COMPARATIVE DIVERSITY AND ABUNDANCE OF BIRDS AT JELI, KELANTAN.

by

AHMAD FARIS ISKANDAR BIN AHMAD REDZUAN
E21A0442

A report submitted in fulfillment of the requirements for the degree of Bachelor of Applied Science (Natural Resources) with Honours

FACULTY OF EARTH SCIENCE
UNIVERSITI MALAYSIA KELANTAN

2024

DECLARATION

I declare that this thesis entitled "Comparative Diversity and Abundance of Birds at Jeli, Kelantan." is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : AHMAD FARIS ISKANDAR BIN AHMAD REDZUAN

Date : 08.08.2024

APPROVAL

"I hereby declare that I have read this thesis and in our opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Natural Resources Science) with Honors"

Signature : …….....

Name of Supervisor : DR. JAYARAJ VIJAYA KUMARAN

Date : ……..

ACKNOWLEDGEMENT

First of all, I would like to express my gratitude to the Almighty God for giving me the knowledge, opportunity, ability, and encouragement to face it, especially in all the challenging and critical moments of completing my thesis work. This thesis appeared in its current form due to the guidance and help of several people, whom I greatly appreciate.

At the beginning, I would like to express my deepest gratitude to Dr. Jayaraj Vijaya Kumaran, my supervisor. Thank you so much for your warm encouragement, insightful decisions, critical comments, insightful guidance, and thesis corrections. Next, I would like to thank Universiti Malaysia Kelantan, Jeli campus, especially the Faculty of Earth Sciences, for giving the final-year students the opportunity to do this project.I would like to thank my groupmate Sulaiman Bin Ahmad and others who helped me a lot during my sampling.

Then, I would also like to thank my family for their support. I would not have come this far without your endless love, support, and prayer encouragement. They have always been my backbone in everything I do. Finally, a huge thank you to everyone who has been a part of my life, either directly or indirectly, supporting and praying for me along the way.

Comparative Diversity and Abundance of Birds at Jeli, Kelantan.

ABSTRACT

A field study conducted in the Jeli area of Kelantan aimed to compare the diversity and abundance of bird species. The objective was to identify and compare bird species diversity and abundance at two locations: the University Malaysia Kelantan Jeli campus (UMK) and the area of "Kampung Baru Jalan Malaysia", Jeli. Throughout May 2024, the UMK Jeli area recorded 13 bird species from 7 families, whereas the "Kampung Baru Jalan Malaysia" area documented 17 species from 12 families. Researchers employed mist netting to capture and record bird species in these areas. Among the recorded species, 10 were identified as resident birds in the UMK Jeli area, and three were migratory species in the "Kampung Baru Jalan Malaysia" area. All recorded bird species were classified as "Least Concern (LC)" on the IUCN Red List. The data were analyzed using the Shannon-Wiener index and the Pielou's Evenness Index. The analysis revealed a species diversity index of 2.39 for the UMK Jeli area and 2.411 for the "Kampung Baru Jalan Malaysia" area, with species evenness indices of 0.932 and 0.851, respectively. These results indicate that the bird diversity in these areas is significantly disturbed. Overall, the Jeli district supports a diverse range of birds, which contributes considerably to biodiversity management and conservation efforts.

Perbandingan Kepelbagaian dan Kelimpahan Burung di Jeli, Kelantan.

ABSTRAK

Kajian lapangan yang dijalankan di kawasan Jeli Kelantan bertujuan untuk membandingkan kepelbagaian dan kelimpahan spesies burung. Objektifnya adalah untuk mengenal pasti dan membandingkan kepelbagaian dan kelimpahan spesies burung di dua lokasi: kampus Universiti Malaysia Kelantan Jeli (UMK) dan kawasan “Kampung Baru Jalan Malaysia”, Jeli. Sepanjang Mei 2024, kawasan UMK Jeli merekodkan 13 spesies burung daripada 7 famili, manakala kawasan “Kampung Baru Jalan Malaysia” mencatatkan 17 spesies daripada 12 famili. Penyelidik menggunakan jaring kabus untuk menangkap dan merekod spesies burung di kawasan ini. Antara spesies yang direkodkan, 10 burung dikenal pasti sebagai burung pemastautin di kawasan UMK Jeli, dan tiga spesies migrasi di kawasan “Kampung Baru Jalan Malaysia”. Semua spesies burung yang direkodkan dikelaskan sebagai "Kurang Keprihatinan (LC)" dalam Senarai Merah IUCN. Data dianalisis menggunakan indeks Shannon-Wiener dan Indeks Keseragaman Pielou. Analisis menunjukkan indeks kepelbagaian spesies 2.39 bagi kawasan UMK Jeli dan 2.411 bagi kawasan “Kampung Baru Jalan Malaysia”, dengan indeks kesekataan spesies masing-masing 0.932 dan 0.851. Keputusan ini menunjukkan bahawa kepelbagaian burung di kawasan ini terganggu dengan ketara. Secara keseluruhannya, daerah Jeli menyokong pelbagai jenis burung, yang banyak menyumbang kepada pengurusan biodiversiti dan usaha pemuliharaan.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

e.g.	Example gratis
h	Hour
i.e.	Example gratis
IUCN	International Union for Conservation of Nature
KM	Kilometer
m	Meter
sp.	Species

LIST OF SYMBOLS

=	Equal to
/	Division slash
%	Percent
&	And
∑	Total all
−	Subtraction
°	Degree
( )	Parentheses

CHAPTER 1

INTRODUCTION

1.1. BACKGROUND OF STUDY

Birds belong to the class Aves and are characterized by features such as feathers, toothless beaks, hard-shelled eggs, a high metabolic rate, a four-chambered heart, and a sturdy yet lightweight skeleton. They exhibit a wide range of sizes, from the petite bee owl measuring 5.5 cm (2.2 in) to the towering common ostrich reaching 2.8 m (9 ft 2 in) in height (Gibbons, 1994). With thousands of living species, the most prevalent group is the passerine bird, also known as perching birds. Studying the diversity and distribution of birds across different habitats is crucial as it enhances our understanding of their abundance and distribution in both natural and human-altered environments. Additionally, it promotes awareness of birds' positive ecological impacts, encourages further research on avian species, and serves as a platform for promoting birdwatching activities nationwide (MacArthur & MacArthur, 1961).

