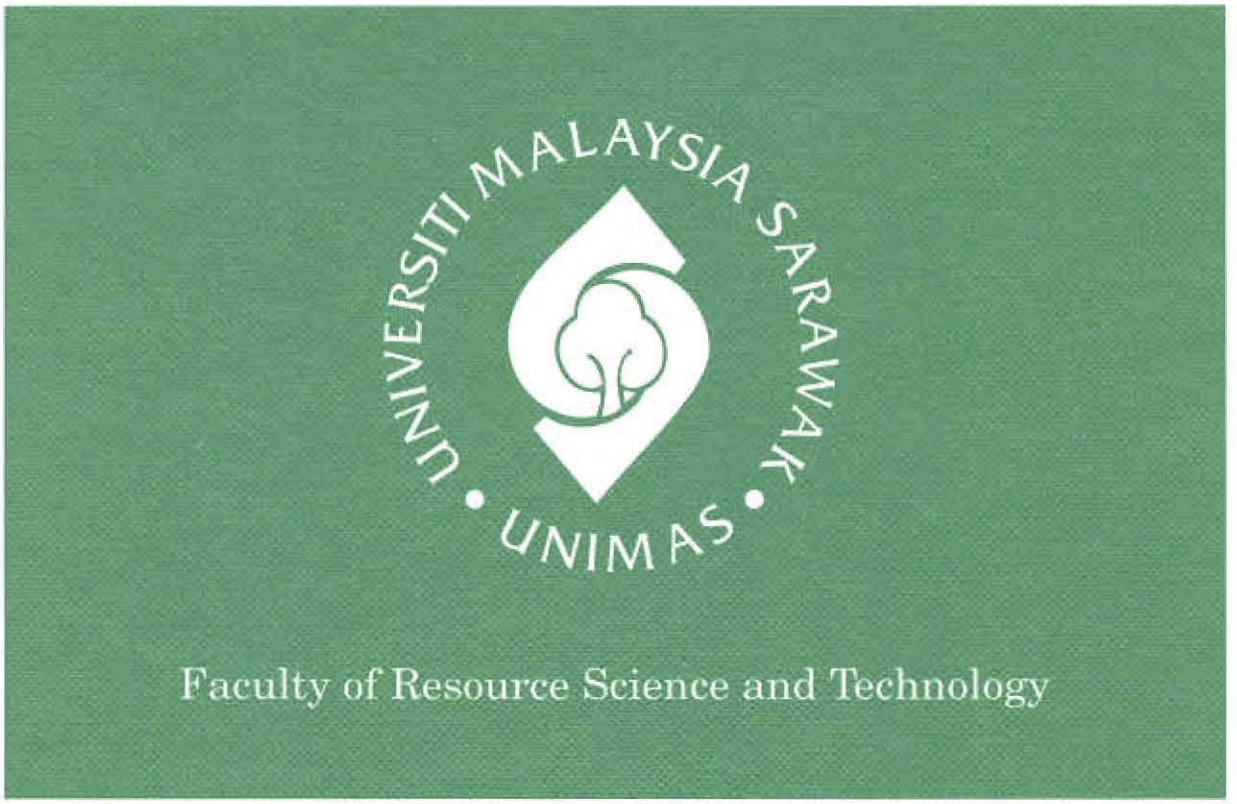

INVENTORY OF FRUIT AND BERRY BEARING TREES FOR FRUIT BATS AND BIRDS IN DIFFERENT STAGES OF SECONDARY FOREST GROWTH

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Bachelor of Science with Honours
(Plant Resource Science and Management)
2006

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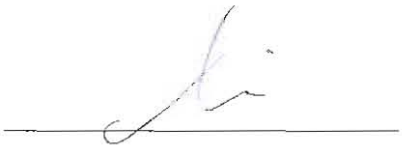
This project is submitted in partial fulfillment of the requirements for the degree of
Bachelor of Science with Honours
(Plant Resource Science and Management Program)

Faculty of Resource Science and Technology
UNIVERSITI MALAYSIA SARAWAK
2006

DECLARATION

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.



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ACKNOWLEDGEMENTS

First of all, I would like to wish a special thanks to my supervisor Dr. Gabriel Tonga Noweg, and my co-supervisor Dr. Mustafa Abdul Rahman for their efforts and willingness to guide me during the implementations of my final year project. Deepest appreciation to my beloved parents Hamdin Adnan and Rusbah Hj. Abd Rajak, also my brother Harizam Hamdin for their encouragement and supports. Special thanks also to all lecturers, lab assistants and all my friends for their helps.

