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COMPOSITION OF BIRD COMMUNITIES IN A 21-YEAR-OLD REHABILITATED FOREST IN UPM BINTULU, SARAWAK CAMPUS

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By

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ABSTRACT

This study was carried out to determine bird species composition in a-21 years old rehabilitated forest. The main objectives were to: (i) determine the composition of bird communities, (ii) generate a species list of birds in rehabilitated forest. This study was conducted in Phase 1 and 2, UPM Bintulu Campus, Bintulu, Sarawak, Malaysia. This area is a hill forest covering an area of 7.13 ha. It was replanted in 1991 with many of local tree species. Mist-netting method was used to obtain the information on bird species. A total of 29 species with 473 individuals of birds were recorded in this study. The group of bulbuls showed a highest number of individuals followed by the babblers. The most abundant species which dominated the rehabilitated forest was the Yellow-vented Bulbul and followed by Striped Tit Babbler. The analysis of bird species using CANOCO showed that most of the birds are dominated at Phase 1 and only half of them were found at Phase 2. The changes in forest vegetation and microclimate might be the main factors which affected the trophic, feeding guild and composition of bird species.

ABSTRAK

Kajian ini dijalankan untuk menentukan komposisi spesies burung di hutan pemulihan yang berusia 21 tahun. Objektif utama adalah untuk: (i) menentukan komposisi komuniti burung, (ii) untuk mendapatkan senarai populasi burung di hutan pemulihan. Kajian telah dijalankan di Fasa 1 dan 2, UPM Kampus Bintulu, Bintulu, Sarawak, Malaysia. Kawasan ini merupakan hutan bukit meliputi kawasan seluas 7.13 ha. Kawasan ini telah ditanam semula pada tahun 1991 dengan pelbagai spesies pokok hutan. Kaedah jaring kabut telah digunakan untuk mendapatkan maklumat mengenai spesies burung. Sejumlah 29 spesies dengan 473 individu telah direkodkan dalam kajian ini. Kumpulan merbah menunjukkan bilangan individu tertinggi diikuti oleh kumpulan rimba. Spesis yang paling banyak yang menguasai hutan pemulihan adalah merbah ekor kuning dan diikuti oleh rimba tit-tit. Analisis spesies burung menggunakan CANOCO menunjukkan bahawa kebanyakan burung ditemui di Fasa 1 dan hanya sebahagian daripada spesies burung didapati di Fasa 2. Perubahan dalam vegitasi hutan dan iklim mikro mungkin menjadi faktor utama yang memberi kesan kepada komposisi, struktur tropik, kumpulan pemakanan, serta kepelbagaian spesies burung.

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APPROVAL

I certify that this research project entitled "Composition of Bird Communities in A 21-Year-Old Rehabilitated Forest in UPM Bintulu, Sarawak Campus" has been examined and approved as a partial fulfilment of the requirement for the degree of Bachelor of Science BioIndustry in the Faculty of Agriculture and Food Sciences, University Putra Malaysia Bintulu Sarawak Campus.

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LIST OF ABBREVIATIONS

UPMKB	Universiti Putra Malaysia Kampus Bintulu
ha	Hectare
cm	Centimeter
hr	Hour
PCA	Principle Component Analysis
SP	Species

CHAPTER I

INTRODUCTION

The tropical rainforest has the most diverse and richest assemblage of plant and animal species in the world. Most wildlife species in the tropical regions depend on the forest for their existence. Tropical rainforest is also known to hold a high diversity of birds due to the physical structure of the environment such as suitable temperature and light intensity.

Some species of birds, particularly forest interior species do not tolerate changes in habitat and microclimate conditions or the predators and parasites that occur at the forest edges. Ecologists acknowledged that forest plays an important role in maintaining biodiversity, ecosystem and of many things as well as it is the home of thousand wild species that some are discovered while many more still unknown. People have exploited forests throughout their history and this activities still going on until present day. In tropical rain forest which was known as the mega diversity of flora and fauna species, the understanding on how to identify factors affecting the pattern of diversity and distribution of avian species is a major issue for conservation biologist.

Maina and Jackson (2003) reported that isolation of forest area have been shown to affect the composition, abundance, and distribution of wild flora and fauna by reducing the amount and proximity of the patches of suitable habitat and increasing the amount of edge. The forest ecosystem provides the basic necessities such as shelter, refuge and feeding and breeding grounds for them to survive and reproduce.

Bird densities were highest in the forests and alike in crop field, reforestation, and restoration treatments. However, bird communities recorded in the restoration treatment were fairly even when compared to the reforestation treatment, and highest bird species composition similarity was recorded between the restoration and forest treatments.

Restoration efforts that include more actions can affect more ecosystem components. In this study, nurse plants not only offered a quick growing structural vegetation component that enhanced habitat structure, but also provided abundant food resources for birds.

Mammal and avian are particularly vulnerable to forest disturbances and clearing for several reasons: a majority of these species depend on primary or tall secondary forest for their existence (Medway, 1983; Steven, 1968). Many species require extensive areas of forest because of their large home range and all species must maintain their gene pools to a sufficient size as to ensure their existence in the future. Eighty-four percent of endemic birds (birds that are not found anywhere else) are found in nature forest. Natural forest also makes up eighty percent of the endemic bird area.

One of the important impacts of primary forest destruction on bird population is a decrease in species number and charge in bird community (Nordin & Zakaria 1997; Blankespoor, 1991). Understorey species have been suggested to be affected mostly when the forest structure is altered (Nordin & Zakaria, 1997). This is because understorey species are highly sensitive to high temperature and light intensity.

1.1 Problem of Statement

Issues relating to forest degradation and its effects on wildlife conservation in tropical forests have become a worldwide debate (Anon, 1990). It can be seen at uncontrolled deforestation and exploitation occurs and can be main factors contributing to these issues and can effect composition of bird in the forest. Rehabilitated forest is needed to enhance that bird composition. Furthermore. Ecological rehabilitation programmes often aim at minimising the compositional, structural and functional differences between undisturbed reference sites and rehabilitating sites. (Van Aarde *et al.*, 1996).

1.2 Objectives

Due to the benefit and discussion on the bird community and rehabilitated forest, this study has been set up with two objectives. Firstly, to determine the composition of bird community in a-21 years old rehabilitated forest in UPMKB and to generate a species list of bird population for further research and knowledge.

CHAPTER II

LITERATURE REVIEW

2.1 General Introduction

The development of bird communities is characterised by increasing in density although often not uniformly, biomass, species richness and indices of species diversity during ecological succession. However, diversity sometimes declines during late successional stage. During succession the environment usually changes from unstable to more stable, leading to the hypothesis that generalist species dominate in early successional habitats and are replace by specialists in more mature habitats.

An increase in complexity of vegetation structure, floristic composition and heterogeneity can increase niche diversity of birds and vice versa (Leito, *et al.*, 2006). Both natural and human induced disturbances such as floods, drought, deforestation change in land use, natural resources and seasonal climatic changes affect vegetation and bird community structures. (Maurer, 1981, Wiens, 1989 & Rahayuninagsih, et. al., 2007). The change in vegetation community structure alters the availability of nest, cover and food for birds. Furthermore, change in vegetation community structure could affect the quantity and quality of food, water and cover which in turn alters the diversity, abundance and distribution of birds (Western & Grimsdell, 1979).

Tropical rainforest covers about 12 percent of the total global land surface and known as the most suitable habitat for various plant and wildlife (Anon, 1990).

Tang, *et al*., (1981) estimated 25000 species of flowering plants which is about 10 percent of the world's flora. One hectare of tropical forest may contain 400 trees of different species while a typical temperate forest contains a mere 10 to 15 trees per ha (Anon, 1990). There are about 1200 species of birds, 293 species of mammal, 294 species of reptiles, 171 species of amphibians and 449 species of fresh water fishes in Malaysian rainforest (Groombridge, 1996). About ninety percent of mammal and nearly 9000 species of birds in the world can be found in the tropical rain forest (Davison, 1990).

2.2 Lowland Rain Forest

The lowland rainforest has the most diverse and complex ecosystem compared to other forest types. This forest can be classified into five vertical zones, namely ground storey, lower storey, middle storey, upper storey or canopy and emergent. The characteristics of these five zones are different from each other. Most of the wildlife species such as birds (babbler, flycatchers and broadbills), big mammals (tiger, elephant and rhinoceros) and primates (gibbons, macaque and langurs) in the tropical rainforest prefer to occupy the lowland rainforest as their primary habitat (Johns, 1983). Although most of the primary forest in the world is being destroyed every day and will become a secondary forest, the regeneration rates will remain a long time, however, the forest is still able to provide food sources and shelter for many wildlife species to survive (Zakaria, 1994).

The tropical rainforest of South-East Asia is the oldest and most complex plant society with a very stable equilibrium among the various components of plants

and wildlife. It is the most species-rich terrestrial ecosystem in the world (Ashton, 1989). Tropical rainforests have between 400-1000 individuals of trees above 10.0 cm diameter at breast height per ha. (Soepadmo & Kira, 1977).

2.3 Tropical Birds Diversity

Tropical rainforest is a suitable habitat for various bird species. According to Davidson (1990), about 9000 species of birds are found in the tropical rainforest. The forest supplies food offers protection and is the best shelter for them to survive and reproduce. Tropical rainforest is also known to contain a high diversity of birds due to the physical structure of the environment such as suitable temperature and light intensity (MacArthur, 1961).

In Malaysia, most of the mammals and birds are dependent on the tropical rainforest for survival. The forests provide excellent cover, refuge, feeding and breeding habitats (Davidson, 1990). Most of the birds and mammals occupy the lowland forest, montane forest and coastal areas (e.g. mangrove) (Medway & Wells, 1971). More than 580 species of birds have been recorded in Borneo by Smythies (1981) whereas; Davidson (1991) has recorded a total of 554 bird species in Peninsular Malaysia. Groombridge (1996) reported that about 1200 species of birds, 293 species of mammals, 294 species of reptiles, 171 species of amphibians and 449 species of fresh water fishes in Malaysia (Peninsular Malaysia and Borneo). About 42 percent of these are birds that can be found in mixed dipterocarp forest (Zakaria, 1994). These figures showed that Malaysia is one of the richest ecosystems in the world in related to avifauna species.

A large number of species (more than 638 species) of birds have been recorded in Peninsular Malaysia (Strange & Jeyarajasingam, 1993). These birds belong to 78 families. 70 percent out of this total number of species are classified as resident birds, while the rest belong to the categories of passage migrants, winter visitors or vagrant's categories.

2.4 Understorey Birds

Understorey birds are birds that often search for food between the canopy level and the forest floor. There are a few groups of understorey birds according to their feeding guilds in the forests (Johns, 1989). Understorey insectivorous birds are birds that feed on insects as their main food source. The five broad foraging groups of understorey insectivorous birds are (i) the terrestrial species (babbler and bulbul), (ii) foliage-gleaning species (babblers), (iii) bark-gleaning species (woodpeckers), (iv) sallying (flycatchers) and (v) sallying substrate-gleaning species (Johns, 1987). Understorey frugivorous bird such as flowerpecker and pigeons are birds that feed on small fruits, from trees including the Melastomaceae, Rubiaceae and Magnoliceae, small-fruited figs Fiqus and mistletoes Loranthaceae. Many of these understorey trees are destroyed during logging, and some, such as figs and mistletoes, which require host trees, may regenerate very slowly (Zakaria, 1994).

Nectarivorous birds refer to the species that visit flowering plants for nectar, and are mostly dominated by flowerpecker and sunbirds. They are commonly found in logged forest where secondary plants start flowering. The abundance of this

species in secondary forest varies seasonally according to the spatial dispersion of flowering among nectar plants.

