ปัจจัยของสิ่งแวดล้อมและการใช้พื้นที่ของมนุษย์ต่อความชุกชุมของประชากรนกยูง *Pavo muticus* บริเวณห้วยทับเสลาและห้วยสองทาง เขตรักษาพันธุ์สัตว์ป่าห้วยขาแข้ง จังหวัดอุทัยธานี.

นางสาวธัญวรัตน์ ปิ่นทอง

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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EFFECT OF ENVIRONMENTAL AND HUMAN USE FACTORS TO ABUNDANCE OF GREEN PEAFOWL *Pavo muticus* AT HUAI TAB SALOA AND HUAI SONGTANG, HUAI KHA KHAENG WILDLIFE SANCTUARY, UTHAI THANI PROVINCE

Miss Tanwarat Pinthong

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Environmental Science
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Thesis Title	EFFECT OF ENVIRONMENTAL AND HUMAN USE FACTORS TO ABUNDANCE OF GREEN PEAFOWL *Pavo muticus* AT HUAI TAB SALOA AND HUAI SONGTANG, HUAI KHA KHAENG WILDLIFE SANCTUARY, UTHAI THANI PROVINCE
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ธัญวรัตน์ ปิ่นทอง: ปัจจัยของสิ่งแวดล้อมและการใช้พื้นที่ของมนุษย์ต่อความชุกชุมของประชากรนกยูง *Pavo muticus* บริเวณห้วยทับเสลาและห้วยสองทาง เขตรักษาพันธุ์สัตว์ป่าห้วยขาแข้ง จังหวัดอุทัยธานี. (EFFECT OF ENVIRONMENTAL AND HUMAN USE FACTORS TO ABUNDANCE OF GREEN PEAFOWL *Pavo muticus* AT HUAI TAB SLOA AND HUAI SONGTANG, HUAI KHA KHAENG WILDLIFE SANCTUARY, UTHAI THANI PROVINCE) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: รศ. วีณา เมฆวิชัย, 148 หน้า.

ในประเทศไทย นกยูงเขียวหรือนกยูงไทย (*Pavo muticus*) ถูกจัดอยู่ในสถานะภาพสัตว์ป่าใกล้สูญพันธุ์ เนื่องจากจำนวนประชากรได้ลดลงมากจากในอดีต สาเหตุจากการสูญเสียถิ่นที่อยู่อาศัย การขาดความต่อเนื่องของถิ่นที่อยู่อาศัย และการรบกวนของมนุษย์ การศึกษาเรื่องการเปลี่ยนแปลงพลวัตรประชากรในรอบปีและการใช้พื้นที่ของนกยูง บริเวณห้วยทับเสลาและห้วยสองทาง เขตรักษาพันธุ์สัตว์ป่าห้วยขาแข้ง จังหวัดอุทัยธานี เริ่มตั้งเดือนมกราคม ถึงเดือนธันวาคม 2552 โดยได้ศึกษาความชุกชุมของนกยูง ในพื้นที่ 3 รูปแบบ คือป่าอนุรักษ์ ป่ากันชน และป่าชุมชน และเก็บข้อมูลเกี่ยวกับลักษณะของถิ่นที่อยู่อาศัยที่เหมาะแก่การดำรงชีวิตของนกยูงได้แก่ พื้นที่หากิน พื้นที่อาบฝุ่น พื้นที่สืบพันธุ์ พื้นที่วางไข่ และต้นไม้ที่นกยูงใช้นอน ผลการศึกษาพบว่า นกยูงมีความชุกชุมมากที่สุดที่ป่าอนุรักษ์ บริเวณลำห้วยทับเสลาและห้วยสองทาง (1.70 ตัวต่อกิโลเมตร) ลักษณะถิ่นที่อยู่อาศัยมีหลายรูปแบบ คือ ป่าเบญจพรรณ ป่าเต็งรัง และป่าไผ่ ใกล้แหล่งน้ำถาวรที่มีหาดทราย นกยูงออกหากินตั้งแต่เวลา 07.00น. ในฤดูฝนและ 08.15น. ในฤดูแล้ง ลักษณะของพื้นที่อาบฝุ่นมีความหนาแน่นของไม้ยืนต้นและไม้พื้นล่างต่ำ (0.167 และ 1.515 ต้น/ตร.ม.) ความหนาแน่นเรือนยอดป่านกลาง (44.4%) ความเข้มแสงสูง ชนิดดินที่ใช้ในการอาบฝุ่นเป็นดินร่วนปนทราย ลักษณะต้นไม้ที่ใช้เกาะคอนนอนเป็นไม้ยืนต้นขนาดใหญ่ ความสูงตั้งแต่ 19 – 30 เมตร อยู่ริมน้ำ ความหนาแน่นเรือนยอดป่านกลาง ลักษระของลานสืบพันธุ์มีความหนาแน่นของไม้ยืนต้น ไม้พื้นล่าง และความหนาแน่นเรือนยอดต่ำ (0.091 และ 1.863 ต้น/ตร.ม. และ 18.75% ตามลำดับ)สำหรับพื้นที่ทำรังวางไข่มีความหนาแน่นไม้พื้นล่าง และความหนาแน่นไม้เรือนยอดสูง (63.438% และ 65.0% ตามลำดับ)

แนวทางในการอนุรักษ์และฟื้นฟูถิ่นที่อยู่อาศัย อันดับแรก แยกพื้นที่เพื่อใช้ในการอนุรักษ์และพื้นที่สำหรับการทำกิจกรรมออกจากกันให้ชัดเจน, สอง จัดการพัฒนาพื้นที่บริเวณป่ากันชนเพื่อใช้สำหรับสันทนาการและการท่องเที่ยวเชิงนิเวศ, สาม สำรวจความชุกชุมของประชากรนกยูงในพื้นที่อย่างสม่ำเสมอ และขยายพื้นที่อนุรักษ์ให้ครอบคลุมบริเวณที่พบนกยูง, สี่ พัฒนาแหล่งน้ำถาวรให้มากขึ้น โดยการจัดทำบ่อน้ำในบริเวณที่นกยูงใช้พื้นที่, ห้า ให้ความรู้และจัดกิจกรรมเพื่อให้เยาวชนในพื้นที่ตระหนักถึงความสำคัญของการอนุรักษ์ และสุดท้าย ผลักดันให้ใช้กฎหมายอย่างมีประสิทธิภาพ

สาขาวิชาวิทยาศาสตร์สิ่งแวดล้อม ลายมือชื่อนิสิต ธัญวรัตน์ ปิ่นทอง

ปีการศึกษา 2552 ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก. .....

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KEYWORDS : ENVIRONMENTAL / ABUNDANCE / GREEN PEAFOWL / HABITAT USE

TANWARAT PINTHONG: EFFECT OF ENVIRONMENTAL AND HUMAN USE FACTORS TO ABUNDANCE OF GREEN PEAFOWL *Pavo muticus* AT HUAI TAB SALOA AND HUAI SONG TANG, HUAI KHA KHAENG WILDLIFE SANCTUARY, UTHAI THANI PROVINCE. THESIS ADVISOR: ASSOC. PROF. WINA MECKVICHAI, 148 pp.

In Thailand, green peafowl (*Pavo muticus*) is classified as an endangered species, according to population declining caused by losing, destruction and fragmentation of habitat and human persecution. The abundance and habitat utilization of green peafowls were studied during January to December 2008 at Huai Tab Saloa and Huai Song Tang river basin, Huai Kha Khaeng Wildlife Sanctuary, Uthai Thani Province. The objectives of this study are to investigate the habitat characteristics which the green peafowls used in foraging, dusting, roosting, breeding, and nesting, and to suggest a management plan for habitat restoration and conservation. Results showed that four habitat types were used by the green peafowls to consisting of mixed deciduous forest, secondary forest, dry dipterocarp forest and bamboo forest near permanent riverine with sand bar. The foraging time in rainy season (May-October) and dry season (November-April) started at 07.00 a.m. and 08.15 a.m., respectively. The characteristics of dust bathing area were loamy sand soil type, low density of tree and understorey (0.167 and 1.515 individuals/m^2), medium canopy cover (44.4%) and high illuminated intensities (748 lux). Green peafowl roosting habitat was characterized by high and large trees, medium canopy cover (61.667%) and 19 – 30 meters of tree height at riverside. The characteristics of mating area were sparsely canopy covers (18.75%), low understorey structure and density (26.406% and 1.863 individuals/m^2) and low tree density (0.091 individuals/m^2). The nesting area characteristics were high understorey vegetation structure (63.438%) and canopy cover (65.0%).

Recommendations for conservation planning of the green peafowls are first, separating preserved and recreation area; second, developing landscape management in buffer zone for recreation ecotourism; third, monitoring green peafowl population regularly and expanding the protected area which green peafowls are found; forth, constructed more permanent water resources within the area of large number of green peafowls tracts are found; fifth, promoting awareness programs for the youth and villagers and sixth, promote the efficiency of law enforcement..

Field of Study : Environmental Science Student's Signature Tanwarat Pinthong

Academic Year : 2009 Advisor's Signature Wina Meckvichai

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CHAPTER I

INTRODUCTION

1.1 Background

Birds and Human relationship — Birds have long been exploited and deeply associated to human cultural tradition over centuries (Fuller and Garson, 2000), as several evidences on cave walls drawn by stone age men, are examples; *c.a.* 25000 years ago in Southern Spain (Thera, 1997), green peafowl about 3000 years ago in Northern Thailand and red junglefowl 2500-3000 years ago at Uthai Thani province (Namthip, 1981; Willyalai, 1999) (Figure 1.1), and feature prominently in the art, religion, myth, social customs, and folklore of different ethnic groups in Asia (Fuller and Garson, 2000). They are used for many purposes such as for consumption as food or traditional medicine, for feather, eggs, and preserved as game species (Ponsena, 1988; Fuller and Garson, 2000).

Green Peafowl — Pheasants are large ground bird and most of them have beautiful feathers, especially male (Johnsgard, 1999). For Green Peafowl (*Pavo muticus*), many people have been emphasized that it is the most beautiful and most elegant pheasant in the world (Delacour, 1977). Because of this reason, this majestic species is described as one of the most admired animals in many Asian cultures and widely concerned outside their native range. They were known as the royal symbol and prestigious pet in several royal palaces (Choicharoen, 2008; Thankappan, 1974). They formerly ranged across much of Southeast Asia, throughout most of the wooded lowlands, riversides, lower hills (up to *c.a.* 600 m from foothill), and agricultural fields adjacent to forests (Lekagul and Round, 1991; Meckvichai *et al.*, 2004; Round, 1984). Their colorful feathers are valuable art objects and hence popularly

used in household crafts and decorations. Green peafowl is facing numerous threats including direct hunting for meat or feathers, poaching for eggs or chick to raise as pet. Habitat alteration across South-east Asia also causes decline in population size, generate fragmented population and, accordingly, local extinction and in some population that behave as crop-pest is consequently poisoned (Balen *et al.*, 1995; Brickle, 2002; Meckvichai *et al.*, 2001). Considering current population trend and all of those threats, green peafowl is listed as "Endangered species" (BirdLife International, 2009) and concerned in the Wild Animal Reservation and Protection Act 1992 (WARPA 1992).

(a) (b)

Figure 1.1 Galliformes in pre-historical period in Thailand; (a) Green peafowl at Pratu Pha (Cliff Gate), Lampang Province, (b) Red junglefowl at Khao PlaRa, Uthai Thani Province

(Photos courtesy of (a) Suttipong Arsirapoj; (b) Tanwarat Pinthong)

In Thailand, green peafowl has a large ancestral range widely spread in the rice field and riverine (Delacour and Jabouille, 1925). However, their abundance is evidently declining and severely fragmented across their range (Meckvichai *et al*., 2001; 2006). The Office of Natural Resources and Environmental Policy and Planning (ONEP: 1997) classified their local status as "Endangered species". At present, the remaining populations inhabiting along main rivers in many intact Northern and Western forests in Thailand and the largest population was found along Huai Kha Khaeng River in Huai Kha Khaeng Wildlife Sanctuary in the Western Forest Complex (Meckvichai *et al*., 2006) where we conducted the current study.

Study area — Huai Kha Khaeng Wildlife Sanctuary located in the Western Forest Complex between the latitudes of 14°59/ N to 15°48/ N and longitudes of 98°59/ E to 99°29/ E) with the total area of 2,780 square kilometer consisting of; hill evergreen forest, dry evergreen forest, mixed-deciduous forest and deciduous dipterocarp forest. It located between tropical and sub-tropical zone which has two seasons; wet season, stretching from May to October, and dry season from November to April. Mean temperature is 24.4°C, with a minimum of 10°C in January and maximum of 39°C in April (Huai Kha Khaeng Forest Fire Control Station, 2009). Average humidity is between 65-70 percent. Mean annual rainfall is about 1,552 millimeter per year.

The sanctuary was first designated as a protected area in September 1972, with an initial area of 637,109,375 square kilometer before enlarged in May 1986 and in December 1992. Huai Kha Khaeng Wildlife Sanctuary has been declared a UNESCO World Natural Heritage site in December 1991 together with East and West Thung Yai Naresuan National Park and several other smaller adjacent protected areas. The logging concession has been

taken place since 1963 to 1986. During logging period, areas were accessed by people and hence encroachment can be found in some areas, e.g. along Huai Tab Saloa river. One year after people along Huai Tab Saloa area has been translocated in 1992, Ponyeam (1993) reported absence of Green peafowl in the area. Interestingly, peafowl was found at 0.9-1.43 birds/kilometer walk in the area during re-surveyed which possibly recovered or recolonized from adjacent area (Meckvichai *et al*., 2006). Our study area cover this area and other two adjacent habitats that occupied by this species. Buffer zone area refers to areas which were planted after abandoned by dipterocarp trees located between wildlife sanctuary and community forest. Community forest outside the sanctuary area adjoins to buffer zone. Human activities are supposed to be highest in this habitat, comparing to other habitats.

1.2 Objectives

The objective of this study is focused on the effect of environmental and human use factors to abundance of green peafowl at Huai Tab Saloa and Huai Song Tang water basin in Huai Kha Khaeng Wildlife Sanctuary, Thailand. In this project were investigate three major aspects:

1. To investigate population dynamic of green peafowl in dry and wet season among differently protected include protected area, buffer area, and community forest.

2. To examine the characteristics of green peafowl habitats use for foraging, roosting, dusting, breeding and nesting.

3. To provide useful information that may improve park management to conserve the species, such as habitat rehabilitation and well managed eco-tourism.

CHAPTER II

LITERATURE REVIEW

2.1 Background – Peafowls in the world

Peafowls are the most beautiful and well known birds for centuries. These birds are symbolic of personal elegance nobility, during the days of chivalry, one of the most solemn oaths were taken "on the peacock" (Odrowaz-Sypniewski, 2009), and use to admire by comparing to beautiful woman (Choicharoen, 2008). Since the beginning of recorded history, the peafowl was known to the pharaohs of Egypt and to 14th- century Europe, India, China, and around Mediterranean Sea where it was roasted and served in its own plumage, but they are still quite rare and confined mostly to royalty and person of means (Thankappan, 1974; Choicharoen, 2008). They have domesticated ornamental peafowl such as both Babylon and Persia had a peacock throne, they are favorite bird on many coats of arms, and kings and nobles used peafowl as living landscapes on their estates (Ellie, 2003; Odrowaz-Sypniewski, 2009). Moreover at the excessive and luxurious banquets of European kings and queens of the Renaissance, there was an epicurean delight consisting of stuffed roast bird one inside the other like the famous Russian wooden mamushka dolls. The outermost shell was the glorious peacock, because people have always thought that what looks amazing must certainly taste wonderful (Ellie, 2003).

The peafowl brings harmony, joy, serenity and peace to the mind. This bird is majestic, proud with much expression and as the male bird walks and dances to the female in courting, this reminds people of the celebration in life, so this bird has been famous in art,

letter, poems and literatures (Thankappan, 1974; Ellie, 2003; Choicharoen, 2008; Odrowaz-Sypniewski, 2009,) e.g. they appear in the Thai literature of King Rama V, Thummatibes, H.M., Pra-ya Trang, and Luang Tuai Han Ragsa, they figures in the Bible and in Greek and Roman myth, where it appears as the favorite bird of the goddess Hera, or Juno, and Myth has the peacock representing fidelity, as it dies of grief, or remains single, if it loses its mate.

In addition, the peafowl's beautiful coloring is said to be a gift from the god, so the peafowl is considered to be a bird of auspicious and protection. This bird is also valued as a protection for the psychic self. Most of temples in the north of Thailand have a peafowl as symbol of pure commandment. In Burma, green peafowl is a forbidden animal for Karen huntsman (McGowan *et al.*, 1999). In Greece, peafowl is the emblem of the bird-god Phaon. Associated with Hera, who is credited with scattering the "Argus Eyes" over its tail, in Egypt, it sometimes accompanies Isis, in China, its feather is an attribute of the goddess Kwan-yin, as same like as in Japan (goddess Kwannon), and the last one, in Hindu, the peacock is the conveyance of god (Figure 2.1).

Figure 2.1 Peafowl illustrations and peafowl were mentioned in many way; (a) The god Murugan with his peacock, (b) Myth: the lost book of Nostradamus, (c) Thai dance (Thai Ballet), (d) Ritual flag, (e) Old Persian (Turkish) painting, (f) Peafowl stamp from worldwide, (g) The peafowl at the front door of the temple in Prayoa Province, (h) Peafowl in banknote and coin, (i) Peacock constellation, (j) peafowl feather accessories of royalty, (k) Chinese dress, (l) tattoo, and (m) The inspiration accessories from peafowl

Photos courtesy of (a) http://www.angelfire.com/mi4/polcrt/Peacocks.html

(b), (e), (i) http://www.crystalinks.com/peacocks.html

(c), (d), (g) Tanwarat Pinthong

(f) http://www.bird-stamps.org/species/35203.htm

(h) http://www.powercoin.it/images/products/Peacock_tn.gif

(j) http://en.wikipedia.org/wiki/Elizabeth:_The_Golden_Age

(k), (l), (m) http://www.peafowl.org/peacockart/peacockart.htm

Peafowls in the world basically refer to three galliforms; African Congo Peafowl (*Afropavo congensis*), Indian or Blue Peafowl (*Pavo cristatus*), and Green Peafowl (*Pavo muticus*) (Figure 2.2). However, African Congo Peafowl has unique morphological characteristics, i.e. lack of elaborate ornamentation and monogamous mating system, and their distribution is restricted in Zaire, unlike other two true peafowls (*Pavo* spp.) that found in South and South-east Asia (Johnsgard, 1999). Though they are genetically different form true peafowls (Delacour, 1977), they are closer related to those peafowls than any sympatric gallinaceous birds who are living in the same continent (De Boer and Bocxstaele, 1981, Kimball *et al*., 1997). They are, hence, placed in their own genus, *Afropavo.*

True peafowls are best known for male's elaborate tail which applied for display as part of courtship behavior (Loyau *et al.,* 2005; 2007, Petrie and Williams, 1993; Yasmin and Yahya 1996). Terms of “peacock” refers to male, “peahen” refers to female, and “peachick” refers to young peafowl.

Indian Peafowl (*P. cristatus*) is generally described as monotypic species. However, there are three types of mutation are known in captivity which are; Black-shouldered Peafowl (*P. c. mut. nigripennis*), White Peafowl, and Pied Peafowl (Delacour, 1977). The earliest known mutations are the white and the black-shouldered peafowl. While both male and female of White peafowl are pure white, black-shouldered peacock has dark coverts, instead of barred coverts, the peahen is much lighter than typical peahens. The pied peafowl is considered as another mutation form, but white color on plumage is highly variable (Figure 2.3) (Smith, 1999). Though they are resident breeder in the Indian subcontinent, they have long been known outside native ranges for their gorgeous appearance, through exportation. The species accordingly excluded from list of the

Convention on International Trade in Endangered Species: CITES (Delacour, 1977; Arrathrakorn, 2001).

Three sub-species of Green peafowl are recognized by color and distribution ranges. Those are; Javanese (*P. m. muticus*), Indo-Chinese or Thai (*P. m. imperator*) and Burmese (*P. m. spificer*). The two first subspecies are found in Thailand (Delacour, 1977; Robson, 2000; 2008; Meckvichai *et al*., 2008). Though typical ranges of green and Indian peafowls are no overlapping, cross-breeding practices between them are apparently successful in captivity and the hybridized peafowl is called “Spalding Peafowl” in honor of Mrs. Keith Spalding of California (Figure 2.3d) (Newlands, 2007).

(a)

(b)

(c)

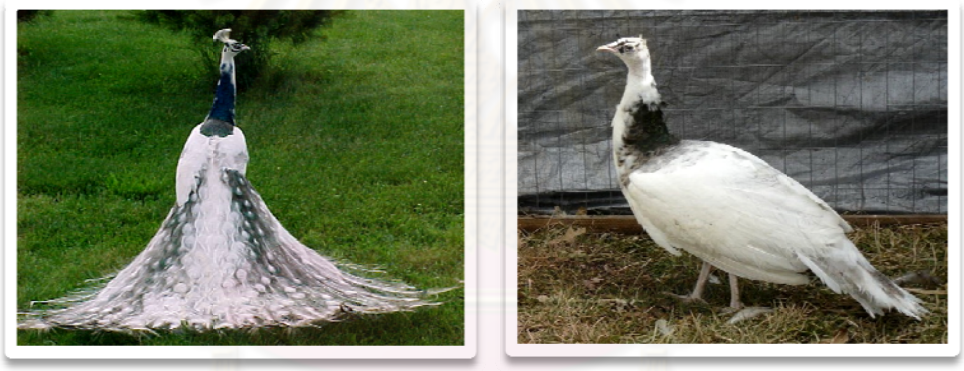
Figure2.2 Males (left) and females (right); (a) African Congo peafowl (*Afropavo congensis*), (b) Indian Peafowl or Blue Peafowl (*Pavo cristatus*), and (c) Green Peafowl (*Pavo muticus*)

(Photos courtesy of (a) http://commons.wikimedia.org/wiki/File:Congo_Peafowl/, (b) http://www.biolib.cz/en/image/id41676/, and (c) Tanwarat Pinthong)

(a)

(b)

(c)



(d)

Figure2.3: Mutation and hybridization in Peafowls: Male (Left) and Female (right); (a) White peafowl, (b) Black-shouldered peafowl, (c) Pied Peafowl (d) Spalding Peafowl (Photos courtesy of (a) – (d) http://www.4peas-peafowl.com/breeds.html)

2.2 General Characteristics of Green Peafowl

The green peafowl is a large ground-dwelling bird. The average dimensions are, body length 180.0-250.0 cm; train 140.0-160.0 cm; wing 46.0-54.0 cm; rectrices 40.0-47.5 cm; culmen 4.2-4.5 cm; tarsus 16.0-17.0 cm. Adult male and female are morphologically different but colorations between male and female are quite similar, they have brilliant green plumage, long upright tufted crest of barbed feathers, an iridescent breast and long neck. There are white to sky blue double-stripes with a yellow to orange crescent at the rear of facial skin (Delacour, 1977; Meckvichai and Arsirapoj, 2009; Robson, 2000; 2008).

Male normally reaches mutuality by the age of three years and they associated with elongated upper-tail coverts or train during breeding season. The train covered with large colorful ocelli. Males with a fully-developed train will exhibit territorial display in November, and maintain them until the end of the breeding season in April when molting of train feathers begins (Rojanadilog *et. al*, 1985). Their plumage is largely glossy green with blackish on upperparts and wings. Crown and crest are dark blue-green where shoulders are blue. Throat is largely blackish where the remaining under-part is dark brown with tinged green on lower breast and flanks. Wings are blackish-brown but buff at the edges with contrasting caramel-colored primaries. Their tail composed by 20 feathers (Delacour, 1977; Meckvichai and Arsirapoj, 2009; Robson, 2000; 2008). Immature male has blackish-brown upper-tail covert with pale bars, blackish lore (area between beak and eyes), and caramel-colored primaries. The second-year male is more similar to adult but has shorter train, often without ocelli (Laowthong and Piriyapong, 1989).

Female averagely reaches maturity in the second-year and tail may keep growing over another two to three years (Laowthong and Piriyapong, 1989). They lack of train, shorter crest, smaller legs and spur, and may also be slightly duller but almost identical to non-breeding male. Their upper-part, primaries, and tail are blackish-brown with pale bars and vermiculated. Tail consists of 18 feathers. The under-parts mixed green and bronze like male. The immature female similar adult female but duller (Laowthong and Piriyapong, 1989; Meckvichai and Arsirapoj, 2009; Ponsena, 1988).

Among three described sub-species, males of the mainland race, *P. m. muticus*, is the brightest bluish-green form and they have iridescent plumage with golden-green neck, fresh metallic blue green wing covert, and less bluish on breast. *P. m. imperator* is bigger, taller, and tends to has more vivid facial skin than other sub-species. While most characteristic is similar to the *muticus spp.* but the feather color is slightly duller. Neck, breast and wing-coverts are metallic-blue where outer webs of secondary are blue-green. *P. m. spicifer* is distinctive, they look more bluish-green and duller, primaries are brown with black bar in outer webs (only in female). Neck and breast are bluer where wing-coverts, outer webs of secondary and facial skin are extensively black (Delacour, 1977; Meckvichai and Arsirapoj, 2009; Ponsena, 1988; Robson, 2000; 2008).

2.3 Status and distribution

The order Galliformes is comprised of five families, with 284 species currently recognized (Keane *et al.,* 2005). Galliforms, especially pheasants in sub-family Phasianinae, are highly threatened birds as they are subjects to direct exploitation e.g., for food, sport or in association to human cultures. Therefore, more than 30 out of 52 pheasant species are in globally concern (IUCN, 2009).

Green peafowl likes other pheasants, with the exception of African Congo Peafowl, are limited their distribution to Asia (Johnsgard, 1999; Madge and McGowan, 2002). At the beginning of the 20th century, green peafowl was widely distributed over large area of East and South-east Asia from Bangladesh to Indo-China, Thailand, Malaysia (west), and Indonesia (Java), (Delacour 1977). At that time, they are very common as second highest abundant game bird in Indo-China where abundance of Red junglefowl (*Gallus gallus*) was highest (Delacour and Jabouille, 1925).

In last decades however, the species has undergone dramatically decline. The only sizeable remaining populations are found in dry forests in Cambodia, Myanmar, the southern portion of Laos, and west-central Vietnam (Brickle *et al*., 2008). Outside of this region populations persist in West and North of Thailand (Meckvichai *et al*., 2007), Yunnan in China (Liu *et al*., 2009) and on Java, Indonesia (Balen *et al*., 1995). Green peafowl has seriously declined to very low density (Brickle *et al*., 2008). Furthermore, remain populations are indeed persisting in patchy habitats. All three sub-species are seemingly gone to locally extinct in many of their former ranges e.g., *P. m. muticus* has gone to extinct in Malaysia and southern part of Thailand (Balen *et al*., 1995; IUCN, 2009; Meckvichai and Arsirapoj,

2009), P. m. *spicifer* became rarer in the eastern range of *P. m. imperator* whom remains fairly common throughout former range (Liu *et al*, 2009) or event thought that remain only in one wildlife sanctuary (Zoological Parks and Gardens Board of Victoria, 2003). (Figure 2.4)

With no argument, a lot of convincing evidences supporting that population decline has been accelerated by humans activities are such as; direct hunting or poaching, habitat disturbance and modification (Balen *et al*., 1995; Brickle, 2002, Keane *et al*., 2005). Similarly, pollutants and chemicals that are inattentively released from industry or agricultural land into ecosystem and accordingly as well affect the species distribution pattern (Arrathrakorn, 2001; Han *et al.,* 2007; Henderson and Clark, 2006; Meckvichai *et al*., 2004; Worrapimphong and Meckvichai, 2001).

Regarding to several described threats above, conservation issue on the species has been concerned globally. They are assigned to “Vulnerable” category in the Red list for many years (1994 - 2008), prior to latest updated to “Endangered” category in 2009 which majorly due to several local extinctions in North-East India, Bangladesh, Malaysia and peninsular Thailand (BirdLife International, 2009). The Pheasant Specialist Group of the World Pheasant Association (WPA), as well as the IUCN Species Survival Commission (IUCN/SSC) and the Birdlife International included them into a list of top-prioritized species. They are listed in the appendix II of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). They are too concern locally e.g., in Thailand (Wild Animal Reservation and Protection Act: WARPA, 1992)

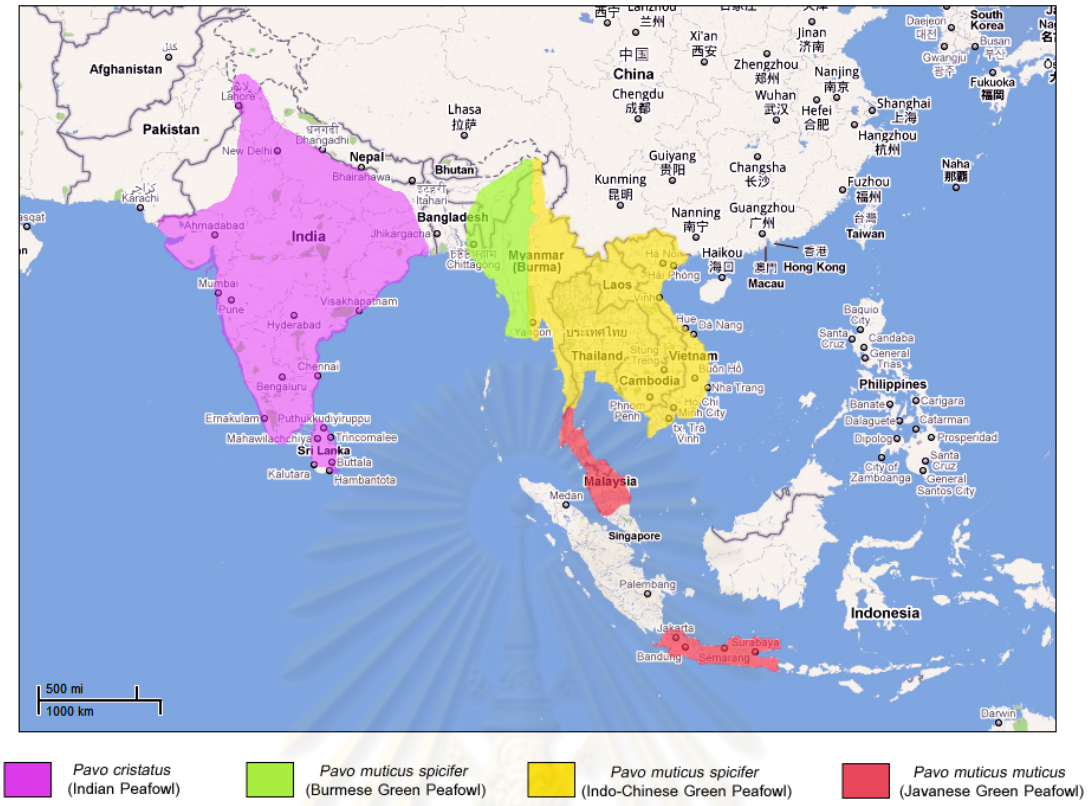


Figure 2.4 Shows map of distribution range of peafowl (Genus *Pavo*)
(Photos modified and courtesy of googlemaps.com)

2.4 Status and Distribution – Thailand

There are ten species of pheasants can be found in Thailand and six of them, including green peafowl, are known as threatened birds of Asia (IUCN, 2009). Green peafowl is nationally classified as “Endangered” species by the Office of Natural Resources and Environmental Policy and Planning (ONEP: 1997). In last decade, there are 14 protected areas that occupied by green peafowl which are; 1) Huai Kha Khaeng Wildlife Sanctuary, 2) Thung Yai Naresuan Wildlife Sanctuary, 3) Salawin Wildlife Sanctuary, 4) Phu Khieo Wildlife Sanctuary, 5) Yod Dome Wildlife Sanctuary, 6) Bung Kroeng Krawia Non-hunting area, 7) Phu Kao-Phu Phan Kham National Park, 8) Phu Phan National Park, 9) Khao

Sok National Park, 10) Mae Yom National Park, 11) Doi Phu Nang National Park, 12) Khuean Srinagarindra National Park, 13) Srinan National Park, and 15) Mae charim National Park (Arrathrakorn, 2001; Meckvichai et al., 2001; Meckvichai et al., 2007) (Appendix I).