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INVENTORY OF FRUIT AND BERRY BEARING TREES FOR FRUIT BATS AND BIRDS IN DIFFERENT STAGES OF SECONDARY FOREST GROWTH

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ABSTRACT

This study documented the trees that bearing fruit and berry for fruit bats and birds at three sites secondary forest at Bau District. These sites represented a different stages of forest regeneration (5, 20, and 30-year old forest) following small-scale shifting agriculture. Data were analyzed for distribution, species diversity, and relative density of bats and birds foraging trees. The results indicate that bats and birds tree species diversity index is highest in the 20- year old forest and lowest in 5-year old forest. Whereas, the 30-year old forest diversity index is nearly to the 20-year old forest index.

Key words: Bats and birds foraging trees; Forest regeneration; Shifting agriculture; Species diversity.

ABSTRAK

Kajian ini adalah bertujuan untuk menyenaraikan tumbuhan berkayu yang menghasilkan buah sebagai sumber makanan kelawar dan burung di tiga kawasan hutan sekunder Daerah Bau. Ketiga-tiga tempat ini adalah berbeza peringkat pertumbuhan hutan (5, 20, dan 30 tahun) akibat daripada aktiviti pertanian pindah. Data yang diperolehi dianalisa untuk mendapatkan taburan, kepelbagaian dan ketumpatan relatif spesies tumbuhan berkayu yang menghasilkan buah sebagai makanan kelawar dan burung. Analisis data menunjukkan kepelbagaian spesies tumbuhan yang dimakan oleh kelawar dan burung adalah paling tinggi pada hutan 20 tahun dan paling rendah pada hutan 5 tahun. Manakala, hutan 30 tahun menunjukkan nilai yang hampir dengan hutan 30 tahun.

Kata kunci: Tumbuhan makanan kelawar dan burung; Pertumbuhan hutan; Pertanian pindah; Kepelbagaian spesies.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Sarawak is located on the island of Borneo in the South China Sea and in part of Malaysia. The climate is characterized by heavy rainfall, uniformly high temperature and relative humidity. According to Whitmore (1984), Sarawak is included of the Malesian rain forest, which extends through the Malay Archipelago from Sumatra in the west to New Guinea in the east. Tropical rainforest in Sarawak characterized by its richness of plant communities with the canopy 30m tall or more and the canopy is also diverse of flora and fauna species and the plant growth processes is rapid for the whole year (Burrows, 1990). It also has rainfall that varies between 2000 to 4000 millimeters distributed throughout the year. These forests have extreme diversity of plants both in term of species composition and growth form.

Sarawak was mainly covered by forest which include dry dipterocarp forest, lowland mixed-dipterocarp forest, peat swamp forest, heath forest, mangrove forest and also limestone forests. In Sarawak, traditional farming system or shifting cultivation is still being practiced by the rural farmers in highlands area to open the small-scale agriculture with extensive slash and burn and clear-cutting. The purpose of this activity is to open areas for agriculture land where rice, cassava, maize, sugar cane and potatoes are usually cultivated for subsistence. On the other hand, the more permanent cultivated area is usually found in the lowland area where people usually plant crops for long-term purposes such as oil palm plantations.

1.2 Purposes and Objective

The main purpose of this study is to document the trees that bear fruits and berries for fruit bats and birds in different stages of forest growth in shifting cultivation area. The study objectives are to study and estimate the distribution, density and diversity of fruits and berries bearing trees species according to different stages of forest growth.

1.3 Specific Objectives

The specific objectives of this study are;

i) To study the species distribution of fruit and berries bearing trees in relation to the overall community population.

ii) To calculate the relative density of these fruit and berries bearing trees.

iii) To calculate the diversity index of these fruit and berries bearing trees.

iv) To compare the relative density, relative diversity and diversity index of the fruit and berries bearing trees at different stage of secondary forest growth.

1.4 Importance of the Study

This study is important to document the trees that bearing fruit and berry especially for fruit bats and birds because different stages of forest growth are expected to produce different species of forest trees that are beneficial for wildlife such as fruit bats and birds. The abundance of tree species is expected different according to the forest ages and land use history of the area. The documentation of trees may reveal various utilization purposes such as edible and medications. So, the value of plants will be more appreciated and hopefully there will be a better conservation of these valuable plants to avoid the extinction of plant

species and to maintain the stability of plant diversity. It also hopeful that this study results can be used in future research.