Tropical rainforest support many understorey bird species that are much specialised in their feeding guilds. They feed heavily on insect and small fruits as their main food source. The number of forest understorey insectivorous species is higher in tropical forest than temperate forest with an average of 4.3 individual/species (Orians, 1969). It is expected that logging activities will affect the understorey insectivores greatly.

Understorey bird species are very sensitive to the changes in microclimate and habitat destruction because they need suitable condition such as temperature, humidity and light intensity to adapt. Rehabilitated forest can produces small fruit and provide much more support to the foliage of insect. The species richness of understorey insectivores increases rapidly without logging activities and birds not move away into other habitat.

2.5 The Importance of Birds Species

Birds play an important task in spreading seeds and help to regenerate some plant species (Ridley, 1930). A particular fruit is suitable for bird dispersal for a number of morphological characteristics (Stept, 1984; Carlguist, 1967). The orthithologist's observations also suggest that a certain bird eats fruit of a particular species of plant (Sody, 1955).

Many plants depend on frugivorous vertebrates for the dispersal of their seeds (Pijl, 1982). In order to attract the dispersers plants (*Ficus* sp.), have evolved such

From a plant's perspective, seeds that are swallowed by animals or birds have a better chance of survival if they are deposited further from the parent plant than seeds dropped underneath the plant (Augspurger 1983a, 1983b, 1984a, 1984b, Augspurger & Kelly, 1984; Clark & Clark, 1981; Howe, *et al.*, 1985; Janzen, 1970). The factors, which can influence the birds' foraging strategy, include the abundance of fruiting trees, the birds' safety from predators, and the technique of finding trees bear which ripe fruits. These factors will affect the number and diversity of seeds dispersed due to the differences in the foraging pattern of different species of birds and the frequently of feeding in the primary forest compared to the logged forest.

2.6 Role of rehabilitated forest as the alternative habitat for bird population

One of alternative habitat for bird population is rehabilitated forest. The development of bird communities is characterised by increases in density, biomass, species richness and indices of species diversity during ecological succession. Rehabilitated forest has several advantages that enhance the capacity of the forest to maintain commercial or social productivity by promoting the growth of bird species (Kritzinger & Van Aarde, (1998). Rehabilitated forest gives way to built much of vegetation and tree species.

Terborgh (1985) identified factor for bird community composition is depends on the presence or absence of food resources and richness of food resources makes an area interested for bird to built nesting and searches some food like insect or cherries fruit. High understory density were the guilds strongest correlated with nectarivores and omnivores. In addition, important to determining the distribution of

cherries fruit. High understory density were the guilds strongest correlated with nectarivores and omnivores. In addition, important to determining the distribution of birds is from the species composition of the vegetation. (Antongiovanni & Metzger, 2005; Borges & Stouffer, 1999; Stouffer & Bierregaard, 1995b; Terborgh, 1985).

Beside primary or secondary forest, rehabilitated forest also can give the same environment or more better to build population of birds. Micro-climatic conditions may also be important for certain birds population. Rehabilitation activities time by time is effort to help more birds to extend population in the forest. Pearman (2002) also stated because of elevated temperatures in second growth, probably for certain ant following insectivores, which appear to be restricted to primary forest.

CHAPTER III

METHODOLOGY

3.1 Study Area

Rehabilitated forest in UPM Bintulu, Sarawak Campus lies between the longitude 113° 05` 67`` east and the latitudes 03° 21` 07`` north. It is located within campus area in the Bintulu District of Sarawak state (Figure 1). Phase 1 and 2 were chosen as the study area (Figure 2). The area covers about 7.13 ha which has been rehabilitated with replanting program joint venture with Mitsubishi Cooperation since 1991. Many studies on wildlife such as bird and small mammal have been carried out in this area. Most of the area is still under primary forest and it forms a watershed area.

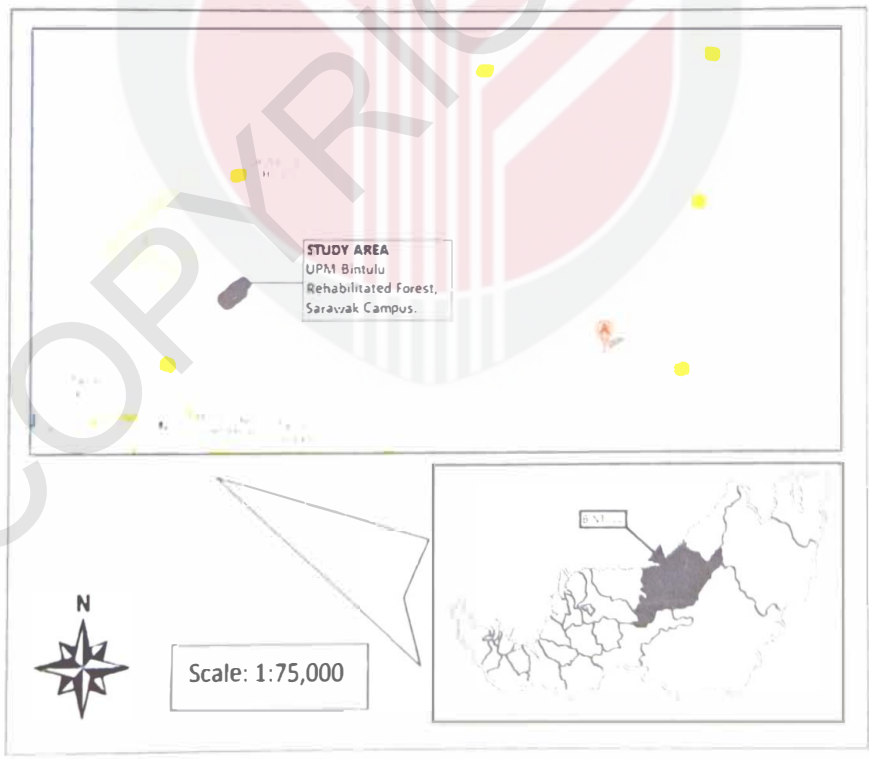

Figure 1: Map showing the location of UPM Bintulu Rehabilitated Forest, Sarawak Campus, Bintulu, Sarawak.

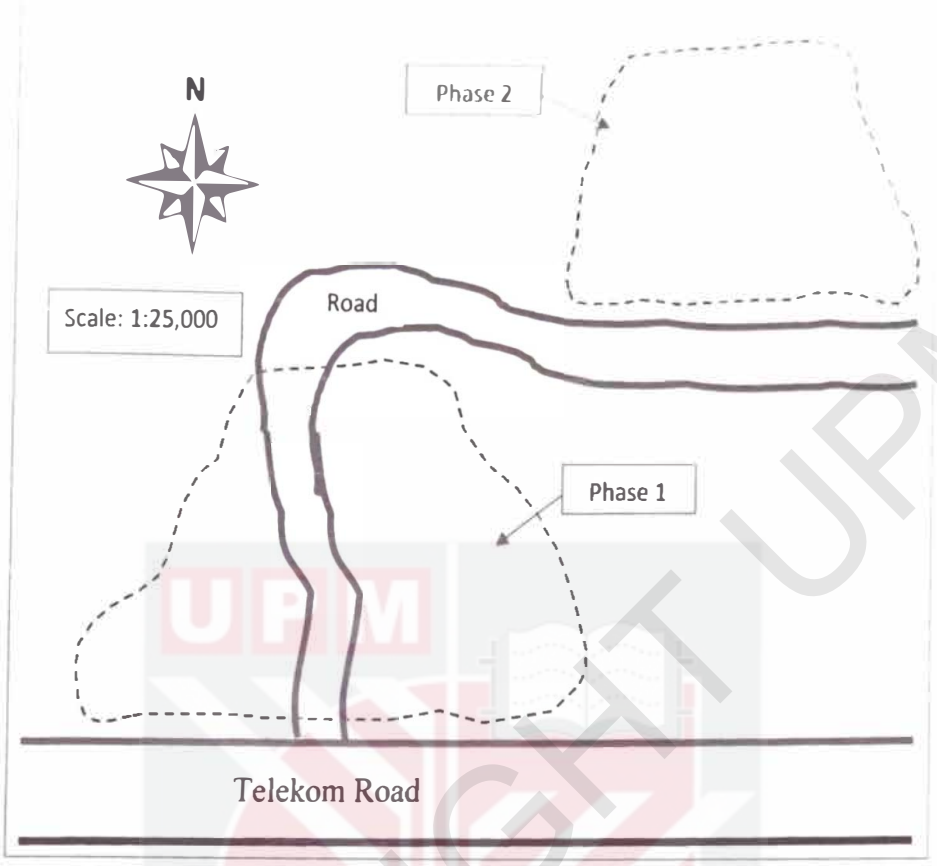

Figure 2: Location of the study area (Phase 1 and 2) in UPM Bintulu Rehabilitated Forest, Sarawak Campus.

3.2 Materials and Method

Mist-netting method was used to obtain the information on the understorey birds. Mist-netting was used in this study as understrorey birds such as babblers and spiderhunter were difficult to detect in the forest. When other methods such as the transect survey are used, bird cannot be detected successfully due to their color which allows camouflage in forest condition. Mist-netting method is commonly used in the tropical forest because of several advantages. According to Mason (1996), the mist net method does not rely on the assumption of territoriality, which is required in other procedures.

In addition, mist-netting is the only effective way to catch species that are shy or seldom give distinctive calls (Terbourgh & Weske, 1996) such as the birds found in the tropical forest of Malaysia. Fodgen (1972); Karr (1980); Pearson (1975); Well (1971); Wong (1986) also reported that mist-netting is also the most effective and widely used method for gathering quantitatively reliable data on forest understorey birds in the humid tropic.

3.2.1 Site Location and Sampling Point

A pre-survey on the area was carried out to establish understorey bird habitats before the net was set up. The term habitat implies the place where as organism live, and is described by its geographical, physica, edaphic (soil) and biotic (living) components (Chew, 1968).

The structure of the habitat, particularly the vegetation, is an important variable affecting wildlife species. The distribution of different types of habitats is complex and is influenced locally by such factors as topography, exposure, and drainage near to the water courses. Selection of the habitat is based on a field survey of the vegetation in the area, the climate, topography and flora that suitable for understorey birds. In this study, net were randomly placed in the study area. The distance between each net was at least 10 to 15 metres. The location of the selected habitats is shown in Figure 3.

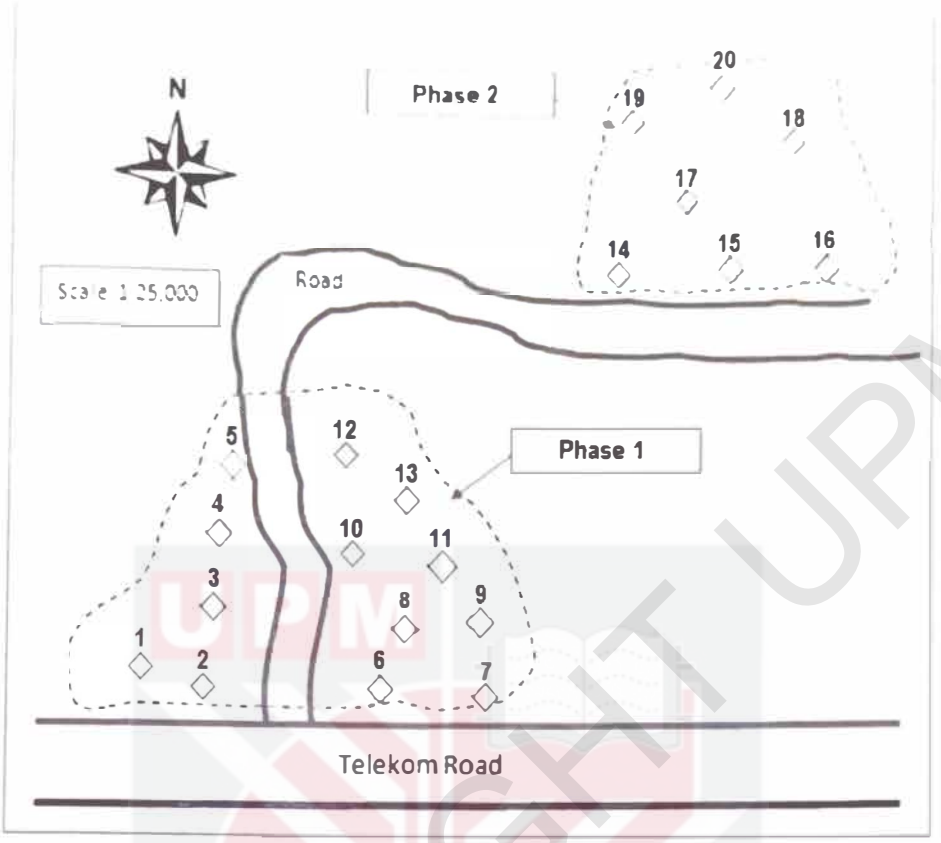

Figure 3: Location of point and mist nets was set up randomly.