As widely reported in tropic, pheasant (also for other wildlife species) suitable habitats in Thailand have largely been converted to agricultural land which mainly is lowland forest (Round, 1988). Habitat alteration does not just cause to loosing in Green peafowl habitat, also mean to increasing hunting or poaching pressure and concentration of chemical pollutants e.g., Paraquatdichloride: (weed killer) and Monochrotophos (insecticide). Persisting chemical substances can harm Green peafowl population through biological magnification (Worrapimphong and Meckvichai, 2001).

An effective management, at least, partially improve green peafowl population in the Huai Kha Khang Wildlife Sanctuary. Law enforcement and expansion of secondary forest, a potential altered habitat, this population is presumably increasing along main rivers in North and West of Thailand (Meckvichai *et al*., 2007), nevertheless, most of other population is still restricted to several protected areas (Arrathrakorn, 2001; Dumkeaw *et al*., 2009; Pinthong and Meckvichai, 2009; Ponsena, 1988; Sukumal, 2010).

The largest population found along the Huai Kha Khaeng main stream from Srinakarin Dam up to Huai Kra Ding and in the branches of Huai Kha Khaeng. A minimum number of 200 peafowls were once estimated by Round (1984). Slightly higher number, 206 peafowls, with potential recolonized population in some areas were revealed by latest survey and increasing in population size was thought to be related to good area protection and abundance of suitable food (Meckvichai *et al.,* 2007). The highest abundance was

found in Huai Ai Yoh, 4 birds/ kilometers, and the lowest abundance was found in Huai Kra Ding, 0.14 birds/ kilometers. The peafowl also found in Huai Tab Saloa and Huai Song Tang water basins where Ponyeam (1993) reported the species absence, however at relatively low abundance, 1.43 and 0.90 birds/ kilometers (Meckvichai *et al.,* 2007).

However, in Thailand, the effective conservation actions support the green peafowl population, e.g. the Wild Animal Reservation and Protection Act of BE 1992 (WARPA: 1992). Due to prohibition by law, regeneration of secondary forest, reduced hunting and improved protection, their populations are increasing along main rivers in northern and western of Thailand (Meckvichai *et al*, 2007) but, limit within several protected areas (Arrathrakorn, 2001; Dumkeaw et al., 2009; Pinthong and Meckvichai, 2009; Ponsena, 1988; Sukumal, 2010).

2.5 Ecology of Green peafowl

2.5.1 Habitat Utilization

Knowledge on the ecology and behavior of green peafowl is somewhat limited and largely based on qualitative studies. Most records are found in a wide range of habitats including dry deciduous forest (Brickle, 2002, Bult and Vongkamjan, 2005; Evans and Timmins 1996; Johnsgard, 1999; Liu *et al*., 2008), primary and secondary forest, both tropical and subtropical (Delacour, 1977), pastures or open forest (Balen *et al.,* 1995). The majority of records are from the lowlands riverine forest (0-500 meters) and foothill to hill ridge, particulary where the hill ridge is not higher than 500 meters from the foothill (Brickle *et al*., 1998; Meckvichai *et al.,* 2004); however green peafowl have been recorded up to 915 meters in Thailand (Robson, 2008), 620 meters to 1,070 meters in Shiyangjiang and

Xiaojianghe Basins, China (Liu *et al.*, 2008), and 3,000 meters in Java (Balen *et al.* 1995). They may also be found areas dominated by bamboo (Brickle, 2002), agricultural fields (cotton black bean and corn) (Arrathrakorn, 2001; Meckvichai *et al.,* 2004; Worrapimphong and Meckvichai, 2001) plantations (teak, rubber) (Balen *et al.,* 1995), and forest fringes (Arrathrakorn, 2001)

Although their requirement on fresh water seems to be variable, some authors suggested that water availability of good and plentiful water resources are indispensable (Brickle, 2002; Johnsgard, 1999; Liu *et al.*, 2008) and some other conclusions hinted that birds can tolerate during periods that no such good water source is available (Balen *et al.*, 1995; Evans and Timmins, 1996), availability of water source appears to be an important factor which confounded with the highest densities along undisturbed wetlands (BirdLife International, 2009). Moreover, most observers considers that green peafowl is less adaptable to people (Brickle *et al.*, 1998; 2002; Ponsena, 1988), unlike Indian peafowl, their close relative. Human settlement can be considered as threat to the species.

Green peafowl is found in a variety of habitat types in Thailand which are open mixed deciduous, broadleaved evergreen and semi-evergreen forest, particularly along rivers and boarding wetland, forest edge, secondary growth, bamboo; from mean sea level (msl) to at least 915 msl (Bult and Vongkamjan, 2005; Robson, 2000; 2008; Rojanadilog *et al.*, 1985) reported that green peafowl prefers open spaces within forest because there are many kinds of food. Similarly, Arrathrakorn (2001) confirmed that green peafowl regularly use in open area such as forest edge and agriculture field where as Brickle (2002) referred to Hoogerwerf (1970) noted that they are most attracted by pastures, forest fringes and park-like surroundings of light or open forest, birds may be not disperse further into deeper

forest if the presence of food or water source are adequate. A study on radio tracking also revealed that movement of radio-tracked bird more associated to riverside (47.34% of their times) which characterized by shallow, present of sand bar and sandy bottomed with grassy banks, mixed deciduous forest (40.77% of the times), and free from human disturbance (Ponsena, 1988). An average area of a male bird used within a day was 68.28 ha where as average female home range was larger, confounding to number of female in a flock, female usually more aggregate than male.

2.5.2 Daily Active, Foraging Behavior and Diet Composition

Green peafowl is a diurnal bird. They generally leaves roosting tree in early morning, c.a. 0700 hour (Rojanadilog *et al*., 1985). In case of heavily fogged, the active time for foraging may be started a bit later (Ponsena, 1988). They spend their time for foraging in the morning and in the evening in open area, near the area with tall grasses and sedges, around riverbanks where point bars and sand bars are presence, and in agricultural area (e.g., orchard and field) (Arrathrakorn, 2001; Dumkeaw *et al*., 2009; Meckvichai *et al.,* 2004; Ponsena, 1988; Worrapimphong and Meckvichai, 2001). During the rest of the day, they inactive in sheltered site e.g., bush and bamboo groves (Ponsena, 1988) and valley nearby the riverside (Liu *et al*., 2008) because the temperature is lower in the shade.

They are omnivorous bird, consume on a variety of animal and plant materials. The diet consists mainly of; seed, bamboo grain, fruits, young leaves, flower petals, a variety of invertebrate, and small vertebrates e.g., amphibian and reptiles (Arrathrakorn, 2001; Bult and Vongkamjan, 2005; Dumkeaw *et al*., 2009; Meckvichai *et al.,* 2004). However, their diet

composition is mostly vegetation (Ponsena, 1988). They sometimes eat gravel and small stones, and drinks mineral water at salt lick (Rojanadilog *et al*., 1985).

Ponsena (1988) collected plant specimens which fed by the peafowl in various areas in Huai Kha Kaeng Wildlife Sanctuary. Those specimens were classified to two main groups; 1) vegetation material, is the main diet of green peafowl (At least 66 species in 57 genera) which are; flowers, seed, young leaves, bamboo, herbs, climbers, fern, shrubs and tree (Appendix II) and 2) animal material such as both larva and mature stage of insect is favorite food, some amphibian and fishes.

2.5.3 Maintenance Behaviors

Avian implies variety of major and minor maintenance behaviors which are; preening, scratching, bathing, dusting, sunning, anting, bill wiping, shaking, and ruffling of the feathers, in order to keep their plumage in good condition (Cotgreave and Clayton, 1994), comfortable muscle, and removing ecto-parasite (Healy and Thomas, 1973 and Ponsena, 1988). A maintenance behavior requires energy and takes time (Walther and Clayton, 2005). Energy and time that birds devote for maintenance subtract from those of other behaviors, such as feeding and vigilance (Walther and Clayton, 2005). This trade-off should reinforce maintenance costs associated with comfortable and ornamental traits. Birds average spend 9.2% of their active time for feather maintenance (Cotgreave and Clayton, 1994), but birds with ornamental plumage might spend more time in maintenance behaviors (Walther and Clayton, 2005).

Walther (2003) studied 5 general behaviors of Indian peacock, and grouped those into 3 groups using amount of maintenance behaviors which are; display behavior, walk and feeding, and stand or resting. The result show that the peacock spent 64.9% of daily time budget standing and resting (42% standing and 22.9% resting). For resting behavior such as; preening (*i.e.*, touching the plumage with the bill to groom), scratching (*i.e.* touching the plumage with the foot), and dusting took up more than 99% of maintenance time. These maintenance behaviors are therefore much more important than the other maintenance behavior such as wing stretching, head wiping and shaking and ruffling the feather. Interestingly, the results were agreed with one study on green peafowl in Huai Kha Khaeng wildlife Sanctuary. They comfort themselves regularly by cleaning while performing other activities (Ponsena, 1988).

Grooming behavior — defined as a combination of preening and scratching (Cotgreave and Clayton, 1994), is the most time consuming component. Peacocks spend a quarter of their total grooming time preening their trains and often seen throughout the day but usually in numerous short bouts (Walther, 2003). Grooming serves a variety of functions such as straightening and oiling their feathers and removing dirt and ecto-parasites from the body. In the end of the breeding season, preening also apply in order to remove old-tattered tail feathers (Ponsena, 1988).

Dusting — alters the condition of feathers, and probably serves a similar function as grooming, cleaning the plumage and possibly removoing ecto-parasites (Walther, 2003). Peafowl in deciduous forest prefers dusting when it becomes satiated and generally performs in the dry period (Ponsena, 1988). Bird will create a shallow pit on sandy ground prior to lying down, stretching wings out and using them to take sand over the back

and then followed by shaking and ruffling movement to distribute sand into all feather over the body, each wing tossing action lasts for 5-10 minutes (Ponsena 1988; Walther, 2003).

Other maintenance behaviors — probably serve similar functions as grooming and dusting above. Sunning or sun-bathing is usually conducted to provide warmth to body. The sequences of this behavior conducting by Green peafowl is beginning with standing, crouching down or lying on one side and then alternate with wing spreading (Ponsena, 1988). Other related behaviors somewhat more limited to be interpreted, likewise, head wiping may only serve to distribute preen oil into the head plumage, and wing stretching may not even have a maintenance function but may rather be a comfort behavior to stretching up the muscle (Walther, 2003).

2.5.4 Roosting Behavior

Peafowls are both socially and solitary rooster (Ponsena, 1988; Subramanian and John, 2001). An adult male commonly roost alone or together with one or two other adult males where peahen roosts together in small group of 3-4 birds along with sub-adult males. Peahen with chicks roosts on the ground in dense the thorny bush. However, there are cases that adult male roosts together with female and sub-adult male in small group in the same tree and there is a case that peafowl roosts on a telecommunication pylon (Subramanian and John, 2001).

Peafowl roosting was observed when light intensity dropped below 8 lux (Indian peafowl; Subramanian and John, 2001), which is usually during 1800-1830 hour but in winter when the day length is shorter they will roost c.a. 30 minutes earlier in trees nearby feeding sites (Ponsena, 1988). Male often call from trees in early morning (Liu *et al*., 2008).

Roosting tree can be found in various types of forest and not specific to what tree species, but preferred to roost primarily on tall tree (>7 meters) with thick branch (Ponsena, 1988; Yasmin, 1995; Subramanian and John, 2001; Liu *et.al*, 2008) or stand commonly taller and larger than nearby stand (Ponsena, 1988; Yasmin, 1995) and never been found to roosting on dead tree (Ponsena, 1988). When peafowl roosted in tree with dense foliage, they prefer the highest branches (Yasmin, 1995; Subramanian and John, 2001). On leafy trees having several thick branches, the peafowl first rested on a lower branch and then moved to the final roosting site (Subramanian and John, 2001). It could be interpreted to roosting site selection that depends on visibility around the site (Yasmin, 1995). Birds generally return to the same roosting tree for long period of time with exception that they are disturbed at roosting site (Ponsena, 1988).

2.5.5 Breeding Behavior

Peafowls like other pheasants, with prominent sexual dimorphism, in which males do not provide resources for offspring, and females prefer to mate with those males that possess the most elaborate trains (Arrathrakorn, 2001; Petrie and Williams, 1993; Takahashi and Hasegawa, 2008). Evolution on sexual dimorphism is believed that driven by mating selection. Most male pheasants associated with specialized characteristics that related to attractive displays or courtship behaviors and green peacock, in this case, develops fantastic elaborate tail which is called “train” (Petrie and Williams, 1993).

In breeding season, for green peafowl ranges from November to March when male train start molting, and peak of one population in Huai Kha Kaeng Wildlife Sanctuary found in February (Ponsena, 1988), an adult peacock separates himself from his

flock or other male to occupy, declare and defend his territory (Arratharakorn, 2001; Ponsena, 1988). Rojanadilog *et al*. (1985) emphasized that during breeding season adult males with fully-developed train will move to the point bars along the main streams to establish their mating territory in order to defense his territory from other males. The male of peafowl is famous as a dancer bird (Delacour, 1977), their display site were 3.46± 1.84sq.m, mostly were open space and less canopy cover (Arratharakorn, 2001). Mating usually occurs in the morning and late afternoon (Ponsena, 1988). Peahens are thought to select a peacock that possesses the most elaborate tail (Petrie and Williams, 1991; 1993). Train characteristics *e.g.* total number or density of eye-spots, feather ornaments and colors, length or symmetric of train, usually measured as factors that might explain male mating success (Loyau *et al,* 2005; 2008, Petrie and Williams, 1991; 1993; Yasmin and Yahya 1996). However, train morphology alone may inadequately explain those question, male mating success could be a combining result between male and active female choices (Rands *et al.,* 1984), food resources in display site location (Loyau *et al*, 2006), certain behavioral factors that conducted by peacock as a part of display behavior also attribute to mating success of the species e.g., shivering display and call length (Takahashi and Hasegawa, 2008; Takahashi *et al.,* 2008).

Male display usually begins with the male remaining close to (or within) his display site for much of the day (Ponsena, 1988). There are two pattern of male display; wing-shaking and train-rattling display (Dakin and Montgomerie, 2009). When he approach a active female, he will move in front of females and raises and spreads his train with train-rattling display on average directed at about 45° to the right of the sun azimuth, otherwise if females were behind, they generally use the wing-shaking display (Dakin and Montgomerie,

2009). Sometimes, male might continue to turn away from her as he moves around her (Ponsena, 1988). Moreover, If females remain in nearby and active, the male may keep the fan spread or maintain shivering for up to 15 minutes (Ponsena, 1988) and Dakin and Montgomerie (2009) confirmed this behavior that involved in the communication of a visual signal.

The seasonal and diurnal effected to calling activity of peafowl (Takahashi and Hasegawa, 2008). Mating calls may be developed with peacock age (Takahashi and Hasegawa, 2008) and can vary from year to year in association to food availability (Davison, 1983; McGowan, 2004). He found highest level of calling occurred in a year when trees of many families flowered and fruited synchronously, resulting in an abundance of fruit and insects.

2.5.6 Nesting

Nesting is very important for the survival and breeding of birds. Especially, endangered species or geographically isolated populations, reproductive failures may also increase the probability of extinction (White *et al*., 2006).

Site selection for nesting – is arguably one of the most profound choices affecting an individual's fitness, and ultimately, a species persistence (White *et al*., 2006). Refuge provided by the environment of nests can influence the survival rate of birds, and the nest environment is characterized mainly by the vegetation around it (Nan *et al*., 2006). After mating, the peahen will separate herself to select nest site for laying eggs. She usually nests in the undergrowth of the mixed deciduous forest, on the ground which high grasses patch along the riverside or sand bars, safe from predators, forest fires and flood

(Arrathrakorn, 2001; Ponsena, 1988). Sometime, nest on the low trees in the jungle near riversides (Rojanadilog *et al*., 1985). Moreover, Subramanian and John (2001) reported that the Indian peahen preferred *Prosopis* bush for nesting.

Nest character – normally, the green peahen has a ground nesting type (Meckvichai, 2008; Ponsena, 1988; Robson, 2008). She nests on the ground without any structure in the shrub or high grasses and generally near the water source (Meckvichai, 2008). The nests are shallow depressions scratched on the ground's surface. It is slightly rounded with 30cm in diameter and 5-6 cm deep. In the bottom of the nest is covered with dry leaves and dry sticks which are available in the immediate vicinity (Meckvichai, 2008; Ponsena, 1988).

2.6 Site Description - Huai Kha Khaeng Wildlife Sanctuary

There are 4 main types of protected areas in Thailand: national park, wildlife sanctuary, non-hunting area, and forest park (Panusittikorn and Prato, 2001). A wildlife sanctuary is designed to conserve habitat in which wildlife can breed and expand in a natural setting Educational and research activities are allowed (WARPA, 1992). Of Thailand's 42 wildlife sanctuaries, Haui Kha Khaeng and Thung Yai Naresuan were the first to be established (Chettamart, 2003; Panusittikorn and Prato, 2001).

2.6.1 Geographical Location

The Huai Kha Khaeng Wildlife Sanctuary established on the 26th August 1972. About geographical location, the sanctuary lies mainly in Uthai Thani Province, but extends into Tak Province with the total area of 257,464 hectare (ha) (UNEP, 2005). It is

located at the southern end of the Dawna Range, about 300 kilometers north-west of Bangkok, Thailand 15°00'-15°50'N, 99°00'-99°28'E (Ponsena, 1988; UNEP, 2005). This wildlife sanctuary covers the areas of six districts of three provinces: Amphoe Ban Rai, Amphoe Lan Sak, Amphoe Huai Kod - Uthai Thani Province, Amphoe Sangkhlaburi, Amphoe Thong Pha Phum - Kanchanaburi Province, and Amphoe Umphang - Tak Province. It is contiguous with Thung Yai Naresuan Wildlife Sanctuary (320,000ha) to the west. Although the two sanctuaries are administered separately, they are essentially a single conservation area representing the largest legislated protected area in mainland South-east Asia (1,208,300ha) (UNEP, 2005). Especially, Thung-Yai Naresuan - Huai Kha Khaeng Wildlife Sanctuary has been legally registered as a World Heritage Site with UNESCO since 1991 (ONEB, 1990; UNEP, 2005). (Figure 2.5)

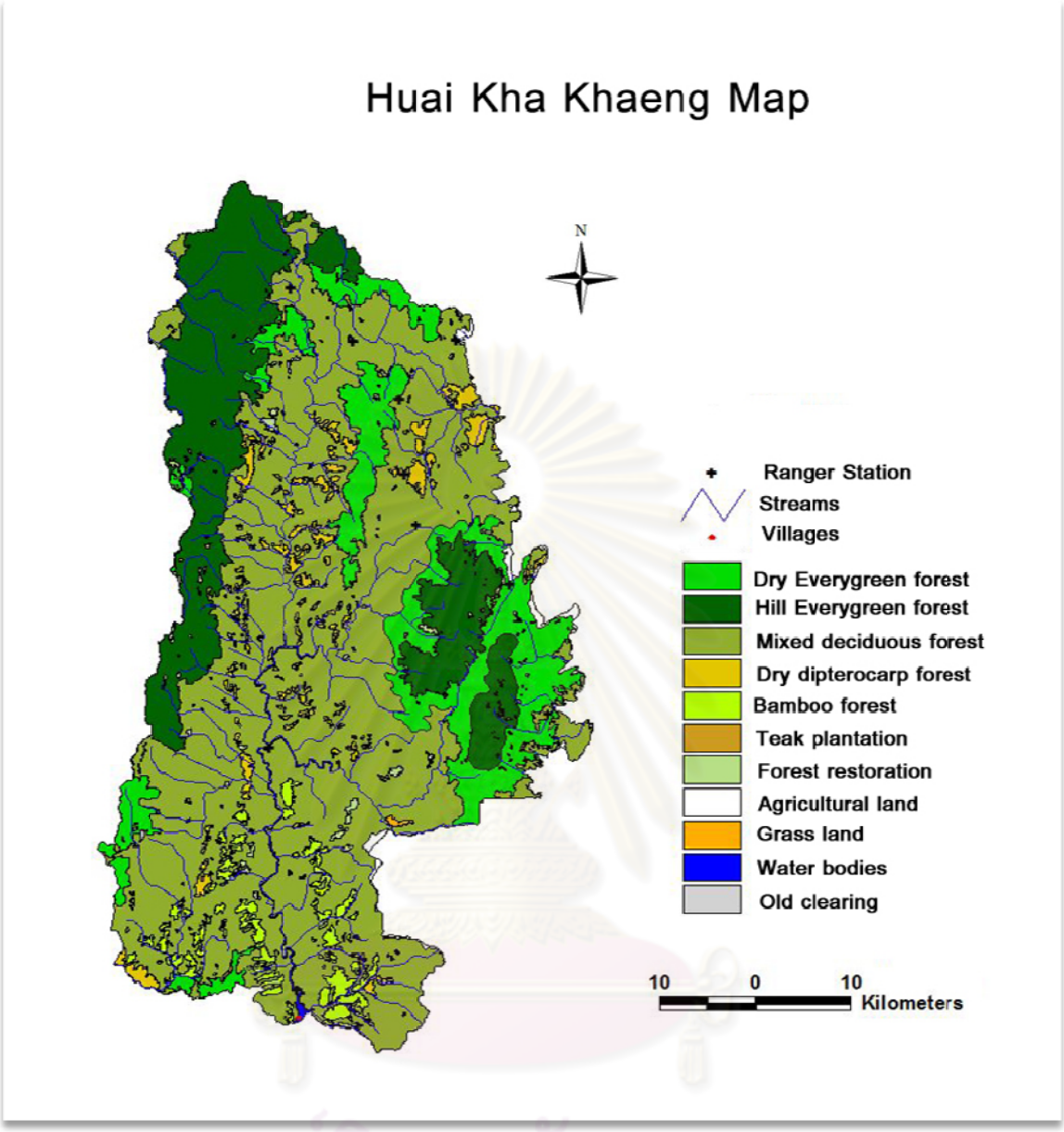


Figure 2.5 Shows map of Huai Kha Khaeng Wildlife Sanctuary.

(Photos courtesy of Huai Kha Khaeng Wildlife Sanctuary)

Geological setting consists of mainly igneous rocks e.g. granite, granodiorite and diorite of Triassic (Saminpanya *et al.*, 2004). Red-brown earths and red-yellow podzols are the predominant soils, the former derived from limestone and found in the level uplands and Mae Chan Valley, whilst the latter is found in the Huai Kha Khaeng Valley (UNEP, 2005).

In addition, the soils in Mixed Deciduous and Deciduous Dipterocarp Forests were sandy loam and the soil in Dry Evergreen Forest was silty loam (Saminpanya *et al*., 2004). There are 15 large saltlicks, small lakes, ponds and swampy areas occur, some being seasonal whilst others are perennial; these are important wildlife habitats (Saminpanya *et al*., 2004; UNEP, 2005).

2.6.2 General Topography and Climate

Topography – The sanctuary area is composed of steep complex mountains where elevations range from 200-1,687 meters above mean sea level, the highest peak of the area is Khao Plai Huai Kha Khaeng. The topography is mainly mountainous with the longest stream, Huai Kha Khaeng, running from the north to the south of the area (Ponsena, 1988).

Climate - In Huai Kha Khaeng Wildlife Sanctuary, the climate is monsool, intermediate between Tropical and Sub-Tropical climates. There are 3 seasons which are: summer, February-April; rainy season, May – November; short winter, December – January (Saminpanya *et al*., 2004). In 3 seasons can divided into 2 main climatically periods which are determined by dryness, wetness and low and high relative humidity of the sites. They are the dry period (winter and summer) and the wet period (rainy season). Ponsena (1988) describe in detail of the 2 period as:

The dry period can be divisible in to 3 parts *i.e*. the early dry period from November to December, the middle of dry period in January to February and late dry period from March to April. The wet period can also be divided into 3 parts *i.e*. the early wet period

from May to June, the middle wet period from July to August and late wet period from September to October.

The heaviest rains generally arrive in September or October, as a result of typhoons in the South China Sea. Annual mean rainfall is about 1,552mm, relative humidity is about 65-70%, evaporation is about 700-900mm/year, and temperature is 24.4°C which range from an average of 20°C in December (min. 10°C, max. 28°C) to an average of 28°C in May (min. 20°C, max. 37°C) (Saminpanya *et al*., 2004; UNEP, 2005; Huai Kha Khaeng Forest Fire Control Station, 2009; Ministry of Natureral Resource and Human Secure, 2008).

2.6.3 Natural Resource

Vegetation - The forest land of Huai Kha Khaeng Wildlife Sanctuary compose of 6 types that can be distinguished; Dry Evergreen (18%), Hill Evergreen (15%) Mixed Deciduous (46%), Dry Dipterocarp (13%), Tropical Rain forest (8%), and Secondary forest (0.26%) (Ministry of Natureral Resource and Human Secure, 2008). The vegetation in Huai Tab Saloa and Huai Song Tang basin found 2 types include Dry Dipterocarp and Mixed Deciduous forest. The detail of each as follow (Ponsena, 1988; Ministry of Natureral Resource and Human Secure, 2008; Saminpanya *et al*., 2004; UNEP, 2005):

Dry Dipterocarp forest: the vegetation of this type can be found in many part of the basin, especially the head office of the sanctuary and the natural trail. The type usually associates with Mixed Deciduous forest. There are 13 plant species found from 12 individual trees in this type (10mx10m) *e.g. Shorea obtusa, Cratoxylon floribunda*, and *Porana bialata*, and the undergrowth consists of seedling, shrubs, grasses and cycad.

Mixed Deciduous forest: this type generally composed of varieties of bamboos. There are 26 plant species found from 276 individual trees (10mx10m) e.g. *Bambusa arundinacea, Camanga latifolia,* and *Bauhinia glauca*, and the ground flora are composed of seedlings, climbers and grasses.

Water quality – Saminpanya *et al.* (2004) studied the water quality at the Huai Tab Slao, a stream near the head office of the sanctuary with 4 parameters, and reported that Huai Tab Salao stream are in the ranges of the surface-water standards according to the National Environment, Ministry of Natural Resources and Environment, Thailand (include; dissolved oxygen (DO) is 7.25mg/l, pH = 6, conductivity is 40.81μs/cm, transparency is 28.5 cm, and temperature is 24.25°C.)

Fauna – this wildlife sanctuary is rich and has a high diversity. There are at least 860 species of animals which are; 130 for mammals, 410 for birds, 100 for reptiles, 42 for salamanders and 178 for aquatic animals (Ministry of Natureral Resource and Human Secure, 2008; Sonthirat *et al*., 2541). Among these are 3 in 9 National Reserved Wildlife Species of the country: wild water buffalo, *Bubalus arnee*, in the south; mainland serow, *Capricornis sumatraensis*; and hog deer, *Cervus porcinus*, exist in this area (Ponsena, 1988; UNEP, 2005).

Of Thailand's 986 species of birds (Napeetapat *et al*., 2007), 410 have so far been recorded in the sanctuary. Many of these are now rare in Thailand, including Green Peafowl, *Pavo muticus*; Red-headed Vulture, *Torgos calvus*; Kalij Pheasant, *Lophura leucomelana*; Burmese Peacock-pheasant, *Polyplectron bicalcaratum*; Rufous-necked Hornbill *Aceros nipalensis* and White-winged Wooduck *Cairina scutulata* (UNEP, 2005).

Also present are several nationally rare species of reptiles and amphibian, including Indian Monitor, *Varanus bengalensis*; giant Asiatic Toad, *Bufo asper;* and Asiatic Giant frog. *Rana Blythii (*Ministry of Natureral Resource and Human Secure, 2008; ONEB, 1990; UNEP, 2005*)*.

2.6.3 Local Human Population

There are no longer any villages within the Huai Kha Khaeng Wildlife Sanctuary, following relocation of the population in the 15 years before designation of the site (UNEP, 2005). There are 3 of 16 villages near the border of the Sanctuary, which are; Bung Cha-Roen, Phai-Ngam and Khao-Khiew (Ministry of Natureral Resource and Human Secure, 2008). People have mainly agricultural occupations, but the high income is from fishery at the reservoir of Tab Saloa Dam or selling forest products. (Saminpanya *et al*., 2004).

2.6.4 Visitors and visitor Facilities

The whole area of this wildlife sanctuary is divided into 4 categories i.e. area for biodiversity conservation and preservation, area for study and research of flora and fauna, area for study of nature, and buffer zone. There are 3 nature trails in Huai Kha Khaeng had been constructed (Saminpanya *et al*., 2004).

Neither Sanctuary is open to the general public, but permission may be given to researchers, naturalists and student groups for specific purposes. It is well known for academic research and tourist attraction (Chettamart, 2003; Saminpanya *et al*., 2004), because of their rich biological resources and registered as a World Heritage Site, and A

World Heritage Center and a Nature Education Center have been built there. About 1,000 visitors come to Huai Kha Khaeng during the dry season (UNEP, 2005).

Huai Kha Khaeng is accessible from Bangkok in 6-7 hours via Uthai Thani. As far as Lansak the road is metalled, but thereafter a four-wheel drive vehicle is often necessary. The journey to Thungyai by mostly unsurfaced road from Bangkok via Kanchanaburi takes 10-12 hours. A four-wheel drive road passes through the Sanctuary from the headquarters to a mining concession on the international border. There are buses from Bangkok to Uthai Thani and Lansak, but no public service as far as the Sanctuary (UNEP, 2005).

