified tree, particularly those used by Red-shanked Douc Langurs. Seasons of blooming, fruiting and ripening were recorded regularly.

Frequency and density of plant species in the study plots were calculated by using the following equations:

$$\text{Frequency} = \frac{\text{Number of plots having plant A}}{\text{Total number of sampling plots}} \times 100\%$$

$$\text{Density} = \frac{\text{Number of plant species A}}{\text{Sampling area}} \quad \text{(tree/ha)}$$

Plant plot descriptions are presented and compared among the study plots. All food plants which were used by Red-shanked Douc Langur were presented in number and percentage. Food plants which had high frequency use by the animal and which the animal took time for feeding each time are considered important food plants (food plants that the animal used more than 3 times). These important food plants can be called a favorite food of Red-shanked Douc Langur. The food plants identified from

the study plots were summarized and compared to the trees used by the animal from direct observations.

Scan Sampling was part of the animal behavior observations in which the data was recorded for a maximum of 10 minutes for every 30 minute-intervals from two animal groups. Group 1 (G1) had 19 individuals and Group 2 (G2) had 39 individuals. Behavior data were collected between March 2007 and June 2008 by using binoculars (10x40 mm) to identify the activities and food plants they used. When the animals were observed in feeding, local villagers gave the local names of the tree immediately. If any plants was unidentified by local name, the tree was marked and identified later with local botanists. At the time of the observation, food types and food ages were also identified. The records of food plant species were made every time the animals changed eating from one food plant to another food plant or moved to feed in other trees.

The scan sampling helped us to know which food plants that the animal used. Also, the plant part used, including fruits, leaves, leaf buds or flowers were noted. In addition, foods used most by the animal during the wet season were directly tasted as to understand what taste they preferred most.

7.4 Results

These 6 plots were located in different study camps, of which 3 plots were at lower altitude (200 m) and other 3 at higher altitude (500 m). Most plots were evergreen forest except plot 1 and 3 as hill evergreen forest. All plots have 3-4 canopy layers (Table 7.1). Each plot different slope degree, number of trees present and

emergent trees. The plot 5 and 6 at C5 had highest number of tree counted and the highest number of tree species identified was the plot.

Table 7.1 Details of plant study plots in Hin Namno NPA

Plot	Camp	Altitude (m)	Slope (degree)	Habitat	Canopy layers	No. tree count	Tree height	Tree species	Emgt tree spp.
1	1	526	10	H	3	98	36	33	7
2	2	506	2	E	4	115	44	38	18
3	6	205	20	H	3	91	38	43	17
4	4	220	12	E	3	86	40	44	7
5	5	253	10	E	3	121	36	40	21
6	5	520	0	E	4	129	42	53	25

Remarks: H = Hill evergreen , E = Evergreen forest, Emgt = Emergent

7.4.1 The Dominant Trees in Study Plots

Distribution of most trees was not random in Hin Namno NPA, as some species were recorded in high density in one plot but not in other plots. From a total of 649 trees found, Dok khama *Paranephelium spirei* Lecomte was the highest percentage 31.36% (53 counts), then Maidang *Flacourtiaceae* 18.34% (31 counts), Khoypha 17.16% (29 counts), Koukha 15.38% (26 counts), Pieuy nam *Lagerstroemia floribunda* Jack sec. Griff. 12.43% (21 counts) and Mai yai 11.83% (20 counts).

The most common plant species are Tasua khao *Vitex glabrata* R. B. R., Khoypha, Maidang (Flacourtiaceae), Koukha *Pometia pinnata* J. R.&G. F., and Pieuy nam *Lagerstroemia floribunda* Jack sec. Griff. (Table 7.2)

Dok khama (*Paranephalium sperei* L.), however not common, has the highest density (8.83 trees ha^{-1}). It was mostly found in the lower altitude as high number in plot 4 and 5, but none of them were found in plot 1 and 2.

A total of 189 plant species of 36 families were found in Hin Namno NPA, of which 146 species were identified from 649 trees counted from the study plots. Some plant species used by the langur beyond the study plots were also included on the food plant list of the Red-shanked Douc Langur.

Table 7.2 The most common tree species identified in the study plots

Local name	Scientific name	Frequency (%)	Density (tree ha^{-1})
Tasua khao	*Vitex glabrata* R.B.R	100.0	5.67
Khoy pha	Maroceae	83.3	4.83
Mai dang	Flacourtiaceae	83.3	5.17
Koukha	*Pometia pinnata* J.R.&G.F.	83.3	4.33
Pieuy nam	*Lagerstroemia floribunda* Jack sec. Griff.	83.3	3.50
Khaune louy	unidentified	83.3	2.50
Dok khama	*Paranephalium sperei* L.	66.6	8.83
Kouy hen	*Mitrephora vandaeflora* Kurz	66.6	2.17
Mai heart	*Knema pierrei* Warb.	66.6	2.00
Chakium	*Nephelium* spp.	66.6	2.00
Derman	*Quercus aliena* Blume	66.6	1.67
Mai An	*Memecylon scutellatum* (Lour.) Hook. & Arn.	50.0	2.17
Deng dong	*Walsura robusta* Roxb	50.0	1.67
Maihat	unidentified	50.0	1.17
Maikou	Sapindaceae	50.0	1.17
Makfai	*Toona ciliata* M. Roem	50.0	1.33
Tongmop	unidentified	50.0	1.33
Mai moun	*Elaeocarpus concinnus* S. Moore	50.0	0.50
Tinpet	*Vitex* spp.	50.0	0.50
Hepha	*Mitrephora* sp.	50.0	1.50
Kasin	Sterculiaceae	50.0	1.00

A total of 112 food plant species from used by Red-shanked Douc Langur, these food plant species belong to 25 families (Table 7.3) were identified while the rest were known only by family names or even in local names. The families which had the highest number of food plants species were Sapindaceae, Fagaceae and Meliaceae

Table 7.3 Food plants used by Red-shanked Douc Langur identified in family

Family	Number of tree species	Percentage	Family	Number of tree species	Percentage
Sapindaceae	6	5.35	Dipterocarpaceae	2	1.78
Fagaceae	6	5.35	Simaroubaceae	2	1.78
Meliaceae	6	5.35	Maraceae	2	1.78
Moraceae	4	3.57	Rhamnaceae	2	1.78
Ebenaceae	4	3.57	Opiliaceae	1	0.89
Euphorbiaceae	4	3.57	Burseraceae	1	0.89
Annonaceae	3	2.67	Loganiaceae	1	0.89
Sterculiaceae	3	2.67	Labiatae	1	0.89
Rubiaceae	3	2.67	Anacardiaceae	1	0.89
Lauraceae	3	2.67	Staphyleaceae	1	0.89
Myrtaceae	3	2.67	Myristicaceae	1	0.89
Celastraceae	3	2.67	Flacourtiaceae	1	0.89
Tiliaceae	2	1.78	Other (unidentified)	46	41.07

Many food plant species provide only fruits or leaves while some plant species provide both fruits and leaves (Table 7.4). However, (Dok Khama *Paranephalium sperei* L) provides leave, bud, flower, fruit and seed. From the scan sampling we identified various food plants used by Red-shanked Douc Langur. Some these plants were used only in wet season particularly the species that provide fruits. Therefore, during the wet season, 55 of 112 plant species were used by the animal. Whereas during dry season, the leaves and other parts were mostly used. Sometimes, the animal used fruits, and leaves during dry season.

Table 7.4 Proportion of various food parts used by Red-shanked Douc Langur

Food part	Number of food plant species	Percentage
Fruit	41	36.60
Leave	29	25.89
Leave and fruit	11	9.82
Fruit and seed	8	7.14
Leave and bud	6	5.35
Bud only	5	4.46
Leave, flower and fruit	3	2.67
Leave, fruit and seed	3	2.67
Leave, fruit and bud	3	2.67
Fruit and bud	2	1.78
Seed only	1	0.89
Leave, flower, fruit, seed and bud	1	0.89

Twenty four favorite food plants were identified (Table 7.5). The most favorites are Maidang *Flacourtiaceae* spp. Ko Namtao *Quercus aliena* Blue, Dok khama *Paranephelium spirei* Lecomte, Khoypha, Mai ho, Kou kha *Pometia pinnata* J. R. & G. Forst, Kham thap *Dialium indum* L., Hepha *Mitrephora* sp. and Deangdong *Walsura robusta* Roxb. These favorite food plants were identified when we found the use the same food plants more than 3 times and each over one hour. Many of these food plants were found in the study plots; nevertheless, three of them were not present in the study plots. Often, Red-shanked Douc Langurs were observed to take time for feeding these favorite food plants so that they did not eat many food plants just up to 10 food plants per day, during the wet season.