3.2.2 Bird Netting

Standard mist nets each measuring 4.0 m x 10.0 m were used in this study. This standard length of 4.0m x 10.0m net was used because of several advantages, such as ease of handling and setting up in a small forest or habitat as well as ease to transferring from one sampling point to another.

The mesh size of the nets used was 2.0 cm, 2.5 cm, 3.0 cm. Before setting up the net, the surrounding area was cleared in order to remove branches and leaves that may be trapped under the net. The arrangement of the net was based on the methods used by Fodgen (1972); Karr (1980); Wong (1986), where the nets were placed at or

near the ground in linear sequences within the selected habitat. The nets were opened before sunrise (around 0700hr) and closed in the late evening (around 1800hr) depending on the weather. They were checked every two hours. Birds that were caught were carefully removed from the nets, placed in small sacks and brought to the base camp for identification. This study was carried out for three (3) month from January until March 2013.

3.2.3 Bird Identification

The information of bird caught during sampling was recorded in a 'Bird Ringing Record' form as shown in Appendix C. The birds were identified using the field guidebook of Birds of South-East Asia (Craig Robson, 2002) and A Photographic Guide to the Birds of Malaysia & Singapore (Periplus, 2002).

3.2.4 Data Analysis

All data recorded were pooled in the final analysis. The data was analysed using Canoco for Windows 4.5, Principal Component Analysis (PCA) methods including partial variants, with Monte Carlo permutation tests for constrained ordination methods.

CHAPTER IV

RESULTS

4.1 Species Composition of bird communities in a-21 years old rehabilitated forest

A total of 29 species from 473 individuals of rehabilitated forest birds were recorded in phase 1 and 2 for three (3) month. This figure (29 species) represented 5.27 percent of the total number of bird species in Sarawak, nearly 550 species, Madoc (1976). The number of species and individuals is shown in figure 4.

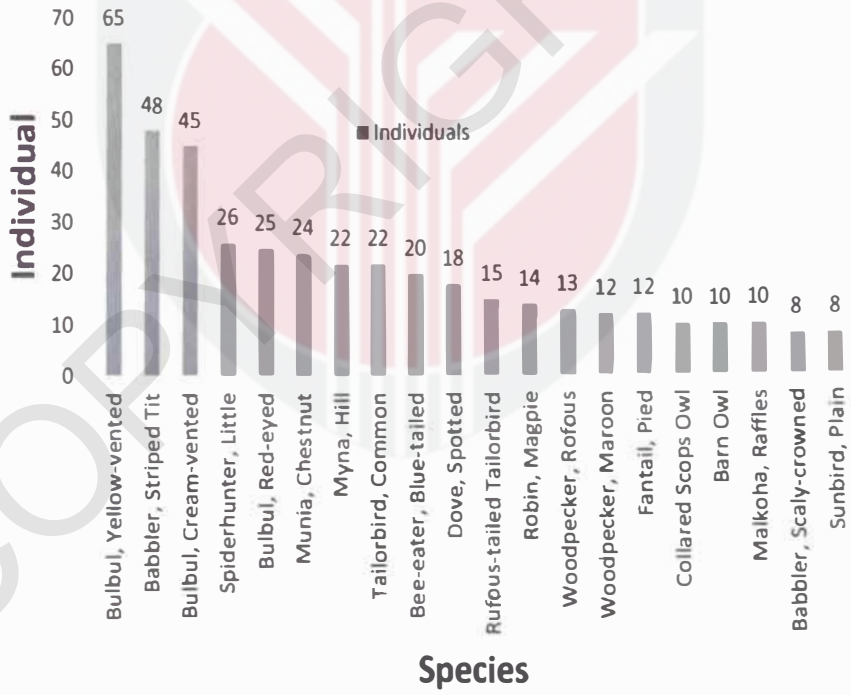

Figure 4: Number of species and individuals of rehabilitated forest birds captured in UPMKB Rehabilitated Forest, Bintulu, Sarawak.

The number of species based on family of rehabilitated forest birds that were netted in Phase 1 and 2 is shown in Table 1. Four families of birds showed the highest number in term of species composition. The largest family of rehabilitated forest birds netted was belongs to the Muscicapidae with 4 species (13.79 percent) followed by Timaliidae, Pycnonotidae, Dicaeidae with 3 species (10.34 percent). Other groups that were recorded made up less than 3 species each.

In term of the number of individuals, it is clearly shown in Table 2 that the Pycnonotidae family represented the high number of the individuals with 135 individuals (28.54 percent) followed by the Timaliidae with 60 individuals (12.68 percent) and Cisticolidae with 37 individuals (7.82 percent). The number of other species recorded was less than 35 individuals each.

The distribution of species abundance clearly showed that most of the species were present at high to low numbers (Table 3). Five most abundant species were belongs to Yellow-vented Bulbul, (65 individuals), Striped Tit Babbler, (48 individuals), Cream-vented Bulbul, (45 individuals), Little Spiderhunter, (26 individuals), Red-eyed Bulbul, (25 individuals). Other species were represented with less than 25 individuals each.

Table 1: Number of species and percentage of rehabilitated forest birds recorded for each family from highest to lowest number.

No.	Bird Population by Family	Number of Species	Percent
1	Muscicapidae	4	13.79
2	Timaliidae	3	10.34
3	Pycnonotidae	3	10.34
4	Dicaeidae	3	10.34
5	Cuculidae	2	6.90
6	Cisticolidae	2	6.90
7	Nectariniidae	2	6.90
8	Picidae	2	6.90
9	Tytonidae	1	3.45
10	Meropidae	1	3.45
11	Strigidae	1	3.45
12	Columbidae	1	3.45
13	Rhipiduridae	1	3.45
14	Alcedinidae	1	3.45
15	Estrildidae	1	3.45
16	Sturnidae	1	3.45
	Total	29	100.00

Table 2: Number of individual and percentage of rehabilitated forest birds recorded for each family from highest to the lowest number.

No.	Bird Population by Family	Number of Individual	Percent
1	Pycnonotidae	135	28.54
2	Timaliidae	60	12.68
3	Cisticolidae	37	7.82
4	Nectariniidae	34	7.19
5	Muscicapidae	28	5.92
6	Picidae	25	5.29
7	Estrildidae	24	5.07
8	Sturnidae	22	4.65
9	Meropidae	20	4.23
10	Columbidae	18	3.81
11	Cuculidae	17	3.59
12	Dicaeidae	16	3.38
13	Rhipiduridae	12	2.54
14	Tytonidae	10	2.11
15	Strigidae	10	2.11
16	Alcedinidae	5	1.06
	Total	473	100.00

Table 3: Ranking of the most abundant species in rehabilitated forest bird

No.	Species	Number of Individuals
1	Bulbul, Yellow-vented	65
2	Babbler, Striped Tit	48
3	Bulbul, Cream-vented	45
4	Spiderhunter, Little	26
5	Bulbul, Red-eyed	25
6	Munia, Chestnut	24
7	Myna, Hill	22
8	Tailorbird, Common	22
9	Bee-eater, Blue-tailed	20
10	Dove, Spotted	18
11	Rufous-tailed Tailorbird	15
12	Robin, Magpie	14
13	Woodpecker, Rofous	13
14	Woodpecker, Maroon	12
15	Fantail, Pied	12
16	Collared Scops Owl	10
17	Barn Owl	10
18	Malkoha, Raffles	10
19	Babbler, Scaly-crowned	8
20	Sunbird, Plain	8
21	Flycatcher, Asian Brown	8
22	Flowerpecker, Scarlet-breasted	7
23	Coucal, Greater	7
24	Flowerpecker, Plain	6
25	Kingfisher, Rufous-backed	5
26	Flycatcher, Brown-chested	5
27	Babbler, Short-tailed	4
28	Flowerpecker, Yellow-breasted	3
29	White-rumped Shama	1
	Total	473

This study shows that each point has a different of bird species and the number of individuals as indicated in Table 4. The differences are very significant in the number of bird species and individuals in Phase 1 and 2 and total of bird species is more in Phase 1 compared to Phase 2. There are 12 points in Phase 1 and 8 points in phase 2 with different forest conditions.

In Phase 1, each point has more than 10 species and 20 individuals of birds. It was different with point in Phase 2 where each point has not more than 5 species and not more than 6 individuals at each point. The higher bird species and individual in this area is due to the factor of the area itself. Based on the observation, Phase 1 has more food sources and suitable environment compared with Phase 2 which is not suitable for bird communities and lack of food sources.

Point with the highest number of bird species is points 3. The point has 21 bird species, followed by point 12 with 19 bird species and 18 species in points 6. In tenns of the number of individual, point that has the highest individual is point 3 with 55 individual. Followed by point 1 and 8 with 42 individuals and point 9 with 40 individuals.

Table 4: Summarise of birds recorded in each point.

Point	Number of Species	Number of Individuals
1	16	42
2	16	34
3	21	55
4	15	34
5	14	32
6	18	36
7	15	34
8	17	42
9	15	40
10	16	31
11	15	34
12	19	26
13	2	2
14	2	2
15	5	6
16	5	5
17	5	5
18	4	5
19	4	4
20	4	4

Composition of the Rehabilitated forest Bird in UPM Bintulu Campus based on PCA analysis.

The summary of PCA ordination for rehabilitated forest bird species for different point from the forest, (Table 5) using Monte Carlo Stimulations under 449 permutations test showing that 100% of the total variation of species data in the region. The first two axes of species data were accounted for 54.2% and 64.7% of the variation respectively.

Table 5: Summary table of PCA ordination for rehabilitated forest bird

Term	Axis				
	1	2	3	4	Total variance
Eigenvalues :	0.542	0.104	0.071	0.066	1.000
Cumulative percentage Variance of species data :	54.2	64.7	71.7	78.3	
Sum of all eigenvalues					1.000

Result of the PCA ordination diagram (Figure 5) showed that most of the bird species were scattered along the Phase 1 and 2. The Yellow-vented Bulbul, Striped Tit Babbler, and Cream-vented Bulbul, were observed at high number at the Phase 1. The Collared Scops Owl, Hill Myna, and Scaly-crowned Babbler, were observed at high number at the Phase 2 (Table A2 and A3: Appendix A).

In this study, many of bird species were scatted at point 3, such as; Bulbul, Yellow-vented (*Pycnonotus goiavier*), Babbler, Striped Tit (*Macronus gularis*), Myna, Hill (*Gracula religiosa*), Bulbul, Red-eyed (*Pycnonotus brunneus*), Munia, Chestnut (*Lonchura atricapilla*), Robin, Magpie (*Copsychus saularis*), and Tailorbird, Common (*Orthotomus sutorius*). The Bulbul, Cream-vented (*Pycnonotus*

simplex) was strongly correlated with Point 7, while the Bulbul, Yellow-vented (Pycnonotus goiavier), Babbler, Striped Tit (*Macronus gularis*) and Tailorbird, Common (*Orthotomus sutorius*) was strongly correlated with Point 1.