CHAPTER III

MATERIALS AND METHODS

3.1 Study areas

This study was conducted at the area about 34sq.km where including Huai Tab Saloa and Huai Song Tang water basin in Huai Kha Khaeng Wildlife Sanctuary. There are three habitat categories in study site cover; protected, buffer, and community forest area, and there are two seasons; a dry season from November to April and a wet season from May to October (Saminpanya *et al*., 2004).

3.2 Preliminary Study

Prior to conducting intensive field survey were initiated (see table 3.1);

1. Literature reviews on the study area, survey techniques, and behaviors of green peafowl. I constructed and improved field data forms simultaneously to transect preliminary survey.

2. Consultations with sanctuary officers and park rangers who know the area and have field experience about distribution of green peafowl and location of used micro-habitats *i.e*., foraging, dusting, roosting, and nesting habitat (none of breeding habitat is reported). I rechecked those sites and recorded collected UTM coordinates by reliable Global Positioning System (GPS).

3. Preliminary field survey started in rainy season, July 2007, using strip transect approach with 10m strip width, to explore potential green peafowl's habitats (Bult and Vongkamjan, 2005), focusing on areas that reported in previous studies or reported by

sanctuary officers and park rangers. During survey I recorded green peafowl habitat utilization *i.e.,* foraging, dusting or dust bathing, roosting, and nesting habitat. Again, no such information on breeding habitat has been recorded as this survey was conducted during non- breeding season.

4. Examination on size of vegetation sampling plot for habitat utilization study, using species area curve approach in each forest type in both Huai Tab Saloa and Huai Song Tang water basin.

3.3 Population dynamic study

Green peafowl relative abundance and their signs were monthly surveyed along six transects in three habitats as follows; 1) protected area 2) buffer zone and 3) community forest in dry and wet seasons during January 2008 to January 2009. The presence of green peafowl was recorded through; direct sighting and signs (call, track, bird dropping, and feather) which found within 10m distance from transect. Additionally, UTM co-ordinates of all locations were simultaneously collected and respectively mapped using ArcView 3.2a (Martin *et al*., 1997).

Six surveyed transects are consisting of three transects in protected area; 4-km transect roughly parallel to Huai Song Tang (**ST1**), 10-km transect roughly parallel to Huai Tab Saloa (**TS1**), and 6-km transect Huai Kha Khaeng Wildlife Sanctuary Road (**HKKR1**) (head office-9th km). A 3-km transect was located in buffer area (**HKKR2**) between Huai Kha Khaeng Wildlife Sanctuary Road and community forest (9th km-Thung Phak) and two transects were located in community forest (out of wildlife sanctuary); 1) 1.9-km roughly

parallel to Huai Tab Slao (**TS3**), and 2) 2.6-km in Huai Kha Khaeng Wildlife breeding station Road (**BSR3**) (Figure 3.1).

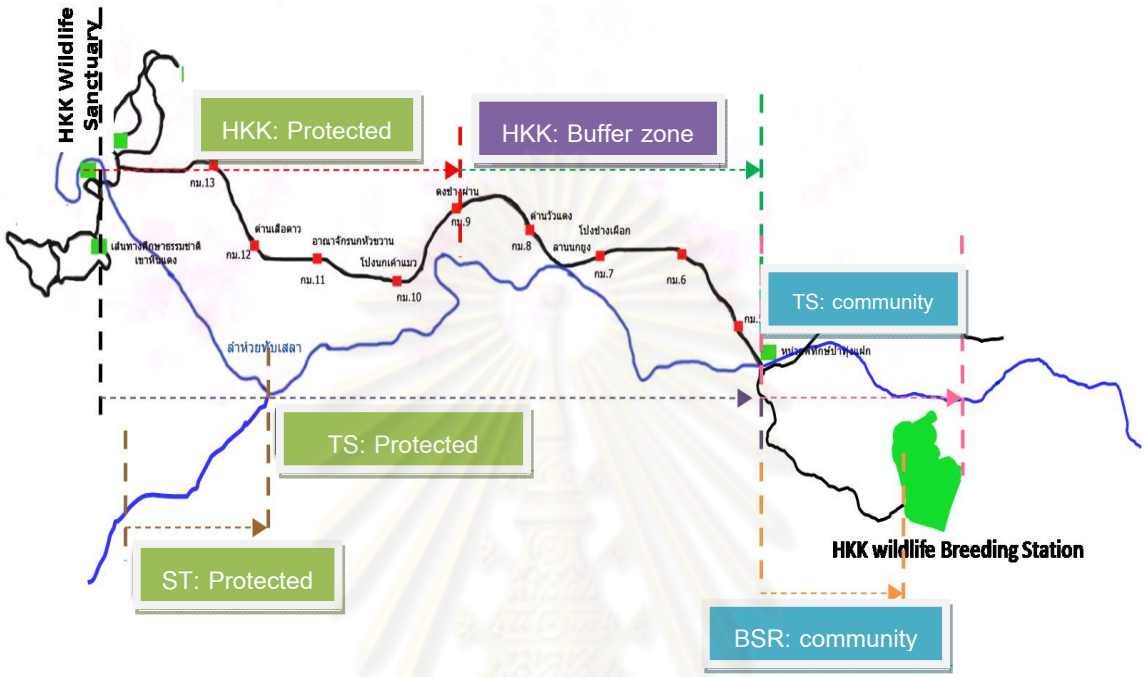


Figure 3.1 Shows the study site in six surveyed transects in Huai Tab Saloa and Huai Song Tang water basin in three different habitats. Black and blue lines are representing road track and streams.

3.4 Threats and habitat disturbance

During peafowl survey, the information was noted on; 1) environmental factors influencing habitat use of the green peafowl *i.e.*, permanent water, flooding, erosion, and wild fire, 2) tracks and signs of potential predators e.g., Felids (tiger and smaller cat species), Viverids (civets and palm-civets), Monitor lizard (*Varanus spp.*), and raptors (Ponsena, 1988), and 3) evidence of human presence e.g., sighting, hearing, foot print, and human activities *i.e.*, poaching, logging, collection on non-timber forest products, and land

encroachment. Locations were recorded by GPS and respectively mapped using ArcView 3.2a (Martin *et al.*, 1997)

3.5 habitat characteristics

Since knowing peafowl habitat selection may help researcher and park manager understand factors that influence peafowl population in the area, green peafowl behaviors were regarded and classified all peafowl used locations as; 1) feeding or foraging, 2) dusting or dust-bathing, 3) roosting, 4) breeding, or 5) nesting habitats (Table 3.1). In order to examine habitat selection, habitat characters in used locations were hence compared to those in random locations which green peafowl are absent or not found (Manly *et al.*, 2002). Random locations along all transect were located without replacement after stratified by habitat types. With exception of roosting habitat, 80x80 meters sampling plot was used for all habitat types. For roosting habitat, size of plot is depending on habitat type; 80x80 meters in community forest and 20x20 meters in other habitats. I established plots by centering them on the sites where peafowl or their signs found and located plot boundary by aiding of GPS. Habitat characteristics within plots were then collected as described below.

3.5.1 Foraging habitat

3.5.1.1 Physical factors

There are two local weather stations in the study area, first station is belonging to the Forest Fire Control Station next to community forest and another station located within an area of Huai Kha Khaeng head office (Land slide protection unit) within

protected and nearby buffer zone area. Information from two stations used to represent physical characteristics of the study sites. Moreover, to evaluate reliability of derived information, simple weather station within plots were set up, which are;

1) Topography – the typical characteristics of forest were noted and elevations were recorded by GPS (Figure 3.3).

2) 24 hour rainfall – starting at 08.00 hour using rain gauge. (Figure 3.3)

3) Ambient humidity and temperature – were measured according to two periods; in the morning (06.00 hour) and in the afternoon (12.00 hour). Using hygrometer and thermometer (Figure 3.3).

3.5.1.2 Biological factors

1) Total density – All tree within plots were classified into two size classes. The taller or larger trees are referred to tree which taller than 2 meters height or larger than 10 centimeters DBH (Diameter at Breast Height, measuring at 1.2 meters above ground). The understory is referred to grasses, herbaceous, seedling, sapling, and tree that lesser than 2 meters in height and smaller than 10 centimeters DBH (Takeda and Takaku, 1999). All data were estimated using Point Centered Quarter (PCQ) technique (Michell 2007) applying at distance of 10 meters from observing point and skip points where focal tree is absence within distance of 30 centimeters (Figure 3.2). Frequency of tree was calculated using method following Rabinowitz (1999), and fruiting period of each species was noted if fruit found during sampling.

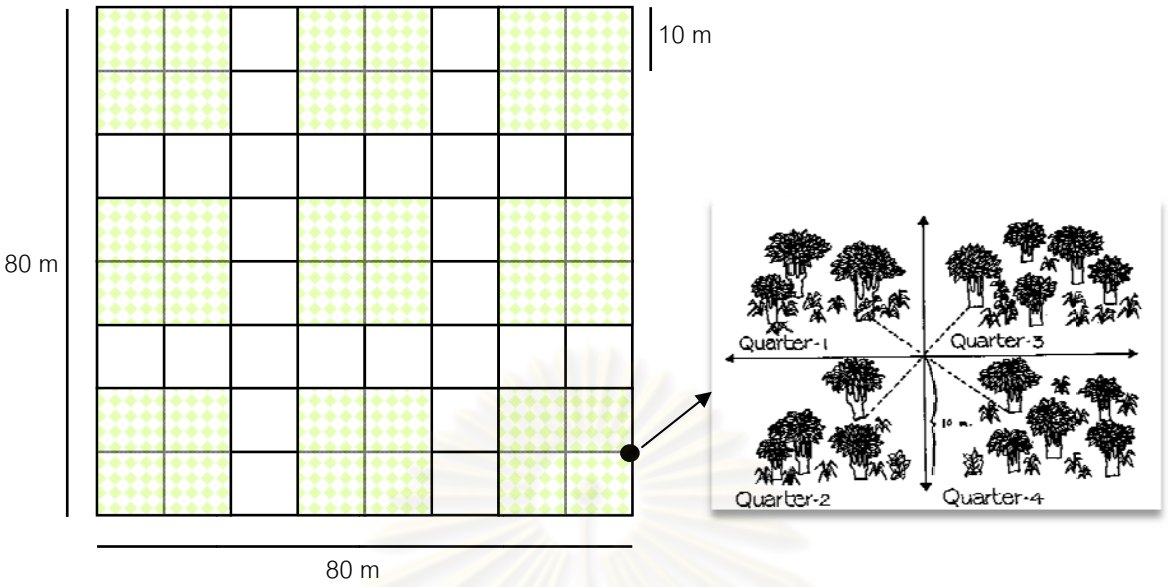


Figure 3.2 Shows 80x80 centimeters Quadrate Sampling and Point Center Quarter Method.

2) Density of feeding trees – referring to Ponsena (1988) including; *Eugenia cumini*, *Ficus hispida*, *F. racemosa*, *Schleichera* oleosa, and *Spodias pinnata* were noted and counted all feeding tree in sampling plot.

3) Understory structure – estimated by using a painted 2m-PVC pole (Figure 3.3). Holding PVC pole vertically at 0, 5, 15, and 20m distance from the center points, noted number of 20cm-colored bar that covered by understory and then calculated proportion to the PCV height as percentage prior to average all reading from four random directions (Rabinowitz 1999).

4) Total basal and ground cover – were randomly sampled by 1x1m quadrates (Figure 3.3), 90 quadrates within foraging habitat and community forest and 40 quadrates in other habitats. They are classified as; grasses, climbers, herbaceous plants, seedlings, saplings, seeds, and fruits. The relative abundance of each class in each plot

was made by number of plot that they found per number of total sampling plot (Rabinowitz 1999).

5) Basal and ground cover of green peafowl food plants – using 1x1m sub-sampling plots at 64 random locations within each foraging site and then noted the presence and percent cover of 60 feeding plant species according to Ponsena (1988).

6) Relative abundance of soil fauna – for both small vertebrates, within nine 20x20m, and invertebrates (classified to order), within a hundred 20x20cm random sub-plots, were estimated by number of individual found per total sub-plot area.

7) Relative abundance of macro-soil invertebrate (>5mm) based on number of individual found within a hundred random 20x20x5cm subplots (Figure 3.3) per total sampling surface (Takeda and Takaku, 1999).

8) Estimated average canopy cover – using 6cm-convex mirror with 25 grid intersections (Figure 3.3), hold the mirror horizontally, noted number of intersections that cover by canopy at the plot center for dusting site and at 1m form tree trunk in 4 directions for roosting site. Averaged covered intersections by total intersections (Rabinowitz, 1999).

9) Green peafowl's fecal analysis – All droppings were collected and dried in oven at 60°C for 24hr. 40 samples were chosen randomly and analyzed to determine food habits. To quantify dietary composition, food items in peafowl drops were divided manually into vegetable and animal elements first, then vegetable items were separated into 5 categories; grass seed, dicotyledon, monocotyledon, fruits, and unknown in a Petri dish (Archad *et al*., 2000). The weight of each dropping was evaluated two widely-used methods; dry weight and percentage of occurrence (Wanghongsa and Hayashi, 2010). The data were pooled to examine the overall percentage of each food categories.

Student t-test analysis was done to examine the difference of food categories intake between habitats.

3.5.2 Dusting or dust bathing habitat

3.5.2.1 Physical factors

1) The physical factors (topography, 24 hour rainfall, ambient humidity and temperature) – were noted as -3.5.1.1 foraging habitat.

2) Soil type – A volume of 100cc sampled soil was collected from the center of sampling plots and brought to lab. I spread samples on the baking sheet and left them in oven which set temperature at 60°C for 24hr. I then screened rocks, roots, and other large particle and put 100cc soil particle into the clear 1000cc graduated-cylinder. Saturated soil by water and measured the depth of the settled material after 24hr.Determine the soil type using the Textural triangle method (Figure 3.3).

3) Relative illumination intensity (light intensity) – the average rate of light intensity (at ground level and all other possible height) was calculated from three random locations within each dusting and roosting habitat, using Lux meter model GE type213 (Takeda and Takaku, 1999) (Figure 3.3).

3.5.1.2 Biological factors

1) The biological factors (total density, understory structure, total basal and ground cover, and estimated average canopy cover) – were noted as -3.5.1.2 foraging habitat

3.5.3 Roosting habitat

3.5.3.1 Physical factors

1) The physical factors (topography, 24 hour rainfall, ambient humidity and temperature, and relative illumination intensity) – were noted as -3.5.2.1 dusting habitat.

3.5.3.2 Biological factors

1) The biological factor (estimated average canopy cover) – was noted as -3.5.2.2 dusting habitat

2) The roosting trees – were identified by; 1) direct sighting, 2) expectation from height relative to adjacent trees (Ponsena, 1988), 3) hearing their crow in the early morning and late evening (Boeker and Scott, 1969), and 4) the presence of droppings under the tree (Boeker and Scott, 1969). The roosting trees were collected the Universal Transverse Mercator (UTM) coordinates with a GPS unit. The height of first fresh branch and perch branch were directly estimated and measured using rangefinder and Haga altimeter (Figure 3.3).

3.5.4 Breeding habitat

3.5.4.1 Physical factors

1) The physical factors (topography, 24 hour rainfall, ambient humidity and temperature) – were noted as -3.5.2.1 dusting habitat.

3.5.4.2 Biological factors

1) The biological factor (total density, understory structure, total basal and ground cover, and estimated average canopy cover) – was noted as -3.5.2.2 dusting habitat

3.5.5 Nesting habitat

3.5.5.1 Physical factors

1) The physical factors (topography, 24 hour rainfall, ambient humidity and temperature) – were noted as -3.5.2.1 dusting habitat.

3.5.2.2 Biological factors

1) The biological factor (total density, understory structure, total basal and ground cover, and estimated average canopy cover) – was noted as -3.5.2.2 dusting habitat

3.6 Statistical analysis

Compared abundance form current study to previous studies using Chi-square test. Relative abundance of green peafowl in each season, transect and type of area were compared by using Mann-Whitney test. Lastly, we examined association between relative abundances of green peafowl, predators' track, and human activities by Spearman's correlation tests. Critical values were set at 0.05 for all tests. Data on Physical and biological factors in each plot were analyzed with Mann-Whitney U test.

3.6 Statistical analysis

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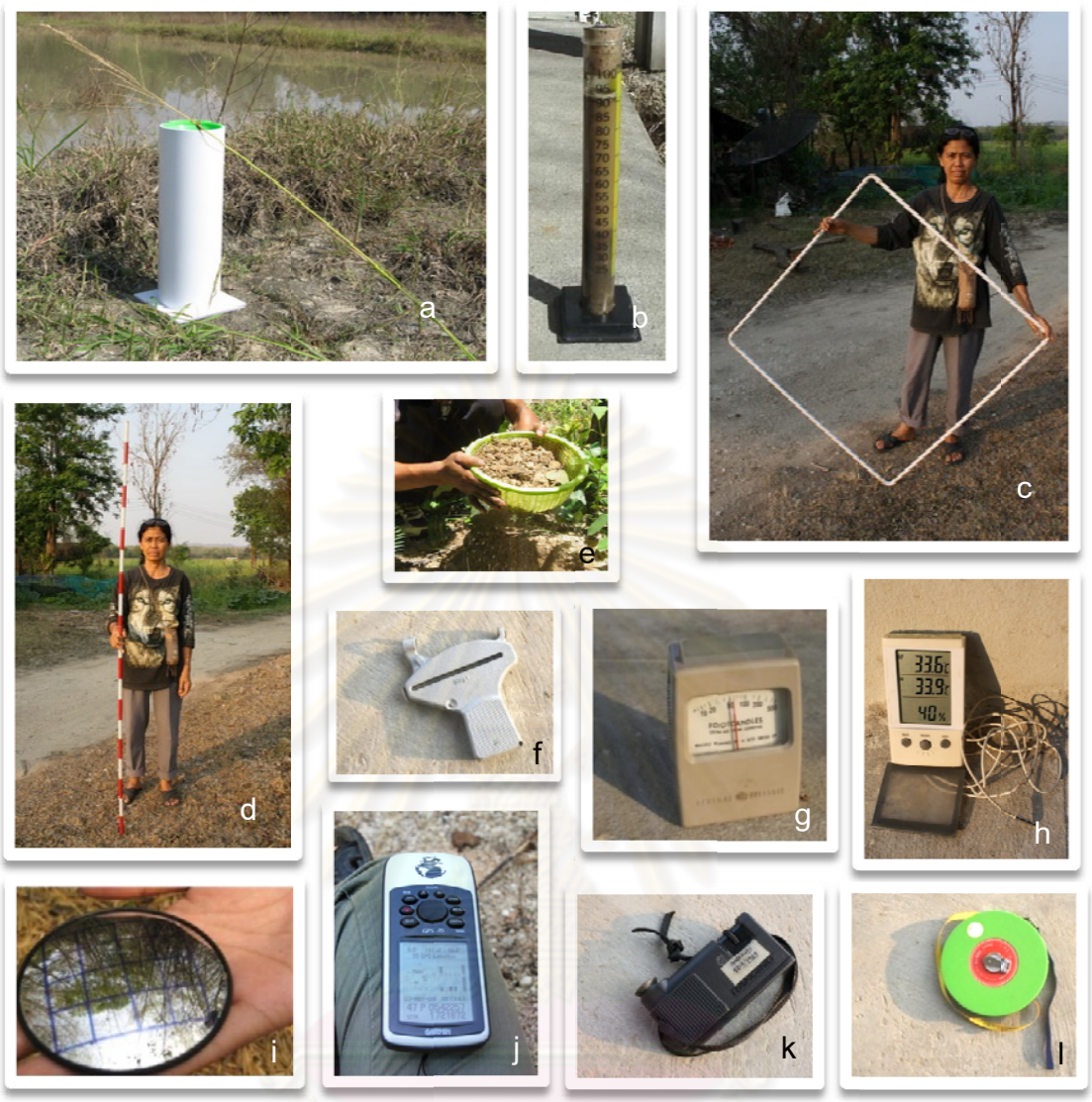


Figure 3.3 Equipments used to collect physical and biological factors (from left to right): a) Rain gauge; b) Graduated Measure 1000cc; c) 1x1m portable quadrate; d) painted PVC 20m; e) Basket for sampled macro-soil screening; f) Haga altimeter; g) Lux meter modelGE213; h) Digital thermometer and humidity; i) Convex mirror; j) Garmin GPS model76; k) Range finder; and l) Measuring tape (50m).

(Photo courtesy of Suttipong Arsirapoj)

Table 3.1 Summary methodology of habitat characteristics

Habitat characteristics	methods														
	Physical factors					Biological factors									
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Foraging habitats	/	/	/			/	/	/	/	/	/	/			/
Dusting or dust-bathing habitats	/	/	/	/	/	/		/	/				/		
Roosting habitats	/	/	/		/								/	/	
Breeding habitats	/	/	/			/		/	/				/		
Nesting habitats	/	/	/			/		/	/				/		

CHAPTER IV

Results

4.1 Population dynamic

During a nine-month survey, a total transect length of 247.5km was covered by walks which were 180, 27, and 40.5km respectively in protected area, buffer zone and community forest. We covered 165 km in dry season and 82.5 km in wet season. In this study, 64 green peafowls are found and believe that there is more population up to 275 green peafowls presence in this area which were mostly made on foot print. In total, 222 signs of peafowl presence found in protected area, 31 signs in buffer zone, and 22 signs in community forest, 183 in dry season and 92 in wet season.

From current study, green peafowl relative abundance was significantly difference across habitats (Kruskal-Wallis rank sum test: $\chi^2 = 31.6169$, df = 5, $P < 0.0001$). The highest was found along Huai Tab Saloa1, in protected area (N = 9, Median = 1.70 Birds/km) and the lowest relative abundance was found along Huai Tab Saloa3, in community forest (N = 9, Median = 0.00 Birds/km). In Comparison to previous studies in the same areas; Ponyeam (1993) and Meckvichai, *et al*. (2006), though not fully tested, we found highest relative abundance which may hint to population recolonization in Huai Tab Saloa and Huai Song Tang water basin since 1993 (Table 4.1).

From monthly monitoring in the peafowl relative abundance, I found some changes across our sampling period but all of them always associated with wide

variation among sites (Table 4.2 and Figure 4.1), hence, overall green peafowl relative abundance between dry and wet season, in another sense, between breeding and non-breeding season, was not significantly different (Wilcoxon rank sum test: W = 296.5, P = 0.6163) (Figure 4.2).

As we expected, the highest relative abundance, greater than three times of those from other sites (N = 6, Median = 0.17 Animals/km) was in HKKR1 transect, within protected area along (Kruskal-Wallis rank sum test: χ^2 = 22.1068, df = 5, $P < 0.01$). Human activity (Kruskal-Wallis rank sum test: χ^2 = 31.6045, df = 5, P < 0.0001) and environmental changes index (Kruskal-Wallis rank sum test: χ^2 = 17.6053, df = 5, $P <$ 0.01) were significantly varied among sites and the highest degree of human activity (N = 6, Median = 10.38 Records/km) and environmental changes index (N = 6, Median = 0.53 Records/km) were found in community forest (Table 4.1). However, by looking at pattern of monthly changes in the peafowl relative abundance and disturbance factors i.e., potential predator abundance, human activity, and environmental change index (Figure 4.1), the peafowl relative abundance were not correlated with relative abundance of potential predators (P = 0.009, r_s = 0.35) and human activity (P = 0.1772, r_s = 0.32) and not correlated to environmental changes (P = 0.1809, r_s = -0.18).

Table 4.1 Relative abundance of green peafowl from previous study (Ponyeam, 1993; Meckvichai *et al*., 2006) and current study (A), potential predators (B), human activity (C), and environmental effect index (D).

	Protected area			Buffer zone area	Community forest		χ^2	P-*value*
	ST1	TS1	HKKR1	HKKR2	TS3	BSR3		
A. Peafowl/km								
1993	——— Absence ———		N/A	N/A	N/A	N/A		
2006	——— 1.12 ———		N/A	N/A	N/A	N/A		
2008	1.5 (1 - 2.50)	1.7 (1.30 - 2.50)	0.17 (0 - 0.50)	1 (0.33 - 3)	0 (0 - 0.53)	0.38 (0 - 5.38)	31.6169	< 0.0001
	N = 58	N = 123	N = 29	N = 9	N = 27	N = 32		
B. Predator relative abundance	0.5 (0.25 - 0.5)	0 (0 - 0.1)	0.17 (0 - 0.17)	0*	0	0 (0 - 0.38)	22.1068	0.0005
C. Human activity index	0	0 (0.01)	0	0 (0 - 0.67)	1.58 (0.53 - 3.68)	10.38 (2.31 - 25.77)	31.6045	< 0.0001
D. Environmental effect index	0 (0 - 0.25)	0 (0 - 0.1)	0	0	0.53 (0 - 0.53)	0	17.6053	0.0035

* Zero “0” under threats abundance was not represented the absolute absence of threats.

Table 4.2 Green peafowl relative abundance, predator relative abundance and an index of environmental effect found in each month during transect survey representing as median (1st - 3rd Quantile).

Season	Month	Peafowl/ km	Predator/ km	Human activity/ km	Environmental effect index
Dry	Nov	1.52 (0.58 - 1.87)	0.14 (0.025 - 0.23)	0.00 (0 - 0.50)	Absence
	Dec	1.35 (0.38 - 1.87)	Absence	Absence	Absence
	Jan	0.59 (0.04 - 2.13)	0.00 (0 - 0.29)	0.00 (0 - 0.24)	0.19 (0.04 - 0.24)
	Feb	0.88 (0.41 - 1.31)	0.27 (0.18 - 0.46)	0.13 (0 - 0.43)	0.10 (0 - 0.43)
	Mar	0.34 (0 - 1.11)	Absence	0.00 (0 - 0.21)	0.05 (0 - 0.21)
	Apr	0.17 (0 - 0.83)	Absence	0.05 (0 - 0.19)	0.00 (0 - 0.19)
Wet	May	N/A	N/A	N/A	N/A
	Jun	1.42 (0.73 - 1.88)	0.22 (0.03 - 0.37)	0.27 (0.05 - 0.37)	Absence
	Jul	N/A	N/A	N/A	N/A
	Aug	0.91 (0.42 - 1.23)	0.05 (0 - 0.15)	1.00 (0 - 4.54)	Absence
	Sep	N/A	N/A	N/A	N/A
	Oct	0.34 (0 - 1.48)	0.00 (0 - 0.13)	1.13 (0.24 - 3.15)	Absence

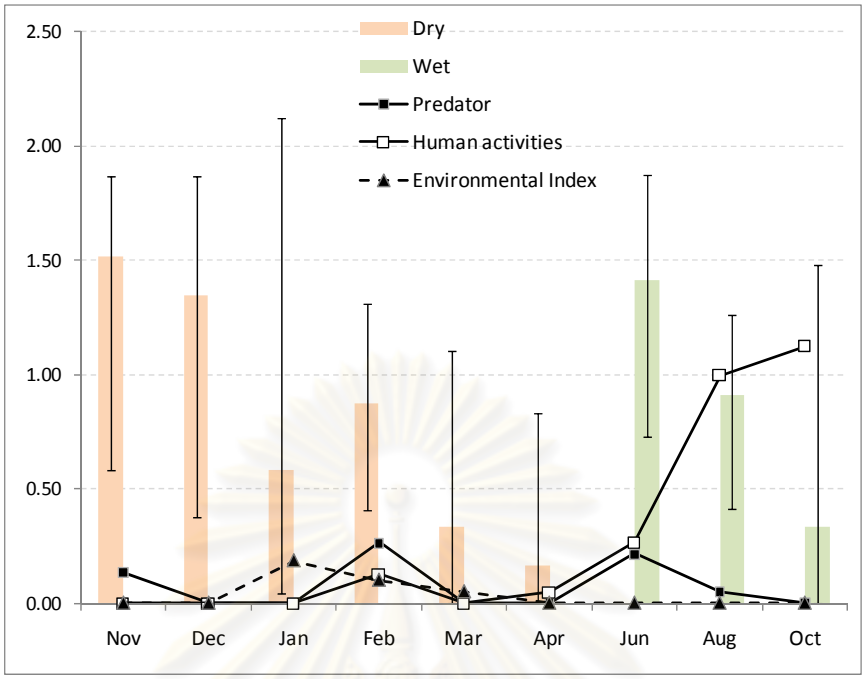


Figure 4.1 The associations between the peafowl relative abundance and disturbance factors.

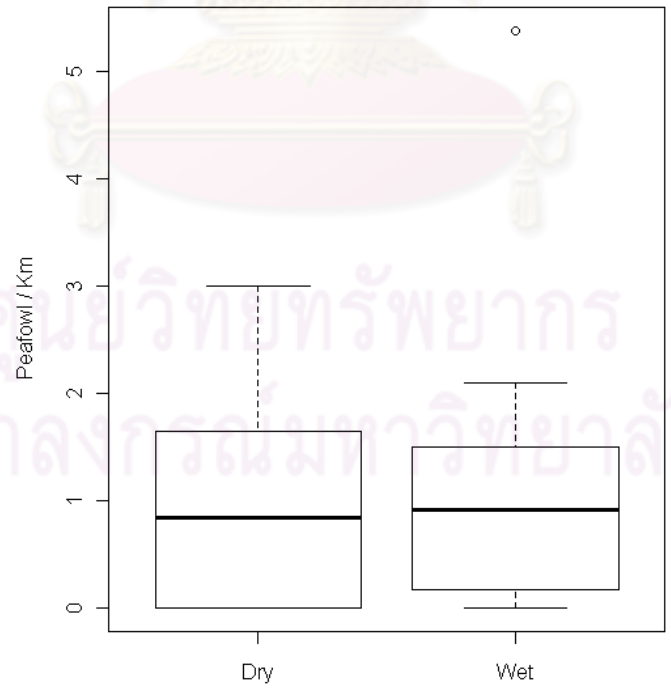


Figure 4.2 Green peafowl relative abundance in dry and wet seasons which was not significantly different.

4.2 Habitat Utilization

4.2.1 Habitat characteristics of foraging site

Foraging habitat of the green peafowl was classified at eight locations during transect survey; four locations in protected area, two in buffer zone, and two in community forest respectively. Eight used foraging sites, as well as eight random locations, were sampled by 80x80m-plots collecting both physical and biological factors in order to test influence of those physical factors and food availability during dry and wet season or, in another sense, breeding and non-breeding season (Table 4.3).

