

**BIRD SPECIES DIVERSITY IN PRIMARY,  
LOGGED AND BURNED FOREST AREAS OF  
CROCKER RANGE PARK, SABAH**



**GLORIA MURING GANANG**

**UMS**  
UNIVERSITI MALAYSIA SABAH

**SCHOOL OF INTERNATIONAL TROPICAL  
FORESTRY  
UNIVERSITI MALAYSIA SABAH  
2012**

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LOGGED AND BURNED FOREST AREAS OF  
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**GLORIA MURING GANANG**



**THIS IS SUBMITTED IN FULFILLMENT FOR  
THE DEGREE OF MASTERS OF SCIENCE**

**SCHOOL OF INTERNATIONAL TROPICAL  
FORESTRY  
UNIVERSITI MALAYSIA SABAH  
2012**

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## DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.

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Gloria Muring Ganang  
PF20088315



UMMS  
UNIVERSITI MALAYSIA SABAH

## CERTIFICATION

NAME : **GLORIA MURING GANANG**

MATRIC NO. : **PF20088315**

TITLE : **BIRD SPECIES DIVERSITY IN PRIMARY, LOGGED AND  
BURNED FOREST AREAS OF CROCKER RANGE PARK,  
SABAH.**

DEGREE : **MASTERS OF SCIENCE  
( SCIENCE IN FORESTRY )**

VIVA DATE : **26<sup>TH</sup> JANUARY 2012**

  
**1. SUPERVISOR**  
Dr. Andy Russel Immit Mojiol

DECLARED BY

**UMMS**  
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Signature

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Gloria Muring Ganang  
30<sup>th</sup> August 2012

**ABSTRACT**  
**BIRD SPECIES DIVERSITY IN PRIMARY, LOGGED AND BURNED FOREST**  
**AREAS OF CROCKER RANGE PARK, SABAH.**

Birds are important elements of the tropical rainforest ecosystem especially in the process of destructed forest restoration through seed dispersal. The forest area of Sabah has been decreasing due to extensive human economy activities such as logging and natural phenomena like the draught period of El Niño which causes wild fire occurrences. This causes forest bird species to be threatened by the reduction of their habitat. The type of forest areas studied are primary, logged and burned forest where mist-netting method was applied in each forest type to find out the difference in bird composition, diversity, feeding guild as well as local and international conservation status. Habitat surveys were also conducted using square plots with a total of 0.1ha for each forest type. Habitat variables associated with bird composition were quantified. There were a total of 69 species recorded in the three forests combined. There were 27 species in the primary forest, 35 species in the logged forest and 38 species in the burned forest. The logged forest is highest in bird diversity with the Shannon Index diversity value of  $H' = 3.25$ , followed by primary forest ( $H' = 3.11$ ) and burned forest ( $H' = 2.54$ ). However primary forest has the highest value in bird species richness, followed by logged forest and burned forest. Burned forest has the lowest species evenness value. This showed high dominance of a few species in the area. Most birds occurred in the burned forest are belonging to the nectarivore/ insectivore guild. However primary forest and logged forest has more bird belonging to insectivore guild. Primary forest has the most species that are near threatened, followed by burned forest and logged forest. The study showed that distribution of forest birds depend on vegetation of habitat. Therefore, it is important to conserve these forest areas for the continuous survival of forest bird species.

