THE EFFECTS OF FOREST RESTORATION ON THE SPECIES DIVERSITY AND COMPOSITION OF A BIRD COMMUNITY IN DOI SUTHEP-PUI NATIONAL PARK THAILAND FROM 2002-2003

TIDARACH TOKTANG

MASTER OF SCIENCE

IN BIOLOGY

GRADUATE SCHOOL

CHIANG MAI UNIVERSITY

OCTOBER 2005

ISBN 974-9889-00-2

THE EFFECTS OF FOREST RESTORATION ON THE SPECIES DIVERSITY AND COMPOSITION OF A BIRD COMMUNITY IN DOI SUTHEP-PUI NATIONAL PARK THAILAND FROM 2002-2003

TIDARACH TOKTANG

A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE
IN BIOLOGY

GRADUATE SCHOOL
CHIANG MAI UNIVERSITY
OCTOBER 2005
ISBN 974-9889-00-2

THE EFFECTS OF FOREST RESTORATION ON THE SPECIES DIVERSITY AND COMPOSITION OF A BIRD COMMUNITY IN DOI SUTHEP-PUI NATIONAL PARK THAILAND FROM 2002-2003

TIDARACH TOKTANG

THIS THESIS HAS BEEN APPROVED
TO BE A PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE
IN BIOLOGY

EXAMINING COMMITTEE

..... CHAIRPERSON
Dr. Stephen Elliott

..... MEMBER
Dr. George A. Gale

..... MEMBER
Dr. Kriangsak Sri-Ngernyuang

21 October 2005

ACKNOWLEDGEMENTS

My thesis could not have been completed without help and encouragement from many kind persons. Foremost, I express gratitude to my thesis supervisor, Dr. Stephen Elliott for his suggestions, help and for correcting my thesis. I also express gratitude to Dr. Gorge Gale, my co-advisor for all his suggestions, and provision of many useful journals and books. I am thankful to Mr.James .F Maxwell, my co-advisor for his helps with identifying my plant specimens and to Dr. Assoc. Prof. Dr. Narit Sritasuwan for his suggestions and I also thank Dr. Kriangsak Sri-Ngernyuang from Mae Jo University, one of my thesis committee.

I thank the staff of FORRU for books, much helpful data, kind of assistance, and good-intension from them, especially Mr. Kunakorn Boonsai. I am grateful to Pranee Palee for her help and suggestions. Thanks also to Ms. Wangworn Sangkamaetawee for her English and happy times in Chiang Mai. Thanks are also given to many people at Ban Mae Sa Mai villages, especially Mr. Kasem and his family for my accommodation, food and good times in this village and Mr. Neng for his help.

I am also thankful to the Education Foundation of Shell 100 Years for financial support of this research.

Tidarach Toktang

Thesis Title The Effects of Forest Restoration on the Species Diversity and Composition of a Bird Community in Doi Suthep-Pui National Park Thailand from 2002-2003

Author Ms. Tidarach Toktang

Degree Master of Science (Biology)

Thesis Advisory Committee

Dr. Stephen	Elliott	Chairperson
Assoc. Prof. Dr.Narit	Sitasuwan	Member
Dr. George	Gale	Member
Mr. James Franklin	Maxwell	Member

ABSTRACT

As tropical forests continue to be destroyed, restoration of forest ecosystems is becoming a high priority for biodiversity conservation. However, few studies have been carried out to determine the effects of forest restoration on biodiversity recovery. Therefore, this study was carried out to examine the effects of forest restoration on the species richness and composition of bird communities in northern Thailand. Bird surveys were carried out in framework species plantations, established by the Forest Restoration Research Unit (FORRU) at Ban Mae Sa Mai in Suthep-Pui National Park, 1200-1300 meter above sea level, 18° 52´ N, 98° 51´ E. Framework tree species are chosen to be attractive to seed-dispersing wildlife such as birds or bats. Surveys were carried out over 1 year from June 2002-July 2003. Point counts and the Mackinnon List Method were used to determine the species richness, diversity, abundance and density of birds in non-planted control plots and

planted plots of different ages established in 1998, 2000 and 2002. In addition, observations of bird behavior in the planted trees were made.

Eighty-eight bird species were recorded from 57 genera and 30 families; 64 resident and 19 species of migratory birds. Three species of frugivorus bird and 15 species of omnivorous bird were found. Thirty-six birds species were observed in the non planted control plots and 68 species in planted plots; 43, 45 and 47 species in recently planted plots, 2-year-old and 4-year-old planted plots respectively. Bulbul species e.g. Red-whiskered Bulbul, Sooty-headed Bulbul and Flavescent Bulbul were the dominant species in the planted plots. Chestnut-capped Babbler, Red-whiskered Bulbul and Grey-breasted Prinia were the dominant species in the non-planted control plots. The Mackinnon List Method showed highest species richness of birds in 2-year-old planted plots, followed by the control plots, recently planted plots and lastly 4-year-old planted plots. The Point Count Method showed that planted plots had higher richness indices and diversity indices than non-planted control plots. Non-planted control plots had more even bird communities than the oldest (4-year-old) planted plots. Similarity indices showed that the oldest planted plots were most similar to medium-aged planted plots and were most different from recently planted plots. The population density of birds in the control plots was higher than in the planted plots. However, non-planted control plots had a higher population density of birds of open areas than planted plots, whilst forest birds had a higher population density in the planted plots. Birds used 41 woody plant species and 18 species were food plants. The birds fed on fruits, flower and nectar.

This study showed that planting framework tree species increased bird species richness (at the landscape level), and attracted several bird species which could disperse seeds into planted area and thus help to accelerate forest regeneration. In addition, tree planting attracted progressively more forest birds as the plots matured. Fifty-four percent of bird species recorded in planted plots were the same as those in the nearest patch of remnant forest, Dong Seng community forest.

ชื่อเรื่องวิทยานิพนธ์ ผลของการฟื้นฟูป่าต่อความหลากหลายของชนิดและองค์ประกอบของสังคมนกในอุทยานแห่งชาติดอยสุเทพ-ปุย ประเทศไทย ระหว่าง พ.ศ. 2545-2546

ผู้เขียน นางสาวธิดารัชต์ ตกแต่ง

ปริญญา วิทยาศาสตรมหาบัณฑิต (ชีววิทยา)

คณะกรรมการที่ปรึกษาวิทยานิพนธ์

ดร. สตีเฟน	อีเลียต	ประธานกรรมการ
รศ. ดร. นริทธิ์	สีตะสุวรรณ	กรรมการ
ดร. จอร์ท	เกลล์	กรรมการ
นาย เจมส์ เอฟ	แม็กเวลล์	กรรมการ

บทคัดย่อ

ในขณะที่การทำลายป่ายังคงเป็นไปอย่างต่อเนื่อง การฟื้นฟูระบบนิเวศป่าไม้จึงถูกยกให้เป็นประเด็นสำคัญในระดับต้น ๆ ของการอนุรักษ์ความหลากหลายทางธรรมชาติ แต่งานวิจัยเกี่ยวกับผลของการฟื้นฟูป่าและความหลากหลายทางชีวภาพมีจำนวนน้อยมาก งานวิจัยชิ้นนี้เป็นการวิจัยเพื่อศึกษาผลของการฟื้นฟูป่าต่อความหลากหลายของชนิดและองค์ประกอบของสังคมนกในพื้นที่ภาคเหนือของประเทศไทย ในพื้นที่แปลงปลูกป่าซึ่งปลูกโดยใช้วิธีการพรรณไม้โครงสร้างของหน่วยวิจัยเพื่อการฟื้นฟูป่า (FORRU) ณ บ้านแม่สาใหม่ ในเขตอุทยานแห่งชาติดอยสุเทพ-ปุย ตั้งอยู่ระดับความสูง 1200-1300 เมตรจากระดับน้ำทะเล พิกัด18°52'N, 98°51'E ชนิดของพรรณไม้ที่ปลูก เป็นพรรณไม้ท้องถิ่นที่สามารถดึงดูดสัตว์ป่าซึ่งทำหน้าที่เป็นตัวกระจายเมล็ดพันธุ์ตามธรรมชาติ เช่น นก หรือ ค้างคาว การวิจัยใช้เวลา 1 ปี เดือนมิถุนายน พ.ศ.2545-กรกฎาคม พ.ศ. 2546 โดยวิธีการศึกษาแบบ Point counts และ Mackinnon List เพื่อศึกษาความหลากชนิด ความชุกชุม และความหนาแน่นของนกในแปลงควบคุมและแปลงปลูกป่าที่มีอายุต่างๆกัน คือแปลงปลูกในปี พ.ศ. 2541 (อายุ 4 ปี) พ.ศ. 2543 (อายุ 2 ปี) และพ.ศ. 2545 รวมทั้ง

บันทึกพฤติกรรมการใช้ประโยชน์จากต้นไม้ของนก เพื่อศึกษาชนิดของต้นไม้ที่ดึงดูดนกให้เข้ามาในแปลงปลูกป่า

จากการวิจัยพบนกทั้งหมด 88 ชนิด 57 สกุล 30 วงศ์ เป็นนกประจำถิ่น 64 ชนิด นกอพยพ 19 ชนิด เป็นนกกินผลไม้ 3 ชนิด นกกินทั้งพืชและสัตว์ 15 ชนิด พบนกในแปลงควบคุม 36 ชนิด พบนกในแปลงปีพ.ศ.2543, 2545 และ2541 จำนวน 43 45 และ 47 ชนิดตามลำดับ กลุ่มนกปรอดเป็นชนิดนกเด่นในแปลงปลูกป่า เช่น นกปรอดหัวโขน นกปรอดหัวสีเขม่า และนกปรอดหัวตาขาว ชนิดนกเด่นในแปลงควบคุมคือ นกกินแมลงกระหม่อมแดง นกปรอดหัวโขน และนกกระจิบหญ้าอกเทา ผลการศึกษาจากวิธีการ Mackinnon List พบว่าแปลงอายุ 2 ปีมีความหลากชนิด (richness indices) ของนกมากที่สุด รองลงมาคือแปลงควบคุม แปลงอายุ 1 ปี และสุดท้ายคือแปลงอายุ 4 ปี วิธีการ Point count ได้ผลสรุปว่าแปลงปลูกป่ามีค่าความหลากชนิดของนก และค่าความหลากหลาย (diversity indices) มากกว่าในแปลงควบคุม ในแปลงควบคุมมีความสม่ำเสมอ (evenness) ของค่าความชุกชุมของนกสูงกว่าแปลงปลูกทุกแปลงซึ่งสอดคล้องกัน เมื่อเทียบค่าความเหมือนกัน (similarity) พบว่าแปลงอายุ 4 ปีกับแปลงอายุ 2 ปีมีความเหมือนกันมากที่สุด และแปลงอายุ 4 ปีกับแปลงอายุ 1 ปีมีความต่างกันมากที่สุด ความหนาแน่นของประชากรนกในแปลงควบคุมมีมากกว่าในแปลงปลูกป่า อย่างไรก็ตามพบว่าในแปลงควบคุมมีความหนาแน่นของประชากรนกที่ชอบอาศัยในพื้นที่เปิดโล่งมากกว่าในแปลงปลูกป่าในขณะที่ในแปลงปลูกป่ามีความหนาแน่นของประชากรนกที่ชอบอาศัยในพื้นที่ป่ามากกว่าในแปลงควบคุม นกใช้ประโยชน์จากพืชที่มีเนื้อไม้จำนวน 41 ชนิด ซึ่งในจำนวนนี้ 18 ชนิดเป็นพืชอาหารของนก โดยนกใช้ประโยชน์ด้วยการกินผลไม้ ดอกไม้ และน้ำหวานจากดอกไม้

การวิจัยนี้แสดงให้เห็นว่าการปลูกป่า ด้วยวิธีการพรรณไม้โครงสร้างสามารถเพิ่มความหลากชนิดของนกโดยคิดจากทั้งพื้นที่ ด้วยการดึงดูดนกที่อาจนำพาเมล็ดพันธุ์เข้ามาสู่พื้นที่ปลูกป่าและช่วยในการฟื้นตัวของป่าโดยธรรมชาติ นอกจากนี้การปลูกพรรณไม้โครงสร้างยังสามารถเพิ่มจำนวนชนิดของนกให้เข้ามาในพื้นที่มากขึ้นตามอายุที่เพิ่มขึ้นของแปลงปลูกป่า และยังพบว่า 54% ของชนิดนกในพื้นที่ปลูกป่าเป็นชนิดเดียวกันกับที่พบในป่าธรรมชาติใกล้เคียง เช่น ป่าดงเซ้งของหมู่บ้าน

TABLE OF CONTENTS

LIST OF TABLE

LITST OF FIGURES

LITST OF FIGURES (CONTINUED)

LITST OF FIGURES (CONTINUED)

LITST OF FIGURES (CONTINUED)

LITST OF FIGURES (CONTINUED)

LITST OF FIGURES (CONTINUED)

LITST OF FIGURES (CONTINUED)

LITST OF FIGURES (CONTINUED)

LITST OF FIGURES (CONTINUED)

LITST OF FIGURES (CONTINUED)

LIST OF APPENDICES

LIST OF APPENDICES (CONTINUED)

CHAPTER 1

INTRODUCTION

Rationale

Deforestation is undoubtedly the most serious threat to biodiversity in Thailand. The percentage of land covered by forest in 1961 was reported as 53% (Bhumibamon, 1986). In 1997, FAO estimated that Thailand's natural forest cover (excluding plantations) was about 21.7 %, whilst Royal Forest Department (RFD, 2004) reported about 25.28 % forest cover (129,722 km^2). In 1976-1982, Thailand highest deforestation rate in the tropical zone at 3.85 % per year (Jantakad and Gilmour, 1999). Jantakad and Gilmour (1999), wrote that the main causes of deforestation in Thailand were 1) encroachment in to conservation areas for economic agriculture 2) bad planning and management of logging concessions 3) increasing human population growth 4) infrastructure development e.g. roads, bridges and buildings and 5) land concessions for private corporation e.g. oil palm, shrimp farms and eucalyptus plantations. The effects of deforestation have been flooding, erosion and the climate change (Beaver, 1988). An economic valuation of the environmental aspects of deforestation in terms of soil quality water quality and temperature rise was estimated to be 688,235 baht per hectare. This did not include the value of wildlife and wildlife habitat, drug resources, food and tourism revenue (Wittawatchutikul, 2000)

Thailand's forest history started with logging concessions from 1880 until 1989. After flooding in southern Thailand was thought to have been aggravated by

deforestation in 1988 (Rao, 1988), the government terminated logging concessions to address this problem. Despite the subsequent ban on commercial logging, since 1989, the annual rate of deforestation still exceeds 1,000 km^2 (112,417 ha, i.e. 0.7 % yr^{-1}, 1990-2000 (FAO, 2001)). The RFD has made several attempts at replanting deforested areas in Thailand. This often involves establishing plantations of non-native trees in monocultures, especially commercial trees such as eucalyptus, pine teak, para rubber, and Acasia sp. which provide poor wildlife habitat (Perera, 1994; Garcia *et.al.*, 1998). Moreover, the survival rate of replanting seedlings in conservation areas has been low also (Jantakad and Gilmour, 1999).

Doi Suthep-Pui National Park has a diverse fauna and flora. About 2,250 species of vascular plant have been recorded, of which 485 species are trees (21.6%) (Maxwell and Elliott, 2001). Animal species include 50 mammals, 28 Amphibians, 50 Reptiles (Nabhitabhata, 1987), 326 species of bird (Round, 1984) and 500 butterfiles (Banziger, 1988). These plants and animals have functional relationships with each other. Plants are habitat and food resource for animals and animals are seed dispersers and reproductive agents for plants. Recently, many large animal species on Doi Suthep-Pui National Park have become rare or extirpated (Nabhitabhata, 1987; Elliott, Ua-Apisitwong and Beaver, 1989) including all 5 species of Hornbill (Round, 1984). The animal species diversity of Doi Suthep-Pui National Park has declined. It includes 31 mammals, 360 birds, 18 Amphibians and 30 Reptiles (Sukwong et. al., 1987). Round (1984) reported that the bird species richness of Doi Suthep-Pui National Park declined with every subsequent survey. Fifty bird species disappeared during 1978 to 1984 and probably even more species have disappeared that could not be estimated. The main reasons causing this

reduction in animal and bird species richness are illegal hunting, forest burning and the felling of the larger trees by the people living in the park.

Deforested areas should be restored by natural processes to complex forest, but this needs a long time to return. Fire is an important factor which prevents recovery of forest ecosystem diversity. If fire comes every year, or very often, tree seedlings are destroyed. Animals are important seed dispersers. In areas, with few animal species or where large animals, which disperse large seeds have become extirpated, birds are now the most important seed dispersers and are essential agents for forest rehabilitation.

The Forest Restoration Research Unit (FORRU) was established in 1994. FORRU is a joint initiative between Chiang Mai University and Doi Suthep-Pui National Park to promote reforestation and forest restoration research. FORRU started developing the framework species method of forest restoration, which was originally pioneered in Australia to convert deforested areas into natural forest ecosystems (Goosem and Tucker, 1995; Tucker and Murphy, 1997). The framework species method involves planting mixtures of 20-30 both climax and pioneer tree species. Basic forest structure and function is re-established by the planted trees. The framework tree species must have a high survival rate, grow rapidly and shade out herbaceous weeds. They must also attract wildlife such as birds or bats for feeding and nesting. These animals disperse seeds into the planted areas and bring about recovery of biodiversity. Therefore, framework tree species must produce resources such as fruits, nectar and habitat for wildlife at an early age (Goosem and Tucker, 1995; Tucker and Murphy, 1997).

Tucker (2000) suggested using wildlife as indicators of forest recovery. Wildlife monitoring can determine the ability of plantations to increase biodiversity and suggest ways to improve plantation methods in the future (Elliot *et al.*, 1998). Birds are suitable as bio-indicators of forest recovery (Bibby *et al*, 2000) and biodiversity of regenerating areas, because they are relatively easy to observe. They occupy all trophic levels in food webs such as herbivores, omnivores and carnivores. Moreover, bird species and communities are often affected by changes in vegetation cover. They also disperse seeds and carry out pollination that can increase plant diversity in planted areas. Thus, if we can attract birds to planted areas, wildlife conservation objectives will be met and the areas may recover more of their former biodiversity.

Therefore, this research monitored bird communities in experimental plots of framework species to assess the recovery of biodiversity in plots of different ages since planting. Interactions between the birds and the planted trees were observed to determine the relative attractiveness of different tree species. The results can be used to optimize methods of reforestation.

The research tested the following hypotheses:

1) Planting of framework tree species increases bird species richness compared with non-planted control plots.
2) Older framework plots have higher bird species richness than younger plots, due to greater habitat complexity.
3) Bird species found in framework species plots are more characteristic of forest habitats than open degraded areas.

4) Different framework species attract different bird species to differing degrees, depending on the resources they have to offer.

Research Objectives

1) To determine the species richness and composition of bird communities in experimental framework species plots of different ages.
2) To determine the relative attractiveness of the various planted framework tree species to seed-dispersing bird species and how the birds use these "attractive" plant species.

Usefulness of the Research

This research enables refinements of the framework species method of forest restoration, by determining which species are most likely to accelerate the recovery of biodiversity. Improvements in plantation design to maximize the attractiveness of the planted areas to seed dispersers should yield positive benefits for wildlife conservation in northern Thailand.

CHAPPER 2

LITERATURE REVIEW

Bird monitoring and Forest structure

Forest structure can greatly affect the species richness and diversity of bird communities (Beaver and Sritasuwan, 1985). The occurrence and abundance of bird species can mirror habitat quality, which is helpful for habitat evaluation. For example, different Bulbul species on Doi Suthep-Pui are found in different forest types, depending on food resources and degree of disturbance. For example, the Striated Bulbul (*Pycnonotus striatus*) can be found only in climax undisturbed evergreen forest, while the Red-whiskered Bulbul (*P. jocosus*) often occurs near man-made habitats from 340 to 1,400 meter above sea level. Thus, the Red-whiskered Bulbul can be used as an indicator of disturbance (Singhakan, 1986 , Portigo, 1994).

Portigo (1994) studied composition of bird communities in 4 different habitat types with differing degrees of disturbance on Doi Suthep-Pui and the ecological flexibility of bird species in the family Pycnonotidae to these habitat types. Twenty species lists were used to assess the bird communities and the "Point Count Method" was used to determine the abundance and distribution of bubuls. One hundred and eighteen bird species were found in evergreen forest on Doi Suthep-Pui and 39 bird species were found on a demonstration farm. Undisturbed evergreen forest supported the highest species richness and taller and denser vegetation structures were directly related to the richness of the bird community. The lowest diversity was

in the demonstration farm. The Black-headed Bulbul (*P. atriceps*) was found only in undisturbed habitats and Red-whiskered Bulbul was found in all disturbed area and demonstration farm. Similarly to Singhakan, she found that the Red-whiskered Bulbul usually inhabited man-made habitats and suggested that this species is a good indicator of disturbance. She concluded that deleterious human activities such as burning, habitat clearance and poaching, threatens the diverse composition of the bird community on Doi Suthep-Pui.

Chanthorn (2002) studied the relationship between bird communities and fallow-shifting cultivation. He studied rice-fields, fallows and mature forest. The study sites differed in age and composition of habitat. One hundred and thirty-eight bird species were found in all habitats. Mature forest supported the highest species richness of birds (68 species) and rice-field had the lowest. Many kinds of habitat were mosaics, composed of many differing microhabitats with edge effects or ecotones which increased the diversity of birds. He found that the composition of bird communities is specific to each habitat type and in ecotone or moving between forests to the forest edge. The diversity of microhabitats in this area was divided in to 1) mature forest, 2) the edge between fallow and mature forest site, 3) edges between open and fallow site, 4) fallow habitat and 5) open habitats

Birds as seed disperser and forest recovery

Seed dispersers in tropical forests are mostly birds and mammals. These animals have the highest potential to accelerate forest recovery (Wunderle, 1997). Willson and Crome (1989) studied seed dispersal at the edge of a tropical

Queensland rain forest. They found that both wind and animals (especially birds and bats) dispersed seeds from forests into degraded areas more than from degraded areas into forests and those animals can disperse seeds farther than the wind. Habitat structure affects seed dispersal in terms of availability of perches, complexity of vegetation structure and the presence of food resources that can attract seed-dispersers (Wunderele, 1997; Willson and Crome, 1989). Moreover, plantations which are more attractive to wildlife have a dense seed rain, than those that are less attractive (Wunderele, 1997). In the pastureland of the Amazon basin, the majorities of tree fruits are fleshy and appear to be dispersed by birds, bats and both arboreal and ground-dwelling mammals. One hundred and fifty species of bird were identified, but fewer than 10 frugivores moved into large openings (Uhl, 1988). Frugivorus bird species that are good agents of seed dispersal in forest succession or reforestation areas should be tolerant of degraded landscapes such as Family Pycnonontidae (Bulbuls), Zosteropidae (White-eyes), Megalaimidae (Barbets), Corvidae (Magpies) (Corlett and Hau, 2000). The family Pycnonontidae plays as important role in seed dispersal especially the Black-crested Bulbul which occurs in a wide range of habitats and can eat many kinds of fruits (Chanthorn, 2002, Pattanakaew, 2002).

The Framework Species Method, planting a mixture of fleshy-fruited trees and those that provide perching resources to attract animal seed dispersers such as birds and bats, compared 7-year-old and 5-year-old of plantations with control sites found that plantations established by planting 20-30 tree species recruited up to 72 plant species after 7 years. Older plantations had higher diversity than younger plots. The control site was dominated by grasses and supported only 19 plant

species. Fruit sizes and types suggested birds were the most important dispersal vectors (Tucker and Murphy, 1997).

Parrotta *et. al.* (1997) observed animal and plant diversity, while monitoring the success of reforestation on degraded tropical forest in Brazil. An animal survey focused on birds and bats and the plant survey focused on the floristic composition and structure of the 10-year-old reforested area. Ninety native forest trees species were planted in the area. They found that 75 species had been dispersed from surrounding primary forest into the regenerating degraded forest. The most common dispersers were frugivorous birds and bats, which generally dispersed smaller seeds than other animals. Smaller seeds represented a higher proportion of the colonizing species than larger-seeds, and in general, larger seeds were rare in the reforestation area because the animals that typically dispersed larger seeds (such as trogons, deer and primate) were rare there.

Pattanakaew (2002) studied the effect of local and landscape environments on seed dispersal by birds in regeneration forest. She found that the number of birds species correlated with the number of trees and the number of fruiting trees. Areas with a high percentage of surrounding forest and with shorter distances to forest supported a higher density and species richness of birds and had higher seed input. The vegetation structure in the immediate neighborhood of the plot had relatively little effect on frugivorous birds, compared with vegetation structure inside the plot, but it affected the species of seed input and the species of birds on the plots because most of the seeds and birds on the plots were associated with disturbance.

Food plants of birds

Corlett (1998) found the small fruit and large, soft fruits with many small seed are consumed by a wide spectrum of Frugivorus, including species which thrive in small forest fragments and degraded landscape. Same as, Singhakan (1986); Portigo, (1994); Chanthorn (2002) and Sanitijan (2001),found the fleshiness is the more important characteristic of fruit for birds. Many plant species in the Family Moraceae, Genus Ficus were eaten by birds. The Framework species were planted by FORRU in 1998, 1999 2000 and 2002 found 20 tree species eaten by birds such as *Aphanamixis polystachya, Aglaia lawii, Bischofia javanica* Bl., *Callicarpa arborea* Roxb., *Cinnamonum iners, Duabanga grandiflora* (Roxb. *ex*. DC.) Walp., *Erythrina subumbrans* (Hassk.) Merr., *Eurya accuminata* DC. *var. wallichiana* Dyer, *Ficus glaberrima* Bl., *F. hispida* L. f., *F. racemosa* L., *F. fistulosa* Rcinw. *ex Bl.* var. *fistulosa, F. subulata Bl.* var. *subulata, F. altissima, F. benjamina, F. subcordata, Michelia baillonii, Phoebe cathia, P. lanceolata and Prunnus cerasoides* D. Don (Singhakan, 1986; Portigo, 1994; Chanthorn, 2002; Sanitijan, 2001; Patthanakeaw, 2002; Kitamura et. al, 2002).. Sanitijan (2001) found 55 planted species were eaten by 49 species of birds. 33 plant species of these fruiting was eaten.

Monitoring of FORRU's forest restoration area

Tree monitoring

FORRU has done long-term monitoring of biodiversity recovery in forest restoration plots after planting such as monitoring growth and survival of trees

planted, phenology; to determine the youngest age of each planted tree species produced wildlife resource e.g. flower fruits, birdnest perching sites and monitoring naturally established trees and ground flora. Birds' nests observed during phenology monitoring were found in the following planted trees: *Sapium baccatum, Rhus rhetsoides, Erythrina subumbrans, Bischofia javanica, Quercus semiserrata* and *Prunus cersoides.* Planted tree species which produce fruiting or flowering at young age included *Ficus subulata* during the 1st year, *Macaranga denticulata* and *Rhus rhetsoides* in the 2nd year, *Callicarpa arborea, Ficus hispida, Ficus semicordata, Glochidion kerrii* and *Phoebe lanceolata* in the 3rd year, *Archidendron clyperia*, *Cinnamomun iners, Erythrina subumbrans, Eurya acuminate* and *Helicia nilagirica* in the 4th year and *Bridelia pubescens* in the 5th year (Anusarnsunthorn, 2002).

Animal monitoring

Monitoring birds and mammals in the FORRU plantation area of Ban Mae Sa Mai, northern Thailand, was done to determine the effect of forest restoration. Small mammals were monitored plots planted with framework tree species in 1998, 2000 and in non-planted control plots. Seven small mammal species were found and control plots had the highest abundance of small mammals. After the rainy season in 2000, a higher density and species richness of small mammal species was found in the 2000 plots which were most diverse in small mammal species. Since small mammals use ground flora for habitat and to hide from predator. Ground flora was densest in the control plot, and in the planted plots weeding and 1998 plots weeding reduced it. Planted trees shaded out ground flora. (Thaiying, 2003).

Three previous bird surveys were done in FORRU's plot before the study described here. First, Kuarak and Hitchcock (1998; unpublished) surveyed the site in May 1998, before planting. They found 34 species of birds. Chanthorn (1999) estimated the species richness of birds in December 1998, after the FORRU plots had been planted in June 1998 (6 months after planting) with 29 framework tree species. Planted and non-planted plots were compared. He recorded more birds in the non-planted plots (33 species) than in the planted plots (16 species). Sorensen's index of similarity showed that the two groups of plots were moderately different. He concluded that in the planted plots, weeding activities removed bird resources and therefore, they could not support a large diversity of birds. He predicted that when the trees grow up, they would provide better food resources and habitat and the number of bird species would increase.

Scott (2000) carried out bird surveys in the same area between early in November 1999 to early March 2000. She compared bird species richness between planted and unplanted plots and compared among plantation plots of different ages. Scott's experimental areas included the plantation areas planted in June 1998 and June 1999 and non-planted control plots. She found 33 bird species in the non-planted control plots, 23 species in 1998-planted plots and 23 species in the 1999-planted plots. Bird species richness dropped immediately after planting and did not return within one and half years. In the 1998 plots, species richness was increasing but the outcome was not clear. Within six months, after planting in the year 1999, the number of bird species was same as in 1.5-year-old plantations planted in 1998. The last bird survey for this area was in February 2001. Twenty bird species were found in non-planted plots, 25 species in the 1998 planted plots and 24 species in the

1999 planted plots. In this survey, a total of 45 species were observed in all plots. They could be divided into 3 groups: 1) 8 species that were found only in non-planted plots, 2) 12 species found in both control and planted plots and 3) 25 species found only in planted plots.

A summary of bird surveys from the FORRU reforestation areas.

Obse-rvers	Dates of survey	Age of planted plots	Number of bird species			Total	Comments	Ref.
			non-planted	1998 plots	1999 plots			
Kuarak & Hitchcock	May 1998	before planted	34	-	-	34	MacKinnon List Method	Elliott *et al.* (2001)
Chantorn	Dec 1998	6 months after planted	33	16	-	35	MacKinnon List Method Sorensen's index of similarity found 2 group moderately different	Chantorn (1999)
Scott	Nov 1999 - Mar 2000	1) planted in 1998; 1 year 4 months 2) planted in 1999;4months	33	23	23	42	MacKinnon List Method	Elliott *et al.* (2001)
Chantorn *et al.*	Feb 2001	1) 2 years 9 months 2) 1 year 9 months	20	25	24	45	1) 8 sp. found only non-planted, 2) 13 sp. found both plot, 3) 24 sp. found only planted plot	Elliott *et al.* (2001)

Scott who done the survey in the FORRU's plantation area, told that the MacKinnon method provides a good estimate of species richness, which does not necessitate standardization of bird survey methods and is most suitable for area with

large numbers of species. However, this method was not suitable for the deforested site on Doi Suthep-Pui, which was relatively species-poor. On the other hand, this method might be usable, as species richness recovers, in this area in the future. Scott suggested using ten hours of observations per each 0.64 ha (four rai) plot, because it was a sufficient amount of time to create an accurate species list. She suggested that future research should use a standardized number of survey locations per plot and count number of individuals sighted. Application of Simpson's index or Shannon's index would also result in a useful measure of species diversity. These suggestions agree with the suggested from O'Dea *et a*l (2004), who compared the rapid assessment of the MacKinnon list and the point counts method. The detail of methodology of this studied and the O'Dea's were done in similarly way such as 10-species list for Mackinnon list, fixed radius count 25 m for Point count, done the survey only in the morning period and all surveys were conducted on days without rain or strong wind. Bird species recorded in the point counts were also recorded in MacKinnon lists to ensure maximum sampling using the MacKinnon list methodology. They found the limitation of MacKinnon and Point Count that the MacKinnon method provided a more accurate estimate of the magnitude of the species richness for the specie-rich area, while estimate for the specie-poor area stabilized with relatively few samples better for using point count method. MacKinnon showing a bias towards solitary and territorial species and against monospecific flocking species relative to the point count data. As a consequence of this bias, MacKinnon list data also fail to reflect accurately the structure of communities as quantified by an index of community evenness. Point counts, on the other hand, failed to capture the full species complement of the species-rich

Ecuadorian study area. Both methods are subject to biases that limit their value, if used alone. They also propose in collecting data of scientific and management value, a hybrid rapid assessment methodology that capitalises on the strengths of both techniques while compensating for their weaknesses.

The recovery of species richness in the six-month-old and one-and- half-year-old plot was not clear (Elliott, 2001). The plantation plots required the further investigation after the plantations had more time to mature. Framework Tree Species trees should produce foods or perches for birds and other seed-dispersing wildlife 2-3 years after planting (Goosem and Tucker, 1995). They should therefore become more attractive to birds over time. Bird surveys done in 1998 and 2000 were carried out when the plantations were 6 months, and 18 months old respectively. These plantation areas should be monitored as they grow. The plantation activity is still going on and different ages of plantation, from 4 years old until recent plantings, are now available in the area. For these reasons, this research is proposed to compare plantations of different ages with non-planted control plots.

Navakitbumrung (2003) studied effects of mature trees on seedling establishment on deforested sites at Ban Mae Sa Mai. He found 37 planted species were dispersal by birds. He found Sooty-headed Bulbul, Flavescent Bulbul, and Red-whiskered Bulbul were importance dispersal agents in the FORRU's planted areas.

CHAPTER 3

STUDY SITE

Location

Near Ban Mae Sa Mai (BMSM) in Doi Suthep-Pui National Park, Chiang Mai Province of northern Thailand (Figure 3.1), the study plots were formerly covered with evergreen forest, which was cleared approximately 20 years ago and cultivated for cabbages, corn, potatoes, and fruit trees. These areas have also been subject to frequent fires. The plots were positioned in a degraded watershed area, 3-5 km from the village (18° 52'N, 98° 51'E), altitude at 1,207-1,310 m above sea level (1,000 m elevation at BMSM village) (Elliott, S., *et.al,* 2000), 5-10 % of slope and 350° aspect (Khopai, 2000)

Figure 3.1 Mae Sa Mai village in Doi Suthep Pui National Park with disturbed area on the left side and natural forest on right side above the village. This is the largest Hmong settlement in the northern Thailand.

Figure 3.2 Map of Doi Suthep-Pui National Park, Chiang Mai. The green areapresents Doi Suthep-Pui National Park and the location of Ban Mae Sa Mai Village (National Park Division, 2005).

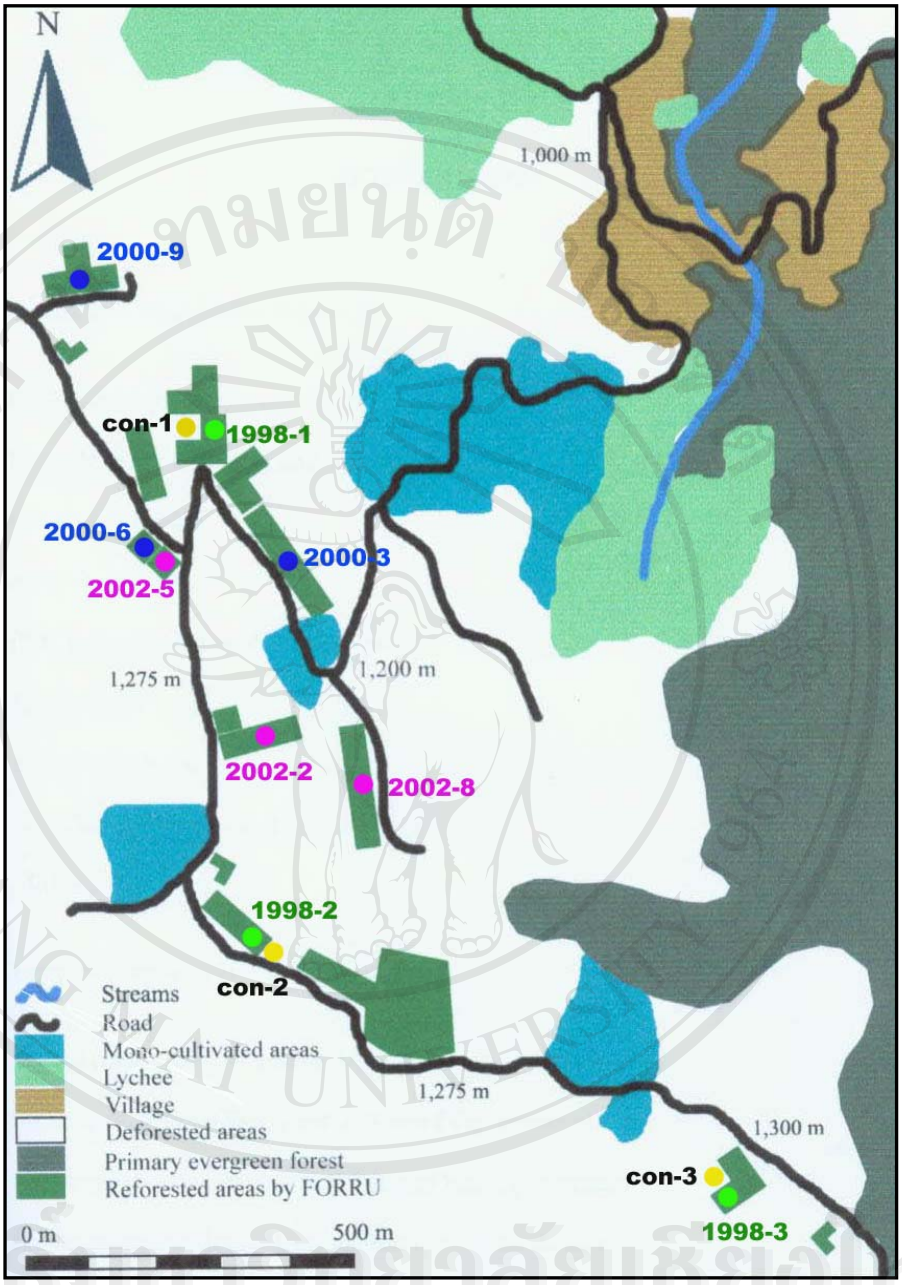


Figure 3.3 Map of study plots in FORRU's planted area at Ban Mae Sa Mai village in Doi Suthep-Pui National Park (Navakitbumrung, 2003).

Figure 3.4 Agricultural land around the planted plots. Cabbage cultivation leaves soil bare for several months each year.

Figure 3.5 Agricultural land around the planted plots; on the way to plots 2002-8. Litchi orchards and crop fields are interspersed with remnant forest fragments.

The climate

The area has two main seasons: a wet season (May - October) and a dry season (mean monthly rainfall is below 100 mm, November - April). The dry season is subdivided into a cool-dry season (November to January) and a hot-dry season (February to April). Average annual rainfall is 2,095 mm. Temperatures vary from a minimum of 4.5 °C in December to a maximum of 35.5 °C in March (Elliott, et.al, 2000).

The Royal Project Center of Ban Mae Sa Mai is the nearest weather station to the study site, 3 km northwest from BMSM at 880 m. elevation (47 QMA. 843878 at 4746 I). The average annual rainfall, there was 1,295.39 mm in 2002 and 799.27 mm in 2003. In 2002, the lowest rainfall was in March (0 mm), while the highest rainfall was in September (375.2 mm). In 2003, the lowest rainfall was in February and December (0 mm) and the highest rainfall was in June (222.8 mm). The average annual temperature was 22.6 °C in 2002 and 22.6 °C in 2003 (Figure 3.6). The average minimum temperature was 21.2 °C in 2002 and 19.0 °C in 2003. The average maximum temperature was 25.6 °C in 2002 and 27.4 °C in 2003 (Figure3.7).

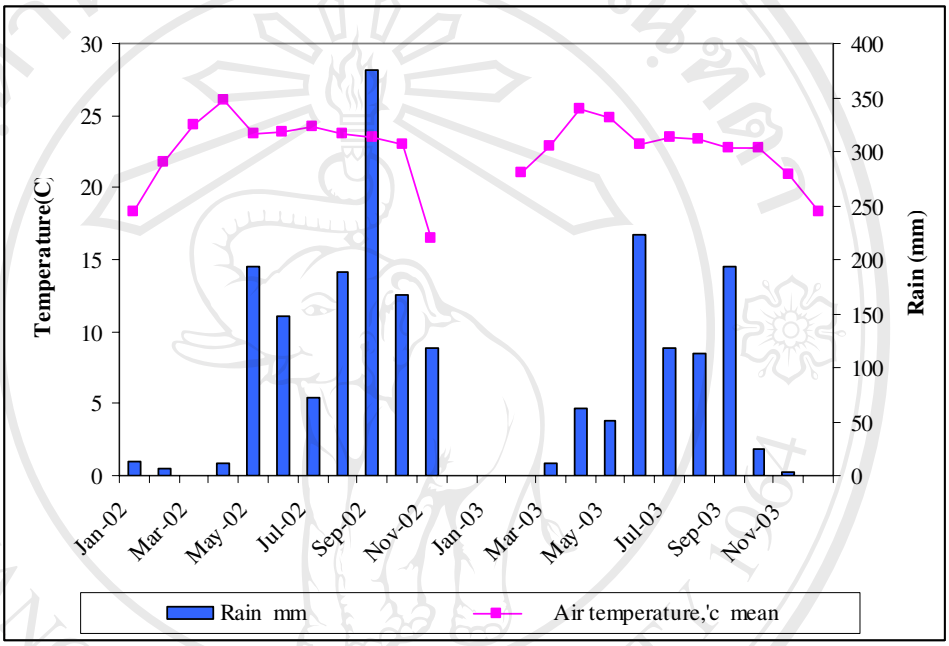


Figure 3.6 Average monthly temperature and rainfall at Royal Project Centre of Ban Mae Sa Mai (2002-2003; 880 m. at elevation and 4 km from study plots).

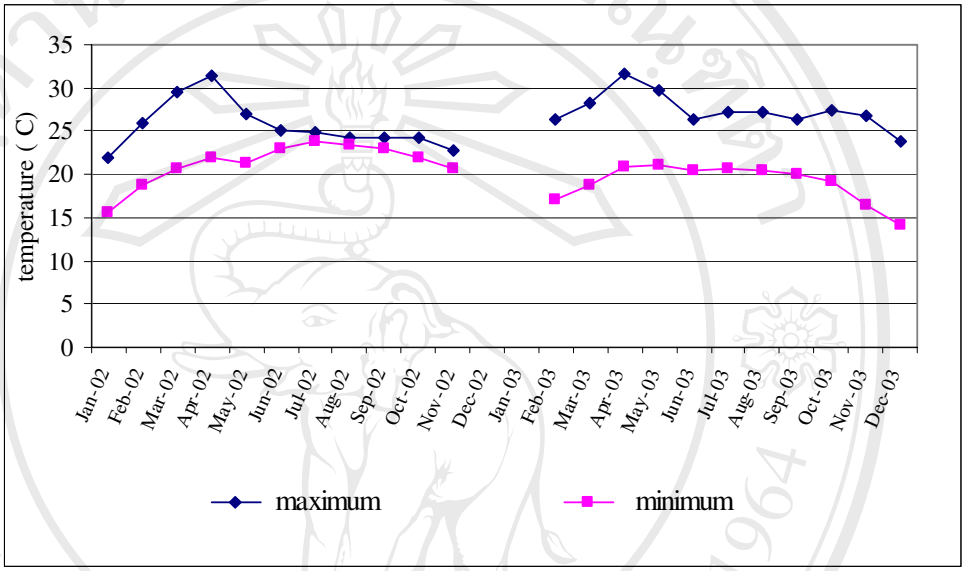


Figure 3.7 Average monthly minimum and maximum temperature at Royal Project Centre of Ban Mae Sa Mai (2002-2003; 880 m. at elevation and 4 km from study plots).

The composition of vegetation in forest restoration area.

The reforestation areas were 2-3 km from natural forest, which had been protected by the villagers more than 10 years. The natural forest was evergreen forest and had natural Pine trees near the summit. Along the road and near the planted plots were plots still cultivated with cabbage, carrot and litchi. The remnant trees scattered around the reforestation area included *Albizia chinensis* (Osb.) Merr. (Leguminosae, Mimosoideae), *Callicarpa arborea* Roxb. var. *arborea* (Verbenaceae), *Erythrina stricta* Roxb. (Leguminosae, Papilionoideae), *Gmelina arborea* Roxb. (Verbenaceae), *Heliciopsis terminalis* (Kurz) Sleum. (Proteaceae), *Sterculia villosa* Roxb. (Sterculiaceae) and *Schima wallichii* (DC.) Korth. (Theaceae) (Hitchcock, unpublished). The other remnant trees in the areas were *Castanopsis diversifolis* (Kurz) king ex Hk. f. (Fagaceae), *Bauhinia variegata* L. (Leguminosae, Caesalpinioideae), *Trema orientalis* (L.) Bl. (Ulmaceae), *Ficus hispida* L. f. var. *hispida* (Moraceae) (Navakitbumrung, 2003) *Markharnia stipulata var. kerri*, *Eurya acuminata* DC. *var. wallichiana* Dyer, *Debregeasia longifolia* and *Litsea cubeba* (Lour.) Pers. *var. cubeba.* Furthermore, the old agriculture trees is *Prunus persica* Batsch Ex St stand in the 2000 plots and some fast-growing trees which planted by the Royal Forest Department is *Pinus kesiya* Roy. ex Gord. (Pinaceae) and *Eucalyptus camaldulensis* Dehnh. (Myrtaceae)

The dominant herbaceous weedy vegetation included *Pteridium aquilinum* (L.) Kuhn (Dennstaedtiaceae, fern), *Bidens pilosa* L. var. *minor* (Bl.) Sherf, *Ageratum conyzoides* L., *Eupatorium odoratum* L. and *E. adenophorum* Spreng. (all Compositae and herbaceous weed), *Commelina diffusa* Burm. F. (Commelinaceae),

Mucuna bracteata A. DC. (Papilionaceae, vine) and grasses e.g. *Pennisetum polystachyon* (L.) Schult., *Phragmites vallataria* (Pluk. ex L.) Veldk., *Imperata cylindrica* (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. ex Hubb. & Vaugh. and *Thysanolaena latifolia* (Roxb. ex Horn.) Honda (both Gramieae) (Elliott, S., *et.al,* 2000 and Khopai, 2000).