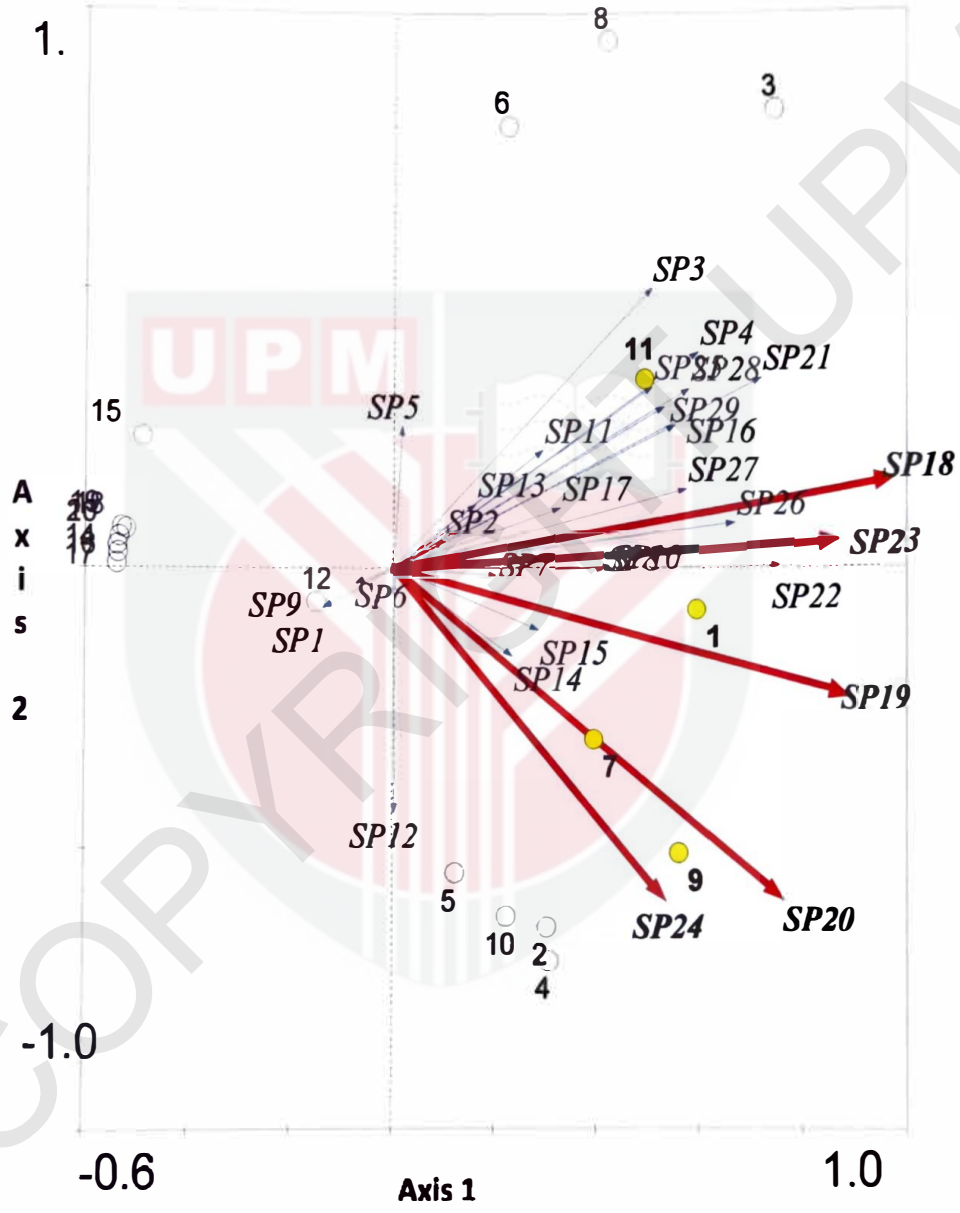

Figure 5: Ordination diagram of the two axes of PCA for the rehabilitated forest bird species. The constrained ordination of PCA accounted for about 100% of the total variation in the region. Axes 1 and 2 accounted for 54.2% and 64.7% of the variance in species data. Bird's species variables are represented by red arrows pointing in the direction of increasing values for tha variable. Respone variables: SP1 (Babbler, Scaly-crowned), SP2 (Babbler, Short-tailed), SP3 (Spiderhunter, Little), SP4 (Woodpecker, Rofous), SP5 (Kingfisher, Rufous-backed), SP6 (Collared Scops Owl), SP7 (Barn Owl), SP8 (Rufous-tailed Tailorbird), SP9 (White-rumped Shama), SP10 (Sunbird, Plain), SP11 (Flycatcher, Asian Brown), SP1 2 (Flowerpecker, Plain), SP13 (Flowerpecker, Scarlet-breasted), SP14 (Flycatcher, Brown-chested), SP15 (Flowerpecker, Yellow-breasted), SP16 (Bee-eater, Blue-tailed), SP17 (Myna, Hill), SP18 (Bulbul, Yellow-vented), SP19 (Babbler, Striped Tit), SP20 (Bulbul, Cream-vented), SP21 (Bulbul, Red-eyed), SP22 (Munia, Chestnut), SP23 (Tailorbird, Common), SP24 (Dove, Spotted), SP25 (Robin, Magpie), SP26 (Woodpecker, Maroon), SP27 (Fantail, Pied), SP28 (Malkoha, Raffles), SP29 (Coucal, Greater). Point variables: P1 (Point 1), P2 (Point 2), P3 (Point 3), P4 (Point 4), P5 (Point 5), P6 (Point 6), P7 (Point 7), P8 (Point 8), P9 (Point 9), P10 (Point 10), P11 (Point 11), P12 (Point 12), P13 (Point 13), P14 (Point 14), P15 (Point 15), P16 (Point 16), P17 (Point 17), P18 (Point 18), P19 (Point 19), P20 (Point 20).

CHAPTER V

DISCUSSION

5.1 Composition of Bird Community in Rehabilitated Forest

Result of the study conducted in phase 1 and 2, UPMKB Rehabilitated Forest had recorded a total of 473 individual birds. The study indicated that phase 1 and 2 contained higher number of bird species (29 species). Total bird species and the number of bird individuals show that most of bird forage at that area probably because of the microclimate condition and may have used the rehabilitated area as a feeding site or just flew through the area. A study conducted by Kritzinger and Van Aarde (1998), showed that bird species richness in forest area does not increase with habitat age. Rehabilitated forest indicates the effort to built richness of species and number of individuals in forest area. Furthermore, rehabilitation is seen as the strategies to minimising biodiversity loses and aim to provide habitat for fauna especially on establishing vegetation (Gould, 2010).

From the result of the study, it was clear that there were three groups of bird species showed differences in terms of species composition and the number of individuals. The group of bulbuls showed a highest number of individuals with a total number of 135 individuals (28.54 percent from the total of individuals netted) from 3 species (Cream-vented Bulbul, Red-eyed Bulbul, Yellow-vented Bulbul) followed by the babblers with a total number of 60 individuals (12.68 percent from the total of individuals netted) from 3 species (Scaly-crowned Babbler, Short-tailed Babbler, Striped Tit Babbler) and the tailorbirds with a total number of 37

individuals (7.82 percent from the total of individuals netted) from 2 species (Common Tailorbird, Rufous-tailed Tailorbird).

In terms of species composition, the most abundant species which dominated the rehabilitated forest was the Yellow-vented Bulbul with a total number of 65 individuals (13.74 percent from the total of individuals netted) followed by Striped Tit Babbler with a total number of 48 individuals (10.15 percent from the total of individuals netted) and Cream-vented Bulbul, with a total number of 45 individuals (9.51 percent from the total of individuals netted).

Besides that, bulbul species also showed that these species were found abundantly in rehabilitated forest. Although the area was considered as rehabilitated forest when the study began, the microclimate was still different compare to a primary forest (Zakaria & Mat Desa, 2001). Moreover, Bulbul can survive in great numbers because they were tolerant of open areas and are able to feed on insect and small fruit which is abundant in such area.

The destruction of their natural habitat will affect the understorey bird population and survival because the ability of this bird to survive in rehabilitated forest depends on the mosaic of vegetation remnants and suitable environment. Even though secondary trees such as *Macaranga spp.* and thick shrubs may have grown, patches of large gaps are still presence (Lambert, 1992). Babbler needs a suitable environment such as humid microclimate with moderate temperature, low light intensity, good forest cover, sufficient regeneration and food for their survival.

From the study conducted at Phase 1 and 2, it was found that the number of individuals is different in both areas. Most of the birds are dominated at Phase 1 with

442 individuals and only half of them were found at Phase 2 with 31 individuals. This was probably due to composition of vegetations and tree species at the area which are suitable for the species to forage and searching their food. Based on the observation, Phase 1 is more compact than Phase 2 with vegetation and tree species. Because of these, most of bird species can be seen at Phase 1 compared to Phase 2. Based on age of the study area, both of the area is enough to increase the richness in bird species. According to Gould (2010), rehabilitation age of forest influence the increasing bird species richness and mean bird abundance.

According to Karr and Freemark (1983), one of the main factors to be considered in shaping bird communities is vegetation structure. In terms of surrounding factors, based on observation at Phase 1 and 2; Phase 1 can be categorized as a secondary forest. It is different from Phase 2, where this area cannot be categorized as secondary forest because it is an open area and less of vegetation and tree species. Bird communities are less at this area. Studies carried out by Borges (2007) also showed secondary forest is often located on the borders between undisturbed forest and human-dominated landscapes.

In this study, other understorey bird likes cuckoo, kingfisher, shama, and woodpecker group did not show any significant difference ($P>0.01$) in terms of species composition and the number of individuals. This was probably due to the difficulties of these species to adapt in the rehabilitated forest conditions.

5.2 Effect of Rehabilitation on Trophic Structure and Feeding Guild of Understorey Bird

Rehabilitation of forest changes the trophic structure and feeding guild of the understorey birds. It had positive and negative impact on certain bird species. The species composition and the number of individuals may increase or decrease. It has been suggested that these changes may be due to the changes in the microclimate condition (temperature, light intensity and humidity). Large gaps may increase the temperature and light intensity but lower the humidity. The large gaps may affect the population of the understorey bird species and change their trophic structure and feeding guild (Johns, 1983a).

5.3 Effect of changes in Vegetation and Microclimate on Birds Species

Rehabilitation generates a variety changes in the physical environment, microclimate, soil, water and nutrients. The regenerated forest also tends to dry and hot in the afternoon with increased light intensity (Johns, 1997). Rehabilitation also predictably causes disturbance to the soil surface and to the remaining vegetation. This study has shown that the condition of vegetation and microclimate at two different location were significant. In the tropical forests, plant species richness is correlated with the range of microhabitats available (Johns, 1997). It has been suggested that the rehabilitated forest may have impacts on microhabitats, at least in early regeneration stages, which should also reduce the species richness of both plant and folivorous insect (Zakaria & Nordin, 1997).

Lynch and Whigham (1984) emphasised the importance of vegetation characteristic in predicting the abundance of forest birds. Vegetation complexity is clearly associated with the structure of avian community (Wilson, 1974). As structure complexity of habitat increases, the number of bird species also increases (MacArthur & MacArthur, 1961; MacArthur, *et. al.*, 1966; Karr, 1968; 1971; Racher, 1969).