A turkey, a hummingbird, a penguin, a parrot, an owl, and an eagle. These are only a few of the many diverse kinds of birds. The contrasts amongst the birds on this list are astounding. Approximately 10,000 bird species are classified into 29 orders within the class Aves (Hildén, 1965). They can be found and reproduce on all seven continents. The tropics have the most bird species diversity. The variety of birds is incredible. Birds' sizes and colors can vary greatly. Some fly, others swim, and still others walk or run. Some are dangerous predators, while others are harmless herbivores. Some are at the bottom, while others are at the top of the food chain.

(Gibbons, 1994). We will delve into the numerous features of bird diversity in this investigation of the avian world. Birds range in size from the smallest bee hummingbird to the largest ostrich. Their plumage is a rainbow of hues, ranging from brilliant and vibrant to subtle and concealed. Each species has adapted to a unique environment, whether it is the lush canopies of rainforests, the parched expanses of deserts, or the open ocean (MacArthur et al., 1962).

1.2. PROBLEM STATEMENT

Bird species diversity and abundance are heavily influenced by a range of ecological and human-induced factors, creating significant challenges for conservation efforts. This problem statement aims to tackle the current issues in comprehending and safeguarding avian biodiversity and population levels, emphasizing the factors affecting these bird populations (Jetz et al., 2012).

Birds are one of the most diverse vertebrate groups on the planet, with a wide range of adaptations and ecological roles. Understanding their diversity and distribution is critical in many fields, including ecology, conservation, and evolutionary biology. Despite significant research on bird variety, there is still a need for a comprehensive and up-to-date study that includes the global distribution of bird species across various habitats and locations. This type of research will provide vital insights into the processes determining bird diversity patterns, the dangers they face, and will contribute in the development of effective conservation measures to protect these avian populations (Smith, J. K., Johnson, L. M., & Anderson, R. S, 2023).

1.3. OBJECTIVE

The objective of this study is:

1. To determine the diversity and abundance of birds species in areas around Universiti Malaysia Kelantan Jeli Campus and at “Kampung Baru Jalan Malaysia”, Jeli, Kelantan.
2. To make a comparison between the diversity and abundance of birds in two areas, that is, the Universiti Malaysia Kelantan Jeli Campus and “Kampung Baru Jalan Malaysia," Jeli, Kelantan.

1.4. SCOPE OF STUDY

The study's scope is related to and focuses on the comparison between diversity and abundance of birds at Universiti Malaysia Kelantan Jeli Campus and at “Kampung Baru Jalan Malaysia”, Jeli, Kelantan. Birds are vertebrate animals that can fly (Bird Pictures & Facts, 2012). Bird diversity and abundance research can be quite broad, encompassing many aspects of bird biology and ecology. This research will be conducted using a mist net method.

1.5. SIGNIFICANCE OF STUDY

The study of bird species diversity and distribution is important in a variety of scientific and conservation situations. This research brings useful insights into numerous domains by examining patterns of bird diversity across different habitats and geographies. Understanding the diversity of birds, for example, is critical for ecological studies. Birds play an important role in ecological dynamics as pollinators, seed dispersers, and predators of a variety of creatures. Researchers can gain a better understanding of the intricate relationship between birds and their environment by studying their distribution and abundance. This understanding aids in the interpretation of ecosystem function, resilience, and the potential impact of environmental change on bird communities (Vallejo et al., 2009).

CHAPTER 2

LITERATURE REVIEW

2.1. Taxonomy Classification of Bird

Birds, also known as Aves, are a varied group of warm-blooded vertebrates in the Animalia kingdom. They are members of the Chordata phylum and have a notochord throughout development. Birds, being Vertebrata, have a strong backbone. They are classified as Aves due to distinguishing characteristics such as feathers, beaks, and hard-shelled eggs (Hendy et al., 2018). Birds are further classified into orders with distinct characteristics, such as Passeriformes, Falconiformes, Strigiformes, and Psittaciformes. Scientists use this taxonomy system to understand the vast diversity and complexities of birds' evolutionary relationships among families, groups, and species, shedding light on avian life on Earth (Safford et al., 2019).

Bird taxonomy classification is a hierarchical system used to categorize and organize our planet's incredible diversity of bird species. This evolutionary biology-based system starts with broad categories and gets more specific as it goes, allowing for a more structured understanding of avian diversity. At the highest level of taxonomy, birds are classified as Eukaryota, indicating that they are complex, multicellular organisms. They are further classified as Animalia, indicating their animal nature (Kratter., 2005).

Birds' primary taxonomic home is found in the class Aves. This class includes all avian species, distinguishing them from other animal classes such as mammals and reptiles. Birds are classified into orders, families, genera, and species within the Aves class. These divisions are based on similarities and evolutionary relationships. The order Falconiformes, for example, includes

birds of prey such as eagles and hawks, while the family Passeridae includes true sparrows (Safford et al., 2019).

2.2. Characteristic

Birds, members of the Aves class, are amazing creatures with a wide range of characteristics that have captivated scientists and bird enthusiasts for centuries. These characteristics cover a wide range of aspects of their biology, behavior, and ecology, revealing important information about their adaptations and ecological roles. Birds' feathers are a distinguishing feature that serve multiple functions. While they provide insulation and waterproofing, their most well-known function is the ability to fly powered. Because of the structure and arrangement of their feathers, as well as their lightweight skeletons, birds can fly. The evolution of feathers and flight mechanics is still a hot topic, shedding light on how birds conquered the skies (Fernández et al., 2019).

Bird beaks, or bills, come in an amazing variety of shapes and sizes, each adapted to a different feeding strategy. Beak morphology reflects niche specialization, from the long, slender bills of hummingbirds for nectar extraction to the robust, hooked bills of raptors for prey capture (Leonard & Pauli, 2019). On going research investigates the connections between beak morphology and foraging techniques, shedding light on how these adaptations relate to ecological roles and resource utilization (Kozma et al., 2022). Birds are famous for their vocalizations, which are necessary for communication, mate attraction, and territorial defense. Birdsong, in particular, is a complex and extensively researched behavior. Recent research looks into the complexities of bird communication, such as the neural basis of song learning and how it affects reproductive success (Fox et al., 2019).