The experimental plots structure

Experimental plots were planted with framework tree species in 1998, 2000 and 2002. Ficus spp. (Moraceae), and trees in the families Legumeminoisae and Fagaceae were considered important framework tree species groups. FORRU planted 500 trees in each plot (40 x 40 m.). Sixty framework species in all were planted over all the study sites (1998, 2000 and 2002) (Appendix B). Thirty-three framework species in 1998 plots, twenty-nine in 2000 plots and thirty in the 2002 plots. In addition, natural trees in the planted plots were left. The study sites were small in comparison with the surrounding area and 1998 plots were adjacent to non-planted control plots (figure 3.8). Weeding with hand tools was carried out tree times during the rainy season, at 4-6 week intervals after planting (Elliott *et. al*., 2003).

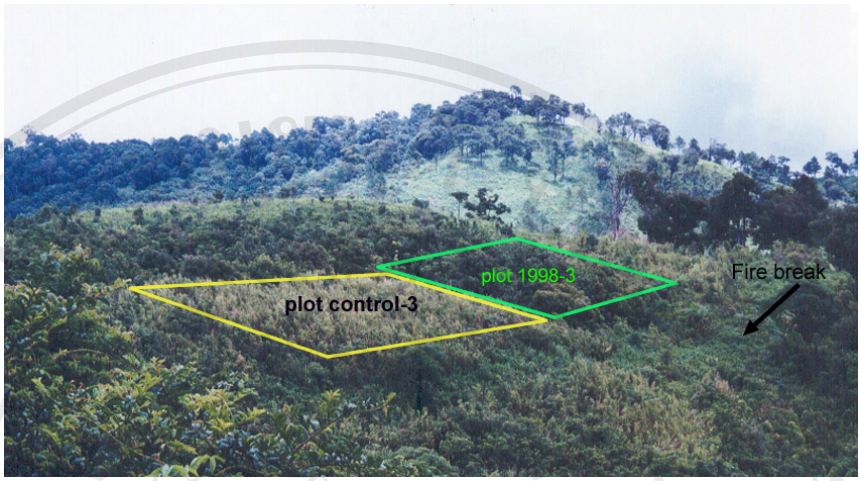


Figure 3.8 Plots 1998-3 (green line) adjacent to the non planted control plots (yellow line)

Non-planted control plots

Non-planted control plots were also maintained for comparison. Individual plots measured 40 x 40 m, with 3 replicated plots laid out in 1998. *Thysanolaena latifolia* (Roxb. Horn.) Honda (control-1) (figure 3.11), *Phragmites vallatoria* (Pluk. ex L.) Veldk (control-3) (figure 3.9 and 3.10) and *I. Cylindrica* 3-5 meter tall (control-2) were the dominant species in non-planted control plot. Natural trees scattered in the non-planted control plots included *Albizia* sp.(control-1 and control-2), *Litsea cubeba* (Lour.) Pers. *var. cubeba.* (control-2 and control 3) *Erythrina stricta* Roxb. (control-1 and control-2) (Appendix C).

Figure 3.9 Without tree planting, the grass *Phragmites vallatoria* (Pluk. ex L.) Veldk (Graminaceae) continues to dominate control plot 1998-3.

Figure 3.10 *P. vallatoria* (Graminaceae) 3-5 meter tall in non planted control plot control-3 (15 January 2005).

Figure 3.11 *Thysanolaena latifolia* (Roxb. Horn.) Honda (Graminaceae) 3-5 meter tall in non-planted control plot (control-1) (September 2002, 4 years old).

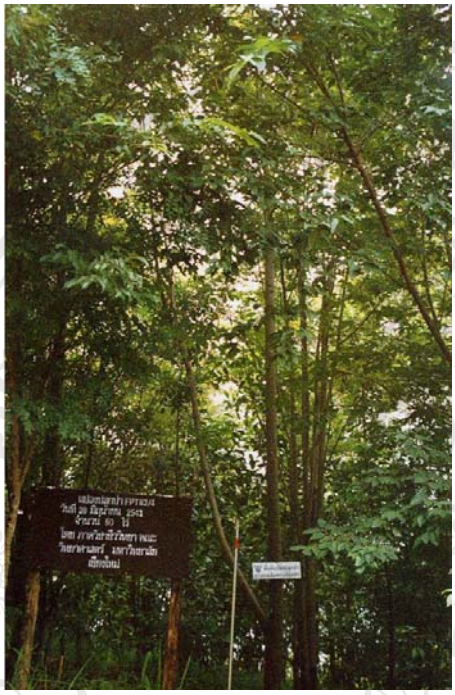


Figure 3.12 Framework species plot planted in June 1998 (Current age at 5 year old).

Figure 3.13 Interior of plot 1998-3 planted with framework species in June 1998 (Current age at 5 years old).

1998 plots

The 1998 plots had dense canopy cover and had the tallest trees, lowest ground flora cover and more shade compared with other the plots. The tallest planted trees were e.g. *Melia toosendan*, *Erytrina subumbran*, and *Spondias axillaris.* Some planted tree species produced flowers and fruits e.g. *Erytrina subumbran, Melia toosendan* and *Prunus cerisoides.* These plots were located adjacent to non-planted control plots.

Figure 3.14 Plot 2000-3 (4.5 years old after planting, 15 January 2005).

2000 plots

In these plots, trees were shorter than in 1998 plots. The 2000-3 and 2000-9, grass and ground flora grew to about 1 meter and *I. cylindrica* was dominant species for ground flora. Canopy cover was incomplete. The tallest tree species and those which produced fruits and flowers were same as in the 1998 plots. White Wild Banana planted in these plots produced flowers and fruits all year round and *Ficus altissima* in 2000-6 also produced fruit all year long.

Figure 3.15 Plot 2002-8 (2002-b) (Photo from June, 2002 just after planting).

2002 plots

These plots were planted in mid June 2002. They had small trees less than 1 meter high and weeds were removed periodically. Weeding was done at 4-6 week intervals after planting. The 2002 planted plots had variable structure in each plot. The 2002-8 plot was setup in lower elevation than the other plots. It had 3-5 pine trees and was near a cultivated area(figure 16, 17), Plot 2002-2 had many tall pine trees and had tall grasses in either side (figure 20), 2002-5 was close to 2000-6 plot (figure 18 and 19) and tree e.g. *Callicarpa arborea* and dense shrubs. The dominant shrub in this plot was *Melastoma malbathricum* L. *ssp. Malabathricum*

Figure 3.16 Cabbage cultivation adjacent to plot 2002-8.

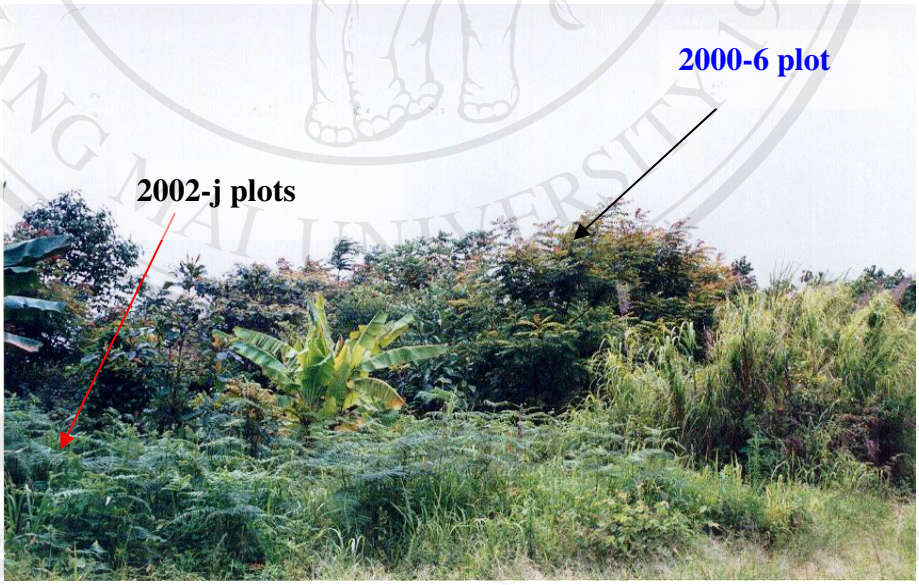


Figure 3.17 Plot 2000-6 (taller trees in background) closes to plot 2002-5 (2002-j). (Photo from August, 2002).

Figure 3.18 Plot 2002-5 (Photo from June, 2002 just after planting).

Figure 3.19 Plot 2002-2 (2002-s) planted with framework species in June, 2002. Some tall pine trees were already present at planting time. (Photo from August, 2002).

CHAPTER 4

METHODOLOGY

Field work:

Field work was divided into three parts; 1) bird surveys, 2) bird behavior survey and 3) basic vegetation survey. Bird surveys were carried out twice a month from June 2002 to June 2003, for 4-5 days at a time. Birds were observed for 1 hour per plot per day covering three plots per day (between 6:30-10:30). At the same time bird behavior was recorded for birds which interacted with trees in the plots. Recorded behavior included perching, feeding on insects, feeding on fruits, feeding on nectar from flowers. Observations concentrated on frugivorus bird species, which fed on fruits produced by the trees in the plots. Basic vegetation surveys were carried out once in the dry season (March-April 2003) and once in the wet season (September 2003).

1) Bird surveys

Bird surveys were done twice a month for twelve months from June 2002 to July 2003 (no data from August 2002 due to frequent rains). Observations were made only in the morning immediately after sunrise between 6:30 a.m.-10:30 a.m. Each plot was observed for one hour; three plots were covered each day. Observation times totaled 24 hours for each plot. The timing of each observation period was varied, so that time-of-day biases were minimized. During each hour of observation time, two survey methods were used. During the first, twenty minutes

both Point Counts (these are more typically known as variable circular plots or point transects because distance sampling techniques were used) and The MacKinnon Lists Method were used. Then, for the remaining forty minutes, data were collected only for the MacKinnon List Method.

Point Counts involve counting birds from a fixed location for a fixed time period. They can be undertaken at any time of year, and are not restricted to the breeding season. This method is used to estimate the population density of birds. The ability to detect of birds decreases with distance from the observer. Most birds are detected at the centre of the counting area, but ability to detect falls off with distance. If the method is coupled with distance estimation, it can provide an absolute density estimate. The Point Count Method is done by an observer standing in a particular spot and then recording all bird contacts for a defined period, often 5 to 10 minutes (Gibbons, Hill and Sutherland, 1997 and Bibby, Jones and Marsden, 1998).

In this study, I stood in the centre of each plot for 20 minutes/plot/time to record all birds coming into plot by both song and sight. The estimated distance from the observer when birds appeared in the plot was recorded. The estimated distance was estimated from centre (0 m) up to 25 meter; since 25 meter was the distance, which covered each entire plot (Figure 4.1). The distance scoring system used estimates of 5 meter intervals, from the centre, 0-5 m, 5-10 m, 10-15 m, 15-20 m and 20-25 m.

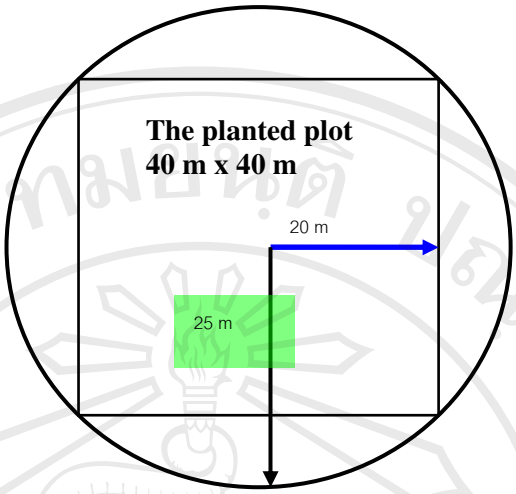


Figure 4.1 The study plot area was 40m x 40 m Estimated distance scoring from the centre (0 m) up to 25 m to cover the entire plot.

Additional, data in each survey included, date and time of observations; start time of Point Count Method, start time of MacKinnon List Method and end time of observation period. Plot location was recorded for each observation period. Notes of the weather were made, including estimated wind speed, rain and percent cloud cover. Both wind speed and rain were scored from 0 to 3; with, 0 = no rain or wind could not move the leaves, 1 = a little rain or wind could move the tree leaves; 2 = strong rain or wind could move the tree leaves stronger than level 2; 3 = heavy rain or wind could move the tree trunks. When the weather was too bad to clearly observe, birds observations were not done. Percentage cloud cover was estimated when the observer stood in the centre of plot before bird observations started. The species and numbers of birds observed were recorded. To reduce the risk of recording the same individual birds, several times, records were not made of the

same species of bird entering the plot for five minutes after first recording that species, if it was uncertain that the individual seen was different. The vertical position of the birds was recorded if they perched or did any activity in the vegetation. Vertical position was divided into 4 zones; ground = perched on the ground; grass/herbs = perched on grass or small herbs, woody plants < 1 m. = perched on the woody plants lower than 1 meter tall and trees >1m = perched on trees above 1 meter. The position and details of the trees were recorded. The position of birds perching on trees was divided into trunk, lower canopy and upper canopy. The species name of any trees visited by birds was recorded (using FORRU tree labels when available or specimens for naturally established trees) with special focus on trees used for feeding and nesting.

The MacKinnon list method can be used to construct a species discovery curve and provide an index of relative abundance. This method differs from other techniques in that it uses the list as the unit of effort rather than time or area. This makes the method relatively insensitive to differences in the ability of observers with out affecting the results. Moreover, this method produces similar results during periods of high or low activity. The observer makes a list by recording each new species seen until a pre-determined number of species is reached. The length of the each list can vary between 8 and 20 species. Each species can be record only once in each list. Lists are repeated until a minimum of ten (and preferably more than fifteen) lists have been produced for each site (Bibby, Jones and Marsden, 1998).

For MacKinnon, the length of the list can vary between 8 and 20 species. In this study, MacKinnon Lists Method was used with 10 bird species for each list, for

young forest restoration areas, where the number of bird species is low. Same as O'Dea N. *et al*. (2004) used 10-species lists which refer to Herzong *et al* (2002) recommended the 10-species list representing the best compromise between stable richness estimation curves and robust sample size. Data recording for the MacKinnon Lists Method started at the beginning of each observation period, simultaneously with the point counts method.

2) Behavior surveys

Observations of bird behavior in the experimental plots were also recorded simultaneously. The type and duration of behavior were recorded. Data collected included date, plot location, time and how many times a bird used the tree, species of bird and behavioral activity (e.g. perching, feeding fruit, feeding insect, calling, preening, leaf gleaning or bark foraging). The tree species where behavioral observations were made was identified from the labels attached to them at planting time or, for naturally established trees, from specimens collected.

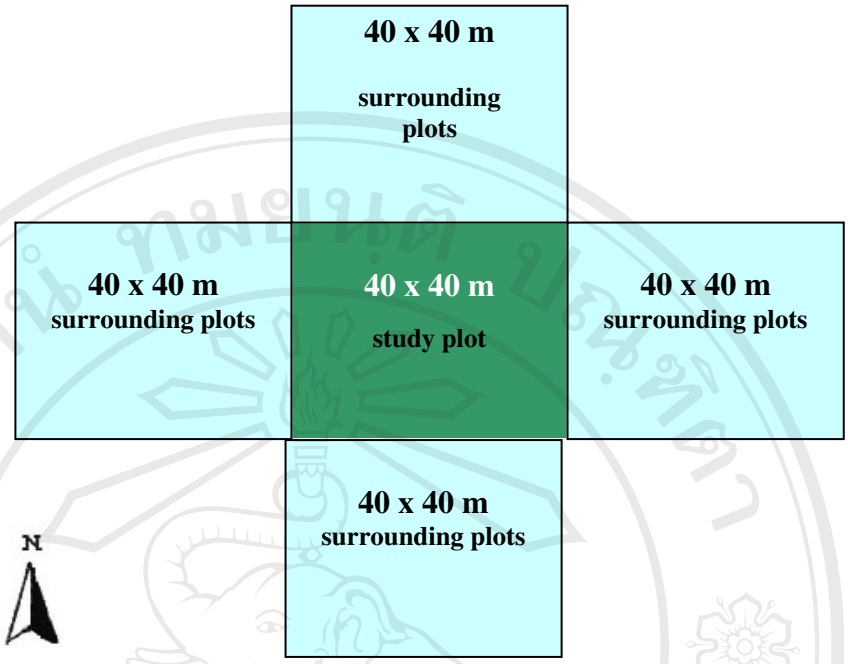


Figure 4.2 Locations of vegetation surveys. Twelve study plots were sampled plus four surrounding plots for each main plot.

3) Basic vegetation surveys

Basic vegetation surveys were carried out twice in the dry season (March-April 2003) and wet season (September 2003). Measurements included percent ground vegetation cover, percent canopy cover and tree density. Tree density was measured only once because in a year, tree density did not change much. Basic vegetation surveys were done within twelve study plots and also in four plots surrounding each study plot (Figure 4.2) for a total of 48 plots.

Each study plot and the surrounding plots were divided into 16 sub-plots; 10 m x 10 m Percentage ground vegetation cover; percentage canopy cover and tree density were estimated in every plot. Canopy cover was assessed in the centre of all

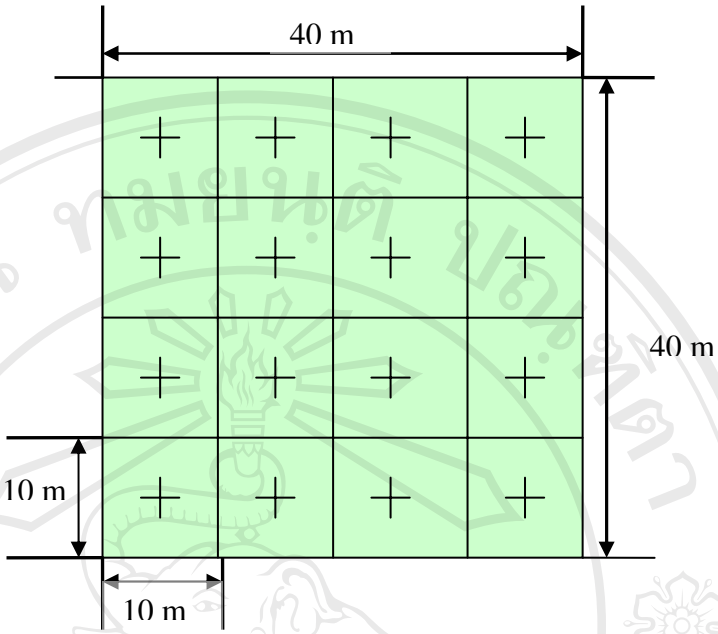


Figure 4.3 Each plots was divided into 16 sub-plots; 10 m x10 meach. The percentage of canopy cover was assessed in the centre of each sub-plot.

sixteen sub-plots (Figure 4.3). Canopy cover was measured with an ocular tube, following the method described by Pattanakaew (2002). The ocular tube was made from a cardboard tube with two threads, bisecting each other at right angles across one opening of the tube with for sighting. The observer held the ocular tube and stood upright and recorded the presence or absence of canopy vegetation at the point where the two treads crossed. These sixteen points were used to calculate the percentage of canopy cover in side the plots.

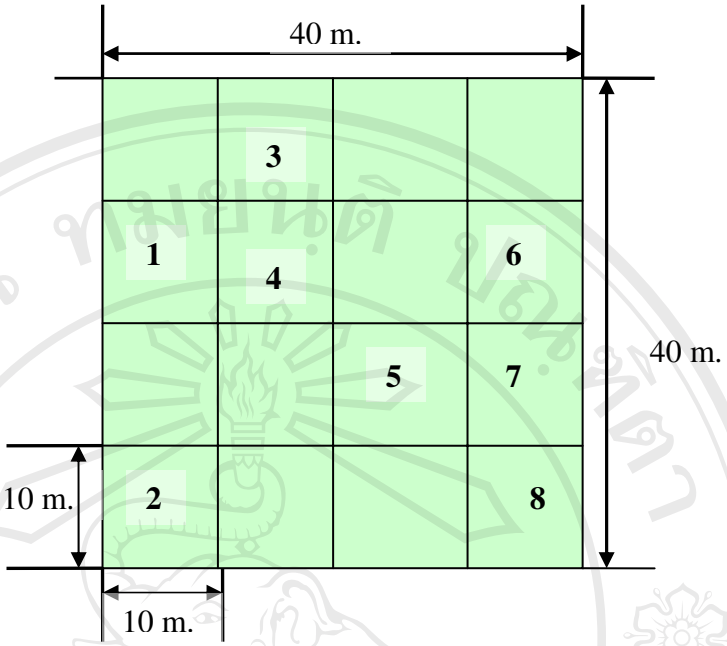


Figure 4.4 Eight randomly selected sub-plot. The numbers of trees were count for tree density and tree height, DBH, and width of tree crown were measured.

Then, eight of the sixteen sub-plots were randomly selected for measurement of tree density and percent cover of ground vegetation (Figure 4.4). In each of the eight subplots, the number of trees presents which height >1 meter was counted and divided by the area to determine tree density. Data collected included date and plot location, tree species (using FORRU tree labels when available or naturally established trees by identifying a collected specimen, Tree height, DBH (diameter at breast height) and width of canopy. Tree height, DBH and width of canopy followed FORRU's monitoring technique; 1) the distance from ground level to the highest meristem was measured with a tape measure or measuring pole; 2) tree diameter was measured at breast height (DBH) with a tape measure and trees sapling (such as

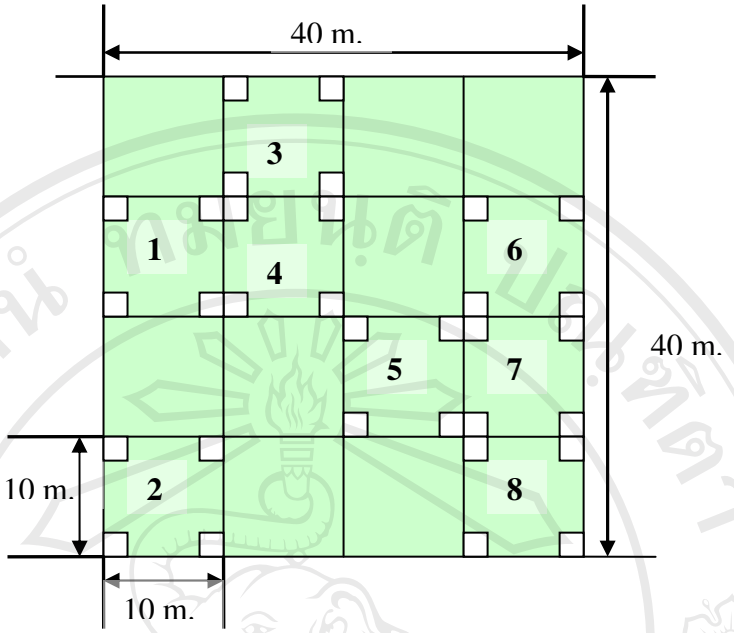


Figure 4.5 Thirty–two square plots (1x 1m.) at the corners of eight randomly selected sub-plots, used to estimate percentage ground cover of each plot.

2002 plots) root collar diameter was measured with calipers using a vernier scale; 3) width of tree crown was measure at the widest point, using tape measure.

Percent cover of ground vegetation was assessed in the same 8 randomly selected sub-plots. Square plots (1x1m) were located at the four corners of each experimental plot (Figure 4.5). Data collected included date and plot location and percentage cover of each habit. Plant habit was divided into grasses, ferns, other herbs, tree seedlings <1m and bare ground. These thirty-two square plots (1x1 m) were used to calculate the percentage of ground cover of each 40 x 40 m plot (Figure 4.5). Plant species were named by collecting specimens for unknown species. All plant species were identified at CMU herbarium Biology Department, Faculty of Science, Chiang Mai University (Maxwell, 2003).

Materials and Equipment:

1. Binoculars (10 x 42 mm)
2. Bird Guide (Lekagul and Round, 1991)
3. Data sheets (Bird Survey and Basic Vegetation Survey)
4. Cassette tape and tape recorder (Behavior survey)
5. Platform for bird observation
6. Measuring tape
7. String
8. Ocular tube
9. Plastic tree tag to mark trees bird used
10. Plant press, newspaper and cutters
11. Camera and film

Analytical methods:

MacKinnon Lists Method

Bird species discovery curves were produced by plotting the cumulative total number of species observed against the number of lists made. Then, the number of bird species not seen in each survey plot was predicted by plotting the log frequency of number of species occurring on a given number of lists against the number of list on which each species occurs. A regression line of best fit was then extrapolated back to zero, providing an estimate of the number of species occurring on zero lists (i.e. number of species not seen). This number added to the number of species seen gives a prediction of the total number of species in each area. These data can also be analyzed to provide an index of relative abundance of each species in each study

plots. This was done by calculating the proportion of the lists on which the species occurred. This index could vary between 0 (species not recorded) and 1 (species recorded on every list) (Bibby, et al, 1998).

The MacKinnon List Method was employed by compiling lists with 10 species per list. Since the data for each time period in each plot was almost always less than 10 bird species, complete lists could not be made in each time period. The data were therefore combined for each plot and arranged in order of the date and time of observation. Then lists of 10 bird species were complied from these data. These lists were then used to plot graphs, estimate the number of bird species present and calculate the index of relative abundance for each bird species.

Point Count Method

Point count data were used to quantify the composition of the bird communities and the density of birds using the program "Distance 5 Beta 3" (Thomas et al. 2004) (a program which allows to design and analyze of distance sampling surveys of wildlife populations). Species richness indices, Simpson's index and Shannon's index were calculated to quantify bird species diversity and evenness. Sorensen's Index of Similarity was calculated to quantify the similarity of the bird communities among the plots.

In this study, records of birds flying over the plots were cut, because these birds did not really use the plots and all data in August 2002 were also cut, because in that month, heavy rain prevented adequate surveys.

CHAPTER 5

RESULTS

1. BIRD SURVEYS

A total of 88 species of birds from 57 genera and 30 families were observed during all surveys (Appendix D). Sixty-four species were resident (72.7 %), while 19 were winter visitors (21.6 %). Forty-nine species were insectivorous (55.7 %), 15 were omnivorous (17.1 %), 7 were seed eaters (8.0 %), 6 were carnivorous (6.8 %), 6 were nectariforous and insectivorous (6.8%), 3 were frugivorus (3.4 %) and 2 were nectariforous (2.3 %). Thirty-eight species (43.2 %) were birds usually found in open areas with 44 species (50 %) from forest areas and 6 unknown species (6.8 %) (Lekakul and Round, 1991; Kopkate, 1998). The total number of winter visitor bird species included 3 omnivore. The total number of resident bird species included 3 frugivores and 11 omnivores, which were important for seed dispersal (e.g. Black-crested Bulbul, Black-headed Bulbul, Flavescent Bulbul, Sooty-headed Bulbul, Red-whiskered Bulbul, Slender-billed Oriole, Oriental White-eye, Green-billed Malkoha, Mountain Bamboo-Partridge, Greater Coucal, Grey-headed Parakeet, Blue-throated Barbet, Dove sp., Great Tit).

1.1. MacKinnon Lists

Estimates of numbers of bird species not seen and estimated totals in each plot are listed in Table 1 and represented in Figures 5.1 and 5.2. Figure 5.3 shows the cumulative number of bird species against the number of MacKinnon lists (10 species of birds/ lists) in non planted control plots, 1998, 2000 and 2002 planted

plots respectively. Regressions provided an estimate of missed birds at the zero intercept. Log values at the zero intercept were converted into numbers of birds not seen (see Appendix 5).

Table 1 The estimated total number of species of bird in studied plots.

Plot	Observed species	Log value at zero intercept	Estimated Numbers of species not seen	Total estimated species
Control	**56**	**0.7228**	**5**	**61**
Control-1	34	0.9829	10	44
Control-2	35	1.0209	10	45
Control-3	29	1.1064	13	42
2002	**50**	**0.9057**	**8**	**58**
2002-b	25	1.5051	32	57
2002-j	29	1.3315	21	50
2002-s	37	1.0465	11	48
2000	**57**	**0.8461**	**7**	**64**
2000-3	42	1.4086	26	68
2000-6	35	1.0802	12	47
2000-9	33	1.2578	18	51
1998	**51**	**0.6705**	**5**	**56**
1998-1	40	1.1505	14	54
1998-2	40	1.2517	18	58
1998-3	27	0.974	9	36

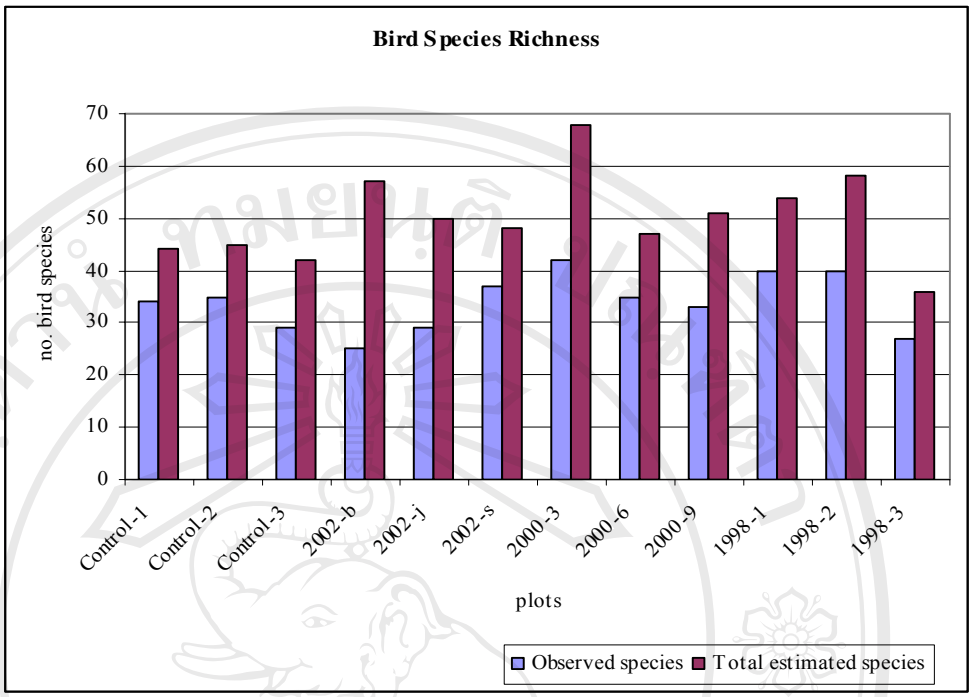


Figure 5.1 Bird species richness in 12 plots.

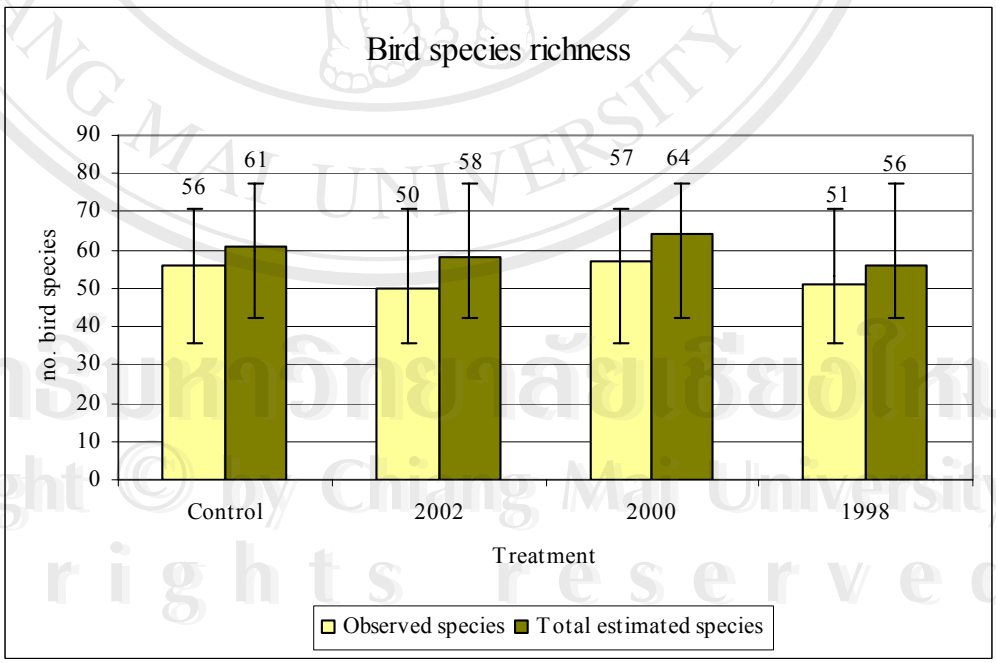


Figure 5.2 The bird species richness of data combining all three replicates in four treatments.

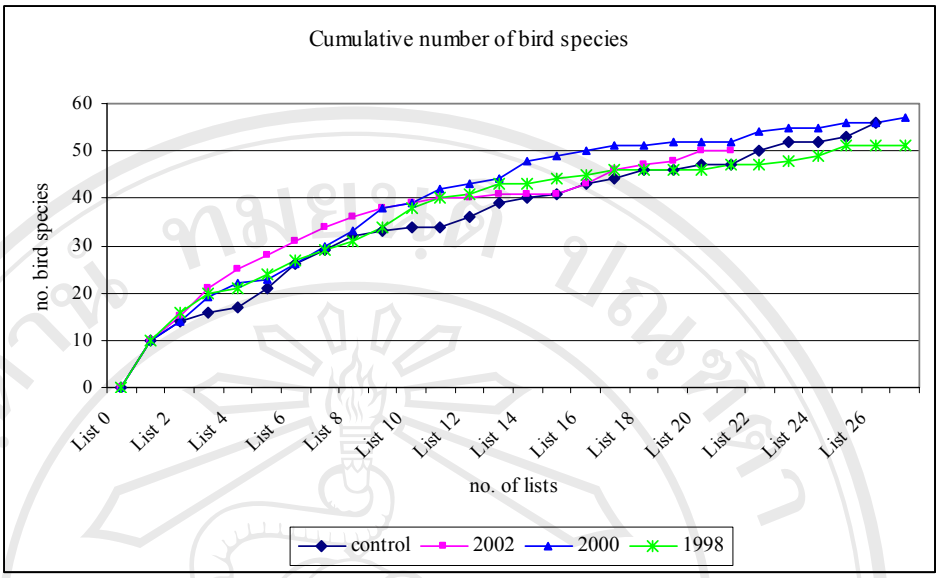


Figure 5.3 The number of bird species / list curve (10 species/list) in four treatments.

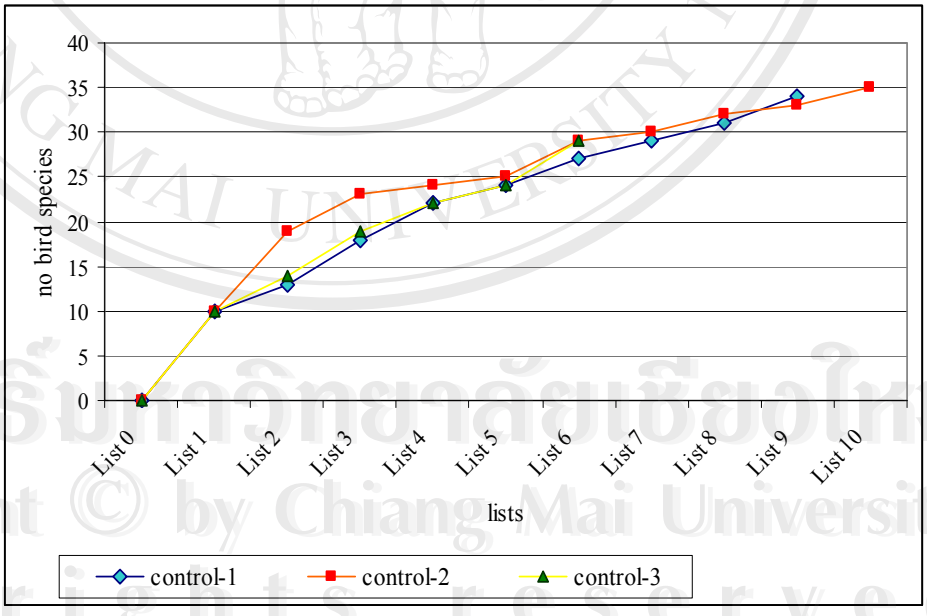


Figure 5.4 Accumulated number of bird species (10 species/list) for control plots (3 replicates).

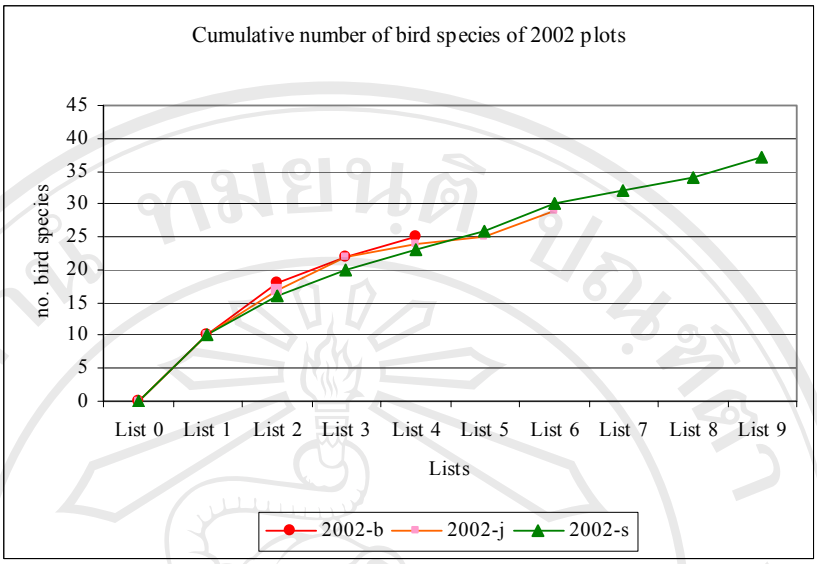


Figure 5.5 Accumulated number of bird species (10 species/list) for 2002 plots (3 replicates).

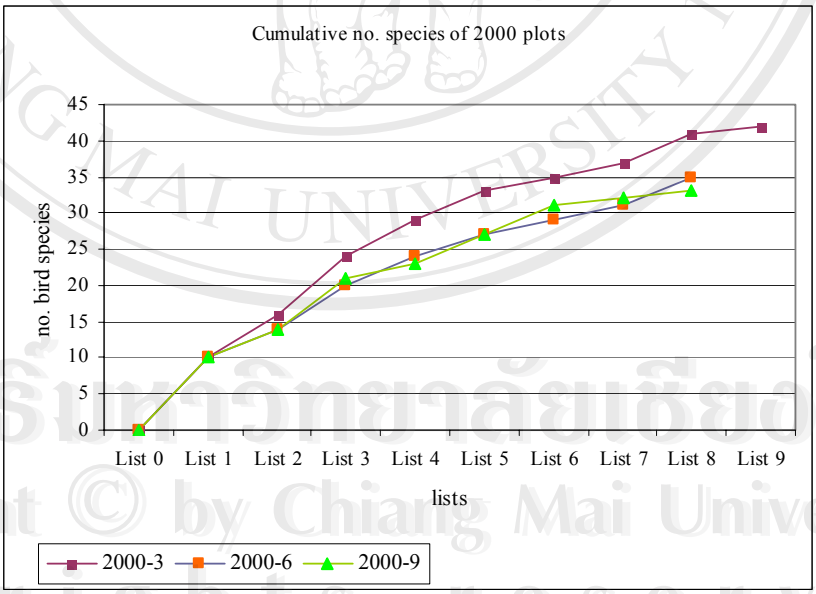


Figure 5.6 Accumulated number of bird species (10 species/list) for 2000 plots (3 replicates).

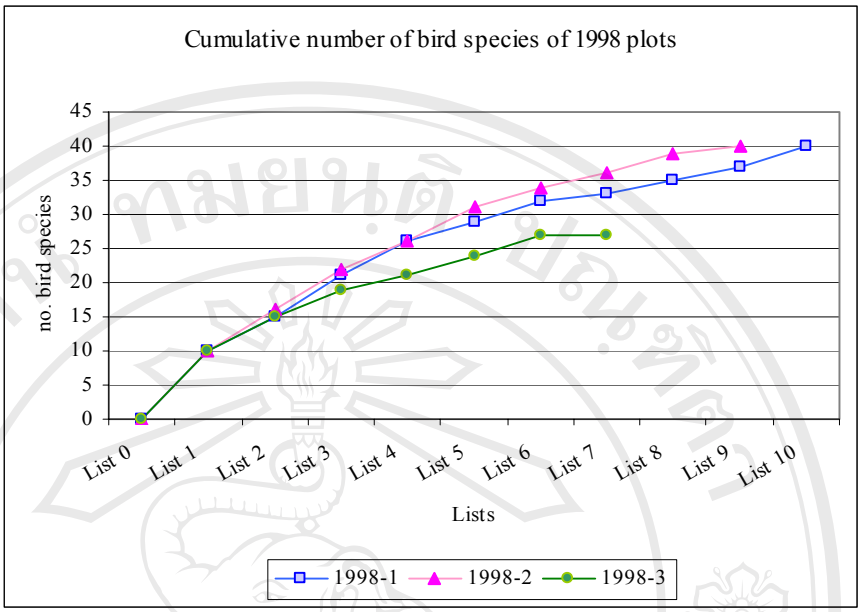


Figure 5.7 Accumulated number of bird species (10 species/list) for 1998 plots (3 replicates).

Table 2 The relative abundance (species / number of list; vary from 0 to 1)of each bird species in each of the four treatment plots (see Appendix D for scientific names).

	species	habitat	control	2002	2000	1998
1	Ashy Drongo	forest	(0.27)[10]	0.10	0.04	0.22
2	Ashy Wood-swallow	open	-	0.05	0.04	-
3	Asian Brown flycatcher	open	0.08	0.05	0.11	-
4	Black-crested Bulbul	forest	0.04	0.10	0.26	(0.33)[10]
5	Black-head Bulbul	forest	-	-	0.04	-
6	Black-naped Monarch	forest	0.04	-	0.04	0.04
7	Black-naped Oriole	forest	0.04	-	-	-
8	Black-throated Sunbird	forest	0.12	-	0.22	0.11
9	Black-winged Cuckoo-shrike	forest	0.04	0.10	0.11	0.04
10	Blyth's Leaf-Warbler	forest	-	0.05	-	-
11	Blue-throated Barbet	forest	-	-	0.04	-
12	Bulbul sp.	-	0.04	0.05	0.11	-
13	Blue Rock-Thrush	open	-	-	-	0.04
14	Burmese Shrike	open	0.15	(0.33)[9]	0.26	0.19
15	Chestnut Bunting	open	0.04	-	-	0.11
16	Chestnut-capped Babbler	open	(0.96)[1]	(0.48)[6]	0.22	(0.56)[3]
17	Common Iora	open	0.15	0.24	(0.41)[7]	(0.37)[9]
18	Common Rosefinch	open	0.08	-	-	0.11
19	Common Tailorbird	open	0.15	0.24	(0.44)[5]	(0.44)[5]
20	Common Wood-shrike	forest	-	-	0.07	-
21	Dark-necked Tailorbird	forest	0.04	0.10	0.07	-
22	Flavescent Bulbul	open	(0.58)[6]	(0.71)[2]	(0.41)[8]	(0.48)[4]
23	Flowerpecker sp.	-	-	-	0.04	-
24	Flycatcher sp.	-	0.04	0.10	0.04	0.11
25	Golden-spectacled Warbler	forest	0.04	0.10	0.07	-
26	Great Tit	forest	0.15	0.19	0.07	0.07

Table 2 (continued)

	species	habitat	control	2002	2000	1998
27	Greater Coucal	open	-	0.10	0.07	0.07
28	Greater Racket-tailed Drongo	forest	-	-	0.04	-
29	Green-billed Malkoha	forest	0.04	0.19	0.19	0.30
30	Greenish Warbler	forest	0.19	0.14	0.19	0.22
31	Grey Bushchat	open	0.04	(0.33)[10]	0.04	0.04
32	Grey-breasted Prinia	open	(0.69)[3]	(0.52)[5]	0.26	-
33	Grey-capped Woodpecker	forest	0.04	-	-	-
34	Grey-headed flycatcher	forest	0.04	-	-	-
35	Hair-crested Drongo	forest	0.04	-	-	-
36	Hill Blue Flycatcher	forest	0.04	0.24	(0.56)[3]	(0.44)[6]
37	Hill Prinia	open	0.23	0.10	0.15	0.11
38	Yellow-browed Warbler	forest	(0.46)[7]	(0.48)[7]	(0.48)[4]	(0.41)[8]
39	Japanese White-eye	forest	0.04	-	-	0.15
40	Little Bunting	open	0.04	-	-	-
41	Little Spiderhunter	forest	0.08	0.24	(0.44)[6]	0.11
42	Long-tailed Minivet	forest	-	-	0.04	0.04
43	Long-tailed Shrike	open	0.04	0.05	0.04	-
44	Minivet sp.	forest	-	0.05	-	-
45	Mountain Bamboo-Partridge	open	0.27	0.05	0.04	0.11
46	Olive-backed Pipit	open	0.04	0.10	-	0.04
47	Olive-backed Sunbird	open	-	-	0.04	-
48	Oriental White-eye	forest	0.08	0.14	(0.37)[9]	0.33
49	Pale-footed Bush-Warbler	open	0.19	-	0.11	0.11
50	Plae-legged Leaf-Warbler	forest	-	-	0.04	-
51	Pied Bushchat	open	0.04	0.05	-	-
52	Plain Flowerpecker	forest	-	0.10	0.07	0.04
53	Prinia sp.	open	0.04	-	-	0.04
54	Puff-throated Babbler	forest	0.19	-	0.15	0.26
55	Purple Sunbird	open	0.08	-	-	0.04
56	Red-throated Flycatcher	open	0.12	(0.43)[8]	0.15	0.11

Table 2 (continued)

	species	habitat	control	2002	2000	1998
57	Red-whiskered Bulbul	open	(0.96)[2]	(0.71)[3]	(0.89)[1]	(0.96)[1]
58	Rufescent Prinia	open	(0.65)[4]	(0.57)[4]	(0.33)[10]	(0.44)[7]
59	Scaly-breasted Munia	open	-	0.05	0.07	-
60	Scarlet Minivet	forest	0.04	-	0.19	-
61	Shrike sp.	open	-	0.05	-	-
62	Shikra	forest	-	-	0.04	-
63	Siberian Rubythroat	open	(0.38)[8]	0.10	0.07	0.11
64	Sooty-headed Bulbul	open	(0.65)[5]	(0.86)[1]	(0.74)[2]	(0.67)[2]
65	Streaked Spiderhunter	forest	0.04	0.19	0.22	0.22
66	Striped Tit-Babbler	forest	(0.38)[9]	0.33	0.33	0.15
67	Sunbird sp.	-	-	-	0.04	0.04
68	Velvet-fronted Nutatch	forest	-	0.05	-	-
69	Warbler sp.	-	0.12	0.19	0.04	-
70	White-browed Piculet	forest	0.15	0.05	0.07	0.26
71	White-browed Scimitar-Babbler	forest	0.27	0.10	0.11	0.22
72	White-browed Shrike-Babbler	forest	-	0.05	0.04	-
73	White-rumped Munia	open	0.04	0.10	-	-
74	White-rumped Shama	forest	-	0.19	0.22	0.22
75	White-tailed Robin	forest	0.04	-	-	-
76	White-throated Fantail	forest	0.04	0.10	-	-
77	Yellow-eyed Babbler	open	0.15	0.10	-	0.07

* The number after parenthesis showed the priority relative abundant from 1st to 10th of each plot.