Table 7.5 Favorite food plants of Red-shanked Douc Langurs in Hin Namno NPA

No	Local name	Scientific name	Plants used by douc		Plant found in the plots	Food parts	Flowering and fruiting period												Taste
			A	B			J	F	M	A	M	J	J	A	S	O	N	D	
1	Mai dang	Flacourtiaceae	37	15.4	YES	fr													Sour
2	Ko Namtao	*Quercus aliena* Blue	29	12	YES	fr													Normal
3	Dok khama	*Paranephelium spirei* L.	18	7.5	YES	le, bu, fl, fr													
4	Khoypha	Moraceae	17	7.1	YES	le, bu, fl													Normal
5	Mai ho	unidentified	15	6.2	YES	fr													Sour
6	Koukha	*Pometia pinnata* J. R.	14	5.8	YES	fr													Sour
7	Khamthap	*Dialium indum* L.	12	5	NO	fr													Sour
8	Hepha	*Mitrephora* sp.	11	5	YES	fr													Normal
9	Deangdong	*Walsura robusta* Roxb.	10	4	YES	fr													Sour
10	Mai hai	*Ficus* sp.	9	4	YES	le, fl, fr													Sweet
11	Mai wajoy	*Syxygium lineatus* (LPN)	8	3	YES	le, fr													Sweet
12	Kouy hen	Annonaceae	8	3	YES	fr													Sweet
13	Kaen luang	*Nauclea orientalis* L.	7	3	YES	le													Normal
14	Mai do	Moraceae	6	3	YES	le, fr													Sour
15	Mak kou	Sapindaceae	5	2	YES	fr													Sour
16	Der man	*Quercus* sp.	5	2	YES	fr													Sweet
17	Hang hen	*Diospyros* sp.	5	2	YES	fr													Sour
18	Mak ham	unidentified	4	2	YES	le, fr													Normal
19	Kho lan	*Aglaia samoensis* A. G.	4	2	YES	fr													Sour
20	Mai yai	*Syxygium* sp.	4	2	YES	fr													Normal
21	Mak ngoh	Bignoniaceae	3	1	YES	fr													Sour
22	Chong yai	Tiliaceae	3	1	NO	fr													Sweet
23	Chong pha	unidentified	3	1	NO	fr													Sweet
24	Ngeo phoh	Meliaceae	3	1	YES	fr													Sour

Remarks: A = accumulated number of count time the animal used the plant, B = percentage of number of count time that the animal used the plant
le = leave, fr = fruit, bu = bud, fl = flower. Favorite food plant is the plant that used by the animal more than one hour per time and that recorded more than 3 times for the same tree species during the observation.

7.4.2 Food Taste

From the tasting of 24 favorite food plants, Red-shanked Douc Langurs preferred most sour (44%), sweet (28%) and the rest for normal and other tastes (Table 7.5). The sour taste was mostly from unripe fruits, but some ripe fruits were also sour. For unripe and young fruits, often the whole fruit or just seeds were consumed, while sweet tastes came mostly from the pulp of ripe fruits. During the wet season, the animal used mostly fruits, only 6 food plants had both leaves and fruits. All fruits from the food plants were considered not poisonous and preliminary it can be said that the major proportion of the food plants of Red-shanked Douc Langur is edible. However, many plant leaves consumed by the animal were not tasted. Therefore, it is uncertain whether or not some of them might be poisonous to human.

Most of favorite food plants produced flowers in April and fruits from May to August (Table 7.5). Therefore, douc langurs had plenty of food during the wet season. However, some plants produced fruits throughout the year. They are Maihai *Ficus* spp., Maido *Ficus* spp., and Der man Fagaceae (family). Therefore, these plants may be a food source for Red-shanked Douc Langurs all year round.

7.5 Discussion

Tree distribution in Hin Namno NPA varies depending on topography and the level of altitudes. More number of tree species in evergreen forest found at lower altitude and some flat ground. The fruit trees often found at lower altitude such as Dok khama *Paranephelium spirei* Lecomte and Khoypha had the highest number of encounter rates at the plant plot 4 and 5. Although, Tasuakhao *Vitex glabrata* R. B. R is the highest frequency because it found in every plant plots but, it density is low.

Whereas, Dok kham is the highest density (8.83 trees ha^{-1}) but it was not found in some plant plot.

Foods of Red-shanked Douc Langurs are diverse with 112 out of 189 tree species found in the study areas. Such number is considered high. Some plant species collected has not yet been identified because we need fruits and flowers for identifying the specimens. Anyway, the food plants counted in Hin Namno NPA is considered higher compared to only 50 species reported in Vietnam (Pham, 1993). Additionally, The Red-shanked Douc Langur in Hin Namno NPA consumed more food plants than Black-shanked Douc Langur (84 species) in non-limestone habitat in Vietnam (Hoang and Baxter, 2006) but lower compared to the recent confirmation as 152 food plants used by Black-shanked Douc Langur in Vietnam (Hoang *et al*., 2009). So if more effort and time were used, more food plants could be identified. For other langur species, the Red-shanked Douc Langur in Hin Namno NPA langurs used more number of food plant species compared to that White-headed Langurs (50 species) in Fusui limestone in China (Li and Rogers, 2004) and over 80 food types which were used by Capped Langur (Stanford, 1991).

Douc langur is recently confirmed as foraging species (Hoang *et al*., 2009); nevertheless, during the wet season this animal is considered frugivore because it used most fruits. If the fruits are available over the year round this animal would prefer fruits. Proportion of fruits and leaves used by douc langur is almost the same as in Vietnam (Hoang and Baxter, 2006) and likely in Cambodia (Rawson, 2007). The fruits season is between May and August while some species starts earlier. Importantly, *Ficus* spp. found in Hin Namno NPA provides fruits all the year round for primates and birds. The *Ficus* spp. gives fruits 3 times a year but that not meant

one *Ficus* spp. can provide fruits three times per year. It changes in rotation amongst different *Ficus* tree species and individual trees.

Favorite food plants of some wild animals are important to study because it is a need to pay more attention if these foods are well protected for the sake of the research animal. However, the term of favorite foods are not recently well defined and agreed. Locally, we understand that any foods that the animal used most are the favorite ones. In this regard, we identified some favorite food plants of Red-shanked Douc Langur in accordance with their feeding times taken in more than 1 hour a time and that at least 3 time counts during the one year observation. While, Hoang *et al*., (2009) reported that there has no favorite food for Black-shanked Douc Langur in Vietnam. Anyway, based on the perception above, the favorite foods of Red-shanked Douc Langurs in Hin Namno NPA is the food plants that the animals taking time and enjoy feeding.

The favorite food plants occur mostly in the wet season, except Mai Kean Luang *Nauclea orientalis* (L.) L. Nevertheless, some food trees were used in both seasons, such as *Ficus* spp. Recent studies in southern Vietnam also found that Red-shanked Douc Langurs used similar food plants, such as *Fagaceae* spp., *Ficus* spp., and *Syzygium* spp. (Dinh *et al*., 2008). In addition, many studies indicate that *Ficus* spp. are considered a stable food and are available all year round (Yimkao and Srikosamatara, 2006; Bhumpakphan, 2008). So the family Moraceae is important for douc langur (Hoang *et al.*, 2009), because various species in this family provide fruits and young leaves all the year round.

Importantly, In Hin Namno NPA, the plant families that contribute high number of food plants for Red-shanked Douc Langur were Sapindaceae, Fagaceae,

Meliaceae, Moraceae and Euphorbiaceae. While Black-shanked Douc Langur in Vietnam used mostly the plant species from Moraceae, Euphorbiaceae, Anacardiaceae and Rutaceae (Hoang *et al.*, 2009).

During the wet season Red-shanked Douc Langurs selected certain food plants and not over 10 plant species per day but the animal take time for feeding one food tree. Often, it takes 1-2 hours per food plants per time for feeding. This finding disagrees with the current research on Black-shanked Douc Langur in Vietnam where they found the species used more diverse diets in the wet season (Hoang *et al*., 2009). On the other hand, they used a greater number of food plants in the dry season, particularly leaves but did not take much time for each food item. Fruits available in the wet season might provide higher quantity of fibers or nutrients. Fruits with high nutrients are considered an important and stable food for animals (Strier, 2003). Surprisingly, at the beginning of dry season between December and January, Red-shanked Douc Langurs were occasionally observed to feed on ground weeds which we found 7 times, like Black-shanked Douc Langur in Southern Vietnam (Hoang *et al*., 2009).

Previous reports show that some langurs can eat poisonous foods because they have a special chambered stomach (Pham, 1993). However, the finding from the group of Red-shanked Douc Langur in Hin Namno as its foods is considered edible, except Tasuadam (*Dysoxylum* spp.) in the family Meliaceae. From the direct taste testing we can suggest that many of the food plants of Red-shanked Douc Langur have no poisonous. Only be aware that the Tasua dam is hard taste, which the tree species was occasionally used by douc langurs during wet season. However, we considered it is inedible and probably poison. We were also told by local hunters that

several cases of local villagers got poison from eating Stripe-headed Black Langur's meat. Tasua dam is used a lot by this black langur. That is why local villagers experienced food poisoning from eating a stomach of the black langur during fruiting season.

7.6 Conclusion

The distribution of plants is not random in Hin Namno NPA and that similarly to the food plants used by Red-shanked Douc Langur. Some plants were found in every plant plot but some plants were found in some plots. Many food plants provide only fruits or leaves. Some of them provide both fruits and leaves which are considered important species. Moreover, very few species provide many plant parts, including leaves, buds, flowers, and ripe fruits. These plants provide foods for Red-shanked Douc Langurs all year round such as Dok khama, Khoypha, and *Ficus* spp. In addition, favorite food plants of Red-shanked Douc Langurs identified are considerably more important for not only the species, but also other primate species during the wet season and the breeding seasons. Therefore, maintaining these plant species in their habitats can contribute to the conservation of primate in Hin Namno NPA as a whole.