## **ABSTRAK**

*Burung merupakan elemen penting dalam ekosistem hutan tropika terutamanya dalam proses pemulihan kawasan hutan terganggu melalui penyebaran biji benih. Kawasan hutan di negeri Sabah semakin berkurang disebabkan aktiviti ekonomi manusia seperti pembalakan dan juga fenomena alam seperti kejadian El Niño yang menyebabkan kebakaran hutan. Ini telah menyebabkan spesies burung hutan terancam disebabkan gangguan habitatnya. Kawasan hutan primer, dibalak dan terbakar telah dipilih dalam kajian ini di mana kaedah jaring kabut telah diaplikasikan di ketiga-tiga jenis hutan untuk mengenalpasti perbezaan komposisi burung, kepelbagaian spesies, jenis pemakanan dan status konservasi di peringkat negeri dan antarabangsa. Pemantauan habitat bagi ketiga-tiga jenis hutan juga telah dikendalikan menggunakan plot empat segi dengan jumlah luas kawasan 0.1ha bagi setiap jenis hutan. Jenis vegetasi hutan yang dikira adalah yang berkaitan dengan komposisi burung. Terdapat 69 spesies burung yang telah direkod di ketiga-tiga kawasan. Terdapat 27 spesies burung di hutan primer, 35 spesies di hutan dibalak dan 38 spesies di hutan terbakar. Kawasan dibalak mempunyai kepelbagaian paling tinggi dengan nilai kepelbagaian Shannon Index,  $H' = 3.25$ , diikuti kawasan hutan primer ( $H' = 3.11$ ) dan kawasan hutan terbakar ( $H' = 2.54$ ). Walau bagaimanapun hutan primer menunjukkan nilai tertinggi dari segi kebanyakan spesies. Burung di kawasan hutan terbakar pula adalah didominasi oleh beberapa spesies burung. Kebanyakan burung di kawasan hutan terbakar adalah daripada kategori pemakan nektar dan serangga. Walau bagaimanapun kawasan hutan primer dan dibalak terdapat lebih banyak burung daripada kategori pemakan serangga. Kawasan primer mempunyai spesies terancam yang paling tinggi, diikuti dengan kawasan terbakar dan dibalak. Kajian ini menunjukkan bahawa burung harus bergantung kepada vegetasi persekitaran dan makanan yang terdapat dalam hutan tertentu. Oleh itu, adalah penting untuk melindungi kawasan-kawasan hutan ini kerana ia menyediakan kawasan habitat yang penting untuk mengekalkan spesies burung hutan di kawasan ini.*



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## CHAPTER 1

### INTRODUCTION

#### 1.1 Study Background

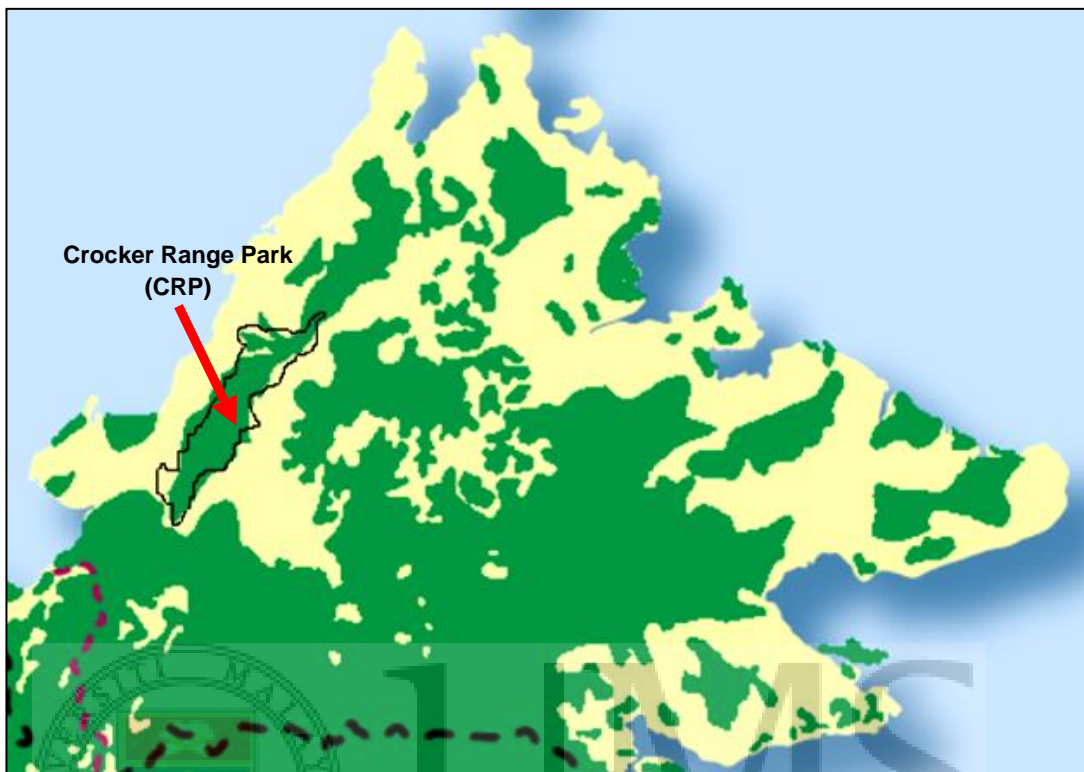
Tropical forests are important habitat for a large percentage of bird species in the world. There are a total of 633 bird species recorded in the tropical forest of Borneo where 430 species are residents (Myers, 2009). Birds are important components of the forest ecosystem where they act as seed dispersers and pollinators to maintain the ecological processes of the forest (Peh *et al.*, 2005). Seed dispersal of forest tree species can help limit the recolonization of pioneer species in forest gaps and therefore regulate the species richness of the forest (Pejchar *et al.*, 2008). They are also important bio-indicators in the monitoring and prediction of forest diversity changes caused by human disturbances. Bird database is extensively available and birds are easy to observe (Hoeven and Iongh, 2001). Therefore, birds are important partners of the forest ecosystem not only assisting in monitoring of forest health but also help in the restoration of forest biodiversity.