Physical features – Elevation at foraging sites reported here ranged from 100 -260msl. I collected the ambient humidity and temperature data within plots and refer from two local weather stations during December – January 2008. The average humidity and temperature of 74.69% and 25.34°C, daily average minimum of 63.65% in March and 21.84°C in January, and maximum of 81.89% in October and 28.60°C in April, respectively. The average 24hr rainfall for whole year is 128.64mm, daily average of 4.15mm, maximum of 16.43 in October and absent in December and January (Table 4.4)

Table 4.3 Particularly of 16 foraging sites; used and random locations and abundance of green peafowl in location

Plot	E	N	Code I	Code II (CCA)	Habitat Zone	Location	Green peafowl abundance (Dry/ Wet season)
1.	535803	1725378	ST	Use_D/W1	1	Huai Song Tang	37/21
2.	535560	1724170	TS1	Use_D/W2	1	Huai Tab Saloa (middle)	44/21
3.	537891	1724672	TS2	Use_D/W3	1	Huai Tab Saloa (office-middle)	41/17
4.	541174	1723137	TS3	Use_D/W4	2	Huai Tab Saloa (Thung Phak)	21/8
5.	538282	1725212	HKKR1	Use_D/W5	2	HKK Road (office-world heritage sign)	6/3
6.	538724	1725159	HKKR2	Use_D/W6	2	HKK Road (Lan-Nokyung)	19/8
7.	542092	1722151	BS1	Use_D/W7	3	HKK Breeding station Road Km.2	8/11
8.	542911	1722002	BS2	Use_D/W8	3	HKK Breeding station boundary	3/10
9.	534391	1722027	ST	Non-Use_D/W1	1	Huai Song Tang	N/A
10.	538063	1724818	TS1	Non-Use_D/W2	1	Huai Tab Saloa Km.9	N/A
11.	539935	1724318	TS2	Non-Use_D/W3	1	Huai Tab Saloa (office)	N/A
12.	540792	1723616	TS3	Non-Use_D/W4	2	Huai Tab Saloa (Thung Phak)	N/A
13.	538317	1725201	HKKR1	Non-Use_D/W5	2	HKK Road (office-world heritage sign)	N/A
14.	541327	1723420	HKKR2	Non-Use_D/W6	2	HKK Road (Thung Phak)	N/A
15.	542606	1722156	BS1	Non-Use_D/W7	3	HKK Breeding station boundary	N/A
16.	542479	1722039	BS2	Non-Use_D/W8	3	HKK Breeding station boundary	N/A

Table 4.4 Variation in year-round microclimate conditions at peafowl foraging sites.

Factors (average/day)	Meteorology: 2008 year								
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Jun.	Aug.	Oct.
Humidity (%)	81.581	76.548	68.274	73.306	63.645	68.952	79.317	78.710	81.887
Temperature(°C)	23.274	21.839	23.871	23.661	27.984	28.597	27.892	27.275	23.661
Rainfall (mm)	5.884	0.000	0.000	0.287	2.381	2.448	4.261	5.661	16.426

Biological factors – Foraging sites significantly positively associated with density of tree (Mann-Whitney test: $U = 185$, $P < 0.05$), density of undergrowth (Mann-Whitney test: $U = 236$, $P < 0.0001$), and also for understory (Mann-Whitney test: $U = 236$, $P < 0.0001$). Contrary to results on ground cover in sub-plots, foraging sites were less frequently found seeds (Mann-Whitney test: $U = 69$, $P < 0.05$), climbers (Mann-Whitney test: $U = 44$, $P < 0.01$), and saplings (Mann-Whitney test: $U = 75.5$, $P < 0.05$). For animals on forest floor, vertebrates and most of soil fauna are largely different between peafowl foraging sites and random sites. The foraging site associated with higher abundance in vertebrate and invertebrate fauna (Figure 4.3). However, this was unclear for macro-soil fauna ($P > 0.05$) as only Arachnida and Coleoptera which were marginally different between those locations (Table 4.5). Within foraging sites, selected understory structure in breeding and non-breeding seasons were mostly consistence except density and size (Wilcoxon test: $V = 236$, $P < 0.05$) of understory which higher in non-breeding season (Table 4.6).

Vegetation type – the foraging utilization rate of green peafowl was higher in a deciduous and secondary forest, whereas it was lower in dipterocarp forest (Table 4.3). Tree density for trees with a DBH > 10 cm was 0.14tree/sq.m (0.131-

0.1628). According to a previous study, Ponsena (1988) lists 66 plant species as food source for Green Peafowl in Huai Kha Khaeng Wildlife Sanctuary. However, during this study only 27 plant species was indentified within used plots and 4 species were recorded here (Table 4.7). Such as; the tall bamboo, *Bambusa arundinacea* (Thai name: Pai Nam or Pai Pa) was very common along the river and the canopy clusters occurred in 30 % of the plots with near the river, the species *Eupatorium odoratum* (Thai name: Saab Sure) was common herb in the understory especially in open areas.

The density of 5-tree species as food source which were; *Eugeni cumini* Druce (Thai name: Wa), *Ficus hispida* Linn. (Thai name: Madue Plong), *F. racemosa* Linn. (Thai name: Madue Utumporn), and *Schleichera oleosa* Merr. (Thai name: Ta Kroe) are lower density. I found 18 trees in eight used-plots, mostly was *F. racemosa* Linn. found near the river.

Grasses dominated the ground cover occurring in 493 of the 512- 1x1 m plots and on average 70% of the total plot area is covered with grass and total of 7 species were found same the previous studied and 4 species were recorded here with *Eragrostis tenella* (L.) P. Beauv (Thai name: Kai Hep) as the most abundant species, and another grasses which were; *E. elongata* (Willd) Jacq (Thai name: Kai Hep Pa), *Paspalidium flavidum* (Thai name: Dok Hang), *Lophatherum gracile* (Thai name: Pai) (Figure 4.4).

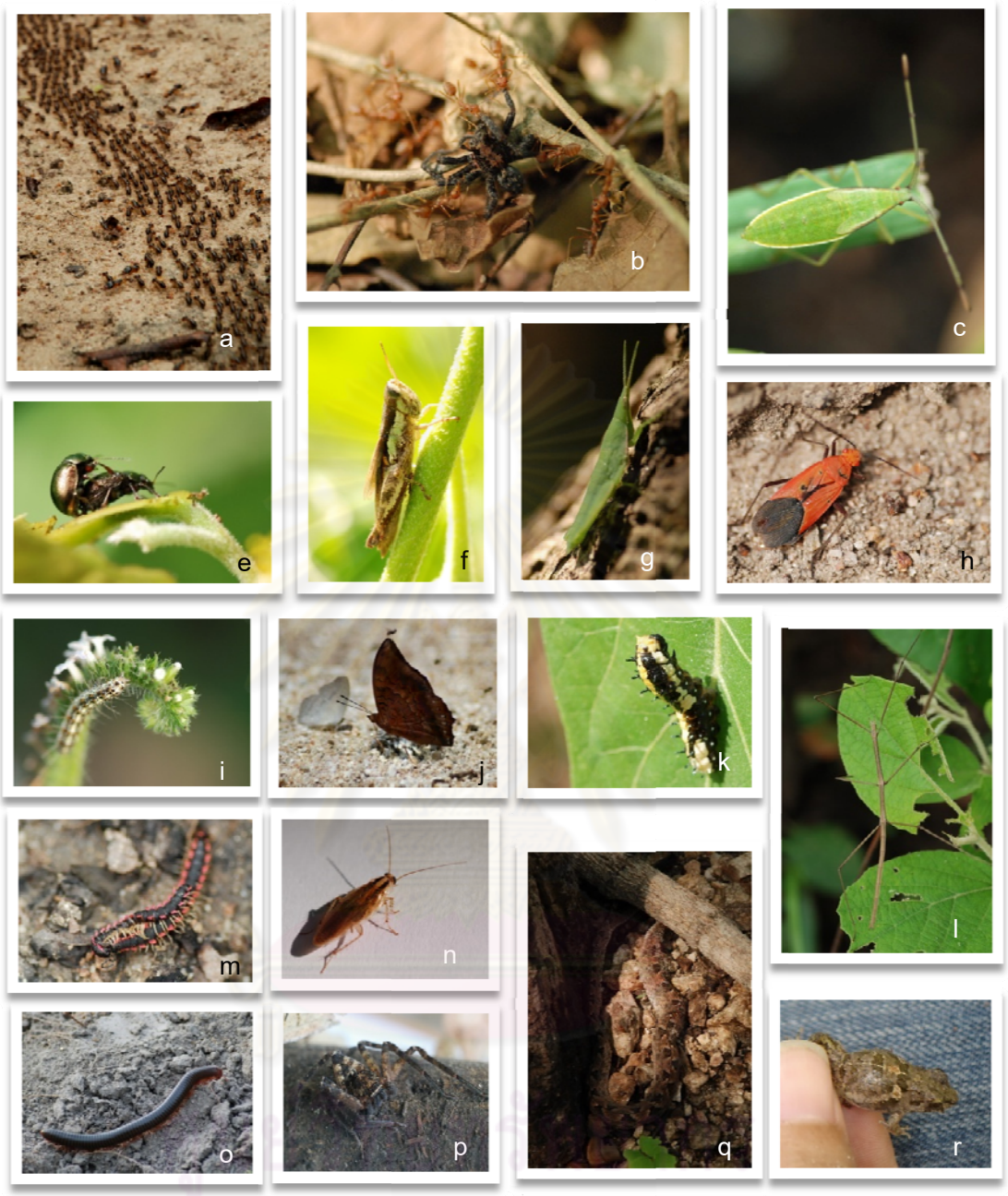


Figure 4.3 Vertebrate and invertebrate faunas were found in eight used-plots which were (from left to right); a) Order Isoptera (mites); b) Hymenoptera (ants); c) and h) Hemiptera (Hemipteran) e); Coleoptera (beetle); f) and g) Orthoptera (grasshopper);; i) and j) Lepidoptera (Larva and adult butterfly); l) Phasmatodea (Stick insect); m) Chilopoda (centipede); n) Dictyoptera (cockroach); o) Diplopoda (millipede) p) Arachnida (spider); q) Reptile (snake); and r) Amphibian (toad)

(Photographer: Tanwarat Pinthong)

Figure 4.4 Some food plants were found in eight used-plots which were (from left to right); a) *Eragrostis elongata* (Willd) Jacq; b) *Paspalidium flavidum*; c) *Eragrostis tenella* (L.) P. Beauv; d) *Sorghum* spp.; e) *Spndias pinnata* Kurzt; f) *Ficus recemosa*; g) *Antidesma sootepensis*; h) mushroom; i) *Cyperus* spp.; j) *Cyperus cyperus*; and k) *Melinis repens* (Willd.) Zizka. (Photographer: Tanwarat Pinthong)

Table 4.5 Vegetation structures (A) and relative abundance of vertebrates (B) and invertebrates (C-D) relative abundance at random and used locations presented as median (1st - 3rd Quantile)

Parameters	Use category		*U*	*P*-value
	Random (N = 8)	Used (N = 8)		
A. Vegetation structures				
1. Tree density (tree/m^2)	0.16 (0.142-0.1960)	0.14 (0.131-0.1628)	185.00	0.0331*
2. Understory density (tree/m^2)	2.85 (2.715-3.474)	1.46 (1.140-2.312)	236.00	< 0.0001***
3. Understory structure (%)	56.41 (48.67-63.05)	32.03 (24.06-42.50)	236.00	< 0.0001***
4. Percent occurrence of ground cover;				
4.1 Grass	50.62 (33.95-75.62)	67.90 (53.09-81.48)	97.00	0.2499
4.2 Seed	4.94 (0-23.46)	22.84 (13.58-31.79)	69.00	0.0262*
4.3 Fruit	4.94 (0-13.89)	9.88 (2.469-16.05)	95.50	0.2215
4.4 Climber	6.17 (0-19.75)	33.95 (29.32-57.41)	44.00	0.0016**
4.5 Herb	64.20 (32.41-75.93)	69.14 (57.41-73.77)	106.50	0.4282
4.6 Shrub	1.23 (0-6.79)	6.79 (2.469-18.83)	78.00	0.0576
4.7 Seedling	18.52 (1.235-44.14)	35.19 (33.020-50.93)	90.00	0.1568
4.8 Sapling	39.51 (6.481-66.36)	64.20 (50.000-80.25)	75.50	0.0496*
B. Vertebrate relative abundance (Animals/plots)	2.00 (2.00-3.25)	6.00 (3.75-7.50)	33.50	0.0003**

Table 4.5 Vegetation structures (A) and relative abundance of vertebrates (B) and invertebrates (C-D) relative abundance at random and used locations presented as median (1st - 3rd Quantile) (continue)

Parameters	Random (N = 8)	Used (N = 8)	*U*	*P*-value
C. Soil fauna relative abundance (Animal/plots)				
1. Order Annelida	249.40 (139.60 -292.90)	1251.00 (799.30-1650.00)	13.00	< 0.0001***
2. Order Arachnida	0.00 (0.00-0.063)	2.78 (0.00-12.50)	77.00	0.0327*
3. Order Chilopoda	19.56 (15.19-25.69)	63.89 (41.72-80.56)	16.00	< 0.0001***
4. Order Coleoptera	1.76 (0.00-3.64)	34.72 (11.11-56.250)	43.00	0.0013**
5. Order Diplopoda	0.00 (0.00-1.56)	11.11 (2.53-20.14)	44.50	0.0012**
6. Order Diptera	3.22 (0.00-9.45)	31.94 (20.83 -121.50)	30.50	0.0002**
7. Order Hemiptera	14.89 (8.44-16.67)	45.83 (24.31-56.94)	38.00	0.0007**
8. Order Hymenoptera	62.28 (41.45-111.80)	405.60 (252.10-658.3)	25.00	0.0001**
9. Order Isoptera	18.06 (5.556-40.89)	54.17 (7.64-299.30)	85.50	0.1129
10. Order Lepidoptera	6.94 (1.333-14.67)	14.67 (13.19-39.58)	46.50	0.0022**
11. Order Mollusca	0.00 (0.00-4.22)	1.39 (0.00-16.67)	99.50	0.2443
12. Order Orthoptera	27.61 (19.44-40.89)	177.80 (138.90-311.10)	19.00	< 0.0001***
D. Macro-soil fauna relative abundance	100.00 (96.72-182.50)	119.50 (87.50-167.70)	130.00	0.9549
1. Order Annelida	1.97 (0.00-8.68)	7.38 (2.56-9.87)	89.00	0.1454
2. Order Arachnida	14.46 (6.92-25.42)	6.50 (3.19-10.06)	190.00	0.0203*
3. Order Chilopoda	2.13 (0.00-5.68)	2.00 (1.45-3.31)	134.50	0.8195
4. Order Coleoptera	1.52 (0.00-5.89)	5.13 (3.94-6.94)	73.50	0.041*
5. Order Diplopoda	0.00 (0.00-1.71)	0.25 (0.25-0.50)	82.00	0.0745
7. Order Hemiptera	0.00 (0.00-4.66)	1.38 (0.50-1.88)	92.00	0.1707
8. Order Hymenoptera	57.39 (20.19-79.62)	41.88 (21.00-67.94)	148.00	0.4622
9. Order Isoptera	15.91 (2.89-41.05)	31.50 (8.75-60.81)	93.00	0.1927
10. Order Orthoptera	9.07 (1.50-20.85)	11.25 (7.19-17.38)	118.00	0.7199

Table 4.6 Parameters at used locations in wet and dry season presented as median (1st - 3rd Quantile).

Statistic and significant value were derived from Wilcoxon Sum-rank test.

Parameters	Seasons		*V*	*P*-value
	Non-breeding (N = 8)	Breeding(N = 8)		
A. Vegetation structures				
1. Tree density (tree/m^2)	0.14 (0.13 - 0.16)	0.16 (0.14 - 0.20)	6.0	0.1814
2. Understory density (tree/m^2)	2.32 (1.94 - 2.53)	1.14 (0.84 - 1.25)	0.0	0.0078**
3. Understory structure	42.81 (32.11 - 45.70)	23.75 (21.33 - 30.78)	0.0	0.0078**
4. Percent occurrence of ground cover;				
4.1 Grass	70.99 (63.27 - 81.48)	59.88 (51.54 - 79.63)	5.0	0.2918
4.2 Seed	23.46 (13.58 - 38.89)	22.84 (13.58 - 26.23)	7.0	0.1484
4.3 Fruit	13.58 (6.48 - 16.05)	6.17 (2.47 - 14.20)	5.0	0.2945
4.4 Climber	30.86 (20.68 - 43.52)	43.21 (29.63 - 58.02)	12.0	0.7998
4.5 Herb	67.28 (57.41 - 74.07)	69.14 (60.49 - 73.77)	8.5	0.3972
4.6 Shrub	4.94 (2.47 - 20.68)	9.26 (2.16 - 18.83)	20.0	0.3525
4.7 Seedling	42.59 (34.26 - 52.16)	33.33 (16.67 - 40.43)	9.0	0.4469
4.8 Sapling	55.56 (43.83 - 75.62)	67.90 (59.26 - 80.25)	8.0	0.6741
B. Occurrence of soil vertebrates fauna (Animals/plots)	6.50 (4.75 - 10.50)	5.50 (3.00 - 7.00)	5.0	0.2918
C. Occurrence of soil invertebrates fauna (Animal/plots)	1553.00 (1121.0 - 1667.0)	951.80 (509.70 - 1375.0)	7.0	0.1484
D. Occurrence of macro-soil invertebrates	98.88 (70.31 - 156.6)	149.2 (90.38 - 176.8)	25	0.3828

Table 4.7 Food resource for green peafowl in Huai Tab Saloa-Huai Song Tang water basin, Huai Kha Khaeng Wildlife Sanctuary

No.	Thai name	Scientific name	Life form
1	หญ้าเจ้าชู้	*Chrysopogon aciculatus* Trin.	Grass
2	หญ้าดอกแดง	*Melinis repens* (Willd.) Zizka.	Grass
3	หญ้าปากควาย	*Dactyloctenium aegyptium* Willd.	Grass
4	หญ้าตีนกา	*Eleusine indica* Gaertn.	Grass
5	หญ้าคา	*Imperata cylindrical* Beauv.	Grass
6	หญ้าหางหมาจิ้งจอก	*Setaria geniculata* Beauv.	Grass
7	หญ้าพง	*Sorghum halepense* Pers.	Grass
8	หญ้าไข่เห็บ	*Eragrostis tenella* (L.) P. Beauv	Grass
9	หญ้าไข่เห็บป่า	*E. elongata* (Willd) Jacq	Grass
10	หญ้าดอกห่าง	*Paspalidium flavidum*	Grass
11	หญ้าไผ่	*Lophatherum gracile*	Grass
12	ไผ่ป่า	*Banbusa arundinacea* Willd.	Bamboo
13	สาบแร้งสาบกา	*Ageratum conyzoides* Linn.	Herb
14	ผักขมหนาม	*A. spinosus* Linn.	Herb
15	ผักปลาบ	*Commelina diffusa* Burn f.	Herb
16	หญ้ารังกา	*Cyperus cyperoides* Ktze.	Herb
17	กกขี้หมา	*C. polystachyos* Roxb.	Herb
18	กกเล็ก	*C. pulcherrimus* Willd. ex Kunth	Herb
19	หญ้าแห้วหมู	*C. rotundus* Linn.	Herb
20	สาบเสือ	*Eupatorim odoratum* Linn.	Herb
21	น้ำนมราชสีห์	*Euphorbia hirta* Linn.	Herb
22	หญ้างวงช้าง	*Heliotropium indicum* R. Br.	Herb
23	ลูกใต้ใบ	*Phyllantus amarus* Schum. & Thonn.	Herb
24	หญ้าคมบางเล็ก	*Scleria lithosperma* Sw.	Herb
25	ตีนตุ๊กแก	*Tridax procumbens* Linn.	Herb
26	ผักแว่น	*Masilia crenata* Presl	Fern
27	หว้า	*Eugeni cumini* Druce	Tree
28	มะเดื่อปล้อง	*Ficus hispida* Linn.	Tree
29	มะเดื่ออุทุมพร	*F. racemosa* Linn.	Tree
30	ตะคร้อ	*Schleichera oleosa* Merr.	Tree
31	มะกอก	*Spondias pinnata* Kurzt	Tree

Fecal Analysis – A total of 40 peafowl droppings were collected and analyzed to determine their food habits. There were 9 and 21 dry samples from community forest and protected area. Peafowl dropping generally includes non-food item, *i.e.*, grits, this study found that was 20.45% of total peafowl dropping weight. After removing grits or non-food item out, I carried further analysis only for peafowl food materials. As food items went through peafowl gastrointestinal tract prior to defecation, this causes difficulty in identification of the fecal remains and, from this study, 24.90% by volume was left unidentified.

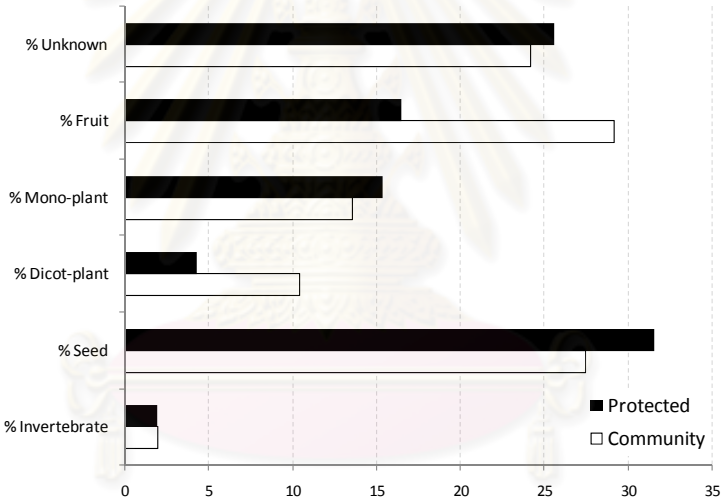
Fecal examination revealed that the peafowl dropping was largely consisted of plant materials; 98.06 in community forest and 96.77% in protected area, while animal material amounted to 1.94 and 1.90% in both areas respectively (Table 4.8). Among six categories, most common diet were grass seeds which constituted as much as 27.48 and 31.60% in community forest and protected area, and fruit which constituted as much as 29.16 and 16.15% in community forest and protected area. The lowest was invertebrate which was 1.94 and 1.90% in community forest and protected area respectively. There was no evidence of consumption on vertebrate was my samples (Table 4.9).

Between two focal habitats for my fecal study, the community forest and protected area, I found that only proportion of fruit found in peafowl dropping was significantly different between habitats and higher proportion was apparently in community forest ($P < 0.01$) where as other remains were similar between sites and identifiable of green peafowl foods showed that the green peafowl consumed five invertebrate orders and seven plant species (Table 4.10)

Table 4.8 Comparison among dry weight of plant and animal matters

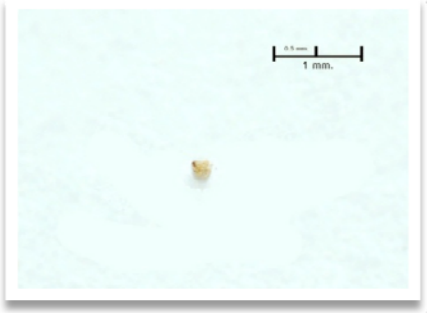
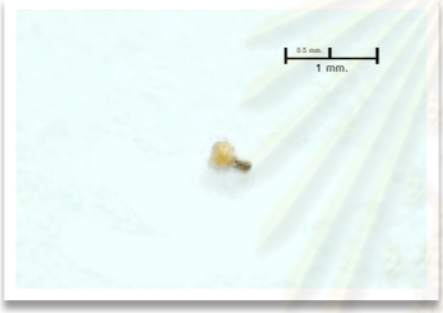
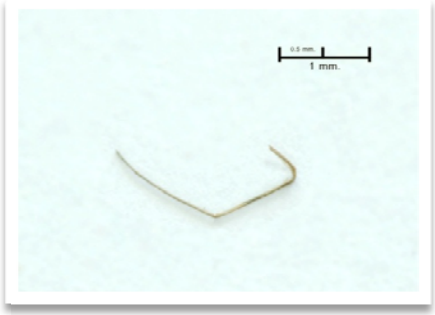
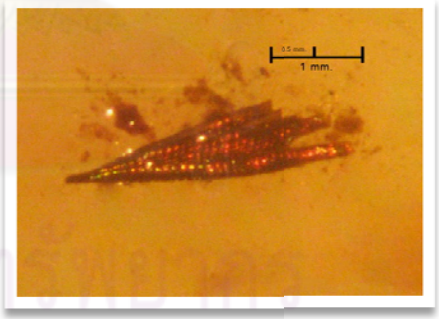
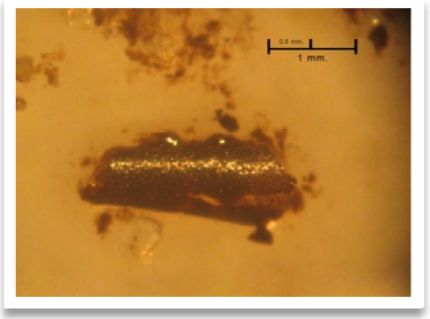
	N	Organic matters		V	P - value
		All plant matters (%)	Animal matters (%)		
Overall	30	96.88 (93.21 - 99.03)	1.92 (0.37 - 9.47)	465	**<0.0001**
Community forest	9	98.06 (93.63 - 99.03)	1.94 (0.97 - 6.73)	45	**0.0090**
Protected forest	21	96.77 (92.96 - 98.39)	1.90 (0.28 - 10.28)	231	**<0.0001**

Table 4.9 total dry weights, excluding grit, and proportion other remains in peafowl feces found in community and protected forest, representing as Median (1st - 3rd Quantile)



Factors	Habitats		W	P - value
	Community (N = 9)	Protected (N = 21)		
Dry weight	3.88 (3.21 - 5.23)	5.56 (3.95 - 6.29)	57	0.0945
% Invertebrate	1.94 (0.97 - 6.73)	1.90 (0.28 - 10.28)	100	0.8208
% Seed	27.48 (14.62 - 27.68)	31.60 (25.78 - 34.26)	60	0.1238
% Dicot-plant	10.39 (2.73 - 15.04)	4.28 (2.16 - 9.40)	113	0.4152
% Mono-plant	13.57 (8.26 - 21.65)	15.37 (13.81 - 19.40)	85	0.6837
% Fruit	29.16 (28.12 - 34.12)	16.50 (1.43 - 20.64)	164	**0.0018**
% Unknown	24.16 (12.38 - 31.78)	25.64 (23.04 - 36.11)	75	0.3898

Table 4.10 Some photos and names of peafowl diet items that commonly found in their dropping

green peafowl foods			
invertebrate			
			
Acari (ticks)	Isoptera (Termites)	Arachnida (Spiders)	Arachnida (Spiders)
			
Chilopoda (Centipedes)	Orthoptera	cf. Coleoptera	cf. Coleoptera

green peafowl foods

grass Seeds

หญ้าไข่เห็บ

Eragrostis tenella (L.) P. Beauv

หญ้าตีนกา

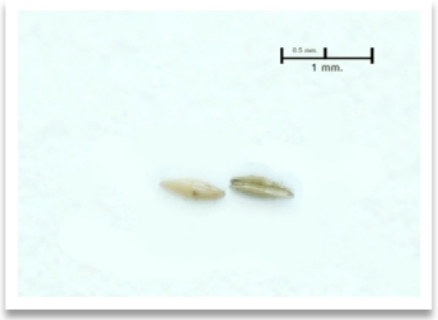
cf. Eleusine indica (L.) Gaertn.