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CHAPTER VIII

THREATS OF RED-SHANKED DOUC LANGUR AND OTHER WILDLIFE IN HIN NAMNO NATIONAL PROTECTED AREA, LAO PDR

8.1 Abstract

Due to the high demand of wildlife markets from Vietnam and China, along with the loss of biodiversity in the Lao-Vietnam border areas, wildlife threats are of high concern. The threats were identified from 10 study sites located in Hin Namno national protected area, from February to December 2007 accompanied with interviews in eight villages. The surveys showed 458 individual threats (0.32 individual threat/km walk), mainly hunting camps, snare lines and gunshots. The sites closest to any Vietic communities had the highest number of threats. A total of 46 wildlife species were harvested and traded from the Hin Namno NPA, of which 18 animal and 12 plant species are in the IUCN Redlist and CITES, respectively. When aid project funding ended in 2006, village patrol effort dropped from 27 trips in 2003 to 4 patrols in 2007. Hunting has increased; all primate species are being hunted and frequently traded. Wildlife is hunted by people from both Laos and Vietnam, but trade in wild animals, particularly primates, is mainly carried out by the Vietnamese. The correlation between wildlife hunting and trade is related to crop season, being more frequent when farmers are not engaged in farm activities.

8.2 Introduction

Wildlife hunting and trade along Lao PDR's eastern border, 2,130 km from the north "triangle of Lao-Vietnam-China" to the south "triangle of Lao-Vietnam-Cambodia," has been suspected to be high. Six international and ten local border checkpoints have been established along the border, where they also function to check for trade in forest and wildlife products. In 1998, the annual wildlife trade crossing Nam Phao check point of Lak Sao (Kham Keut district, Bolikhamxay Province) from Laos to Vietnam was estimated to be worth US$ 11.8 million (Compton *et al*., 1998). Access along such a long border is hard to control due to free access. Since the mid 1980's, Vietnamese poachers have been entering Laos to illegally harvest forest products (Nooren and Claridge, 2001) as well as purchasing wildlife and wild plants. All protected areas in Laos within 10 km from the border have been disturbed by Vietnamese people (Robichaud and Stuart, 1999). Declining natural resources and stronger law enforcement in Vietnam push Vietnamese traders and hunters into Lao territory for the illegal wildlife trade that consequently makes a greater impact on wildlife and forest resources in Laos.

The increase of threats is due to increased market demand, particularly for medicine, then for food and lastly for pets (Gonzalez, 2003; Li and Li, 1998), which can have a significant impact on biodiversity (Milner-Gulland and Bennett, 2003; Peres, 2001). Wildlife trade has been debated for long time as the root cause of species loss, and is influenced by increased prices being paid for wild animals and their products due to a change from local household consumption to trade (Roberton *et al*., 2003).

The wildlife trade is well organized, and despite attempts to enforce measures to combat the illegal trade, the shipment of wildlife products and communication within the network is now highly developed. It is considered second only to narcotic trafficking and is actually in parallel with the drug trade due to lucrative market prices (Lin, 2005). Wildlife trade is increasing in the region due to high demand from China and Vietnam. In order to suppress the trends of wildlife trade along the Lao-Vietnam border, the Cooperative Action Plan between the Government of Laos and Vietnam was made in 2004 for the period of 2005–2010. So far, the action on the ground in accordance to this cooperation has been insufficient.

The understanding of wildlife trade and its relation with wildlife hunting and threats is vitally important to formulate the wildlife conservation legislation to ensure the sustainable use of wildlife. Therefore, this investigation was to examine the main threats and their magnitude to Red-shanked Douc Langur and other wildlife in Hin Namno NPA and Na Phao Lao-Vietnam checkpoints, Khammouane Province.

8.3 Methodology

8.3.1 Study Area

Hin Namno NPA (total area of 820 km^2) is located in Boualapha district, Khammouane Province in central Lao. The area lies within the largest limestone region in Southeast Asia and adjoins the international border with Phong Nha Ke Bang Natural World Heritage Site in Quang Binh Province, Vietnam. The NPA is located at latitude 17°15′–40′ N and longitude 105°43′–106°09′ E, and ranges in altitude from 200 m to 1,000 m above sea level (a.s.l.). Hin Namno NPA is limestone

habitat of which the central and some of the northern limestone mountains are covered with tall closed-canopy evergreen forest, semi-evergreen and mixed deciduous forests.

There are at least 10 primate species recently confirmed in the area. The site is also one of the most significant places for the conservation of Red-shanked Douc Langur and Stripe-headed Black Langur, along with other important birds and mammal species (Timmins and Khounboline, 1996; Thewlis *et al*., 1998; Timmins and Duckworth, 1999; Walston and Vinton, 1999).

The study areas were located in the northwest part of Hin Namno NPA, where eight villages were located within 10 km of Lao-Vietnam border. The villages included the Phuthai, Yoy, and Salang ethnic groups (Figure 8.1).

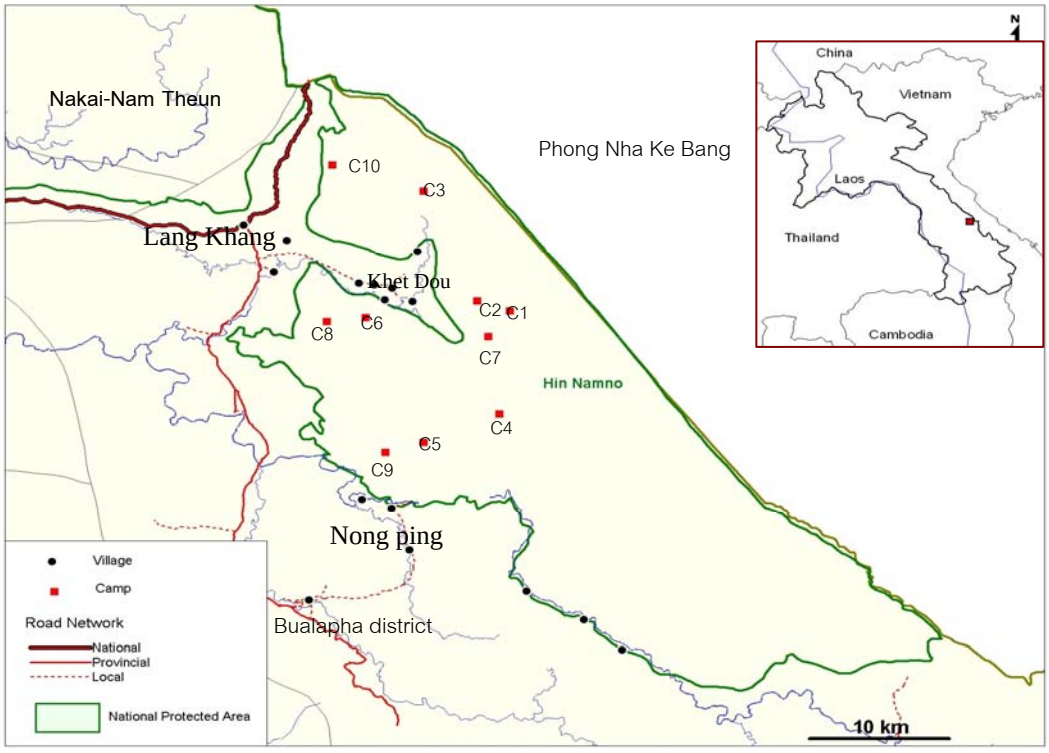

Figure 8.1 Map of the study camps in Hin Namno NPA

8.3.2 Transect Walk and Villager Interview

Conditions of each study camp were obtained, such as distance from the study camps to the Lao-Vietnam border and local communities. The distance was measured on a topography map. Along with primate surveys, the threat identification was conducted in parallel between February and December 2007. Ten study camps in the northwest Hin Namno NPA were selected and 25 transect lines were walked three times to cover a total of 142.8 km.

Direct observations and village interviews on wildlife trade and hunting were conducted periodically from February 2007 to March 2008 in eight villages, mainly Ban Dou, Ban Vangmaneu, Ban Salang and Thongxam. Semi-structured interviews, informal group discussions and individual discussions were held with local hunters, traders and local villagers, including children, who often provided valuable clues about wildlife trade, and with village chiefs to cross check the data (Table 8.1).

Table 8.1 Survey villages in Northern Hin Namno NPA

No	Village	House-hold	Poor HH	People	Female	Motor bike	Hand tractor	Cattle	Hunter Interv.
1	Nong Bua	90	n/a	494	272	11	8	210	3
2	Pha Nob	88	n/a	405	203	9	9	102	2
3	Nongseng	46	21	237	203	6	4	43	2
4	Nong No	56	13	285	174	11	7	70	3
5	Ban Dou	88	17	430	225	28	17	274	5
6	Vangmaneu	42	14	169	97	15	13	86	6
7	Salang	28	28	108	59	0	2	14	5
8	Thongxam	61	18	301	157	13	15	112	3
Total		499		2,429	1,316	93	75	911	29

During the interviews, the identification of wildlife was confirmed by using *Mammals of Thailand and Southeast Asia* (Francis, 2000), *Birds of Lao PDR* (Svengsuksa *et al*., 2003) and *Turtles of Thailand, Laos, Vietnam and Cambodia*

(Stuart *et al*., 2001). Wildlife species found in trade during the surveys were identified and verified with these guidebooks. A price per kg of wild animals and their parts were obtained based on the hunters' reports. Logbooks were used to record primates hunted and presented in the surveyed villages. Government officers (foresters) at Lang Khang sub-district, and at Na Phao checkpoint, along with some other people using the border checkpoint were informally interviewed in March 2008 regarding the species being traded, the dynamics of wildlife hunting, and numbers of dealers.

8.3.3 Data Analysis

Both quantitative and qualitative data were collected during the surveys. The quantitative data of evidence of threats recorded from the transect walks were shown in number of individual threats per km walked by study camp. The distance from the Lao-Vietnam border and local communities of each camp was also taken into consideration as an indicator of whether or not the number of threats is influenced. The prices of wildlife sale estimated from year to year were evaluated and calculated in percentages. The numbers of primate harvest and hunters per year were shown by month. The relationships of wildlife hunting, trade and crop season were analyzed using SPSS Version 12 for Windows and analyzed with Spearman correlation.