The primary forest of Sabah outside the conservation area is declining due to the commercial values of the dipterocarp trees. The logged over forests provide accessibility from logging roads offers opportunities for forest conversion to agricultural land. Some parts of the forest areas have been affected by fire during the El Nino draught event in 1993 and 1998 (Brühl *et al.*, 2003). The changes in forest vegetation structure will affect bird species composition. Sensitive bird species do not tolerate with changes in primary forest environment or microclimate change within the succession process. This will eventually cause risks to their extinction. According to Slik and Van Balen (2006), open forest bird species will increase when a forest area is affected by fire while closed forest birds will decrease. This is due to the reduction of habitat heterogeneity after a forest is burned. Rainforest birds can lose a few species immediately after deforestation because disturbed forests tend to have lower diversity due to the dominance of species that can easily adapt to the disturbed forest condition (Meijaard *et al.*,

2005). Forest specialist birds are directly affected by the reduction of forest area. They are vulnerable towards the competition and predation of invasive bird species that increases with alteration of forest vegetation. This results in the decline of forest value for birds (Sodhi and Smith, 2007). Forests that are disturbed will eventually recover and become potential habitat for forest birds. Peh *et al.* (2005) detected primary forest species in a 30-year-old logged forest where these species were previously absent in the same forest after one and 12 years since logging. This indicates the capability of these birds in recolonizing the logged forest area over time. Sodhi *et al.* (2005) found similarities in forest species richness, forest species density and population density between primary forest and 40-year-old logged forest. It is suggested that secondary forests have high conservation value if they are continuously protected and not further degraded and.