From Table 2, 10 species of open-habitat and forest-habitat bird which had the highest relative abundance of each plot was chosen to make graph in Figure 5.8 and 5.9.

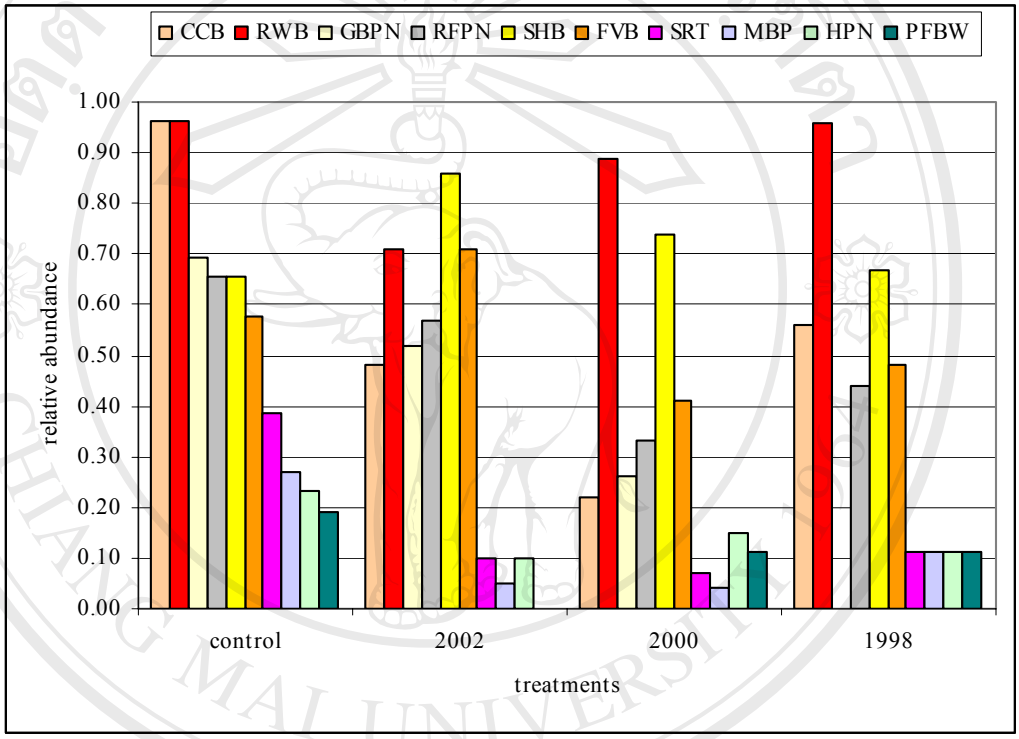


Figure 5.8 The relative abundance (species / number of list) from MacKinnon data. This 10 open-habitat species chose from 10-species top of 4 treatment plots. (CCB = Chestnut-capped Babbler, RWB = Red whiskered Bulbul, GBPN = Grey-breasted Prinia, RFPN = Ruffescent Prinia, SHB = Sooty-headed Bulbul, FVB = Flavescent Bulbul, SRT = Siberian Rubythroat, MBP = Mountain Bamboo-Partridge, HPN = Hill Prinia, PFBW = Pale-footed Bush-Warbler).

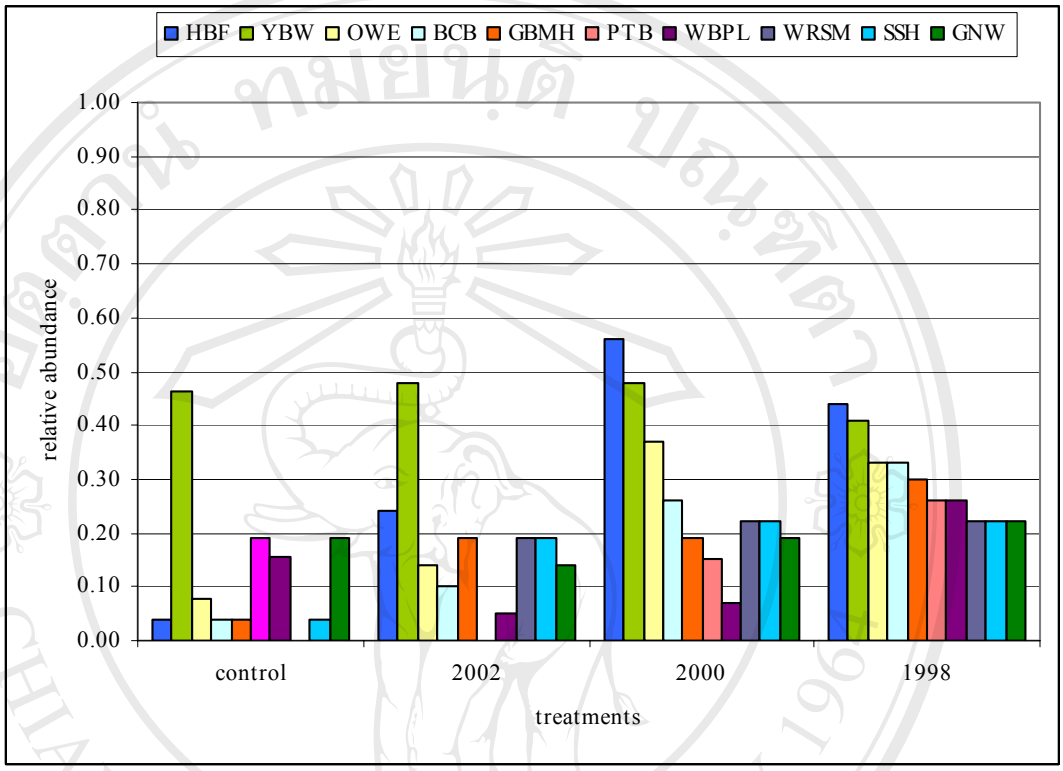


Figure 5.9 The relative abundance (species / number of list) from MacKinnon data. This 10 forest-habitat species chose from 10-species top of 4 treatment plots. (HBF = Hill Blue Flycatcher, YBW = Yellow browed Warbler, OWE = Oriental White-eye, BCB = Black-crested Bulbul, GBMH = Green-billed Malkoha, PTB = Puff-throated Babbler, WBPL = White-browed Piculet, WRSM = White-rumped Shama, SSH = Streaked Spiderhunter, GNW = Greenish Warbler).

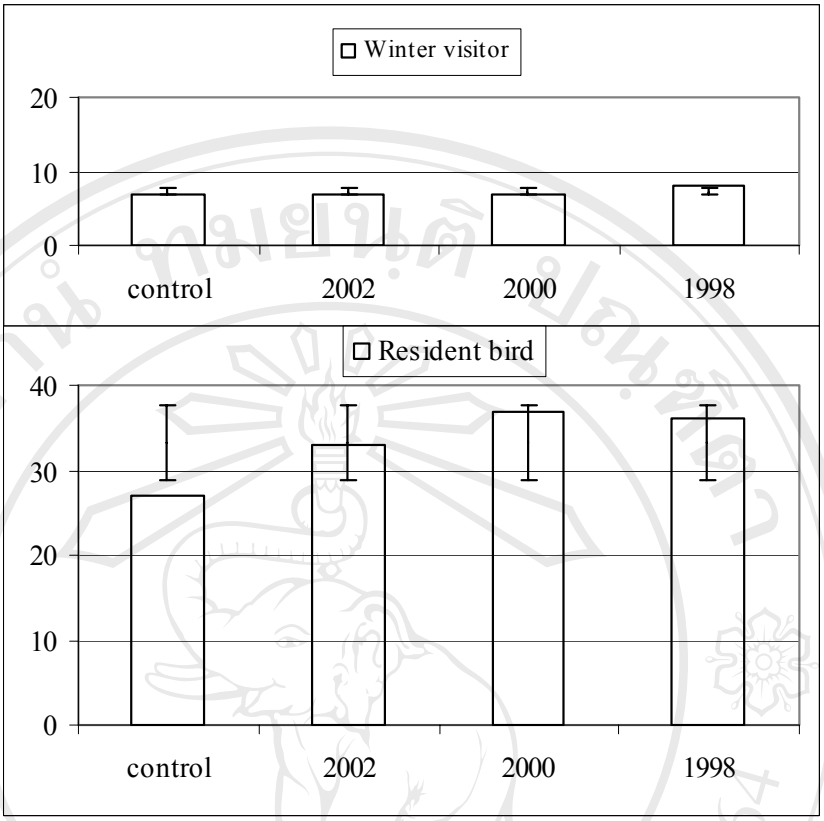


Figure 5.10 The number of residents and winter visitors bird species present.

1.2) Point Counts

From point count data, Table 3 showed bird species which presented in each treatments. Figure 5.10 showed the number of resident and migrant bird, which presented the planted plots had more number of resident bird than the control plots. Then, Birds were divided into 2 groups, forest and open habitat bird species (Lekagul and Round, 1991; Kopkate, 1998-2001). The forest-habitat bird species had more in planted plot than the control plots and the number of species of bird highest in 2000 plots, whereas the lowest in the number of open-habitat bird (Figure 5.11).

Table 3 Bird species found in each plot treatment.

	Bird common names	Non-planted control plots	Plots Planted 2002	Plots Planted 2000	Plots Planted 1998
1	Ashy Drongo	X		X	X
2	Ashy Wood-swallow		X	X	
3	Asian Brown Flycather	X		X	
4	Black-crested Bulbul			X	X
5	Black-headed Bulbul			X	
6	Black-naped Monarch			X	X
7	Black-throated Sunbird	X		X	X
8	Black-winged Cuckoo-shrike		X	X	X
9	Blue Rock-Thrush				X
10	Blyth's Leaf-Warbler		X		
11	Bulbul sp.		X	X	
12	Burmese Shrike		X	X	X
13	Chestnut-capped Babbler	X	X	X	X
14	Common Iora	X	X	X	X
15	Common Rosefinch	X			X
16	Common Tailorbird	X	X	X	X
17	Crested Bunting				X
18	Dark-necked Tailorbird		X	X	
19	Flavescent Bulbul	X	X	X	X
20	Flycatcher sp.	X	X	X	X
21	Golden-spectacled Warbler		X	X	
22	Great Tit	X	X	X	X
23	Greater Coucal			X	X
24	Greater Racket-tailed Drongo			X	
25	Green-billed Malkoha				X
26	Greenish Warbler	X	X	X	X
27	Grey Bushchat		X		
28	Grey-breasted Prinia	X	X	X	X
29	Grey-headed Flycatcher				X
30	Hair-crested Drongo	X			
31	Hill Blue Flycatcher	X	X	X	X
32	Hill Prinia	X	X	X	X
33	Hoopoe				X
34	Inornate Warbler	X	X	X	X
35	Japanese White-eye				X
36	Little Spiderhunter	X	X	X	X
37	Long-tailed Shrike	X	X		
38	Mountain Bamboo-Partridge	X		X	X
39	Olive-backed Pipit	X	X		
40	Oriental White-eye		X	X	X
41	Pale-footed Bush-Warbler	X		X	X

Table 3 Bird species found in each planted plot. (continued)

	Bird common names	Non-planted control plots	Plots Planted 2002	Plots Planted 2000	Plots Planted 1998
42	Pale-legged Leaf-Warbler			X	
43	Pied Bushchat		X		
44	Plain Flowerpecker		X	X	X
45	Prinia sp.				X
46	Puff-throated Babbler	X	X	X	X
47	Purple Sunbird	X			X
48	Red-throated Flycatcher	X	X	X	X
49	Red-whiskered Bulbul	X	X	X	X
50	Rufescent Prinia	X	X	X	X
51	Scaly breasted Munia		X	X	
52	Scarlet Minivet		X	X	
53	Shrike sp.		X		
54	Siberian Rubythroat	X		X	X
55	Sooty-headed Bulbul	X	X	X	X
56	Speckled Piculet				X
57	Streaked Spiderhunter	X	X	X	X
58	Striped Tit-Babbler	X	X	X	X
59	Sunbird sp.				X
60	Velvet-fronted Nutatch		X		
61	Warbler sp.	X	X		X
62	White-browed Piculet	X		X	X
63	White-browed Scimitar-Babbler	X	X	X	X
64	White-browed Shrike-Babbler		X	X	
65	White-rumped Munia	X	X		
66	White-rumped Shama		X	X	X
67	White-tailed Robin	X			
68	White-throated Fantail		X		
69	Yellow-eyed Babbler	X	X		X
	TOTAL	**36**	**43**	**45**	**47**

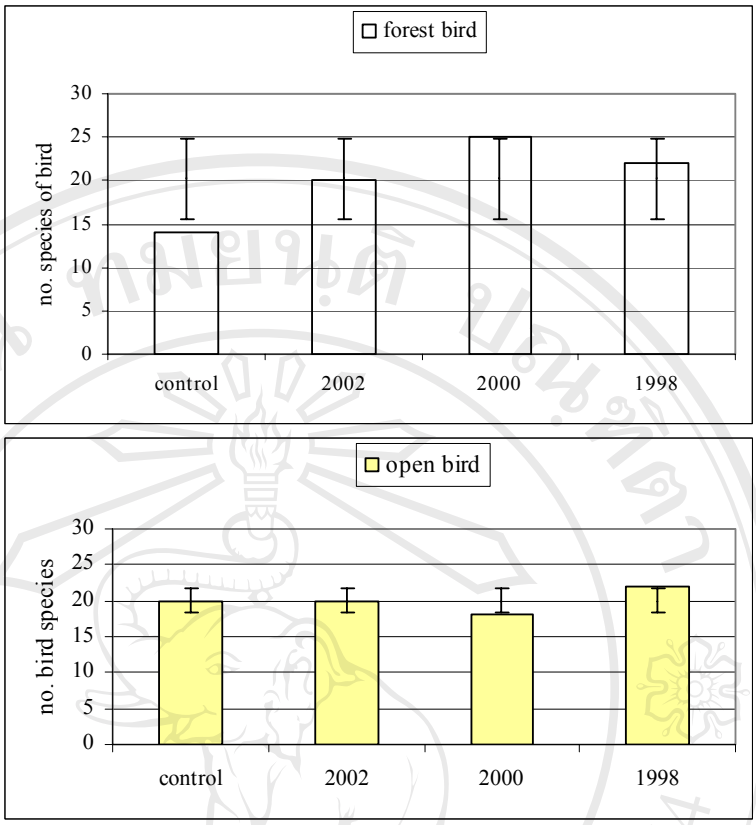


Figure 5.11 Forest and open habitat bird species observed in each treatment plot group.

Point count data were analyzed by using the program, "Distance (ver 5 beta 3)"(Thomas *et al*, 2004) to estimate the population density of birds. The population density was estimated for all surveys, for each of the twelve plots, for each plot age and divided for general habitat preference (forest vs. open) of the birds.

The estimated population density of all birds for using all plots was 29 birds / hectare. The population densities of birds by age of plots are shown in Figure 5.12. Non-planted Control plots had the highest population density of birds (39 birds / ha), followed by oldest planted plot (1998; 4.5 years old) (30 birds/ha), the youngest plot (2002) (25 birds / ha) and lastly 2000 or medium-aged (23 birds / hectare).

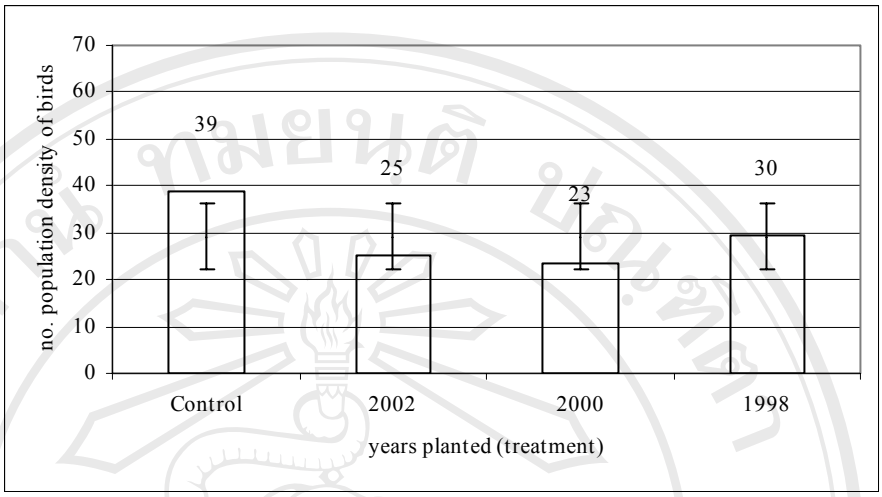


Figure 5.12 This shows the mean of population densities of birds (bird/hectare) in four ages of planted plots.

The population density of bird species characteristic of open habitats in all strata was 20 birds / hectare. The highest population density of open area birds was in non-planted control plots (32 birds / hectare), followed by the youngest planted plots (19 birds / hectare), the oldest planted plots (18 birds / hectare) and lastly the medium-aged planted plots (14 birds / hectare). The population density of birds characteristic of forest habitats in all strata was 9 birds / hectare. The highest population density of forest birds was in the oldest planted plots (12 birds / hectare), followed by the medium-aged planted plots (9 birds / hectare), non-planted control plots (8 birds / hectare) and lastly the youngest planted plots (5.80 birds / hectares) (see Fig 5.13). Figure 5.13 and 5.14 show that, as the age of the plots increases, birds of open habitats decline whilst forest birds increase.

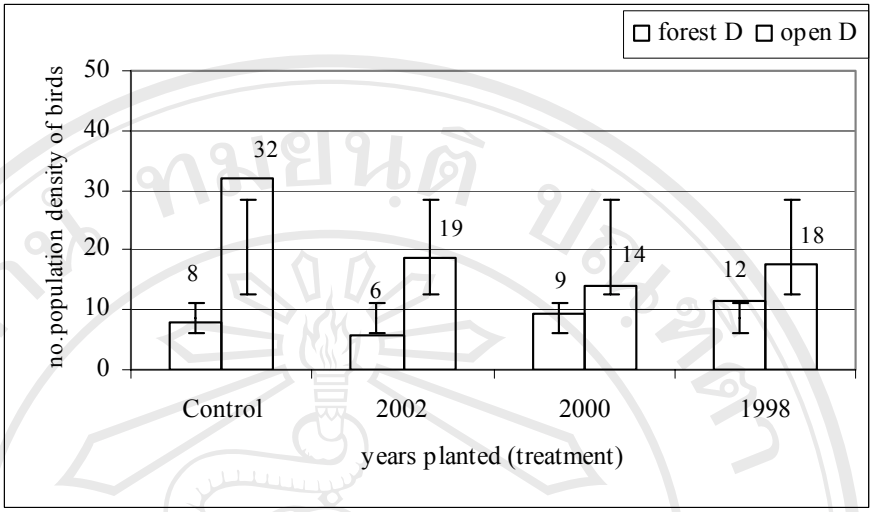


Figure 5.13 Population density of open and forest area bird in each age of planted plots. The green and yellow bars presented the population density of forest and open area birds (birds / hectare).

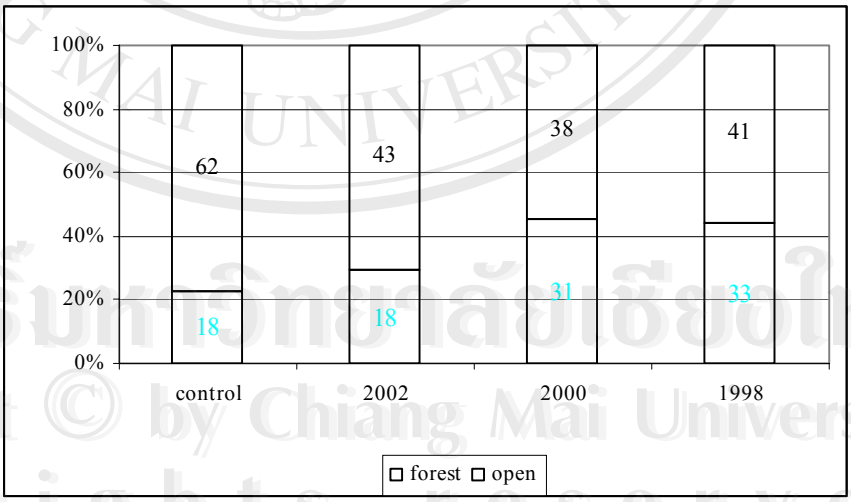


Figure 5.14 Percentage of the total number of individual of forest and open habitat birds species observed in each treatments.

Table 4 Twenty bird species with highest population densities.

	Common name	density estimate					habitat	status
		all plots combined	control	2002	2000	1998		
1	Red-whisker Bulbul	7.05	10.60	4.67	5.23	7.71	open	R
2	Chestnut-capped Babbler	3.64	11.37	0.78	0.28	2.12	open	R
3	Sooty-headed Bulbul	3.47	3.47	4.81	3.32	2.26	open	R
4	Flavescent Bulbul	2.63	6.08	2.55	0.57	1.34	open	R
5	Oriental White-eye	2.39	0.00	4.76	2.12	2.69	forest	R
6	Yellow-browed Warbler	1.73	1.77	1.27	1.77	2.12	forest	W
7	White-rumped Munia	1.23	0.14	4.77	0.00	0.00	open	R
8	Black-throated Sunbird	0.86	0.24	0.00	3.12	0.07	forest	R
9	Grey-breasted Prinia	0.78	1.56	0.92	0.42	0.21	open	R
10	Striped-tit Babbler	0.71	0.78	1.20	0.57	0.28	forest	R
11	Rufescent Prinia	0.67	0.78	1.13	0.28	0.50	open	R
12	Little Spiderhunter	0.67	0.14	1.76	0.57	0.21	forest	R
13	Common Tailorbird	0.50	0.07	0.07	1.20	0.64	open	R
14	Burmese Shrike	0.46	0.00	0.85	0.28	0.71	open	R
15	Common Iora	0.46	0.28	0.14	1.06	0.35	open	R
16	Japanese White-eye	0.46	0.00	0.00	0.00	1.84	forest	W
17	Hill-Blue Flycatcher	0.44	0.07	0.21	0.85	0.64	forest	R
18	Puff-throated Babbler	0.39	0.21	0.07	0.50	0.78	forest	R
19	Hill Prinia	0.38	1.18	0.07	0.21	0.07	open	R
20	Pale-footed Bush-Warbler	0.37	1.05	0.00	0.28	0.14	open	R

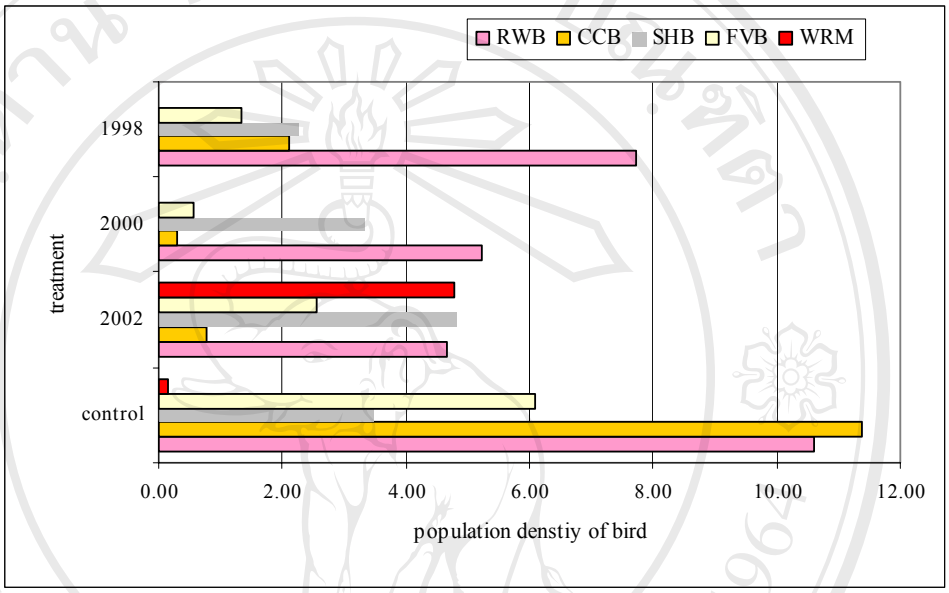


Figure 5.15 Population density of open area bird species; RWB = Red whiskered Bulbul, CCB = Chestnut-capped Babbler, SHB = Sooty-headed Bulbul, FVB = Flavescent Bulbul, WRM = White-rumped Munia. These 5 open habitat birds were selected with highest population density in Table 4.

Figure 5.16 Population density of forest bird species; OWE = Oriental White-eye, INONW = Inornated Warbler, BTS = Black-throated Sunbird, STB = Strip-tit Babbler, LSH = Little Spiderhunter. These 5 forest habitat birds were selected with highest population density in Table 4.

Table 5 Species richness, diversity and evenness in each planted plot.

indices	control	2002	2000	1998
Richness				
n	374	351	332	418
N0	36	43	45	47
R1	5.91	7.17	7.58	7.62
R2	1.86	2.30	2.47	2.30
Diversity				
λ	0.109	0.098	0.094	0.103
H’	2.69	2.87	2.95	2.90
N1	14.73	17.64	19.14	18.15
N2	9.14	10.24	10.63	9.71
Evenness				
E1	1.33	1.31	1.29	1.33
E2	0.41	0.41	0.43	0.39
E3	0.39	0.40	0.41	0.37
E4	0.62	0.58	0.56	0.54
E5	0.59	0.56	0.53	0.51

Bird data from the nearest-forest and pre-planting used to calculate the Sorensen's index in Table 6. The pre-planting data was done in May 1998 before planting the 1998 plots by Kuarak and Hitchcock to give the baseline of species composition data of bird in the area. The survey was done by MacKinnon List Method and 10 species-lists were selected. The pre-planting survey found 34 bird species (Appendix J). The survey in the natural forest done in October 2003 to January 2004 and May 2004 to August 2004 by Tidarach, the objective was to identify bird species which are potential dispersed of seed between nearby forest patches and the planted plots, as well as to compare and determine the extent to which the bird community in the planted plot had recovered to the "natural" species composition. The natural forest about 3-5 km away from the planted plots. This patch of degraded evergreen forest merged with evergreen and pine forest towards an upper ridge (Anusarnsunthorn and Elliott, 2004) Many large trees were still present, protected from felling about 18 years (Polchuanpanyo, 2000) by community forest regulation. The survey was done by the Point count method. Twenty point counts, 25 m radius were observed through the forest. The survey found 71 bird species (Appendix J).

Table 6 Sorensen's index of community similarity values, using 2 x 2 comparisons of species between plots. The index ranges from 0 to 1, 0 indicating nothing in common and 1 indicating identical communities.

Plot	Pre-planted	Control	2002	2000	1998
control	0.364	-	-	-	-
2002	0.411	0.633	-	-	-
2000	0.320	0.667	0.727	-	-
1998	0.260	0.723	0.600	0.739	-
Forest	0.139	0.374	0.491	0.552	0.492

2. BEHAVIOR SURVEY

Forty-one woody plant species were used by the birds. Nineteen were natural and 22 were trees planted by FORRU. The planted trees seemed to be more attractive to the birds. The most attractive tree species was *Melia toosandan* which had 32 bird species coming to perch and feed on insects. The, second most visited tree species was *Pinus kesiya* (26 bird species) and third was *Erythrina subumbrans* (21 bird species). Tree species, planted by FORRU, that were the most attractive to birds were *Melia toosandan, Erythrina subumbrans, Prunus cerasoides* (15 bird species) and *Spondias axillaries* (14 bird species). Eight bird species fed on fruit of 18 woody plant species. Black-crested Bulbul, Flavescent Bulbul, Red-whiskered Bulbul, Sooty-headed Bulbul, Oriental White-eye, Common Iora and White-browed Scimitar Babbler were 7 resident birds which fed on fruits and Japanese White-eye was one migrant bird which fed on fruit. The Table 7 showed the woody planted which used by bird in the all area and appendix M and N showed which plant species used by which bird.

Table 7 Woody plant species using by bird.

	Plant species	planted/natural	no. of bird sp.	Activity	dispersers
1	*Artocarpus lanceolata*	planted	1	FI	mammal
2	*Aralia montana*	natural	4	FF	bitrd
3	*Albizia sp.*	natural	15	P, FI	wind
4	*Balakata baccata*	planted	1	P	bird, mammal
5	*Bambusa tulda* Roxb.	natural	5	P	wind
6	*Bauhinia purpurea*	natural	6	P, FN	wind
7	*Bischofia javanica*	planted	1	P	bird, mammal
8	*Broussonetia papyrifera*	natural	1	FF	bird
9	*Callicarpa arborea var. arborea*	natural	14	P, FN, FF, FI	bird
10	*Castanopsis calathiformis*	planted	1	P	mammal
11	*Castanopsis diversifolia*	planted	1	FN	mammal
12	*Debregeasia longifolia*	natural	8	P, FF, FI	bird
13	*Erythrina stricta*	planted	14	FN, FI	wind
14	*Erythrina subumbrans*	planted	21	FN, FI	wind
15	*Eurya acuminata DC. var. wallichiana Dyer*	planted	1	FF	bird
16	*Ficus alltissima*	planted	2	P	bird, mammal
17	*Ficus hispida var. hispida*	natural	1	P	bird, mammal
18	*Ficus semicordata var. semicordata*	natural	2	P, FI	bird, mammal
19	*Ficus subulata var. subulata*	planted	3	P, FF, FI	bird, mammal
20	*Heynea trijuca*	natural	1	P	mammal
21	*Hovenia dulcis*	planted	2	FI	bird
22	*Lithocarpus elegans*	planted	1	P	mammal
23	*Litsea cubeba*	natural	15	FF, FI	mammal
24	*Litsea salicifolia*	planted	1	FI	mammal
25	*Macaranga denticulata*	planted	3	P, FI	mammal
26	*Machilus bombycina*	natural	1	P	mammal
27	*Malastoma malabalicum*	natural	6	P, FF, FI	bird
28	*Manglietia garrettii*	planted	1	P	mammal
29	*Markharnia stipulata var. kerri*	planted	1	FN	wind
30	*Melia toosandan*	planted	32	P, FI	mammal
31	*Musa sp.*	planted	4	P, FN	mammal
32	*Nyssa javanica*	planted	1	P	bird, mammal
33	*Phyllanthus emblica*	natural	2	P	mammal
34	*Pinus kesiya*	natural	26	P, FI	wind
35	*Prunus cerasoides*	planted	15	P, FF, FI	bird, mammal
36	*Prunus persica Batsch*	natural	2	P	bird, mammal
37	*Quercus semiserrata*	planted	1	P	mammal
38	*Solanum torvum*	natural	1	FF	bird, mammal
39	*Spondias axillaris*	planted	14	P, FI	mammal
40	*Trema orientalis*	natural	7	P, FF, FI	wind
41	*Pavetta tomentosa*	natural	1	FF	mammal

[1] P=perching; FF=feeding on fruit; FN=feeding on nectar; FI=feeding on insects

Figure 5.17 Woody plant species using by birds.

Aralia montanna

Broussnetia papyrifera

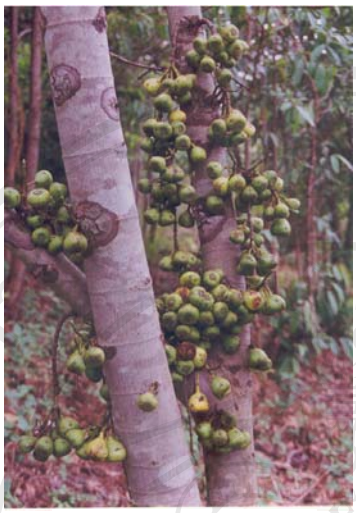
Callicarpa arborea

Erythrina subumbrans

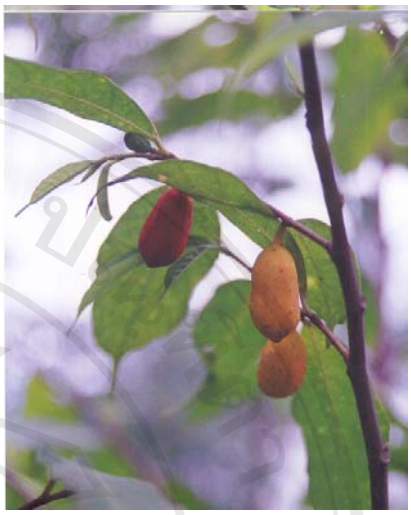
Solanum torvum

Litsea cubeba

Figure 517. Woody plant species using by birds.(continued)



Ficus hispida



Ficus subulata

Treama orientalis

Ficus semicordata

Musa sp.

Malastoma malabalicum

Figure 5.17 Woody plant species using by birds.(continued)

Prunus perica

Prunus cerisoides

Litsea salicifolia

Table 8 Characteristics of 8 framework tree species at age 4 years old and the numbers of bird species that used them.

Frame work tree species	No.of bird sp. observed in each species	Density (trees/ha)	Mean GBH (cm)	Mean Height (cm)	Mean Width crown (cm)
1. *Melia toosandan*	32	106	37.5	970.3	423.3
2. *Erythrina subumbrans*	21	75	38.1	684.0	602.0
3. *Prunus cerasoides*	15	94	16.3	595.3	389.6
4. *Spondias axillaris*	14	175	27.8	734.9	439.1
5. *Ficus subulata* (2 year olds)	3	44	37.0	248.4	191.7
6. *Hovenia dulcis*	2	238	6.6	254.0	161.4
7. *Markharnia stipulata*	1	44	15.0	111.1	77.5
8. *Gmelina arborea*	0	50	22.2	367.3	252.0

Correlations between the number of species of bird using each framework tree species and the "importance value" (IV) of each species, calculated from data presented in Table 8 are shown in Fig 5.18-5.20. The important value (IV) of each tree species done by the number of tree density multiplied by the average value of each character in term; GBH, height and width of canopy. The tree species which appear above the trend line are *Melia toosandan*, *Erythrina subumbrans Prunus cerasoides.* This means these three species were particularly attractive to bird species and at the *M. toosandan* was the most attractive. *Spondias axillaries* had the highest IV's but was positioned below the trend line, which means this species was less attractive compared with the other tree species.

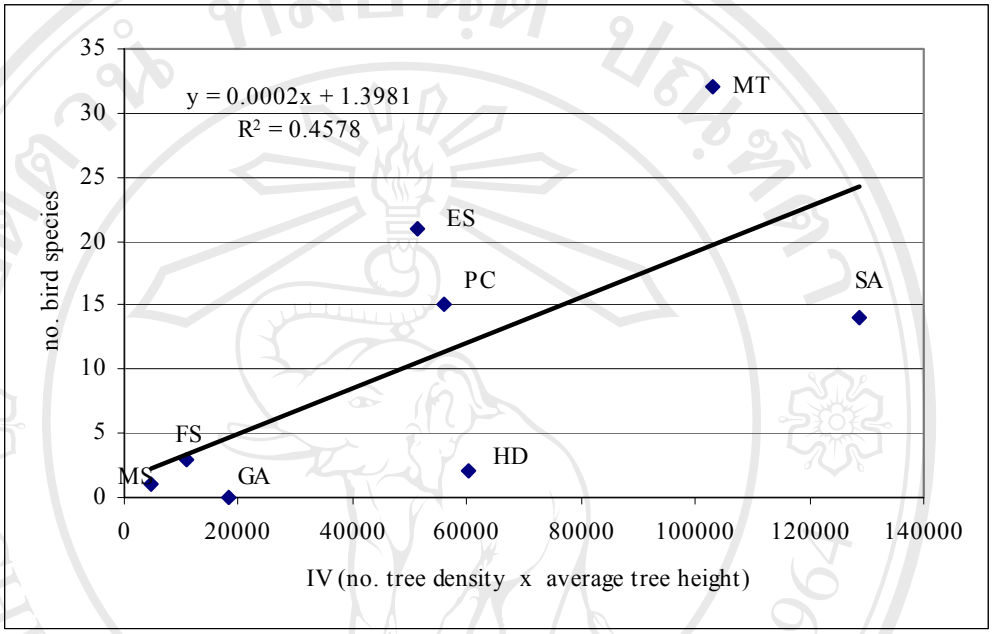


Figure 5.18 Correlation between Importance Value (IV) based on tree height and number of bird species which used each trees. (MT = *Melia toodandan*, ES = *Erythrina subumbrans*, PC = *Prunus cerasoides*, SA = *Spondias axillaries*, FS = *Ficus subulata*, HD = Hovenia dulcis, MS = Markharnia stipulate, GA = *Gmelina arborea)* ($P_{95\%}$ = 0.065, R^2 = 046)

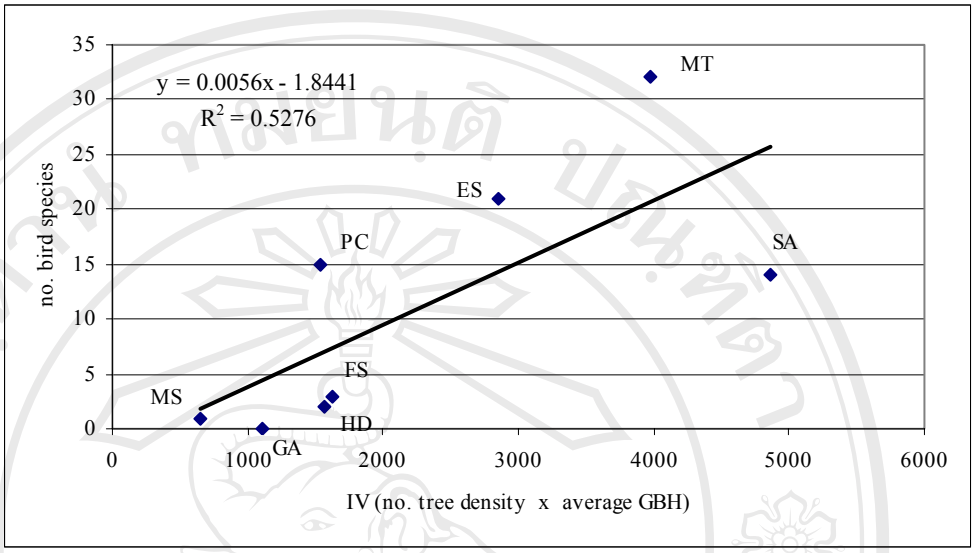


Figure 5.19 Correlation between IV based on mean of GBH and number of bird species which used each tree. ($P_{95\%} = 0.04$, $R^2 = 0.53$)

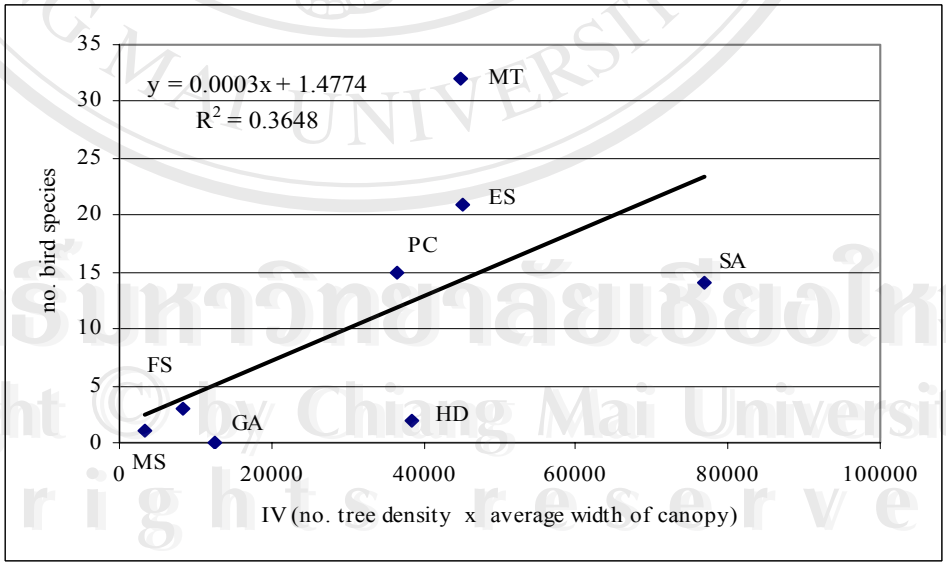


Figure 5.20 Correlation between IV based on crown width and number of bird species which used each tree. ($P_{95\%} = 0.11$, $R^2 = 0.37$)

4. BASIC VEGETATION SURVEY

Basic vegetation surveys were carried out twice in the dry (Mar-03) and the rainy (Sep-03) seasons. Tree density was measured once in dry season.

4.1 Percentage of canopy cover

The percentage of canopy cover done in twelve plots was divided into two groups; within and surrounding study plots.

4.1.1 Within twelve study plots

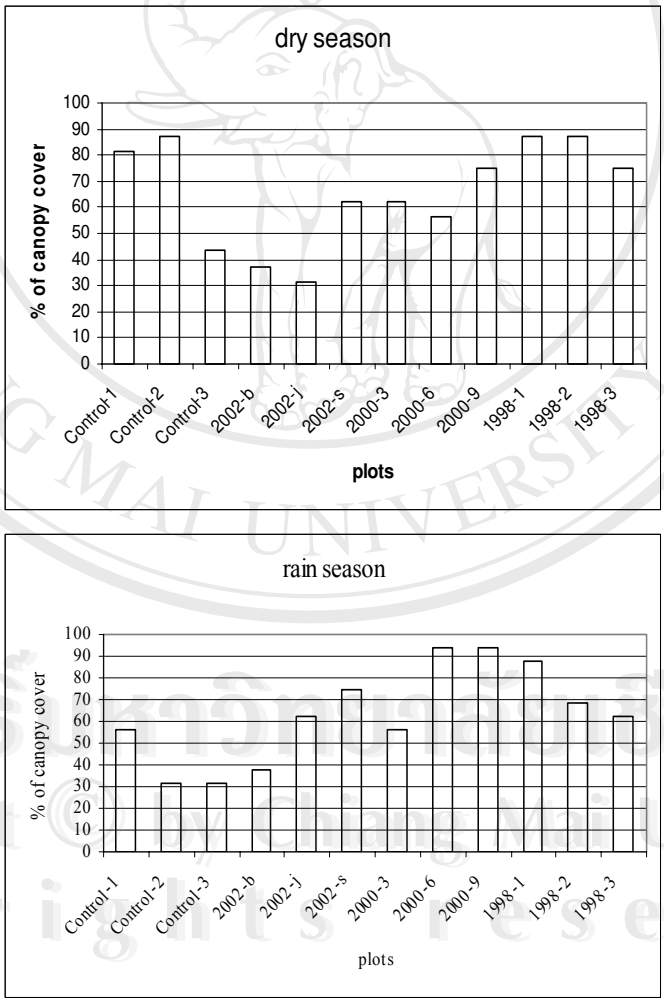


Figure 5.21 Percentage of canopy cover inside each plot.

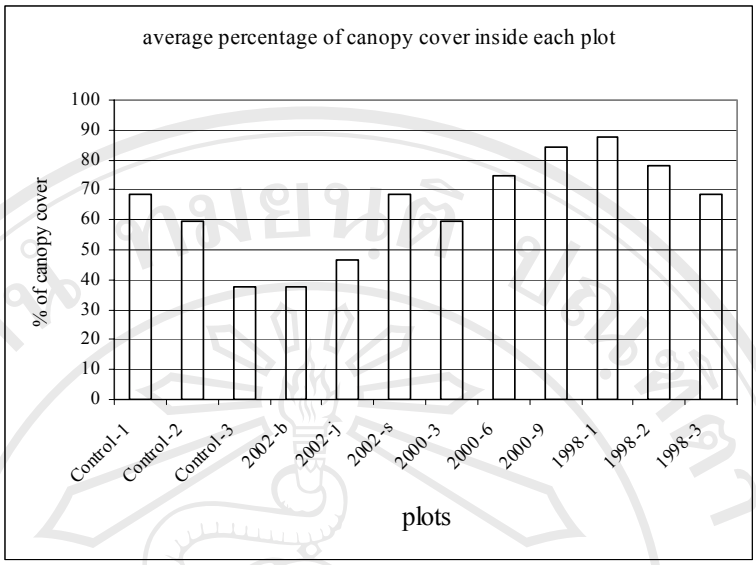


Figure 5.22 Average percentage of canopy cover inside each plot.