According to Giese and Young (1990), in the late twentieth century the increase of population in combination with development of more effective road building and logging equipment in the tropics has made it possible and profitable to intensify the harvesting of rain forest timber and to clear forests for replacement with plantations or to convert the forests to agricultural croplands or pastures. All these activities potentially caused over exploitation and disturbance of the forests diversity. Though the activity of indigenous people such as hunter-gatherers or shifting cultivation-farming system has relatively little impact than the timber or logging activity but it will also cause the losing of species and genotypes or extinction through the loss of native habitats. So, the effort to explore and sample the forest diversity is important to assess the present status and the future of our forest and their properties.

1.5 Study Limitation

The limitation of this study is the time. We have less than one year to observe the trees that are used by fruit bats and birds in the different stages of forest growth. Many of the previous research take more than a year to study the different stages of forest growth as the work involved are tedious and slow. Other factor that contributed to the study limitation is the differences in fruiting behavior of plants. It is because, different tree species might be having different times of fruiting. In the regard, a good study will require several year of continuous observation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In Sarawak, shifting cultivation is still being practiced by the farmers who conduct the small-scale farming system. Shifting cultivation is the process by which people take an area of land to use for agriculture, only to abandon it a short time later. This often involves clearing of a piece of land followed by two or three years of farming until the soil losses its fertility. Once the land becomes inadequate for crop production, it is left to reclaim by natural vegetation. Shifting cultivation categorized as by secondary succession and is still widely practiced in agriculture. Fallow fields are not unproductive. During the fallow period, shifting cultivators use the succession vegetation species widely for timber for fencing and construction, firewood, ropes, clothing, tools, carrying devices and medicines. Fallows commonly contain plants that attract birds and animals and important for hunting but the most important is that tree fallows protect soil against physical erosion and draw nutrients to the surface from deep in the soil profile. Optimum times of fallow period are needed for good production and shorter fallow period will cause reduced fertility and productivity. Fallow period, therefore is correlated to the level of productivity of crops and overall harvest. Longer fallow period also ensures sufficient regeneration of plant the original species composition. When properly practiced, shifting cultivation does not contribute negatively to biodiversity loss as often assumed.

2.2 Plant Community

Primary forest is an ecosystem that is characterized by an abundance of mature trees, relatively undisturbed by human activity. Impacts of human are limited to low levels of hunting, fishing, harvesting of forest produce and low density of migratory of shifting agriculture (Johnson and Cabarle, 1993). Primary forests are also called virgin, climax or undisturbed forest. Secondary forest are ecosystem that regenerate from a substantial disturbance such as (flood, fire, land clearing or extensive logging) which have relatively few mature trees and generally characterized by an abundance of fast growing species (Johnson and Cabarle, 1993).

According to Crawley (1986) he stated that succession is the changes of one plants community into another which involves the immigration and extinction of species. Primary succession occurs when plants invade an area in which no plant had grown before. Shifting cultivation can be considered as secondary succession. Crawley (1986), defined that secondary succession is a recovery of mature community from major disturbance by natural agents (fire, storm, insect attack) or human impact (burning and clearing). Shifting agriculture, variously termed as slash and burned agriculture, rotational bush fallow agriculture or properly known as 'Jhum' in India (Ramakrishnan, 1992). Usually, secondary succession occurs in fallow fields and forests that have been cleared and so on. It is also considered as a modification of the longer lasting succession and secondary succession completes the series by setting back part of the system to an earlier or less developed stage (Young and Giese, 1990).

Species abundance can be affected by physiological characteristics such as stress tolerance, rapid growth rate or high nutrient equilibrium. Once the condition changes, species also can change their competitiveness but they are unable to adapt in certain condition (Huston and Smith, 1987). According to Huston (1979), competitive equilibrium of forest rarely occurs because of the natural disturbance such as wind, fire, drought or single or multiple tree mortality which can cause canopy gaps in early succession.

During secondary succession, in the early successional communities of the first 5 to 10 years the weedy species is dominance and bamboos being an important component of the secondary succession in the fallow up to about 25 to 30 years (Ramakrishnan, 1992). Early successional stages contain fewer species because of the reduction in species diversity during the disturbance (shifting agriculture) but increases gradually as the secondary community develops (Ramakrishnan, 1992). Previous study in secondary succession on abandoned shifting cultivation area by Ohtsuka (1999), shown that there is a rapid change in the composition of species in the first year after abandonment. The *Galinsoga parviflora* dominated the area in months 1-2, *Crassocephalum crepidioides* in months 3-5 and mostly dominated by *Conyza sumatrensis* after 1 year. *Melastoma malabathricum* is the species that have been found dominance as a pioneer species (Kochummen and Ng, 1977). In his study, Kochummen (1966) found that *Macaranga gigantea* is a dominant species that replacing the very early successional species and without disturbance can continues it's regain vegetation after 50 years.