The study was conducted in the Crocker Range Park (CRP) area. The CRP is a mountain range that rises from 10 to 15 kilometers from the western coastal plain of Sabah with the altitude of 914 meters to 1829 meters above sea level. The CRP is the largest terrestrial park in state of Sabah with a total area of 139,919ha apart from other terrestrial parks gazetted under the enactment which are Kinabalu Park and Tawau Hill Park. The Crocker Range area before gazetted as a park was initially designated as Crocker Range Forest Reserve (CRFR) under the Forest Ordinance No. 2 in 1969. Subsistence logging by inhabitants residing in the surrounding district of the forest reserve was then allowed (Payne and Vaz, 1998). The CRFR was later converted to a State Park in 1984 with the name of Crocker Range National Park (CRNP) under the Park Enactment 1984 to conserve its natural resources and ecosystem. Extraction of timber or any other forest product within the park area was forbidden since its gazettelement. The name of CRNP was later changed to Crocker Range Park (CRP) in 1996. The CRP is currently classified as Category II Protected Area in the World Conservation Union (IUCN) list of protected areas (Ministry of Culture, Environment and Tourism, Sabah, 1998). The map below showed the forest cover of Sabah in 1985. The Crocker Range area was not yet established as a park by then. Therefore, timber extraction occurred in and around the CRP boundaries. The forest cover on map is based on satellite imagery and

therefore does not necessarily represent quality of forest. The covered forest may be undisturbed or damaged by logging.