หญ้าไข่เห็บป่า

Eragrostis elongata (Willd) Jacq

หญ้าดอกห่าง

Paspalidium flavidum



หญ้าไผ่

cf. Lophatherum gracile

Sp1

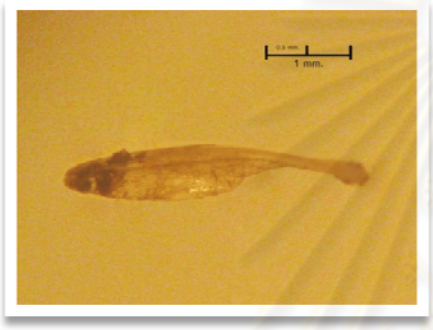
Sp2

Sp3

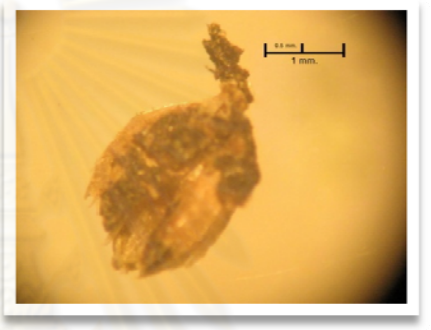
green peafowl foods

grass Seeds

Sp.4



Sp.5



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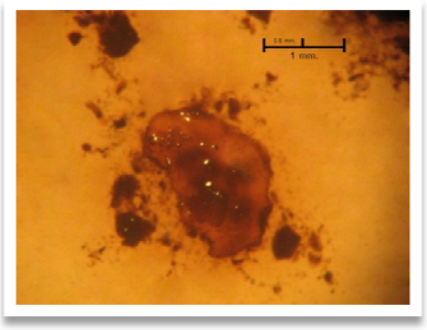
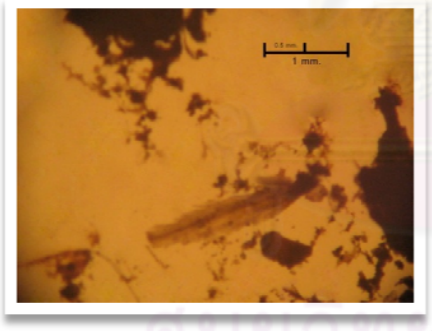
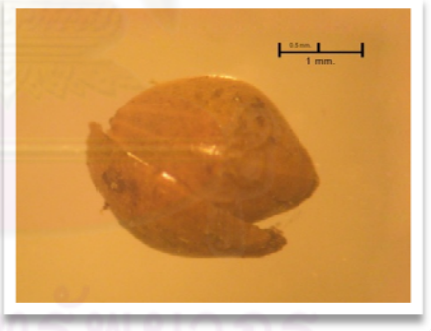


Sp.7

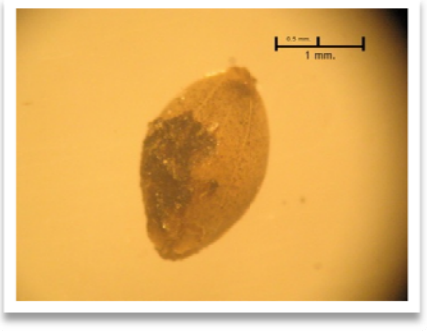
Sp.8



Sp.9



Sp. 10

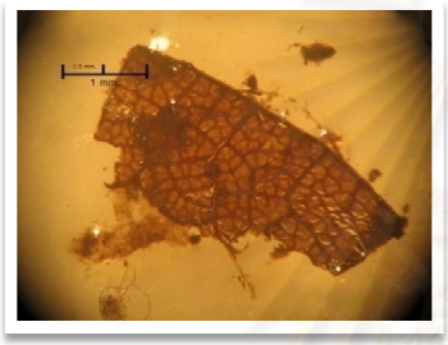


Sp. 11

green peafowl foods

di-cotyledon plants

leaf



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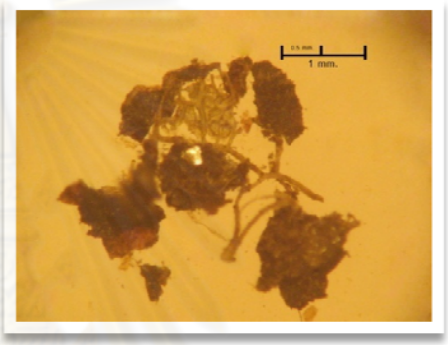

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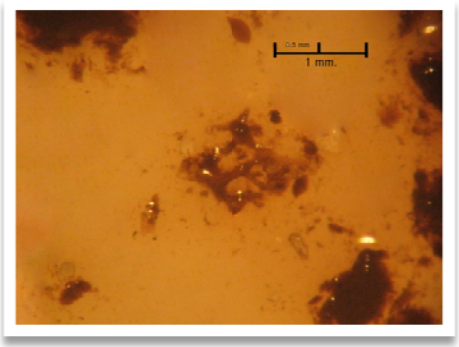

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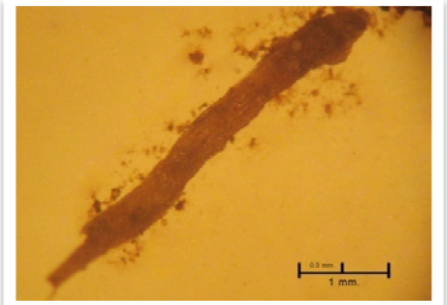

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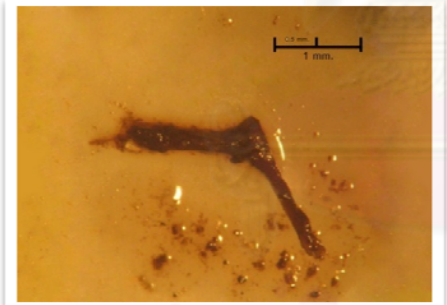

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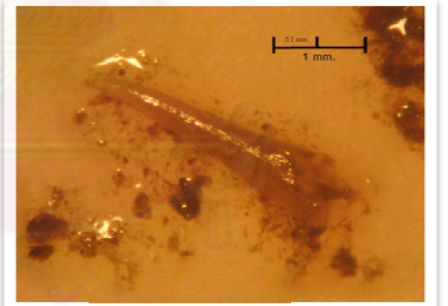

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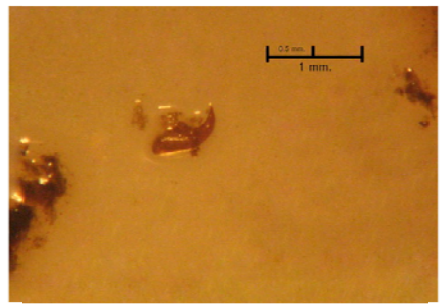
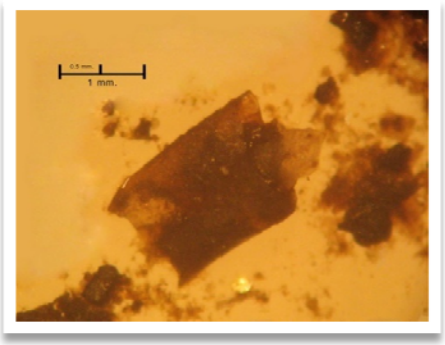


spine

green peafowl foods

fruits and grits



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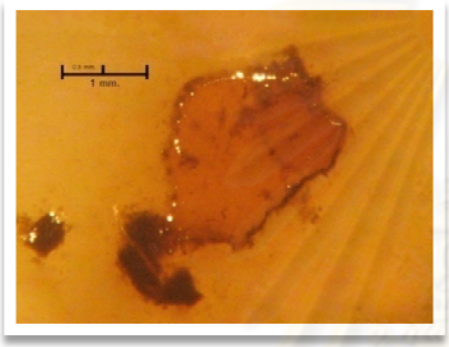

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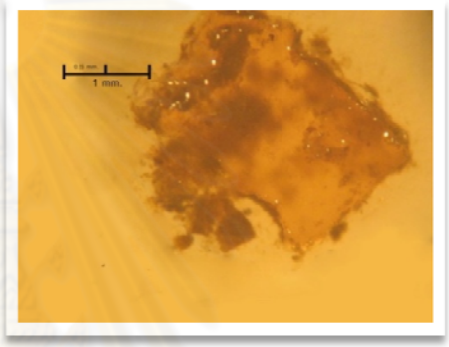

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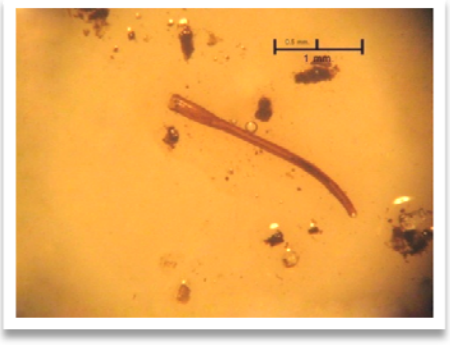

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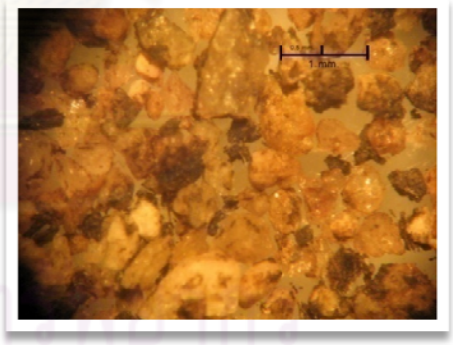
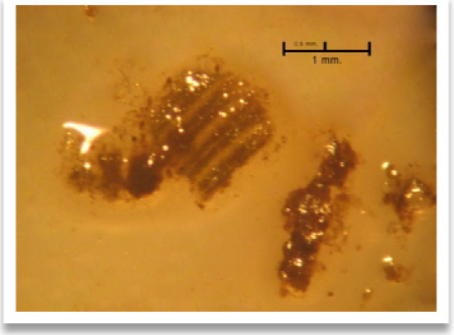


grits

grit

green peafowl foods

mono-cotyledon plants



leafs

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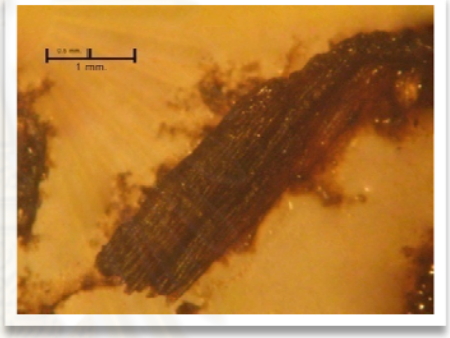
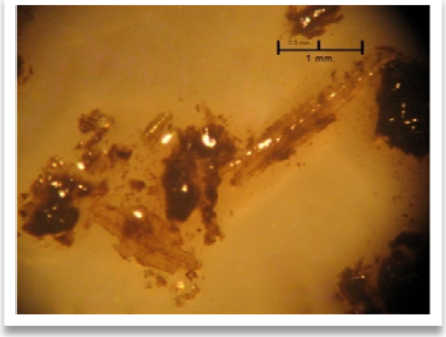


stems



stems

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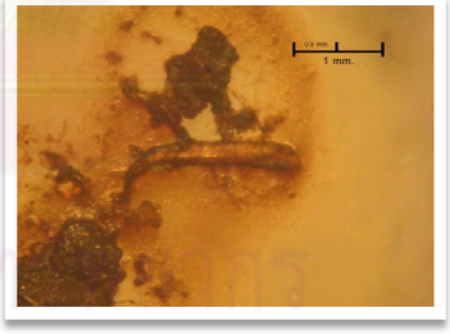


Table 4.11 Average of biological factors in three habitat characteristic: Nesting, Lekking or Breeding, and Dusting Habitat

Habitat type	Forest type	T_dense	U_dense	U_structure	C_cover	G_cover								light
						grass	seed	fruit	climb	herb	shrub	seedling	sapling	
(A) Nesting														
N1_HKKR	Dry-dipterocarp	0.14	1.88	56.88	96.00	15.15	9.85	0.00	13.63	17.42	8.33	7.57	21.21	44.10
N2_TS*	Dry-dipterocarp	0.11	0.98	41.88	80.00	17.42	3.79	0.00	0.60	19.69	11.36	3.03	25.75	54.77
(B) Lekking or Breeding														
L1_HKKR	Mix-diciduous	1.91	0.10	17.50	8.00	23.48	0.00	0.00	6.06	21.21	3.79	12.12	9.09	152.10
L2_TS	sand bar	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	360.00
L3_HKKR	secondary	0.08	2.66	23.13	32.00	26.51	0.00	0.00	4.54	22.72	0.76	20.45	2.27	533.25
L4_TS	sand bar	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	594.00
(C) Dusting														
D1_HKKR	Dry-dipterocarp	0.21	1.63	28.13	60.00	15.91	0.76	0.00	3.79	18.18	3.79	17.42	21.96	344.25
D2_TS2	Mixed-deciduous	0.17	1.22	64.38	72.00	9.85	0.00	0.00	8.33	9.09	2.27	10.60	12.88	270.00
D3_TS5	Mixed-deciduous	0.23	2.28	22.50	80.00	24.99	0.00	7.57	6.06	8.33	4.54	12.12	15.91	173.25

* recorded after wild fire

4.2.2 Habitat characteristics of dusting site

The green peafowl implies variety of feather maintenance behaviors which are; preening, scratching, dusting, sunning, shaking, and ruffling (Meckvichai, 2008; Ponsena, 1988). Dusting and sunning are interested in this study because this behavior associated to habitat conditions.

I found three peafowl dusting sites in two habitat types; two sites were in protected area and another site found in buffer zone area (Figure 4.5). At first site within dry-dipterocarp forest located c.a. 20m from road whereas later two sites found within mixed-deciduous forest, located close to water source, <10m. All three sites, based on our sampling plots, consisted of low tree density (averagely 0.61 tree/sq.m) but high abundance of sapling and grasses (both averagely 16.92%). Density of undergrowth and understory structure (or vegetation high) was found at medium level, averagely 1.71 trees/sq.m and 38.34% as well as light intensity which was 262.5 Lux. I suggested that peafowl used the site with dense canopy cover 70.67% (Table 4.11). Soil type from all dusting sites were identified as sandy loam (Table 4.12). For other feather maintenance behaviors, I rarely found Green peafowl sun bathing in the morning and spend much of their time for self preening and scratching (Figure 4.6).

Table 4.11 Analysis soil type from dusting habitat

plot	Forest type	pH	Soil text			texture
			% sand	% silt	% clay	
HKKR1*	Deciduous	6	63	23	14	Sandy loam
TS1	Deciduous	6	73	17	10	Sandy loam
TS2	Deciduous	7	70	18	12	Sandy loam
HKKR2	Deciduous	7	9	19	12	Sandy loam

* No biological factor was measured as the site found later, after my study period (27 August 2009)

Figure 4.5 Four dusting plots from left to right: TS2, TS1, HKKR2 and HKKR1.

Figure 4.6 Green peafowl sun-bathing behavior in the morning: (a) Huai Kha Khaeng Road and (b) Huai Tab Saloa stream.
(Photos courtesy of (a) Sarawut Sawkhamkhet; (b) Tanwarat Pinthong)

4.2.3 Habitat characteristics of breeding site

This study found 4 breeding sites, two sites on sand bar and other two in buffer zone area. The characteristics and details from each site were described below;

L1_HKKR: One male found with 4 females in the morning at permanent artificial pond, 9thkm on Huai Kha Khaeng road. Distance from birds to road was greater than 100 m.

L2_TS: Five different foot print sizes on 6x1sq.m sand bar at the middle of the Huai Tab Saloa stream.

L3_HKKR: One male found with one female at 3pm. on Huai Kha Khaeng road c.a. 50m away from road

L4_TS: Two courtship site of 2 peacocks on one sand bar at middle of the Huai Tab Saloa stream together with 2 female groups, 3 and 4 birds respectively. Both female groups only came to first male breeding territory.

The habitat composition of the breeding core area varied greatly for individuals, a large part of the habitats used was composed of mix-deciduous and secondary forests. Most breeding sites were open, small number of tree and under growth, 0.498 and 0.695stem/sq.m, with radiation at ground and possible height levels was 409.813lux. Sites on sand bar, peafowl performed courtship at location where almost none of ground and canopy cover where as those in forest sites apparently higher and most common ground cover was grass and herb (averagely 24.995% and 21.965%).

In observation, I found 3 types of peacock behavior to defend his territory, the evidence which were 1) they will drive follow closely, if his territory trespassed by other peacock, smaller or equally animal, e.g. monkey; 2) they will make a stand on their territory, if trespassed by bigger animal, e.g. deer and raptor; and 3) some territories which nearby, they will rivaling by calling and displaying, thus absence peahen flock. This observation supported by Arratharakorn (2001), Ponsena (1988), and Rodjanadilog *et al.* (1985) (Figure 4.7)

Figure 4.7 Peacock behavior to defend his territory.

4.2.4 Habitat characteristics of nesting site

Only two of nesting sites were observed during this study. The first one was, supposedly, successfully-hatched before July 2007, during preliminary survey where the later nest found in April 2009 by a mushroom collector. The nest was burnt by wildfire but all four eggs in it still seemed to be alive.

Two green peafowl nests were located in dry-dipterocarp forest in the protected area. The results showed that green peafowls used the areas with relatively low tree density but high coverage of <2m under growths or shrubs, high grass or

sapling in nest site. Higher proportion of grass and herb (16.29% and 18.55%), the understory structure of 49.38% and average density was 1.43tree/sq.m. Nest characteristics between sites were quite similar, e.g., both were on ground without any special structure and located far from stream and road. However, only the first nest found with shallow rounded sink and scratching tracks on ground with c.a. 53cm diameter where as another nest was found on ground surface with rocks, none of such those tracks found (Figure 4.8).

Figure 4.8 Two nesting habitat of green peafowl were: (a) found in buffer zone area, (b) found in protected area.

4.2.5 Habitat characteristics of roosting trees

The green peafowl does not seem to select any particular roosting tree species (Meckvichai, 2008; Ponsena, 1988) but possibly does for some roosting tree characteristics. in this study, eight roosting trees were identified by; direct sighting (3 trees), hearing their crow early in the morning or evening (2 trees); presence of clump droppings under the tree (one tree), and by expecting from relative height to adjacent trees (2 trees).

For each visual observation, all of the roosts used by the green peafowl were in live trees. The average tree size was 65cm DBH and 22.13m in height (vary from 12-43m min to max), branch with perch height was 10.33m and first fresh branch was 7.33m. Most of green peafowl roosted in tree with moderately dense foliage; average canopy cover was 59.25%. Most of roosting tree was not far from the river (Range from 10 – 30m) (Table 4.12).

Three direct sightings were in breeding season (dry season), I found one male tree roosted solely in dry dipterocarp forest, and other two trees they roosted with females in mixed deciduous forest. Common roosted tree was *Melia azedarach* L. (Thai name: Lean) and *Afzelia xylocarpa* (Kurz) Craib (Thai name: Maka Mong) and the green peafowl were observed to roost when the light intensity of the habitat drop below 10 lux and jumping to change branches for 2-4 steps or even more to find a suitable location (Figure 4.9).

Peahens were observed to fly to the roosting tree right before sunset, between 1830-1845h and departed their roosting tree between 0700-0730h, earlier than male.

Peacocks were observed start crowing with loud resonant at 6.15, 7.05 and 6.20am respectively.

(a) (b)

Figure 4.9 Shows roosting trees of green peafowl which were: (a) *Melia azedarac*h L, and (b) *Lannea coramandelica* (Houtt.) Merr.

Table 4.12 Categories of roosting structures and sizes of roosting trees used by green peafowl in Huai Tab Saloa-Huai Song Tang water basin in 2008

Species name	Thai name	Height tree (m)	DBH (cm)	Perch height (direct sighting) (m)	1st fresh branch (m)	Canopy cover (%)
1. Melia azedarach L	เลี่ยน (Lean)	15	36	11	8	60
2. Afzelia xylocarpa (Kurz) Craib	มะค่าโมง (Maka-Mong)	18	48	10	9	67
3. Lannea coramandelica (Houtt.) Merr	อ้อยช้าง (Aoi Chang)	12	27	10	5	45
4. Vitex limonifolia Wall.	สวอง (Sawong)	15	29	-	4	70
5. *Lagerstroemia loudonii* Teijsm. & Binn.	เสลา (Saloa)	20	44	-	13	70
6. *Lagerstroemia loudonii* Teijsm. & Binn.	เสลา (Saloa)	24	35	-	16	80
7. *Parkia javanica* Merr.	เหรียง (leang)	30	44	-	18	42
8. *Dipterocapus alatus* Roxb. ex G.Don	ยางนา (Yang-na)	43	125	-	26	40

1-3 are direct sighting, 4 and 5 are hearing crow early in the morning or evening, 6 is presence of droppings under the tree, and 7-8 are expectation from height relative to adjacent trees.

4.3 Habitat Suitability

Multivariate tests - Nine biological and physical factors were selected, regarding to results from univariate tests in previous chapter, and included in the in the Canonical Correlation Analysis (CCA), those were; tree density, understory density, understory structure, ground cover, soil fauna abundance, macro-invertebrate abundance, precipitation, humidity and temperature. These tests were conducted with aims to improve results from simple univariate tests in previous chapter and to quantify correlation among factors between used foraging in dry and wet seasons.

4.3.1 Habitat utilization in non-breeding season (wet season)

The CCA ordination of environmental factors of all plot sampling was significant in only one axes (axis 1; $p \leq 0.05$). The accumulation of the percentage variable explanations of 3 axes was 66.1 % and the percentage variable explanation (axes 1 and 3) was 48.1%. The results revealed 7 trend-lines which were; tree density, understory density, understory structure, ground cover, macro-invertebrate, humidity and temperature, representing by red lines and their interpretation indicated that foraging sites used by peafowl are more often associate to higher in tree density, understory density, undergrowth structure but less in ambient humidity (Figure 4.10)

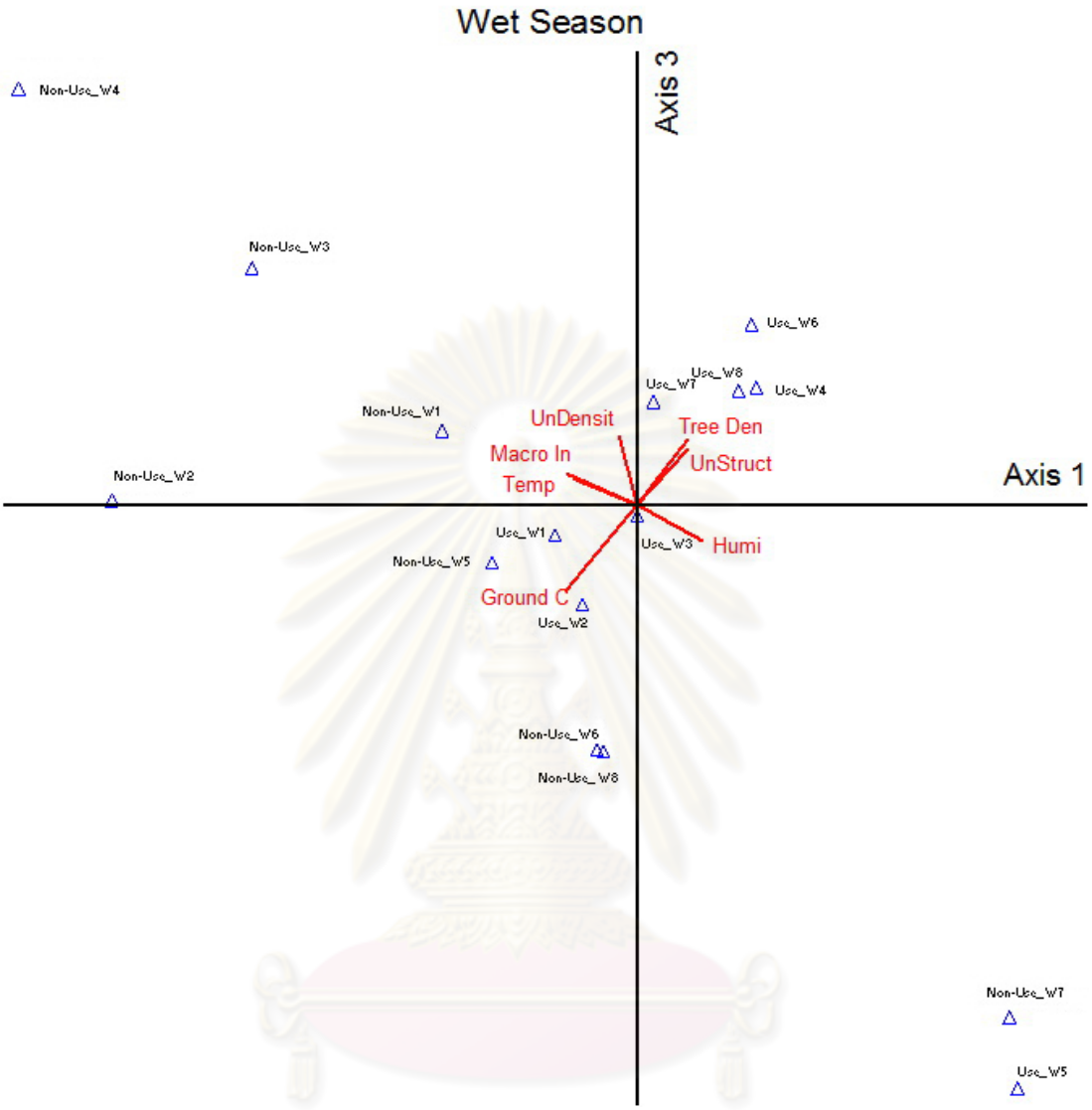


Figure 4.10 Canonical Correspondence Analysis of the physical and biological factors in all foraging habitat in wet season.

4.3.2 Habitat utilization in breeding season (dry season)

The CCA ordination of environmental factors of all plot sampling was significant in both axis 1 and 2 ($p \leq 0.05$). The accumulation of the percentage variable explanations of 3 axes was 90.5 % and the percentage variable explanation (axes 1 and 2) was 86.5 %. There were 7 trend-lines including of; understory density, understory structure, ground cover, soil fauna, macro invertebrate, humidity and temperature. Then, it can be interpreted to higher in temperature, rainfall, undergrowth structure, ground cover, and invertebrate abundance in sites that occupied by peafowl in this season (Figure 4.11).

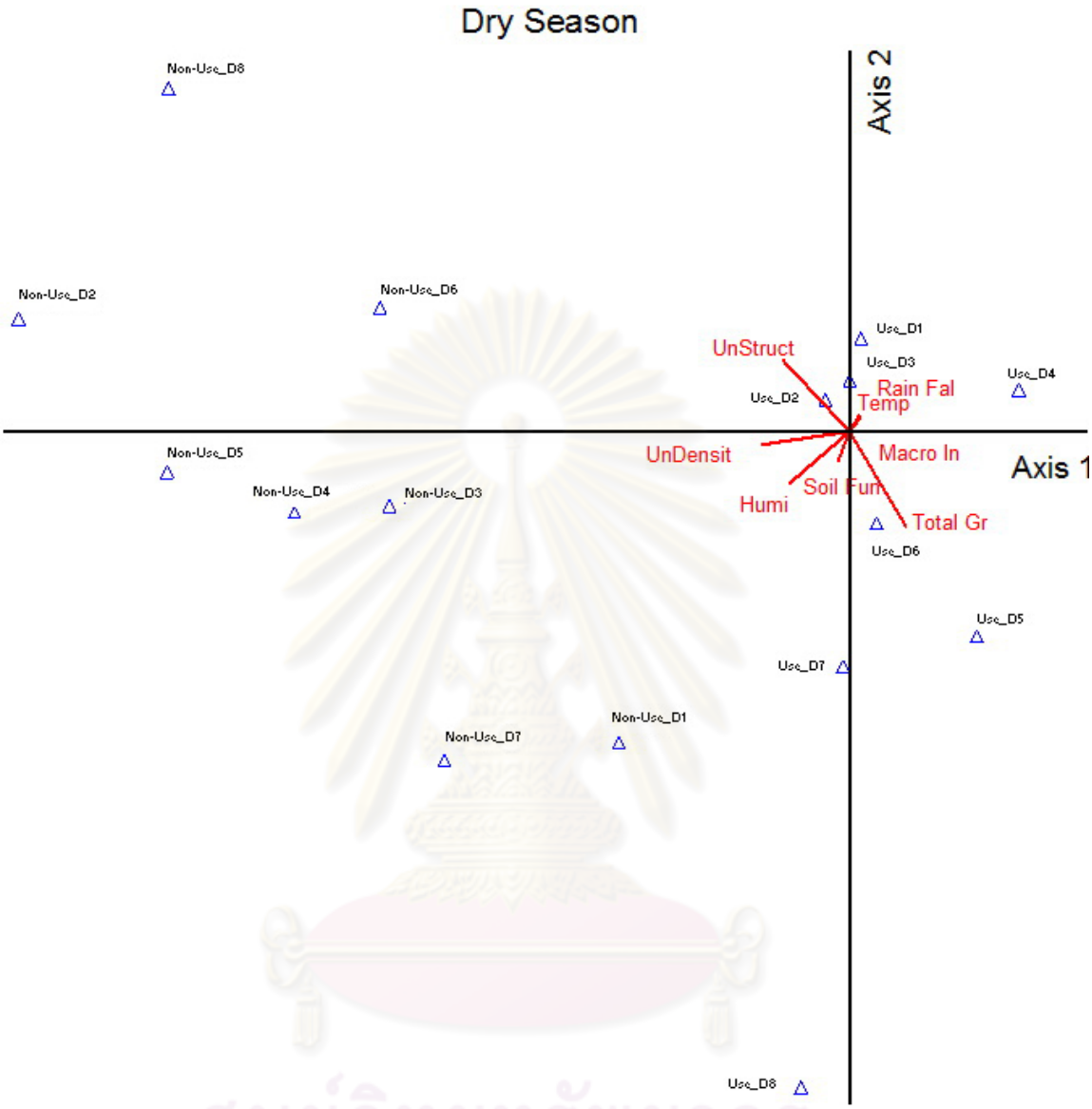


Figure 4.11 Canonical Correspondence Analysis of the physical and biological factors in all foraging habitat in dry season.

Table 4.13 Particularly of 16 foraging sites; used and random locations and abundance of green peafowl in dry season.

Plot	Understory Density	Tree Density	% Understory Structure	% Ground Cover	Soil Funna	Macro Inver.	Precipitation	Humidity	Temperature	Etc
Use_D1	1.14	0.19	42.19	22.89	961.10	69.00	33.00	63.65	27.98	ST
Use_D2	0.69	0.17	27.81	19.67	1302.77	104.50	33.00	68.95	28.60	TS1
Use_D3	1.35	0.15	39.69	25.33	944.40	166.00	0.00	42.56	23.66	TS2
Use_D4	0.78	0.16	25.31	28.00	213.88	43.50	0.00	42.56	23.66	TS3
Use_D5	1.36	0.12	15.94	32.89	399.22	89.23	42.00	63.70	27.98	HKKR1
Use_D6	1.14	0.12	22.19	33.67	547.20	70.75	33.00	69.00	28.60	HKKR2
Use_D7	0.85	0.13	21.88	35.22	2019.40	250.00	0.00	74.20	27.39	BS1
Use_D8	1.22	0.14	19.69	38.67	1591.66	153.50	0.00	76.55	21.84	BS2
Use_D9	2.93	0.19	56.56	35.22	375.00	8.00	0.00	76.55	21.84	ST
Non-Use_D1	2.77	0.16	69.06	11.00	222.22	15.75	0.00	76.55	21.84	TS1
Non-Use_D2	3.26	0.27	61.88	10.56	397.22	48.50	0.00	76.55	21.84	TS2
Non-Use_D3	2.66	0.20	43.13	8.89	348.44	31.50	0.00	76.55	21.84	TS3
Non-Use_D4	2.73	0.15	43.75	10.00	300.00	26.00	0.00	76.55	21.84	HKKR1
Non-Use_D5	1.99	0.14	41.25	25.22	113.89	74.64	0.00	81.58	27.39	HKKR2
Non-Use_D6	2.39	0.14	48.44	33.78	145.78	68.00	0.00	76.55	21.84	BS1
Non-Use_D7	2.48	0.14	52.81	15.33	113.78	38.50	0.00	81.58	27.39	BS2

Table 4.14 Particularly of 16 foraging sites; used and random locations and abundance of green peafowl in wet season.

Plot	Understory Density	Tree Density	% Understory Structure	% Ground Cover	Soil Funna	Macro Inver.	Precipitation	Humidity	Temperature	Etc
Use_W1	3.33	0.19	57.81	28.44	1200.00	87.72	75.00	76.60	26.99	ST
Use_W2	2.46	0.17	43.44	19.67	1458.00	172.75	75.00	76.60	26.99	TS1
Use_W3	2.05	0.15	42.19	24.11	883.33	134.50	146.00	77.35	27.32	TS2
Use_W4	1.56	0.16	45.94	29.89	305.55	86.75	146.00	77.35	27.32	TS3
Use_W5	2.73	0.12	24.69	40.78	2666.66	329.75	64.00	78.71	27.27	HKKR1
Use_W6	1.60	0.12	31.88	40.33	1616.60	86.75	64.00	78.71	27.27	HKKR2
Use_W7	2.31	0.13	45.63	30.44	1644.00	104.00	500.00	81.89	23.66	BS1
Use_W8	2.32	0.14	32.19	36.67	1669.00	189.00	500.00	81.89	23.66	BS2
Non-Use_W1	4.34	0.19	66.56	41.89	650.00	12.75	0.00	81.60	27.39	ST
Non-Use_W2	3.61	0.16	67.81	10.67	286.11	10.50	0.00	81.60	27.39	TS1
Non-Use_W3	3.43	0.28	71.88	6.78	307.50	53.00	0.00	76.60	21.84	TS2
Non-Use_W4	3.43	0.21	58.13	5.67	656.00	8.75	0.00	76.60	21.84	TS3
Non-Use_W5	2.73	0.16	56.25	10.00	363.88	18.50	0.00	68.27	22.87	HKKR1
Non-Use_W6	4.32	0.14	50.31	30.67	208.33	59.25	0.00	68.27	22.87	HKKR2
Non-Use_W7	2.76	0.14	56.88	34.00	184.89	105.50	33.00	28.60	68.95	BS1
Non-Use_W8	4.04	0.14	48.75	34.33	184.89	100.50	0.00	68.30	31.11	BS2

4.3.4 Habitat utilization in zone 1 (ST, TS1 and TS2)

The CCA ordination of environmental factors of all plot sampling was significant in axis 2 and 3 ($p \leq 0.05$). The accumulation of the percentage variable explanations of 3 axes was 66.1 % and the percentage variable explanation (axes 1 and 3) was 48.1%. There were 7 trend-lines including of; understory density, understory structure, macro invertebrate, humidity and temperature. Peafowl abundance in zone 1 was significantly associated to high food (invertebrate abundance) and moderate temperature. Neither dense undergrowth nor ground cover seem to preferred by green peafowl, in contrast, they seem to use dry area, less humidity and lower rain fall, more than wet area (Figure 4.13).