There may be other unknown factors which could also influence the bird species composition in both forest sites. Nesting sites may have been damaged or reduce during rehabilitation activities. Rate of predation may have also increased in the rehabilitated forest as the area was more open (less cover) and prey could be easily detected (Zakaria & Mat Desa, 2001). It is interesting to note that even in primary forest, the colonising species such as bulbuls and spiderhunters were also common (Zakaria & Nordin, 2000b). It is difficult to assess why there were many colonising birds in the primary forest. One of the possibilities is that the primary forest surrounded the rehabilitated forest. Thus, the colonising species may have used the area as a feeding site or just flew through the area.

CHAPTER VI

CONCLUSION

This study conducted indicated that rehabilitated forest could change the bird species composition and the number of individuals in the forest. The results showed that richness of bird species and individual can increase when the area is tending to be a secondary forest. The significant different can be seen of bird species and individuals at different area. The insectivorous birds suffered more from the effects of habitat disturbance when compared to frugivore birds (John, 1983a; b; c).

The changes in the vegetation and microclimate immediately in early stage forming rehabilitated forest had affected the population of understorey insectivorous species because these birds were not tolerant of the temperature and increase and were not able to survive in the rehabilitated forest. They required a suitable environment and climate to survive. However, some species such as understorey insectivores/frugivores may benefit from the clearing forest activity. These species are not affected by the changes in microclimate as they appear to tolerate extreme temperatures. They are also capable of changing their diet from insect to small fruits available in abundance on the secondary plants found in the rehabilitation area.

Populations of animals especially mammals and avians, have been found to greatly reduce in number as a result of the changes in microclimate (Johns, 1983). Understorey and canopy birds restricted their spatial and temporal activities when the temperature in the forest increased (Bell, 1982c; Wong, 1982). The foraging heights of many understorey birds were decreased greatly with the change in forest structure.

Johns (1987) reported that increased penetration of sunlight in rehabilitated forests caused an increase in temperature and decreasing the humidity. Changes in the abundance of understorey birds species may be affected by the changes in food availability, microclimate or other environmental conditions. Rehabilitation rarely eliminates species, especially where damage levels are low, but considerable changes may occur in the relative abundance of species.

Although many species of birds forage rehabilitated forest, it cannot, in its present state, be regarded as a place for bird conservation. At this point very little, is known about the ability of bird to survive and breed successfully in the rehabilitated forest. Many species may still depend largely on the nearby virgin forest for roosting and breeding. Only the virgin provides the requirements to allow a wide range of species to survive and breed successfully.

Generally, studied have shown that certain species especially babbler and flycatcher, were increase significantly in a-21 year old rehabilitated forest. However, the bulbul and spiderhunter species also significantly increased in this forest. The changes microclimate (temperature and humidity) and over-exposure of canopy cover were the factors that caused the changes in species composition and individuals. Hence, the findings from this study can be used to provide information and serve as a guide for further studies on the composition of wildlife especially on bird species.

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APPENDIX A

Table A1: List of species and the total number of individuals

FAMILY Species Common Name	Individuals
ALCEDINIDAE	
Ceyx rufidorsa (Kingfisher, Rufous-backed)	5
CISTICOLIDAE	
Orthotomus sutorius (Tailorbird, Common)	22
Orthotomus sericeus (Tailorbird, Rufous-tailed)	15
COLUMBIDAE	
Spilopelia chinensis (Dove, Spotted)	18
CUCULIDAE	
Centropus sinensis (Coucal, Greater)	7
Rhinortha chlorophaea (Malkoha, Raffles)	10
DICAEIDAE	
Dicaeum minullum (Flowerpecker, Plain)	6
Prionochilus thoracicus (Flowerpecker, Scarlet-breasted)	7
Prionochilus maculatus (Flowerpecker, Yellow-breasted)	3
ESTRILDIDAE	
Lonchura atricapilla (Munia, Chestnut)	24

(continued)

MEROPIDAE	
Merops philippinus (Bee-eater, Blue-tailed)	20
MUSCICAPIDAE	
Muscicapa latirostris (Flycatcher, Asian Brown)	8
Rhinomyias brunneata (Flycatcher, Brown-chested)	5
Copsychus saularis (Robin, Magpie)	14
Copsychus malabaricus (White-rumped Shama)	1
NECTARINIIDAE	
Arachnothera longirostra (Spiderhunter, Little)	26
Anthreptes simplex (Sunbird, Plain)	8
PICIDAE	
Blythipicus rubiginosus (Woodpecker, Maroon)	12
Celeus brachyurus (Woodpecker, Rofous)	13
PYCNONOTIDAE	
Pycnonotus simplex (Bulbul, Cream-vented)	45
Pycnonotus brunneus (Bulbul, Red-eyed)	25
Pycnonotus goiavier (Bulbul, Yellow-vented)	65
RHIPIDURIDAE	
Rhipidura javanica (Fantail, Pied)	12
STRIGIDAE	
Otus bakkamoena (Collared Scops Owl)	10

(continued)

STURNIDAE	
Gracula religiosa (Myna, Hill)	22
TIMALIIDAE	
Malacopteron cinereum (Babbler, Scaly-crowned)	8
Malacocincla malaccensis (Babbler, Short-tailed)	4
Macronus gularis (Babbler, Striped Tit)	48
TYTONIDAE	
Tyto alba (Barn Owl)	10

Table A2: List of species and the total number of individuals along the Phase 1.

No.	Species	Individuals
1	Bulbul, Yellow-vented	65
2	Babbler, Striped Tit	48
3	Bulbul, Cream-vented	45
4	Bulbul, Red-eyed	25
5	Spiderhunter, Little	24
6	Munia, Chestnut	24
7	Tailorbird, Common	22
8	Bee-eater, Blue-tailed	18
9	Myna, Hill	18
10	Dove, Spotted	18
11	Robin, Magpie	14
12	Rufous-tailed Tailorbird	13
13	Woodpecker, Rofous	12
14	Woodpecker, Maroon	12
15	Fantail, Pied	12
16	Malkoha, Raffles	10
17	Barn Owl	7
18	Sunbird, Plain	7
19	Coucal, Greater	7
20	Collared Scops Owl	6
21	Flycatcher, Asian Brown	6
22	Babbler, Scaly-crowned	5
23	Flowerpecker, Scarlet-breasted	5
24	Babbler, Short-tailed	4
25	Flowerpecker, Plain	4
26	Flycatcher, Brown-chested	4
27	Kingfisher, Rufous-backed	3
28	Flowerpecker, Yellow-breasted	3
29	White-rumped Shama	1
	Total	442

Table A3: List of species and the total number of individuals along the Phase 2.

No.	Species	Individuals
1	Collared Scops Owl	4
2	Myna, Hill	4
3	Babbler, Scaly-crowned	3
4	Barn Owl	3
5	Spiderhunter, Little	2
6	Kingfisher, Rufous-backed	2
7	Rufous-tailed Tailorbird	2
8	Flycatcher, Asian Brown	2
9	Flowerpecker, Plain	2
10	Flowerpecker, Scarlet-breasted	2
11	Bee-eater, Blue-tailed	2
12	Woodpecker, Rofous	1
13	Sunbird, Plain	1
14	Flycatcher, Brown-chested	1
	Total	31

APPENDIX B

The number of species and individuals that were captured based on point is shown in figure B1 to B20 arrange from point 1 to point 20.

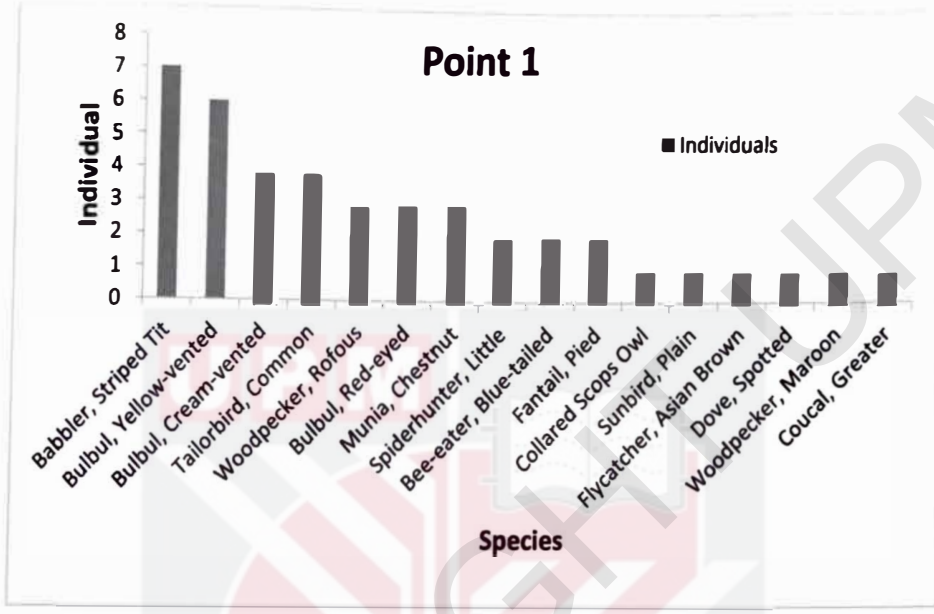

Figure B1: Total number of species is 16 and total number of individuals is 42 in point 1.

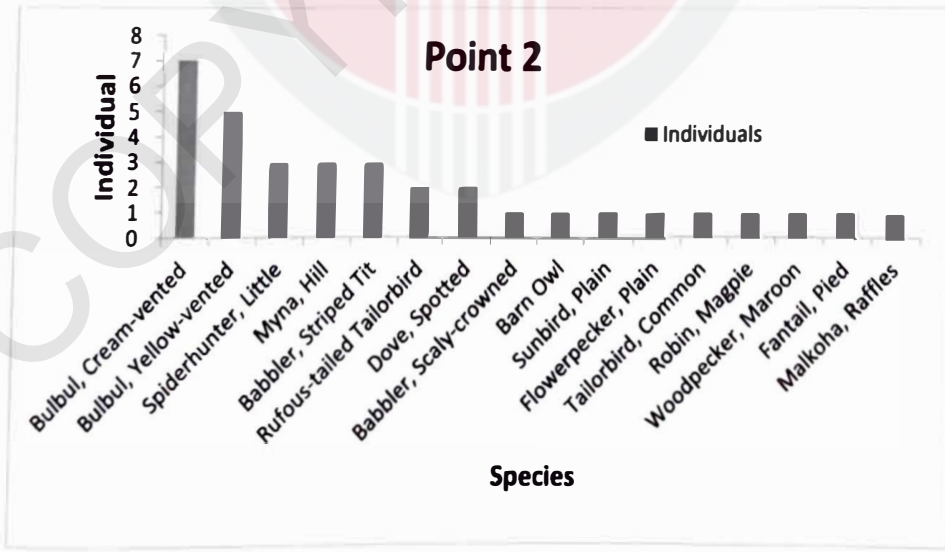

Figure B2: Total number of species is 16 and total number of individuals is 34 in point 2.