8.4 Results

8.4.1 Threat Identification from Transects

Seven different types of threats were classified from 458 records along the transects and an over all average of individual threats per km walk was found to be

3.2, the threats were high at C10, C1 and C5 (Table 8.2). The number of poaching camps (mostly for logging) was highest at C10, and then C5 (mostly for hunting), and frequent gunshots were heard from these two poaching camps (Figure 8.2). The numbers of people encountered were highest at C1 and C5 while numbers of logs were highest at C10,

As a whole, the highest level of threats per km walked was at C10 (8.5), C1 (6.44), C5 (5.67) and C9 (3.12). The threats varied in type and from site to site, with the largest number of threat records being made close to the Lao-Vietnam border (C10, C1) and to nearby Vietic communities C5 and C9. However, C3 was close to the border but threats were low.

Figure 8.2 Skulls and bones of douc langur being smoked in a hunting camp at C5

Table 8.2 Threat identification from transects

Study camp	C1	C2	C3	C4	C5*	C6	C7	C8	C9	C10	Evidence
Distance from the border (km)	3.9	5.6	3.0	10	21	15.5	7.0	14.7	18.0	5.8	
Distance from the nearest village (km)	7.4	5.0	5.5	9	5.2	3.5	4.8	5.0	4.5	5.4	
Threats											
Snare line			10	12	12		2	1	11	9	57
Hunting camp	10	7	2	2	20	3	7	1	5	33	90
Bomb**		1									1
Gunshot	5	1	1	5	14	3	7	1	5	10	52
Hunter	4		5	2	8		8		3		30
People	68	14	4		14	4	7	9	6		126
Log (stumps or logs*** found)				21	29	2				50	102
Individual case	87	23	22	42	97	12	31	12	30	102	458
Individual threat/km walk	6.44	1.21	1.7	2.37	5.67	1.14	1.98	0.8	3.12	8.5	3.20

*C5 is located close to Ban Nave (Vietic community who originally came from Vietnam during Indochina War 50 years ago. Half of Vietic men are professional hunters who hunt with guns and snares).
** Bomb blasted for extracting the roots of *Mai dou lai*. It was intensively collected in 2007.
*** the logging scale in the area is small, used human labour to carry the semi-processing woods.

8.4.2 Villager Interviews

Semi-structured interviews in 8 villages showed that 46 wildlife species used for both household consumption and trade, particularly primate species, were highly hunted and traded. Of these, 18 and 12 species are in the IUCN Red List (IUCN, 2008) and CITES respectively (Table 8.3 and 8.4).

The price paid for wild animals was different from animal to animal, depending on the season, health and size of the animal (Table 8.5). Some animals such as pangolins *Manis* spp., porcupines *Hystrix brachyurus* and *Atherurus macrourus* had a high market demand, with traders paying up to twice the value for live animals. The price of wildlife trade has increased by about 15% every year and has jumped dramatically since the end of 2007. The unit price in 2008 was double the price in 2005. The higher demand for wildlife products is now attracting higher levels of hunting efforts by local villagers and Vietnamese poachers.

Table 8.3 Wild mammals hunting , trade and market demands

No	Species	Scientific names	Legal status	Prefer	Parts of animals in trade needs	Main Purpose	Market Demand	Destination	Levels of harvest effort/trade	Remarks/species status in the wild
	Mammals									
1	East asia porcupine	*Hystrix brachyura*		L		medicine	very high	Vietnam	very high/low	records, very rare
2	Asian brush tailed porcupine	*Atherurus macrourus*		L		medicine	very high	Vietnam	very high/medium	records, rare
3	Large bamboo rat	*Rhizomys summatrasis*		L		food	low	local/Viet.	low/medium	records
4	Lesser bamboo rat	*Cammomys badius*		L		food	low	local /Viet.	low/mediem	records
5	Chinese pangolin	*Manis pentadactyla*	RR	L	S	medicine	very high	Vietnam	very high/low	records, very rare
6	Sunda pangolin	*Manis javanica*	RR	L	S	medicine	very high	Vietnam	very high/low	records, very rare
7	Pygmy loris	*Nycticebus pygmaeus*	IUCN-VU, C II	D	M, Y	pet	medium	Vietnam	low/very low	records
8	Slow loris	*Nycticebus coucang*	C II	D	M, Y	pet	medium	Vietnam	low/very low	records
9	Rhesus macaque	*Macaca mulatta*	IUCN-NT, C II	D	M, b	medicine	very high	Vietnam	high/medium	records
10	Stump-tailed macaque	*Macaca arctoides*	IUCN-VU, C II	D	M, b	medicine	very high	Vietnam	high/medium	records, rare
11	White-cheeked gibbon	*Nomascus siki*	IUCN-DD, C I	D	M, b	medicine	very high	Vietnam	high/very low	records, likely rare
12	Red-shanked douc langur	*Pygathrix nemaeus*	IUCN-EN, C I	L,D	M, b, Y	medicine	very high	Vietnam	very high/very high	records
13	Black langur	*Trachypeticus hatinhensis*	IUCN-VU, C II	D	M, b	medicine	very high	Vietnam	very high/very high	records
14	Assamese macaque	*Macaca assemensis*	IUCN-VU, C II	D	M, b	medicine	very high	Vietnam	very high/high	records
15	Asiatic black bear	*Ursus thibetanus*	IUCN-VU, C I	D	M, b, G. B	medicine	very high	Vietnam	very low/very low	report, very rare
16	Binturong	*Arctictis binturong*		D	M,b	food	low	local/Viet.	very low/very low	report , rare
17	Owston's palm civet.	*Hemigalus owstoni*	IUCN-VU	D	M	food	low	local/Viet.	low/very low	report, rare
18	Palm Civet	*civet* spp.		D	M	food	low	local/Viet.	low/very low	report, rare
19	Wild pig	*Sus scrofa*		D	M	food	high	local/Viet.	very high/high	records
20	Sambar deer	*Cerbus unicolor*	ARL	D	M, H	food	high	local/Viet.	high/low	report , rare
21	Muntjac	*Muntiacus muntjak*		D	M, H	food	medium	local/Viet.	high/low	records, rare
22	Southern Serow	*Naemorhedus sumatraensis*	IUCN-VU, C I	D	M, b, S, G. B, H	medicine	very high	Vietnam	very high/very high	records
23	Black giant squirrel	*Ratufa bicolar*	IUCN-EN, C II	D	M	food	low	local/Viet.	high/low	records, low
24	Pallas' squirrel	*Callosciurus erythraeus*		D	M	food	low	local/Viet.	high/low	report, rare
25	Flying squirrel	*Petaurista* sp.		D	M	food	low	local/Viet.	high/low	records
26	Common squirrel	*Callosciurus* sp.		D	M	food	low	local/Viet.	high/low	records

Remarks: ART = At Risk in Thailand, ARL = At Risk in Laos, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient, EN = Endangered, C = CITES, RR = Regionally Rare, L=Live, D=Dry, T=Timber, M= Meat, b=bone, S= Skin, G.B = Gall bladder, CB = Cross-bow, Y = Young, H = Horn, B = beak.

Table 8.4 The hunting , trade and market demand of birds, reptiles and plants

No	Species	Scientific names	Legal status	Prefer	Parts of animals in trade needs	Main Purpose	Market Demand	Destination	Levels of harvest/trade	Remarks/species status in the wild
	Birds									
1	Red jungle fowl	*Gallus gallus*		D	M	food	medium	local	low/low	records
2	Bar-back partridge	*Arborophila brunneopectus*	ART	D	M	food	medium	local	low/low	records
3	Silver pheasant	*Lophura nycthemera*	ART	D	M	food	medium	local	low/low	records
4	Siamese fireback	*Lophura diardi*	IUCN-VU	D	M	food	medium	local	low/low	records
5	Grey peacock pheasant	*Polyplectron bicalcaratum*	ART	D	M	food	medium	local	low/low	records
6	Crested argus	*Rheinardia ocellata*	IUCN-VU	D	M	food	medium	local	low/low	report,
7	Great hornbill	*Buceros bicornis*	ART	L, D	M, Y, B	food	high	local	low/low	report, rare
8	Brown hornbill	*Anorrhinus tickelli*	IUCN-NT	L, D	M, Y, B	food	medium	local	low/low	records
9	Rufous-necked hornbill	*Aceros nipalensis*	IUCN-VU	D	M, Y, B	food	medium	local	very low/low	rare
10	Wreathed hornbill	*Aceros undulates*	ART	D	M, Y, B	food	medium		n/a	very rare
11	Hill myna	*Gracula religiosa*	ART	L	Y	pet	high	local/Viet.	low/medium	records
	Reptiles									
1	Asiatic soft-shell	*Amyda cutilaginea*	IUCN-VU	L		food	high	local/Viet.	low/low	report, rare
2	Yellow-headed temple turtle	*Hieremys annandalei*	IUCN-VU	L		food	high	local/Viet.	low/medium	report, rare
3	Elongate tortoise	*Indotestudo elongate*	IUCN, C II	L		food	high	local/Viet.	low/medium	report, rare
4	Asian leaf turtle	*Cyclemys dentata* complex	ARL	L		food	high	local/Viet.	low/medium	report, rare
5	Malayan snail-eating turtle	*Damonia Subtrijuga*	ARL	L		food	high	local/Viet.	low/medium	report, rare
6	Burmese python	*Python Resticulata*		D	S	decorate	medium	Vietnam	low/low	records, rare
7	Sing dong snake			L		food	low	Vietnam	low/low	report, rare
8	Bengal monitor	*Varanus bengalensis*		L		food	very high	Vietnam	low/medium	records, rare
9	Water monitor	*Varanus salvator*		L		food	very high	Vietnam	low/medium	records, rare
	Plants									
1	Mai dou lai	*Dalbergia* sp		T		unknown	most high	Vietnam	most high/very high	records, very rare
2	Mai ketsana	*Aquilaria crassna*		T		unknown	most high	Vietnam	most high/very high	records, very rare
3	Mai moun	*Elaeocarpus siamensis*		T		furniture	high	Vietnam	high/very high	records, very rare
4	Orchid (4 species)			T		decorate	high	Vietnam	high/very high	records, declines

Remarks: ART = At Risk in Thailand, ARL = At Risk in Laos, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient, EN = Endangered, C = CITES, RR = Regionally Rare, L=Live, D=Dry meat, T=Timber, M= Meat, b=bone, S= Skin, G.B = Gall bladder, CB = Cross-bow, Y = Young, H = Horn, B = beak.