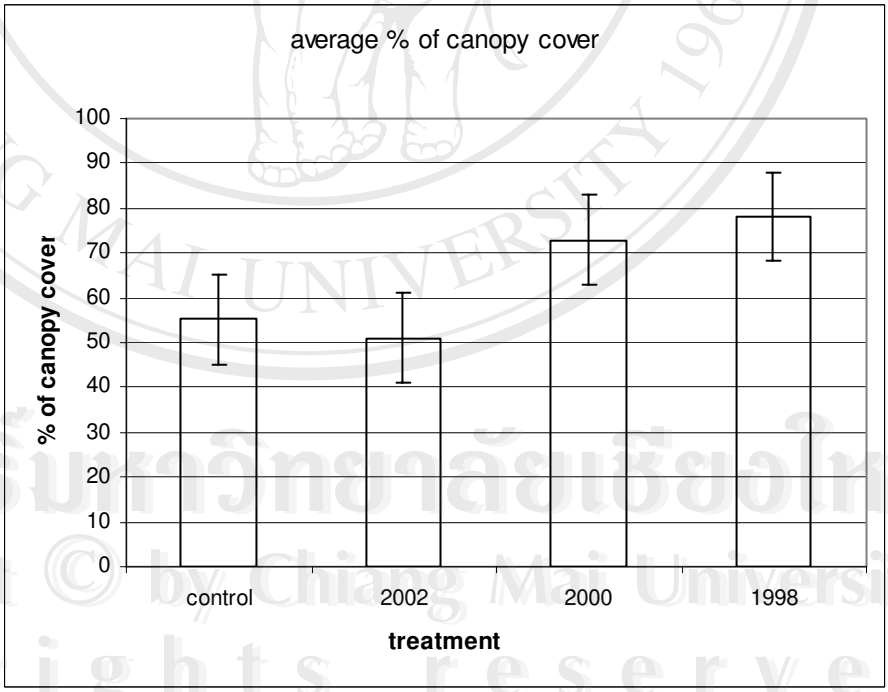


Figure 5.23 Average percentage of canopy cover inside plot in each four treatments.

4.1.2 Surrounding plots

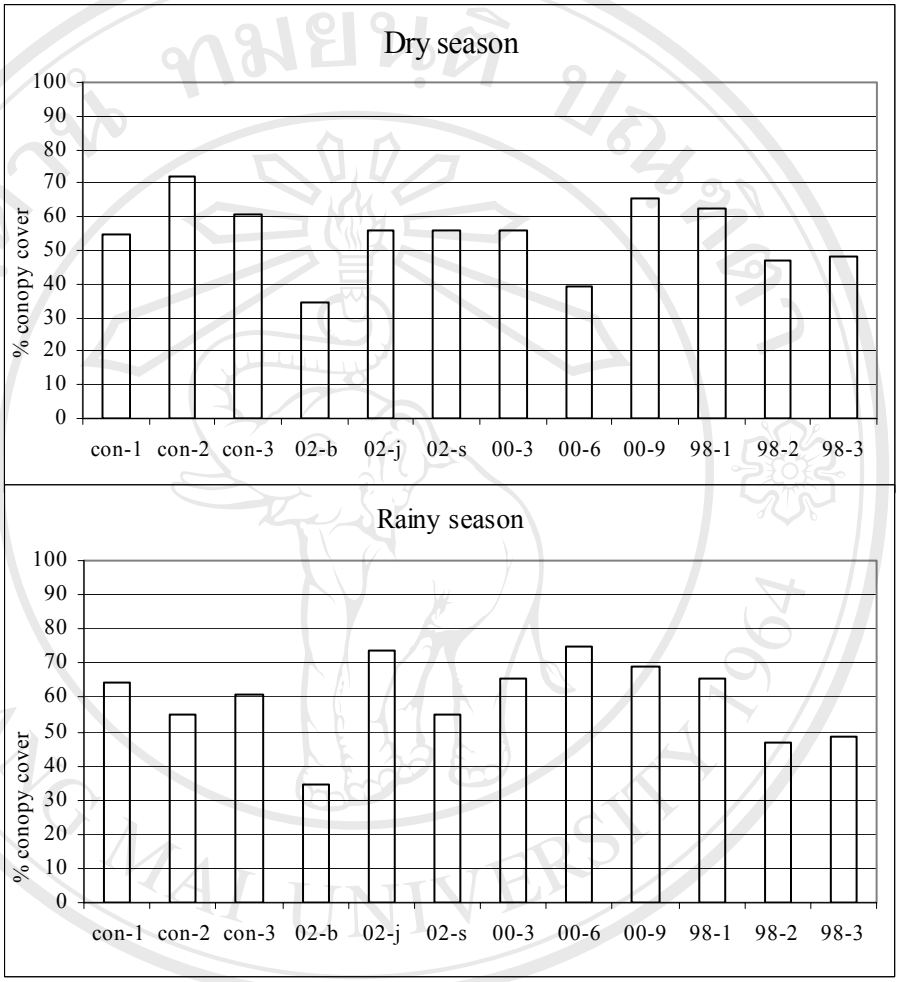


Figure 5.24 The average percentage of canopy cover surrounding each plot. (Of these, twelve study plots were done the canopy cover in surrounding by 4 replicates.).

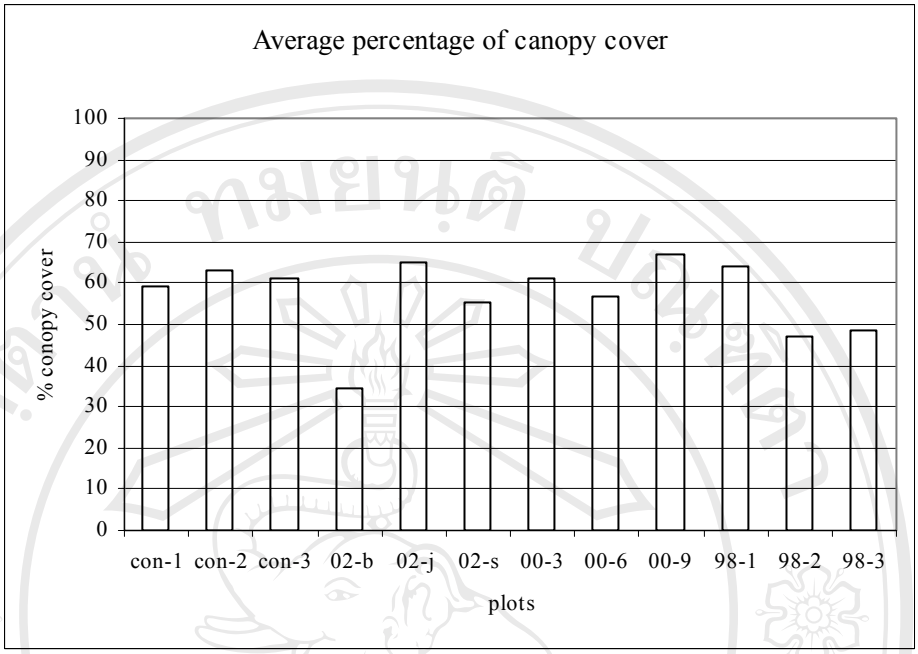


Figure 5.25 The average percentage of canopy cover surrounding plots.

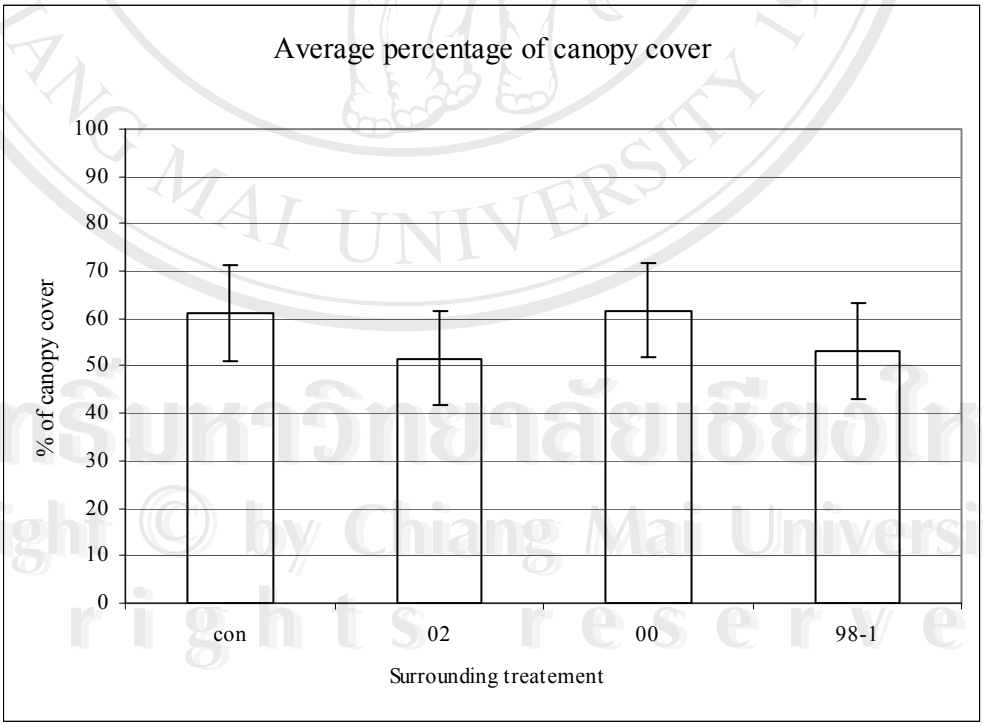


Figure 5.26 The average percentage of canopy cover surrounding plots each four treatment.

4.2 Percentage of ground vegetation cover

4.2.1 Within twelve study plots

Table 9 The percentage ground vegetation cover inside the plot in wet and dry seasons.

plots	Grass		Fern		Herbs		Seedling		Bare	
	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet
control-1	46.9	70.6	12.2	2.5	9.1	12.7	0.3	0.3	31.5	13.9
control-2	38.5	57.0	7.7	5.0	9.4	8.9	0.8	0.1	43.7	29.0
control-3	23.1	55.8	3.8	0.9	23.1	19.4	0.0	0.0	50.0	23.9
2002-b	10.5	22.5	22.8	9.1	18.9	61.9	0.6	0.0	47.2	6.6
2002-j	14.3	19.8	6.6	3.6	19.2	30.0	6.3	1.1	53.7	45.5
2002-s	20.3	39.4	17.0	6.1	11.6	30.2	0.3	0.0	50.8	24.4
2000-3	14.2	28.6	2.7	3.8	12.8	35.8	2.2	3.2	68.2	28.6
2000-6	39.8	16.1	7.3	0.3	25.2	25.0	4.8	0.0	22.8	58.6
2000-9	17.0	16.6	0.0	0.6	10.0	33.1	0.0	0.6	73.0	49.1
1998-1	23.7	26.9	2.8	0.8	13.7	21.8	0.7	0.1	59.2	50.4
1998-2	10.8	15.3	7.3	1.9	9.3	32.2	0.5	0.0	72.2	50.6
1998-3	12.7	47.5	2.3	0.3	20.7	39.5	1.9	0.0	62.3	12.7

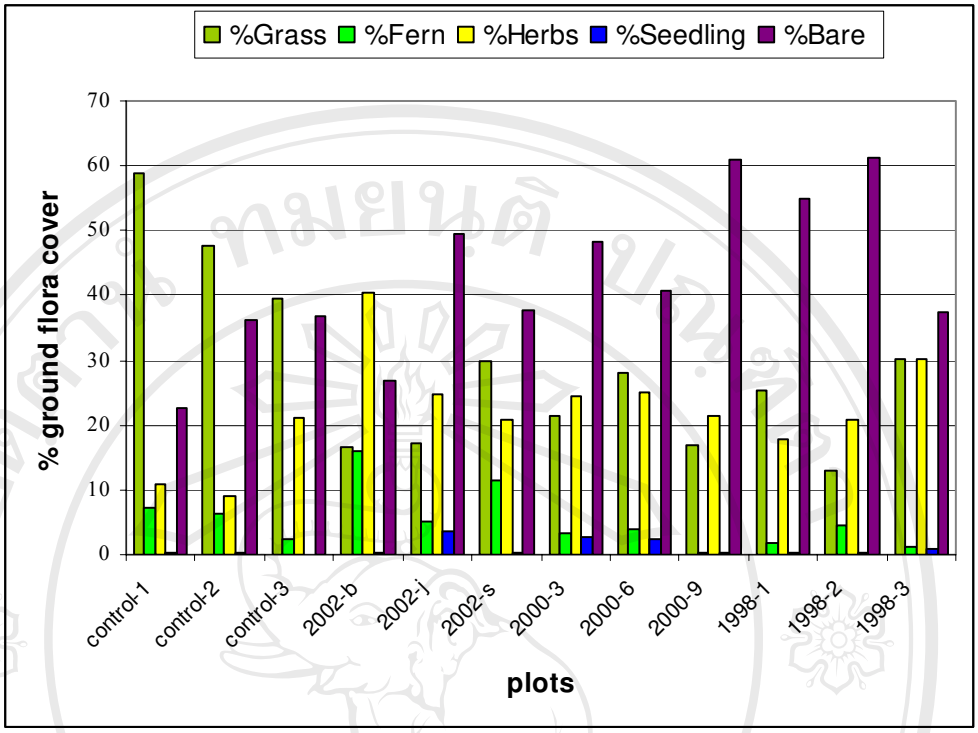


Figure 5.27 The average percentage of ground vegetation cover in the study plots.

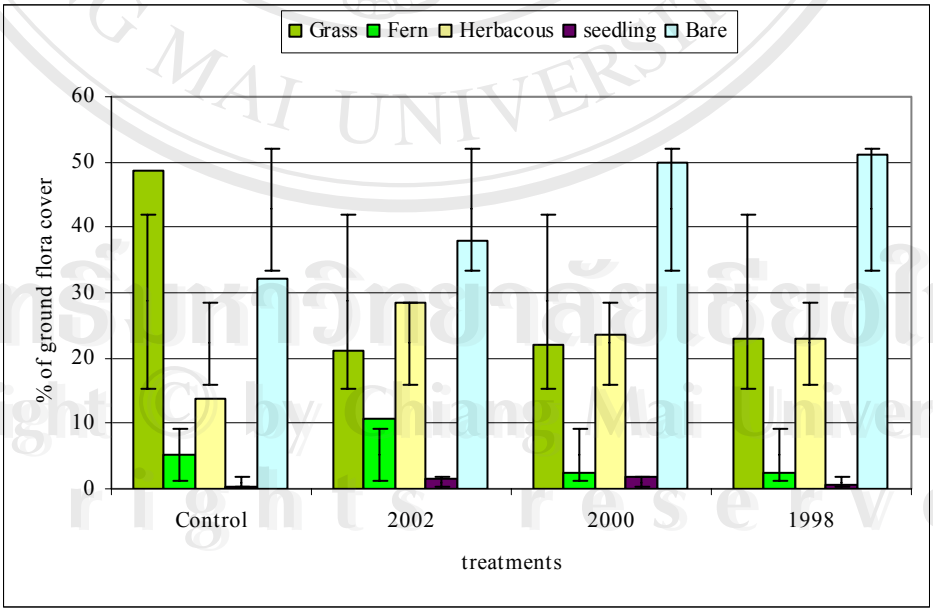


Figure 5.28 The average percentage of ground vegetation cover in the study treatments.

4.2.2 Surrounding plots

Table 10 The percentage of ground vegetation cover inside the plot between wet and dry seasons.

Plot	Grasses		Ferns		Herbs		Seedlings		Bare	
	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet
Control-1	31.99	37.59	7.20	4.57	9.88	15.69	0.86	0.73	50.06	41.43
Control-2	24.88	30.04	7.66	5.23	6.85	17.62	0.98	2.03	59.63	45.08
Control-3	20.34	30.39	3.09	1.56	18.43	23.28	0.74	0.23	57.40	44.53
2002-b	24.30	38.24	16.05	10.90	13.09	30.63	1.56	0.08	45.00	20.16
2002-j	26.13	28.40	3.38	1.80	13.17	14.92	7.09	3.02	50.28	51.93
2002-s	26.52	36.78	11.52	6.20	11.47	29.20	1.63	0.98	48.87	26.84
2000-3	21.71	32.62	7.97	8.15	9.70	22.42	1.01	1.02	59.61	35.80
2000-6	33.41	32.27	5.29	2.51	14.82	20.20	4.35	0.83	42.13	44.20
2000-9	28.40	42.19	0.39	0.27	10.66	17.50	0.23	0.86	60.31	39.18
1998-1	42.80	35.29	3.80	2.19	7.57	12.77	1.27	1.21	44.56	48.54
1998-2	23.94	36.21	8.32	5.63	11.55	17.42	1.09	0.80	55.11	39.95
1998-3	19.97	30.51	7.30	9.45	18.94	28.16	0.82	2.19	52.97	29.69

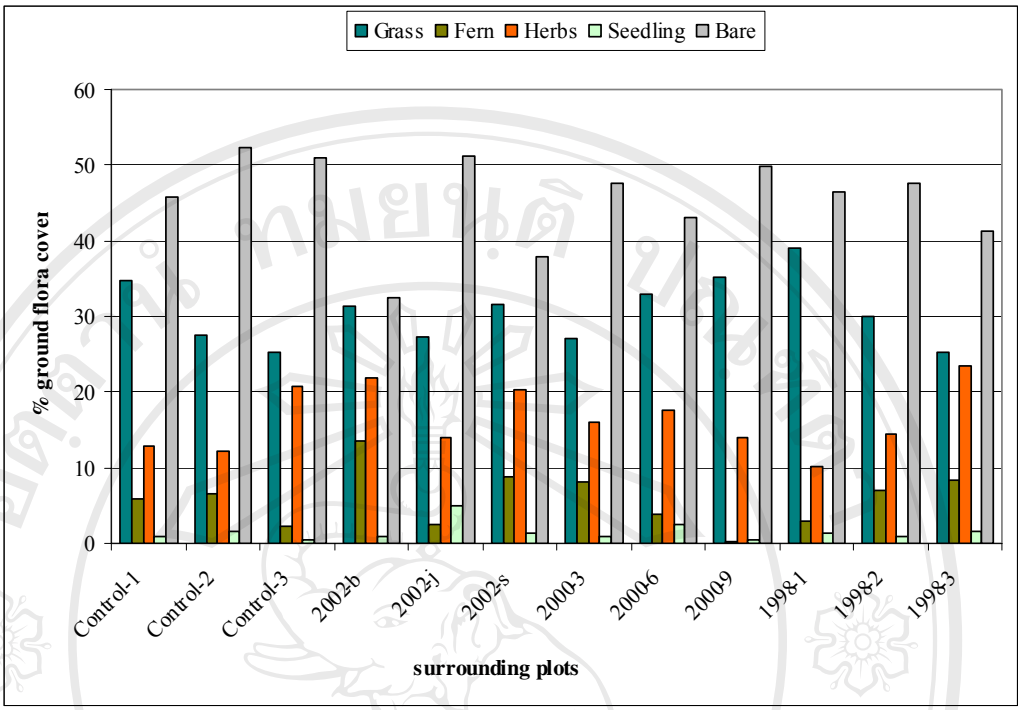


Figure 5.29 The average percentage of ground vegetation cover surrounding the study plots.

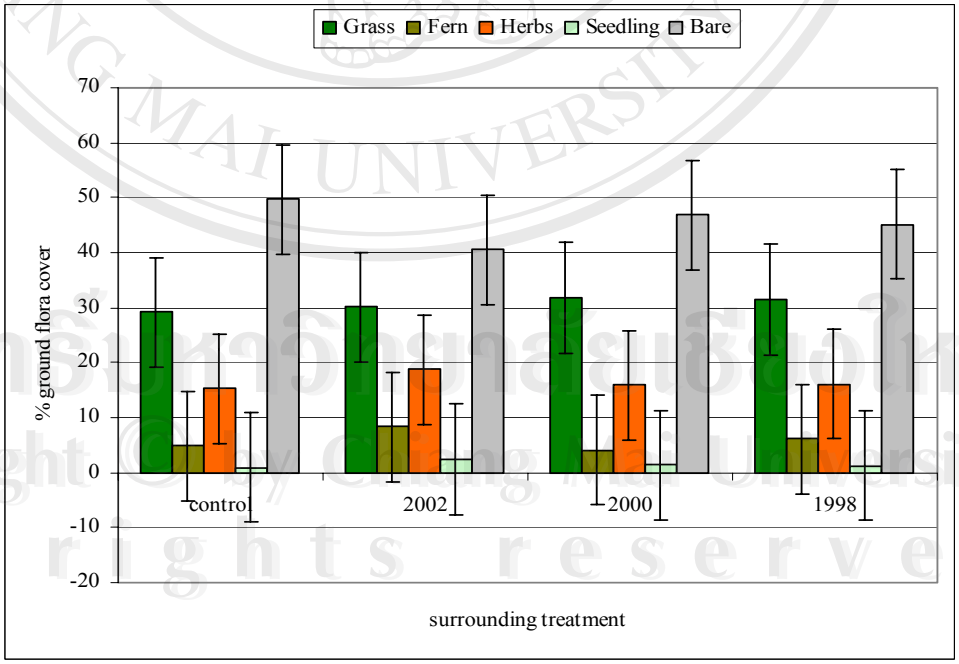


Figure 5.30 The average percentage of ground vegetation cover surrounding the study plots.

4.3 The trees structure

4.3.1 Within 12 study plots

4.3.1.1 Trees density

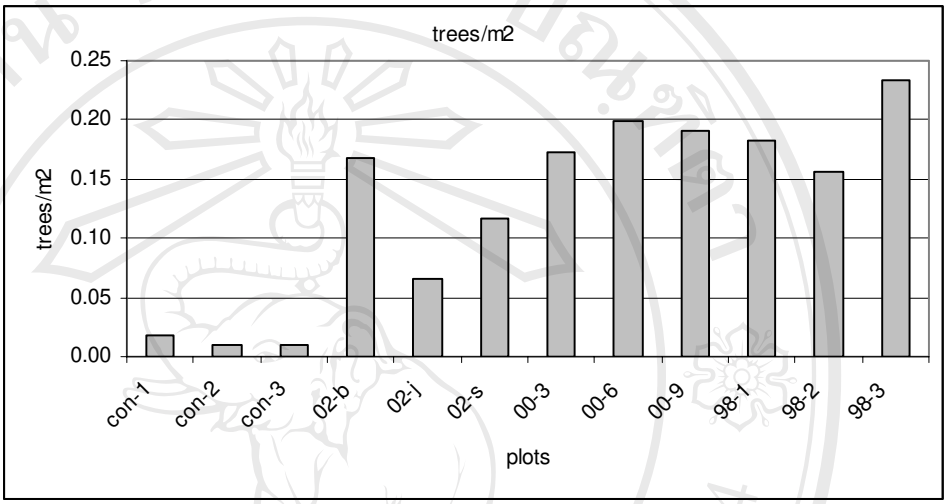


Figure 5.31 The number of tree / m^2 in the 12 study plots.

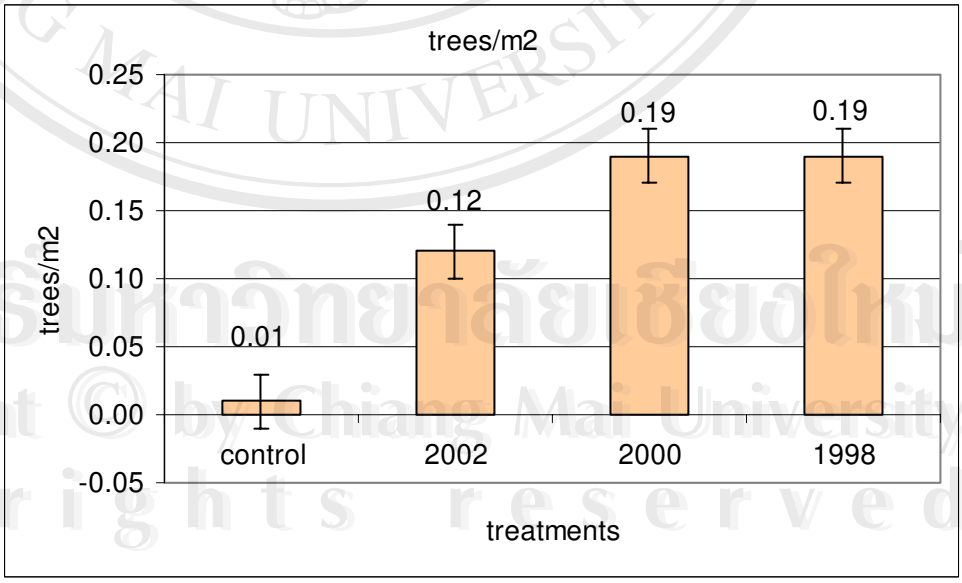


Figure 5.32 The number of tree / m^2 in 4 treatments.

4.3.1.2 Height of trees on the plots

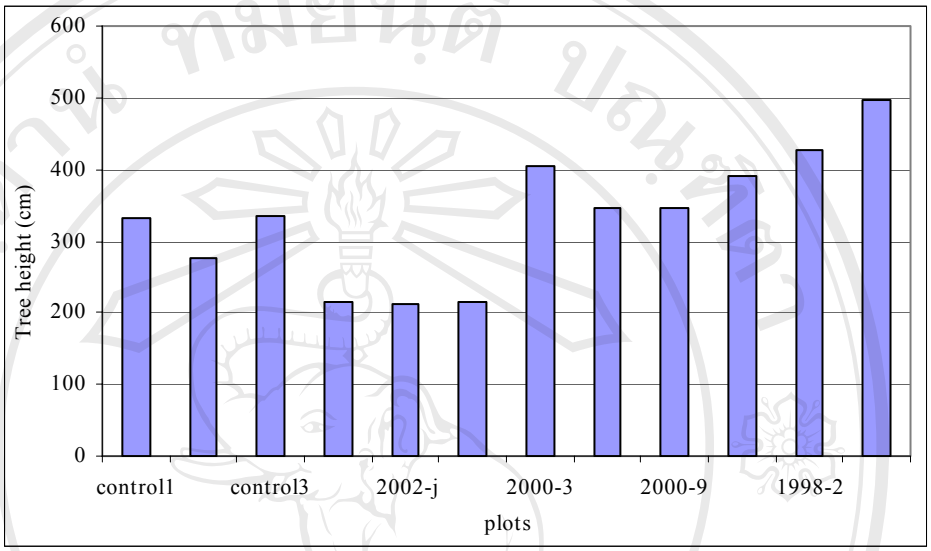


Figure 5.33 The average tree height in 12 study plots.

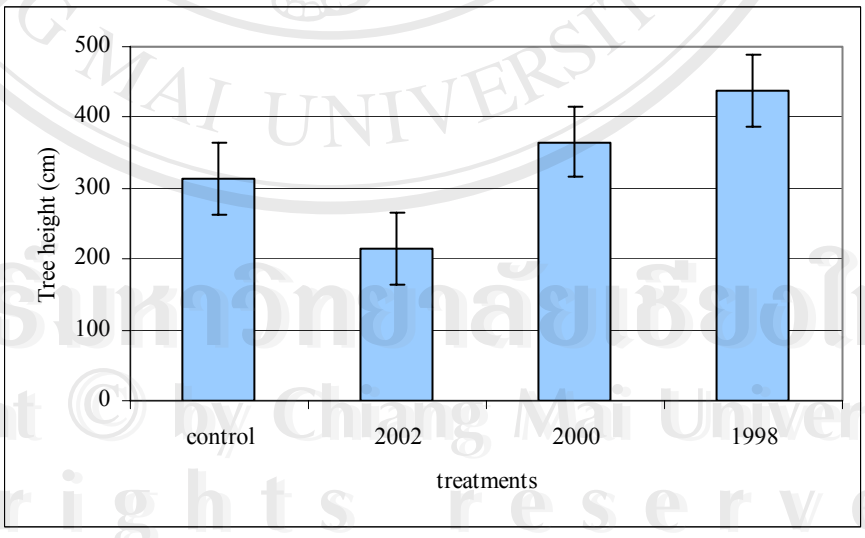


Figure 5.34 The average tree height in 4 treatments.

4.3.1.3 DBH of trees in each plots

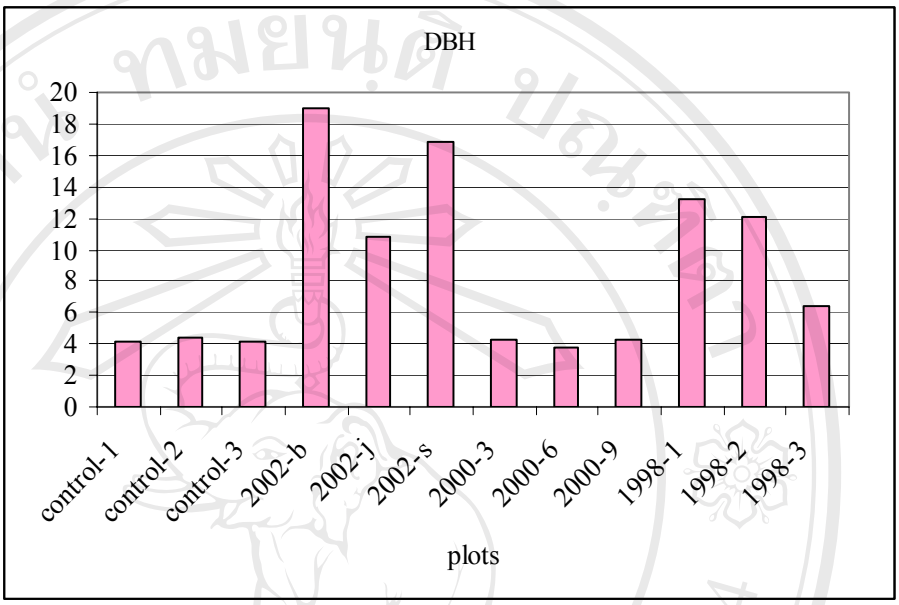


Figure 5.35 The average of DBH in 12 study plots.

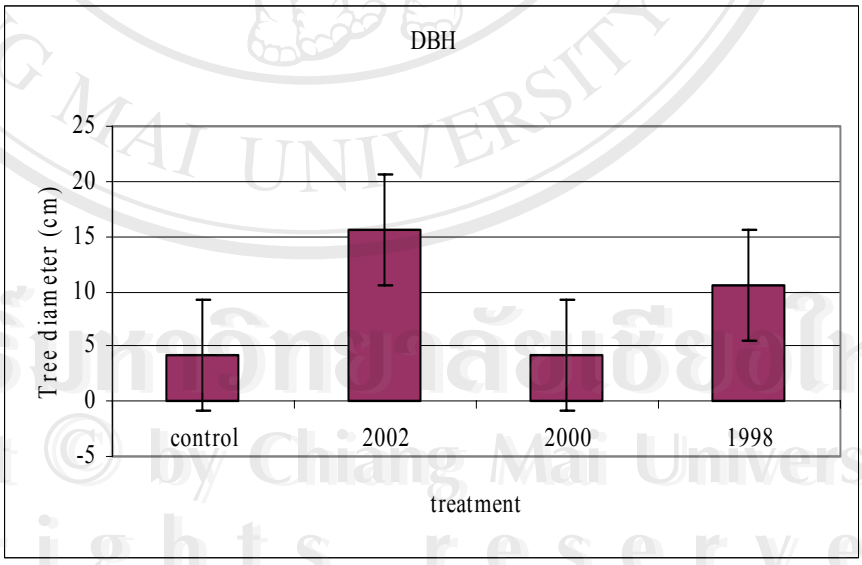


Figure 5.36 The average of DBH in 4 treatements.

4.3.1.4 The average of Canopy width in the plots

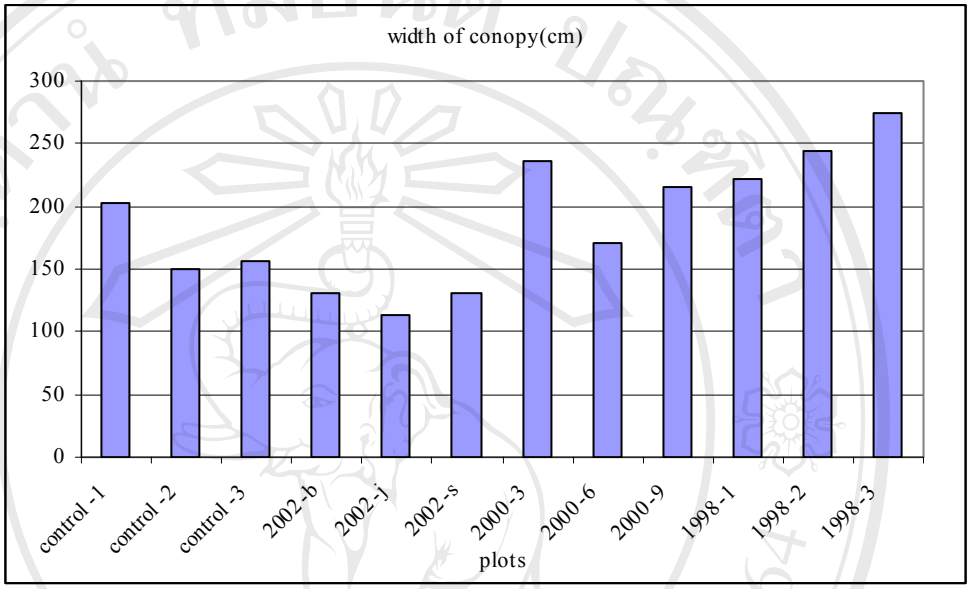


Figure 5.37 The average of Canopy width in 12 study plots.

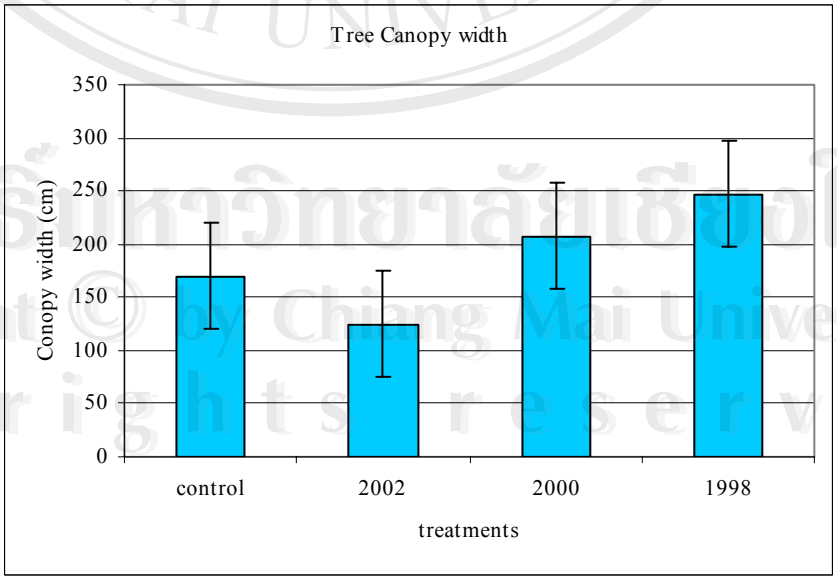


Figure 5.38 The average of Canopy width in 4 treatments.

4.3.2 Plots surrounding

4.3.2.1 Trees density

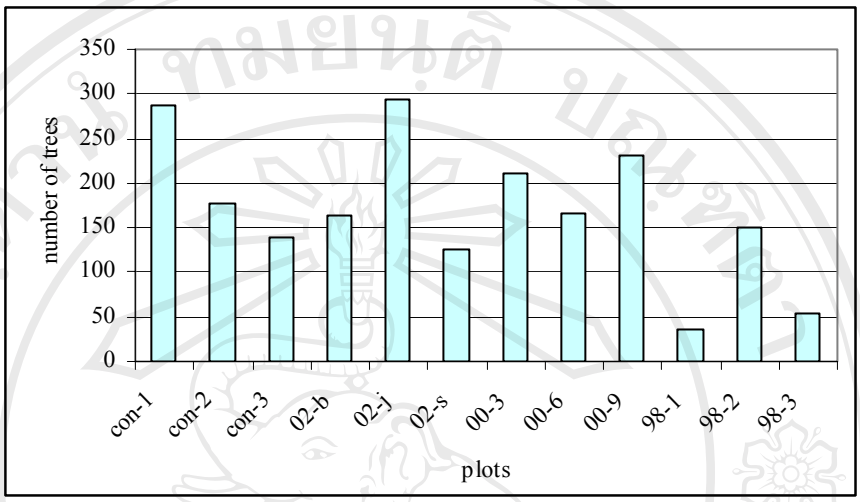


Figure 5.39 The number of trees in surrounding study plot of 12 plots.

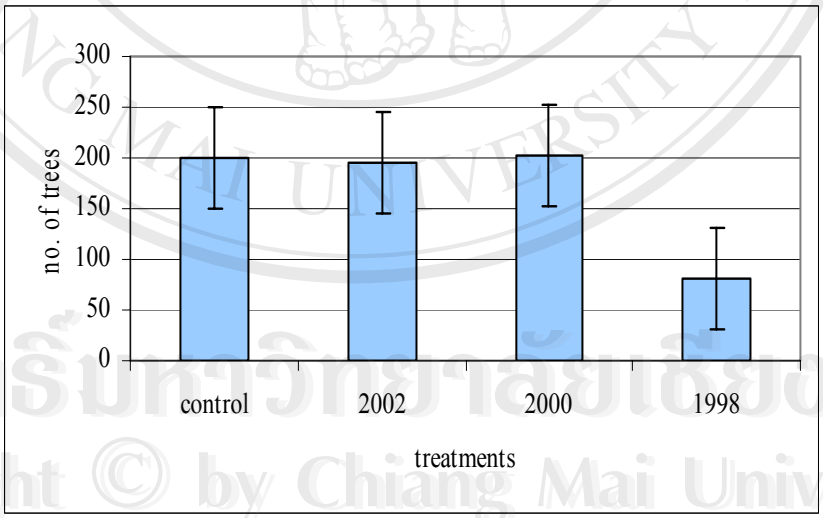


Figure 5.40 The number of trees in surrounding plot of 4 treatments.

4.3.2.2 Height of trees in surrounding study plots

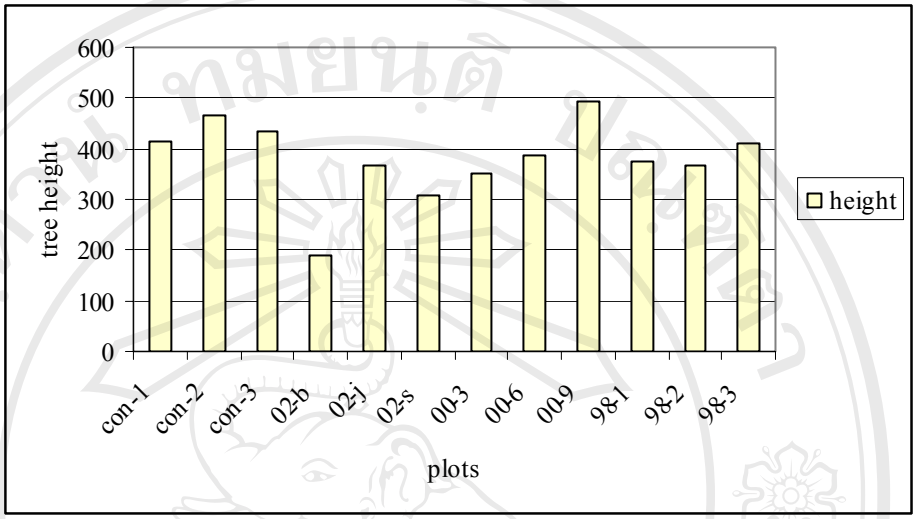


Figure 5.41 The average of trees height in surrounding the study plot of 12 plots.

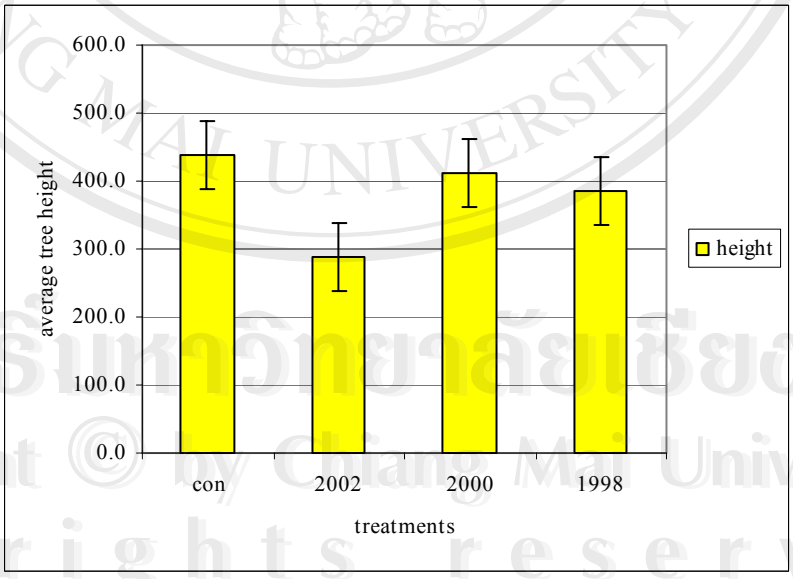


Figure 5.42 The average of trees height in surrounding the study plot of 4 treatments.

4.3.2.3 DBH of trees in surrounding study plots

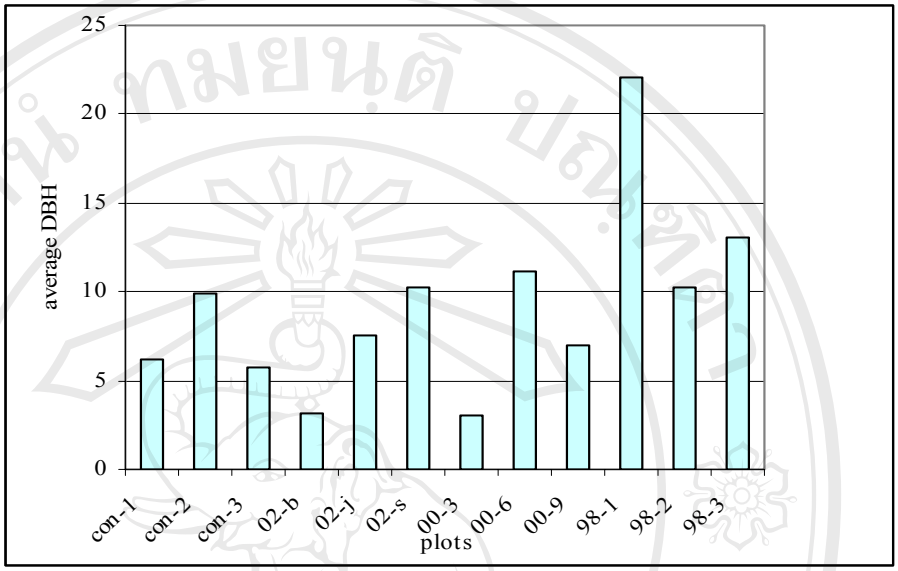


Figure 5.43 The average of trees diameter of surrounding the study plot in 12 plots.

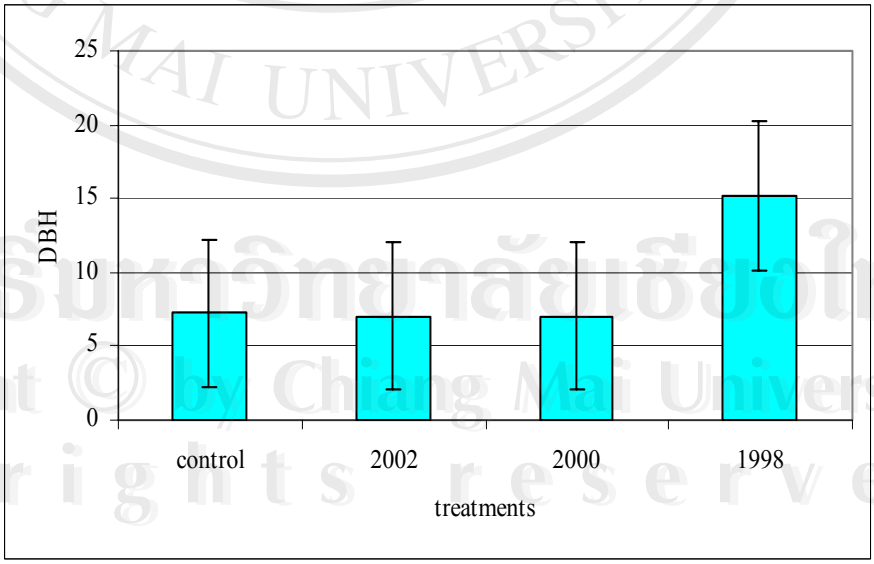


Figure 5.44 The average of trees diameter of surrounding the study plot in 4 treatments.