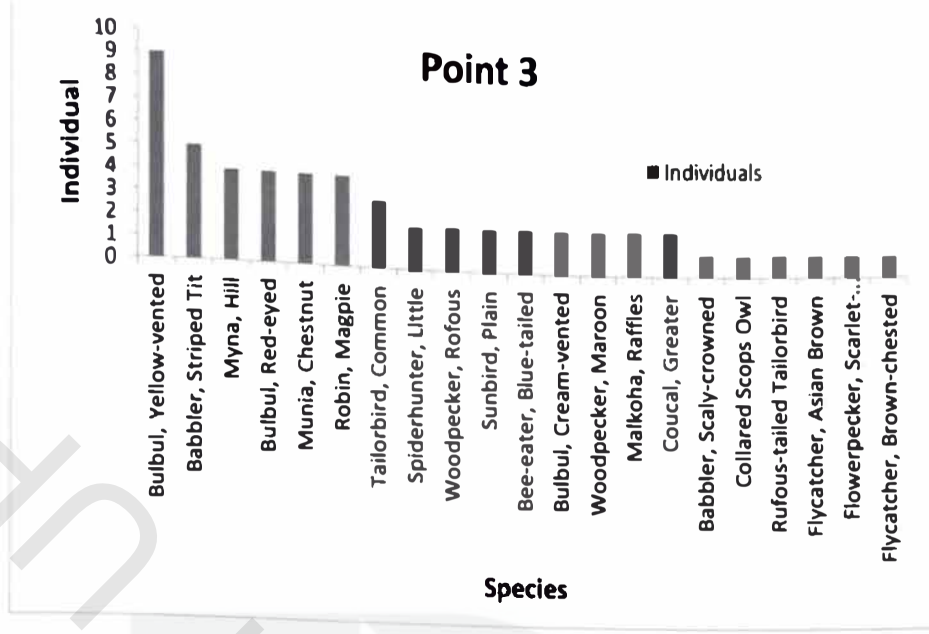

Figure B3: Total number of species is 21 and total number of individuals is 55 in point 3.

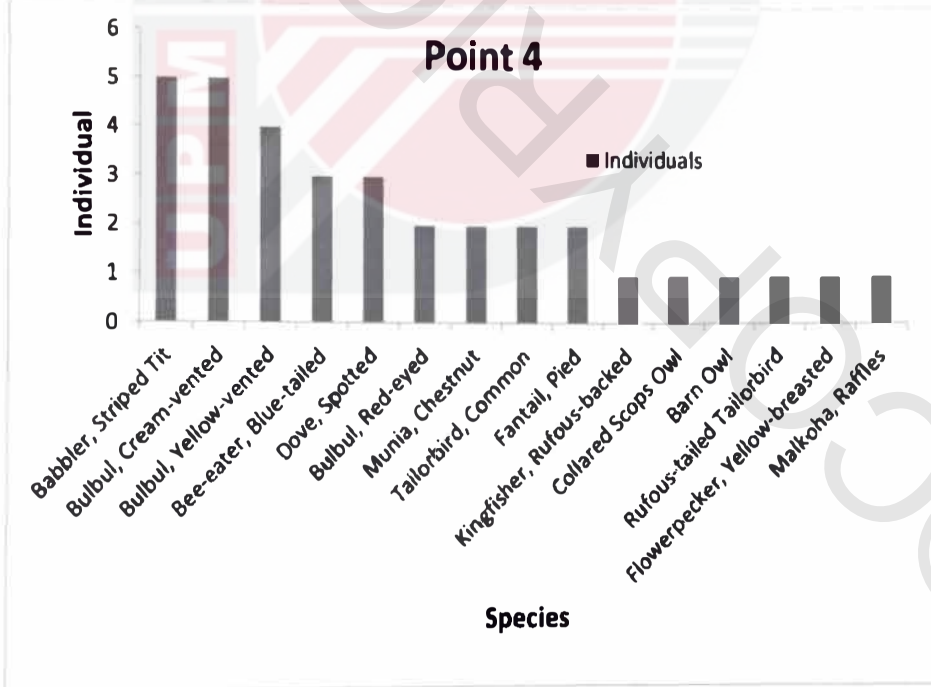

Figure B4: Total number of species is 15 and total number of individuals is 34 in point 4.

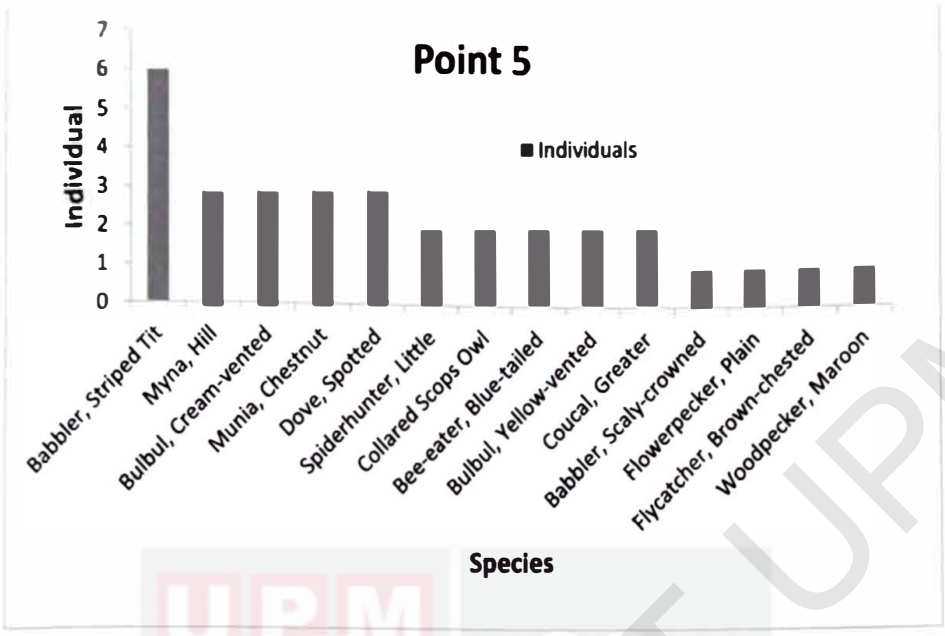

Figure B5: Total number of species is 14 and total number of individuals is 32 in point 5.

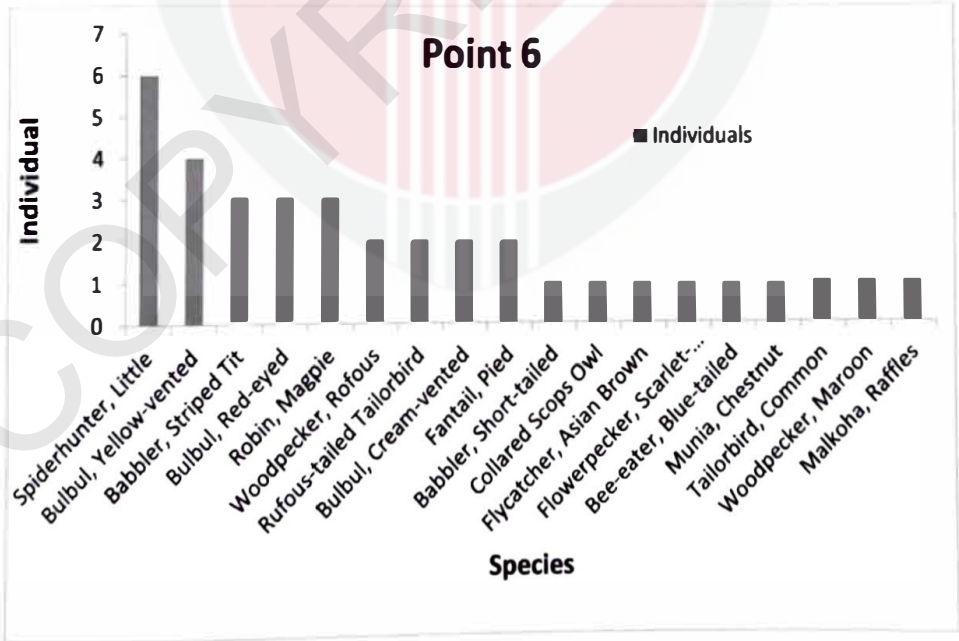

Figure B6: Total number of species is 18 and total number of individuals is 36 in point 6.

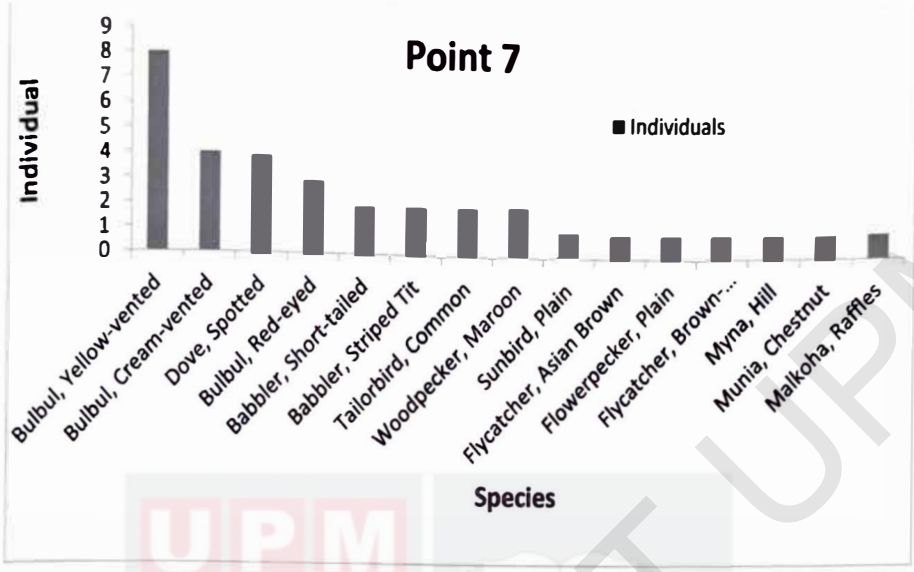

Figure B7: Total number of species is 15 and total number of individuals is 34 in point 7.

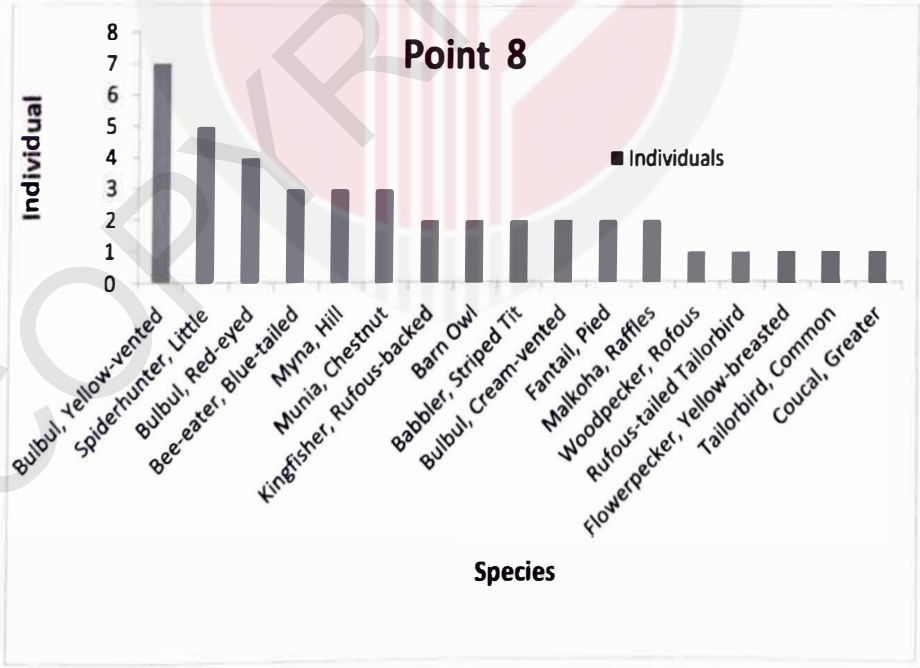

Figure B8: Total number of species is 17 and total number of individuals is 42 in point 8.