2.3 Wildlife and Dependence on Secondary Forest Regeneration

2.3.1 Bats

Bats are a group of mammals and they belong to the order Chiroptera. The order of Chiroptera had almost 950 species from 18 families and 187 genera. The bats species have been classified into 8 families and 11 genera recognized in Borneo (Payne, 1985). Chiroptera is divided into two suborders; Megachiroptera is well known as fruit bats and Microchiroptera, which is well known as insect bats. Both Megachiroptera (family pteropodidae) and Microchiroptera (family phyllostomidae) are represented by similar numbers of species, but the generic diversity of the phyllostomids is greater. *Pteropus vampyrus*, is the largest pteropodid which weighs up to 900 g and *Vampyrum spectrum* (carnivore, not frugivore) is the largest phyllostomid which weighs up to 190 g. Pteropodids are considered as plant feeders and do not eat animals. While, certain phyllostomids such as *Glossophaga soricina* and *Phyllostomus hastatus* are omnivorous, feed on fruit, nectar, and insects. In addition, Megachiroptera is bigger in size rather than Microchiroptera. The distinct differences between these two suborder are the megabats have large eyed due to well developed vision but this suborder is not very good in echolation system. Compared to Microbats those have good echolation system with high frequency whereas used to guide them in terms of prey and avoidance of obstacles (Findley, 1993). The shape of the wings and their capability to fly make the bats difference from the other mammals.

2.3.2 Birds

Ecological succession of forest involve changes of floristic and composition of habitats. Hence, the bird species diversity also changes during the succession. During the succession, diversity increases due to increasing production, standing crop biomass, and structural complexity. According to Wiens (1989), the diversity depend on greater age and greater structural complexity of habitats, greater opportunities, rates of speciation, the presence of resources, higher predation rates and narrow niches. It had been found that the bird diversity was increased with the increasing of the latitude (Jarvinen and Sammalisto, 1976).

According to Deconchat and Balent (2001), Bird community composition and its richness was influenced by the retention level of vegetation density in the lower layers of the forest. Previous study showed that during the first year after logging bird community exists because of the presence of open habitat species. Their species richness was significantly lower in the area 4-10 year old forest after logging because of the closure of coppice canopies that caused a uniform vegetation layer (Deconchat and Balent, 2001).

Species richness depends on the forest ages and it decreases as the forest ages increase. Particularly, the ratio of migrant birds is lowest in the oldest forests as the canopy become closer. Previous study showed that the number of bird species increased during the first 15 years of succession, then declined over the next 25 years. Bird density also increased during the early phase of plant succession and continuing to increase after diversity leveled off at 15 years following cultivation. In shrubby woodlands, the density increased until 30-40 years of age, and reduced in later stages of these stands and in more mature oak woodland.

2.4 Wildlife Foraging

2.4.1 Bats

According to Fleming (in Kunz, 1982), approximately 250 of the 850 known species of bats are dependant on plants as a source of food and there are. There are pteropodidae and phyllostomidae. These families are well known to pollinate or disperse many species of plants and seeds. Pteropodids is known more commonly to consume fruits at the fruiting trees and most of them spent the night on the same trees in which they feed, while the phyllostomids transport fruit from fruiting trees to separate feeding roots (Kunz, 1982). According to Findley (1993), fruit bats feed on fruit, flower and pollen. Previous study showed that Megachiroptera feed on banana, which considered as 'bat plant' (Fujita, 1988) and *F. Benjamina* (Tan *et al.*, 1999). According to Thomas (1988), bats only fed on the ripen fruits and fruit bats used their vision and sense of smell to find their food (Payne, 1985). Actually, there are some characteristics of ripen fruits that can attract the bats such as attractive color of fruit, strong odor and clustered end of bunches (Stashko and Dinerstein, 1988). Plants that produced bat fruits usually reproduced seasonally and in many species. Fruit production and maturation is highly synchronous. This situation can reduce the competition between the frugivorous bats and other seed predator such as rodents and bruchid beetles (Kunz, 1982). On the other hand, there are many species of figs (*Ficus*) characterized by the intraspecific asynchrony in fruit production throughout the world. This asynchrony makes figs crops rather patchy in time and space.

2.4.2 Birds

There is an assumption that has been made of the foraging behavior of birds. The assumption is the differences in foraging behavior among bird species is reflected in differences in the ways they encounter and used the food resources (MacArthur, 1961). As an example, the surface-feeding seabirds encounter different prey than do divers, and the canopy-feeding insectivores are exposed to resources that differ from those of ground-foragers. It been concluded that the differences in behavior among the bird species is the characteristics of their habitat such as height above ground, position in a tree canopy, or substrate types. Previous study showed that males of each species forage in the higher zone than the female. This is because males are normally foraging in the vicinity of singing perches whereas females forage close to the nest sites, which are lower in the trees.