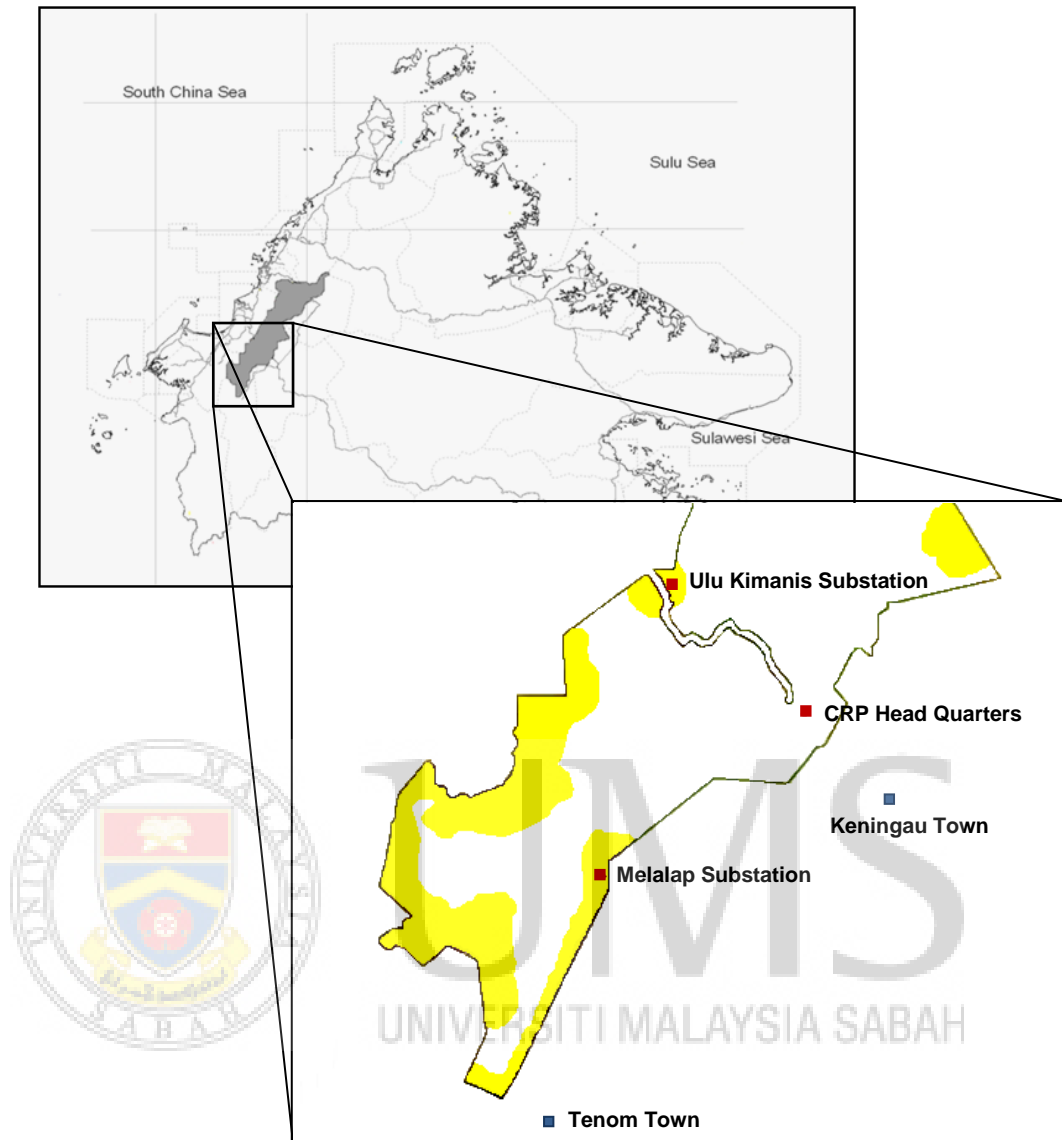


**Figure 1.1: Sabah forest cover in 1985. Yellow areas show open areas and green areas are forest covered area.**

Source: WWF Germany (2005)

Forest fire occurred in the Crocker Range Park several times. During the El Nino draught in 1983, much of the forest in the southern fringe of Cocker Range Park was burned. Parts of the same area were burned in the dry periods in early 1990 and 1991. A much larger area was burned again around and in the Crocker Range Park area during another major El Nino draught in 1997/1998.





**Figure 1.2: Burned areas (yellow patches) of Crocker Range Park, Sabah.**

The most extensive forest fire that occurred at the Crocker Range Park areas have been commercially logged (Ministry of Culture, Environment and Tourism, Sabah, 1998). Timber extraction allows more sunlight penetration into the forest understorey and causes a drier microclimate within the forest area. The production of wood debris from logging activities also increased the chances of forest fire (McMorrow and Mustapa, 2001). Forest fire alters the community composition and population structure of the forest through differential mortality among species and tree sizes. It also changes the composition and diversity of forest plants with the increase of pioneer plants in the forest understorey.

Repetitive forest fire can also negatively affect the flora and avifauna to the point that recovery becomes impossible (Slik and Van Balen, 2006).

The Crocker Range Park is an area of important habitat for many fauna species. This includes endemic and rare bird species where its large continuous forest area provides a variety of food sources and maintains suitable microclimate condition for many birds to survive (Meijaard *et al.*, 2005). Sabah Parks recorded a total of 259 bird species in the CRP. Birdlife International has identified the CRP as one of the 218 Endemic Bird Areas (EBAs) of the world (Sabah Parks, 2006). To qualify as EBAs, an area has to be rich in endemic bird species compared to other parts of the world. The Malaysian Nature Society (MNS) rated the park as one of the Important Bird Area (IBAs) of Malaysia. This is due to the presence of globally threatened species in the CRP area.

## **1.2 Thesis Overview**

This study aims to find out the changes of bird diversity from a primary forest to a burned and logged forest. Forest concessions and licensed forest areas are no longer permitted in the CRP since its gazetement as a park in 1984 and the last forest fire occurred during the 1997/1998 El Niño event. The study produces data for the type of understory species that occurs in the forest several years after logging and fire. The diversity is highest in the logged forest (at least 25 years ago) and lowest in the 12-year-old burned forest. The logged forest is in the transition process of becoming a primary forest. Despite its location that is adjacent to the primary forest, the ecotone community contributes to its higher diversity with the intermixing of both forest and generalist bird species. The logged forest also contains remnants of primary forest vegetation which allows the availability of food sources for more forest birds to utilize the forest. In the regenerating burned area which is mostly dominated by a few pioneer plants contributes to the higher occurrence of several generalist bird species.