Bird migration is a fascinating trait that many species share. As the seasons change, birds migrate long distances, often across continents, in search of suitable habitats and resources. Researchers use advanced tracking technologies to solve the mysteries of migration patterns, highlighting birds' ability to adapt to environmental changes such as climate change (Ng et al., 2022). Birds use a variety of nesting strategies, with species ranging from cavity nesters to ground nesters to canopy nesters. The choice of nesting site and construction is influenced by a complex interplay of ecological factors such as predation risk and climate conditions. Ongoing research looks into the evolution of bird nest types and how these behaviors affect reproductive success (Tellería et al., 2021). Bird social structures range from monogamous pairs to complex communal living. Researchers are particularly interested in cooperative breeding systems in which individuals work together to raise offspring. Understanding the factors that influence these behaviors can help us understand how sociality evolved in birds (Hammers et al., 2019).

Birds are well-known for their devoted parental care, which varies greatly between species. Incubating eggs, feeding nestlings, and protecting offspring are all part of the care. Researchers investigate the adaptations and trade-offs that occur during avian parental care, shedding light on the strategies that ensure the survival of their young (Ng et al., 2022). Birds have an amazing range of colors and plumage patterns. These characteristics serve a variety of functions, ranging from camouflage and mate attraction to species recognition. Recent research on avian color vision and plumage evolution sheds new light on the role of coloration in bird ecology and behavior (La Sorte et al., 2018).

In conclusion, bird characteristics demonstrate the diversity and adaptability of this animal class. Ongoing research in these areas contributes to our understanding of avian biology, behavior,

and ecological importance. This knowledge is useful not only for ornithologists, but also for bird conservation and appreciation of these incredible creatures in our natural world.

2.3. Ecology & Behaviour

Birds exhibit a diverse range of ecological interactions and behaviours that are critical in altering habitats and ensuring their own survival. Their versatility and resilience are demonstrated by their different feeding techniques, breeding practices, and migratory patterns. Many bird species exhibit sophisticated social activities, such as cooperative breeding and intricate courtship rituals, which aid in reproductive success and the preservation of social structures within their populations (Chandler, 2020). Furthermore, bird vocalizations and plumage play important roles in communication and mating selection. Their ecological roles as predators, prey, and seed dispersers significantly contribute to the function and biodiversity of their various habitats. Understanding bird ecology and behaviour is critical for protecting these charismatic creatures as well as the fragile balance of the natural world (Smith, J. K., Johnson, L. M., & Anderson, R. S, 2022).

Bird ecology and behaviour have been the subjects of extensive research and discovery since 2019. These studies have shed light on important aspects of avian life, improving our understanding of their ecological roles and complex behaviours (Klaver, 2020). Recent research has highlighted the significance of birds in ecosystem dynamics. According to research, birds play critical roles in shaping vegetation communities and sustaining biodiversity through their foraging and seed dispersal activities. Frugivorous birds, for example, contribute to forest regeneration by dispersing seeds, thereby influencing plant diversity and composition (Chandler, 2020).

Bird behavioural research has revealed new insights into communication, learning, and social interactions. Technological advancements have made it possible to study avian behavior with great precision. For example, research on the complex vocalizations and learning processes of songbirds has implications for understanding bird communication and cognitive abilities. Recent avian ecological and behavioural research has also highlighted the effects of climate change and habitat loss on bird populations. Studies have shown how changes in food availability and environmental conditions affect migration patterns, breeding behaviour, and population dynamics (Klaver, 2020). Understanding bird ecology and behaviour is still critical for conservation efforts. Scientists and practitioners can develop more effective conservation strategies by applying recent findings to bird species and habitats, ensuring the preservation of avian diversity and their invaluable contributions to ecosystems (Hardy et al., 2022).

2.4. Habitat

Birds are an incredibly diverse group of animals that can be found in a wide variety of habitats all over the world. Their ability to adapt to different environments reflects the complex interplay between their biology and the ecological niches they occupy. This article looks at some of the many different bird habitats, shedding light on the critical role these ecosystems play in bird survival and biodiversity.

Forests are home to a diverse range of bird species, each adapted to the unique conditions of its habitat. With their lush vegetation and abundant insect life, tropical rainforests are home to brilliantly colored parrots, toucans, and a plethora of songbirds. Northern Goshawks and Pine Grosbeaks, on the other hand, live in coniferous forests in northern latitudes. A recent study

Cisneros et al., (2019) emphasized the importance of intact forests in preserving avian diversity while also emphasizing the threats posed by deforestation and habitat fragmentation.

Many grassland bird species prefer open grasslands and prairies as their preferred habitat. To prevent encroachment of woody plants and maintain habitat for species such as the endangered Greater Prairie-Chicken, these ecosystems require active management practices such as controlled burns and grazing (Fuhlendorf et al., 2019). Waterfowl, waders, and other wetland-dependent birds thrive in wetlands, which include marshes, swamps, and estuaries. These habitats serve as critical rest stops during migration and as breeding grounds for species such as ducks and herons. Wetland conservation efforts have become increasingly important in order to protect these birds' habitat (Elmberg et al., 2019).

Seabirds live in coastal areas and marine environments. Species such as albatrosses and penguins have adapted to sea life. Foraging behavior and migration patterns research, such as that of Navarro et al. (2020), are critical for understanding how these birds exploit these often-difficult environments. Birds have demonstrated an extraordinary ability to adapt to urban environments. Cities all over the world are now home to species such as pigeons, sparrows, and peregrine falcons Murgui et al. (2019) investigate how birds coexist with human activity and how urbanization affects avian communities.

Specialized bird species such as ptarmigans and Snow Buntings live in high-elevation habitats in mountains and harsh Arctic conditions. Understanding their adaptations to extreme environments, as well as the impact of climate change, is critical (Smith et al., 2019). Agricultural areas provide habitats for birds like swallows and raptors. Research explores the relationships between farming practices and bird populations, informing sustainable agriculture and bird conservation (Mänd et al., 2021).