Table 8.5 Price of wildlife sale in US$ per kg from 2004 to 2008

No	Common name	Scientific name	2004	2005	2006	2007	2008	Part
1	Pangolin	*Manis* sp	15	23	37	40	70	live
2	Primate bone and skulls	*Pygathrix and macaque*	1	1.5	3	5	6	bone
3	Water Monitor	*Varanus* spp.	4	4.5	5	6	7	live
4	Porcupine spp.	*Hystrix* spp.	3	7	6.5	6.5	7	live
5	Asiatic soft-shell turtle	*Amyda cutilaginea*	6	7	8	9	10	live
6	Muntjac/Sambar	*Muntiacus/Cervus*	3.5	4.5	5	6	7	meat
7	Wild Pig	*Sus scrofa*	3	2	2.5	3	5	meat
8	Pheasants*	*Lophura*	1	2.5	3.5	4	5	meat
9	Burmese python	*Python resticulata*	4	4	5	5	6	skin
10	Turtle/tortoise		1.5	2	2	2	2.5	live
11	Black Giant Squirrel*	*Petaurista* spp.	0.5	1	1	1	2	meat
12	Red Junglefowl*	*Gallus gallus*	0.2	0.3	0.5	0.6	0.7	meat
	Sub-total		42.7	59.3	79.0	88.1	128.2	
	Percent of increased from 2004		0	27.99	45.94	51.53	66.69	

* the animal sale estimated price in kg for this purpose.

Hunting with snares was also used for large animals, such as serows and wild pigs. Snares are now made of steel which are able to catch larger animals. Steel wires in different size are sold in hardware shops. The strings are sold at electronic and mechanic shops at low cost in Lang Khang market (1 metre costing US$ 0.2, which is all that is required to make one snare). The Vietnamese poachers who work in illegal timber harvesting gangs hunt with both guns and snares. Hin Namno NPA was highly disturbed by local villagers and Vietnamese poachers. Evidence of hunting camps of Vietnamese poachers were found, such as polished rice, axes, chain saws, sacks, and clothes, which were confiscated during the village patrols. Local loggers in the area were reported in 2008 and that for Vietnamese traders.

At the study villages, about 15 Vietnamese traders on motorcycles and bicycles visited every week in groups of 2 to 3 people, while there were only two locally based traders. About half of the Vietnamese traders sold Vietnamese goods in the villages and returned with wildlife products. Often, sacks full of primate skulls and other bones, as well as serows, were found in their baskets. Some traders sold

bullets, or gave an advance to the key contact hunters who hunt wildlife for them. The price paid for wild animals at the sub-district town of Lang Khang is a little higher compared with that in the villages, and is about double that paid directly by the middleman. Prices for wildlife range from US$ 0.6 for one adult squirrel to around US$ 175 for one adult pangolin.

Wildlife hunting and involvement in wildlife trade were different from village to village, being highest in Ban Dou, Ban Vangmaneu and Ban Thongxam. These villages are considered rich villages in the area which have many motorbikes, hand-trail tractors and cattle with only few poor household (Table 8.1) and the hunters were not the poor. They were the mid-class citizen and better off families who involved in wildlife trade. From the village logbooks, the primate harvest in one year showed that 495 Red-shanked Douc Langurs and 275 black langurs were hunted during the dry season 2007/2008 (Table 8.6).

Table 8.6 Records of primate harvested by 8 villages from Mar 2007 to Feb 2008

Month	Douc Langur	Black Langur	Assamese Macaque	Stump-tailed Macaque	Gibbon spp.	Loris spp.
Mar	12	9	3	1		
Apr	3	12	1	2		
May		9	1			
Jun	3	18	2			
Jul	2	11		1		
Aug	7	9	1	0		
Sep	14	7	6	1		
Oct	85	24	21	7	1	
Nov	97	37	12	9		
Dec	83	55	19	11	2	3
Jan	98	45	2	1		
Feb	91	39	5	2	1	2
Total	495	275	73	35	4	5

Before this, not many villagers were involved in wildlife hunting (just 15 hunters in these villages). Villagers tried to prevent illegal Vietnamese intrusion, as they had 27 patrolling trips in 2003. However, from 2007, when a greater number of villagers were engaged in hunting, the patrols had dropped to only 4 in 2007 and none in the first quarter of 2008. The number of hunters increased sharply to 92 people in these 8 villages in 2007 (Table 8.7). The hunter in this context is the person who regularly hunts with guns or snares. They worked in team and village militias are often hunters because they posses army guns. Also, the hunters were not the poor, most of them were considered mid-class citizen from rich families. While, the poor just relies on collecting forest products rather than wildlife hunting.

Table 8.7 Number of hunters and their family status

No	Village	No of hunters		Family status of hunters		
		2003	2008	**Rich**	**Average**	**Poor**
1	Ban. Dou	4	28	2	21	4
2	Vangmaneu	3	14		11	3
3	Salang	2	8		5	3
4	Nongno		3		3	
5	Nongseng		4		4	
6	Thongxam	4	21	1	18	2
7	Nongbua	2	7		5	2
8	Phanob		6		6	
	Total	15	92	3	80	9

Remarks: family status classified based on the reports of village heads (2007).

Wildlife hunting and trade was lowest during the wet seasons, especially in July when villagers changed their efforts to growing rice. However hunting traders still came into the villages. Wildlife hunting by local hunters has increased when they have fewer farming activities, while wildlife trade activity kept going over time

(Figure 8.3). In this regard, we tested the correction of this dimension and found that there was a high correlation between wildlife trade and hunting (Table 8.8).

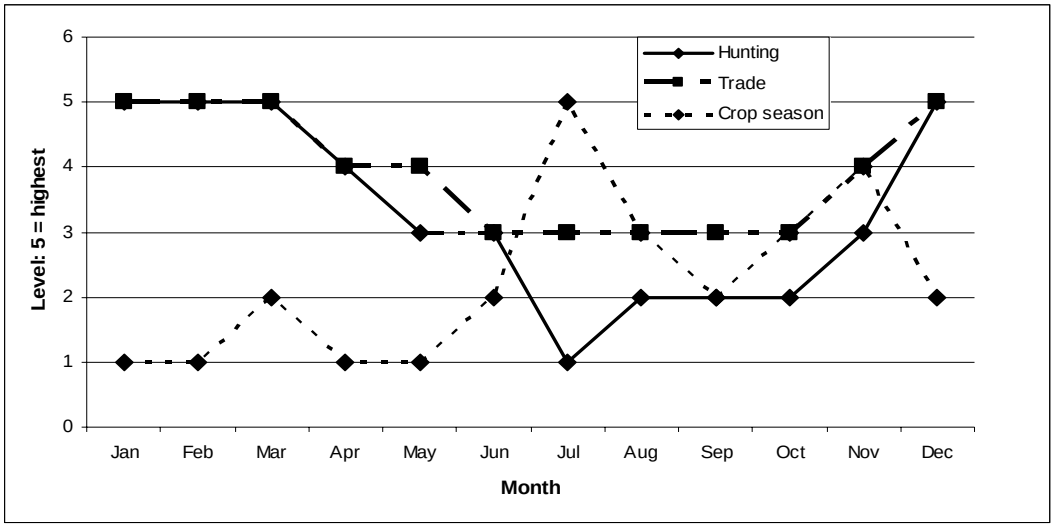

Figure 8.3 Correlation of wildlife hunting, trade and crop season

Table 8.8 Spearman Correlation Coefficient of wildlife hunting, trade and crop season

	Hunting	Trade	Crop season
Hunting	1.0	.939**	-.672*
Trade	.939**	1.0	-.573
Crop season	-.672*	-.573	1.0

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Even though wildlife hunting and trade were obviously high in the villages, there were few records of wildlife shipments crossing at the checkpoint. The villagers at Lang Khang reported that most illegal traders transported their wildlife products crossing the Lao-Vietnam border by pass-by and under cover.

8.5 Discussion

Seven categories of wildlife threats were identified from the transect walks. The study camps C1, C3, C2 and C10 were located close to the Lao-Vietnam border (less than 5.5 km). Two of them, C10 (8.5 individual threats/km) and C1 (6.4 individual threats/km), had the highest numbers of threats. C10 is easy to access and closest to the Vietnamese villages – just by the border. At one time, this camp had a high density of *Maimoun (Elaeocarpus siamensis*), which attracted many illegal poachers into this area. Vietnamese hunting camps were recognized from cans of energy drink left around their hunting and logging camps, or by the fenced areas to keep live animals. C1 was another high threat area and very close to the border but most camps found were for hunting and logging. Most people found in this camp were Lao villagers. In this example, it was not only a short distance to the border that showed more disturbances by Vietnamese. The geography and availability of wild resources are other factors. For example, even though C3 (1.7 individual threat/km) and C2 (1.2 individual threat/km) are close to the Lao-Vietnam border, the number of threats is low because these areas are more difficult to access than C10.