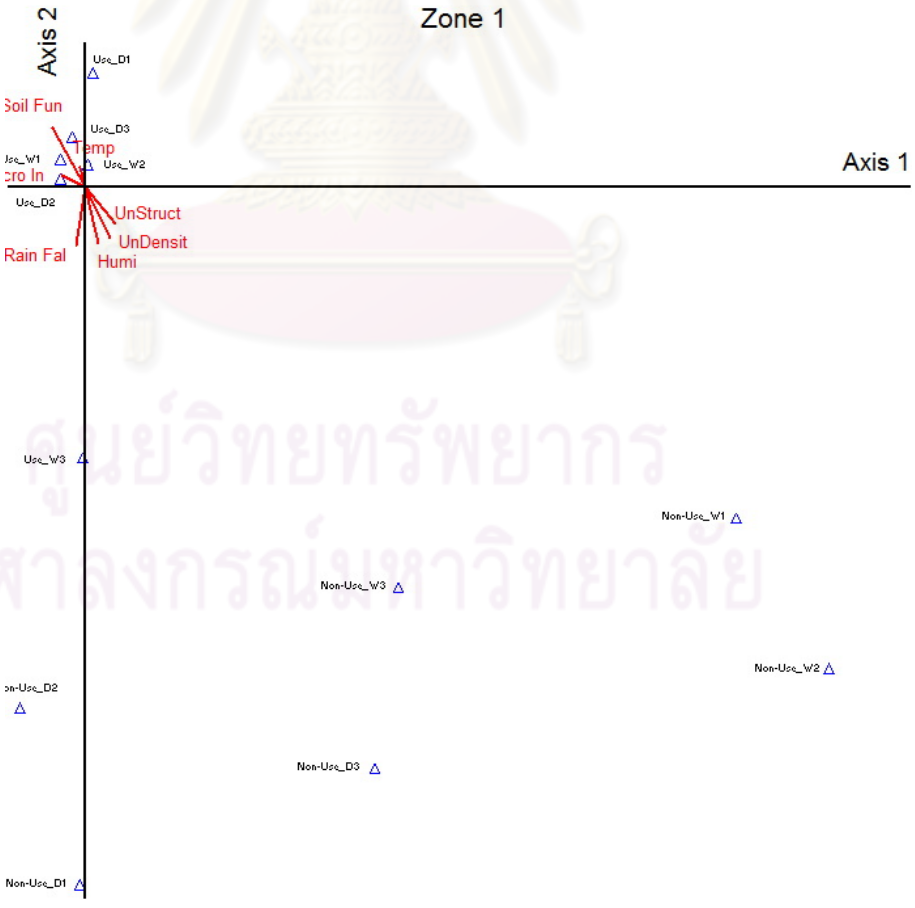


Figure 4.12 Shows habitat utilization in zone 1.

4.3.5 Habitat utilization in zone 2 (TS3, HKKR1 and HKKR2)

The CCA ordination of environmental factors of all plot sampling was significant in only one axis (axis 1 and 2; $p \leq 0.05$). The accumulation of the percentage variable explanations of 3 axes was 95.2 % and the percentage variable explanation (axes 1 and 3) was 54.6%. There were 5 trend-lines including of; understory density, understory structure, macro invertebrate, humidity, and temperature. The interpretation suggested that the used foraging sites in zone 1 are associated to high rain fall, ground cover, soil fauna, macro soil fauna but not in high tree density nor undergrowth (Figure 4.13).

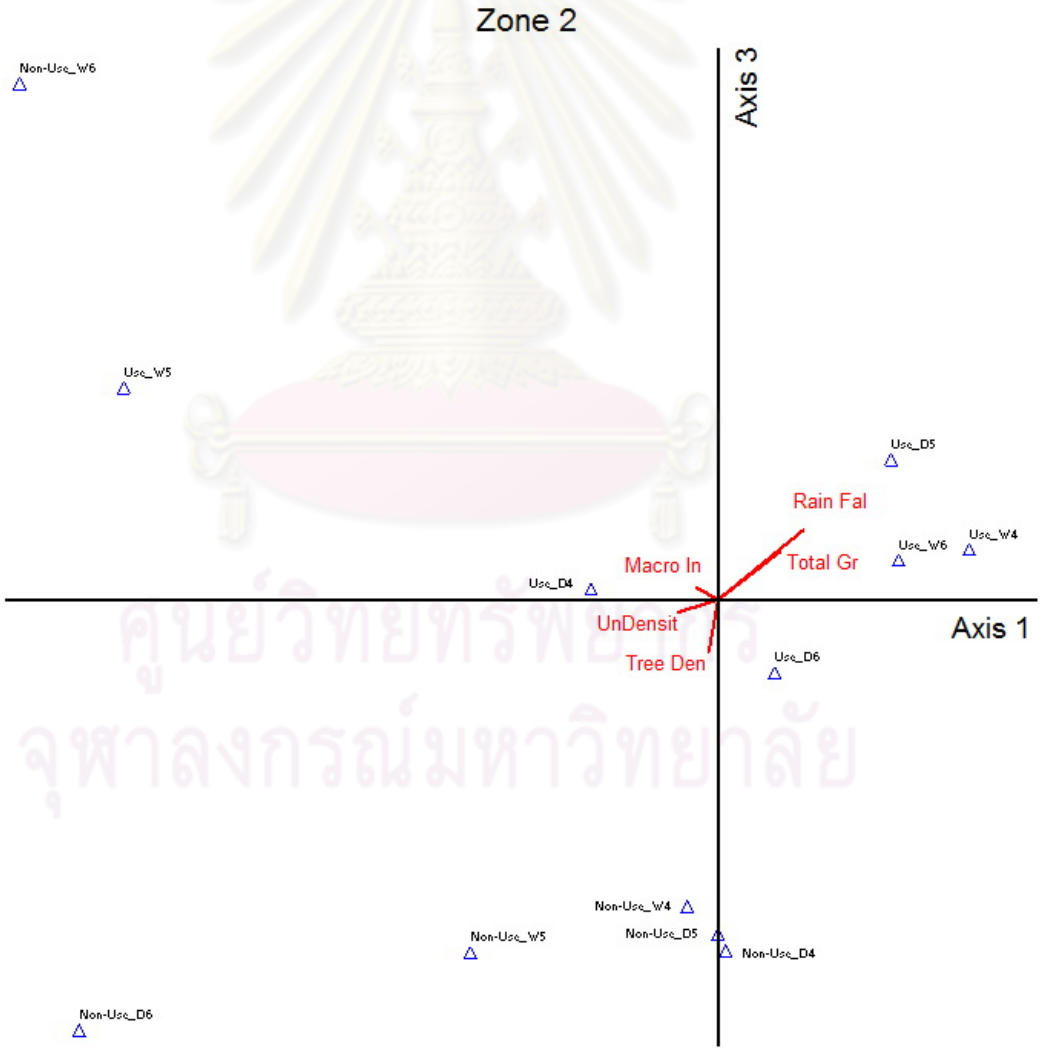


Figure 4.13 Shows habitat utilization in zone 2.

4.3.6 Habitat utilization in zone 3 (BS1 and BS2)

In this analysis, biological and physical factors are separately tested. For biological factors i.e., understory density, tree density, understory structure, ground cover, soil fauna and macro-invertebrate. The CCA ordination of biological factors of all sampling plot was significant in only one axis (axis 1 and 2; $p \leq 0.05$). The accumulation of the percentage variable explanations of 3 axes was 95.2 % and the percentage variable explanation (axes 1 and 3) was 54.6%. It showed that green peafowl habitat utilization is associated to precipitation ground cover and macro invertebrate. There were 6 trend-lines including of; understory density, understory structure, macro invertebrate, humidity, soil fauna, and temperature. The interpretation suggested that used foraging site in zone 3 is associated to high food abundance, soil fauna, macro soil fauna, and ground cover (Figure 4.14).

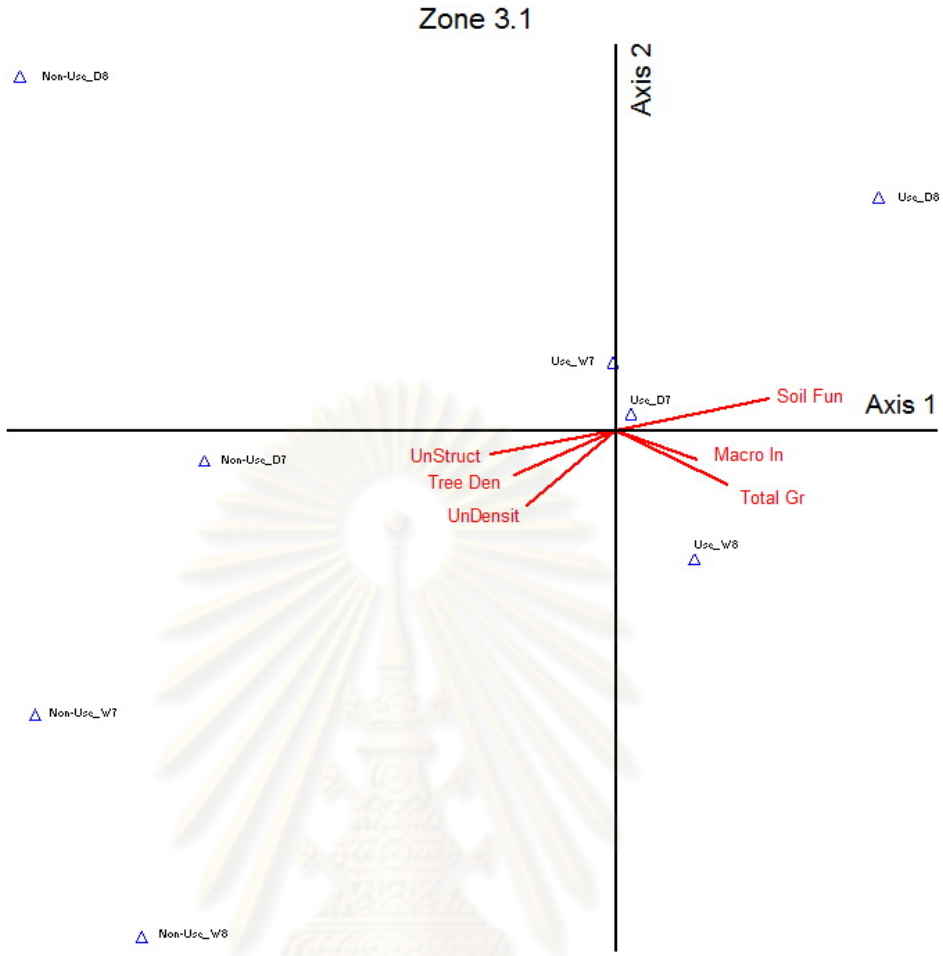


Figure 4.14 Shows habitat utilization in zone 3.1.

For physical factors i.e., precipitation, humidity and temperature, CCA ordination of all sampling plot was significant in only one axis (axis 3; $p < 0.05$). The accumulation of the percentage variable explained by 3 axes was 48.4% and the percentage variable explanation in Figure 4.3 (axes 1 and 3) was 43.1%. The result indicated that high humidity and precipitation are associated to green peafowl habitat utilization. There were 3 trend-lines including of; precipitation, humidity, and temperature. The interpretation suggested that the area with higher precipitation with moderate temperature is more likely to be used by green peafowl than another (Figure 4.15).

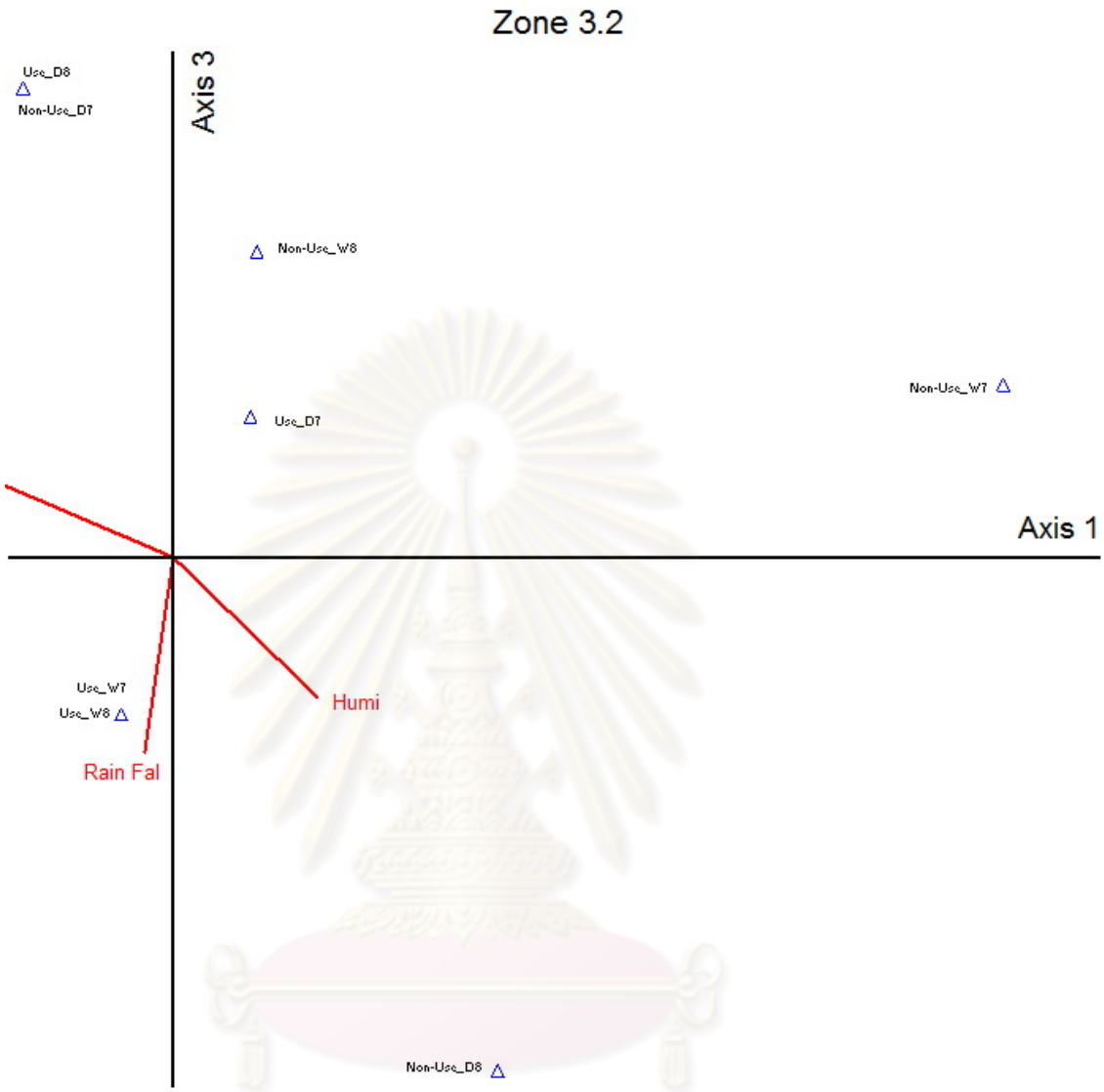


Figure 4.15 Shows habitat utilization in zone 3.2.

CHAPTER V

DISCUSSION AND CONCLUSION

5.1 Population Dynamic

A species' status is indicated by both its distribution and abundance, and the rate at which these components are changing (McGowan, 1997). The aim of study was to determine population dynamic of green peafowl, disturbance factors and change in the number of sites from which a species had been recorded in Huai Tab Saloa and Huai Song Tang water basin. In this study I included three factors that reasonably influence or limit green peafowl survival and hence abundance. Those factors were relative abundance of potential predators such as cat species, civets, and wild dogs, human activity index, and environmental change index. I divided all results in to two parts regarding to, first, variation among habitat types and, secondly, season.

5.1.1 Habitat types and green peafowl abundance

Huai Kha Kaeng associated to five water basins (Srisupan, 1997). Huai Tab Saloa- Huai Song Tang basin is one of the most important basin as due to its higher habitat diversity, covering by protected area, buffer zone, and community forest which reasonably too supporting high wildlife diversity and abundance (Rabinowitz 1999), including green peafowl. I approve the pattern of this association in my study area, I collected information on factors that might explain variation in peafowl relative abundance and I found that peafowl abundance seem to be negatively associated to all three selected factors, but not statistically, and humans activity index such as;

fishery, land encroachment, and modification was apparently strongest different among habitat types (Table 4.1).

Though almost peafowl relative abundance in protected sites were higher than those in other sites, a green peafowl relative abundance estimated along the HKKR1 was, relatively low. From my field experience, I here explained this pattern by road effects. Three out of six transect I conducted were located on existing roads, one for each habitat types. Green peafowl relative abundance among these sites was found highest in buffer zone area, the HKKR2, not the one in HKKR1. This result might be explained; 1) there is actually no human activity observed during survey, hence no data on it; 2) the HKKR2 is closely the stream than HKKR1 and have the permanent water near the road; 3) different in vegetation in each site, HKKR1 is covered by thick bushes but the HKKR2 is covered by grass and, in contrast, the forest is more open than in protected, differences in vegetation cover might related to visibility during survey, more birds and tracks hence found in buffer zone area where visibility is greater than another habitat; and 4) sampling roads might not so attractive to green peafowls, more or at equal numbers and qualifications of the comparable habitats, e.g., gully, trail, track, or along fire break, are adequately, widely distributed in each habitat types, which finally cause no significant bias to road sites. During transect survey, the distance to water and road when found birds or their track were estimated. I found that, although the green peafowl prefers open area, like in HKKR2, but it seem to avoid by forage far from the road (>50m) same the previously report, Thapook (2005) found that some mammals avoided the Huai Kha Khaeng road (>250m) that this study conducted (Figure 4.1).

As we found that the green peafowl abundance was difference among site and each site associated with difference degree of disturbance, again, human activity was greatest varied among sites. therefore, I further explored and discussed about difference in type, number, and time period (during 05.00-21.00h) of vehicle that driven through Huai Kha Khaeng road (both of HKKR1 and HKKR2), and Huai Kha Khaeng Wildlife Breeding Station Road (BSR3) here, from seven-months observation (4 months in dry season and 3 months in wet season) at one check point. I found that 9,398 vehicles, in total, driven through protected area (HKKR1 and HKKR2). The most common was car, 4,685 cars, during 09.00-12.00h and second most was motorcycle, 2,130 motorcycles, during 05.00-09.00h. Most common vehicle that driven through BSR3 was higher than in protected area, 12,137 vehicles in total, and 5,007 out of this number were car, peak found during 05.00-09.00h. The second most common was Rod-e-tak (a modified car from engine of tractor to load agriculture material), 1,330 during 05.00-09.00h. Notably, since here many more vehicle driven through BSR3, however, the different in level of effects from traffic on road to peafowl among sites might be arguable as large proportion of vehicle entered into BSR3 stopped by community forest or even on parked somewhere on roadside prior to access or sneak into protected area without permission e.g., poacher and non-timber forest product (NTFP) collectors (figure 5.1).

There are two more reasons explain high green peafowl abundance in community forest. Firstly, cropping for livestock around Wildlife Breeding Station, e.g., corn, sorghum, and some seed grains, sometime attracted to green peafowl in distance and they usually travel through community forest. Distinct peafowl foot prints,

several size, were found outside the enclosure nearby pheasants' cages and one staff confirm that he directly found 8 wild green peafowls foraging around wildlife breeding station in crop harvest season. Secondly, food availability in community forest presumable stay high through year round. Bamboo seeds, especially, was over abundant in the study period in community forest and they considered as a food type of green peafowl (Ponsena, 1988). Both reasons were analogous to results from a previous study on sympatric Red junglefowl (*Gallus gallus*) fowl which animals were followed from July 2007 to August 2008 (Arsirapoj, 2008). He found that junglefowl movement was associated to food distribution, in wet season they aggregated around fruiting *Antidesma sootepensis* trees in community forest and they intensively, 80%, used the area that bamboo seed was over abundant. Moreover, in dry season, they moved to cropping area near Breeding Station, like I expected for green peafowl, as it was crop harvesting period.

5.1.2 Disturbance factors and green peafowl abundance

Predators and green peafowl population — Most of the losses of pheasants released to the wild are caused by predators (Dumke and Pils 1973; Waurisch 1975; Leif 1994; Sodeikat and Pohlmeyer 1996; Bliss *et al*., 2005), thus, the survival rate will predominantly depend on predator avoidance behavior (Rütting *et al*., 2007). In the field, I found three green peafowls flight and timidity to only one avian predator, the Oriental Honey-Buzzard (*Pernis ptilorhyncus*). Ponsena (1988) found that they disturbed by five predators e.g., Crested Serpent-Eagle (*Spilornis cheela*), Masked Palm Civet (*Paguma larvata*), Water monitor (*Varanus salvator*), Bengal monitor (*Varanus bengalensis*), Leopard (*Phantera padus*). Which was similar to one

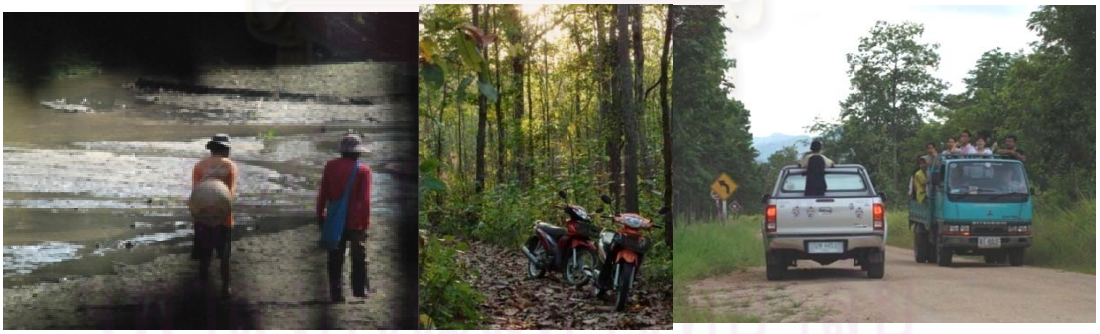
report conducted, predators such as Tiger and Leopard can drive or control prey population in area (Srikrachang, 2005). In this study, I suggested that the dynamic of peafowl population partially associated to the abundance of potential predator and the pattern could be explained by Lotka-Volterra model (Beals *et al*., 1999).

Human activity index and green peafowl abundance—in wet season, especially August to October, human activity index dramatically increased and, synchronously, to the decrease of peafowl abundance (Figure 4.1). One obvious activity is NTFPs collection during mushroom season, the season that Termite mushroom (*Termitomyces fuliginosus*) bloom right after the first rain, hundreds people entered peafowl habitats to collect them as this mushroom becomes very expensive in the market. A survey during 2008-2009 on the mushroom market near by the Wildlife breeding station where many traders from several provinces came to buy (Figure 5.2). A villager from one adjacent village, Bueng Chareon, is frequently access into peafowl habitats to collect NTFPs (e.g., bamboo shoot and mushroom) in October and November. Additionally, another activity that might also influence peafowl abundance is free-releasing livestock such as cattle and goats into protected area (Srikrachang, 2005).

(a) (b)

Figure 5.1 Green peafowls detected along Huai Kha Khaeng Road in different vegetations; (a) HKKR1 and (b) HKKR2. The later photograph supports that though peafowl seem to occupy rather open habitat, they keep some distance from road (Photographer: Tanwarat Pinthong).

(a) (b)



(c) (d) (e)

Figure 5.2 Evidences of human activities within study area; around the BSR3, some people parked their motorbike prior to access protected area by foot (a) and mushroom collectors during mushroom season in October 2009 (b) and within the protected area fishery encroachment in TS1 (c), land encroachment in HKKR1 (d), and tourist car and student activity in HKK1(e). (Photographer: Tanwarat Pinthong).

5.1.3 Seasonal and population dynamic

The results suggested no significantly change in peafowl relative abundance between wet and dry season. This possibly true in the studied population as similar result revealed in another green peafowl population in Pha Miang subdistrict Doi Saket district Chiang Mai province, North of Thailand (Dumkeaw *et al*., 2009). However, I suggested that the pattern of change in peafowl abundance in the area was correlated to weather pattern and this can be explained by known peafowl behaviors; 1) Identical increasing in peafowl abundance in November may be explained by changing in weather as it is about transferring from wet to dry season (Rodjanadilog *et al*., 1985). The water level in Huai Tab Saloa and Huai Song Tang become lower and wider sand bars are emerged. More green peafowl, possibly, move to utilize this extended foraging habitat; 2) in another sense, from peafowl behavior point of view, it is the period that peafowl start to breed (Arratharakorn, 2001; Ponsena, 1985), adult peafowls form male-multifemale flock and mate near riverside or on sand bars where high frequency of peafowl activities (foraging, defend territories, lekking and display) observed and this might possibly explain increasing in peafowl relative abundance in this period, in this site.

In another end, after reproduction the area used by the pheasants was always reduced in every group of Pheasant (Bagliacca *et al*., 2008), thereby, during March to April is known as late breeding season of green peafowl, peacock disperse and become solitary where peahen which successfully were spent her time to provide maternal care e.g., selecting nesting site, laying eggs, and, of course, rearing her chicks (Ponsena, 1988, Surbamamian and John, 2001). The flock of peahens which did

not succeed in their reproduction or lose their chicks or eggs, and sub-adult peacock were not killed by the predators start moved from their home-range and observed new habitat, which was similar to adapting phase (Bagliacca *et al*., 2008). Moreover, during the period of upcoming dry season, peafowls also attracted by sprouting grass after annually wild fire, they supposedly move away from river site to burnt area and these reasons caused in decreasing in their relative abundance in the sites.

During May to June, beginning wet season, grasses and herbs are suddenly increase and as well as green peafowl abundance (Rodjanadilog *et al*., 1985), peafowl comeback to riverside or sand bars for foraging. However, this period is usually short, once heavy rain start in July causes to flooding around riverside and, instead, peafowl moves to forage in forest site (Rodjanadilog et al., 1985) which hence caused in lower peafowl abundance in riverside until the end of wet season. These whole consequences can explain fluctuation pattern in peafowl abundance in year round.

5.1.4 Temporal changes in peafowl abundance

Prior to declaration as a World heritage site in 1991, Rodjanadilog *et al*., (1985) and Ponsena (1988) reported that green peafowl occurred at low abundance in Huai Tab Saloa, possibly less than 20 birds in up-stream region. Direct sighting was very rare, mostly found solitary or in pair. The situation of this species in buffer zone area which at that time excluded in the Wildlife Sanctuary area is dangerously caused by high human activities in the area, the last sighting was in 1981. Two years after declaration, threats from land encroachment and other human activities still occurred

(Tantiwittayapitak, 2000), at any rate green peafowl still absence (Ponyeam, 1993). Some wildlife species were thought to move from Huai Tab Slao down-stream up to higher elevation, around Khao Nang Rum area, where they were better protected (Srikosamatara, 1993).

Interestingly, after action on wildlife protection has long been improved by both government and non-government units, there are some believes that some of wildlife species moved back to lower elevation (Srikrachang, 2005) and this might related to peafowl recovering. By 15 years after declaration Meckvichai *et al*. (2006) report that peafowl present at 1.12 Birds/km which thought to be a sign of re-colonization. The current study, 19 yrs after declaration, I here reported peafowl abundance within range between 1.3-2.5 Birds/km which support a view of positive population trend in Huai Tab Saloa. A hypothesis that intensity of human activity negatively impacts to peafowl abundance was tested and, though not statistically accepted. Higher intensity of human activity e.g., in community forest associated to lower peafowl abundance and, in contrast, higher peafowl abundance e.g., in protected area associated to lower intensity of human activity. Yielding results from this study, re-colonized population can be considered as a consequence of removing such human settlement, as well as other human activity, out from peafowl habitat.

Habitats are both resources and conditions present in an area that produce occupancy of a given organism. Habitat use on each specific resource, both of physical and biological, is related to minimum specific requirement to survive and reproduce successfully in that habitat (Krausman, 1999). Numerous habitat characteristics in this manner were hence studied in regard to factors that both

associated to reproductive success and survival of the species, including foraging, maintenance, sheltering, breeding and nest-sites habitat (Hilden; 1965; Li *et al*., 2009; Riley *et al*., 1998), in order understand reasonable explanation that influence the species habitat use (Hilden, 1965). For endangered birds, including green peafowl the study of the relationship between their habitat preference and habitat structure is exclusively useful to predict their suitable habitat, assess their habitat quality and further improve their habitat conditions for the conservation and management of their populations (Morris, 2003).

5.2 Habitat Utilization

5.2.1 Habitat characteristics of foraging site

Since I questioned that how peafowl used habitats change across year, by this single-year study, I hence only able to compare selected factors between wet and dry season. Moreover, as this study was not focus on differences in used habitat between seasons, no attempt is made here. I, instead, discussed how those seasonal changes within used plots different from seasonal changes within random plots. The comparisons revealed that most of seasonal changes pattern between used and random plots were truly identical, most of those was not apparently at all which were; firstly, definitely, total density, ground coverage, and occurrence of seed, fruit, climber, shrubs, seedling, and sapling. Some of those were changes in similar direction which were; total understory density, understory structures, frequency of occurrence of vertebrates and invertebrates.

Results from this study found that the predominant forest type is open deciduous forest. This apparent habitat preference is consistent with most previous studies of green peafowl (Brickle, 1998; 2002; Delacour, 1977; Evans and Timmins, 1996; Lui *et al*., 2007; Meckvichai *et al.,* 2004; Ponsena, 1988; Round, 1983). Habitat utilization was associated to lower density of tree, density of understory, dense understory structure, but higher in grass, seed, and climber abundance. Moreover, abundance of vertebrates and invertebrates within use and random locations were varied across various orders and this possibly caused by peafowl foraging site selection and also by nature of those prey species who occurs at extremely abundance *e.g*., ants (Toda and Kitching, 1999). These results are dissimilar to some other studies on other galliformes, *e.g*. one study on Brown-eared pheasants (*Crossoptilon mantchuricum*) (Li *et al*., 2009) and hen Pheasant (Hill, 1985) which concluded that pheasant habitat utilization positively correlated to type of trees and grasses, tree size, tree height and density.

Seasonal changes in use of foraging site in this study were observed only on understory density and structure. In another point of view, use of foraging site was changed according to breeding stages as previously described in some previous studies on other galliforms (Jia *et al*., 2005). Other variables that might affect use of or selection on foraging site can be other factors else out of our scope such as terrain, distance to nearest water source, and other spatiotemporal factors (Brickle, 1998; 2002; Li *et al*., 2009; Lu and Zheng, 2002; Sukumal, 2010; Yasuhiro and Noritomo, 2003). Understanding in factors that significantly influence occupancy or abundance such as food availability and abundant which reasonably widely known to effect animal distribution and abundance, is the most useful tool for wildlife management and it is

crucial important for the species conservation program, especially on endangered species (Morris, 2003) like green peafowl.