Finally, birds have mastered a remarkable range of habitats, from dense forests to vast oceans. These ecosystems, each with its own set of challenges, demonstrate avian life's adaptability and resilience. We can develop more effective conservation strategies and ensure that the rich tapestry of avian biodiversity is preserved for future generations to enjoy as we continue to understand the complexities of these habitats and their importance for bird survival.

2.5. Overview of Malaysian Birds

Malaysia is well-known for having the world's richest bird. Bird species are present in Malaysia for approximately 742 species, with Peninsular Malaysia recording 662 species and Borneo recording 552 and 557 bird species in Sabah and Sarawak, respectively (Lang et al., 2014).

There are four endemic species in Peninsular Malaysia (MNS- Bird Conservation Council, 2010) while in Borneo, there are between 38 and 52 endemic species depending on the taxonomic authority referred to Yeap et al. (2007).

The distribution of large species is known to be forest dependent (Wells, 2007). which can be found in the following habitats: lowland mixed dipterocarp forest, lowland evergreen forest, freshwater swamp forest, lower montane forest, and upper montane forest (Duncan et al., 2014). Furthermore, Malaysian lowland forests are the primary home and habitat for 311 bird species (Peh et al., 2005).

2.6. Mist Net

Various techniques are available for identifying bird species diversity and abundance, with many researchers favoring the use of mist nets, as noted by Remsen and Good (1996). According to their findings, 95% of flights with an average height of 2 meters will range between 0 and 4 meters, and 95% of flights with an average height of 10 meters will range between 0 and 20 meters. This demonstrates the effectiveness of mist nets in acquiring relatively straightforward data compared to other methods.

A mist net is a fine, nearly invisible mesh used to capture birds for research purposes in ornithology and ecology. The net, made of vertically hung nylon or polyester threads, is intended to entangle birds as they fly into it, allowing researchers to study and collect data on various avian species safely. Mist nets are frequently used in field studies to collect data on bird populations, migration patterns, behavior, and demographics (Arizaga et al., 2011).

Mist nets are made of lightweight, nearly transparent materials, reducing the ability of birds to detect and avoid the nets. The nets are typically placed in strategic locations, such as bird habitats or along migration routes, where researchers expect to see a high level of bird activity. Mist nets are hung horizontally between two poles, forming a barrier through which birds unintentionally pass (ZOU et al., 2010).

CHAPTER 3

MATERIAL AND METHODS

3.1 Materials

The materials needed to do this study are mist nets used to catch birds. This is because it is the most secure method of catching birds for research purposes. While the poles are used to hang mist nets to make catching birds easier. A Pesola spring balance was used to weigh the captured birds. External morphological characteristics were measured with a steel ruler and a Mitutoyo electronic digital caliper (Mitutoyo Corporation).

3.2 Methods

3.2.1 Study Area

The study was conducted at the Universiti Malaysia Kelantan Jeli Campus, located in Jeli, Kelantan, Malaysia (Figure 3.1). This key campus of UMK has been operational since January 1, 2012. Spanning 279 acres, the Jeli campus is strategically positioned along the East-West Highway, which links Malaysia's eastern and western regions. It is nestled within Gemang's forest and surrounded by scenic hills, with geographical coordinates of 5.7124° N latitude and 101.8317° E longitude. The campus includes several centers of excellence, such as the Agro Techno Park (ATP), and is designed to facilitate teaching, learning, and

research. It offers facilities and services that provide a safe, comfortable, and harmonious environment for both students and staff.

The geographical coordinates of the Universiti Malaysia Kelantan Jeli Campus are 5.7124° N latitude and 101.8317° E longitude, and it is originally known as Kampung Universiti Malaysia Kelantan Jeli Campus. The region is characterized by its rural setting and natural beauty, including forests, rivers, and agricultural land. Nearby, there is a village area with some houses and settlements close to the Jeli Polytechnic area. The presence of a forest and proximity to hilly terrain make it an ideal location for studying bird diversity. Additionally, the UMK Jeli Campus area is home to a variety of flora and fauna**.**

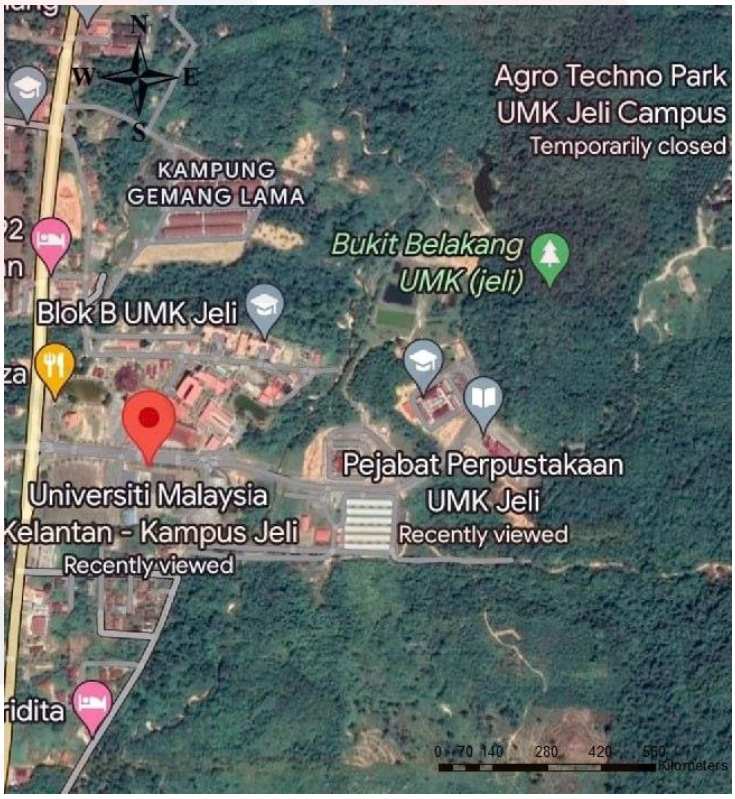


Figure 3.1: Universiti Malaysia Kelantan Jeli Campus, Jeli, Kelantan Area
(Source: Google, 2024)

The study was also conducted at a second location, “Kampung Baru Jalan Malaysia” in Jeli, Kelantan (Figure 3.2). Kampung “Kampung Baru Jalan Malaysia” is situated in Jeli, Kelantan, Malaysia, with geographic coordinates of 6° 6' 54" N latitude and 102° 14' 29" E longitude. The area, originally known as Kampung “Kampung Baru Jalan Malaysia,” is distinguished by its rural setting and natural beauty, including forests, rivers, and agricultural land. It features a village and several settlement houses near the Jeli Polytechnic area. The presence of a forest and nearby hilly terrain make it an excellent location for studying bird diversity. Additionally, the area hosts a variety of flora and fauna.