In contrast, C9 and C5 are located far from the Lao-Vietnam border, but had a high level of threat. C5 had the second highest threat since it is close to the Vietic communities at Ban Nave and Ban Nakha Nyom. The Vietic people originated from Vietnam and settled there over 40 years ago. The Vietic villagers from Ban Nave are all experienced hunters, and hunt with both army guns and snares. Some Vietic hunters reported to own up to 80 large snares. However, C7, close to a Lao community, had low threats (1.9 individual threat/km).

Vietnamese poachers mainly entered the area during wet season when Lao villagers were engaged in rice cropping. Hunting camps and evidence of logging were found, but no Vietnamese poachers were found in the forest. They were possibly aware of a patrol team in the area. Nowadays, it was also reported that some Lao villagers of Ban Thongxay and Nongbua do occasionally inform the Vietnamese poachers to leave before officials enter the forests.

Usually, the village patrol team consisted of army, police and village militias. From the report of Khet Dou cluster village head, 12 Vietnamese poachers were arrested by patrol teams in 2005 and 2006. However, after the WWF project ended at the beginning of 2007, the frequency of village patrols went down to just a few times. From our transect walks, Lao villagers who entered the area for collecting *Mai dou lai* were found in 2007. Since this tree species had a high value (US$ 20–30/kg), and found only in Hin Namno NPA and had not yet been known in the scientific community, all of this plant has been completely harvested.

8.5.1 Wildlife Species Involved in Hunting and Trade

Some species have become rare or difficult to find in Hin Namno NPA due to over-harvesting and high market demands. If this situation continues, these species may be extirpated from the area in the near future. Pangolins *Manis* spp., as well as East Asian Porcupines, *Hystrix brachyura*, are difficult to find and are believed to be eradicated from northwest Hin Namno. Elephants *Elephas maximus*, and Gaur *Bos frantalis*, used to be found in the area are probably extirpated from the area. All villagers said that those wild animals were hunted freely by the Vietnamese in the 1980s. Over-hunting of one species can impact the long-term wildlife ecosystem

(Terborg, 1992).

Wildlife hunting and trade occurred not only in Laos, but in all neighbouring countries (Srikosamatara *et al*., 1992; Srikosamatara and Suteethorn 1994; Donovan 1998; Nooren and Claridge 2001). Due to weak law enforcement in Laos, the hunting of some species on the national category I as prohibited species in accordance with the Wildlife Law (MAF, 2008), such as Red-shanked Douc Langur and Gibbons, have rarely been fined. Local villagers have a poor understanding of wildlife protection laws. Some local hunters were aware that only large animals are legally protected, such as the Asian Elephant *Elephas maximus*, Tiger *Panthera tigris*, Gaur *Bos frantalis*, and Gibbons *Hylobates*. In discussions with local villagers, it was found that they considered hunting douc langurs was not unlawful compared with hunting Sambar *Cervus unicolor*.

8.5.2 Hunting Arrangements

Hunting teams usually consist of 3 to 6 people with 2 to 4 army guns. Some teams have up to 6 people with only 2 guns, but numerous snares. Hunting teams spend up to 2 weeks in forests and then a few days in villages to sell their wildlife and prepare for the next round. Some hunters borrow guns from village militia units, soldiers or outsiders. Normally, the hunters who borrow other people's guns return the gun to the owner with some bush meat in exchange. Bullets are available from the person lending the gun, or sometimes local traders will exchange bullets for bush meat or sell them at a price of US$ 0.3–0.5 per bullet.

Hunting teams also use snares when they camp in the forest. They set a long snare line and hunt, particularly primates during the daytime. One team reported being

able to catch 15–20 douc langurs and 1–2 serows per trip during the dry season from December 2007 to March 2008. On average, each hunter earns US$25–$30 per trip. Since locally made guns have been handed over to the officials in 1997, local hunters now only use army guns for wildlife hunting. Vietnamese poachers used army guns to hunt in the area as well. Some village militias' guns were even stolen by Vietnamese poachers.

8.5.3 Hunting Technique

There are many hunting techniques applied to different animals and market needs. A local hunting team recently duplicated the Vietnamese hunting style. For example, when they find a group of Red-shanked Doucs, they assigned 2 out of the 3 gunmen to wait where the monkeys may escape. One of the gunmen then walks into the group of animals and shoots. Any animals escaping from the main group will be shot by other gun men. Douc langurs are easier to hunt compared to other animals because they prefer to hide motionless in the trees, rather than escaping. Animals are shot one by one and sometimes hunters are able to kill 5 to 6 doucs per group. That is why more Red-shanked Douc Langurs are killed compared to other primates.

Hunting with snares is simple, cheap, and the most effective method of hunting, widely used in Vietnam (Nguyen *et al*., 2004). Two types of snares are used; either as a neck-hold trap or leg-hold trap. The neck-hold trap is often used for small terrestrial animals. Hunting dogs are now used to hunt pangolins during the beginning of the wet season when the species is more active. Hunting dogs are also used to search and chase for wild animals, especially serows, wild pigs, deer, and turtles.

Above are some descriptions of hunting activity. There are many hunting

techniques, which are likely driven by market needs. As some markets need only live animals, hunting with guns is not used for animals such as pangolins *Manis* spp., porcupines *Hystrix* spp., monitors *Varanus* spp. and turtles. The trapping of black langur *Trachypithecus hatinhensis* is often done with bamboo traps at the species' sleeping cave.

Wildlife hunting by local villagers jumps to higher levels during the dry season from December to May, because local villagers are free from cropping activities and it is easier to travel in limestone areas. Meanwhile, during cropping season, more Vietnamese poachers enter Hin Namno NPA for logging, hunting and snaring.

8.5.4 Wildlife Trade

Vietnamese traders maintain contacts in the villages for buying wildlife. Traders routinely come on bicycles to the villages to sell Vietnamese goods, and on their return they bring back wildlife products. Many of these Vietnamese people live in Thakhek and travel to the villages once a week. Sometimes bush meat is sent to Thakhek hidden in sacks with other products by hand tractors. While wildlife trade is common in the villages, it is rarely found at the Na Phao Lao-Vietnam checkpoint next to Quang Binh in Vietnam. Instead, wildlife is smuggled across the border via illegal routes to avoid the checkpoints, so officials rarely detect it. Nguyen *et al.* (2004) reported that wildlife used to be shifted from Laos to Vietnam by petrol tank truck. In the past, Lak Sao (Nam Phao) was a well-known place for wildlife trade, crossing the border into Vietnam (Compton *et al.*, 1998).

The selling price for some wild animals is about three times higher in Hanoi

than the price paid to Lao villagers. For example, in 1998, one kg of golden turtle *Cuora trifasciata* at a Lao village was US$ 100–150 but it was over US$ 700 in Hanoi (Hendrie, 1998). In Hanoi, wildlife consumption is a fashionable. The main factor that encourages people to consume wildlife is that it is perceived to be a health imparting medicine. In 2003, wildlife trade surveys carried out in Ho Chi Minh City showed that 80% of 1,627 restaurants were involved in wildlife trade. Wildlife trade and hunting was shown to increase with improved road access, increased demand of wildlife for medicine and from restaurants (Nguyen *et al.*, 2004).

The market needs of each wild animal are different. Live animals, bush meat and bones are sold per kilogram, while prices for horns and gall bladders are negotiated per piece. Bones and skulls of primates receive the same price, irrespective of species, and are often mixed together in sacks for sale. Wildlife sales occur over the entire year, but there is a slightly lower demand during the wet season when villagers are busy with cropping activities. Besides the wildlife trade from the northwest part of the Hin Namno NPA, it is also present in the southern part of the NPA at Ban Nam Chala and Thang Beng, and in the Central part of Ban Nongping and Pak Phanang. However, the trade in these villages is lower.

Although the price of wildlife has increased from year to year, within some years, the price of species changes by the season, the condition of the animal and the wildlife supply. For turtles, pangolins and snakes, traders need live animals. Price of primate's bone per kilogram was $ 1.3 in 1997 (Timmins and Duckworth, 1999; Davison *et al.*, 1997) but is now $7 in Hin Namno NPA.

Wildlife trade at the village level goes along with wildlife hunting, which is high during the dry season and goes down slightly during the cropping season from

June to October. Although villages have less wildlife available for sale during the wet season, traders continue to visit the villages throughout the year. This situation is similar to Vietnam, where the fluctuation of hunting during the year depends on farming activities (Nguyen *et al*., 2004). Remote villages rely on hunting for food and hunting happens everywhere. As high as 50 douc langurs were killed per year by 18 households in Nam Ngong, Attapeu (Davidson *et al*., 1997; Timmins and Duckworth, 1999).

8.5.5 Over-Harvesting and Species Extirpation Concerns

Wildlife is important to maintain the integrity of the ecosystem; the extinction of one species could impact the rest of the ecosystem. Therefore, sustainable use of wildlife is required (Lee, 2004). Demand for wildlife products from China, Hong Kong and Vietnam is having a significant impact on the survival of wildlife in neighbouring countries (TRAFFIC, 2007). Key factors driving the over-exploitation of wildlife is due to high market demand, coupled with lucrative prices paid, especially for those species that are used for traditional medicine purposes such as tigers, bears and pangolins (Robinowitz, 1998; Lynam, 2003 cited in Nooren and Claridge, 2001). If this situstion continues at this rate, many species with high trade value will become extinct across their ranges, even in the most protected areas. In Laos, Vietnamese poachers have been entering the Hin Namno NPA since 1989 to log *Mai ketsana (Aquilaria* sp.*)* and *Mai moun* (*Elaeocarpus sianensis*). While there, they also hunt wildlife. From 2004 to 2007, Vietnamese poachers have over-harvested *Mai dou lai* while Lao villagers only been harvesting this tree from May to October, 2007. Nowadays, *Mai dou lai* have been completely cut out and even their roots have been

unearthed.