5.2.2 Fecal analysis

Food habit of Galliforms, including other birds, is mostly studied by examining bird crop content, bird stomach and gizzard, which is relatively simpler than bird fecal analysis. Moreover, remains in bird feces are usually more difficult to indentify than remains in bird crop. However, such an endangered species, examining crop content is not applicable for green peafowl. Fecal analysis technique was hence applied for this study.

It is generally accepted that food habits studied from analysis of animal dropping tends to overestimate proportion of items that poorly digestible, e.g., bone, and, on the other hand, underestimate the easily digested items, e.g., burry fruit (Zielinski, 1986; Arim and Naya, 2003; Williams, 1976; Ottino and Giller, 2004). Another limitation of the method is known as very time-consumed technique (Agnelli and Mainis, 1992) and in this study, it roughly took 25hrs per one sample in laboratory (weight of each sample is averagely 6.23 g). This relatively less than time required for scat of owl pellet and fox analysis, 39 and 73 hrs for first and later studies (Agnelli and Marinis, 1992). However, this limitation for each study too depends on detail of interest and hence number of food types or species found in samples and it consequently highly constraint on number of sample that we can carry.

Like other birds, peafowl also swallow some grits in order to improve their digestion system. Some of those grits are defecated and contained within bird

droppings. I found that approximately 20% of peafowl dropping consisted of many grits, suggested that green peafowl also ingested non-food item e.g. grits between foraging which confirmed by the previous study (Rodjanadilg, 1985). However, this proportion was far smaller than what reported in red jungle fowl which much greater as above 80% of red jungle fowl (Wanghongsa and Hayashi, 2008).

The green peafowl, from the results, can be classified as an omnivorous bird concordantly to the general previous study (Arrathrakorn, 2001; DumKeaw *et al*., 2009; Meckvicha *et al*., 2004; 2008; Ponsena, 1988; Rodjanadilog *et al*., 1985) but degrees of gramnivory and frugivory were remarkably higher degree of insectivory. This ever be true when insect matters are generally not digestible and there proportion in the diet are, presumably, over represented e.g., beetles in order Coleoptera (Freeman, 1981).

Invertebrates in order Arachnida (spiders) was predominant order in green peafowl dropping and then followed by order Hymenoptera (mostly ants) and Isoptera (termites). This result, at least, partially explained by their poor in flight ability, most of them are flightless. In addition, especially for ants and termites, they are social insects who living in colony which generally occur in high abundance, clump in distribution and they do not seem to fluctuated between seasons (Arshad *et al*., 2000; Hill, 1985; Toda and Kitching, 1999; Wanghongsa and Hayashi, 2008;). The green peafowl may advantage from those traits might allow fed on them relatively easier than other invertebrates (Collins, 1989, Toda and Kitching, 1999). Moreover two dominant invertebrates that we found, Hymenoptera and Isoptera, are similary to two study on the diet of Red junglefowl (*Gallus gallus*) with exceptional, the most common group

was not Arachnida (Arshad *et al*., 2000; Wanghongsa and Hayashi, 2008). They, instead, reported another insect order, Coleoptera (beetles) was a main food source for red jungle fowl.

It was so far that no any of 40 samples contained part of vertebrates. They are agile and very well developed to such predators, for instance vigilance behavior and camouflage coloration, then rarely hunted by green peafowl. Cost for foraging on such highly-dispersed fast-moving preys presumably much higher than foraging on fruit, seed, or even easy preys which far higher abundant on floors and then reasonably caused vertebrate absence in our samples.

Food is the source of nutrients and energy. The animal body is the field of numerous mechanical activities which are sustained by the energy derived from the food. The nutrient in food support growth and maintenance of body structure (Bolen and Robinsen, 1989). The Insect are source of protein (Arshad *et al*., 2000; Collias and Saichuae, 1967) and plant food contained calcium level that essentially for egg production (Arshad *et al*., 2000). However, most of plant matter was unidentified species. From this result, I only recognized witch part they ingested was predominant in grasses seed, freshly leaves, shoot, herbaceous stem and thorn. The results hence suggested that green peafowl can feed on any plant part that has soft tissue.

Lastly, here I present and discuss on diet of peafowl based on bird dropping study from two different habitat types but only in one wet season. No attempt is made to discuss in detail out of this area as some parts of them may vary across years and, of course, sites. For any future study, the comparisons across sites in other period of time need to be done carefully.

5.2.3 Dusting habitat

Green peafowls spend their time in the morning for sun bathing and self preening and, for peacock, might associated with territorial calling which similarly described in previous studies (Arrathrakorn, 2001; Mackvichai, 2008; Ponsena, 1988; Walther 2003). Green peafowls spread their primary and train out during expose to sun shine, presumably, to dry up those feathers after got some moisture from roosting site.

Dusting is known to improve feather barb alignment and reduced dandruff, helps to control ecto-parasites and promotes cleanliness (Healy and Thomas, 1973; Mackvichai, 2008; Petrie and Williams, 1993; Ponsena, 1988; Rodlanadilog *et al.*, 1985; Takahashi and Hasegawa, 2008). All soil samples were sandy loam (medium-texture soils) including of sand silt and clay particles in similar proportion. Chumnansid (1985) reported that this soil type can be found in Dry- and mixed- dipterocarp forest and mostly found in my study area. One interesting point is those soils were sampled in the area where wildlife commonly occurs, hence, reasonably contain low moisture and this might provide good advantage for peafowl dusting since Healy and Thomas (1973) suggested that dust particles can absorb oil and moisture during bird shaking through their feathers.

The obvious characteristic of peafowl dusting site was high percentage of canopy cover and low level of light intensity, suggested that the micro-climate in daytime effects peafowl activity. This seem to be true as peafowl often move to shade area near water source during hottest period of the day and move back once temperature goes down (Meckvichai, 2008; Rodjanadilog, 1985; Ponsena 1988).

5.2.4 Breeding Habitat

From the results confirmed previous study that the green peafowl, are lek-breeding bird (Arrathrakorn, 2001; Dumkeaw *et al.*, 2009; Meckvicha *et al.*, 2004; 2008; Petrie and Williams, 1993; Ponsena, 1988; Rodlanadilog *et al.*, 1985; Takahashi and Hasegawa, 2008).

In this study confirmed the purpose by Rands *et al.*, (1984) that the site position was potentially affect the mating success of peacocks. the spacious habitats were usefully green peafowl, due to, in breeding season, peafowl were changing ecto-characteristics especially male, the train of male starts to elongate, and mostly activities e.g. courtship display, lekking, or breeding in this season are reasonable in open area (Arratharakorn, 2001; Petrie *et al.,* 1991; Petrie and Williams, 1993; Ponsena, 1988; Rodlanadilog *et al.*, 1985; Takahashi and Hasegawa, 2008).

Green peafowl performed courtship at location where almost none or less of ground and canopy cover, suggested that the light intensity effected to habitat selection such as courtship displays which might be to the position of the sun. Dakin and Montgomerie (2009) supported that the males were on average directed at about 45° to the right of the sun azimuth with the female positioned directly. But different in the studied of Loyau *et al.* (2006) reported that food resource influenced display site selection.

5.2.5 Nesting habitat

Peafowl nest was difficult to find in nature (Ponsena, 1988). Nest-site selection for one bird is always similar, but the characteristics of the nest often vary to habitats (Nan *et al.,* 2006). In this study found peahen nested in Dry-dipterocarp forest whereas Ponsena (1988) found two nests in mixed deciduous forest around Krueng Krai and Khao Ban Dai Forest Guard Station

Nest success and survival rate of birds depends on environment of nests such as predator, weather, and the position of the nest (Nan *et al.,* 2006; Traylor *et al.,* 2004). Therefore, nest site selection by females is influenced by those reasons for nest success. The nesting season of green peafowl commonly start from post-breeding season or dry season, unfortunately, similar period that wildfire becomes more common, especially between March to April.

The nest site used by peahens, from this study, was associated to taller vegetation cover with a higher density of understory and grasses similar to other peafowl and peasants such as Indian Peafowl (Subramanian and John, 2001), White-eared Pheasant (Nan *et al.,* 2006) and Siamese Fireback (Sukumal, 2010).

5.2.6 Roosting trees

The result confirmed the previous study that the green peafowl has never been found to roost on dead tree same the (Ponsena, 1988) and the peacock commonly roosts alone (Ponsena, 1988; Subramanian and John, 2001)

Roosting trees observed here were medium-sized species and the lowest fresh branch was not very high, Lui *et al.* (2009) confirmed that the average height of the trees in Shuangbai Konglonghe Nature Reserve, China was 7 – 13m, different from the result of Ponsena (1988) who reported that green peafowl preferred taller and larger than the nearby stand. Form the result could be attributed that the select of roosting tree by green peafowl more likely depends on visibility from that point, possibly related to vigilance behavior.

The green peafowl selected roosting tree with medium canopy closure may be important to green peafowl for several reasons. Dense canopy structure may also provide good cover from predators (Arsirapoj, 2008; Ponsena, 1988) but dense canopy also limit peafowl visibility and chance to detect predator. Subramanian and John, 2001 reported that in tree with dense foliage, the Indian peafowl preferred roost on highest branch as well as Yasmin (1995) in India. Three roosting trees selected by green peafowls also filled up by fewer branches and leaves underneath the canopy which probably provide better visibility for green peafowl to able to detect predators during roost selection (Arshad and Zakaria, 2009; Arsirapoj, 2008; Subramanian and John, 2001).

Table 5.1 Particularly of 16 foraging sites; used and random locations and abundance of green peafowl in dry season.

Plot	Understory Density	Tree Density	% Understory Structure	% Ground Cover	Soil Fauna	Macro Inver.	Precipitation	Humidity	Temperature	Etc
Use_D1	1.14	0.19	42.19	22.89	961.10	69.00	33.00	63.65	27.98	ST
Use_D2	0.69	0.17	27.81	19.67	1302.77	104.50	33.00	68.95	28.60	TS1
Use_D3	1.35	0.15	39.69	25.33	944.40	166.00	0.00	42.56	23.66	TS2
Use_D4	0.78	0.16	25.31	28.00	213.88	43.50	0.00	42.56	23.66	TS3
Use_D5	1.36	0.12	15.94	32.89	399.22	89.23	42.00	63.70	27.98	HKKR1
Use_D6	1.14	0.12	22.19	33.67	547.20	70.75	33.00	69.00	28.60	HKKR2
Use_D7	0.85	0.13	21.88	35.22	2019.40	250.00	0.00	74.20	27.39	BS1
Use_D8	1.22	0.14	19.69	38.67	1591.66	153.50	0.00	76.55	21.84	BS2
Use_D9	2.93	0.19	56.56	35.22	375.00	8.00	0.00	76.55	21.84	ST
Non-Use_D1	2.77	0.16	69.06	11.00	222.22	15.75	0.00	76.55	21.84	TS1
Non-Use_D2	3.26	0.27	61.88	10.56	397.22	48.50	0.00	76.55	21.84	TS2
Non-Use_D3	2.66	0.20	43.13	8.89	348.44	31.50	0.00	76.55	21.84	TS3
Non-Use_D4	2.73	0.15	43.75	10.00	300.00	26.00	0.00	76.55	21.84	HKKR1
Non-Use_D5	1.99	0.14	41.25	25.22	113.89	74.64	0.00	81.58	27.39	HKKR2
Non-Use_D6	2.39	0.14	48.44	33.78	145.78	68.00	0.00	76.55	21.84	BS1
Non-Use_D7	2.48	0.14	52.81	15.33	113.78	38.50	0.00	81.58	27.39	BS2

Table 5.2 Particularly of 16 foraging sites; used and random locations and abundance of green peafowl in wet season.

Plot	Understory Density	Tree Density	% Understory Structure	% Ground Cover	Soil Funna	Macro Inver.	Precipitation	Humidity	Temperature	Etc
Use_W1	3.33	0.19	57.81	28.44	1200.00	87.72	75.00	76.60	26.99	ST
Use_W2	2.46	0.17	43.44	19.67	1458.00	172.75	75.00	76.60	26.99	TS1
Use_W3	2.05	0.15	42.19	24.11	883.33	134.50	146.00	77.35	27.32	TS2
Use_W4	1.56	0.16	45.94	29.89	305.55	86.75	146.00	77.35	27.32	TS3
Use_W5	2.73	0.12	24.69	40.78	2666.66	329.75	64.00	78.71	27.27	HKKR1
Use_W6	1.60	0.12	31.88	40.33	1616.60	86.75	64.00	78.71	27.27	HKKR2
Use_W7	2.31	0.13	45.63	30.44	1644.00	104.00	500.00	81.89	23.66	BS1
Use_W8	2.32	0.14	32.19	36.67	1669.00	189.00	500.00	81.89	23.66	BS2
Non-Use_W1	4.34	0.19	66.56	41.89	650.00	12.75	0.00	81.60	27.39	ST
Non-Use_W2	3.61	0.16	67.81	10.67	286.11	10.50	0.00	81.60	27.39	TS1
Non-Use_W3	3.43	0.28	71.88	6.78	307.50	53.00	0.00	76.60	21.84	TS2
Non-Use_W4	3.43	0.21	58.13	5.67	656.00	8.75	0.00	76.60	21.84	TS3
Non-Use_W5	2.73	0.16	56.25	10.00	363.88	18.50	0.00	68.27	22.87	HKKR1
Non-Use_W6	4.32	0.14	50.31	30.67	208.33	59.25	0.00	68.27	22.87	HKKR2
Non-Use_W7	2.76	0.14	56.88	34.00	184.89	105.50	33.00	28.60	68.95	BS1
Non-Use_W8	4.04	0.14	48.75	34.33	184.89	100.50	0.00	68.30	31.11	BS2

5.3 Conclusions

In this study, peafowl relative abundance along six transects in three areas that differently managed which are wildlife sanctuary, buffer zone, and community forest, were examined. The peafowl sampling was conducted in order to compare peafowl abundance among areas and re-survey one potential re-colonizing population. The results suggested that green peafowl abundance was varied across transects and areas that differently managed. Wildlife sanctuary, strictly protected area, apparently held highest peafowl abundance and community forest where human activity was significantly higher than other habitats held lowest peafowl abundance. I hence concluded that peafowl abundance in the study area was strongly influenced by human activities and this should be principally concerned for the species conservation. The conclusion of the study was supported by observation on one re-colonizing population that keeps slowly increasing in their abundance after villages were translocated out from the area, based on couple studies in different periods. Numerous factors were measured, including both physical and biological factors, in association to used and random locations aiming to explain green peafowl habitat utilization pattern. The study revealed that peafowl foraging sites were positively associated to undergrowth, like in nesting site, but in dusting site and some roosting site they used the area with less in undergrowth or understory. Habitat use, at least for foraging, was changed according to breeding stages similarly to other galliforms. The fecal analysis suggested that fruit and seed were common in peafowl droppings which associated to results on use of foraging sites. I here concluded that, supplementing to human activity control, diversity in peafowl habitats must be preserved.

CHAPTER VI

RECOMMENDATION

Green peafowl*, Pavo muticus,* has a large historical range. They once commonly widely spread across regions. Not many decades ago, hunting and poaching came along with massive habitat lost or degradation and were expected to be the most serious threats to green peafowl. At beginning of this century, as consequence of high demands in worldwide plumage trade, green peafowl were killed for their train feathers which later sold to trophy collectors or sold as decorative materials. Their population, therefore, undergone globally declined and only sizeable remaining populations are found in dry forests where water accessibility and human disturbance strongly influence green peafowl abundance and distribution. There is a hypothesis on the species habitat preference such as in open deciduous forest where believed to allow peafowl reproduce in larger clutch size, coincide with mass fruiting season. Regarding to results from this study, recommendations were made as follow;

6.1 Extensive and intensive surveys

Presence of green peafowl in many of established as well as proposed protected forests i.e., nature reserves, wildlife sanctuaries, and national parks, are largely unconfirmed. With no doubt, many new areas were included into the species distribution range such as in extensive teak (*Tectona grandis*) plantations in Central and East Java, these areas should be surveyed intensively. As well as smaller reserves, 17-45 ha in size, which located in peafowl range, should be studied (Balen *et*

al., 1995). Moreover, intensive research on habitat requirements and interactions with people are still required to improve management specific to each circumstance.

6.2 Reintroductions

Peafowl chicks are regularly confiscated by the Department of Nature Conservation at local bird markets. The zoological gardens where confiscated birds are normally released are currently saturated. Releasing is only rarely conducted into wild peafowl habitat, e.g. 11 birds in Mae Wong in 2009. However, with no carefully following standard protocol, this activity may harm to wild population health i.e., introduce exotic diseases. An alternative procedure could ideally be reintroduction in an area where the species recently, locally, gone extinction by over exploitation where as the habitat left in good condition. Green peafowls in Huai Tab Saloa and Huai Song Tang water basin, for instance, able to re-establish in the area as partially due to suitable habitat condition.

6.3 Public awareness

The installation by the Thailand Government of new, much improved environmental laws in 1990 could without doubt ameliorate the present situation, if properly enforced. However, green peafowl is mainly distributed over regions that lowest per capita incomes, together with relatively high prices of peafowl feathers and live specimens, this can cause to difficulty in public awareness program. Law enforcement, education and economic concept should be accompany for extensive programs for each specific area i.e., ecotourism cold be properly promoted in an area

that has good potential, in order to assist local people to earn some benefit from the species and other wildlife conservation.

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APPENDIX I

List of protected areas that the green peafowl inhabit

Appendix I List of protected areas: Showing site and locations of protected area in Thailand which green peafowl population present.

No.	Name of Protected Area	Area (ha)	Location (province)
1	Huai Kha Khaeng Wildlife Sanctuary	257,464	Uthai Thani, Tak
2	Thung Yai Naresuan Wildlife Sanctuary	320,000	Kanchanaburi, Tak
3	Salawin Wildlife Sanctuary	87,500	Mae Hong Son
4	Phu Khieo Wildlife Sanctuary	156,000	Chaiyaphum
5	Yod Dome Wildlife Sanctuary	24,512	Ubon Ratchathani
6	Bung Kroeng Krawia Non-hunting area	51,200	Kanchanaburi
7	Phu Kao-Phu Phan Kham National Park	32,200	Nongbua lumpu, Udon Thani, and Khon Kaen
8	Phu Phan National Park	66,470.24	Sakon Nakhon, Kalasin
9	Khao Sok National Park	73,874	Surat Thani
10	Mae Yom National Park	45,475	Lumpang, Phrae
11	Doi Phu Nang National Park	86,100	Phayao
12	Khuean Srinagarindra National Park	153,200	Kanchanaburi
13	Srinan National Park	93,400	Nan
14	Mae charim National Park	43,200	Nan

APPENDIX II

Green peafowl food plants in Huai Kha Khaeng Widlife Sanctuary

Appendix II Green peafowl food plants: refer to Ponsena (1988) and in the table showing Thai name,life form and species name of 66 food plants in Huai Kha Khaeng Widlife Sanctuary

No.	Thai name	Scientific name	Life form
1	หญ้าพริกพราน	*Apluda mutica* linn.	G
2	อ้อ	*Arundo donax* Linn.	G
3	หญ้าแขมโคก	*Bothriochloa glabra* Stapf	G
4	หญ้าเจ้าชู้	*Chrysopogon aciculatus* Trin.	G
5	หญ้าข้าวป่า	*Ceolorachis glandulosa* Stapf	G
6	หญ้าขน	*C. striata* A. Camus	G
7	หญ้าแพรก	*Cynodon dactylon* Pers.	G
8	หญ้างา็ด	*Cyrtococcum accrescens* Stapf	G
9	หญ้าปากควาย	*Dactyloctenium aegyptium* Willd.	G
10	หญ้าตีนกา	*Eleusine indica* Gaertn.	G
11	หญ้าหวาย	*Eragrostis diplachnoides* Steud.	G
12	หญ้าหนวดพระฤาษี	*Heteropogon contortus* Beauv. ex Roem. et Schult.	G
13	หญ้าคา	*Imperata cylindrical* Beauv.	G
14	หญ้าปล้องอ้อ	*Panicum auritum* Presl & Nees	G
15	หญ้าหางหมาจิ้งจอก	*Setaria geniculata* Beauv.	G
16	หญ้าพง	*Sorghum halepense* Pers.	G
17	หญ้าหางหมา	*S. nitidum* Pers.	G
18	หญ้าพุ่งชู้	*Themeda australis* Stapf	G
19	ไผ่ป่า	*Banbusa arundinacea* Willd.	B
20	ซาง	*Dendrocalamus strictus* Nees.	B
21	ไผ่รวก	*Thyrsostachys siamensis* Gamble	B
22	สาบแร้งสาบกา	*Ageratum conyzoides* Linn.	H

23	ผักเป็ดไทย	*Altennanthera sessilis* DC.	H
24	ผักขมหัด	*Amaranthus gracilis* Desf.	H
25	ผักขมหนาม	*A. spinosus* Linn.	H
26	ผักขมสวน	*A. tricolor* Linn.	H
27	กระต่ายจามขน	*Bergia ammanioides* Roxb.	H
28	ผักขมหิน	*Boerhovia diffusa* Linn.	H
29	ผักปลาบ	*Commelina diffusa* Burn f.	H
30	กระเจานา	*Corchorus aestuans* Linn.	H
31	หญ้ารังกา	*Cyperus cyperoides* Ktze.	H
32	กกขี้หมา	*C. polystachos* Roxb.	H
33	กกเล็ก	*C. pulcherrimus* Willd. ex Kunth	H
34	หญ้าแห้วหมู	*C. rotundus* Linn.	H
35	กะเม็ง	*Eclipta prostrate* Linn.	H
36	สาบเสือ	*Eupatorim odoratum* Linn.	H
37	น้ำนมราชสีห์	*Euphorbia hirta* Linn.	H
38	หญ้างวงช้าง	*Heliotropium indicum* R. Br.	H
39	หญ้าปลวกดิน	*Isodon striatus* Kudo	H
40	หญ้านกเค้า	*Leucas aspera* Link.	H
41	ลูกใต้ใบ	*Phyllantus amarus* Schum. & Thonn.	H
42	ผักเบี้ยใหญ่	*Portulaca oleracea* Linn.	H
43	หญ้าคมบางเล็ก	*Scleria lithosperma* Sw.	H
44	หญ้าคมบาง	*S. psilorrhiza* Clarke	H
45	หญ้าคมบาง	*S. scrobiculata* Nees. & Mey. ex Nees.	H
46	ผักคราด	*Spilanthes acmella* Murr.	H
47	ตีนตุ๊กแก	*Tridax procumbens* Linn.	H
48	ส้มลม	*Aganonerion polymorphum* Pierre ex Spire	C
49	ขี้ไก่ยาน	*Mikania cordata* Rob.	C
50	หญ้าตดหมา	*Paederia pilifera* Hook. F.	C
51	บวบงู	*Trichosanthes angunia* Linn.	HC

52	เถาขี้กาขาว	*T. cordata* Linn.	HC
53	บวบขม	*T. cucummrira* Linn.	HC
54	หญ้ายายเภา	*Lygodium flexuosum* Sw.	F
55	ผักแว่น	*Masilia crenata* Presl	F
56	หว้า	*Eugeni cumini* Druce	T
57	มะเดื่อปล้อง	*Ficus hispida* Linn.	T
58	มะเดื่ออุทุมพร	*F. racemosa* Linn.	T
59	ตะคร้อ	*Schleichera oleosa* Merr.	T
60	มะกอก	*Spondias pinnata* Kurzt	T
61	แข้งกวางดง	*Wendlandia particulate* A. DC.	ST
62	ถั่วลิสงนา	*Alysicarpus vaginalis* DC.	S
63	ผักกูด	*Asystasiella neesiana* Lindau	S
64	ตองแตก	*Baliospurmum montanum* Muel. Arg.	S
65	มะเดื่อขี้นก	*Ficus chartacea* Wall.	S
66	เส้งเล็ก	*Melochia corchorifolia* Linn.	HUS
67		*Unknown*	
68		*Unknown*	
69		*Unknown*	

G = Grass F = Fern

B = Bamboo T = Tree

H = Herb ST = Shrubby tree

C = Climber S = Shrub

HC = Herbaceous climber HUS = Herbaceous undershrub

APPENDIX III

Disturbance of green peafowl in Huai Kha Khaeng Wildlife Breeding Station Road

Disturbance of green peafowl

in Huai Kha Khaeng Wildlife Breeding Station Road

Location: Thung Phak Check point

Collectors: Chaloemwut Sriyaphume; Korn Pintha; Nitas Lila; Bunlard Chansing

categories	time	month											
		1	2	3	4	5	6	7	8	9	10	11	12
Truck	05.00-09.00	0	0	27	0	0	0	0	6	5	1	0	0
	09.01-12.00	0	0	17	0	0	0	0	10	1	3	0	0
	12.00-15.00	0	0	13	5	0	0	0	5	0	0	0	0
	15.01-18.00	0	0	4	0	0	0	0	2	1	3	0	0
	18.00-21.00	0	0	3	0	0	0	0	1	0	1	0	0
Car	05.00-09.00	0	0	36	41	0	0	0	52	61	73	0	0
	09.01-12.00	0	0	68	44	0	0	0	75	54	127	0	0
	12.00-15.00	0	0	59	49	0	0	0	73	58	90	0	0
	15.01-18.00	0	0	45	24	0	0	0	68	55	20	0	0
	18.00-21.00	0	0	12	3	0	0	0	29	14	2	0	0
Motorcycle	05.00-09.00	0	0	285	145	0	0	0	599	1035	1601	0	5
	09.01-12.00	0	0	116	29	0	0	0	203	599	1355	20	2
	12.00-15.00	0	0	122	21	0	0	0	152	452	327	0	2
	15.01-18.00	0	0	84	45	0	0	0	348	326	408	0	5
	18.00-21.00	0	0	7	8	0	0	0	73	344	535	0	0
Bicycle	05.00-09.00	0	0	2	0	0	0	0	1	0	0	0	0
	09.01-12.00	0	0	0	6	0	0	0	0	3	0	0	0
	12.00-15.00	0	0	3	1	0	0	0	0	0	0	0	0
	15.01-18.00	0	0	0	1	0	0	0	0	0	0	0	0
	18.00-21.00	0	0	0	0	0	0	0	0	0	0	0	0
Others	05.00-09.00	0	0	59	8	0	0	0	107	269	72	0	0
Rod e-Tak	09.01-12.00	0	0	52	2	0	0	0	82	153	39	0	0
	12.00-15.00	0	0	43	2	0	0	0	71	119	36	0	0
	15.01-18.00	0	0	49	3	0	0	0	118	121	34	0	0
	18.00-21.00	0	0	3	0	0	0	0	16	53	16	0	0

Disturbance of green peafowl

in Huai Kha Khaeng Wildlife Breeding Station Road

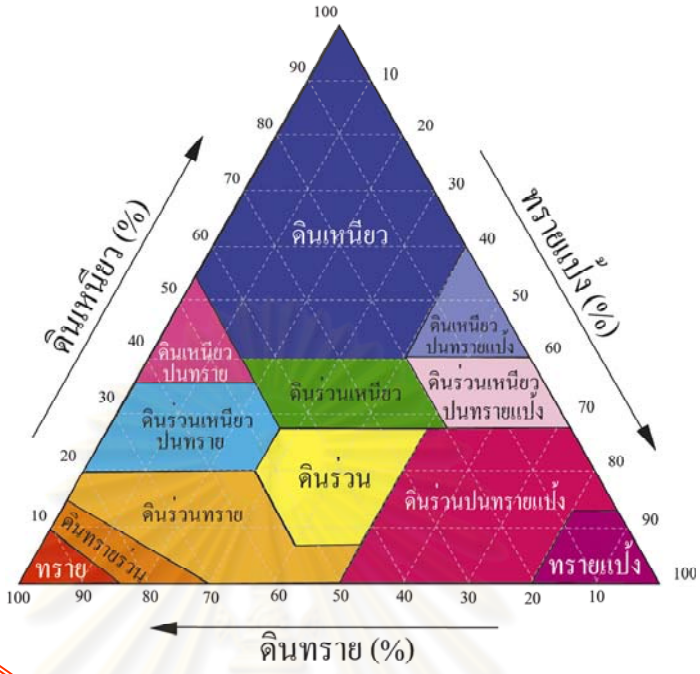
Location: Thung Phak Check point

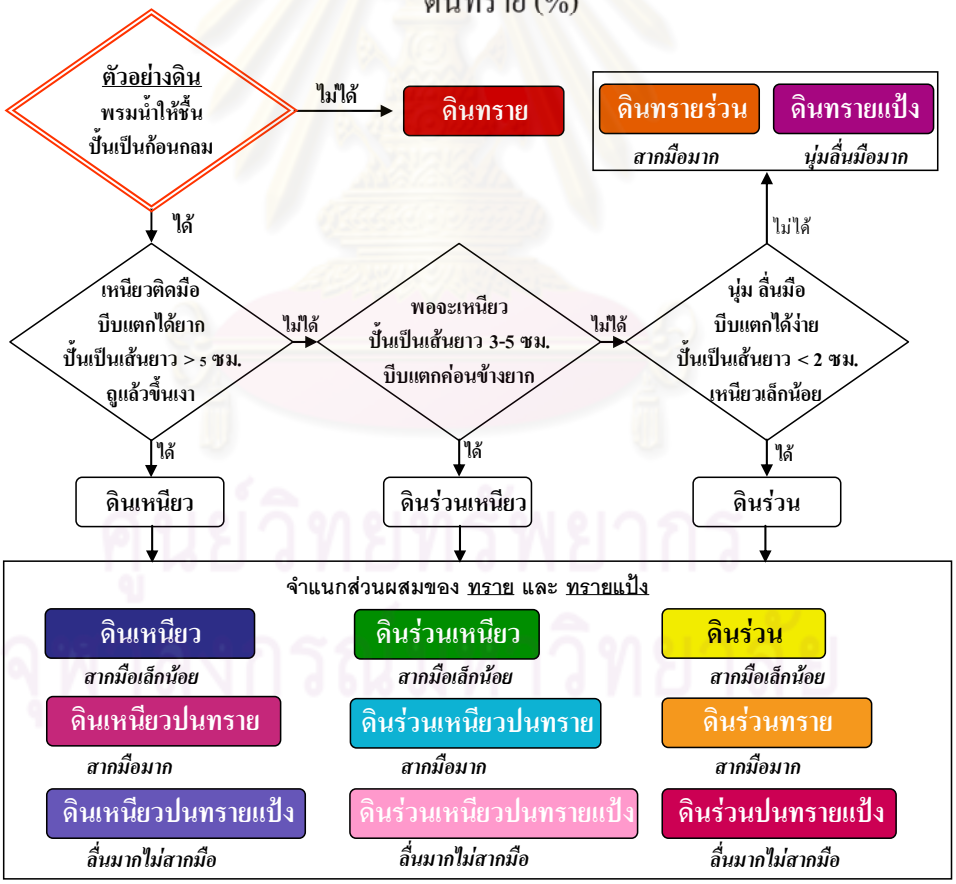
Collectors: Chaloemwut Sriyaphume; Korn Pintha; Nitas Lila; Bunlard Chansing

categories	time	month											
		1	2	3	4	5	6	7	8	9	10	11	12
Truck	05.00-09.00	0	0	11	9	0	0	0	37	7	6	14	5
	09.01-12.00	0	0	43	16	0	0	0	44	24	16	34	18
	12.00-15.00	0	0	21	11	0	0	0	23	12	13	10	8
	15.01-18.00	0	0	11	2	0	0	0	20	11	8	4	1
	18.00-21.00	0	0	2	0	0	0	0	1	2	2	2	5
Car	05.00-09.00	0	0	169	108	0	0	0	240	158	87	108	192
	09.01-12.00	0	0	299	239	0	0	0	424	109	156	149	322
	12.00-15.00	0	0	268	231	0	0	0	359	130	159	123	210
	15.01-18.00	0	0	172	184	0	0	0	242	128	165	143	223
	18.00-21.00	0	0	30	27	0	0	0	121	42	35	76	58
Motorcycle	05.00-09.00	0	0	214	252	0	0	0	257	6	165	156	207
	09.01-12.00	0	0	73	45	0	0	0	60	60	105	73	70
	12.00-15.00	0	0	53	45	0	0	0	40	37	81	82	60
	15.01-18.00	0	0	159	101	0	0	0	149	115	125	82	84
	18.00-21.00	0	0	20	4	0	0	0	7	3	5	27	9
Bicycle	05.00-09.00	0	0	0	0	0	0	0	0	0	0	0	0
	09.01-12.00	0	0	0	0	0	0	0	0	0	0	1	0
	12.00-15.00	0	0	0	0	0	0	0	0	0	0	0	0
	15.01-18.00	0	0	0	0	0	0	0	0	0	0	0	0
	18.00-21.00	0	0	0	0	0	0	0	0	0	0	0	0
Others	05.00-09.00	0	0	0	0	0	0	0	11	2	0	0	0
Rod e-Tak	09.01-12.00	0	0	0	8	0	0	0	2	0	0	0	0
	12.00-15.00	0	0	1	0	0	0	0	0	0	0	0	0
	15.01-18.00	0	0	0	0	0	0	0	2	1	0	0	0
	18.00-21.00	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX IV