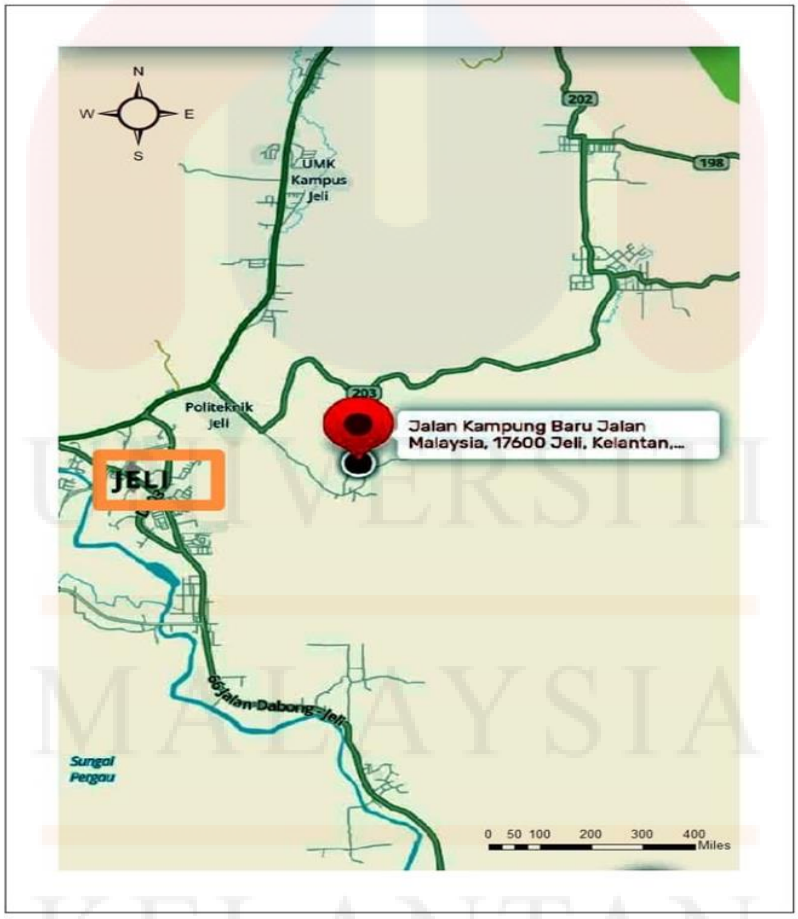


Figure 3.2: “Kampung Baru Jalan Malaysia”, Jeli, Kelantan Area

(Source: Google, 2024)

3.2.2 Mist Net

In this study, I used a mist net as my researched method to investigate the diversity and abundance of birds in areas around Universiti Malaysia Kelantan Jeli Campus and at "Kampung Baru Jalan Malaysia", Jeli, Kelantan. A mist net measured 14m in length and 1.5-2m in height, with a mesh size of 36 mm, was installed at the station. The net was stretched between two poles that were between 5 and 10 metres long, depending on the length of the mist net. It was expected that up to 5 mist nets had been used in several locations that were considered potential bird flight paths, such as small streams, rivers, and trails, used this method. Mist net locations had been chosen based on a thorough assessment of potential bird flight paths, taking into account factors such as habitat typed, topography, and historical bird sightings. This systematic sampling approached would result in a more representative and reliable collection of bird data. The distance between the mist net station and the other mist net stations was at least 200 metres. This studied was conducted for 21 days at the study site, started on May 16 until June 5, 2024. Mist nets were used before sunrise, closed after sunset, and checked every hour between 0700 and 1900 hours. Mist nets should have enough vertical slack to form pockets between self-strings (Sutherland et al., 2004).

When birds became entangled in the nets during inspection, they were collected and placed in cloth bags before being taken for identification. Relevant reference materials were used to identify all captured birds. Each bird was weighed using a Pesola spring balance, and its morphological characteristics (wingspan, total length, tail length, wing length, bill width, bill depth, bill length, and tarsus length) were measured using Mitutoyo electronic

digital calipers (Mitutoyo Corporation). After the identification process, the birds were released (Hawa et al., 2016).

3.3 Data Analysis

3.3.1 Accumulative Graph

The number of bird species recorded can be determined using cumulative graphs, which were created based on data collected from the study area. This data is derived from the total number of birds counted daily. Cumulative graphs are widely employed to depict groups or populations, offering a variation of frequency distribution graphs. These graphs are preferred in scientific and statistical contexts due to their clear depiction of the slope, position, and overall shape of the data curve. They also facilitate the display of the number of value classes or the range of sizes within a group, contrasting with the potential confusion that may arise from numerical entries in a table. In a cumulative graph, an increasing accumulation of the dependent variable from the right signifies the cumulative total, with the last data value on the right representing this total (Richardson, 1985).