Wildlife trade is considered to have high rewards. Wildlife trade from Laos to Vietnam at one checkpoint in Nam Phao alone was valued at US$ 11.8 million (Compton *et al*., 1998). Foppes *et al*. (1996) showed that the value of wild plants sold to Thailand recovered from the forests in Champasak, crossing at the Chongmek checkpoint were valued at US$ 110,000 per year. Over 80,000 pangolin skins exported from Laos to international markets were confiscated between 1993 and 2003 (Nguyen *et al*., 2004). Due to this continuing and unsustainable over-harvest of wildlife resources in Laos, the country will soon demonstrate the "empty forest syndrome" where only trees and no wildlife will exist (Nooren and Claridge, 2001).

8.5.6 Status and Effort of Village Patrol Teams

The situation has deteriorated since funding support for protected areas has not been available, and lack of staff support since 2006. Wildlife management is largely absent. Before, a WWF funded project supported per diems for government staff to visit the villages regularly. Local patrol teams were also financed. However, after the project ended in 2006, no funds have been available for staff to follow up. Immediately, number of local hunters started to increase, while number of patrols went down dramatically. Thus hunting pressure has increased. Every vertebrate, including small birds, is now hunted. This situation is likely to keep going as long as the site is not being regularly visited by government staff and no malefactors are being legally punished.

In the past, an active local management system for protecting forest land was

in place, but this is no longer the case. Local villagers used to have strong patrolling teams to prevent Vietnamese poachers from entering Hin Namno NPA for illegal logging and poaching. Each village was responsible for the protection of their village territory within the Hin Namno NPA and reducing poaching. Usually, the team consisted of the village militia, army and policemen from Lang Khang sub-district, and often took action when poachers were reported. The teams worked basically without any payment, unless any government officials come along. Most incentive to villagers was that they gained rice, axes, saws, clothes, and sacks when the Vietnamese poachers escaped from being arrested. One chainsaw which was confiscated in 2006 is now used by the commune of Ban Dou. Since 1990, the local villagers have actively defended their forests and wildlife resources from Vietnamese poachers.

Unfortunately, Lao villagers have not been well and regularly supported by government officials, and now many of the villagers are joining the rush to illegally harvest wild products from the Hin Namno NPA. Not many poor villagers are engaged in wildlife hunting. Hunters and group of people dealing with wildlife trade are often from rich families who possess some 10 domestic buffalos. However, the poor villagers who might suffer first from loss of biodiversity as well as their food sources in relation to meeting their protein requirements (Krahn and Johnson, 2007), are usually not wildlife traders. Local villagers normally receive few benefits from the wildlife trade while the middlemen are getting double the price for the onward sale of the products. During the study, local leaders are not able to insist local hunters to stop hunting when many of the villagers are now involved.

8.6 Conclusion

The level of wildlife disturbance in Hin Namno NPA is high, particularly at the study camps close to the Lao–Vietnamese border and close to Vietic communities. More hunting camps were noticed from the transect walk. The camps were for collecting timber and for hunting. At the village level, wildlife hunting and trade have increased dramatically since funding support became unavailable, along with a lack of staff visits and weak law enforcement. Hunting is now being conducted by professional wildlife hunting teams for trade purposes and that not the poor involved in this business. Local hunters do not care which species are legally prohibited and that was not the poor who involved in wildlife hunting and trade and not for their basic livelihood needs. Due to a high market demand for wildlife products, prices have doubled from 2007 and 2008, which encourages more hunting. Wildlife hunting and trade is related to the cropping season, being more active when farmers are not engaged in farming activities. Finally, wildlife trade is probably the root cause of the wildlife loss, with high demands from China and Vietnam. High consumption of wildlife products from these countries has made a significant impact on wildlife in Hin Namno NPA and other NPAs along the Lao - Vietnamese border.

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CHAPTER IX

CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

9.1.1 Population and Distribution of Red-shanked Douc Langur in Hin Namno NPA

The line transect survey of Red-shanked Douc Langurs was conducted over a total walked length of 142.8 km in Hin Namno National Protected Area between January and December 2007. It is a limestone habitat, an area of 820 km^2 located in Bualapha district, Khammouane Province. We found a total of 46 groups, 450 animals seen with 668 estimated animals. We used the equation of Li and Rogers (2007) to analyze the data and identify a potential habitat for the group density calculation. Therefore, the group density is 5.8±4.7 group km^{-2} (95% CL), with a total of 1,187 groups or 17,765 individuals in the Hin Namno NPA. The species found was not specific to limestone, they were found most in hill evergreen forest (48.15% of the total group encounters), evergreen forest (35.5%) and mixed deciduous forest (14%). During the dry season, they spent the most time in hill evergreen forests (58.8%) at an average elevation of 464 m above sea level (a.s.l.), ranging up to 653 m. During the wet season, they used evergreen forest for 42% in lower areas or around foothills at an average elevation of 380 m a.s.l. The study camps located as far as 10 km from any settlement, especially from the Lao-Vietnam border, as well as in areas supporting

larger flat grounds, have higher group densities. The group density km^{-2} ranged from 1.3–14.0 and was highest at the study camp C4 (14.), C7 (9.7) and C5 (9.0).

9.1.2 Density and Conservation Significance of Primates in Hin Namno NPA

The same line transect survey was conducted in a total length of 142.8 km walked in Hin Namno NPA between January and December 2007. At least ten primate species were found and reported, of which 6 species were confirmed from the transect walk. We analyzed data of primate records in the transects per km walk and found that a group density of Stripe-headed Black Langur *Trachypithecus hatinhensis* was 0.42, Red–shanked Douc Langur *Pygathrix n. nemaeus* was 0.32, Assamese Macaque *Macaca assamensis* was 0.27, Stump–tailed Macaque *Macaca arctoides* was 0.03, and Southern White-cheeked Gibbon *Nomascus siki* was 0.03. One group of another form of Striped-headed Black Langur *Trachypethecus hatinhensis* was once spotted. Red-shanked Douc Langur is a flagship species for Hin Namno NPA which the study camp found high encounter rate of the species was also other primate species. The uniqueness of limestone functions as an important refuge area for primate species and makes this area the place for primate conservation in Lao PDR.

9.1.3 Time Budget and Activity of Red-shanked Douc Langur in Hin Namno NPA

Two unaccustomed groups of Red-shanked Douc Langur *Pygathrix nemaeus* were studied in Hin Namno National Protected Area, Khammouane Province in Lao PDR. Group 1, which had 19 individuals, had more human pressure while group 2

with 39 individuals had lower human pressure. The activity of every 30-minute intervals was recorded via scan sampling from March 2007 to June 2008. Time budget of the species was examined, depending upon seasons. Only data for adults were used for this analysis. Results show that feeding (39.5%) was the highest proportion of time used; then inactivity (18.9%), which mostly consisted of listening for threats, sleeping (13.8%) and social activity was the lowest (5.0%). The significant difference between groups was feeding, inactivity and traveling. The differences between dry and wet seasons were inactivity, sleeping, feeding and social activities. In addition, the species has certain home range (292 ha) and overlap with other groups, with a larger home range in dry season.

9.1.4 Food Plants of Red-shanked Douc Langur in Hin Namno NPA

Foods of Red-shanked Douc Langurs were identified in study plots and during the observation of two study groups in Hin Namno National Protected Area from March 2007 to June 2008. A total of 189 tree species were identified, of which 146 were located in the research plots, with 112 species used by Red–shanked Douc Langur. The distribution of food plants is not random; some food trees were abundant while some were not. The families with more number of food plants were Sapindaceae, Fagaceae, Meliaceae, Moraceae, Ebenanceae and Euphorbiaceae. Many food plants identified provide only fruits (36.6%), only leaves (25.89%) and both fruits and leaves (9.87%). The fruiting season is mostly from May to August and this period is considered masting fruit period for the douc langur. There were 24 plants considered favorite foods for Red-shanked Douc Langurs, including Mak dang in Flacourtiaceae, Ko Namtao (*Quercus aliena* Blue) in Fagaceae and Dok khama

(*Paranephelium spirei* Lecomte) in Sapindaceae. The fruits of all plants, except Mai Kean Luang (*Nauclea orientalis* (L.) L.) were eaten. Ripe fruits were mostly chosen while pulp and seeds of some unripe fruits, and some young fruits were also consumed. In addition, the fruits that the animal likes most were sour taste of unripe fruits and some ripe fruits and then sweet.

9.1.5 Threats of Red-shanked Douc Langur and Other Wildlife in Hin Namno NPA

Due to the high demand of wildlife markets from Vietnam and China, along with the loss of biodiversity in the Lao-Vietnam border areas, wildlife threats are of high concern. The threats were identified from 10 study sites located in Hin Namno national protected area from February to December 2007 through interviews in eight villages. The surveys showed a total of 458 individual threats (0.32 individual threat/km walk), mainly hunting camps, snare lines and gunshots. The sites closest to any Vietic communities had the highest number of threats. A total of 46 wildlife species were harvested and traded from the Hin Namno NPA, of which 18 animal and 12 plant species are included in the IUCN Red List and CITES respectively. When aid project funding ended in 2006, village patrol effort dropped from 27 trips in 2003 to 4 patrols in 2007. Hunting has increased; all primate species are being hunted and frequently traded. Wildlife is hunted by people from both Laos and Vietnam, but trade of wild animals, particularly primates, is mainly carried out by the Vietnamese. The correlation between wildlife hunting and trade is related to cropping season, being more frequent when farmers are not engaged in farming activities.