Chapter one introduces the background of the study which includes the importance of birds in forest ecology and background of the Crocker Range Park. Chapter two consists of literatures related to the field of study which includes

description of primary, logged and burned forests, previous studies of birds in Crocker Range Park, role of birds in forest ecology, bird feeding guild, birds response to habitat change and the description of edge effect and ecotone. Chapter three describes the geographical background of Crocker Range Park and methods for data collection and analysis. Understorey birds are the targeted groups in this study, therefore standardized mist netting methods were applied in the three forest areas. Vegetation variables were sampled to find out their relationship with bird species diversity in each forest types. In the data analysis section, the equations to obtain bird species density, diversity and evenness of each forest is discussed. Analysis to compare bird species diversity between forest types and its relation with forest vegetation were also explained in the chapter. Lastly, the chapter includes the list of bird feeding guilds and description of bird conservation status in the local and international level which is according to the Sabah Wildlife Enactment 1997 and IUCN Red List of Threatened Species respectively.

Chapter four focus on overall data results and analysis. The total number of bird individual, species and family were presented, followed by results of bird diversity, richness and evenness, T-test result for diversity, bird feeding guild and list of recorded plant species in the primary, logged and burned areas. The results of regression analysis were presented and threatened birds were also listed in this chapter. Chapter five explains the different findings of bird diversity in primary, logged and burned forests. Finally, Chapter six concludes the research findings and suggestions for further research and management strategies.

### **1.3 Objectives**

1. To distinguish bird species composition in primary, logged and burned forests of Crocker Range Park (CRP).
2. To compare species diversity in primary, logged and burned forests of Crocker Range Park (CRP).
3. To relate habitat variable with birds that occur in primary, logged and burned forests at Crocker Range Park (CRP).
4. To categorize birds into feeding guilds and conservation status.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Forest description

##### 2.1.1 Primary forest

The primary forest has a higher tree density and number of species and has lower canopy openness compared with logged forest and burned forest (Slik *et al.*, 2002). The most common tree species in primary forest in terms of number of stems are trees from the family of Dipterocarpaceae, Euphorbiaceae and Anacardiaceae, however in terms of basal area trees of Dipterocarpaceae, Fabaceae and Anacardiaceae family are most common (Brearley *et al.*, 2004). According to Rahman *et al.* (2002), the primary forest of Crocker Range Park is dominated by large dipterocarp trees including *Shorea* spp., *Dipterocarpus* spp., and *Arthocarpus* spp. In comparing the diversity of primary forest and old secondary forest, the primary forest is significantly higher in diversity than the old secondary forest.

##### 2.1.2 Logged forest

The regeneration of logged forest vegetation varies between the logging methods and system used. In the selectively logged dipterocarp forest of Pasoh Forest Reserve in Peninsular Malaysia for example, Okuda *et al.* (2003) found difference in canopy height and tree height when compared with primary forest. The forest area was logged using Malaysian Uniform System (MUS) approach in 1958. The study was conducted in 1999 which is 41 years after logging. It was found that there was less variation in canopy height in the logged forest compared to primary forest due to the immediate regeneration of trees after logging. In the primary forest, trees regenerate irregularly after natural gap formation. Logged forests also have smaller average canopy crown and high density of small crowned trees. Primary forests have uneven crown sizes and many emergent crowns. It takes more than 40 years of a selectively logged forest to allow emergent species to grow tall enough and penetrate the canopy layer. In terms of composition, the regenerating forest

comprise of medium sized trees which may be remnants of the selectively logged forest. These trees were left unharvested because it had not reached the minimum size during the logging operation. Typical early-successional species such as *Porterandia anisophylla*, *Croton argyratus* and *Endospermum malaccense* were found more common in regenerating forest after logging.