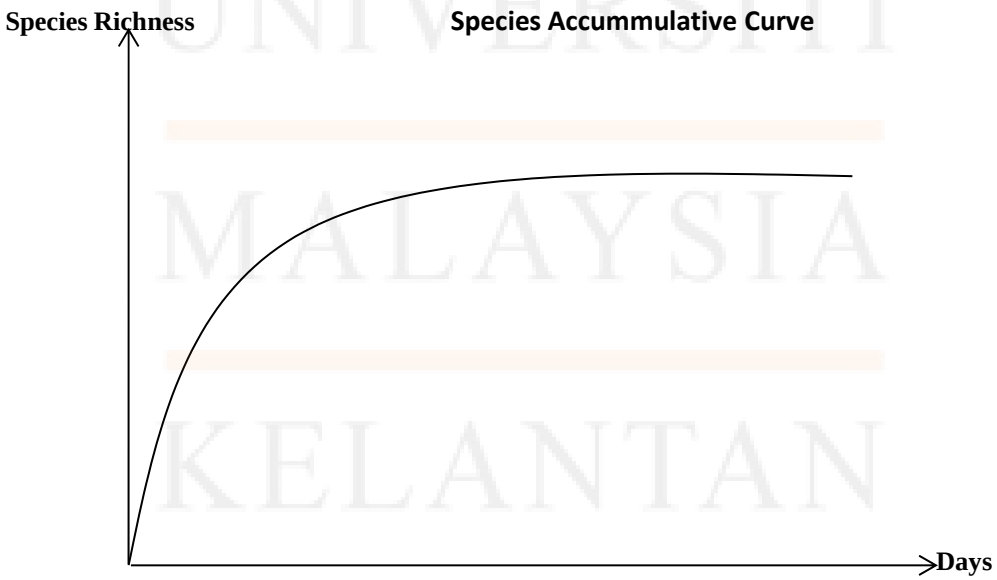


Figure 3.3 Species Accummulative Curve

3.3.2 Shannon-Wiener Diversity Index

The methods used to calculate bird diversity. Statistics summarize how each member of a population belongs to a distinct group. Even though the Shannon-Wiener index is widely used, many diversity indices have been proposed.

The equation of this calculation:

$$\text{Shannon-Wiener heterogeneity index } (H') = \sum_{i=1}^{S} P_i \ln(P_i) \qquad (3)$$

Equation 3.1

where:

H'= Diversity index

pi = The proportion of individuals found in the i^{th} species.

S= Species count

Ln= Natural logarithm

3.3.3 Pielou's Evenness index

This calculation determines the frequency (number) of each species found in a given area. This can be proven when various equations have been proposed to calculate equality from the measure of diversity (Sarma & Das, 2015). Evenness values (E) range between 0 and 1, with lower values indicating less even communities among species.

The equation of this calculation:

$$J' = \frac{H'}{H'_{Max}}$$

Equation 3.2

H'= Value Shannon index for certain population

H'max= Maximum value of Shannon index with same species and a total number of individuals sampled.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Species Richness

At the Universiti Malaysia Kelantan Jeli Campus, mist nets were used to record 13 bird species from 7 families. The data include 30 individual birds from 13 different species spread across 7 families. It is expected that the total composition of bird species will be greater than what is recorded here because birds, due to their shy and secretive nature, may hide in thick bushes that observers cannot see. The IUCN classifies all observed species as "Least Concern (LC)," indicating that they are not currently at significant risk of extinction. The overall "Least Concern" status across all species is promising, indicating no immediate conservation threats to these birds. However, continuous monitoring is essential to ensure these populations remain stable, considering potential environmental changes and human impacts. The diversity of families and species also underlines the ecological richness of the habitat, making it a significant area for bird conservation efforts and further ornithological studies.

Among the bird species identified at the Universiti Malaysia Kelantan (UMK) Jeli Campus, the results of the study show that the diversity of bird species in the area studied is that the Nectariniidae family has the highest number of individuals (14), especially the population, which shows stability. local population of nectar-feeding birds. The family Meropidae shows a combination of resident and migratory behavior, which may be related to seasonal variation and food availability. Notably, the presence of Brown Quail and Spotted

Dove as migrants indicates that the area serves as a temporary habitat for certain species at certain times of the year. According to the data collected, discovered that the little spiderhunter *(Arachnothera longirostra)* is the most abundant bird species at UMK Jeli, with the highest frequency number recorded, which is up to six individuals, followed by the chestnut-headed bee-eater (*Merops leschenaulti*), which was recorded as up to four individuals.

The Pycnonotidae family, which includes the Yellow-vented Bulbul (*Pycnonotus goiavier*) and the Asian Red-eyed Bulbul (*Pycnonotus brunneus*), demonstrates that these species thrive in their natural habitat, with a "Least Concern" status indicating stable populations. Notably, three yellow-vented Bulbuls and one Asian red-eyed Bulbul were spotted, highlighting the need for ongoing monitoring to ensure their survival. The Little Spiderhunter *(Arachnothera longirostra)* is the leader of the Nectariniidae family, which has six members. This species, along with the long-billed spiderhunter *(Arachnothera robusta*) and purple-naped spiderhunter (*Kurochkinegramma hypogrammicum*), each with two or three individuals, exemplifies the group's diversity. Their "Least Concern" status emphasizes their adaptability and ecological value as pollinators.

The Olive-backed Sunbird *(Cinnyris jugularis)*, with its iridescent plumage and three observed individuals, exemplifies the adaptability of the Nectariniidae family. Its presence reinforces the species' ability to thrive in a variety of settings, including human-modified landscapes. The Chestnut-headed Bee-eater (*Merops leschenaulti*) and the Little Bee-eater (*Merops pusillus)* are members of the Meropidae family, each with four and one

individuals. These insectivorous birds play an important role in maintaining ecological balance, and their "Least Concern" status reflects this.

The solitary Brown Quail (*Synoicus ypsilophorus)* of the Phasianidae family, with its cryptic plumage, is an important migrant, contributing to the seasonal dynamics of the avian community. The Common Myna *(Acridotheres tristis)* of the Sturnidae family, which lives in pairs, is well-adapted to urban environments, as evidenced by its "Least Concern" status. The White-throated Kingfisher (*Halcyon smyrnensis)* of the Alcedinidae family, which has two individuals recorded, represents a healthy aquatic ecosystem. Meanwhile, the Columbidae family, which includes the Spotted Dove (*Spilopelia chinensis)* and the Emerald Dove (*Chalcophaps indica)*, demonstrates adaptability to a variety of habitats, with both having a "Least Concern" status.