4.3.2.4 The average of Canopy width the plots

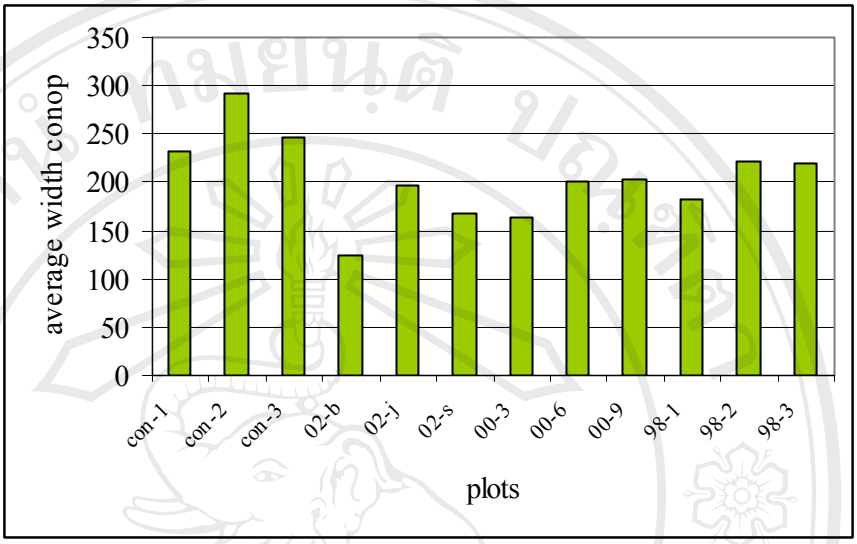


Figure 5.45 The average of canopy width of surrounding the study plot in 12 plots.

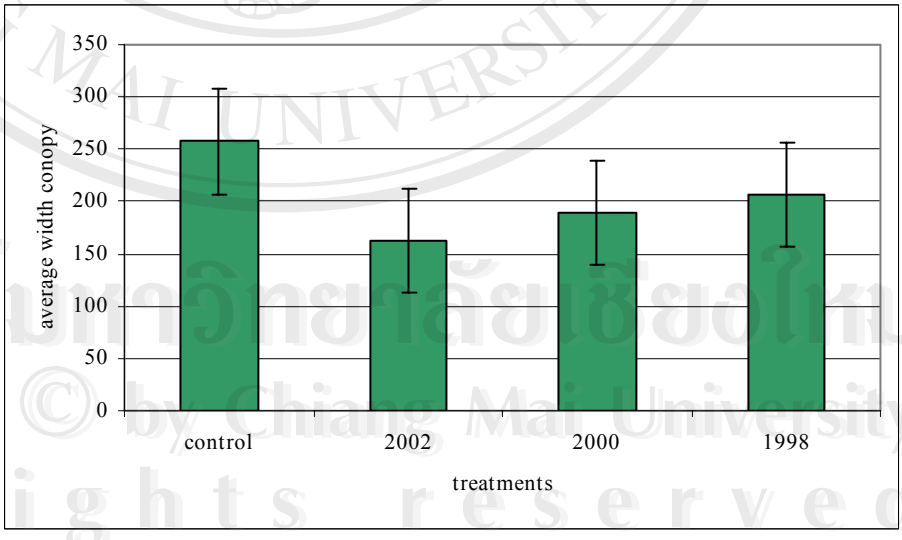


Figure 5.46 The average of canopy width of surrounding the study plot in 4 treatments.

Correlations of basic vegetation data were used to explain the structure of the study plots and surrounding study plots. Figures 5.47-5.55 show correlations within the study plots. Figures 5.56-5.67 show the correlations in the surrounding of study plots.

In study plots

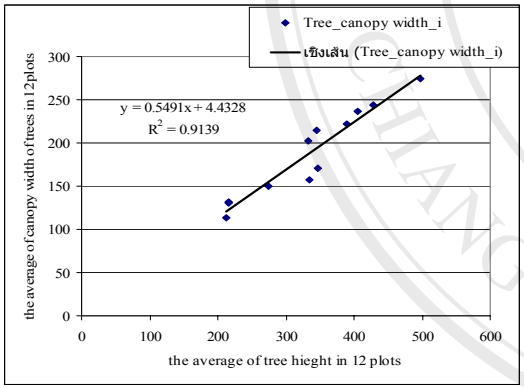


Figure 5.47 The average of tree crown width was positively correlated with the average of tree height ($P_{95\,\%}$ = 1.21E-06, R^2 = 0.91).

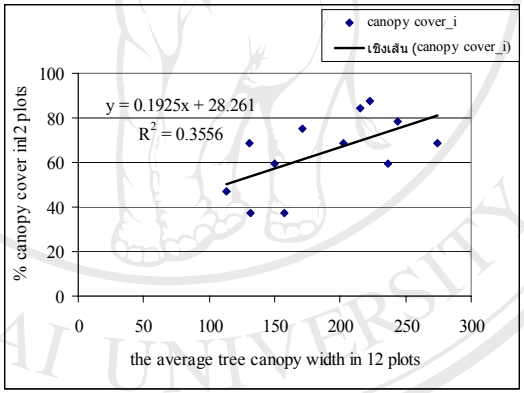


Figure 5.48 The percentage of canopy cover was positively correlated with the average of trees crown width ($P_{95\,\%}$ = 0.04, . R^2 = 0.36).

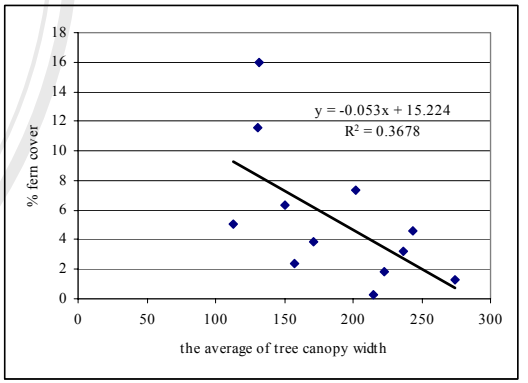


Figure 5.49 Percentage fern cover was negatively correlated with average of tree crown width ($P_{95\,\%}$ = 0.04, . R^2 = 0.37).

In study plots (continued)

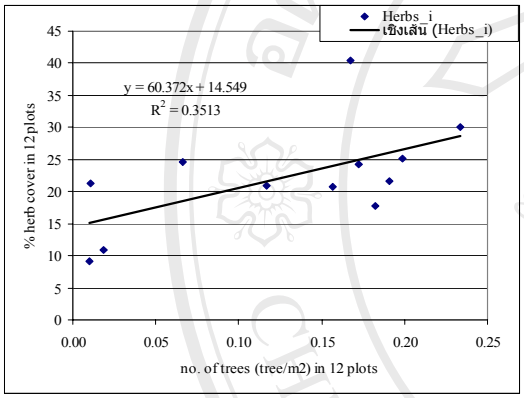


Figure 5.50 Percentage herb cover was correlated with tree density ($P_{95\,\%}$ = 0.04, R^2 = 0.35).

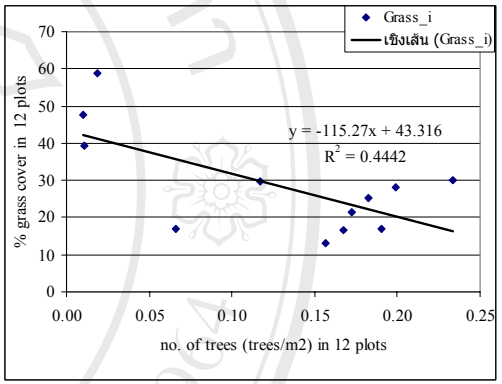


Figure 5.51 Percentage grass cover was negatively correlated with the number of trees (trees/m2) ($P_{95\,\%}$ = 0.02, R^2 = 0.44).

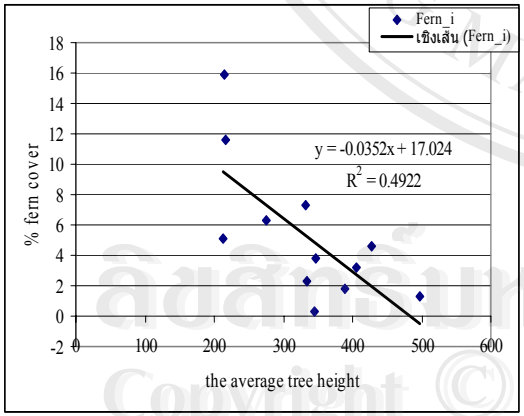


Figure 5.52 Percentage of fern cover was negatively correlated with the average of trees height ($P_{95\,\%}$ = 0.01, R^2 = 0.49).

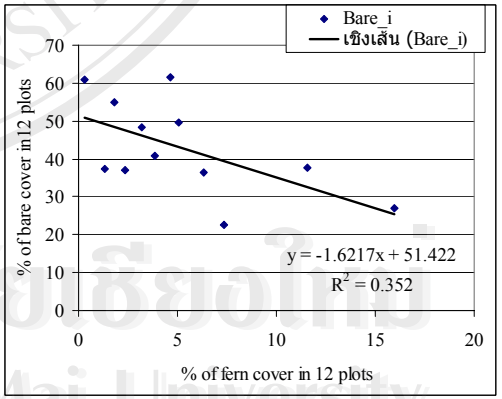


Figure 5.53 Percentage of bare area was negatively correlated with the percentage of fern cover ($P_{95\,\%}$ = 0.04, $R^2$0.352).

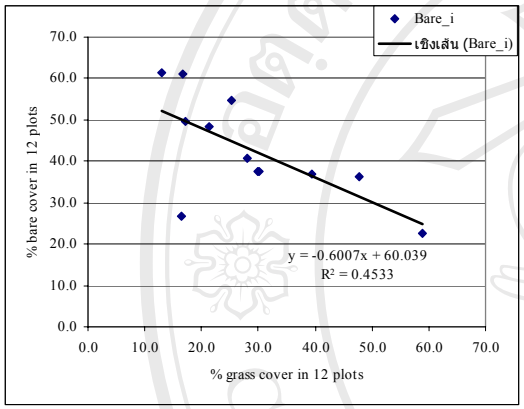


Figure 5.54 Percentage of bare area was negatively correlated with the percentage of grass ($P_{95\,\%} = 0.02$, $R^2 = 0.45$).

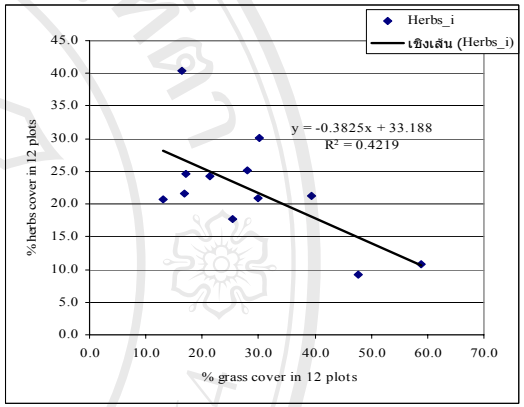


Figure 5.55 The percentage of herb cover was negatively correlated with the percentage of grass ($P_{95\,\%} = 0.02$, $R^2 = 0.42$).

Surrounding study plots

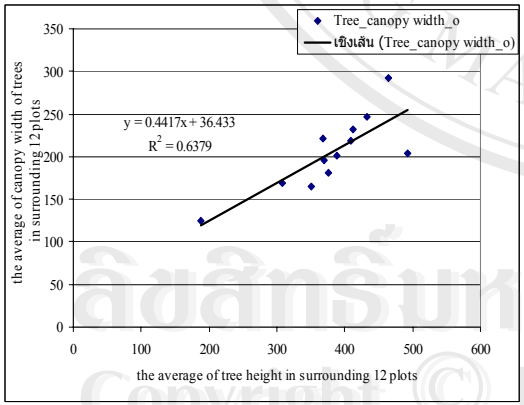


Figure 5.56 Average of trees crown width was positively correlated with the average tree height ($P_{95\,\%} = 0.002$, $R^2 = 0.64$).

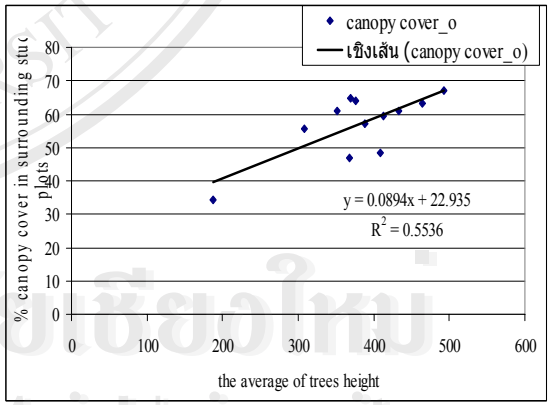


Figure 5.57 Percentage of canopy cover was positively correlated with the average of tree height ($P_{95\,\%} = 0.006$, $R^2 = 0.64$).

Surrounding study plots (continued)

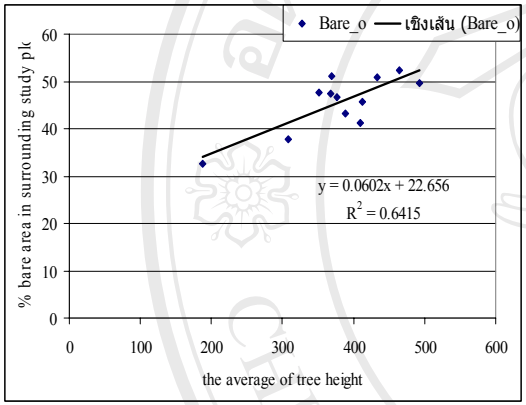


Figure 5.58 Percent bare area was positively correlated with the average of tree height ($P_{95\,\%} = 0.002$, $R^2 = 0.64$).

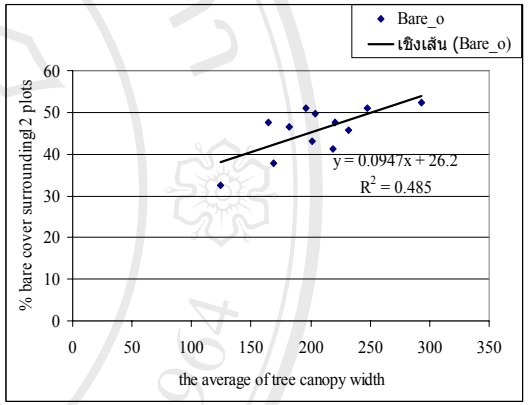


Figure 5.59 Percentage of bare area was positively correlated with the average of tree crown width ($P_{95\,\%} = 0.01$, $R^2 = 0.49$).

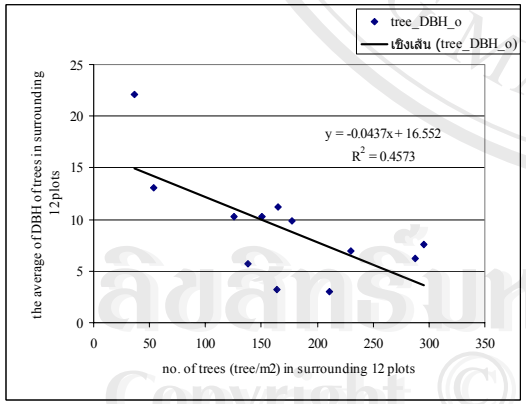


Figure 5.60 Average of DBH of trees was negatively correlated with the number of trees ($P_{95\,\%} = 0.02$, $R^2 = 0.46$).

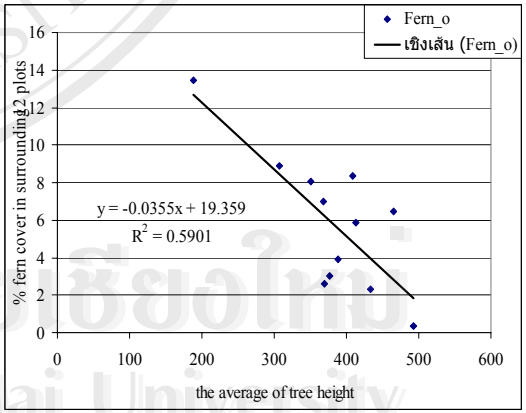


Figure 5.61 Percentage fern cover was negatively correlated with the average of tree height ($P_{95\,\%} = 0.004$, $R^2 = 0.59$).

93

Surrounding study plots (continued)

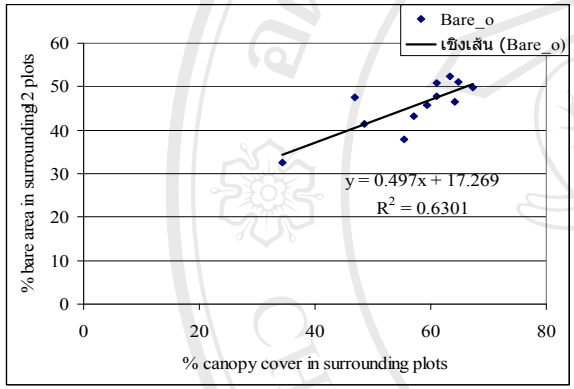


Figure 5.62 Percentage bare area was positively correlated with the percentage of canopy cover ($R^2 = 0.63$).

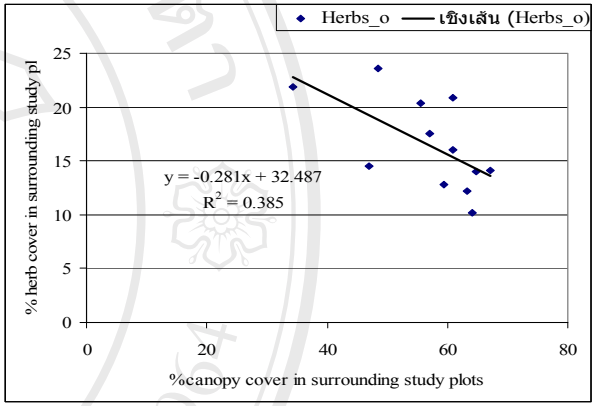


Figure 5.63 Percentage herb cover was negatively correlated with the percentage of canopy cover ($R^2 = 0.39$).

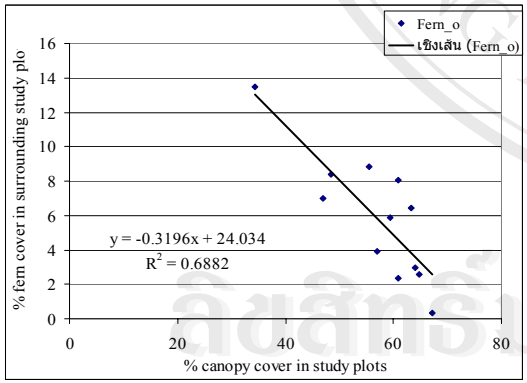


Figure 5.64 Percentage fern cover was negative correlated with the percentage of canopy cover ($R^2 = 0.69$).

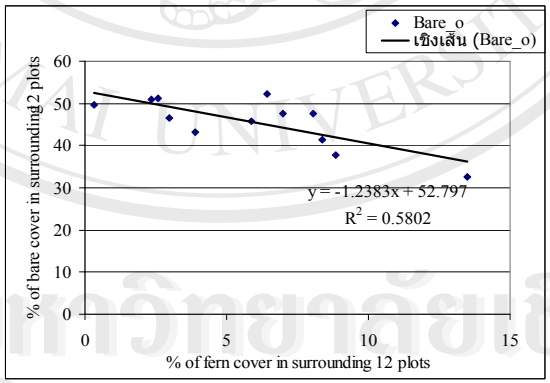


Figure 5.65 Percentage bare area was negativel correlated with the percentage of fern cover ($R^2 = 0.58$).

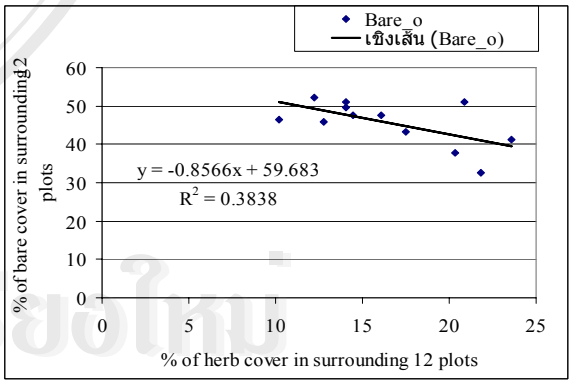


Figure 5.66 Percentage bare area was negatively correlated with the percentage of herb cover ($R^2 = 0.38$).

The correlation between bird and vegetation structure of the study plots.

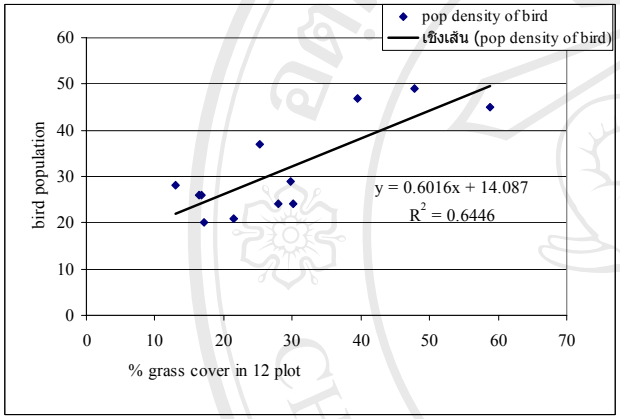


Figure 5.67 Bird population density was positively correlated with percentage grass cover ($R^2 = 0.65$).

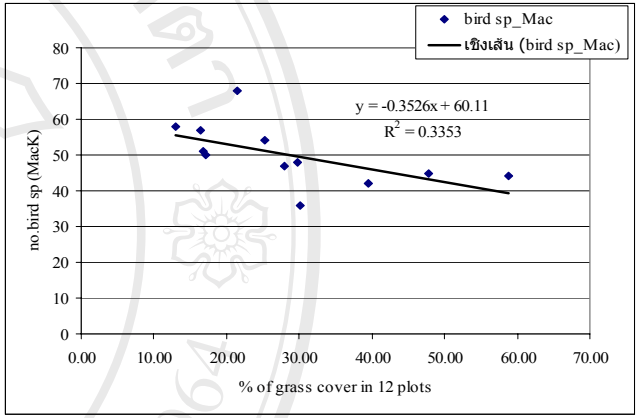


Figure 5.68 Bird species richnesw was negatively correlated with percentage grass cover ($R^2 = 0.33$).

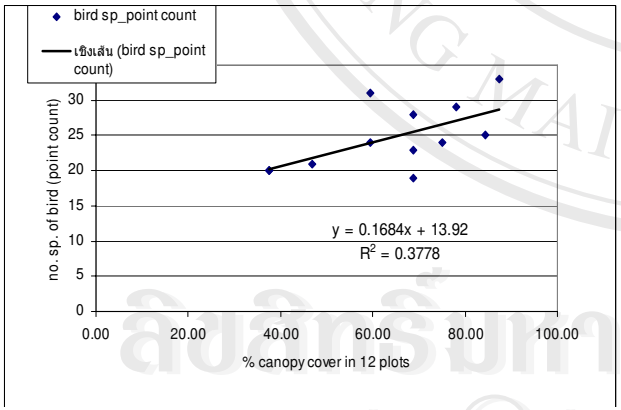


Figure 5.69 Species richness (point count) was positively correlated with percentage canopy cover ($R^2 = 0.38$).

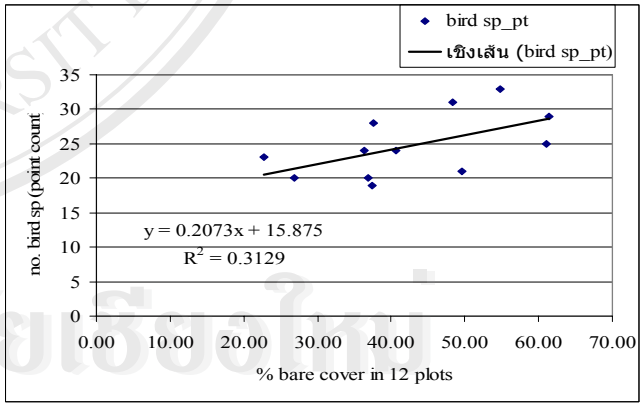


Figure 5.70 Bird species richness was positively correlated with percentage bare area ($R^2 = 0.31$).

95

The correlation between bird and vegetation structure of the study plots (continued).

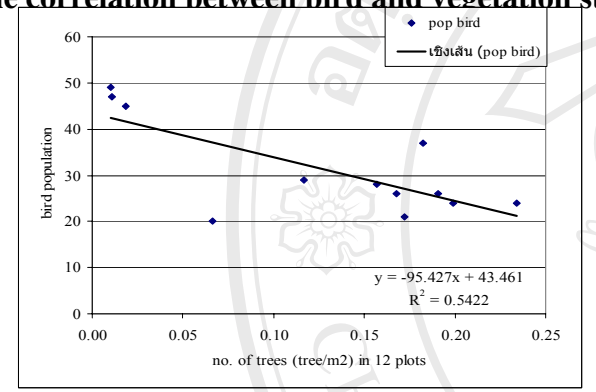


Figure 5.71 Bird population density was negatively correlated with number of trees ($R^2 = 0.54$).

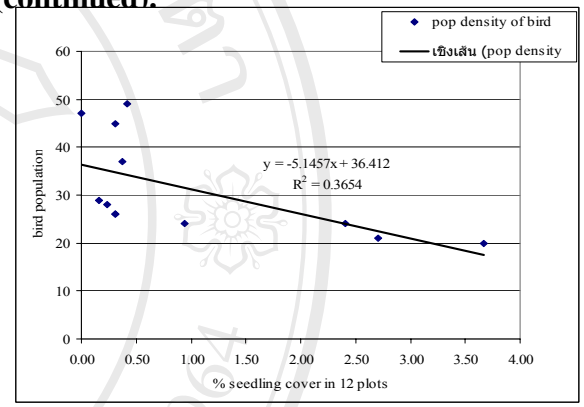


Figure 5.72 Bird population density was negatively correlated with percentage of seedling cover ($R^2 = 0.37$).

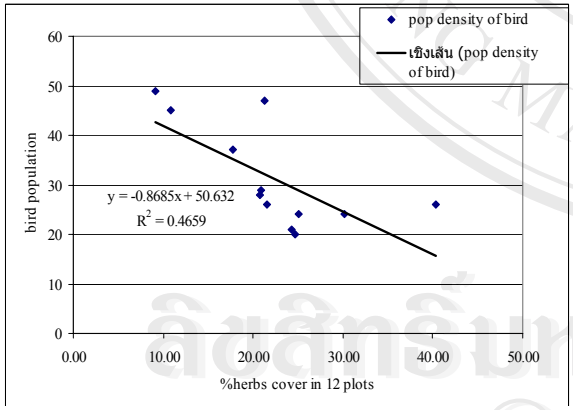


Figure 5.73 Bird population density was negatively correlated with percentage of herbs cover ($R^2 = 0.47$).

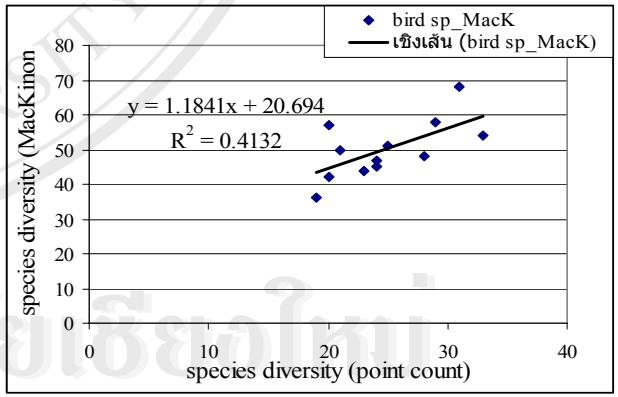


Figure 5.74 Bird diversity of point count and Mackinnon was positively correlated either ($R^2 = 0.41$).

96

The correlation between bird and vegetation structure of the surrounding plots.

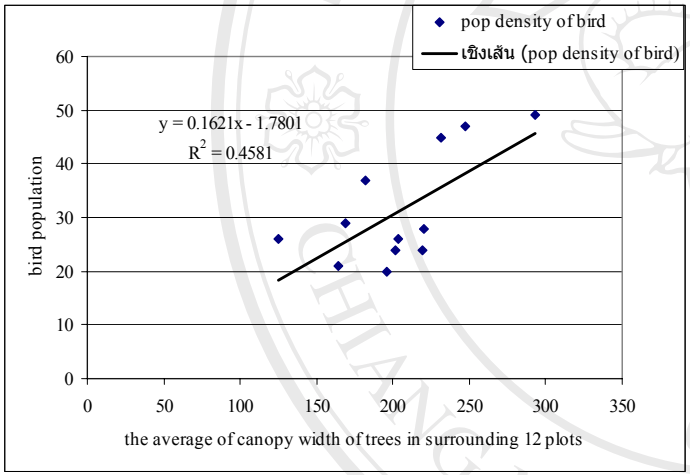


Figure 5.75 Bird population density was positively correlated with the average of crown width of trees ($R^2 = 0.46$).

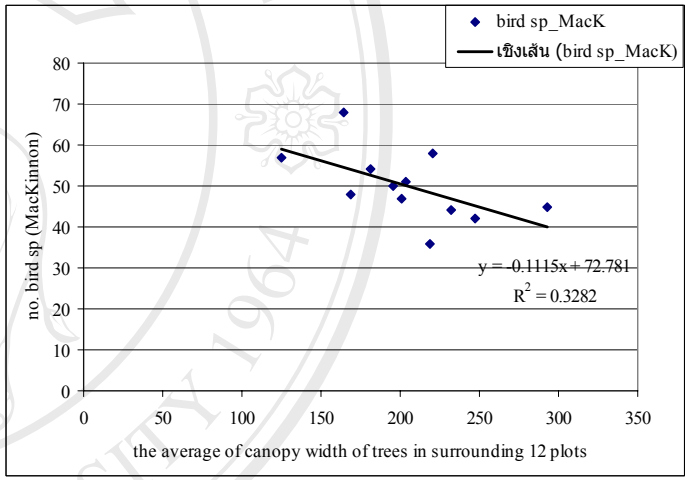


Figure 5.76 Species richness of bird was negatively correlated with the average crown width of trees ($R^2 = 0.33$).

Figure 5.77 Ground flora species was found in the study plots.

Grass (Graminae)

Cyrtococcum accrescens (Trin.) Stapf

Setaria palmifolia (Koren.) Stapf var. palmifolia

Panicum notatum Retz

Imperata cylindrical var. *major*

Thysanolaena latifolia (Roxb. Horn.) Honda

Fern

Pteridium aquilinum (L.) Kuhn (Dennstaedtiaceae)

Herbs

Eupatorium adenophorum Spreng

E. odoratum L.

Polygonum chinensis L.

Pueraria stricta

Clerodendrum fragrans (Vent.) Willd.

Bare area

Fruiting woody plant

Solanum nigrum

Embelia subcoridacea (Cl.) Mez

Saurauia roxburghii Wall (in 2000-s)

CHAPTER 6

DISCUSSION

This research involved surveys of the vegetation to explain the structure of the study plots and a bird survey to explain the composition of bird community.

The structure of the study site

The study site consisted of 12 study plots divided into 2 groups, non-planted control plots (3 replicates) and planted plots(figure 3.3). These planted plots varied in age from recently planed to, 2-year-old-plots and 4-year-old-plots (3 replicate each). The plots were setup amongst other planted plots of varians age and carried out, open areas or agriculture land, with secondary forest about 2-5 km away. The basic vegetation survey was inside the study plots and in the surrounding study plots. The vegetation survey showed that, as the planted plots aged, the tree grew larger, and developed larger crowns, which led to a denser forest canopy and reduction in ground flora cover and increase in bare ground. This was because the developing forest canopy reduced light intensity at ground level so that light –loving weed such as grasses, bracken fern an Eupatorium spp. could not survive. No single vegetation parameter showed any strong correlation with bird density or species richness, except possibly grass cover, which showed a weak positive relationship with bird population density. Since each bird species required specific habitat factors, it is unlikely that single, simple vegetation parameters can be used to indicate quality of bird habitat in general.

The diversity and composition of bird community

This research was designed to answer the following the questions:

1) Does the species richness of the bird community increase?

Compared with the 34 bird species observed in the area before planting the 88 species reparted in this study, 5 years after planting the trees, shows that the number of bird species has substantially increased at the landscape level (See Appendix J). This was due to the creation of habitat diversity with a mosaic of the microhabitats in the area such as the open areas, agriculture land, grassy areas, multi aged planted plots and natural secondary forest.

2) Does species richness of the bird community increase as the age of the planted plots increases?

Diversity and richness indices from the point count data showed the planted plots had higher birds diversity than the control plots and that diversity increased as the plots grow older (Table 5). Control plots had the highest evenness values, and supported low diversity of bird species with most bird species being common and few rare species. This agrees with the results of the correlation between bird population density and grass cover. The control plots had a high percentage of grass cover and tended to have a high population density of bird, but low bird species diversity (Fig 5.67, 5.68). The correlation between tree canopy cover and bird species richness showed that a dense canopy supported more bird species (Fig 5.69) and the canopy cover was highest in the 2 and 4-year-old planted plots. This showed that planted plots supported more bird species but in lower numbers and the

control plots supported higher bird population density but lower species diversity (Figure 5.12, Table 5).

The MacKinnon curves gave a slightly different result, probably because the MacKinnon method is more accurate where species diversity is high and was therefore not suitable for the low species richness found in forest restoration area (O'Dea *et a*l, 2004). The planted plots still supported low species diversity compared with natural climax forest. Therefore, the Point count method is recommended to give a more accurate assessment of bird diversity in this area in the future. However, the point count and the MacKinnon list results were significantly positively correlated. Plots tended to have high levels of richness using either method ($P = 0.02$, $R^2 = 0.41$).

3) Dose the species composition of bird become more like that of the nearest patch of forest?

38 species (53.52%) of bird found in natural forest were the same as those the species composition in planted plots. Similarity indices (Table 6) showed that, the 4-years-old and 2-years-old planted plots the most similar and the 4-years-old and the recently planted plots were the most different. The similarity of the planted plots compared with natural forest showed that the bird community in the FORRU area was more similar to natural forest than to that present in the area before planting. Even the control plots had more similar to natural forest than the pre-planted area.

The 1998 plots attracted more forest birds than the control plots, even though they were both close together. Similarly the non planted control plots attracted a higher density of open-habitat bird species than the oldest planted plots. The

medium aged plots attracted a higher density of forest bird species than the youngest plots and the control plots, because the structure of these plots was closer to that of forest than the youngest plots and control plots. Although, non-planted control plots and the youngest plots had an open structure, scattered trees in the plots sometimes produced resources for forest habitat bird species, so occasionally such birds were recorded in the non-planted control plots and youngest plots. The analysis from the distance program showed that the forest bird species increased with the age of the planted plots, whereas the open habitat bird species decreased (Fig 5.13 and 5.14). These results were as same as those from the relative abundance (MacKinon) lists method (5.8 and 5.19). Indicators species for forest habitat such White-rumped Sharma were not found in the control plots. Furthermore the Grey-breasted Prinia an (open habitat bird) was not found in the oldest planted plots.

Gale in Anusarnsunthorn and Elliott, 2004 reported that the FORRU plots very small, compared with the territory sizes or home ranges of forest breeding birds. The FORRU plots are currently not large enough to support a complete forest bird fauna. Only the most ecologically tolerant species, capable of surviving in a mosaic of forest and open habitat, are currently able to survive in the landscape created by the FORRU plots.

4) Which birds are attracted to each of the framework tree species planted?

Behavioral observations showed 41 woody plant species were used by bird including both tree and shrub. Eighteen were natural and 22 were planted tree species. Planted species were most attractive to birds when they produced fruit

or nectar or rich flowers. The most attractive tree species was *Melia toosandan,* which birds used for perching and feeding on insects. Second, was *Pinus kesiya* and third, *Erythrina subumbrans*. Four tree species planted by FORRU, which were the most attractive to birds, were *M. toosandan, E. subumbrans, Prunus cerasoides* and *Spondias axillaris* , *E. subumbrans* and *P. cerasoides* produced nectar and fruit. *S. axillaries* and *M. toosandan* provided perch site (since they were taller than the other species) and were a source of insects. *M. toosandan* trees were tall, compared with others planted at the same time (7.96 meter tall at 1.5 years old). *Spondias axillaris, E. subumbrans* and *P. cerasoides* also grew rapidly (Anusartsuntorn and Elliott, 2004). These characteristics provided ideal points for birds to sit and look out for food. Natural *P. kesiya* trees were present in the recently planted plots and the control plots, which had an open structure and plenty of grasses. P. *kesiya* was the tallest trees in the plots and usually attracted insectivorous bird species e.g. Yellow-browed Warbler and White-browed Shrike Babbler which fed on insects on the tree trunks. Naturally established *Pinus kesiya* in the plot 2002 were the tallest trees species, so they were used as perch trees by many bird species. Some birds also visited the pine trees to feed on insects in the bark. In addition, *E. subumbrans* also supported insects living on the trunks, so many insectivorous birds came to feed on ihem. Moreover, when *E. subumbran*s and *P. cerasoides* produced fruits or flowers, many bird species came to feed on nectar, fruits and insects. The framework tree species planted by FORRU produced fruits and flowers mostly within 2-3 years after planting so some fruits were fed upon by bird species. *Melia toosandan* and *Spondias axillaris* were the most attractive tree species, because of their height.

They were the tallest in the plots and produced broad crowns for birds to perch on. *Erythrinal subbumbran*s flowers produced nectar, which attracted many birds both from planted and non-planted plots. *Prunus cerasoides* produced fruits and nectar within 2-3 years after planting and when this tree produced flowers and fruits, many birds came to feed on then.

M. toosandan, *E. subumbrans* and *P. cerasoides* were the most attractive to bird species when importance value was taken into accerent, to correct for difference in size and density among the tree species. *Spondias axillaris* was less attractive to birds even these tree species had high importance value and the highest number of tree trunks per unit area.

5) Which bird species are most likely to disperse seeds from forest to planted plots?

In this study 88 bird species were found over all plots, of which the largest group (72.73 %) was resident species. Resident birds had a greater effect on forest restoration than the winter visitors because they occurred in the area more frequently than the winter visitors. For the forest restoration frugivorous and omnivorous birds are most importance, because they could disperse seeds into the areas undergoing restoration and thus increase tree species richness. Of the 64 species of resident birds, 3 were frugivores and 11 omnivores. Of the 19 of winter visitors recorded, only 3 were ominovorous. Bulbuls were probably the most important group of birds, because they were represented by many species (5 species) and were present at high population densities and were usually found in flocks often composed of several species.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

Forest restoration increased the species richness of birds at the landscape level. Moreover, planted plots supported higher bird species diversity than non-planted control plots. However, the non-planted control plots had higher population densities and higher evenness of bird species than the planted plots. In the planted plots, the bird species richness increased with age of planted trees. In addition, as the age of the plots increased, birds that typically inhabited open areas declined, whilst forest birds increased. The planted plots attracted bird species that were more characteristic of forest than the open-habitats, whilst open-habitat birds were most attracted to the non-planted control plots. The 17 bird food-plant species observed in this study, will allow plantation design to be modified in the future to be more attractive to birds. Improvements in plantation design to maximize the attractiveness of the planted areas to seed dispersers should yield positive benefits for wildlife conservation in northern Thailand.

This study showed that planting framework tree species increased bird species richness (at the landscape level), and attracted several bird species which could disperse seeds into planted area and help accelerate forest regeneration. In addition, tree planting attracted more forest birds as the plots matured. Fifty-three percent of bird species recorded in planted plots were the same as bird species recorded in Dong Seng Communities Forest, the nearest remnant patch of forest to the plots (about 2-3 km away). In short, forest restoration led to a more the 50% recovery in the bird communities in 4-5 years.

RECOMMENDATIONS

FORRU plantations have the capacity to increase bird species richness and diversity of birds in the forestation areas, this increases natural forest regeneration by seed-dispersal by birds. However, high numbers of bird are still being hunted in the area and this might significantly reduce seed dispersal and forest recovery. One group of children in the village were known to catch birds 4 or 5 times per month in the summer with 12 to 18 birds caught per group. Thus 600 birds were estimated to be caught per month per group. This may have a significant impact of bird community recovery, seed dispersal and ultimately forest regeneration. I suggested to do some activities with the children in the village to give them the knowledge or change their attitudes to words their environment.

The recommendation from George Gale (in Anusarnsunthorn and Elliott, 2004) to test different sizes of plantation would be particularly useful to determine the minimum area required to bring back a community that is somewhat similar to natural forest. In addition, information on the quality of the planted plots in relation to biodiversity would be particularly valuable. These questions will require a large area for restoration and more sophisticated techniques (such as radio-telemetry, mark-recapture data from a variety of plot type, long-term monitoring data, etc.) to answer, but are likely to be essential for finding optimal method of meeting specific biodiversity objectives.

REFERENCES

Anusarnsunthorn, V. and Elliott, S. 2002. *Interim Report to Biodiversity Research and Training Program (1/3/02-31/8/02) in Title of Long-term Monitoring of Biodiversity Recovery in Forest Restoration Plots in Northern Thailand (BRT 344004).* Forest Restoration Research Unit. Department of Biology, Faculty of Science, Chiang Mai University. 15 pp. (unpublished)

Anusarnsunthorn, V. and Elliott, S. 2004. *Final Reprot to the BiodiversityResearch and Training Program (1/9/03-28/2/04) in Title of Long-term Monitoring of Biodiversity Recovery in Forest Restoration Plots in Northern Thailand (BRT 344004).* Forest Restoration Research Unit. Department of Biology, Faculty of Science, Chiang Mai University. 71 pp. (unpublished)

Banziger, H. 1988. *Biodiversity, Buddhism and Bulldozers in Thai and's Doi Suthep Sanctuary.* Deparment of Entomology, Faculty of Agriculture, Chiang Mai University. 9 pp.

Beaver, O.P. .1988. *Human-Ecosystem and ecosystem of Thailand.* Thai Watthana Panit, Bangkok, 207-245 pp.

Beaver, O.P. and Sritasuwan, N. 1985. "Classification of some bird communities in Chiang Mai Province", *Journal of Natural History Bulletin of the Siam Society*, 33 (2), 121-138.

Bhumibamon, S. 1986. *The environmental and socio-economic aspects of tropical deforestation: a case study of Thailand*. Department of Silviculture, Faculty of Forestry, Kasetsart University. 102 pp.

Bibby, C.J., Burgess, N.D., Hill, D.A. and Mustoe S. 2000. *Bird Cencus Techniques.* Academic Press, London. 302pp.

Bibby, C., Jones, M. and Marsden, S. 1998. *Expedition Field Techniques Bird Surveys.* The Expedition Advisory Centre, Royal Geographical Society, London. 133 pp.

Chanthorn, W. 1999. *Effect of Forest Restoration Activities on the Bird Community of a Degraded Upland Watershed*. B.Sc. Thesis, Department of Biology, Faculty of Science, Chiang Mai University. 32 pp.

Chanthorn, W. 2002. *Effect of Fallow-Shifting Cultivation in Upland Area on Bird Community at Mae Chaem District, Chiang Mai Province***.** M.Sc. Thesis, Department of Biology, Faculty of Science, Graduate School, Chiang Mai University. 83 pp. (in Thai)

Corlett, R.T. 1998. Frugivory and seed dispersal by vertebrates in the Oriental (Indomalayan) Region. Cambridge Philosophical Society, United Kingdom, Biol. Rev. 73, pp 413-448.

Corlett, R.T. and Hau, B.C.H. 2000. Seed Dispersal and Forest Restoration. Pp 317-325 in Eilliott, S., J. Kerby, K. Hardwick, D. Blakesley, K. Woods, and V. Anusarnsunthorn (Eds), *Restoration for Wildlife Conservation*, International Tropical Timber Organisation and The Forest Restoration Research Unit, Chiang Mai University, Thailand.

Elliott, S.D., Ua-Apisitwong, S. and Beaver, O. 1989. "The small mammal communities of Doi-Suthep Pui National Park", *Proceeding of the 10th annual Wildlife Symposium*. Kasetsart University, Bangkok.

Elliott, S., Blakesley D. and Anusarnsybthorn V. (Eds) 1998. *Forests for the future: growing and planting native trees for restoring forest ecosystems*. Forest Restoration Research Unit. Biology Department, Science Faculty, Chiang Mai University, Thailand. 60 pp.

Elliott, S., Puttipong, N., Zangkum, S., Kuarak, C., Kerby, J., Blakesley, D., and Anusarnsunthorn, V. 2000. Performance of six native tree species, planted to restore degraded forestland in northern Thailand an their response to fertiliser. Pp. 245-254 in Eilliott, S., J. Kerby, K. Hardwick, D. Blakesley, K. Woods, and V. Anusarnsunthorn (Eds), *Restoration for Wildlife Conservation*, International Tropical Timber Organisation and The Forest Restoration Research Unit, Chiang Mai University, Thailand.

Elliott, S., Puttipong, N., Kuarak, C., Zangkum, S., Anusarnsunthorn, V. and Blakesley, D. 2003. "Selecting framework tree species for restoring seasonally dry tropical forests in northern Thailand based on field performance", *Journal of Forest Ecology and Management*, 184 (2003), 177-191.

Food and Agriculture Organization of the United Nations. 1997. *State of the World's Forests 1997.* FAO, Rome, 200 Pp.

Food and Agriculture Organization of the United Nations. 2001. *State of the World's Forests 2001.* FAO, Rome, 200 pp.

Garcia, S., Finch, D.M. and Leon, G. C. 1998. "Pattern of forest use and endemism in resident bird communities of north-central Michoacan, Mexico", *Journal of Forest Ecology and Management,* 110 (1998) 151-171.

Gibbons, D.W., Hill, D. and Sutherland,W.J. 1997. "Birds" Pp. 227-259. in Sutherland, W.J. (editor). *Ecological Census Techniques A Handbook.* Cambridge University Press, United Kingdom. 336 pp.

Goosem, S. P. and Tucker, N.I.J. 1995. *Repairing the Rainforest – Theory and Practice of Rainforest Re-establishment in North Queensland's Wet Tropics.* Wet Tropics Management Authority, Cairns. 71 p.

Hitchcock, D. and Kuarak, C. 1998. *The Role of Birds in Forest Restoration in Northern Thailand.* Forest Restoration Research Unit, Department of Biology, Faculty of Science, Chiang Mai University. 8 pp. (unpublished).

Jantakad, P. and Gilmour, D. 1999. *Forest Rehabilitation Policy And Practice inThailand.* Royal Forest Department of Thailand. 54 pp. (in Thai)

Khopai, O. 2000. *Effect of Forest Restoration Activities on The Species Diversity of Ground Flora and Tree Seedlings.* M.Sc. Thesis, Department of Environmental Science, Faculty of Science, Graduate School, Chiang Mai University. 124 pp.