Soil Analysis Key





APPENDIX V

Meteorology in Huai Tab Saloa-Huai Song Tang Water basin (January-December 2008)

Meteorology in Huai Tab Sloa-Huai Song Tang Water basin (January-December 2008)

January								February							
day	rain	temp			Humidity			day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG			mor	aft	AVG	mor	aft	AVG
1	0.0	16.5	29.0	22.8	82.0	56.0	69.0	1	0.0	21.0	33.5	27.3	100.0	57.0	78.5
2	0.0	11.5	29.5	20.5	100.0	42.0	71.0	2	0.0	21.0	33.0	27.0	96.0	69.0	82.5
3	0.0	10.0	25.5	17.8	83.0	50.0	66.5	3	0.0	22.0	33.0	27.5	100.0	62.0	81.0
4	0.0	11.0	26.0	18.5	94.0	58.0	76.0	4	0.0	21.0	29.0	25.0	96.0	77.0	86.5
5	0.0	10.0	27.0	18.5	100.0	46.0	73.0	5	0.0	21.5	24.0	22.8	96.0	51.0	73.5
6	0.0	11.0	30.0	20.5	95.0	52.0	73.5	6	0.0	19.0	30.0	24.5	100.0	51.0	75.5
7	0.0	11.0	28.0	19.5	100.0	44.0	72.0	7	0.0	20.0	33.0	26.5	91.0	57.0	74.0
8	0.0	11.0	29.0	20.0	100.0	44.0	72.0	8	0.0	19.0	34.0	26.5	78.0	46.0	62.0
9	0.0	13.0	30.0	21.5	95.0	22.0	58.5	9	0.0	19.0	34.0	26.5	100.0	41.0	70.5
10	0.0	20.0	32.5	26.3	83.0	40.0	61.5	10	0.0	21.0	33.0	27.0	100.0	57.0	78.5
11	0.0	19.0	33.0	26.0	71.0	40.0	55.5	11	0.0	19.5	32.5	26.0	95.0	46.0	70.5
12	0.0	19.0	34.0	26.5	74.0	45.0	59.5	12	0.0	18.5	34.0	26.3	74.0	57.0	65.5
13	0.0	16.5	33.5	25.0	82.0	53.0	67.5	13	0.0	21.0	33.5	27.3	91.0	46.0	68.5
14	0.0	17.0	33.5	25.3	81.0	68.0	74.5	14	0.0	20.0	30.0	25.0	96.0	55.0	75.5
15	0.0	17.5	33.0	25.3	86.0	67.0	76.5	15	0.0	20.5	31.0	25.8	87.0	50.0	68.5
16	0.0	16.5	31.5	24.0	86.0	44.0	65.0	16	0.0	18.5	19.0	18.8	87.0	46.0	66.5
17	0.0	15.0	30.0	22.5	85.0	52.0	68.5	17	0.0	20.0	31.0	25.5	95.0	50.0	72.5
18	0.0	16.5	30.5	23.5	81.0	39.0	60.0	18	0.0	20.0	32.5	26.3	96.0	43.0	69.5
19	0.0	18.0	30.0	24.0	90.0	50.0	70.0	19	0.0	20.0	34.0	27.0	0.0	0.0	0.0
20	0.0	19.5	33.0	26.3	83.0	51.0	67.0	20	0.0	19.0	29.5	24.3	0.0	0.0	0.0
21	0.0	19.5	36.0	27.8	71.0	40.0	55.5	21	0.0	15.0	27.0	21.0	0.0	0.0	0.0
22	0.0	18.0	33.5	25.8	71.0	39.0	55.0	22	0.0	16.0	29.5	22.8	0.0	0.0	0.0
23	0.0	16.0	33.0	24.5	81.0	44.0	62.5	23	0.0	24.0	32.0	28.0	0.0	0.0	0.0
24	0.0	15.5	30.0	22.8	81.0	42.0	61.5	24	0.0	17.0	33.0	25.0	0.0	0.0	0.0
25	0.0	19.5	32.0	25.8	91.0	85.0	88.0	25	0.0	19.5	34.0	26.8	0.0	0.0	0.0
26	0.0	20.0	34.0	27.0	96.0	63.0	79.5	26	0.0	20.5	35.0	27.8	0.0	0.0	0.0
27	0.0	21.5	29.0	25.3	96.0	61.0	78.5	27	3.5	11.0	34.0	22.5	0.0	0.0	0.0
28	0.0	21.5	29.5	25.5	81.0	55.0	68.0	28	5.4	21.0	24.5	22.8	0.0	0.0	0.0
29	0.0	21.0	33.0	27.0	96.0	42.0	69.0	29	0.0	19.0	30.0	24.5	0.0	0.0	0.0
30	0.0	21.5	32.5	27.0	96.0	51.0	73.5	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	22.0	33.5	27.8	96.0	41.0	68.5	31	0.0	0.0	0.0	0.0	0.0	0.0	0.0

March							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	0.0	21.0	33.0	27.0	0.0	0.0	0.0
2	0.0	19.0	33.0	26.0	0.0	0.0	0.0
3	0.0	18.0	33.0	25.5	0.0	0.0	0.0
4	0.0	15.0	31.0	23.0	0.0	0.0	0.0
5	0.0	15.0	30.5	22.8	85.0	36.0	60.5
6	0.0	16.0	31.5	23.8	65.0	32.0	48.5
7	0.0	17.0	33.0	25.0	82.0	60.0	71.0
8	0.0	19.0	33.5	26.3	82.0	69.0	75.5
9	0.0	21.0	33.5	27.3	92.0	68.0	80.0
10	0.0	21.0	34.0	27.5	100.0	73.0	86.5
11	2.9	21.0	33.5	27.3	100.0	80.0	90.0
12	0.0	21.0	34.5	27.8	77.0	77.0	77.0
13	0.0	24.0	36.0	30.0	92.0	69.0	80.5
14	0.0	23.0	36.0	29.5	96.0	75.0	85.5
15	0.0	24.0	35.0	29.5	92.0	86.0	89.0
16	0.0	25.0	32.0	28.5	88.0	75.0	81.5
17	9.7	23.0	36.0	29.5	92.0	75.0	83.5
18	0.7	24.0	36.5	30.3	88.0	56.0	72.0
19	0.0	21.0	37.0	29.0	92.0	42.0	67.0
20	0.0	21.0	38.0	29.5	88.0	41.0	64.5
21	13.0	22.0	36.0	29.0	84.0	44.0	64.0
22	0.0	21.5	36.0	28.8	73.0	36.0	54.5
23	0.0	21.0	37.0	29.0	33.0	81.0	57.0
24	0.0	21.0	37.0	29.0	84.0	86.0	85.0
25	12.6	22.5	36.0	29.3	92.0	61.0	76.5
26	0.5	24.5	35.5	30.0	78.0	67.0	72.5
27	0.0	25.0	34.0	29.5	74.0	67.0	70.5
28	4.9	23.0	36.0	29.5	100.0	57.0	78.5
29	16.2	22.0	36.0	29.0	77.0	49.0	63.0
30	0.6	25.0	36.0	30.5	78.0	48.0	63.0
31	12.7	22.0	36.5	29.3	88.0	64.0	76.0

April							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	0.0	21.0	36.5	28.8	92.0	51.0	71.5
2	4.6	22.0	33.0	27.5	96.0	57.0	76.5
3	8.8	21.5	32.5	27.0	96.0	60.0	78.0
4	0.0	23.5	33.5	28.5	84.0	77.0	80.5
5	0.0	24.0	33.0	28.5	91.0	64.0	77.5
6	0.0	23.0	35.0	29.0	88.0	61.0	74.5
7	0.0	24.0	35.0	29.5	81.0	47.0	64.0
8	8.8	22.5	35.0	28.8	88.0	62.0	75.0
9	0.0	25.0	34.0	29.5	84.0	47.0	65.5
10	0.0	26.0	36.5	31.3	78.0	45.0	61.5
11	4.7	25.0	37.5	31.3	85.0	50.0	67.5
12	5.4	23.0	37.0	30.0	82.0	44.0	63.0
13	0.0	25.0	36.0	30.5	85.0	48.0	66.5
14	3.4	23.0	37.0	30.0	100.0	52.0	76.0
15	1.1	25.0	37.0	31.0	84.0	49.0	66.5
16	0.0	25.0	36.5	30.8	88.0	57.0	72.5
17	0.0	25.0	36.0	30.5	71.0	41.0	56.0
18	0.0	24.0	37.5	30.8	84.0	43.0	63.5
19	0.0	25.0	37.0	31.0	78.0	37.0	57.5
20	0.0	25.0	37.0	31.0	85.0	45.0	65.0
21	0.0	25.0	37.0	31.0	78.0	42.0	60.0
22	0.0	26.5	37.0	31.8	81.0	42.0	61.5
23	3.1	24.0	37.5	30.8	96.0	42.0	69.0
24	0.0	23.0	37.5	30.3	88.0	66.0	77.0
25	9.0	23.5	34.0	28.8	96.0	76.0	86.0
26	19.1	22.0	32.0	27.0	92.0	60.0	76.0
27	0.0	23.0	35.0	29.0	96.0	71.0	83.5
28	0.0	24.0	35.0	29.5	81.0	85.0	83.0
29	0.0	24.0	31.0	27.5	88.0	76.0	82.0
30	7.9	23.0	29.0	26.0	92.0	70.0	81.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0

May							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	11.8	23.0	30.0	26.5	96.0	78.0	87.0
2	14.5	23.5	29.0	26.3	77.0	60.0	68.5
3	9.0	24.0	33.0	28.5	92.0	78.0	85.0
4	8.4	23.0	32.0	27.5	92.0	62.0	77.0
5	0.0	24.0	33.0	28.5	84.0	58.0	71.0
6	0.0	25.0	33.5	29.3	81.0	44.0	62.5
7	0.0	25.0	33.5	29.3	81.0	67.0	74.0
8	0.0	26.0	34.0	30.0	74.0	51.0	62.5
9	0.0	27.0	34.0	30.5	100.0	48.0	74.0
10	27.2	24.0	35.0	29.5	71.0	62.0	66.5
11	49.0	23.0	36.0	29.5	71.0	96.0	83.5
12	81.0	23.0	36.0	29.5	71.0	89.0	80.0
13	57.5	23.0	36.0	29.5	96.0	92.0	94.0
14	38.6	23.0	25.5	24.3	92.0	92.0	92.0
15	28.0	21.5	25.0	23.3	92.0	73.0	82.5
16	23.1	28.0	30.5	29.3	92.0	74.0	83.0
17	0.0	23.0	32.0	27.5	92.0	73.0	82.5
18	7.4	21.0	32.0	26.5	84.0	79.0	81.5
19	0.3	23.0	32.0	27.5	65.0	64.0	64.5
20	0.0	22.5	32.0	27.3	92.0	73.0	82.5
21	23.5	23.0	30.0	26.5	92.0	70.0	81.0
22	0.0	23.5	31.5	27.5	84.0	62.0	73.0
23	26.9	22.0	33.5	27.8	92.0	68.0	80.0
24	12.0	22.0	33.5	27.8	81.0	62.0	71.5
25	8.1	24.0	32.0	28.0	88.0	63.0	75.5
26	1.9	24.0	33.0	28.5	88.0	76.0	82.0
27	0.0	25.0	31.0	28.0	78.0	62.0	70.0
28	0.0	25.0	34.0	29.5	71.0	67.0	69.0
29	3.2	23.5	33.0	28.3	88.0	72.0	80.0
30	0.0	25.0	31.0	28.0	92.0	84.0	88.0
31	6.2	24.0	28.0	26.0	81.0	86.0	83.5

June							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	0.0	23.0	33.0	28.0	88.0	56.0	72.0
2	0.6	23.0	33.5	28.3	88.0	70.0	79.0
3	23.0	23.0	33.5	28.3	96.0	92.0	94.0
4	1.6	22.5	27.0	24.8	96.0	96.0	96.0
5	2.5	22.0	30.0	26.0	96.0	6.0	51.0
6	0.0	22.0	33.0	27.5	88.0	67.0	77.5
7	2.4	22.5	33.0	27.8	92.0	77.0	84.5
8	11.6	23.0	33.0	28.0	92.0	68.0	80.0
9	0.0	22.5	32.5	27.5	92.0	73.0	82.5
10	3.5	24.0	33.0	28.5	88.0	67.0	77.5
11	61.5	24.0	33.5	28.8	88.0	57.0	72.5
12	3.5	23.5	34.0	28.8	88.0	68.0	78.0
13	1.5	23.5	33.0	28.3	88.0	67.0	77.5
14	1.2	23.5	33.0	28.3	96.0	78.0	87.0
15	0.0	22.5	31.0	26.8	96.0	79.0	87.5
16	0.5	23.0	31.0	27.0	96.0	72.0	84.0
17	1.6	23.0	30.0	26.5	96.0	73.0	84.5
18	7.2	23.5	32.0	27.8	92.0	78.0	85.0
19	0.0	23.5	30.0	26.8	96.0	72.0	84.0
20	12.0	24.0	30.0	27.0	92.0	73.0	82.5
21	8.9	24.0	30.0	27.0	92.0	74.0	83.0
22	3.3	22.0	33.0	27.5	92.0	86.0	89.0
23	0.0	23.0	32.5	27.8	96.0	65.0	80.5
24	0.0	25.5	33.0	29.3	81.0	62.0	71.5
25	6.2	25.0	33.5	29.3	81.0	55.0	68.0
26	0.0	25.0	34.0	29.5	78.0	67.0	72.5
27	0.0	25.0	33.0	29.0	81.0	65.0	73.0
28	0.0	27.0	33.0	30.0	74.0	62.0	68.0
29	0.0	24.5	34.0	29.3	85.0	71.0	78.0
30	0.0	23.5	32.5	28.0	88.0	71.0	79.5
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0

July							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	9.1	22.5	32.5	27.5	88.0	67.0	77.5
2	0.0	24.0	32.5	28.3	84.0	80.0	82.0
3	19.8	22.0	33.0	27.5	96.0	72.0	84.0
4	0.0	24.0	29.5	26.8	84.0	57.0	70.5
5	0.0	25.0	32.5	28.8	81.0	64.0	72.5
6	0.0	24.0	30.0	27.0	89.0	76.0	82.5
7	0.0	25.0	29.5	27.3	75.0	72.0	73.5
8	0.3	23.0	28.0	25.5	96.0	89.0	92.5
9	0.8	22.0	28.5	25.3	92.0	92.0	92.0
10	10.6	23.0	26.0	24.5	88.0	73.0	80.5
11	0.0	24.0	31.0	27.5	84.0	68.0	76.0
12	1.9	24.0	31.0	27.5	84.0	47.0	65.5
13	17.4	24.0	32.0	28.0	92.0	57.0	74.5
14	13.3	23.5	33.0	28.3	96.0	77.0	86.5
15	0.0	24.5	33.5	29.0	81.0	57.0	69.0
16	0.0	23.0	32.0	27.5	88.0	70.0	79.0
17	0.0	25.0	30.0	27.5	74.0	58.0	66.0
18	0.0	24.0	33.5	28.8	85.0	68.0	76.5
19	7.9	22.0	33.0	27.5	92.0	71.0	81.5
20	6.9	24.5	30.0	27.3	100.0	62.0	81.0
21	0.0	23.5	32.5	28.0	96.0	62.0	79.0
22	23.0	24.5	33.0	28.8	92.0	52.0	72.0
23	0.0	24.5	33.0	28.8	96.0	72.0	84.0
24	0.0	25.0	29.0	27.0	92.0	72.0	82.0
25	0.0	22.5	29.5	26.0	88.0	67.0	77.5
26	10.3	23.0	29.5	26.3	92.0	86.0	89.0
27	1.2	25.0	29.5	27.3	77.0	5.0	41.0
28	5.4	23.5	30.0	26.8	88.0	72.0	80.0
29	0.0	25.0	29.5	27.3	78.0	67.0	72.5
30	0.0	24.5	30.0	27.3	84.0	78.0	81.0
31	4.2	25.0	28.5	26.8	84.0	70.0	77.0

August							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	10.9	22.5	31.0	26.8	92.0	73.0	82.5
2	32.4	24.0	32.5	28.3	92.0	72.0	82.0
3	0.8	22.0	29.0	25.5	92.0	71.0	81.5
4	45.4	24.0	32.0	28.0	96.0	70.0	83.0
5	0.0	25.0	30.0	27.5	58.0	67.0	62.5
6	0.5	24.0	30.0	27.0	74.0	67.0	70.5
7	5.2	25.0	27.0	26.0	88.0	78.0	83.0
8	2.2	23.0	27.0	25.0	96.0	78.0	87.0
9	2.3	22.0	25.0	23.5	92.0	72.0	82.0
10	0.0	23.0	30.0	26.5	92.0	67.0	79.5
11	0.0	24.0	31.0	27.5	92.0	73.0	82.5
12	5.1	24.0	32.5	28.3	96.0	65.0	80.5
13	11.5	24.0	32.0	28.0	96.0	82.0	89.0
14	0.4	23.5	33.0	28.3	96.0	65.0	80.5
15	0.1	24.5	32.0	28.3	88.0	60.0	74.0
16	2.3	23.0	30.0	26.5	88.0	60.0	74.0
17	0.0	25.0	33.0	29.0	92.0	77.0	84.5
18	0.0	25.5	32.0	28.8	84.0	57.0	70.5
19	0.5	24.5	33.0	28.8	74.0	67.0	70.5
20	12.6	24.5	33.0	28.8	88.0	62.0	75.0
21	15.2	24.5	33.0	28.8	92.0	78.0	85.0
22	0.0	23.0	33.0	28.0	88.0	57.0	72.5
23	0.0	24.5	29.0	26.8	84.0	67.0	75.5
24	0.0	23.0	29.0	26.0	88.0	63.0	75.5
25	0.0	22.5	31.0	26.8	92.0	76.0	84.0
26	0.4	23.0	30.0	26.5	88.0	68.0	78.0
27	15.3	25.0	30.0	27.5	88.0	68.0	78.0
28	0.0	23.5	29.0	26.3	96.0	73.0	84.5
29	12.4	25.5	33.0	29.3	92.0	66.0	79.0
30	0.0	24.5	28.0	26.3	92.0	68.0	80.0
31	0.0	25.0	30.0	27.5	84.0	63.0	73.5

September							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	0.9	23.0	26.5	24.8	96.0	67.0	81.5
2	1.6	22.0	26.0	24.0	96.0	67.0	81.5
3	0.0	22.5	27.5	25.0	92.0	63.0	77.5
4	0.0	23.0	28.0	25.5	88.0	62.0	75.0
5	23.0	23.0	26.5	24.8	96.0	63.0	79.5
6	5.4	23.0	27.0	25.0	84.0	73.0	78.5
7	4.7	22.0	27.0	24.5	96.0	68.0	82.0
8	0.0	22.5	25.8	24.1	92.0	67.0	79.5
9	8.6	23.0	27.0	25.0	96.0	76.0	86.0
10	0.0	22.0	25.8	23.9	92.0	67.0	79.5
11	28.0	23.0	25.0	24.0	96.0	78.0	87.0
12	17.7	23.5	25.5	24.5	96.0	85.0	90.5
13	7.8	23.0	26.5	24.8	96.0	88.0	92.0
14	5.1	22.0	27.0	24.5	92.0	68.0	80.0
15	3.7	23.0	22.5	22.8	92.0	62.0	77.0
16	2.7	23.0	25.8	24.4	92.0	85.0	88.5
17	0.0	23.5	25.5	24.5	88.0	75.0	81.5
18	0.9	23.0	26.5	24.8	88.0	72.0	80.0
19	32.3	23.0	27.0	25.0	96.0	69.0	82.5
20	18.7	24.0	26.5	25.3	92.0	78.0	85.0
21	0.2	24.0	26.0	25.0	84.0	61.0	72.5
22	0.0	22.0	26.8	24.4	88.0	61.0	74.5
23	0.0	22.5	27.3	24.9	88.0	73.0	80.5
24	0.0	23.5	26.0	24.8	78.0	62.0	70.0
25	0.8	25.0	26.3	25.6	84.0	96.0	90.0
26	0.3	23.5	27.5	25.5	92.0	79.0	85.5
27	0.0	24.0	27.5	25.8	92.0	65.0	78.5
28	0.0	23.0	27.5	25.3	92.0	89.0	90.5
29	4.3	22.5	27.8	25.1	80.0	51.0	65.5
30	0.0	22.5	27.5	25.0	77.0	60.0	68.5
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0

October							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	15.5	23.0	26.0	24.5	92.0	2.0	47.0
2	7.1	23.5	26.0	24.8	96.0	82.0	89.0
3	5.6	22.0	27.0	24.5	96.0	67.0	81.5
4	10.4	23.5	27.3	25.4	96.0	86.0	91.0
5	0.0	23.0	27.8	25.4	92.0	92.0	92.0
6	73.3	22.5	27.0	24.8	96.0	98.0	97.0
7	9.5	22.0	27.8	24.9	92.0	76.0	84.0
8	0.4	22.0	26.5	24.3	96.0	71.0	83.5
9	34.8	23.0	27.0	25.0	92.0	96.0	94.0
10	0.0	23.0	27.0	25.0	88.0	68.0	78.0
11	12.1	23.0	27.0	25.0	96.0	63.0	79.5
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	17.8	22.5	27.3	24.9	96.0	63.0	79.5
14	1.4	22.5	27.3	24.9	96.0	73.0	84.5
15	0.0	23.5	27.3	25.4	92.0	62.0	77.0
16	0.0	23.0	27.5	25.3	96.0	78.0	87.0
17	7.1	22.0	22.0	22.0	96.0	67.0	81.5
18	4.1	23.0	27.3	25.1	96.0	89.0	92.5
19	12.2	23.0	24.8	23.9	96.0	73.0	84.5
20	0.0	22.0	26.5	24.3	96.0	73.0	84.5
21	40.6	21.5	26.0	23.8	96.0	73.0	84.5
22	8.4	23.0	26.5	24.8	92.0	73.0	82.5
23	0.0	23.0	26.5	24.8	88.0	54.0	71.0
24	31.5	22.5	26.3	24.4	96.0	72.0	84.0
25	17.6	22.5	25.3	23.9	96.0	96.0	96.0
26	84.7	22.0	26.0	24.0	96.0	79.0	87.5
27	39.9	22.5	23.3	22.9	92.0	71.0	81.5
28	0.0	22.5	26.8	24.6	92.0	85.0	88.5
29	1.5	23.0	24.8	23.9	96.0	96.0	96.0
30	16.1	22.5	25.8	24.1	96.0	78.0	87.0
31	57.6	22.5	24.5	23.5	96.0	89.0	92.5

November							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	15.1	23.5	29.5	26.5	80.0	82.0	81.0
2	34.1	21.5	30.0	25.8	66.0	79.0	72.5
3	0.0	21.5	31.0	26.3	96.0	67.0	81.5
4	0.0	21.0	29.0	25.0	92.0	78.0	85.0
5	4.4	23.5	27.0	25.3	96.0	96.0	96.0
6	13.0	22.5	30.0	26.3	96.0	96.0	96.0
7	67.0	21.5	31.0	26.3	96.0	67.0	81.5
8	0.0	22.0	31.0	26.5	96.0	79.0	87.5
9	42.0	22.0	28.0	25.0	96.0	92.0	94.0
10	6.3	20.0	29.0	24.5	96.0	85.0	90.5
11	0.0	24.0	26.0	25.0	91.0	64.0	77.5
12	0.0	15.0	26.0	20.5	95.0	64.0	79.5
13	0.0	14.5	26.5	20.5	95.0	92.0	93.5
14	0.0	16.0	27.0	21.5	95.0	64.0	79.5
15	0.0	17.5	29.0	23.3	81.0	72.0	76.5
16	0.0	20.0	28.0	24.0	87.0	76.0	81.5
17	0.0	21.5	29.0	25.3	91.0	78.0	84.5
18	0.0	22.0	29.0	25.5	96.0	78.0	87.0
19	0.5	21.0	25.0	23.0	88.0	84.0	86.0
20	0.0	20.0	28.0	24.0	96.0	71.0	83.5
21	0.0	20.0	29.0	24.5	96.0	72.0	84.0
22	0.0	20.0	29.0	24.5	91.0	79.0	85.0
23	0.0	20.5	30.0	25.3	100.0	73.0	86.5
24	0.0	21.5	29.0	25.3	96.0	72.0	84.0
25	0.0	21.5	28.0	24.8	96.0	78.0	87.0
26	0.0	21.0	29.0	25.0	96.0	72.0	84.0
27	0.0	18.0	28.0	23.0	83.0	78.0	80.5
28	0.0	15.0	25.0	20.0	91.0	77.0	84.0
29	0.0	13.0	27.0	20.0	93.0	65.0	79.0
30	0.0	13.0	26.0	19.5	90.0	71.0	80.5
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0

December							
day	rain	temp			Humidity		
		mor	aft	AVG	mor	aft	AVG
1	0.0	13.5	26.0	19.8	90.0	85.0	87.5
2	0.0	12.5	26.0	19.3	84.0	57.0	70.5
3	0.0	14.0	27.0	20.5	90.0	63.0	76.5
4	0.0	16.0	27.0	21.5	90.0	71.0	80.5
5	0.0	18.0	29.0	23.5	74.0	60.0	67.0
6	0.0	19.0	29.0	24.0	78.0	65.0	71.5
7	0.0	18.0	27.0	22.5	91.0	72.0	81.5
8	0.0	17.0	28.0	22.5	91.0	77.0	84.0
9	0.0	17.5	29.0	23.3	91.0	64.0	77.5
10	0.0	15.0	28.0	21.5	95.0	51.0	73.0
11	0.0	14.0	29.0	21.5	90.0	53.0	71.5
12	0.0	14.0	29.0	21.5	86.0	53.0	69.5
13	0.0	15.0	30.0	22.5	85.0	53.0	69.0
14	0.0	14.0	28.0	21.0	91.0	65.0	78.0
15	0.0	17.0	28.5	22.8	90.0	53.0	71.5
16	0.0	15.0	26.0	20.5	90.0	70.0	80.0
17	0.0	16.0	26.0	21.0	90.0	70.0	80.0
18	0.0	16.0	26.0	21.0	95.0	70.0	82.5
19	0.0	17.0	26.0	21.5	91.0	69.0	80.0
20	0.0	13.0	27.0	20.0	79.0	42.0	60.5
21	0.0	13.0	28.0	20.5	76.0	49.0	62.5
22	0.0	15.0	28.0	21.5	90.0	58.0	74.0
23	0.0	17.0	29.0	23.0	91.0	59.0	75.0
24	0.0	16.5	28.5	22.5	95.0	50.0	72.5
25	0.0	16.5	29.0	22.8	95.0	59.0	77.0
26	0.0	19.5	26.5	23.0	91.0	90.0	90.5
27	0.0	20.0	26.0	23.0	96.0	56.0	76.0
28	0.0	20.5	20.5	20.5	91.0	84.0	87.5
29	0.0	17.5	28.0	22.8	95.0	78.0	86.5
30	0.0	17.0	29.0	23.0	91.0	71.0	81.0
31	0.0	17.0	29.0	23.0	86.0	71.0	78.5

BIOGRAPHY

Tanwarat Pinthong was born on September 19, 1983, educated in high school level from Jormsurang Upatham School, Ayutthaya province in 2001. In 2005, accomplished the Bachelors Degree from the faculty of Education, Chulalongkorn University, majoring Biology in High school Educational branch. Then, continued in Master Degree of Environmental Science, Chulalongkorn University. During the Master Degree education, received research support scholarship from the Research Program on Conservation and Utilization of Biodiversity and the Center of Excellence in Biodiversity, Faculty of Science, Chulalongkorn University (CEB_M_44_2008) and partially supported by CU.GRADUATE SCHOOL THESIS GRANT, Chulalongkorn University

Accomplishments & Activities

1. Intended in International workshop on landfill technology: Design and Application 16-20 October 2006 at Chulalongkorn university, Thailand

2. Poster presentation at ATBC titled: Habitat Utilization and Conservation Planning of Green Peafowl (*Pavo muticus*) in Huai Tab Slao, Huai Kha Kaeng Wildlife Sanctuary, Uthai Thani Province

3. Oral presentation at 35th Congress on Science and Technology of Thailand titled: Influence of predator abundance and Human Activities on Green Peafowl (*Pavo muticus*) abundance in Huai Kha Kaeng Wildlife Sanctuary

4. Lecturer for Peafowl conservation youth camp in 2009 subjected: Food type of Green Peafowl along Huai Tab Salao and Huai Songthang rivers in Huai Khakhaeng Wildlife Sanctuary, Uthai Thani province.

5. Lecturer for Peafowl conservation youth camp in 2010 subjected: Feeding ecology, roosting, dusting and breeding habitats of Green Peafowl in Huai Khakhaeng Wildlife Sanctuary, Uthai Thani province.