Table 4.1 Birds species in Universiti Malaysia Kelantan, Jeli Kelantan

Bird Species	Number of Individual	Distribution Status	IUCN Status
Pycnonotidae			
Yellow-vented bulbul*(Pycnonotus goiavier)*	3	R	Least Concern (LC)
Asian red-eyed bulbul *(Pycnonotus brunneus)*	1	R	Least Concern (LC)
Nectariniidae			
Little spiderhunter *(Arachnothera longirostra)*	6	R	Least Concern (LC)
Long-billed spiderhunter *(Arachnothera robusta)*	2	R	Least Concern (LC)
Purple-naped Spiderhunter *(Kurochkinegramma hypogrammicum)*	3	R	Least Concern (LC)
Olive-backed Sunbird *(Cinnyris jugularis)*	3	R	Least Concern (LC)

Meropidae			
Chestnut-headed bee-eater *(Merops leschenaulti)*	4	R	Least Concern (LC)
Little bee-eater *(Merops pusillus)*	1	M	Least Concern (LC)
Phasianidae			
Brown quail *(Synoicus ypsilophorus)*	1	M	Least Concern (LC)
Sturnidae			
Common myna/Indian myna *(Acridotheres tristis)*	2	R	Least Concern (LC)
Alcedinidae			
White-throated kingfisher *(Halcyon smyrnensis)*	2	R	Least Concern (LC)
Columbidae			
Spotted dove/Eastern spotted dove *(Spilopelia chinensis)*	1	M	Least Concern (LC)
Emerald dove/Common emerald dove *(Chalcophaps indica)*	1	R	Least Concern (LC)
Total number of Individu	30		
Total Number of Species	13		
Total Number of Family	7		

Legend: Distribution Status (R= Resident, M= Migrant); Status IUCN (LC= Least Concern).

Migratory birds typically arrive in Peninsular Malaysia as early as July and August, with the majority arriving between September and November (Zahidin, 2017) According to Medway (1973), the Barn Swallow is a non-breeding winter visitor that migrates to West Malaysia from late July, peaking in November, aligning with the study's sampling period. Additionally, commonly found species such as the Little Bee-eater (*Merops pusillus)* and Brown Quail (*Synoicus ypsilophorus)* were recorded at the site, possibly as residents or as migrants during the migratory seasons.

Table 4.2 Birds species in "Kampung Baru Jalan Malaysia", Jeli Kelantan

Bird Species	Number of Individual	Distribution Status	IUCN Status
Pycnonotidae			
Yellow-vented bulbul *(Pycnonotus goiavier)*	6	R	Least Concern (LC)
Asian red-eyed bulbul (Pycnonotus brunneus)	2	R	Least Concern (LC)
Columbidae			
Spotted dove/ Eastern spotted dove *(Spilopelia chinensis)*	6	R	Least Concern (LC)
Emerald dove/ Common emerald dove (Chalcophaps indica)	3	R	Least Concern (LC)
Zebra dove (Geopelia striata)	3	R	Least Concern (LC)
Cuculidae			
Green-billed malkoha *(Phaenicophaeus tristis)*	2	R	Near Threatened (NT)
Rallidae			
White-breasted waterhen *(Amaurornis phoenicurus)*	1	R	Least Concern (LC)
Sturnidae			
Common myna/ Indian myna *(Acridotheres tristis)*	4	R	Least Concern (LC)

Javan myna (*Acridotheres javanicus)*	3	M	Least Concern (LC)
Passeridae			
Eurasian tree sparrow *(Passer montanus)*	7	R	Least Concern (LC)
Sturnidae			
Metallic starling *(Aplonis metallica)*	18	M	Least Concern (LC)
Asian glossy starling *(Aplonis panayensis)*	13	M	Least Concern (LC)
Muscicapidae			
Oriental magpie-robin *(Copsychus saularis)*	1	R	Least Concern (LC)
Alcedinidae			
White-throated kingfisher *(Halcyon smyrnensis)*	1	R	Least Concern (LC)
Oriolidae			
Black-naped oriole *(Oriolus chinensis)*	1	R	Least Concern (LC)
Caprimulgidae			
Large-tailed nightjar *(Caprimulgus macrurus)*	2	R	Least Concern (LC)
Turnicidae			
Barred Buttonquail *(Turnix suscitator)*	1	R	Least Concern (LC)
Total Number of Individual	74		
Total Number of Species	17		
Total Number of Family	12		

Legend: Distribution Status (R= Resident, M= Migrant); Status IUCN (LC= Least Concern, NR= Near Threatened).

Table 4.2 shows the research that has been carried out in the second area, which is in the area of "Kampung Baru Jalan Malaysia", Jeli Kelantan. Through research in this area, we have been able to record a total of 74 individual species of birds, which exhibits

exceptional biodiversity with 17 species of birds across 12 families. Among the resident species, the Yellow-vented Bulbul *(Pycnonotus goiavier)* was a common sight, with six individuals observed. Recognized by its melodious call and bright yellow vents, this bulb is categorized as "Least Concern" by the IUCN. The Asian Red-eyed Bulbul *(Pycnonotus brunneus)*, although less abundant with only two individuals recorded, shares the same conservation status, indicating stable populations for both species.

Based on the data recorded in Table 4.2, it was found that the Columbidae family contributes significantly to the diversity of birds around the area “Kampung Baru Jalan Malaysia”. The spotted dove or eastern spotted dove *(Spilopelia chinensis)*, with six individuals recorded, fills the area with its soft hum. The Emerald dove *(Chalcophaps indica)*, seen with three individuals, adds elegance with colorful feathers. Likewise, the Zebra Dove *(Geopelia striata)*, also with three individuals, enhances the local habitat with its distinctive black-and-white striped neck feathers. In contrast, the Green-billed Malkoha (*Phaenicophaeus tristis*) is a rare find in the region, with only two individuals observed, making its "near threatened" status a call for focused conservation efforts.

The White-breasted Waterhen (*Amaurornis phoenicurus*) is the only waterbird represented, with only one spotted. These elusive birds live in wetlands and marshes, blending in with their surroundings. The Sturnidae family contains both resident and migratory species. The Common Myna (*Acridotheres tristis)*, which has four individuals, is known for its adaptability and mimicry abilities, thriving in human-modified environments. The Javan Myna *(Acridotheres javanicus)*, a migrant with three individuals observed, is distinguished by its glossy black plumage and yellow eye patches. Other notable species in that study area include the Eurasian Tree Sparrow *(Passer montanus),*

which has seven individuals thriving in the local habitat and has adapted well to human settlements. The Metallic Starling *(Aplonis metallica)*, seen with a flock of 18 individuals, and the Asian Glossy Starling *(Aplonis panayensis)*, seen with 13 individuals, both add a gleam to the avian ensemble with their iridescent plumages. The Oriental Magpie-Robin (Copsychus saularis), a solitary bird with striking black-and-white plumage, and the White-throated Kingfisher (*Halcyon smyrnensis*), another solitary bird commonly found near bodies of water, add to the area's diversity.