Kopkate, O. 1998. *Bird of Thailand,* book 1. Sarakadee Publishing, Bangkok, Thailand. 247 pp.

Kopkate, O. 1999. *Bird of Thailand,* book 2. Sarakadee Publishing, Bangkok, Thailand. 227 pp.

Kopkate, O. 2000. *Bird of Thailand,* book 3. Sarakadee Publishing, Bangkok, Thailand. 259 pp.

Kopkate, O. 2001. *Bird of Thailand,* book 4. Sarakadee Publishing, Bangkok, Thailand. 270 pp.

Kopkate, O. 2001. *Bird of Thailand,* book 5. Sarakadee Publishing, Bangkok, Thailand. 287 pp.

Kitamura, S., Yumoto, T., Poonswad, P., Chuailua, P., Plongmai, K., Maruhashi, T. and Noma, N. 2002. *Interactions between fleshy fruits and frugivores in a tropical seasonal forest in Thailand.* Journal of Oecologia, 133:559-572.

Lekagul, B., Round, P.D. 1991. *A guide to the Bird of Thailand*. Daha Karn Bhaet Co. Ltd. Bangkok, Thailand. 457 pp.

Maxwell, J.F. and Elliott, S. 2001. *Vegetation and Vascular Flora of Doi Suthep-Pui National Park, Northern Thailand.* CMU Herbarium, Department of Biology, Faculty of Science, Chiang Mai University, In Thai Studies in Biodiversity Project of BRT. 205 pp.

Maxwell, J.F. 2003. Personal communication.

Nabhitabhata, J. 1987. *Wildlife in Doi Suthep-Pui National Park.* Kog-Ma Watershed Resarch Bulletion, Number 40. Department of Conservatipm, Faculty of Forestry, Kasetsart University. 42 pp.

National Park Division. 2005. *Map of Doi Suthep-Pui National Park area* [Online]. Wildlife and Plant Conservation Department, Royal Forestry of Thailand. Available http://www.dnp.go.th (24 May 2005).

Navakitbumrung, P. 2003. *Effects of Mature Trees on Seedling Establishment on Deforested Sites.* M.Sc. Thesis, Department of Biology, Faculty of Science, Graduate School, Chiang Mai University. 153 pp.

O'Dea N., Watson J. E. M. and Whittaker R. J. 2004. *Rapid assessment in conservation research: a critique of avifaunal assessment techniques illustrated by Ecuadorian and Madagascan case study data.* Journal of Diversity & Distributions 10: 55-63.

Parrotta, J.A., Knowles, O.H., and Wunderle Jr., J.M. 1997. "Development of floristic diversity in 10-year-old restoration forests on a bauxite mined site in Amazonia", *Journal of Forestry Ecology and Management*, 99 (1997) 21-42.

Pattanakaew, P. 2002. *Effect of Local and the Landscape Environment on Seed Dispersal by Birds in Regenerating Forest*. M.Sc. Thesis. Natural Resource Manangement, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, Bangkok. 75 pp.

Perera, G A. 1994. *Restoration of degraded dry zone woodland in sri lanka using natural regeneration*. Green College Oxford. 66 p.

Polchuanpanyo, C. 2000. *Natural Resources and Environmental Management through Community Culture Approach: A Case Study of Mae Sa Mai Village, Pong Yang Sub district, Mae Rim District, Chiang Mai Province.* M.A. Thesis. Master of Man and Environmental Management, Graduate School, Chiang Mai University, 111 pp.

Portigo, M.Fe.L. 1994. *Effects of Different Types of Land use on Pycnonotidae.* M.S. Thesis. Master of Science in Environmental Risk Assessment for Tropical Ecosystems, Graduate School, Chiang Mai University. 95 pp.

Rao, Y.S. 1988. "Flash floods in Southern Thailand", *Journal of Tigerpaper*, 15 (4): 1–2

Royal Forestry Department of Thailand. 2004. *Thailand's Forest area* [Online]. Available http://www.forest.go.th (3 November 2004).

Round, P.D. 1984. "The status and conservation of the bird community in Doi Suthep-Pui National Park, Northwest Thailand", *Journal of Natural History Bulletin of the Siam Society,* 32(1) : 21-46.

Sanitijan, S. 2001. *Species Compoosition of Birds at Tham Nam Lod Wildlife Conservation Development and Extension Center, Mae Hong Son Province.* M.Sc. Thesis, Department of Biology, Faculty of Science, Graduate School, Chiang Mai University. 189 pp. (in Thai)

Scott, R. 2000. *Comparing Species Richness of Deforested Sites with Planted Site on Doi Suthep*. Bird Monitoring Report to FORRU. Forest Restoration Research Unit, Department of Biology, Faculty of Science, Chiang Mai University. 10pp. (unpublished)

Singhakan, B. 1986. *The distribution of Bulbuls (Family Pycnonotidae) on Doi Suthep and Doi Pui, Chagwat Chiang Mai.* M.Sc. Thesis. Department of Biology, Faculty of Science, Graduate School, Chiang Mai University. 161 pp. (in Thai)

Sukwong, S., Boonyawetchiwin, S. and Poomiparkpun, N. 1987. Teresstrial ecosystem. Pp15-30. in WongSiri, S. and Lorlohakan, S. (Eds.). *Biodiversity in Thailand*. 7th Seminar in Biology in topic Biodiversity in Thailand. The Annual Meeting of Biology Section of the Science Society of Thailand, Chiang Mai University. (in Thai)

Thaiying, J. 2003. The Diversity of Small Mammal Communities in FORRU's Reforested Areas. B.Sc. Thesis, Department of Biology, Faculty of Science, Chiang Mai University. 55 pp.

Thomas, L., Laake, J.L., Strindberg, S., Marques, F.F.C., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Hedley, S.L., Pollard, J.H. and Bishop, J.R.B. 2004. Distance 5.0. Release Beta 3. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. http://www.ruwpa.st-and.ac.uk/distance/

Tucker, N.I.J. and Murphy, T.M. 1997. "The effects of ecological rehabilitation on vegetation recruitment: some observation from the Wet Tropics of North Queensland", *Journal of Forest Ecology Management*, 99: 133-152.

Tucker, N. 2000. Wildlife colonisation on restored tropical lands: what can it do? How can we hasten it and what can we expect?. Pp. 279-295 in Eilliott, S., J.

Kerby, K. Hardwick, D. Blakesley, K. Woods, and V. Anusarnsunthorn (Eds), *Restoration for Wildlife Conservation*, International Tropical Timber Organisation and The Forest Restoration Research Unit, Chiang Mai University, Thailand.

Uhl, C. 1988. Resoration of Degraded land in the Amazon Basin. Pp 326-332 in Wilson, E.O.(Ed.).1988. *Biodiversity.* National Academy Press, Washington D.C..

Welty, J.C. 1982. *The Life of Birds*. CBS College Publishing, Philadelphia, America. 754 pp.

Willson, F. M. and Crome, F.H. J. 1989. "Patterns of seed rain at the edge of a tropical Queenland rain forest", *Journal of Tropical Ecology*, 5:301-308.

Wittawatchutikul, P. 2000. *Some Economic Valuation of Environmental Quality Aspects of Forest Destrction.* Disseminate paper on 2nd /2000, Huay Hin Dard Watershed Research Unit, Watershed Group, Forest Environment Research and Development Section, Forestry Technology Bureau, Royal Forestry Department of Thailand. 15 pages (in Thai)

Wunderle Jr., J.M. 1997. "The role of animal seed dispersal in accelerating native forest regeneration on degraded tropical lands**",** *Journal of Forestry Ecology and Mana*

APPENDICES

Appendix A The meteorological report on 2002-2003 from the Royal Project of Ban Mai Sa.

METEOROLOGICAL REPORT 2002

BAN MAE SA MAI

Month	Temperature,'c			Humidity,%			Rain
	max	min	mean	max	min	mean	mm
JAN	22.02	15.65	18.37	77.62	63.29	70.45	13.90
FEB	25.96	18.66	21.79	69.80	56.97	63.39	6.90
MAR	29.45	20.58	24.38	67.41	51.27	59.34	0.00
APR	31.52	21.93	26.04	66.74	49.80	58.27	11.30
MAY	27.06	21.23	23.72	76.01	71.12	73.56	193.50
JUN	25.17	22.90	23.87	80.58	94.77	87.68	148.16
JUL	24.79	23.74	24.19	82.16	76.37	79.26	72.00
AUG	24.21	23.34	23.71	85.75	102.49	94.12	188.00
SEP	24.22	23.00	23.52	85.77	78.61	82.19	375.15
OCT	24.34	21.97	22.98	83.97	99.52	91.75	167.88
NOV	22.74	20.59	16.49	85.67	76.50	78.90	118.60
DEC							
Total							1295.39
Mean	25.59	21.23	22.64	78.32	74.61	76.27	

* : Equivalent to evaporation water , mm/d

Appendix A The meteorological report on 2002-2003 from the Royal Project of Ban Mai Sa. (continued)

METEOROLOGICAL REPORT 2003

BAN MAE SA MAI

Month	Temperature,'c			Humidity,%			Rain
	max	min	mean	max	min	mean	mm
JAN							
FEB	26.27	17.09	21.02	80.14	61.47	70.81	0.00
MAR	28.16	18.82	22.82	77.05	0.00	0.00	11.40
APR	31.67	20.87	25.49	82.39	0.00	0.00	62.95
MAY	29.79	21.06	24.80	84.01	72.01	78.01	50.53
JUN	26.30	20.52	22.99	91.97	84.78	88.38	222.83
JUL	27.26	20.69	23.50	92.65	83.86	88.25	117.65
AUG	27.18	20.47	23.34	89.66	82.05	85.85	113.53
SEP	26.40	20.10	22.80	94.50	90.38	92.44	193.66
OCT	27.42	19.23	22.73	91.07	82.14	86.61	24.22
NOV	26.83	16.50	20.92	85.11	80.86	82.98	2.50
DEC	23.90	14.11	18.30	90.14	82.76	86.45	0.00
Total							799.27
Mean	27.38	19.04	22.61	87.15	65.48	69.07	

* : Equivalent to evaporation water , mm/d

Appendix B Framework tree species list for experimental plots. (FORRU database).

NO.	SPECIES	Family	Years		
			1998	2000	2002
1	*Acrocarpus fraxinifolius*	Leguminosae (Caesalpinioideae)			X
2	*Aglaia lawii*	Meliaceae	X		
3	*Aphanamixis polystachya*	Meliaceae	X		
4	*Aquilaria crassna*	Thymelaeaceae			X
5	*Archidendron clypearia*	Leguminosae (Mimosoideae)	X		
6	*Balakata bacatum*	Euphorbiaceae		X	
7	*Betula alnoides*	Betulaceae		X	
8	*Bischofia javanica*	Euphorbiaceae	X		X
9	*Castanopsis acuminata*	Fagaceae		X	X
10	*Castanopsis calathiformis*	Fagaceae	X		
11	*Castanopsis diversifolia*	Fagaceae			X
12	*Castanopsis tribuloides*	Fagaceae		X	X
13	*Cinnamomum iners*	Lauraceae	X		
14	*Diospyros glandulosa*	Ebenaceae	X		
15	*Duabanga grandiflora*	Sonneratiaceae	X		
16	*Elaeocarpus lanceifolius*	Elaeocarpaceae			X
17	*Erythrina stricta*	Leguminosae (Papilionoideae)			X
18	*Erythrina subumbrans*	Leguminosae (Papilionoideae)	X	X	X
19	*Eugenia albiflora*	Myrtaceae	X		X
20	*Eugenia fruticosa*	Myrtaceae	X		
21	*Eurya acumminata var. wallichiana*	Theaceae	X		
22	*Ficus abeli*	Moraceae		X	
23	*Ficus altissima*	Moraceae	X	X	
25	*Ficus callosa*	Moraceae			X

Appendix B (Continued)

NO.	SPECIES	Family	Years		
			1998	2000	2002
26	*Ficus capillipes*	Moraceae			X
27	*Ficus fistulosa*	Moraceae			X
28	*Ficus glaberrima*	Moraceae		X	
29	*Ficus racemosa*	Moraceae		X	
30	*Ficus semicordata*	Moraceae		X	
31	*Ficus subulata*	Moraceae		X	X
32	*Ficus superba*	Moraceae		X	
33	*Garcinia mackeaniana*	Guttiferae	X		
34	*Gmelina arborea*	Verbenaceae	X	X	X
35	*Helicia nilagirica*	Proteaceae	X	X	
36	*Horsfieldia amygdalina*	Myristicaceae	X		
37	*Horsfieldia thorelii*	Myristicaceae	X		
38	*Hovenia dulcis*	Rhamnaceae	X	X	X
39	*Lithocarpus elegans*	Fagaceae		X	
40	*Macaranga denticulata*	Euphorbiaceae		X	X
41	*Manglietia garrettii*	Magnoliaceae	X		
42	*Markhamia stipulata var. kerrii*	Bignoniaceae	X	X	
43	*Melia toosendan*	Meliaceae	X		X
44	*Micromelum hirsutum*	Rutaceae	X		
45	*Morus macrouea*	Moraceae		X	
46	*Nyssa javanica*	Nyssaceae	X	X	X
47	*Ostodes paniculata*	Euphorbiaceae			X
48	*Phoebe lanceolata*	Lauraceae	X		
49	*Phoebe lanceolata*	Lauraceae		X	X
50	*Phoebe lanceolata*	Lauraceae	X		

Appendix B (Continued)

NO.	SPECIES	Family	Years		
			1998	2000	2002
52	*Prunus cerasoides*	Rosaceae	X	X	X
53	*Quercus kerrii var. pubescens*	Fagaceae	X		
54	*Quercus semiserrata*	Fagaceae	X	X	X
55	*Rhus rhetsoides*	Anacardiaceae		X	X
56	*Sapindus rarak*	Sapindaceae	X	X	X
57	*Sarcosperma arboreum*	Sapotaceae	X		X
58	*Spondias axillaris*	Anacardiaceae	X	X	X
59	*Trichilla connaroides*	Meliaceae	X	X	X
60	White Wild Banana	Musaceae		X	
	Total		**33**	**29**	**30**

Appendix C The natural plant species in the experimental plots (FORRU database).

No.	Species	Family	C-1	C-2	C-3	98-1	98-2	98-3	00-3	00-6	00-9	02-1	02-5	02-8
1	*Acacia megaladena* var. *megaladena*	Leguminosae (Mimosoideae)	/	/	/	*	*							
2	*Albizia chinensis*	Leguminosae (Mimosoideae)	/		/	*			+					
3	*Albizia lebbeck*	Leguminosae (Mimosoideae)							+					
4	*Albizia odoratissima*	Leguminosae (Mimosoideae)	/								+	#		
5	*Anneslea fragrans*	Theaceae						*						
6	*Antidesma acidum*	Euphorbiaceae	/		/	*				+			#	
7	*Antidesma bunius* var. *bunius*	Euphorbiaceae											#	
8	*Aporusa dioica*	Euphorbiaceae				*	*							
9	*Aporusa villosa (Wall. ex lindl.) Baill.*	Euphorbiaceae			/	*				+				
10	*Aporusa wallichii*	Euphorbiaceae			/		*		+					
11	*Aralia montana*	Araliaceae	/											
12	*Artocarpus lakoocha*	Moraceae		/					+	+	+			
13	*Artocarpus lanceolata*	Moraceae							+	+				
14	*Bauhinia purpurea*	Leguminosae (Caesalpinioideae)								+				#
15	*Bombax anceps*	Bombacaceae								+				
16	*Broussonetia papyrifera* (L.) Vent.	Moraceae						*			+			

Appendix C (Continued)

No.	Species	Family	C-1	C-2	C-3	98-1	98-2	98-3	00-3	00-6	00-9	02-1	02-5	02-8
17	*Buddleja asiatica*	Buddlejaceae				*								
18	*Canthium parviflorum*	Rubiaceae			/									
19	*Castanopsis diversifolia*	Fagaceae										#		
20	*Clerodendrum serratum* Moon	Verbenaceae			/									
21	*Cratoxylum formosum*	Hypericaceae	/											
22	*Dalb stipulacea*	Leguminosae (Papilionoideae)						*	+	+				
23	*Dalbergia cana*	Leguminosae (Papilionoideae)									+			
24	*Dalbergia cultrata* var. *cultrata*	Leguminosae (Papilionoideae)	/			*				+				
25	*Dalbergia discolor*	Leguminosae (Papilionoideae)				*								
26	*Dalbergia ovata*	Leguminosae (Papilionoideae)				*								
27	*Debregeasia longifolia*	Urticaceae						*			+			
28	*Dillenia parviflora* var. *kerrii*	Dilleniaceae	/							+			#	
29	*Dillenia pentagyna*	Dilleniaceae										#		
30	*Diospysos glandulosa*	Ebenaceae							+					
31	*Erythrina stricta*	Leguminosae (Papilionoideae)	/			*								
32	*Erythrina subumbrans*	Leguminosae (Papilionoideae)				*								
33	*Eugenia albiflora*	Myrtaceae			/	*			+	+	+			
34	*Eugenia fruticosa*	Myrtaceae	/										#	

Appendix C (Continued)

No.	Species	Family	C-1	C-2	C-3	98-1	98-2	98-3	00-3	00-6	00-9	02-1	02-5	02-8
35	*Eugenia fruticosa*	Myrtaceae				*								
36	*Eurya acumminata* var. *wallichiana*	Theaceae	/									#		
37	*Fernandoa adenophylla*	Bignoniaceae				*								
38	*Ficus hirta* var. *roxburghii*	Moraceae				*								
39	*Ficus hispida* var. *hispida*	Moraceae	/	/					+			#		
40	*Firmiana colorata*	Sterculiaceae								+				
41	*Glochidion eriocarpum*	Euphorbiaceae				*								
42	*Glochidion sphaerogynum*	Euphorbiaceae	/	/		*							#	
43	*Gmelina arborea*	Verbenaceae	/	/						+		#	#	#
44	*Litsea cubeba*	Lauraceae	/	/	/	*	*	*		+	+	#	#	
45	*Litsea monopetala*	Lauraceae							+					
46	*Litsea semecarpifolia*	Lauraceae										#		
47	*Machilus bombycina*	Lauraceae			/							#		
48	*Machilus bombycina*	Lauraceae			/									
49	*Maesa montana*	Myrsinaceae					*			+				
50	*Maesa ramentacea*	Myrsinaceae					*							
51	*Mallotus philippensis* var. *philippensis*	Euphorbiaceae							+					

Appendix C (Continued)

No.	Species	Family	C-1	C-2	C-3	98-1	98-2	98-3	00-3	00-6	00-9	02-1	02-5	02-8
52	*Markhamia* sp.	Bignoniaceae											#	
53	*Markhamia stipulata* var. *kerrii*	Bignoniaceae	/	/	/			*				#		
54	*Melastoma malabathricum*	Malastomataceae											#	
55	*Melia toosendan*	Meliaceae	/			*								
56	*Michelia baillonii*	Magnoliaceae	/				*	*					#	
57	*Mussaenda parva*	Rubiaceae		/										
58	*Oroxylum indicum*	Bignoniaceae							+					#
59	*Phoebe lanceolata*	Lauraceae		/					+		+			
60	*Phyllanthus emblica*	Euphorbiaceae	/			*			+	+				
61	*Pinus kesiya*	Pinaceae												#
62	*Pterocarpus macrocarpus*	Leguminosae (Papilionoideae)				*			+	+	+			
63	*Pterospermum* sp.	Sterculiaceae				*								
64	*Pyrenaria garrettiana*	Theaceae				*								
65	*Rhus chinensis*	Anacardiaceae				*			+	+			#	#
66	*Sapindus rarak*	Sapindaceae							+					#
67	*Sarcosperma* sp.	Sapotaceae						*						
68	*Saurauia roxburghii*	Saurauiaceae										#		
69	*Schima* sp.	Theaceae	/							+	+			

Appendix C (Continued)

No.	Species	Family	C-1	C-2	C-3	98-1	98-2	98-3	00-3	00-6	00-9	02-1	02-5	02-8
70	*Schima wallichii*	Theaceae			/		*	*	+					
71	*Securinega virosa Baill.*	Euphorbiaceae	/											
72	*Sterculia villosa*	Sterculiaceae		/	/			*	+				#	
73	*Stereospermum colais*	Bignoniaceae		/		*				+				
74	*Styrax benzoides*	Styracaceae							+					
75	*Turpinia pomifera*	Staphyleaceae							+					
76	*Vernonia* sp.	Compositae			/									
77	*Wendlandia tinctoria ssp. floribunda*	Rubiaceae							+					
Total			**21**	**11**	**15**	**25**	**8**	**10**	**22**	**19**	**10**	**11**	**12**	**6**
			34			**37**			**38**			**24**		

Appendix D Bird species recorded in all surveys (Lekagul and Round, 1991; Kopkate, 1997-2001).

no.	Species of bird	Science name	Family	Diet	Status	Habitat
1	Ashy Drongo	*Dicrurus leucophaeus*	Dicruridae	insectivore	resident	forest
2	Ashy Wood-swallow	*Artamus fuscus*	Artamidae	insectivore	resident	open
3	Asian Brown Flycatcher	*Muscicapa dauurica*	Muscicapidae	insectivore	winter visitor	open
4	Black-crested Bulbul	*Pycnonotus melanicterus*	Pycnonotidae	omnivore	resident	forest
5	Black-headed Bulbul	*Pycnonotus atriceps*	Pycnonotidae	omnivore	resident	forest
6	Black-naped Monarch	*Hypothymis azurea*	Monarchidae	insectivore	resident	forest
7	Black-naped Oriole	*Oriolus xanthonotus*	Oriolidae	insectivore	winter visitor	forest
8	Black-shouldered Kite	*Elanus caeruleus*	Accipitridae	carnivore	resident	open
9	Black-throated Sunbird	*Aethopyga saturata*	Nectariniidae	nectar/insectivore	resident	forest
10	Black-winged Cuckoo-shrike	*Coracina melaschista*	Campephagidae	insectivore	resident	forest
11	Blue Rock-Thrush	*Monticola solitarius*	Turdidae	insectivore	winter visitor	open
12	Blue-throated Barbet	*Megalaima asiatica*	Megalaimidae	frugivore	resident	forest
13	Blyth's Leaf-Warbler	*Phylloscopus reguloides*	Sylviidae	insectivore	winter visitor	forest
14	Bulbul sp.	*Pycnonotus sp.*	Pycnonotidae	omnivore	resident	-
15	Burmese Shrike	*Lanius collurioides*	Laniidae	carnivore	resident	open
16	Chestnut Bunting	*Emberiza rutila*	Emberizidae	seed-eater	winter visitor	open
17	Chestnut-capped Babbler	*Timalia pileata*	Timaliidae	insectivore	resident	open
18	Common Buzzard	*Buteo buteo*	Accipitridae	carnivore	winter visitor	open
19	Common Iora	*Aegithina tiphia*	Chloropseidae	insectivore	resident	open
20	Common Rosefinch	*Carpodacus erythrinus*	Fringillidae	seed-eater	winter visitor	open
21	Common Tailorbird	*Orthotomus sutorius*	Sylviidae	insectivore	resident	open
22	Common Wood-shrike	*Tephrodornis virgatus*	Campephagidae	insectivore	resident	forest
23	Crested Bunting	*Melophus lathami*	Emberizidae	seed-eater	winter visitor	open

Appendix D Bird species recorded in all surveys. (continued)

no.	Species of bird	Science name	Family	Diet	Status	Habitat
24	Dark-necked Tailorbird	*Orthotomus atrogularis*	Sylviidae	insectivore	resident	forest
25	Dove sp.	-	Treron	omnivore	resident	-
26	Flavescent Bulbul	*Pycnonotus flavescens*	Pycnonotidae	omnivore	resident	open
27	Flowerpecker sp.	*Dicauem sp.*	Dicaeidae	nectariforous	resident	-
28	Flycatcher sp.	*unknown*	Muscicapidae	insectivore	winter visitor	-
29	Golden-spectacled Warbler	*Seicercus burkii*	Sylviidae	insectivore	resident	forest
30	Great Tit	*Parus major*	Paridae	omnivore	winter visitor	forest
31	Greater Coucal	*Centropus sinensis*	Cuculidae	omnivore	resident	open
32	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	Dicruridae	insectivore	resident	forest
33	Green-billed Malkoha	*Phaenicophaeus tristis*	Cuculidae	omnivore	resident	forest
34	Greenish Warbler	*Phylloscopus trochiloides*	Sylviidae	insectivore	winter visitor	forest
35	Grey Bushchat	*Saxicola ferrea*	Turdidae	omnivore	winter visitor	open
36	Grey-breasted Prinia	*Prinia hodgsonii*	Sylviidae	insectivore	resident	open
37	Grey-capped Woodpecker	*Picoides canicapillus*	Picidae	insectivore	resident	forest
38	Grey-headed Flycatcher	*Culicicapa ceylonensis*	Muscicapidae	insectivore	resident	forest
39	Grey-headed Parakeet	*Psittacula finschii*	Psittacidae	frugivore	resident	forest
40	Hair-crested Drongo	*Dicrurus hottentottus*	Dicruridae	insectivore	resident	forest
41	Hill Blue Flycatcher	*Cyornis banyumas*	Muscicapidae	insectivore	resident	forest
42	Hill Prinia	*Prinia atrogularis*	Sylviidae	insectivore	resident	open
43	Hoopoe	*Upupa epops*	Upupidae	insectivore	resident	open
44	Yellow-browed Warbler	*Phylloscopus inornatus*	Sylviidae	insectivore	winter visitor	forest
45	Japanese White-eye	*Zosterops japonicus*	Zosteropidae	omnivore	winter visitor	forest
46	Little Bunting	*Emberiza pusilla*	Emberizidae	seed-eater	winter visitor	open

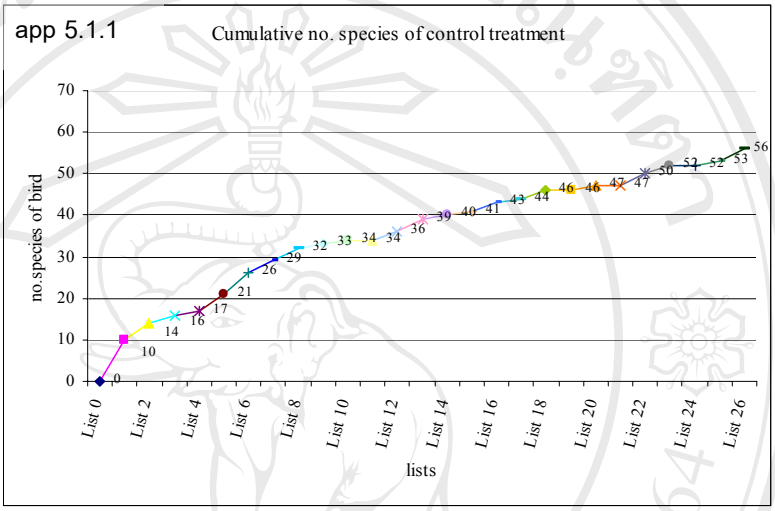
Appendix D Bird species recorded in all surveys. (continued)

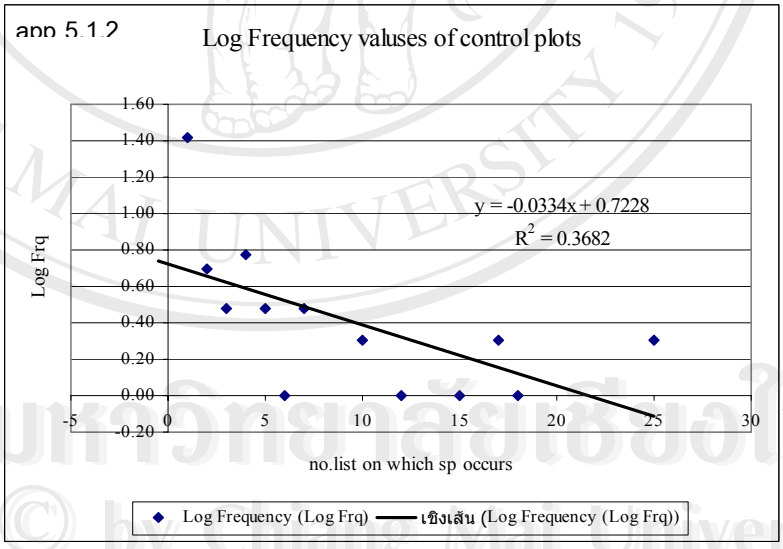
no.	Species of bird	Science name	Family	Diet	Status	Habitat
47	Little Spiderhunter	*Arachnothera longirostra*	Nectariniidae	nectar/insectivore	resident	forest
48	Long-tailed Minivet	*Pericrocotus ethologus*	Campephagidae	insectivore	resident	forest
49	Long-tailed Shrike	*Lanius schach*	Laniidae	carnivore	resident	open
50	Minivet sp.	*Pericrocotus sp.*	Campephagidae	insectivore	resident	forest
51	Mountain Bamboo-Partridge	*Bambusicola fytchii*	Phasianidae	omnivore	resident	open
52	Munia sp.	*Lonchura sp.*	Estrildidae	seed-eater	resident	open
53	Olive-backed Pipit	*Anthus hodgsoni*	Motacillidae	insectivore	winter visitor	open
54	Olive-backed Sunbird	*Nectarinia jugularis*	Nectariniidae	nectar/insectivore	resident	open
55	Oriental White-eye	*Zosterops palpebrosus*	Zosteropidae	omnivore	resident	forest
56	Pale-footed Bush-Warbler	*Cettia pallidipes*	Sylviidae	insectivore	resident	open
57	Pale-legged Leaf-Warbler	*Phylloscopus tenellipes*	Sylviidae	insectivore	resident	forest
58	Pied Bushchat	*Saxicola caprata*	Turdidae	insectivore	resident	open
59	Plain Flowerpecker	*Dicaeum concolor*	Dicaeidae	nectariforous	resident	forest
60	Plaintive Cuckoo	*Cacomantis merulinus*	Cuculidae	omnivore	resident	open
61	Prinia sp.	*Prinia sp.*	Sylviidae	insectivore	resident	open
62	Puff-throated Babbler	*Pellorneum ruficeps*	Timaliidae	insectivore	resident	forest
63	Purple Sunbird	*Nectarinia asiatica*	Nectariniidae	nectar/insectivore	resident	open
64	Red-throated Flycatcher	*Ficedula parva*	Muscicapidae	insectivore	winter visitor	open
65	Red-whiskered Bulbul	*Pycnonotus jocosus*	Pycnonotidae	omnivore	resident	open
66	Rufescent Prinia	*Prinia rufescens*	Sylviidae	insectivore	resident	open
67	Scaly breasted Munia	*Lonchura sp.*	Estrildidae	seed-eater	resident	open
68	Scarlet Minivet	*Pericrocotus flammeus*	Campephagidae	insectivore	resident	forest
69	Shikra	*Accipiter bdius*	Accipitridae	carnivore	resident	forest

Appendix D Bird species recorded in all surveys. (continued)

no.	Species of bird	Science name	Family	Diet	Status	Habitat
70	Shrike sp.	*Lanius sp.*	Laniidae	carnivore	resident	open
71	Siberian Rubythroat	*Luscinia calliope*	Turdidae	insectivore	winter visitor	open
72	Slender -billed Oriole	*Oriolus tenuirostris*	Oriolidae	omnivore	resident	forest
73	Sooty-headed Bulbul	*Pycnonotus aurigaster*	Pycnonotidae	omnivore	resident	open
74	Speckled Piculet	*Picumnus innominatus*	Picidae	insectivore	resident	forest
75	Streaked Spiderhunter	*Arachnothera magna*	Nectariniidae	nectar/insectivore	resident	forest
76	Striped Tit-Babbler	*Macronous gularis*	Timaliidae	insectivore	resident	forest
77	Sunbird sp.	*Fam. Nectariniidae*	Nectariniidae	nectar/insectivore	resident	-
78	Velvet-fronted Nuthatch	*Sitta frontalis*	Sittidae	insectivore	resident	forest
79	Warbler sp.	*Phylloscopus sp.*	Sylviidae	insectivore	winter visitor	-
80	White-browed Piculet	*Sasia ochracea*	Picidae	insectivore	resident	forest
81	White-browed Scimitar-Babbler	*Pomatorhinus schisticeps*	Timaliidae	insectivore	resident	forest
82	White-browed Shrike-Babbler	*Pteruthius flaviscapis*	Timaliidae	insectivore	resident	forest
83	White-eye sp.	*Zosterops sp.*	Zosteropidae	omnivore	resident	forest
84	White-rumped Munia	*Lonchura striata*	Estrildidae	seed-eater	resident	open
85	White-rumped Shama	*Copsychus malabaricus*	Turdidae	insectivore	resident	forest
86	White-tailed Robin	*Cinclidium leucurum*	Turdidae	insectivore	resident	forest
87	White-throated Fantail	*Rhipidura albicollis*	Rhipiduridae	insectivore	resident	forest
88	Yellow-eyed Babbler	*Chrysomma sinense*	Timaliidae	insectivore	resident	open

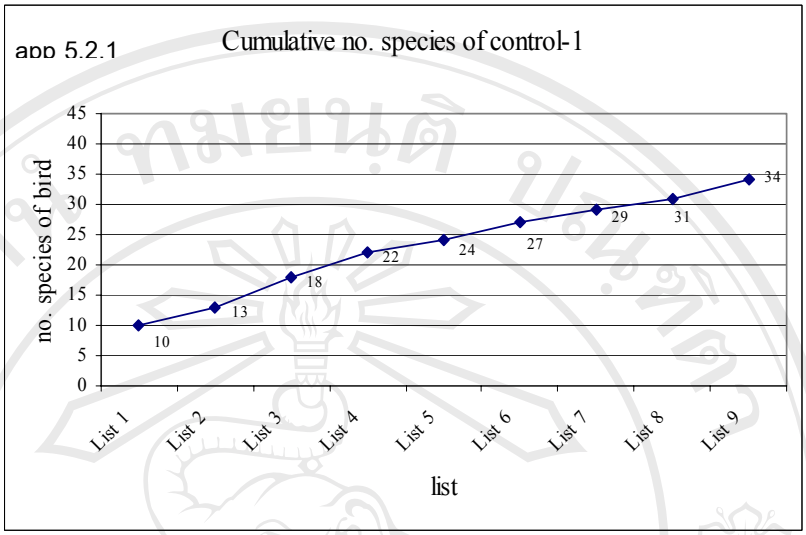
Appendix E Cumulative number of bird species (10 species/list) and Log Frequency value of number of species occurring on any given number of lists.

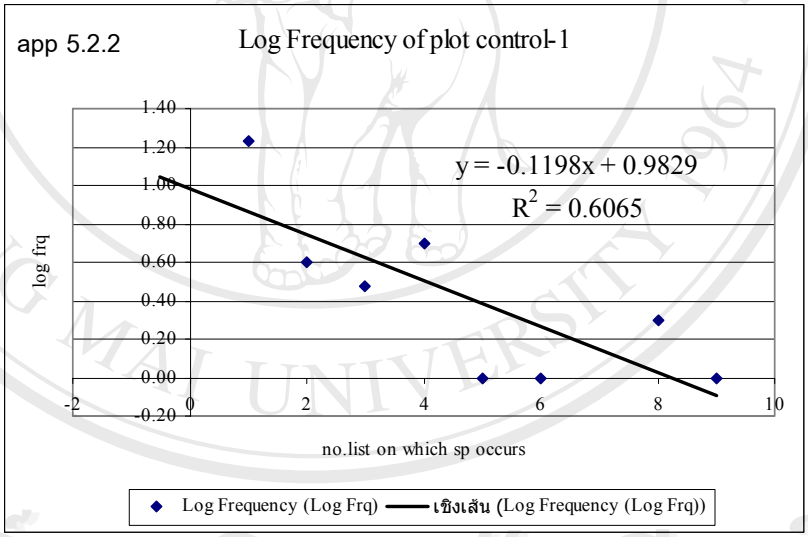




5.1.1) Number of bird species/list curve of control plots.

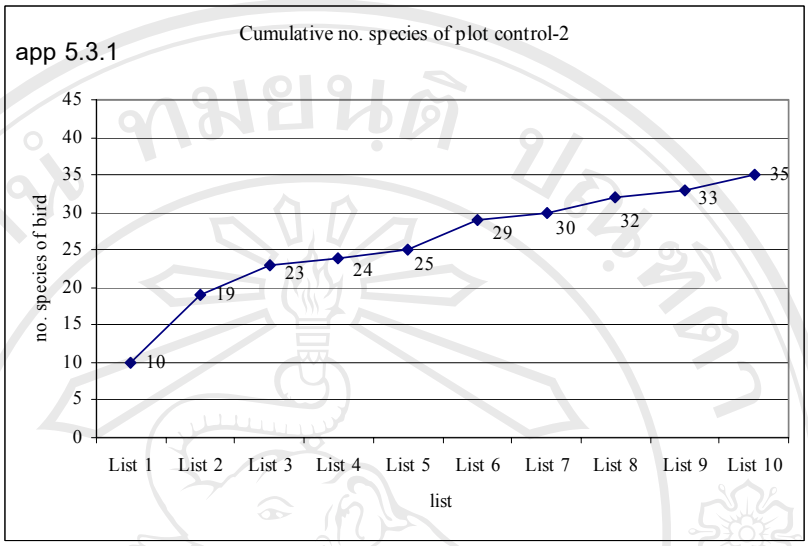
5.1.2) Log frequency values of number of species occurring on given number of lists of control plots.

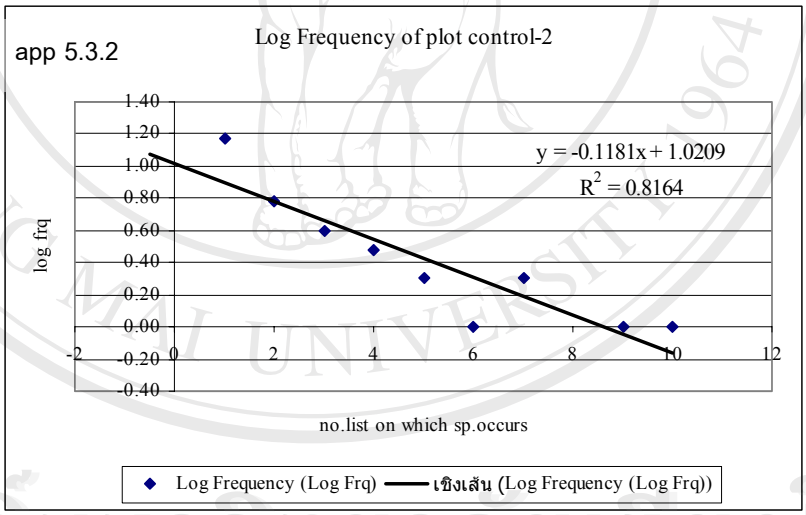




5.2.1) Number of bird species/list curve of control-1 plot.

5.2.2) Log frequency values of number of species occurring on given number of lists of control-1 plot.

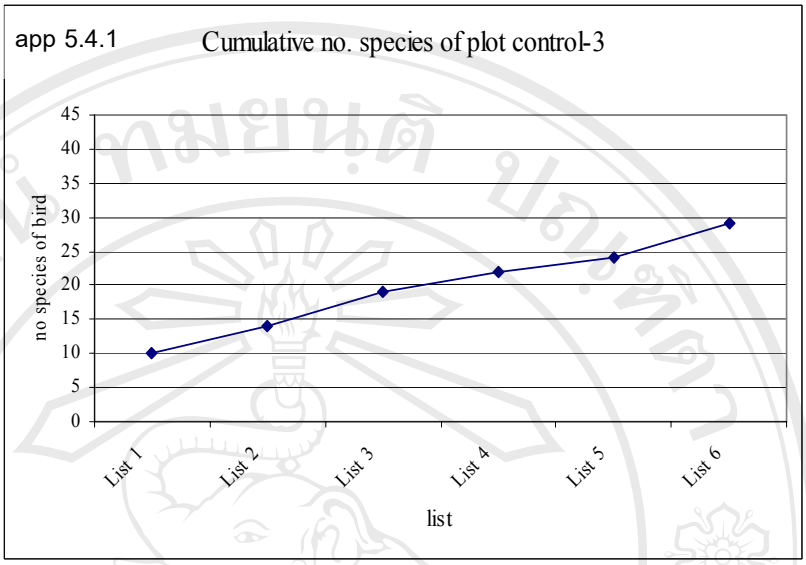




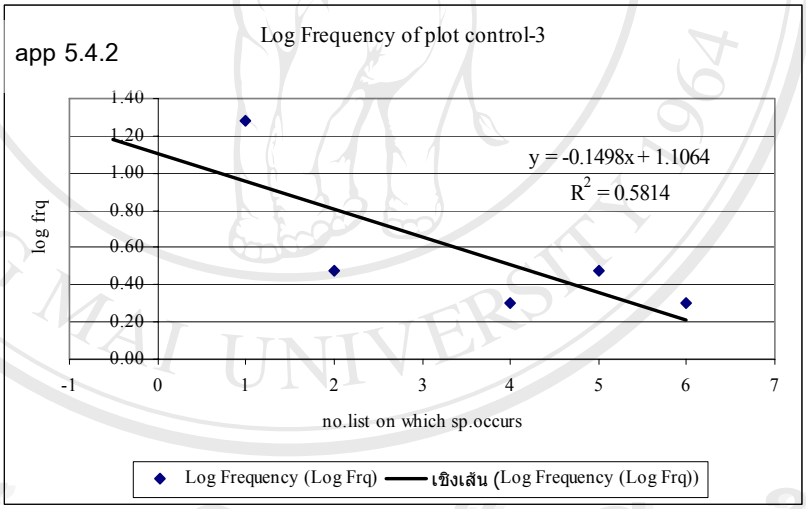
5.3.1) Number of bird species/list curve of control-2 plot.

5.3.2) Log frequency values of number of species occurring on given number of lists of control-2 plot.

app 5.4.1

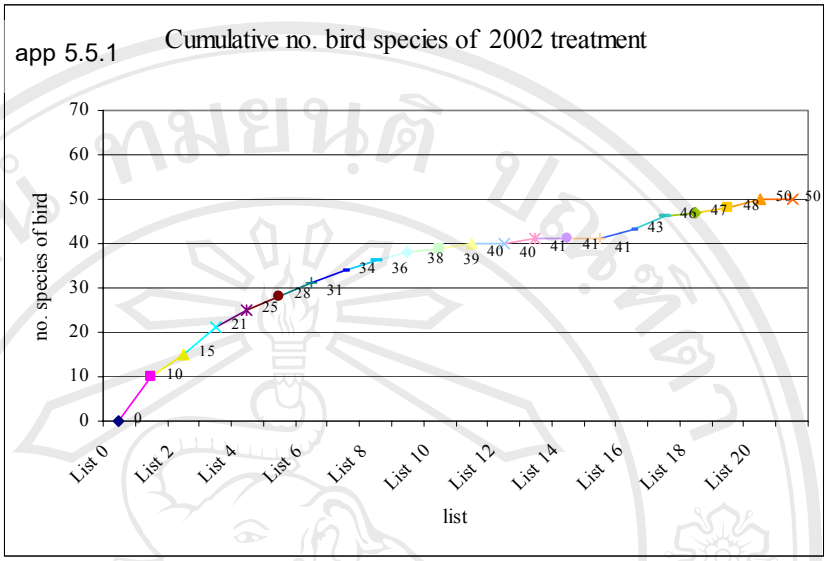


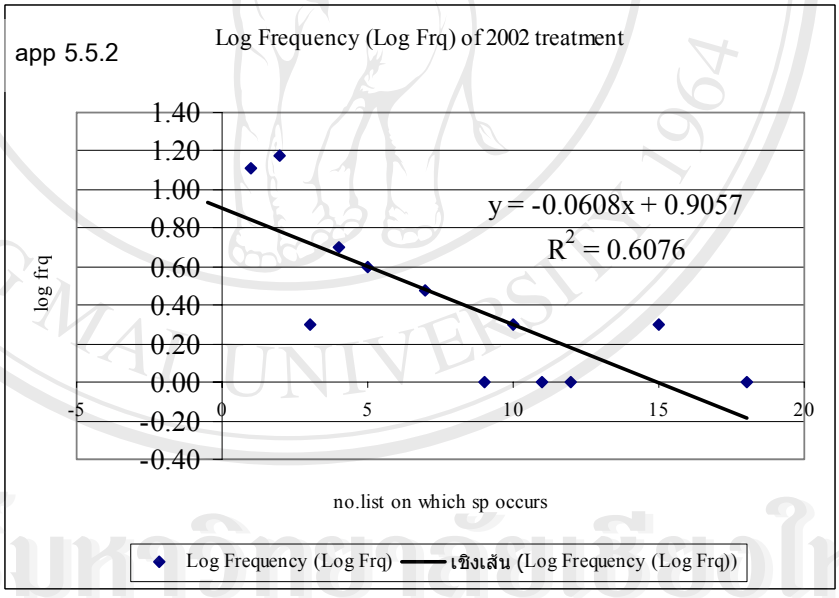
app 5.4.2



5.4.1) Number of bird species/list curve of control-3 plot.