### **2.1.2 Burned forest**

Fire destruction will affect the habitat heterogeneity by the reduction of vegetation structure, plant species diversity and composition. The maximum tree height also decreases and the ground cover is dominated by terrestrial ferns, ginger, bamboo and wild bananas. The woody species is dominated by pioneer trees from the genus *Macaranga* (Slik and Van Balen, 2006). According to Harrison (2001), eighty percent of lianas and trees less than 5cm dbh died during the 1982-1983 El-Niño Southern Oscillation (ENSO) in East Kalimantan. However, larger trees of above 30cm dbh were less affected. Cleary and Priadjati (2005) found that the density of sapling and seedling, species richness and composition are significantly different between burned and unburned forest area. Seedlings and saplings species were mostly found in unburned forest. Most of the species found in the burned area are non-dipterocarp species. Seedling density declined from burned to unburned forest and this is related to the particular patterns of regrowth after fire. Pioneer species especially *Macaranga gigantea* and ferns (*Blechnum orientale*, *Microlepia speluncae* and *Pteridium aquilinum*) were the principle sources of regrowth in the burned forest.

According to Slik (2004), the difference between tree mortality during the 1997/1998 El nino drought is influenced by tree composition. Tree mortality is found to be higher in the logged area compared to the unlogged area. This tree mortality is contributed by the pioneer *Macaranga* trees which are common in logged forest and almost absent in unlogged forest. The reason of high mortality in *Macaranga* tree is unclear but it is suspected that it is due to the rooting system of the tree which does not reach to the lowered soil water level during droughts. Besides seedlings, sprouts, lianas and young trees which are not protected by thick barks and can easily burn, fire can also kill dipterocarp trees which also lack thick

barks and has flammable tree resin (Meijaard *et al.* 2005). Trees of the family Dipterocarpacea which are the most important trees in Borneo may not have resprouting capabilities, however they can regenerate in lightly burned areas.

## 2.2 Birds in Crocker Range Park (CRP)

In comparison with the information of bird community in Kinabalu Park, a protected area under the Sabah Parks administration, less is known about birds in CRP (Rahman *et al.*, 2002). There are only several research and records of birds in the park area. Sabah Parks compiled a total of 259 species of birds in the CRP area (Sabah Parks, 2006). An inventory of bird species diversity by Rahman *et al.* (2002) captured 17 species from seven families after 840 mist netting hours and recorded 51 species from 24 families in their transect studies. The findings showed no marked difference in bird diversity between secondary and primary forests. Majority of these birds utilize both secondary and primary forest such as the Little Spiderhunter (*Arachnothera longirostra*) and Yellow-bellied Bulbul (*Pycnonotus phaeocephalus*). There were also migrant species present such as the Mugimaki Flycatcher (*Ficedula mugimaki*) and Siberian Blue-Robin (*Erithacus cyane*). Endemic species recorded includes White-crowned Shama (*Copsychus stricklandi*) and Duski Munia (*Lonchura fuscans*). The relative density of bird was 0.03 bird/net unit in secondary forest and 0.05 bird/net unit in primary forest. It is suggested that agricultural development which caused forest fragmentation in the secondary forest area affects the distribution of and diversity of birds in the secondary area.

Shahrul Anuar *et al.* (2002) recorded 11 species from eight families after conducting half day of field observation in Mahua Substation of Crocker Range Park. They also conducted a 6-day bird observation and mist netting of disturbed and undisturbed areas in the Ulu Senagang Substation, and recorded 41 species from 18 families. The most species recorded were from the family of Pycnonotidae (Bulbuls), Muscicapidae (Flycatchers), Cuculidae (Cuckoos) and Eurylaimidae (Broadbills). There were a total of 45 resident species and four migrant species recorded in both Ulu Senagang and Mahua forest areas. The migratory species includes the Grey Wagtail (*Motacilla cinerea*), Blue and White Flycatcher (*Cyanoptila cyanomelana*), Pied Wagtail (*Motacilla alba*) and Siberian Blue Robin (*Erithacus*

*cyane*). Endemic birds were also recorded in these areas including the Bornean Treepie (*Dendrocitta cinerascens*) and Dusky Munia (*Lonchura fuscans*). Many of the birds at the undisturbed area of Crocker Range Park are regular visitors that utilize the forest as food source and nesting site.