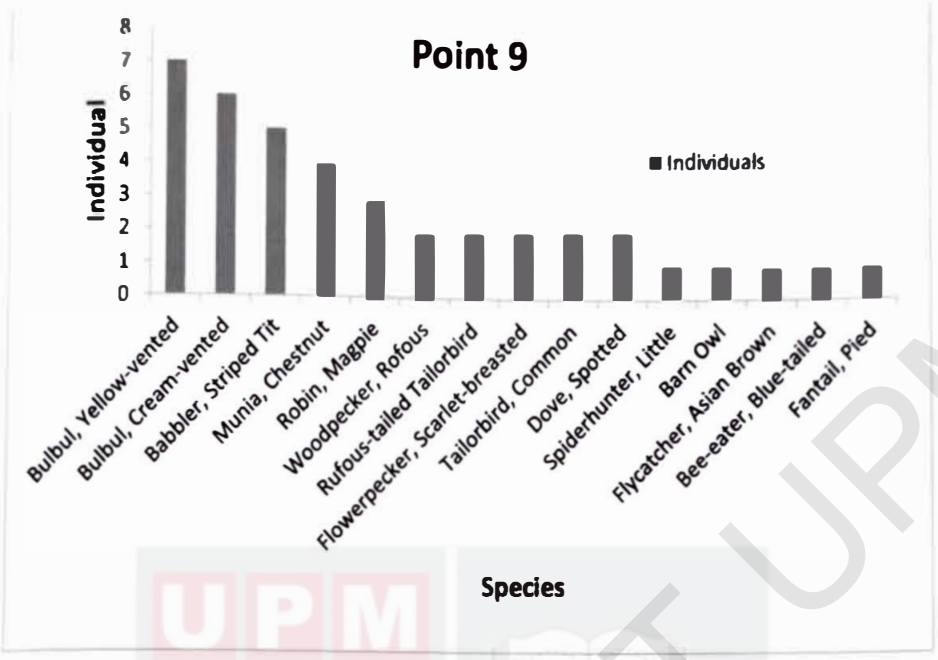

Figure B9: Total number of species is 15 and total number of individuals is 40 in point 9.

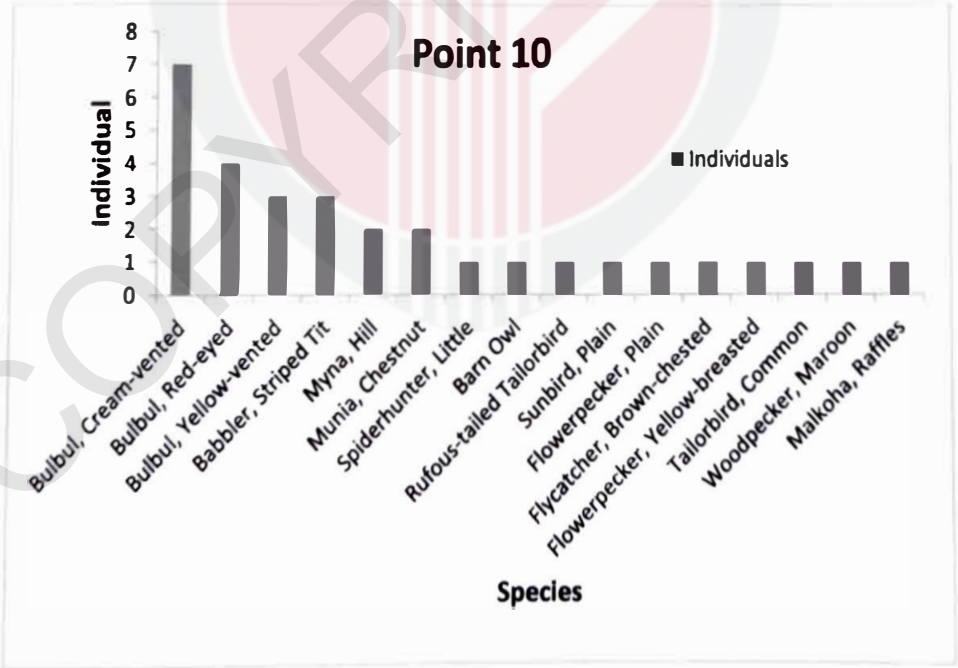

Figure B10: Total number of species is 16 and total number of individuals is 31 in point 10.

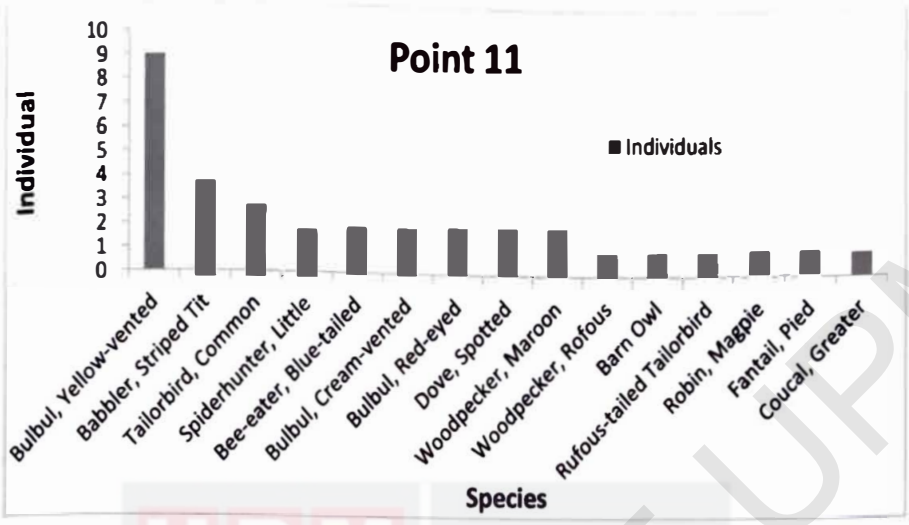

Figure B11: Total number of species is 15 and total number of individuals is 34 in point 11.

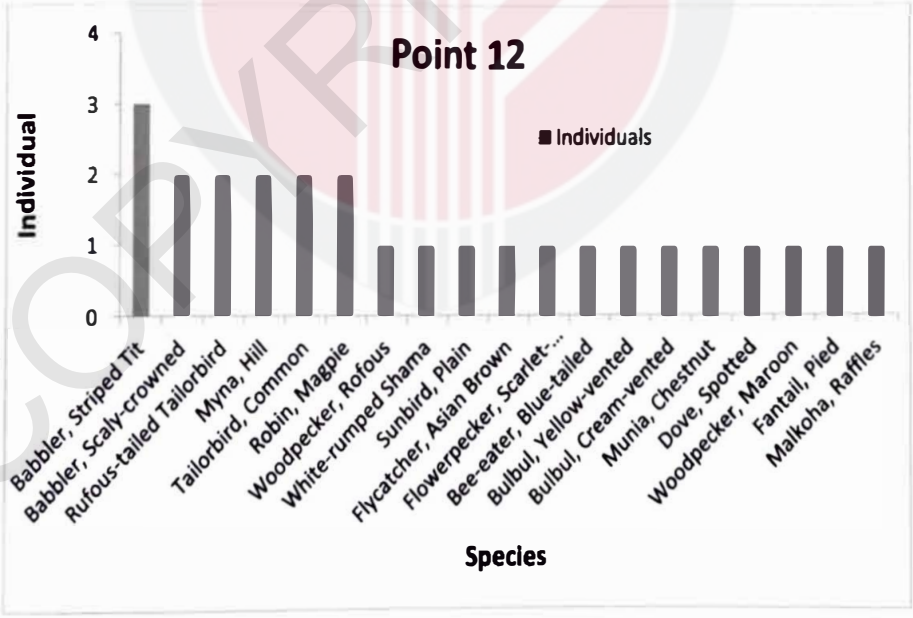

Figure B12: Total number of species is 19 and total number of individuals is 26 in point 12.

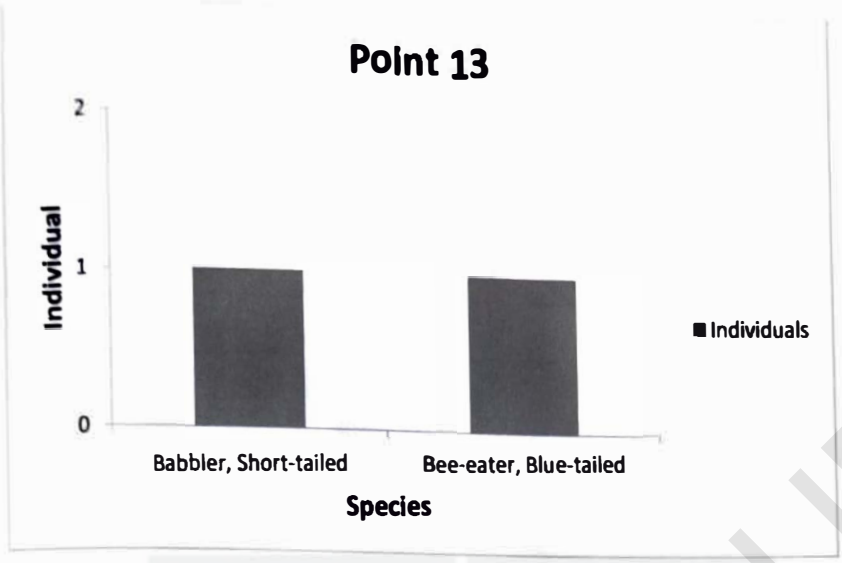

Figure B13: Total number of species is 2 and total number of individuals is 2 in point 13.

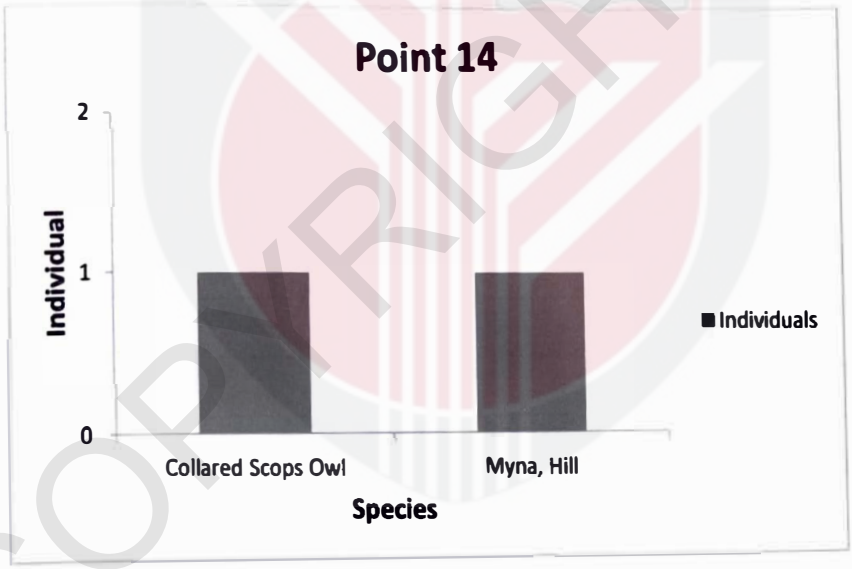

Figure B14: Total number of species is 2 and total number of individuals is 2 in point 14.

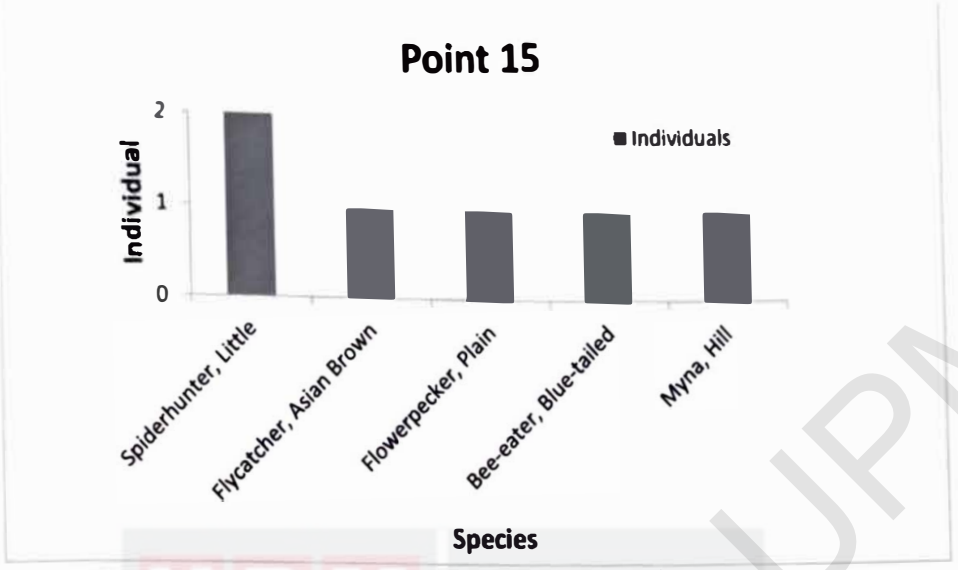

Figure B15: Total number of species is 5 and total number of individuals is 6 in point 15.