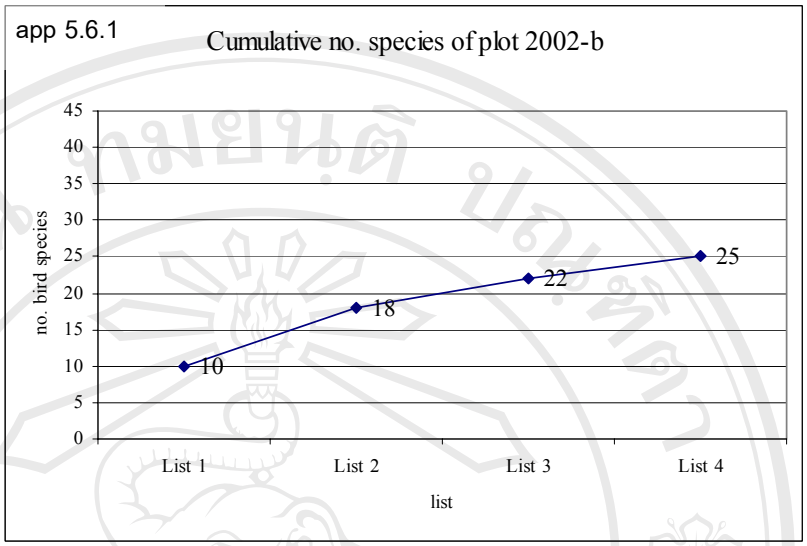
5.4.2) Log frequency values of number of species occurring on given number of lists of control-3 plot.

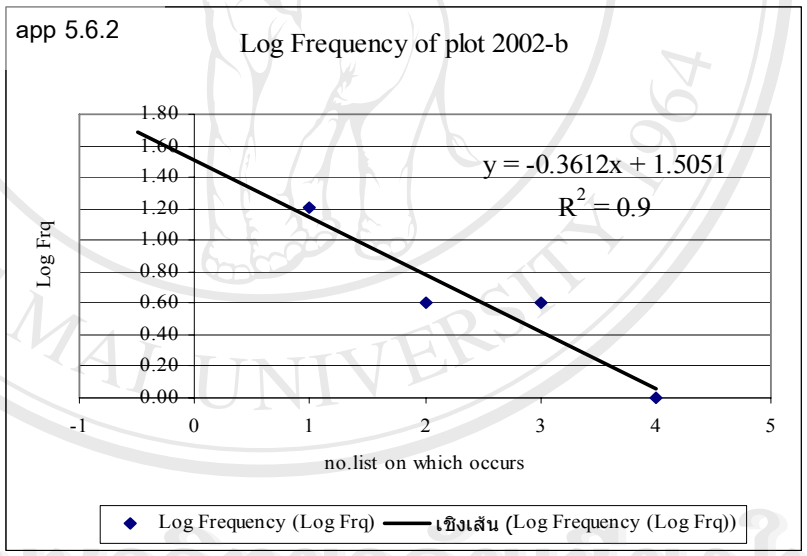




5.5.1) Number of bird species/list curve of 2002 plots.

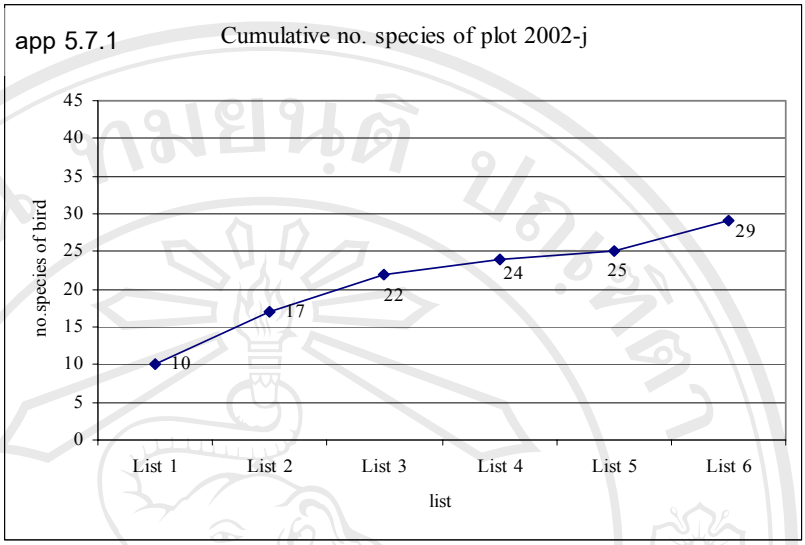
5.5.2) Log frequency values of number of species occurring on given number of lists of 2002 plots.

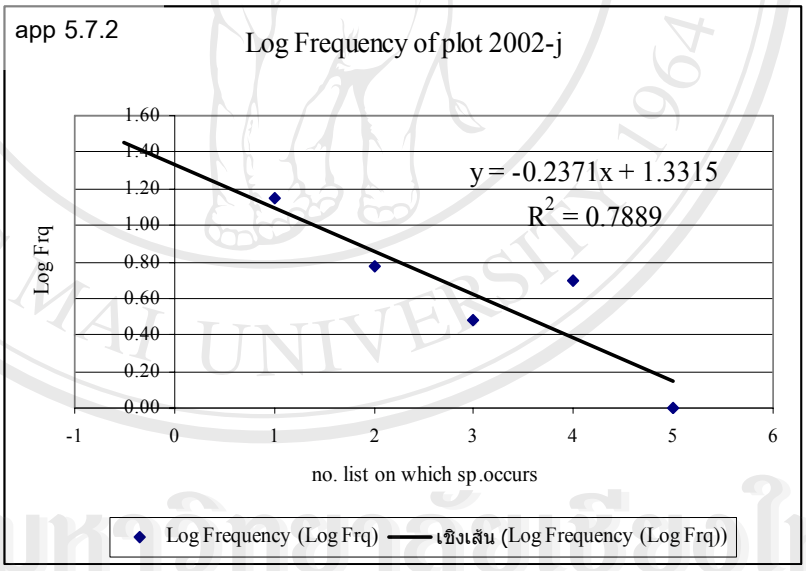




5.6.1) Number of bird species/list curve of 2002-b plot.

5.6.2) Log frequency values of number of species occurring on given number of lists of 2002-b plot.

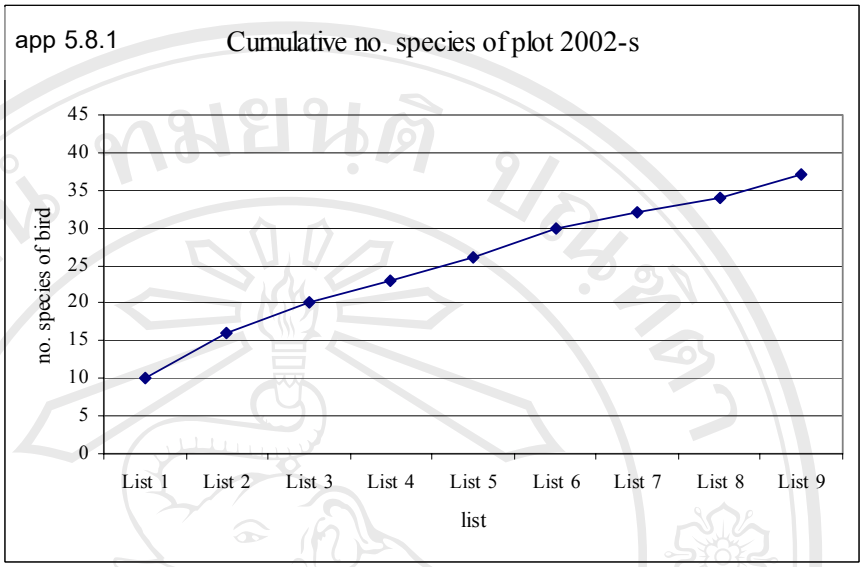




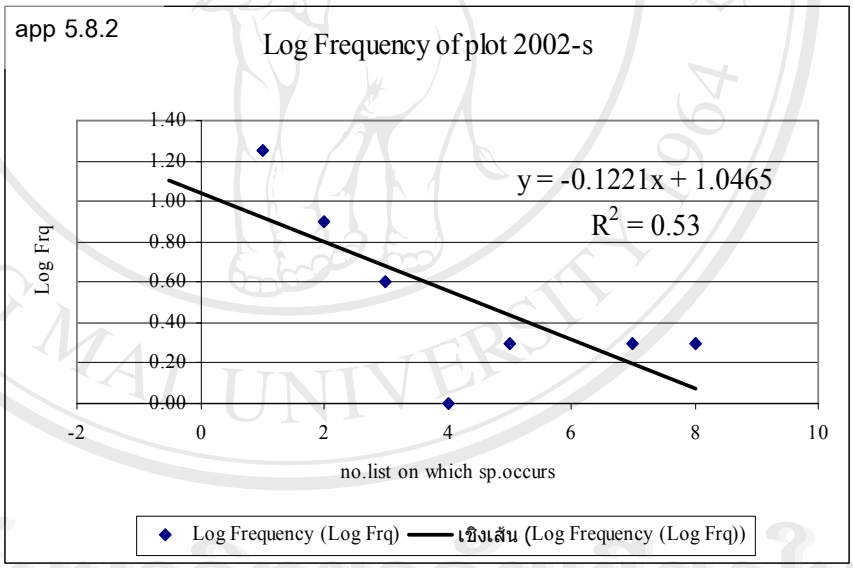
5.7.1) Number of bird species/list curve of 2002-j plot.

5.7.2) Log frequency values of number of species occurring on given number of lists of 2002-j plot.

app 5.8.1

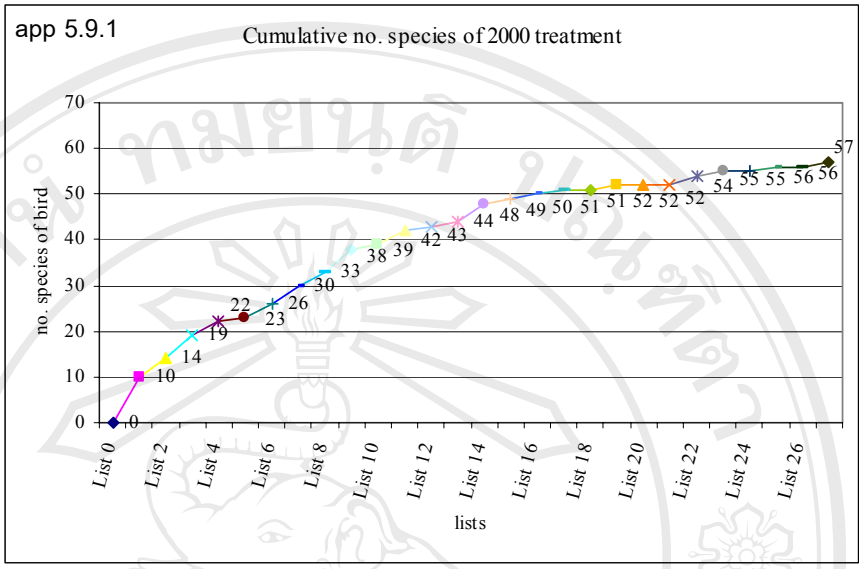


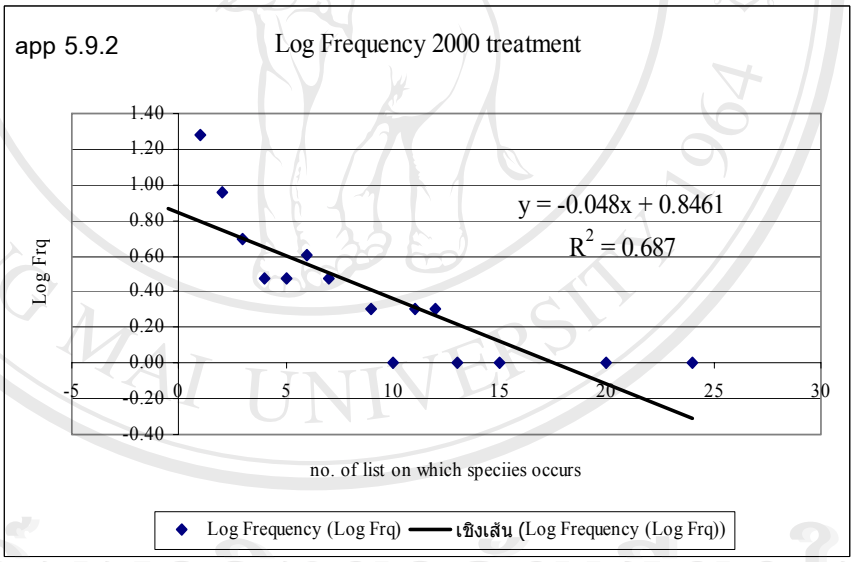
app 5.8.2



5.8.1) Number of bird species/list curve of 2002-s plot.

5.8.2) Log frequency values of number of species occurring on given number of lists of 2002-s plot.

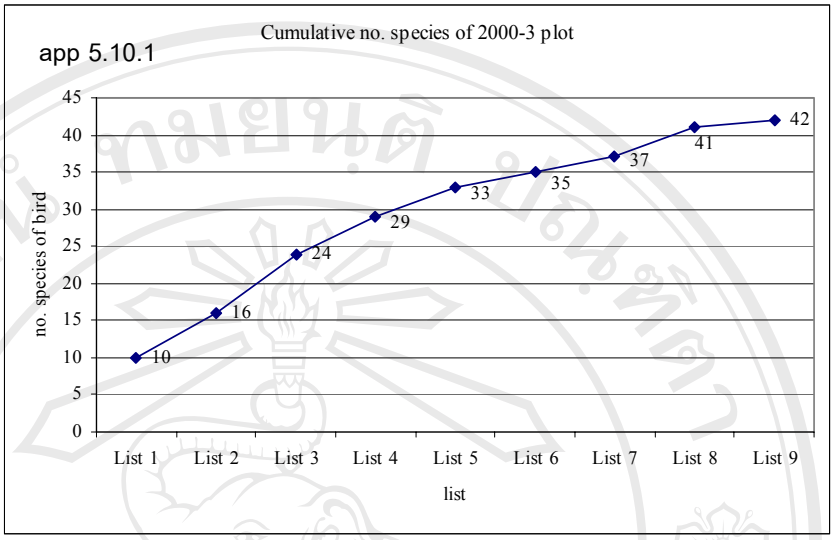




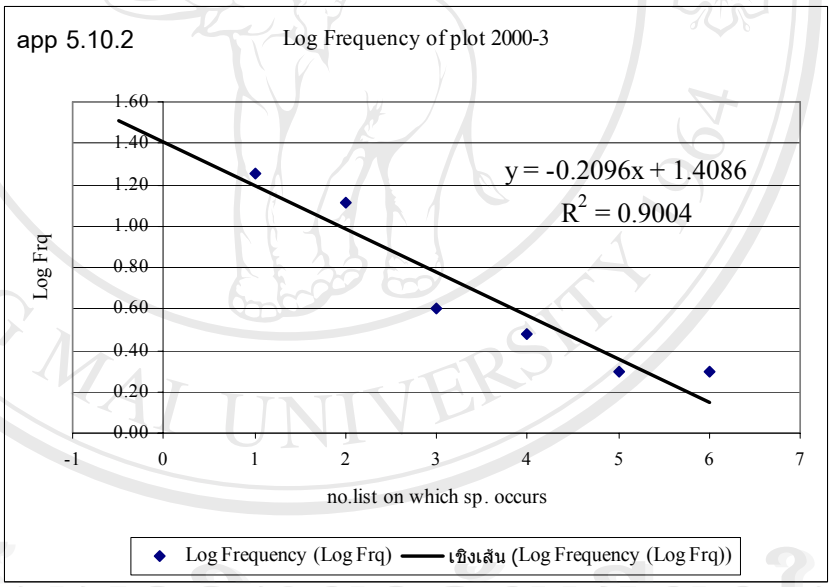
5.9.1) Number of bird species/list curve of 2000 plots.

5.9.2) Log frequency values of number of species occurring on given number of lists of 2000 plots.

app 5.10.1



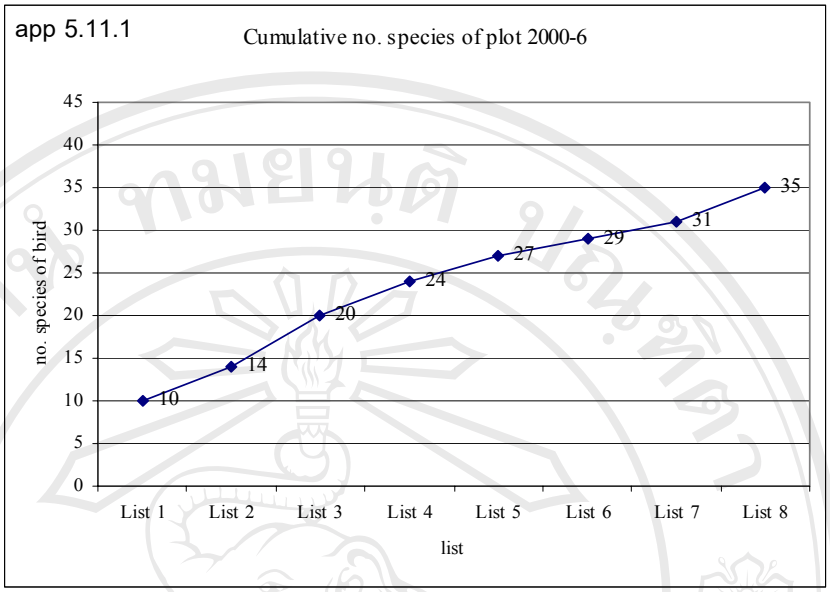
app 5.10.2



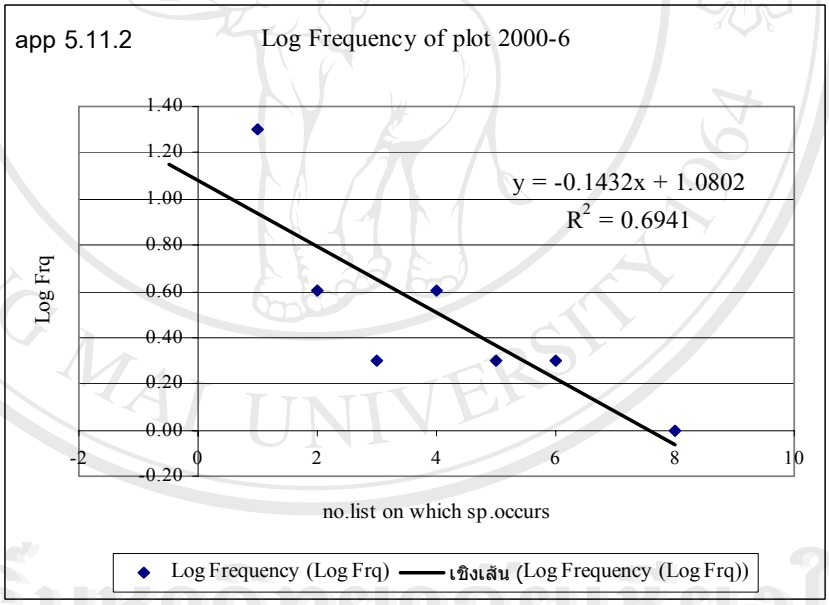
5.10.1) Number of bird species/list curve of 2000-3 plot.

5.10.2) Log frequency values of number of species occurring on given number of lists of 2000-3 plot.

app 5.11.1

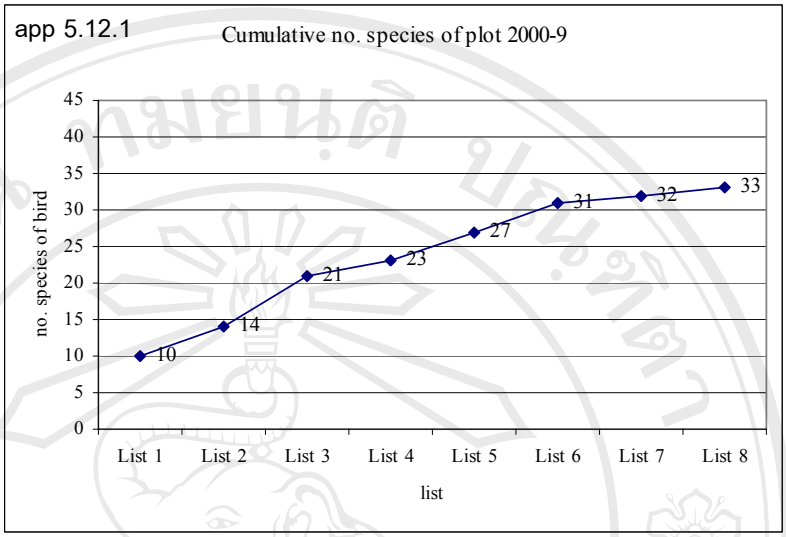


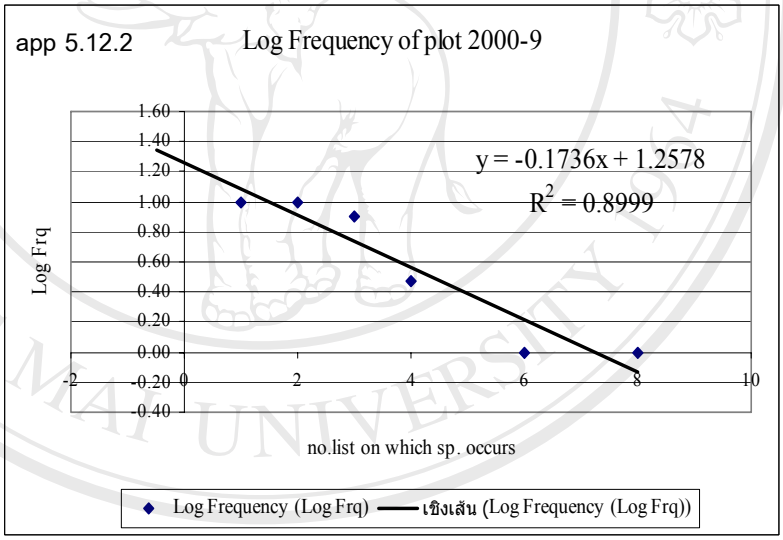
app 5.11.2



5.11.1) Number of bird species/list curve of 2000-6 plot.

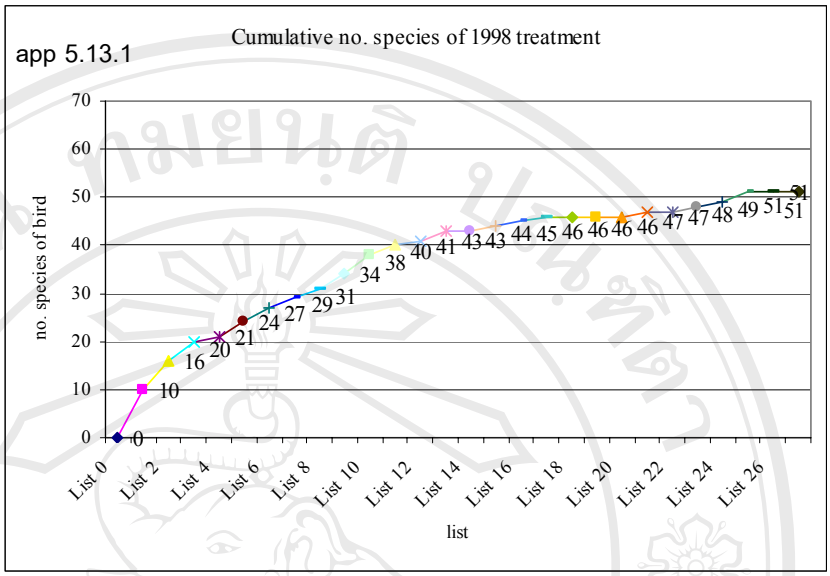
5.11.2) Log frequency values of number of species occurring on given number of lists of 2000-6 plot.

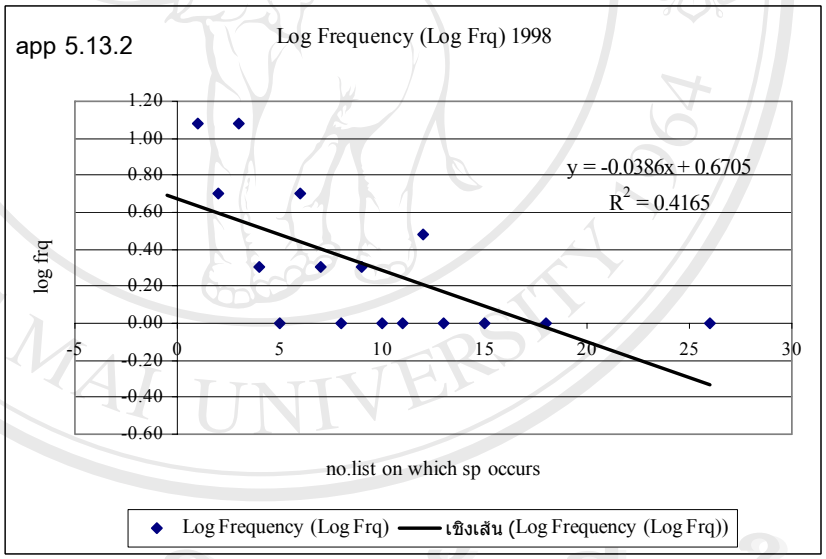




5.12.1) Number of bird species/list curve of 2000-9 plot.

5.12.2) Log frequency values of number of species occurring on given number of lists of 2000-9 plot.

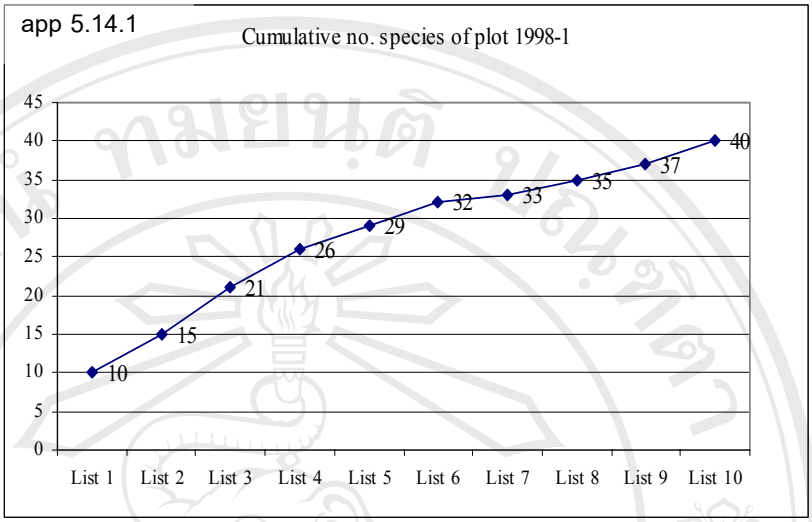




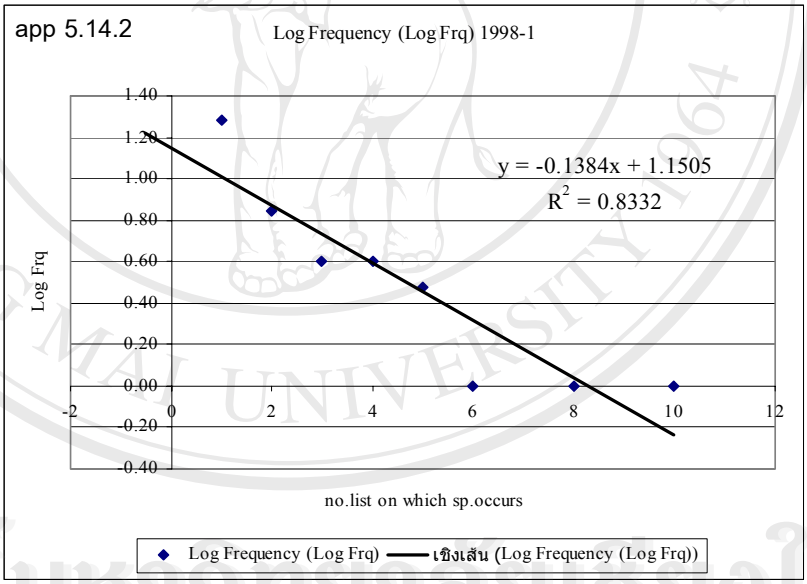
5.13.1) Number of bird species/list curve of 1998 plots.

5.13.2) Log frequency values of number of species occurring on given number of lists of 1998 plots.

app 5.14.1



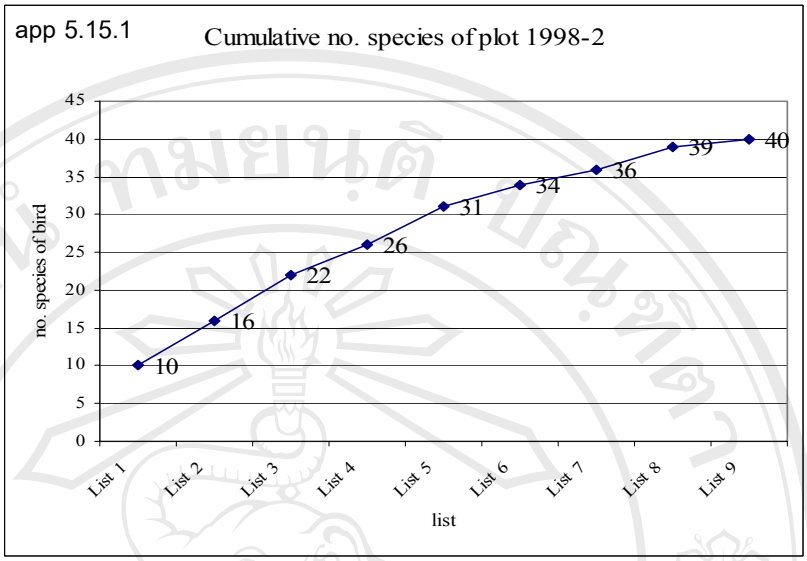
app 5.14.2



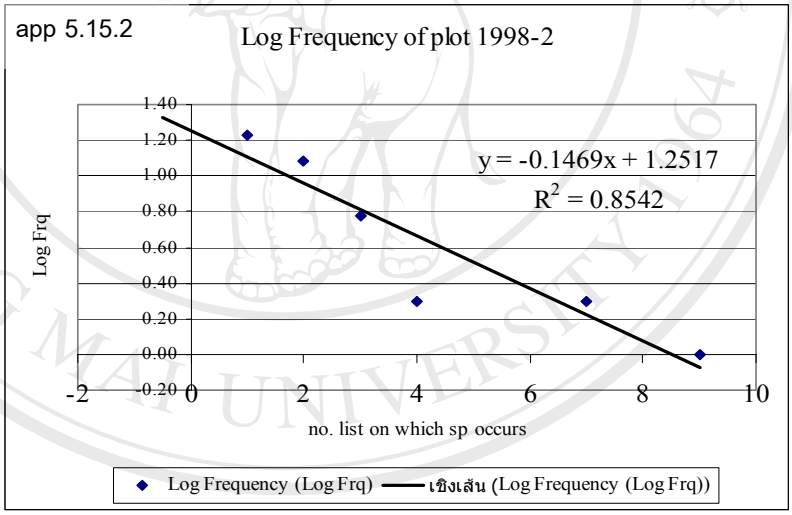
5.14.1) Number of bird species/list curve of 1998-1 plot.

5.14.2) Log frequency values of number of species occurring on given number of lists of 1998-1 plot.

app 5.15.1

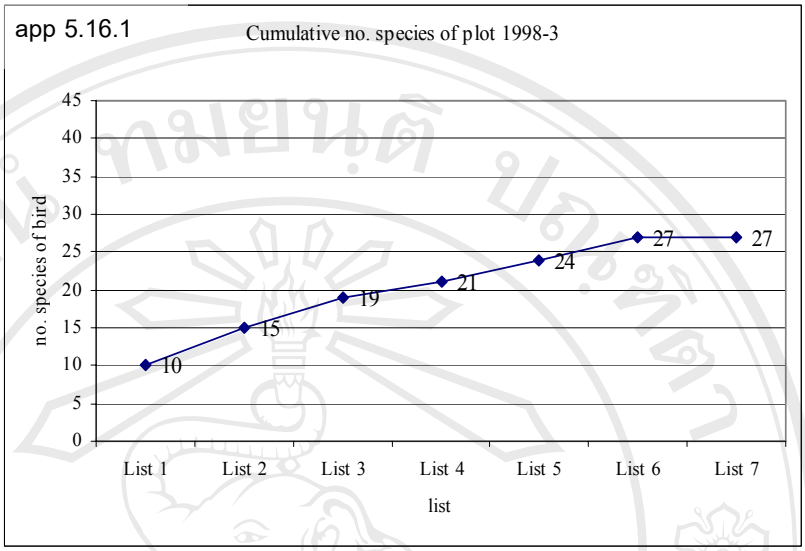


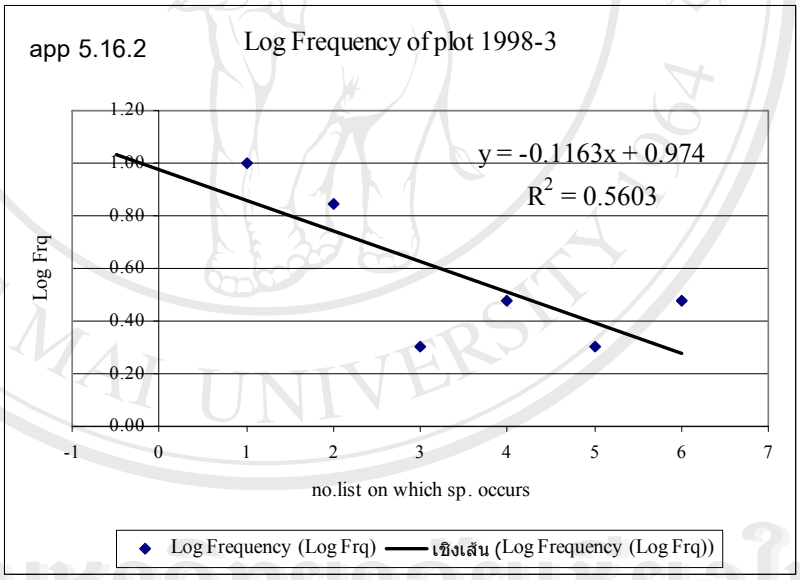
app 5.15.2



5.15.1) Number of bird species/list curve of 1998-2 plot.

5.15.2) Log frequency values of number of species occurring on given number of lists of 1998-2 plot.





5.16.1) Number of bird species/list curve of 1998-3 plot.

5.16.2) Log frequency values of number of species occurring on given number of lists of 1998-3 plot.

Appendix F Estimation summary of density and abundance by distance sampling.(Point Count Method) of all specie with in 12 plots.

	Estimate	%CV	df	95% Confidence Interval	
Stratum: 1998-1					
Uniform/Cosine					
DS	16.340	11.40	77.00	13.032	20.487
D	37.136	18.92	76.00	25.562	53.951
Stratum: 1998-2					
Uniform/Cosine					
DS	17.401	11.04	82.00	13.978	21.662
D	27.587	13.03	81.00	21.309	35.714
Stratum: 1998-3					
Uniform/Cosine					
DS	14.006	12.31	66.00	10.964	17.891
D	23.979	14.82	65.00	17.866	32.185
Stratum: 2000-3					
Uniform/Cosine					
DS	15.279	11.79	72.00	12.090	19.309
D	20.584	13.34	71.00	15.794	26.827
Stratum: 2000-6					
Uniform/Cosine					
DS	15.915	11.55	75.00	12.655	20.017
D	24.192	13.84	74.00	18.384	31.833
Stratum: 2000-9					
Uniform/Cosine					
DS	13.369	12.60	63.00	10.404	17.179
D	25.677	18.43	62.00	17.819	36.999
Stratum: 2002-b					
Uniform/Cosine					
DS	14.430	12.13	68.00	11.339	18.364
D	25.889	13.94	67.00	19.629	34.146
Stratum: 2002-j					
Uniform/Cosine					
DS	10.186	14.43	48.00	7.6315	13.595
D	19.735	17.90	47.00	13.807	28.208

Appendix F (continued)

Stratum: 2002-s
Uniform/Cosine

DS	15.703	11.62	74.00	12.466	19.781
D	29.285	15.86	73.00	21.390	40.092

Stratum: Control-1
Uniform/Cosine

DS	30.263	50.81	77.00	11.655	78.580
D	44.717	51.14	79.10	17.134	116.71

Stratum: Control-2
Uniform/Cosine

DS	33.980	33.52	95.00	17.779	64.943
D	48.808	33.87	99.42	25.383	93.852

Stratum: Control-3
Uniform/Cosine

DS	26.193	21.30	69.00	17.205	39.876
D	46.913	22.18	85.55	30.347	72.522

Estimation Summary - Density&Abundance

Pooled Estimates:

	Estimate	%CV	df	95% Confidence Interval	
DS	18.589	11.47	11.00	14.453	23.907
D	31.209	9.64	11.00	25.252	38.570

* D = DS x E(S)

D = estimate of density of birds.

DS = estimate of density of clusters of birds.

E(S) = estimate of expected value of cluster size of birds.

Appendix G Estimation summary of density and abundance by distance sampling.(Point Count Method) of all specie with in 4 treatment.

	Estimate	%CV	df	95% Confidence Interval	
Stratum: 1. 1 (Control)					
Uniform/Cosine					
DS	25.750	33.73	149.06	13.462	49.256
D	38.782	33.87	151.64	20.223	74.374
Stratum: 2. 2 (1998)					
Uniform/Cosine					
DS	15.915	6.30	2.00	12.139	20.866
D	29.567	9.49	10.14	23.954	36.497
Stratum: 3. 3 (2000)					
Uniform/Cosine					
DS	14.854	5.15	2.00	11.903	18.537
D	23.484	7.84	10.56	19.750	27.924
Stratum: 4. 4 (2002)					
Uniform/Cosine					
DS	13.440	12.41	2.00	7.8954	22.877
D	24.970	13.60	2.88	16.066	38.807

Estimation Summary - Density&Abundance

Pooled Estimates:

	Estimate	%CV	df	95% Confidence Interval	
DS	17.490	16.01	3.00	10.542	29.016
D	29.201	11.80	3.00	20.084	42.457

Appendix H Estimation summary of density and abundance by distance sampling.(Point Count Method) of forest area birds within 4 treatments.

	Estimate	%CV	df	95% Confidence Interval	
Stratum: 1. 1 (control)					
Uniform/Cosine					
DS	6.0016	30.96	9.04	3.0286	11.893
D	7.7965	31.26	9.40	3.9248	15.487
Stratum: 2. 2 (1998)					
Uniform/Cosine					
DS	6.9321	19.87	2.00	2.9723	16.167
D	11.601	25.32	5.23	6.1648	21.829
Stratum: 3. 3 (2000)					
Uniform/Cosine					
DS	6.5784	11.33	2.00	4.0467	10.694
D	9.2664	13.21	3.69	6.3516	13.519
Stratum: 4. 4 (2002)					
Uniform/Cosine					
DS	3.8905	28.57	2.00	1.1654	12.987
D	5.8003	30.47	2.58	2.0482	16.426

Estimation Summary - Density&Abundance

Pooled Estimates:

	Estimate	%CV	df	95% Confidence Interval	
DS	5.8506	11.64	3.00	4.0446	8.4630
D	8.6160	14.19	3.00	5.4978	13.503

Appendix I Estimation summary of density and abundance by distance sampling.(Point Count Method) of open area birds within 4 treatments.

	Estimate	%CV	df	95% Confidence Interval	
Stratum: 1. 1 (control)					
Uniform/Cosine					
DS	19.927	37.35	175.08	9.7650	40.666
D	31.847	37.56	178.92	15.551	65.221
Stratum: 2. 2 (1998)					
Uniform/Cosine					
DS	8.7005	7.45	2.00	6.3168	11.984
D	17.684	9.45	5.15	13.906	22.489
Stratum: 3. 3 (2000)					
Uniform/Cosine					
DS	7.9931	1.77	2.00	7.4071	8.6255
D	13.935	8.97	111.06	11.669	16.640
Stratum: 4. 4 (2002)					
Uniform/Cosine					
DS	9.1956	18.67	2.00	4.1468	20.391
D	18.603	19.79	2.53	9.2799	37.294

Estimation Summary - Density&Abundance

Pooled Estimates:

	Estimate	%CV	df	95% Confidence Interval	
DS	11.454	24.75	3.00	5.2714	24.888
D	20.517	19.05	3.00	11.249	37.421

Appendix J List of all species observed in different study areas and plots. List for the Pre-planting areas were based on Mackinnon list Method only, while the forest plots and planted plots were based on point count only.

No.	Common Name	Pre-planting survey	Semi-natural forest	1998 plots	2000 plots	2002 plots	Control Plots
1	Ashy Bulbul	X					
2	Ashy Drongo		X	X	X		X
3	Ashy wood swallow	X			X	X	
4	Asian Brown Flycather				X		X
5	Asian Palm-Swift	X					
6	Babbler sp.		X				
7	Bar-winged Flycatcher-shrike		X				
8	Black-crested Bulbul		X	X	X		
9	Black-headed Bulbul		X		X		
10	Black-headed Sibia	X					
11	Black-naped Monarch		X	X	X		
12	Black-naped Oriole		X				
13	Black-throated Sunbird		X	X	X		X
14	Black-winged Cuckoo-shrike			X	X	X	
15	Blue Magpie	X					
16	Blue Rock-Thrush			X			
17	Blue-throated Barbet		X				
18	Blyth's Leaf-Warbler					X	
19	Bronzed Drongo		X				
20	Brown-cheeked Fulvetta		X				
21	Brown Shrike	X					
22	Buff-bellied Flowerpecker		X				
23	Buff-breasted Babbler	X					
24	Bulbul sp.		X		X	X	
25	Burmese Shrike			X	X	X	
26	Changeable Hawk-Eagle	X					
27	Chestnut-capped Babbler	X		X	X	X	X
28	Chestnut-winged Cuckoo	X					
29	Common Buzzard	X					
30	Common Iora		X	X	X	X	X

Appendix J (continued)

No.	Common Name	Pre-planting survey	Semi-natural forest	1998 plots	2000 plots	2002 plots	Control Plots
31	Common Rosefinch			X			X
32	Common Tailorbird		X	X	X	X	X
33	Common Wood-shrike		X				
34	Crested Bunting			X			
35	Dark-necked Tailorbird				X	X	
36	Eye-browed Thrush	X					
37	Flavescent Bulbul		X	X	X	X	X
38	Flowerpecker sp.		X				
39	Flycather sp.		X	X	X	X	X
40	Golden-fronted Leafbird		X				
41	Golden-spectacled Warbler		X		X	X	
42	Great Barbet		X				
43	Great Tit			X	X	X	X
44	Greater Coucal			X	X		
45	Greater Racket-tailed Drongo		X		X		
46	Green-billed Malkoha		X	X			
47	Greenish Warbler		X	X	X	X	X
48	Grey Bushchat	X				X	
49	Grey-breasted Prinia	X	X	X	X	X	X
50	Grey-capped Woodpecker		X				
51	Grey-cheeked Fulvetta		X				
52	Grey-eyed Bulbul		X				
53	Grey-headed Flycather		X	X			
54	Grey-throated Babbler		X				
55	Hair-crested Drongo						X
56	Hill Blue Flycatcher		X	X	X	X	X
57	Hill Prinia	X		X	X	X	X
58	Hoopoe			X			
59	Yellow-browed Warbler		X	X	X	X	X
60	Japanese White-eye			X			
61	Large Wood-shrike	X					
62	Laughingthrush sp.		X				
63	Little Pied Flycatcher		X				
64	Little Spiderhunter		X	X	X	X	X
65	Long-tailed Broadbill		X				
66	Long-tailed Minivet		X				
67	Long-tailed Shrike	X				X	X

Appendix J (continued)

No.	Common Name	Pre-planting survey	Semi-natural forest	1998 plots	2000 plots	2002 plots	Control Plots
68	Minivet sp.		X				
69	Mountain Bamboo-Partridge			X	X		X
70	Olive-backed Pipit					X	X
71	Orange-bellied Leafbird		X				
72	Oriental White-eye		X	X	X	X	
73	Pale-footed Bush-Warbler		X	X	X		X
74	Pale-legged Leaf-Warbler	X			X		
75	Partridge sp.		X				
76	Pied Bushchat	X				X	
77	Plain Flowerpecker		X	X	X	X	
78	Prinia sp.			X			
79	Puff-throated Babbler	X	X	X	X	X	X
80	Puff-throated Bulbul		X				
81	Purple Sunbird			X			X
82	Radde's Warbler	X	X				
83	Red-rumped Swallow	X					
84	Red-throated Flycatcher		X	X	X	X	X
85	Red-whiskered Bulbul	X	X	X	X	X	X
86	Rufescent Prinia	X		X	X	X	X
87	Rufous-backed Sibia	X					
88	Rufous-frounted Babbler		X				
89	Rusty-nape Pitta	X					
90	Scaly breasted Munia				X	X	
91	Scarlet Minivet	X	X		X	X	
92	Short-billed Minivet		X				
93	Shrike sp.					X	
94	Siberian Rubythroat			X	X		X
95	Silver-breasted Broadbill		X				
96	Slatey-backed Flycather		X				
97	Sooty-headed Bulbul	X	X	X	X	X	X
98	Speckled Piculet		X	X			
99	Spotted Bush Warbler	X					
100	Stonechat	X					
101	Streaked Spiderhunter		X	X	X	X	X
102	Striped Tit-Babbler		X	X	X	X	X
103	Sunbird sp.		X	X			
104	Unknown 1		X				
105	Unknown 2		X				
106	Velvet-fronted Nutatch		X			X	

Appendix J (continued)

No.	Common Name	Pre-planting survey	Semi-natural forest	1998 plots	2000 plots	2002 plots	Control Plots
107	Verditer Flycatcher		X				
108	Warbler sp.		X	X		X	X
109	White-bellied Yuhina		X				
110	White-browed Piculet		X	X	X		X
111	White-browed Scimitar-Babbler	X	X	X	X	X	X
112	White-browed Shrike-Babbler		X		X	X	
113	White-hooded Babbler	X					
114	White-rumped Munia	X				X	X
115	White-rumped Shama		X	X	X	X	
116	White-tailed Robin						X
117	White-throated Fantail		X			X	
118	Woodpecker sp.		X				
119	Yellow-eyed Babbler	X		X		X	X
	Total = 119	**34**	**71**	**47**	**45**	**43**	**36**

Appendix K Diet and status of bird species recorded in natural forest, planted plots, non-planted controls and area prior to planting.