9.2 Recommendations

This research covers major components of Red-shanked Douc Langur in the wild, focusing mainly on a basic understanding of the species in the wild, especially in limestone habitats. Some recommendations for future studies of the species as below:

9.2.1 Distribution Study

- Examine the trend of the species population in the area due to pressure from both Vietnam and Lao side. Threat degree, demands/supply, death and growth ratio would be used as references for this scenario analysis.
- The presence of other sympatric primates need to be confirmed in Hin Namno NPA, like Phayre's Langur and Long-tailed macaque, and to discover more new species in the area.
- Further test and improve the modified transect method for censusing primates on limestone as to make it more accurate and scientifically accepted but be convenient for a student research.

9.2.2 Behavior Study

- Select higher numbers of group samplings to undertake age-classes of Red-shanked Douc Langur.
- Study the group size effect of Red-shanked Douc Langur behavior.
- Study the meaning of various sounds of Red-shanked Douc Langur.

- Using a high technology method such as radio telemetry and GPS collar, to study a home range of Red-shanked Douc Langur, especially during the dry season between March and June.
- Using a high technology method, examine home ranges of three forms of Red-shanked Douc Langur in different seasons.

9.2.3 Food Plant Study

- To study more details of plant distribution in upper limestone hills.
- Identify more food types used by Red-shanked Douc Langur in upper limestone hills.
- Identify the major food of Red-shanked Douc Langur in upper limestone hills from March to June.

9.2.4 Threat Study

- Study wildlife trade dynamics and people's perceptions in more details as to find the way to stop the root cause of hunting and trade activities.

9.2.5 Management and Conservation

- Promote co-management of local people for Hin Namno conservation and management.
- Analyze hunter thoughts as to convert the hunters to conservationists.

APPENDICES

APPENDIX A

DATA COLLECTION FORMS

A1. Record Form: Line Transect

Investigator: Date: Name of the site Site no. GPS Weather

Total time contact Total time out Total time walk Walking speed

Time	Species/ threats	No Indiv seen	AM	AF/ sub-adult	JU	IF	Total estim	Total time contact	Distance to the animal/to the group	Compass Bearing	Activities (what do they do) inactive, **F**eeding, **G**rooming, **P**laying, **S**leeping...	Feeding type, part, height	Habitat	Location GPS/ alt

A2. Record Form: Group Observation

Investigator: Date: Name of the site Site no. GPS Weather

Group description: Group Identity:
Member and sex:
No of infant (1 and 2) and sex:

Time	**Activities** (what do they do at that time and what details), **I**nactive, **F**oraging, **F**eeding, **S**ocial, **T**raveling, **O**ther (to specify)	Habitats/ Height/canopy	GPS/ Altitude Other	Weather S, C, R, T
30’	1. Adult female 2. Adult male			
	3. Sub-adults 4. Juveniles			
	5. Infant			
30’	1. Adult female 2. Adult male			
	3. Sub-adults 4. Juveniles			
	5. Infant			
30’	1. Adult female 2. Adult male			
	3. Sub-adults 4. Juveniles			
	5. Infant			

Note: use this record form alongside the category of activity budget sheet to record the target animals every 30’ interval (AF, AM, Sub-adult, Juveniles, Infant) and each time to be completed in a maximum of 10 minutes. Be aware of not to record the same animals every time. Need to record a position (height) of which the animals are being described.

A3. Abbreviation and Categories of Activity Budget

ia	**inactive**		**fo**	**foraging (searching and handling)**	
	no	normal	fl, fr, le, pi, ba, sh, dr, so, fi, am	flower, fruit, leaf, pith, bark, shoot, drink, soil, figs, animal matter	
	mo	monitoring with eyes open	**part**	**apply to fruit, flower, leaf**	
	mo?	eye open but unclear monitoring	wh, pu se. ps, ex, p, lb, bl	whole, pulp, seed, pulp and seed, exocarp, petiole, leaf base, blade	
	?	attention unknown	**age part**	**apply to fruit, flower, leaf**	
sl	Sleep		bu, yo, ma, ol	bud, young, mature, old	
fe	**feeding (ingesting, chewing)**		____	underscore for unknown	
	fl, fr, le, pi, ba, sh, dr, so, fi, am	flower, fruit, leaf, pith, bark, shoot, drink, soil, figs, animal matter			
	Part	**apply to fruit, flower, leaf**	**ot**	**other (specify)**	
	wh, pp, se, pp+se, ex, p, lb, bl	whole, pulp, seed, pulp and seed, exocarp, petiole, leaf base, blade		sp	solitary play
	Age part	**apply to fruit, flower, leaf**		ag	auto-grooming/ scratching
	bu, yo, ma, ol	bud, young, mature, old		ago	agonistic behavior (aggression)
	____	underscore, unknown		sex	sexual behavior
so	**Social (specify behavior and recipient**				
	gr	grooming			
	e	embracing		other	
	rp	rough play		A	Adult
	cp	Chase play		AM/AF	Adult Male/Adult Female
				Sub	Sub-Adult
IF	**Infan**t, body contact, height			SAM/SAF	Sub-Adult Male/Female
ca	Carry a baby			JM/JF	Juvenile Male/Female
nc	Nipple contact			IF2	Infant 2 (6 months to 2 years)
bc	body contact (excluding trail)			IF1	Infant 1 in orange color up to 6 month
bg	note if a monkey grooms the one you just take the activity for				
h	height from the ground to all the target animals (m)				
Od	**Oddity**				
	tr, br, c, h	travel, brachiation, call, height			

(Modified from Koenig *et al*., 2007. Primate Ecology and Conservation, General teaching manual for workshop at Phu Kieo Wildlife Sanctuary).

APPENDIX B

LIST OF RESEARCH PARTICIPANTS AND SSISTANTS

No	Name and surname	Position	Office/village	Duty
1	Mr. Sisomphone Southichak	Head of PCU	PAFO	Coordinator
2	Mr. Sengchanh Sisoumang	Staff	DAFO	Assistant
3	Mr. Maimone	Staff	DAFO	Assistant
4	Mr. Chom	Militia	Ban Dou	Guide
5	Mr. Ken	Militia	Ban Dou	Assistant
6	Mr.Thong	Elder	Ban Dou	Assistant
7	Mr. Sat	Militia	Ban Dou	Guide
8	Mr. Khamsen	Militia	Ban Dou	Guide
9	Mr. Thongbai	Village chief	Ban Dou	Gen. advice
10	Mr. Xay	Militia	Ban Dou	Guide
11	Mr. Noy	Youth	Ban Dou	Guide
12	Mr. Sat	Village chief	Vangmaneu	Climate recorder
13	Mr. Soun	Militia	Vangmaneu	Guide
14	Mr. Thongkhoun	Militia	Vangmaneu	Guide
15	Mr. Say	Militia	Vangmaneu	Guide
16	Mr. Thueng	Militia	Salang	Guide
17	Mr. Pan	Militia	Salang	Guide
18	Mr. Tam	Elder chief	Salang	Guide
19	Mr. Than	Militia	Salang	Guide
20	Mr. Oa	Militia	Salang	Assistant
21	Mr. Kee	Youth	Salang	Guide
22	Mr. Siey	Village head	Salang	Guide
23	Mr. Kaem	Villager	Salang	Assistant
24	Mr. Khamlek	Villager	Salang	Assistant
25	Mr. On	Militia	Thongxam	Guide
26	Mr. Lerd	Militia	Thongxam	Guide
27	Mr. Bounchanh	Village chief	Nongseng	assistant
28	Mr. Tanoy	Village chief	Nongbua	Gen. advice
29	Mr. Thone	Militia	Nongbua	Guide
30	Mr. Kai	Militia	Nongbua	Guide
31	Mr. Khampha	Militia	Nongbua	Guide
32	Mr. Khamchanh	Village chief	Phanob	Gen. advice
33	Mr. Khamphone	Militia	Phanob	Guide
34	Mr. Ta	Youth	Phanob	Guide
35	Mr. Khot	Village chief	Nongping	Gen. advice
36	Mr. Pin	Elder chief	Phathoung	Gen. advice

Note: PAFO = Provincial Agriculture and Forestry Office
DAFO = District Agriculture and Forestry Office
PCU = Provincial Conservation Unit, Gen = General assistance and advice

CURRICULUM VITAE

Name Mr. Phaivanh Phiapalath

Date of Birth 12 December 1972

Place of Birth Sayabouli Province, Lao PDR

Education

- M.Sc. (Natural Resource Management) – Asian Institute of Technology, Thailand, 1999.
- B.Sc. (Biology) – National University of Laos, 1995.

Publications

- Suwanwaree, P. and P. Phiapalath. 2008. The local livelihood and natural resource management survey and its implication on the integrated conservation and development projects: a case study in Attapeu, Lao PDR. *KKU Science Journal*. 36 (Supplement): 199–211.
- Suwanwaree, P. and P. Phiapalath. 2006. Environmental policy of Lao PDR: a review, *Environment and Natural Resources Journal*. 4: 1–16.

Grants and Fellowships

- The WWF Russell E. Train Fellowship
- Institute of Research and Development, Suranaree University of Technology

Position and Place of Work

- Senior Program Officer (Protected Areas Management and Wildlife), IUCN Lao PDR