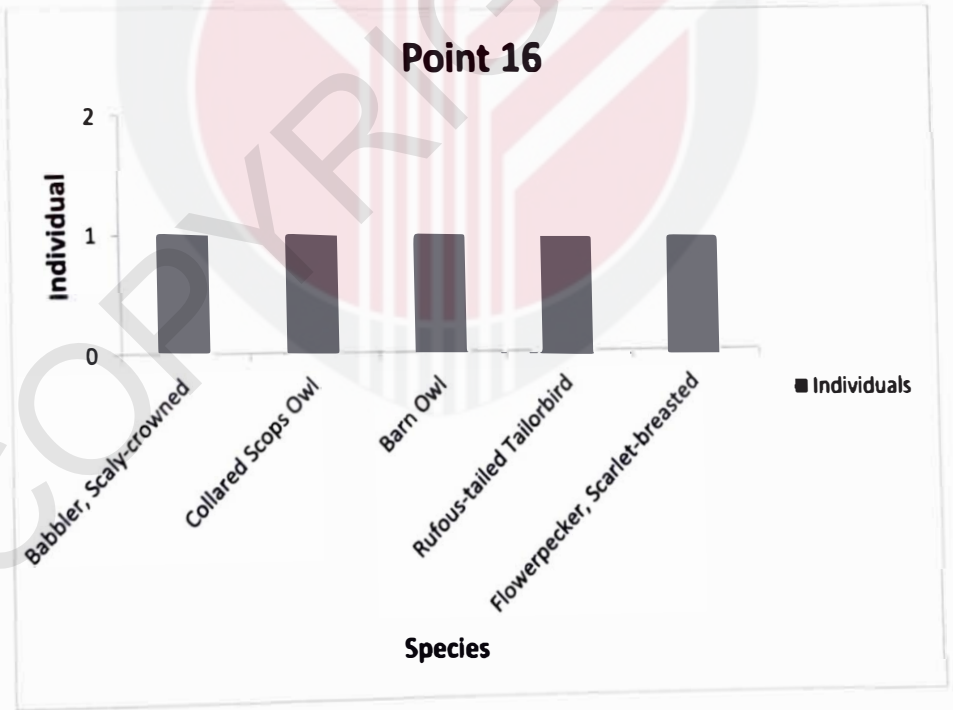

Figure B16: Total number of species is 5 and total number of individuals is 5 in point 16.

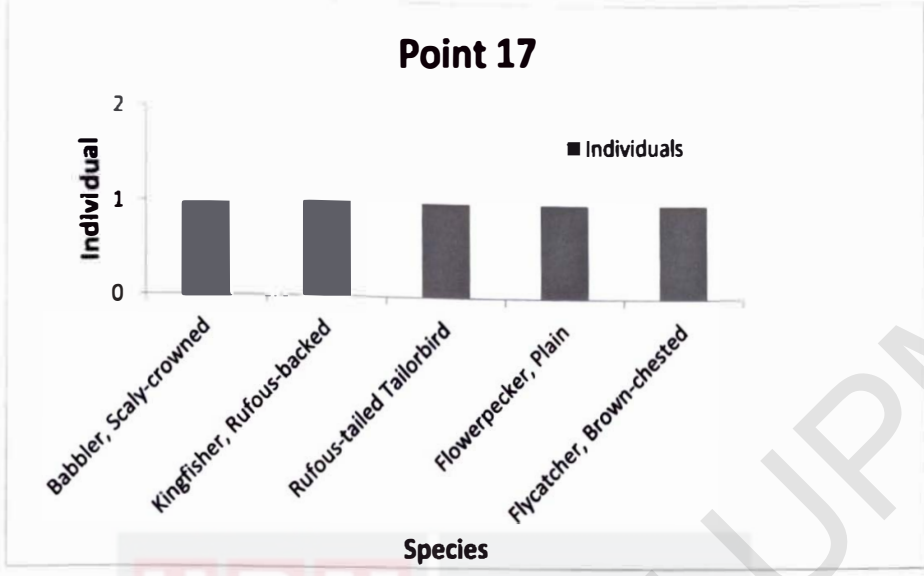

Figure B17: Total number of species is 5 and total number of individuals is 5 in point 17.

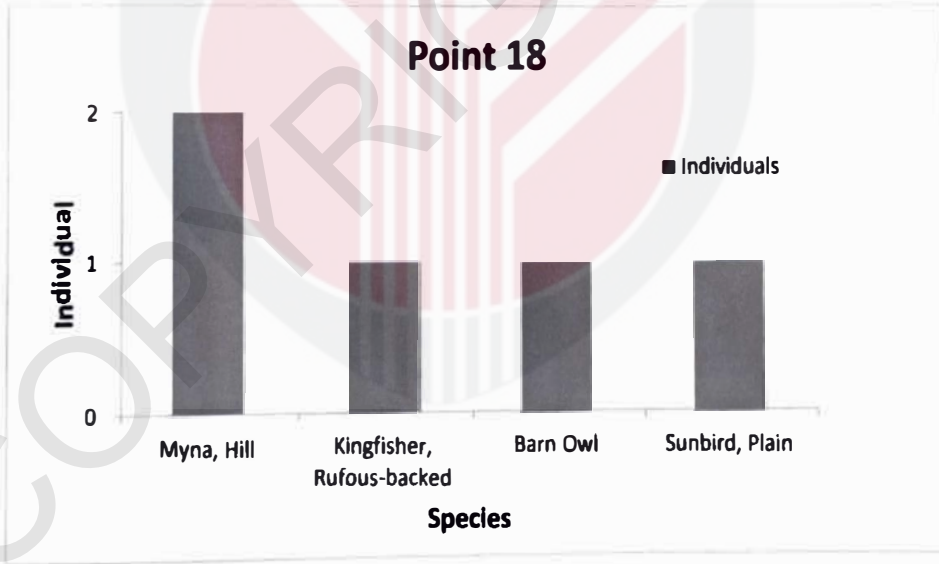

Figure B18: Total number of species is 4 and total number of individuals is 5 in point 18.

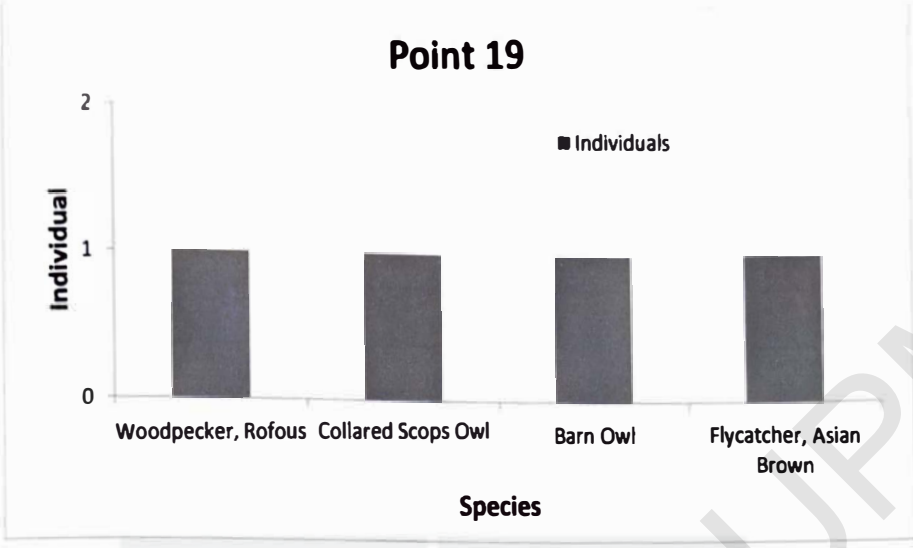

Figure B19: Total number of species is 4 and total number of individuals is 4 in point 19.

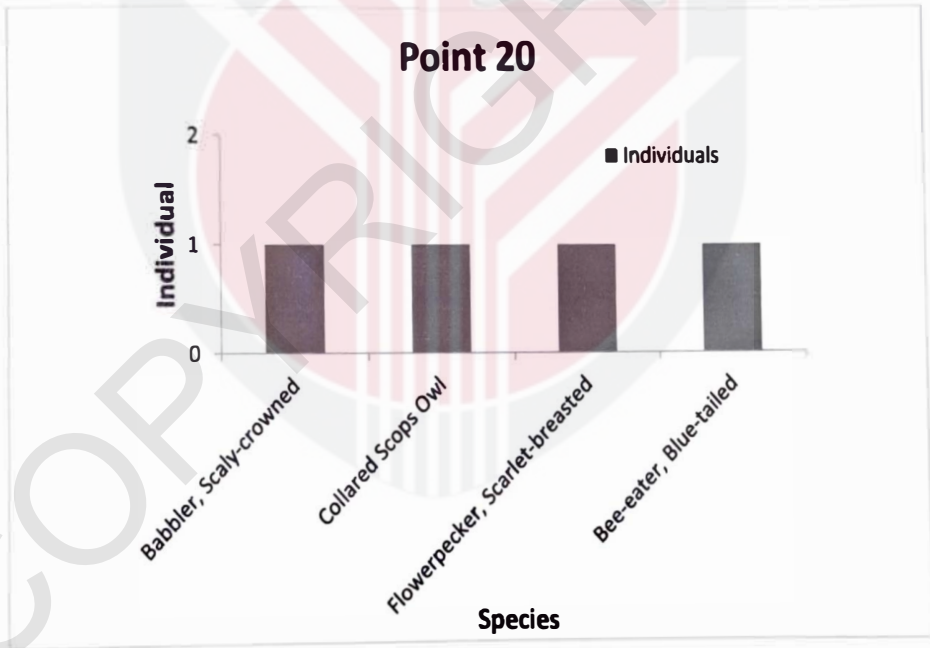

Figure B20: Total number of species is 4 and total number of individuals is 4 in point 20.

APPENDIX C

Table C1: An example of a bird ringing record

Bird Ringing Record

Worksheet No : 1…..

Date : 27.01.2013

Study Site : Bintulu

Location : UPM Bintulu Campus

Phase : 1 / 2

Ring No.	Species	Time	Sex	Age	Net No.	Wing Right (mm)	Tail (mm)	Tarsus Right (mm)	Bill (mm)			Weight (gm)
									G	W	C	
1	Woodpecker, Rofous	7.00 am			2							
2	Collared Scops Owl	8.30 am			4							
3	Barn Owl	10.00 am			7							
4	Flycatcher, Asian Brown	4.00 pm			3							

PUBLICATION OF THE PROJECT UNDERTAKING

This study is to certify that I have no objection to publish the project entitles **"Composition of Bird Communities in A 21-Year-Old Rehabilitated Forest in UPM Bintulu, Sarawak Campus"** by supervisor in a joint authorship. However, it has to be evaluated by the Faculty of Agriculture and Food Science, University Putra Malaysia Bintulu Sarawak Campus and published in the form approved by the faculty.

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Mohammad Hisyam Izairie bin Abu Bakar

Date: 01 07 2013