No.	Common Name	Science Name	Diet	Status	habitat
1	Ashy Bulbul	*Hypsipetes flavala*	omnivore	resident	forest
2	Ashy Drongo	*Dicrurus leucophaeus*	insectivore	resident	forest
3	Ashy wood swallow	*Artamus fuscus*	insectivore	resident	open
4	Asian Brown Flycather	*Muscicapa dauurica*	insectivore	winter visitor	open
5	Asian Palm-Swift	*Cypsiurus balasiensis*	insectivore	resident	open
6	Babbler sp.	*unknown*	-	-	-
7	Bar-winged Flycatcher-shrike	*Hemipus picatus*	insectivore	resident	forest
8	Black-crested Bulbul	*Pycnonotus melanicterus*	omnivore	resident	forest
9	Black-headed Bulbul	*Pycnonotus atriceps*	omnivore	resident	forest
10	Black-headed Sibia	*Heterophasia melanoleuca*	insectivore	resident	forest
11	Black-naped Monarch	*Hypothymis azurea*	insectivore	resident	forest
12	Black-naped Oriole	*Oriolus xanthonotus*	insectivore	winter visitor	forest
13	Black-throated Sunbird	*Aethopyga saturata*	nectar&insectivore	resident	forest
14	Black-winged Cuckoo-shrike	*Coracina melaschista*	insectivore	resident	forest
15	Blue Magpie	*Urocissa erythrorhyncha*	insectivore	resident	forest
16	Blue Rock-Thrush	*Monticola solitarius*	insectivore	winter visitor	open
17	Blue-throated Barbet	*Megalaima asiatica*	frugivore	resident	forest
18	Blyth's Leaf-Warbler	*Phylloscopus reguloides*	insectivore	winter visitor	forest
19	Bronzed Drongo	*Dicrurus aeneus*	insectivore	resident	forest
20	Brown-cheeked Fulvetta	*Alcippe poioicephala*	omnivore	resident	forest
21	Brown Shrike	*Lanius cristatus*	carnivore	winter visitor	open
22	Buff-bellied Flowerpecker	*Dicaeum ignipectus*	nectariforous	resident	forest
23	Buff-breasted Babbler	*Trichastoma tickelli*	insectivore	resident	forest
24	Bulbul sp.	*Pycnonotus sp.*	omnivore	-	-
25	Burmese Shrike	*Lanius collurioides*	carnivore	resident	open
26	Changeable Hawk-Eagle	*Spizaetus cirrhatus*	carnivore	resident	forest
27	Chestnut-capped Babbler	*Timalia pileata*	insectivore	resident	open
28	Chestnut-winged Cuckoo	*Clamator coromandus*	insectivore	breeding vistor	open
29	Common Buzzard	*Buteo buteo*	carnivore	winter visitor	open
30	Common Iora	*Aegithina tiphia*	insectivore	resident	open
31	Common Rosefinch	*Carpodacus erythrinus*	seed-eater	winter visitor	open
32	Common Tailorbird	*Orthotomus sutorius*	insectivore	resident	open

Appendix K (continued)

No.	Common Name	Science Name	Diet	Status	habitat
33	Common Wood-shrike	*Tephrodornis pondicerianus*	insectivore	resident	forest
34	Crested Bunting	*Melophus lathami*	seed-eater	winter visitor	open
35	Dark-necked Tailorbird	*Orthotomus atrogularis*	insectivore	resident	forest
36	Eye-browed Thrush	*Turdus obscurus*	insectivore	winter visitor	forest
37	Flavescent Bulbul	*Pycnonotus flavescens*	omnivore	resident	open
38	Flowerpecker sp.	*Dicauem sp.*	nectar&insectivore	resident	forest
39	Flycather sp.	*unknown*	insectivore	winter visistor	-
40	Golden-fronted Leafbird	*Chloropsis aurifrons*	omnivore	resident	forest
41	Golden-spectacled Warbler	*Seicercus burkii*	insectivore	winter visitor	forest
42	Great Barbet	*Megalaima virens*	frugivore	resident	forest
43	Great Tit	*Parus major*	omnivore	resident	forest
44	Greater Coucal	*Centropus sinensis*	omnivore	resident	open
45	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	insectivore	resident	forest
46	Green-billed Malkoha	*Phaenicophaeus tristis*	omnivore	resident	forest
47	Greenish Warbler	*Phylloscopus trochiloides*	insectivore	winter visitor	forest
48	Grey Bushchat	*Saxicola ferrea*	omnivore	winter visitor	open
49	Grey-breasted Prinia	*Prinia hodgsonii*	insectivore	resident	open
50	Grey-capped Woodpecker	*Picoides canicapillus*	insectivore	resident	forest
51	Grey-cheeked Fulvetta	*Alcippe morrisonia*	omnivore	resident	forest
52	Grey-eyed Bulbul	*Hypsipetes propinquus*	omnivore	resident	forest
53	Grey-headed Flycather	*Culicicapa ceylonensis*	insectivore	resident	forest
54	Grey-throated Babbler	*Stachyris nigriceps*	insectivore	resident	forest
55	Hair-crested Drongo	*Dicrurus hottentottus*	insectivore	resident	forest
56	Hill Blue Flycatcher	*Cyornis banyumas*	insectivore	resident	forest
57	Hill Prinia	*Prinia atrogularis*	insectivore	resident	open
58	Hoopoe	*Upupa epops*	insectivore	resident	open
59	Yellow-browed Warbler	*Phylloscopus inornatus*	insectivore	winter visitor	forest
60	Japanese White-eye	*Zosterops japonicus*	omnivore	winter visitor	forest
61	Large Wood-shrike	*Tephrodornis virgatus*	insectivore	resident	forest
62	Laughingthrush sp.	*Garrulax sp.*	ominvore	-	-
63	Little Pied Flycatcher	*Ficedula westermanni*	insectivore	resident	forest
64	Little Spiderhunter	*Arachnothera longirostra*	nectar&insectivore	resident	forest
65	Long-tailed Broadbill	*Psarisomus dalhousiae*	omnivore	resident	forest
66	Long-tailed Minivet	*Pericrocotus ethologus*	insectivore	resident	forest
67	Long-tailed Shrike	*Lanius schach*	carnivore	resident	open
68	Minivet sp.	*Pericrocotus sp.*	insectivore	-	-
69	Mountain Bamboo-Partridge	*Bambusicola fytchii*	omnivore	resident	open

Appendix K (continued)

No.	Common Name	Science Name	Diet	Status	habitat
70	Olive-backed Pipit	*Anthus hodgsoni*	insectivore	winter visitor	open
71	Orange-bellied Leafbird	*Chloropsis hardwickii*	omnivore	resident	forest
72	Oriental White-eye	*Zosterops palpebrosus*	omnivore	resident	forest
73	Pale-footed Bush-Warbler	*Cettia pallidipes*	insectivore	resident	open
74	Pale-legged Leaf-Warbler	*Phylloscopus tenellipes*	insectivore	resident	forest
75	Partridge sp.	*unknown*	ominvore	-	-
76	Pied Bushchat	*Saxicola caprata*	insectivore	resident	open
77	Plain Flowerpecker	*Dicaeum concolor*	nectariforous	resident	forest
78	Prinia sp.	*Prinia sp.*	insectivore	resident	open
79	Puff-throated Babbler	*Pellorneum ruficeps*	insectivore	resident	forest
80	Puff-throated Bulbul	*Criniger pallidus*	omnivore	resident	forest
81	Purple Sunbird	*Nectarinia asiatica*	nectar&insectivore	resident	open
82	Radde's Warbler	*Phylloscopus schwarzi*	insectivore	winter visitor	open
83	Red-rumped Swallow	*Hirundo smithii*	insectivore	resident	open
84	Red-throated Flycatcher	*Ficedula parva*	insectivore	winter visistor	open
85	Red-whiskered Bulbul	*Pycnonotus jocosus*	omnivore	resident	open
86	Rufescent Prinia	*Prinia rufescens*	insectivore	resident	open
87	Rufous-backed Sibia	*Heterophasia annectens*	insectivore	resident	forest
88	Rufous-frounted Babbler	*Stachyris rufifrons*	insectivore	resident	open
89	Rusty-nape Pitta	*Pitta oatesi*	omnivore	resident	forest
90	Scaly breasted Munia	*Lonchura sp.*	seed-eater	resident	forest
91	Scarlet Minivet	*Pericrocotus flammeus*	insectivore	resident	open
92	Short-billed Minivet	*Pericrocotus brevirostris*	insectivore	resident	open
93	Shrike sp.	*Lanius sp.*	carnivore	-	open
94	Siberian Rubythroat	*Luscinia calliope*	insectivore	winter visitor	forest
95	Silver-breasted Broadbill	*Serilophus lunatus*	insectivore	winter visitor	open
96	Slatey-backed Flycather	*Ficedula hodgsonii*	insectivore	winter visitor	forest
97	Sooty-headed Bulbul	*Pycnonotus aurigaster*	omnivore	resident	forest
98	Speckled Piculet	*Picumnus innominatus*	insectivore	resident	open
99	Spotted Bush Warbler	*Bradypterus thoracicus*	insectivore	winter visistor	open
100	Stonechat	*Saxicola torquata*	insectivore	winter visistor	open
101	Streaked Spiderhunter	*Arachnothera magna*	nectar&insectivore	resident	forest
102	Striped Tit-Babbler	*Macronous gularis*	insectivore	resident	forest
103	Sunbird sp.	*Fam. Nectariniidae*	nectar&insectivore	resident	open
104	Unknown 1	*unknown*	-	-	-
105	Unknown 2	*unknown*	-	-	-
106	Velvet-fronted Nutatch	*Sitta frontalis*	insectivore	resident	forest
107	Verditer Flycatcher	*Eumyias thalassina*	insectivore	resident	forest
108	Warbler sp.	*Phylloscopus sp.*	insectivore	-	-
109	White-bellied Yuhina	*Yuhina zantholeuca*	insectivore	resident	forest

Appendix K (continued)

No.	Common Name	Science Name	Diet	Status	habitat
110	White-browed Piculet	*Sasia ochracea*	insectivore	resident	forest
111	White-browed Scimitar-Babbler	*Pomatorhinus schisticeps*	omnivore	resident	forest
112	White-browed Shrike-Babbler	*Pteruthius flaviscapis*	ominvore	resident	forest
113	White-hooded Babbler	*Gampsorhynchus rufulus*	insectivore	resident	forest
114	White-rumped Munia	*Lonchura striata*	seed-eater	resident	forest
115	White-rumped Shama	*Copsychus malabaricus*	insectivore	resident	open
116	White-tailed Robin	*Cinclidium leucurum*	insectivore	resident	forest
117	White-throated Fantail	*Rhipidura albicollis*	insectivore	resident	forest
118	Woodpecker sp.	*unknown*	insectivore	-	-
119	Yellow-eyed Babbler	*Chrysomma sinense*	insectivore	resident	forest

Appendix L Indices of species richness, diversity indices and similarity index.

a. Richness Indices (Ludwig and Reynolds, 1988)

1. Margalef (1985) index; $R1 = S-1/\ln(n)$

2. Menhinick (1964) index; $R2 = S/n^{1/2}$

S = total number of species in the community

n = total number of individual observed

b. Diversity Indices

1.Shannon's index (Ludwig and Reynolds, 1988 refer to Shannon and Weaver, 1949)

$$H' = -\sum_{i=1}^{s} (Pi \ln Pi)$$

2.Simpson's index (Ludwig and Reynolds, 1988 refer to Simpson, 1949)

$$\lambda = \sum_{i=1}^{s} Pi^2$$

Pi = ni/N

ni = number of individuals of the i^{th} species

N = total number of individuals

3. Hill indices (Ludwig and Reynolds, 1988)

$N0 = S$

$N1 = e^{H'}$

$N3 = 1/\lambda$

N0 = number of all species

N1 = number of abundant species

N2 = number of abundant species

c. Evenness indices (Luwig and Reynolds, 1988)

E1 = H'/ln(S) = ln(N0)/ln(N1) (Pielou, 1977)

E2 = $e^{H'}$/S = N1/N0 (Sheldom, 1969)

E3 = $e^{H'}$-1/S-1 = N1-1/N0-1 (Heip, 1974)

E4 = (1/λ)/ $e^{H'}$ = N2/N1 (Hill, 1973)

E5 = ((1/λ)-1)/($e^{H'}$-1) = N2-1/N1-1 (Alatalo, 1981)

d. Index of Similarity

1. Sorensen index (Southwood, 1978)

$$I_{AB} = 2j / a+b$$

I_{AB} = Silimarity of 2 habitat (A and B)

a = the number of species of bird found in A habitat.

b = the number of species of bird found in B habitat

j = the number of species of bird found both A and B habitat

Appendix M Woody plants which birds feeding on.

	Plant species	Ashy Drongo	Asian Brawn Flycatcher	Black-crested Bulbul	Black-naped Monarch	Black-throated Sunbird	Chestnut Bunting	Common Iora	Common Rosefince	Common Tailorbird	Dark-necked Tailorbird	Flavescent Bulbul
1	***Artocarpus lanceolata***											
2	***Aralia montana***			o								o
3	***Albizia sp.***							~				
4	***Bauhinia purpurea***					+						
5	***Broussonetia papyrifera***											
6	***Callicarpa arborea var. arborea***	∗		o				o		~		o
7	***Castanopsis calathiformis***											
8	***Castanopsis diversifolia***											∗
9	***Debregeasia longifolia***											o
10	***Erythrina stricta***	+		+			+		+			+
11	***Erythrina subumbrans***	+		+	~		+	~+	+			+
12	***Eurya acuminata DC. var. wallichiana Dyer***											
13	***Ficus hispida var. hispida***											
14	***Ficus semicordata var. semicordata***											
15	***Ficus subulata var. subulata***											
16	***Hovenia dulcis***											
17	***Litsea cubeba***			o		~		o			~	o
18	***Litsea salicifolia***											
19	***Macaranga denticulata***											
20	***Malastoma malabalicum***											o
21	***Markharnia stipulata var. kerri***											
22	***Melia toosandan***	~						~			~	
23	***Musa sp.***						+					
24	***Nyssa javanica***											
25	***Phyllanthus emblica***											
26	***Pinus kesiya***		~					~		~		
27	***Prunus cerasoides***					+						o
28	***Prunus persica Batsch Ex St***											
29	***Quercus semiserrata***											
30	***Solanum torvum***											
31	***Spondias axillaris***		~									
32	***Trema orientalis***			o								
33	***Pavetta tomentosa***											

Appendix M Woody plants which birds feeding on (continued).

	Plant species	Gloden-spectacle Warbler	Great Tit	Greenish Warbler	Grey-breasted Prinia	Grey Bushchat	Hill Blue Flycatcher	Yellow-browed Warbler	Japanese White-eye	Little Bunting	Little Spiderhunter	Olive-backed Sunbird
1	*Artocarpus lanceolata*											
2	*Aralia montana*											
3	*Albizia sp.*		~		~			~				
4	*Bauhinia purpurea*										+	
5	Broussonetia papyrifera											
6	*Callicarpa arborea var. arborea*					~		~				
7	*Castanopsis calathiformis*							~				
8	*Castanopsis diversifolia*											
9	*Debregeasia longifolia*							~	o			
10	*Erythrina stricta*			~								
11	*Erythrina subumbrans*		~	~	~			~	~+	+		
12	*Eurya acuminata DC. var. wallichiana Dyer*											
13	*Ficus hispida var. hispida*											
14	*Ficus semicordata var. semicordata*											
15	*Ficus subulata var. subulata*		~									
16	*Hovenia dulcis*						~					
17	*Litsea cubeba*	~						~				
18	*Litsea salicifolia*											
19	*Macaranga denticulata*							~				
20	*Malastoma malabalicum*							~	o			
21	*Markharnia stipulata var. kerri*										+	
22	*Melia toosandan*		~				~	~	~			
23	*Musa sp.*										+	
24	*Nyssa javanica*											
25	*Phyllanthus emblica*											
26	*Pinus kesiya*			~			~	~				
27	*Prunus cerasoides*		~	~			~	~	+			+
28	*Prunus persica Batsch Ex St*											
29	*Quercus semiserrata*							~				
30	*Solanum torvum*											
31	*Spondias axillaris*							~				
32	*Trema orientalis*						~	~				
33	*Pavetta tomentosa*											

Appendix M Woody plants which birds feeding on (continued).

	Plant species	Oriental White-eye	Puff-throated Sunbird	Purple Sunbird	Red-throated Flycatcher	Red-whiskered Bulbul	Ruffescent Prinia	Sooty-headed Bulbul	Speckled Piculet	Streaked Spiderhunter	Striped Tit-Babbler	Velvet-fronted Nutatch
1	*Artocarpus lanceolata*	~										
2	*Aralia montana*					o		o				
3	*Albizia sp.*	~							~		~	
4	*Bauhinia purpurea*											
5	Broussonetia papyrifera							o				
6	*Callicarpa arborea var. arborea*	o			~	o		∗o				
7	*Castanopsis calathiformis*											
8	*Castanopsis diversifolia*											
9	*Debregeasia longifolia*	o				o		o				
10	*Erythrina stricta*	+				+		+	~			
11	*Erythrina subumbrans*	~+		+		+		+				
12	*Eurya acuminata DC. var. wallichiana Dyer*					o						
13	*Ficus hispida var. hispida*											
14	*Ficus semicordata var. semicordata*									~		
15	*Ficus subulata var. subulata*							o				
16	*Hovenia dulcis*											
17	*Litsea cubeba*	~				o		o		+		
18	*Litsea salicifolia*											
19	*Macaranga denticulata*											
20	*Malastoma malabalicum*	o				o						
21	*Markharnia stipulata var. kerri*											
22	*Melia toosandan*				~						~	
23	*Musa sp.*									+		
24	*Nyssa javanica*								~			
25	*Phyllanthus emblica*							~			~	
26	*Pinus kesiya*				~		~					~
27	*Prunus cerasoides*	+	~	+				o		+		
28	*Prunus persica Batsch Ex St*										~	
29	*Quercus semiserrata*											
30	*Solanum torvum*							o				
31	*Spondias axillaris*	~					~					
32	*Trema orientalis*	o				o	~	o				
33	*Pavetta tomentosa*							o				

Appendix M Woody plants which birds feeding on (continued).

	Plant species	White-browed Piculet	White-browed Scimitar Babbler	White-browed Shrike-Babbler	White-rumped Shama	Yellow-eyed Babbler
1	*Artocarpus lanceolata*					
2	*Aralia montana*					
3	*Albizia sp.*	~	~			
4	*Bauhinia purpurea*					
5	Broussonetia papyrifera					
6	*Callicarpa arborea var. arborea*		o			
7	*Castanopsis calathiformis*					
8	*Castanopsis diversifolia*					
9	*Debregeasia longifolia*					
10	*Erythrina stricta*					
11	*Erythrina subumbrans*		~+			~+
12	*Eurya acuminata DC. var. wallichiana Dyer*	~				
13	*Ficus hispida var. hispida*	~				
14	*Ficus semicordata var. semicordata*					
15	*Ficus subulata var. subulata*					
16	*Hovenia dulcis*					
17	*Litsea cubeba*	~				
18	*Litsea salicifolia*				~	
19	*Macaranga denticulata*					
20	*Malastoma malabalicum*					
21	*Markharnia stipulata var. kerri*					
22	*Melia toosandan*	~				
23	*Musa sp.*					
24	*Nyssa javanica*					
25	*Phyllanthus emblica*					
26	*Pinus kesiya*			~		
27	*Prunus cerasoides*	~				
28	*Prunus persica Batsch Ex St*					
29	*Quercus semiserrata*					
30	*Solanum torvum*					
31	*Spondias axillaris*					
32	*Trema orientalis*					
33	*Pavetta tomentosa*					

~ = fed on insects, o = fed on fruits, + = fed on nectars, ∗ = fed on flowers

Appendix N Woody plant species which using by bird.

	Plant species	Ashy Drongo	Ashy Wood-swallow	Asian Brawn Flycatcher	Black-crested Bulbul	Black-headed Bulbul	Black-naped Monarch	Black-naped Oriole	Black-throated Sunbird	Blue-rock Thrush	Burmese Shrike	Chestnut-capped Babbler	Chestnut Bunting	Crested Bunting
1	*Artocarpus lanceolata*													
2	*Aralia montana*				p									
3	*Albizia sp.*				p									
4	*Balakata baccata*													
5	*Bambusa tulda* Roxb.									p				
6	*Bauhinia purpurea*								p		p			
7	*Bischofia javanica*													
8	*Broussonetia papyrifera*													
9	*Callicarpa arborea var. arborea*	p									p			
10	*Castanopsis calathiformis*													p
11	*Castanopsis diversifolia*													
12	*Debregeasia longifolia*													
13	*Erythrina stricta*	p			p								p	
14	*Erythrina subumbrans*	p			p		p	p					p	
15	*Eurya acuminata DC. var. wallichiana Dyer*													
16	*Ficus alltissima*													
17	*Ficus hispida var. hispida*													
18	*Ficus semicordata var. semicordata*													
19	*Ficus subulata var. subulata*													
20	*Heynea trijuca*		p											
21	*Hovenia dulcis*													
22	*Lithocarpus elegans*													
23	*Litsea cubeba*								p			p		
24	*Litsea salicifolia*													
25	*Macaranga denticulata*													
26	*Machilus bombycina*													
27	*Malastoma malabalicum*													
28	*Manglietia garrettii*						p							
29	*Markharnia stipulata var. kerri*													
30	*Melia toosandan*	p	p		p	p			p		p			p
31	*Musa sp.*								p		p	p		
32	*Nyssa javanica*													
33	*Phyllanthus emblica*													
34	*Pinus kesiya*	p		p	p						p			
35	*Prunus cerasoides*								p					
36	*Prunus persica Batsch Ex St*													
37	*Quercus semiserrata*													
38	*Solanum torvum*													
39	*Spondias axillaris*				p							p		
40	*Trema orientalis*													
41	*Pavetta tomentosa*													

Appendix N Woody plant species which bird using (continued).

	Plant species	Common Iora	Common Rosefince	Common Tailorbird	Common Wood-shrike	Dark-necked Tailorbird	Daurian Redstart	Flavescent Bulbul	Gloden-spectacle Warbler	Greater Coucal	Great Tit	Green-billed Malkoha	Greenish Warbler	Grey-breasted Prinia
1	*Artocarpus lanceolata*													
2	*Aralia montana*							p						
3	*Albizia sp.*	p									p			p
4	*Balakata baccata*							p	p					
5	*Bambusa tulda* Roxb.							p				p		
6	*Bauhinia purpurea*													
7	*Bischofia javanica*													
8	*Broussonetia papyrifera*													
9	*Callicarpa arborea var. arborea*	p		p				p						
10	*Castanopsis calathiformis*													
11	*Castanopsis diversifolia*							p						
12	*Debregeasia longifolia*			p				p						
13	*Erythrina stricta*		p					p					p	
14	*Erythrina subumbrans*	p	p					p			p		p	
15	*Eurya acuminata DC. var. wallichiana Dyer*												p	
16	*Ficus alltissima*													
17	*Ficus hispida var. hispida*													
18	*Ficus semicordata var. semicordata*													
19	*Ficus subulata var. subulata*										p			
20	*Heynea trijuca*													
21	*Hovenia dulcis*													
22	*Lithocarpus elegans*													
23	*Litsea cubeba*	p				p		p	p					
24	*Litsea salicifolia*													
25	*Macaranga denticulata*													p
26	*Machilus bombycina*													
27	*Malastoma malabalicum*							p						
28	*Manglietia garrettii*													
29	*Markharnia stipulata var. kerri*													
30	*Melia toosandan*	p		p	p	p	p	p		p	p	p		p
31	*Musa sp.*													
32	*Nyssa javanica*													
33	*Phyllanthus emblica*													
34	*Pinus kesiya*	p		p				p			p	p	p	
35	*Prunus cerasoides*							p			p		p	
36	*Prunus persica Batsch Ex St*											p		
37	*Quercus semiserrata*													
38	*Solanum torvum*													
39	*Spondias axillaris*			p	p							p		
40	*Trema orientalis*													
41	*Pavetta tomentosa*													

Appendix N Woody plant species which bird using (continued).

	Plant species	Grey Bushchat	Grey-headed Parakeet	Hill Blue Flycatcher	Hill Prinia	Hoopoe	Yellowed-browed Warbler	Japanese White-eye	Long-tailed Shrike	Little Bunting	Little Spiderhunter	Olive-backed Sunbird
1	*Artocarpus lanceolata*											
2	*Aralia montana*											
3	*Albizia sp.*						p		p			
4	*Balakata baccata*											
5	*Bambusa tulda* Roxb.			p								
6	*Bauhinia purpurea*			p							p	
7	*Bischofia javanica*											
8	*Broussonetia papyrifera*											
9	*Callicarpa arborea var. arborea*	p					p				p	
10	*Castanopsis calathiformis*						p					
11	*Castanopsis diversifolia*											
12	*Debregeasia longifolia*			p			p					
13	*Erythrina stricta*					p	p	p				
14	*Erythrina subumbrans*	p		p		p	p	p		p	p	
15	*Eurya acuminata DC. var. wallichiana Dyer*											
16	*Ficus alltissima*											
17	*Ficus hispida var. hispida*											
18	*Ficus semicordata var. semicordata*											
19	*Ficus subulata var. subulata*											
20	*Heynea trijuca*											
21	*Hovenia dulcis*			p							p	
22	*Lithocarpus elegans*											
23	*Litsea cubeba*			p			p		p			
24	*Litsea salicifolia*											
25	*Macaranga denticulata*						p					
26	*Machilus bombycina*											
27	*Malastoma malabalicum*						p					
28	*Manglietia garrettii*											
29	*Markharnia stipulata var. kerri*										p	
30	*Melia toosandan*		p	p		p	p	p				
31	*Musa sp.*	p									p	
32	*Nyssa javanica*											
33	*Phyllanthus emblica*											
34	*Pinus kesiya*			p			p				p	
35	*Prunus cerasoides*			p			p	p				
36	*Prunus persica Batsch Ex St*											
37	*Quercus semiserrata*						p					
38	*Solanum torvum*											
39	*Spondias axillaris*			p			p				p	
40	*Trema orientalis*			p			p					
41	*Pavetta tomentosa*											

Appendix N Woody plant species which bird using (continued).

	Plant species	Oriental White-eye	Pied Bushchat	Plaintive Cuckoo	Puff-throated Babbler	Puff-throated Sunbird	Purple Sunbird	Red-throated Flycatcher	Red-whiskered Bulbul	Ruffescent Prinia	Scaly-breasted Prinia	Scarlet Minivet	Shikra
1	*Artocarpus lanceolata*	p											
2	*Aralia montana*								p				
3	*Albizia sp.*	p							p				
4	*Balakata baccata*												
5	*Bambusa tulda* Roxb.								p				
6	*Bauhinia purpurea*								p				
7	*Bischofia javanica*								p				
8	*Broussonetia papyrifera*												
9	*Callicarpa arborea var. arborea*	p						p	p				
10	*Castanopsis calathiformis*												
11	*Castanopsis diversifolia*												
12	*Debregeasia longifolia*	p							p				
13	*Erythrina stricta*	p		p					p				
14	*Erythrina subumbrans*	p	p	p	p		p	p	p				
15	*Eurya acuminata DC. var. wallichiana Dyer*								p				
16	*Ficus alltissima*									p			
17	*Ficus hispida var. hispida*												
18	*Ficus semicordata var. semicordata*								p				
19	*Ficus subulata var. subulata*									p			
20	*Heynea trijuca*												
21	*Hovenia dulcis*												
22	*Lithocarpus elegans*												
23	*Litsea cubeba*	p							p				
24	*Litsea salicifolia*												
25	*Macaranga denticulata*								p				
26	*Machilus bombycina*												
27	*Malastoma malabalicum*	p						p	p				
28	*Manglietia garrettii*									p			
29	*Markharnia stipulata var. kerri*												
30	*Melia toosandan*							p	p		p	p	p
31	*Musa sp.*												
32	*Nyssa javanica*												
33	*Phyllanthus emblica*												
34	*Pinus kesiya*		p					p	p	p			
35	*Prunus cerasoides*	p			p		p			p			
36	*Prunus persica Batsch Ex St*												
37	*Quercus semiserrata*												
38	*Solanum torvum*												
39	*Spondias axillaris*	p		p				p		p		p	
40	*Trema orientalis*	p							p	p			
41	*Pavetta tomentosa*												

Appendix N Woody plant species which bird using (continued).

	Plant species	Siberian Rubythroat	Sooty-headed Bulbul	Speckled Piculet	Streaked Spiderhunter	Striped Tit-Babbler	Velvet-fronted Nutatch	White-browed Piculet	White-browed Scimitar Babbler	White-browed Shrike-Babbler	White-rumped Shama	Yellow-eyed Babbler
1	*Artocarpus lanceolata*											
2	*Aralia montana*		p									
3	*Albizia sp.*		p			p		p	p		p	
4	*Balakata baccata*		p		p							
5	*Bambusa tulda* Roxb.								p			
6	*Bauhinia purpurea*		p									
7	*Bischofia javanica*											
8	*Broussonetia papyrifera*		p									
9	*Callicarpa arborea var. arborea*		p						p			
10	*Castanopsis calathiformis*					p						
11	*Castanopsis diversifolia*											
12	*Debregeasia longifolia*		p									
13	*Erythrina stricta*		p	p								
14	*Erythrina subumbrans*		p	p					p		p	p
15	*Eurya acuminata DC. var. wallichiana Dyer*											
16	*Ficus alltissima*										p	
17	*Ficus hispida var. hispida*							p				
18	*Ficus semicordata var. semicordata*				p							
19	*Ficus subulata var. subulata*		p									
20	*Heynea trijuca*											
21	*Hovenia dulcis*											
22	*Lithocarpus elegans*					p						
23	*Litsea cubeba*		p					p				
24	*Litsea salicifolia*										p	
25	*Macaranga denticulata*											
26	*Machilus bombycina*	p										
27	*Malastoma malabalicum*											
28	*Manglietia garrettii*										p	
29	*Markharnia stipulata var. kerri*											
30	*Melia toosandan*		p		p	p			p	p		
31	*Musa sp.*		p		p							
32	*Nyssa javanica*			p								
33	*Phyllanthus emblica*		p			p						
34	*Pinus kesiya*		p		p		p		p	p		
35	*Prunus cerasoides*				p						p	
36	*Prunus persica Batsch Ex St*					p						
37	*Quercus semiserrata*											
38	*Solanum torvum*		p									
39	*Spondias axillaris*		p								p	
40	*Trema orientalis*											
41	*Pavetta tomentosa*		p									

Appendix O The relative abundance (species / number of list; vary from 0 to 1)of each bird species in each of the 12 plots (see Appendix D for scientific names).

	habitat	control-1	control-2	control-3	2002-b	2002-j	2002-s	2000-3	2000-6	2000-9	1998-1	1998-2	1998-3
Ashy Drongo	forest	0.33[6]	0.10[9]	0.17[5]	0.25[4]		0.11[7]	0.11[6]			0.30[6]	0.10[6]	0.29[5]
Ashy Wood-swallow	open				0.25[4]			0.11[6]					
Asian Brown Flycather	open	0.11[8]	0.10[9]			0.17[5]		0.22[5]	0.13[7]				
Black-crested Bulbul	forest					0.17[5]	0.11[7]	0.11[6]	0.13[7]	0.50[3]	0.40[5]	0.20[5]	0.14[6]
Black-headed Bulbul	forest							0.11[6]					
Black-naped Monarch	forest		0.10[9]					0.11[6]				0.10[6]	
Black-naped Oriole	forest		0.10[9]										
Black-throated Sunbird	forest	0.11[8]	0.20[8]					0.22[5]	0.50[4]		0.10[8]	0.10[6]	0.43[4]
Black-winged Cuckoo-shrike	forest		0.10[9]				0.11[7]	0.22[5]		0.13[6]	0.10[8]		
Blue Rock-Thrush	open										0.10[8]		
Blue-throated Barbet	forest								0.13[7]				
Blyth's Leaf-Warbler	forest						0.11[7]						
Bulbul sp.	-			0.17[5]		0.17[5]		0.11[6]		0.25[5]			
Burmese Shrike	open	0.33 [6]		0.17[5]	0.50[3]		0.33[5]	0.33[4]		0.25[5]	0.30[6]	0.10[6]	
Chestnut Bunting	open		0.10[9]								0.10[8]	0.10[6]	
Chestnut-capped Babbler	open	0.89[2]	1.00[1]	0.83[2]	0.25[4]	0.33[4]	0.78[2]	0.11[6]	0.13[7]	0.38[4]	0.40[5]	0.80[2]	0.71[2]
Common Iora	open	0.44[5]	0.10[9]			0.33[4]	0.44[4]	0.56[2]	0.13[7]	0.25[5]	0.40[5]	0.20[5]	0.29[5]
Common Rosefinch	open	0.22[7]									0.20[7]		
Common Tailorbird	forest	0.11[8]	0.20[8]			0.33[4]	0.22[6]	0.22[5]	0.63[3]	0.50[3]		0.80[2]	0.29[5]
Common Wood-shrike	forest							0.11[6]		0.38[4]			
Crested Bunting	open												0.14[6]
Dark-necked Tailorbird	forest	0.11[8]		0.17[5]			0.33[5]	0.22[5]			0.30[6]		

Appendix O (continued)

	habitat	control-1	control-2	control-3	2002-b	2002-j	2002-s	2000-3	2000-6	2000-9	1998-1	1998-2	1998-3
Flavescent Bulbul	open	0.89[2]	0.60[4]	0.83[2]	0.75[2]	0.67[2]	0.89[1]	0.33[4]	0.38[5]		0.40[5]	0.30[4]	0.86[1]
Flowerpecker sp.	-							0.11[6]					
Flycatcher sp.	-	0.11[8]		0.17[5]		0.17[5]	0.11[7]		0.13[7]	0.13[6]	0.10[8]	0.20[5]	
Golden-spectacled Warbler	forest	0.11[8]			0.25[4]		0.11[7]			0.25[5]			
Great Tit	forest		0.40[6]		0.25[4]		0.33[5]	0.22[5]			0.10[8]	0.10[6]	
Greater Coucal	open				0.25[4]		0.11[7]		0.13[7]	0.13[6]		0.10[6]	
Greater Racket-tailed Drongo	forest								0.13[7]				
Green-billed Malkoha	forest	0.11[8]			0.25[4]	0.17[5]	0.22[6]	0.11[6]	0.25[6]	0.38[4]	0.50[4]	0.30[4]	0.14[6]
Greenish Warbler	forest	0.11[8]	0.30[7]	0.17[5]		0.33[4]	0.11[7]	0.11[6]	0.25[6]	0.25[5]	0.20[7]	0.30[4]	0.14[6]
Grey Bushchat	open	0.11[8]			0.75[2]		0.22[6]	0.11[6]					0.14[6]
Grey-breasted Prinia	open	0.44[5]	0.70[3]	0.83[2]	1.00[1]		0.11[7]	0.44[3]	0.13[7]	0.13[6]		0.20[5]	0.14[6]
Grey-capped Woodpecker	forest		0.10[9]										
Grey-headed Flycatcher	forest	0.11[8]						0.22[5]				0.10[6]	
Hair-crested Drongo	forest	0.11[8]											
Hill Blue Flycatcher	forest			0.17[5]	0.25[4]	0.67[2]			0.75[2]	0.38[4]	0.50[4]	0.40[3]	0.71[2]
Hill Prinia	open	0.22[7]	0.30[7]		0.25[4]		0.11[7]		0.50[4]			0.10[6]	0.29[5]
Hoopoe	open										0.10[8]		
Yellow-browed Warbler	forest	0.22[7]	0.70[3]	0.67[3]	0.50[3]	0.50[3]	0.56[3]	0.44[3]	0.50[4]	0.50[3]	0.50[4]	0.30[4]	0.57[3]
Japanese White-eye	forest		0.10[9]								0.10[8]	0.20[5]	
Little Bunting	open		0.10[9]										
Little Spiderhunter	forest	0.11[8]		0.17[5]	0.25[4]	0.17[5]	0.22[6]	0.67[1]	0.63[3]	0.38[4]	0.10[8]	0.20[5]	
Long-tailed Minivet	forest							0.11[6]			0.10[8]		
Long-tailed Shrike	open				0.25[4]			0.11[6]					
Minivet sp.	forest						0.11[7]						

Appendix O (continued)

	habitat	control-1	control-2	control-3	2002-b	2002-j	2002-s	2000-3	2000-6	2000-9	1998-1	1998-2	1998-3
Mountain Bamboo-Partridge	open	0.22[7]	0.30[7]	0.33[4]		0.17[5]			0.13[7]		0.10[8]	0.20[5]	
Olive-backed Pipit	open			0.17[5]		0.33[4]			0.13[7]			0.10[6]	
Oriental White-eye	forest		0.10[9]	0.17[5]		0.33[4]		0.22[5]	0.50[4]	0.25[5]	0.60[3]	0.30[4]	0.29[5]
Pale-footed Bush-Warbler	open	0.33[6]	0.10[9]	0.33[4]					0.25[6]	0.13[6]	0.20[7]		
Pale-legged Leaf-Warbler	forest								0.13[7]				
Pied Bushchat	open	0.11[8]					0.11[7]						
Plain Flowerpecker	forest					0.17[5]	0.11[7]	0.22[5]				0.10[6]	
Plaintive Cuckoo	open										0.20[7]		
Prinia sp.	open			0.17[5]									0.14[6]
Puff-throated Babbler	forest	0.11[8]	0.10[9]	0.33[4]			0.22[6]	0.22[5]	0.13[7]	0.13[6]	0.10[8]	0.40[3]	0.29[5]
Purple Sunbird	open		0.10[9]	0.17[5]								0.10[6]	
Red-throated Flycatcher	open		0.20[8]	0.17[5]	0.75[2]	0.50[3]		0.11[6]	0.13[7]	0.25[5]	0.10[8]	0.10[6]	
Red-whiskered Bulbul	open	1.00[1]	0.90[2]	1.00[1]	0.50[3]	0.83[1]	0.78[2]	0.67[1]	1.00[1]	0.75[2]	1.00[1]	1.00[1]	0.86[1]
Rufescent Prinia	open	0.56[4]	0.50[5]	1.00[1]	0.50[3]	0.67[2]	0.56[3]	0.56[2]	0.13[7]	0.38[4]	0.10[8]	0.20[5]	0.86[1]
Scaly breasted Munia	open					0.17[5]		0.22[5]					
Scarlet Minivet	forest	0.11[8]				0.17[5]		0.22[5]	0.13[7]	0.38[4]			
Shikra	forest								0.13[7]				
Shrike sp.	forest						0.11[7]						
Siberian Rubythroat	open	0.44[5]	0.50[5]	0.17[5]	0.25[4]	0.17[5]	0.11[7]	0.11[6]		0.13[6]	0.20[7]	0.10[6]	0.14[6]
Sooty-headed Bulbul	open	0.67[3]	0.40[6]	0.67[3]	0.75[2]	0.67[2]	0.89[1]	0.44[3]	0.75[2]	1.00[1]	0.80[2]	0.20[5]	0.57[3]
Speckled Piculet	forest						0.22[6]				0.10[8]	0.10[6]	
Streaked Spiderhunter	forest		0.10[9]					0.22[5]	0.13[7]	0.38[4]	0.20[7]	0.10[6]	0.43[4]
Striped Tit-Babbler	forest	0.44[5]	0.40[6]	0.17[5]	0.25[4]	0.50[3]	0.22[6]	0.33[4]	0.38[5]	0.25[5]	0.10[8]	0.20[5]	0.14[6]
Sunbird sp.	-									0.13[6]	0.10[8]		
Velvet-fronted Nutatch	forest						0.11[7]						

Appendix O (continued)

	habitat	control-1	control-2	control-3	2002-b	2002-j	2002-s	2000-3	2000-6	2000-9	1998-1	1998-2	1998-3
Warbler sp.	-	0.11[8]	0.20[8]	0.17[5]	0.25[4]		0.33[5]	0.11[6]			0.10[8]	0.10[6]	
White-browed Piculet	forest		0.20[8]	0.17[5]			0.11[7]	0.11[6]	0.25[6]	0.13[6]	0.30[6]		0.57[3]
White-browed Scimitar-Babbler	forest	0.44[5]	0.30[7]				0.22[6]			0.25[5]	0.10[8]	0.30[4]	0.14[6]
White-browed Shrike-Babbler	forest				0.25[4]				0.13[7]				
White-eye sp.	-									0.13[6]			
White-rumped Munia	open					0.17[5]							
White-rumped Shama	forest					0.67[2]		0.33[4]	0.13[7]	0.25[5]	0.20[7]	0.20[5]	0.29[5]
White-tailed Robin	forest			0.17[5]									
White-throated Fantail	forest				0.25[4]	0.17[5]							
Yellow-eyed Babbler	open	0.11[8]	0.20[8]	0.17[5]		0.17[5]	0.11[7]					0.20[5]	

* The small number showed the priority relative abundant from 1st to 10th of each plot.

Appendix P Bird population density, diversity of bird and and the vegetation survey in and surrounding 12 study plots.

In study plots	Percentage of						trees structure				MacKinon	point count	
	Grass	Fern	Herbs	Seedling	Bare	canopy cover	trees/m^2	hieght	canopy width	DBH	bird sp	bird sp	Population (bird/ha)
Control-1	58.8	7.3	10.9	0.3	22.7	68.8	0.02	332.8	202.2	4.1	44	23	45
Control-2	47.8	6.3	9.1	0.4	36.3	59.4	0.01	275.0	150.3	4.4	45	24	49
Control-3	39.5	2.3	21.3	0.0	37.0	37.5	0.01	333.8	157.1	4.1	42	20	47
2002-b	16.5	15.9	40.4	0.3	26.9	37.5	0.17	215.4	131.5	19	57	20	26
2002-j	17.1	5.1	24.6	3.7	49.6	46.9	0.07	212.7	113.0	10.8	50	21	20
2002-s	29.8	11.6	20.9	0.2	37.6	68.8	0.12	215.8	130.9	16.8	48	28	29
2000-3	21.4	3.2	24.3	2.7	48.4	59.4	0.17	404.6	236.5	4.3	68	31	21
2000-6	28.0	3.8	25.1	2.4	40.7	75.0	0.20	347.0	171.1	3.8	47	24	24
2000-9	16.8	0.3	21.6	0.3	61.0	84.4	0.19	345.0	214.9	4.3	51	25	26
1998-1	25.3	1.8	17.7	0.4	54.8	87.5	0.18	389.5	222.5	13.2	54	33	37
1998-2	13.0	4.6	20.7	0.2	61.4	78.1	0.16	427.7	243.6	12.1	58	29	28
1998-3	30.1	1.3	30.1	0.9	37.5	68.8	0.23	497.3	274.0	6.4	36	19	24

Appendix P (Continued)

In study plots	Percentage of						trees structure				MacKinon	point count	
	Grass	Fern	Herbs	Seedling	Bare	canopy cover	trees/m^2	hieght	canopy width	DBH	bird sp	bird sp	Population (bird/ha)
Control-1	34.79	5.89	12.79	0.79	45.75	59.38	288	412.6	6.2	231.9	23	44	45
Control-2	27.46	6.45	12.23	1.51	52.36	63.28	177	464.5	9.9	293	24	45	49
Control-3	25.37	2.32	20.86	0.49	50.96	60.94	138	433.2	5.7	247.4	20	42	47
2002-b	31.27	13.48	21.86	0.82	32.58	34.38	164	187.9	3.2	124.6	20	57	26
2002-j	27.27	2.59	14.05	5.06	51.11	64.84	295	368.9	7.6	195.8	21	50	20
2002-s	31.65	8.86	20.34	1.30	37.85	55.47	126	307.9	10.3	168.5	28	48	29
2000-3	27.16	8.06	16.06	1.01	47.70	60.94	211	351.3	3	164.3	31	68	21
2000-6	32.84	3.90	17.51	2.59	43.16	57.03	165	388.7	11.2	201.3	24	47	24
2000-9	35.29	0.33	14.08	0.55	49.75	67.19	230	493.4	7	203.7	25	51	26
1998-1	39.04	2.99	10.17	1.24	46.55	64.06	36	376.1	22.1	181.6	33	54	37
1998-2	30.07	6.97	14.48	0.94	47.53	46.88	151	367.7	10.3	220.6	29	58	28
1998-3	25.24	8.38	23.55	1.50	41.33	48.44	54	409	13.1	219.1	19	36	24

CURRICULUM VITAE

Name: Tidarach Toktang

Date of Birth 13 June 1976

Birth Place Kanchanaburi, Thailand

Education Background:

2005 Master's Degree of Science in Biology, Chiang Mai University, Chiang Mai

1998 Bachelor's Degree of Science (Biology), Khon Khean University, Khon Khean.

1994 Senior high School, Visutharang-sri School, Kanchanaburi.

Work Experiences:

2003-2004 Researcher in "Monitoring birds in plantation and natural areas as indicator for reforestation at Ban Mae Sa Mai, Mae rim District for The Forest Restoration Research Unit, Biology Department, Faculty of Science, Chiang Mai University.

2001-2002 Researcher Assistant in "The effect of artificial perches and local vegetation on bird-dispersed seed deposition into

regenerating sites", King Mongkut's University of Technology of Thonburi.

2000-2001	Field Co-ordinator in Community-base Forest Management Research Project in Upper-Ping Watershed, Sustainable Management of Resources in The Lower Mekong Basin Project (SMRP) and The Watershed Management Unit (Huay Keaw), Royal Forestry Department, Chiang Mai.
1999-2000	Coordinator and Researcher in "The Project of Bring Clean Water Back to Pong River by coordinate community, factory and government, Environmental Health Centre region 6 (Khonkean), Khon Kaean.

Research grant	I was given the research grants from the Education Foundation of Shell 100 Year in semester 2002.