### **2.3 Role of birds in forest ecology**

Birds play important role as seed dispersal agents which is an important process of forest regeneration and maintaining forest tree diversity. This is through the advantages of success regeneration of seeds when dispersed a distance from their adult trees (Phillips, 1997). Birds seed dispersing ability is also important in recolonizing forests. Sodhi *et al.* (2005) found that forest bird species utilizing mixed rural habitat provide ecosystem services by seed dispersal and pollination which will contribute to native tree regeneration. This applies especially to the regeneration of disturbed areas adjacent to primary forests, where birds that utilize both areas would bring native seeds of primary forests to the disturbed area.

Birds are also important bio-indicators that reflect forest health. According to Heaven and Iongh (2001), understory insectivores are the most consistent in predicting disturbance in the Bornean forests. Besides its availability in database and current research, understory insectivores are more sensitive to forest disturbances. According to Barlow *et al.* (2006), understory birds responds to the changes in forest vegetation structure, floristic composition and food availability. Johns (1996) found the decline in abundance of terrestrial insectivore from a logged to an unlogged area of Sabah. This may due to the reduction of litter arthropods which are food sources for the terrestrial insectivores, which is related to the dried out litter in the forest after logging. The sensitivity of bark gleaning insectivores and understory foliage-gleaning insectivores are useful ecological indicators of forest degradation. It is because forest degradation can affect food availability for bird occurrence in the area (Arriaga-Weiss *et al.*, 2008).

According to Zakaria *et al.* (2005), the number of Red-eyed bulbul (*Pycnonotus brunneus*) and Grey-bellied bulbul (*Pycnonotus cyaniventris*) is less in logged forest compared to the primary forest. There was also a high occurrence of

Rufous-tailed shama (*Trichixos pyrropyga*) in the primary forest. However, the number of Moustached babbler (*Malacopteron magnirostre*) in primary forest is higher than logged forest. The changes in number of these habitat sensitive species can be good indicators to reflect the condition of a forest. According to Soh *et al.* (2006), the loss of montane-restricted bird species and emerging of lowland and geographically wide ranging bird species can indicate degradation of montane habitat. The sensitivity of montane birds species to slight deforestation is because of the high proportion of these birds with restricted ranges and specialized physiology that adapts with the mountain environment.

#### **2.4 Bird feeding guild**

The occurrence of birds is influenced by the availability of food source in an area. The alteration of vegetation composition which changes food availability of a forest area will affect bird composition. For example, the composition and number of individual of insectivorous birds change from logged to unlogged forest (Zamri and Zakaria, 2002). The high numbers of frugivore/insectivore birds in logged forest are mostly colonizing secondary species which are the bulbuls (Pycnonotidae). Their ability to switch to insectivorous diet is also an advantage to tolerate seasonal variation in fruit abundance in logged forest (Zakaria *et al.*, 2005). Meijaard *et al.* (2005) suggested that species with wider ecological niches such as those that feed on many food items are more tolerant with changing environmental conditions. After a forest is logged or burned, the availability of insect is reduced due to the loss of trees for the leaf feeding, bark feeding, crevice-dwelling and wood boring insects (Zakaria and Nordin, 1998). Slik and Van Balen (2006) found that there is a significant increase in insectivorous birds foraging on forest floor and above forest canopy after fire. This is related to the changes in forest understorey after fire with the appearance of more woody plants and pioneer herbs as well as the reduction of foliage cover in the middle and upperstorey level of the burned forest. The recorded insectivore birds are also possibly those that are passing through within the burned area since the location of study area next to unburned forest.

The loss of continuous supply of fruits due to deforestation in small forest remnants will impact frugivorous birds. Sodhi *et al.* (2005) found the abundance of