CHAPTER 3

METHODOLOGY

3.1 Study Area

Kampung Serasot in Bau District is an area near Kuching that have been selected as the study site. The area is inhabited by the Bidayuh native communities. Bau is well known as a shifting cultivation area because agriculture is their main activity and most of the people there still practiced the traditional farming system or shifting cultivation. Most of the activity involved the clear cutting or slashing and burning of land before cropping.

This study was conducted in the secondary forest. Here, the secondary forest referred to the area that has been used as a shifting cultivation area by the Bidayuh community. Shifting cultivation area mentioned in this study is the land that has been used by a farmer for cropping purposes for a certain time before they leave it and move to or open new areas elsewhere. It should be noted that the study site is the area that has been used by Bidayuh community as a rice planting area.

The study area was covered three sites selected which are on 30 years old forest (N 1.37, E 110.5), 20 years old forest (N 1.372, E110.144) and 5 years old forest (N 1.3713, E 110.0532). All the areas were selected with the assumption that there are distinct differences in plant species, as determined by their regeneration age.

3.2 Study Design and Data Collection

3.2.1 Sampling Methods

The method proposed for use in this study was the standard procedure used in forest inventory. Forest inventory is the study of quality, quantity and the characteristics of trees or plant in the forest. The role of the inventory is to get the actual information about the forest resources. Forest inventory was conducted by the use of systematic sampling. Systematic sampling is often used because it is easier to implement and it require less time to walk between plots. In systematic sampling, sampling plots are located at specific intervals along straight inventory lines running across the baseline. The distance between the inventory lines is 100m and the distance between the main plots along the inventory line is 20m or 40m from the center of the plots. In each forest type, there are at least 10 to 15 sampling plots. Each sampling plot then has been divided to 4 subplots and each of these subplots has the size of 10m x 10m (Appendix 1).

3.2.2 Data Collection

To collect the data, the assistance of informants was used. The elderly or more knowledgeable members of the Bidayuh community especially for those who have the experience with the forest were engaged to assist in the inventory. These informants were asked of the importance of fruits and berries of trees species which are for bats and birds. All the information was recorded while the inventory took place. All higher trees were inventoried in each plot. Identification of the trees species were made by the informants using the local Bidayuh vernacular names. Scientific names were later given by identification of collected specimens at the herbarium. The assistance of various experts was also obtained to ensure accuracy of identification. For the purpose of this study, only the fruit and berry bearing trees were the

focus. Therefore, it was important that all these trees that are foraged by birds and bats are properly recorded. It should be noted that not all the fruit and berry bearing trees species are collected or in this study. The main focus here is limited to the species that are commonly known by the Bidayuh communities as food for birds and bats. Observation of the trees in the sampling plot also have been conducted to identify whether the trees were bearing fruit or berry and also to observe if there were food residue that have been taken by birds or bats.

3.3 Data Processing and Analysis

3.3.1 Data Processing and Recording

All the data are primarily collected in the field. The local name of the trees, the uses, and also the number of trees and other data are collected and recorded in the form that provided (Appendix 2). The scientific name of the trees later will be identified. These data will be processing and will be analyzed using Shanon-Weiner Index to estimate the tree species diversity and the relative density in different stages of forest age also will be calculated.

3.3.2 Data Analysis

3.3.2.1 Species Diversity

In this study to evaluate tree species diversity, Shanon-Weiner Index of diversity (***H'***) and Pielou's evenness index (***J'***) are used. Shanon-Weiner Index is a simple quantitative expression that combined both the richness of plant species and the evenness of species abundance. Species richness is one of the concepts of species diversity which represent the number of species in the community. The diversity can be measured by the Shanon-Weiner Index;

$$H' = -\Sigma p_i (\ln p_i)$$

Where, p_i is the proportion of the individual taxon divided by the combined abundances of all species in the sample or;

$$p_i = n_i / N$$

Where, n_i is the number of individuals of species I, and N is the total number of individuals observed in all species. The larger the value of ***H'***, means the greater of the uncertainty and the increases of ***H'*** is proportional with the number of species in the community.

The species evenness is defined as the number of individual that represent each of the species. Evenness is the formula to measure the relative similarity of the abundance of two different species. The value of evenness is one, when the proportions of all species are identical and the value increases when the abundance are dissimilar.

$$J' = H'/H'_{max} \quad @\ J' = H'/\mathbf{ln(number\ of\ species)}$$

Where, H'max is the maximum level of diversity possible within a given population which equals ln(number of species).