The Black-naped Oriole (*Oriolus chinensis)*, a single individual, graces Jeli's trees with its golden-yellow plumage, while nocturnal species like the Large-tailed Nightjar *(Caprimulgus macrurus)*, with two individuals, silently hunt insects at dusk. The Barred Buttonquail (*Turnix suscitator)*, a secretive ground-dweller with only one individual recorded, further underscores the region's rich avian diversity. In summary, Jeli's avifauna reflects a vibrant tapestry of species, from the common to the elusive. The "Least Concern" status of most species provides reassurance, yet ongoing conservation efforts are crucial to protect their habitats. This ensures that the melodious calls and vibrant sights of these birds continue to resonate through the lush landscapes of "Kampung Baru Jalan Malaysia".

4.2 Comparative Bird's Family in Both Study Area

A total of 7 families representing 13 species were recorded at Universiti Malaysia Kelantan, Jeli. Referring to Figure 4.1, the Nectariniidae family is also the most dominant species for this study because it has shown a total of 4 species and 14 total of individual detected during this study. They have slender downcurved bills, partially tubular tongues, and short, rounded wings. They feed on small insects and sip nectar from small flowers (e.g., Anthreptes, Nectarinia, Aethopyga). The group called spider hunters (Arachnothera) are found primarily in the Orient(Nectariniidae | Sunbirds, Hummingbirds & Flowerpeckers, 1998)

Bee-eaters from the family Meropidae are the second most species caught in this study because the presence of Meropidae, known as bee-eaters, is influenced by several factors related to their habitat and behavior. These colorful birds inhabit open, mild areas such as savannas, forests, grasslands, and scrub deserts. Some species prefer rainforests. They are often found near water sources. Bee-eaters exhibit cooperative behavior and live in colonies, except for a few solitary species. Their main diet consists of insects, especially bees and wasps, which influence their choice of habitat. In summary, the presence of bee-eaters is closely related to suitable habitat, nesting opportunities, social interaction, and food availability, collectively determining their distribution and abundance in the area. This can be proven when the UMK Jeli area is suitable for their habitat compared to the study area of " Kampung Baru Jalan Malaysia", Jeli.

Bulbul, a member of the Pycnonotidae family, was the third most common species caught in this study because it thrives in forests disturbed by habitat structural modification, is commonly found in lowland rainforests (Ghasemi, 2015), and sometimes sees fodder on the same small side where there is a single or sometimes other birds to eat on fruit trees

(Jeyarajasingam, 2012). Bulbuls are insectivorous-frugivorous birds that can adapt to seasonal fruit availability (Azman et al., 2011). Some species are considered plant pests, especially in gardens (Fox, 2011), which explains why the Pycnonotidae family, with a total of two Bulbul species caught from the sampling (Table 4.1), has the largest number of species because the Jeli UMK area has a well-known area of secondary forest covered by plantations.

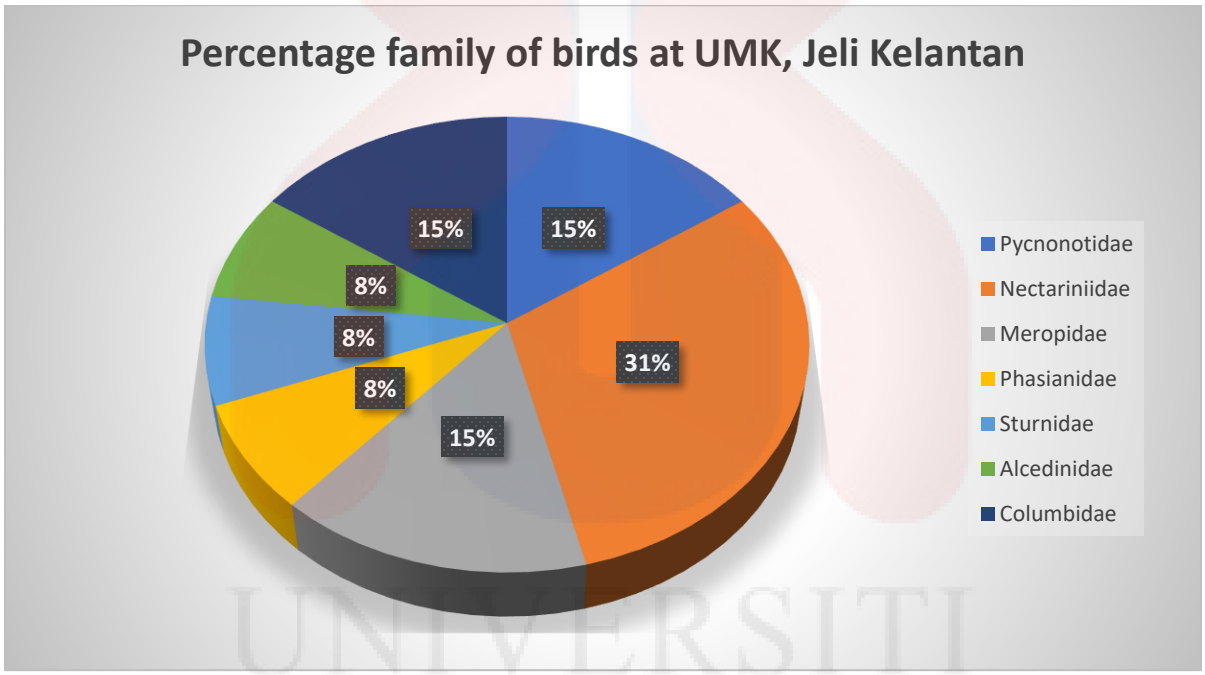


Figure 4.1 Percentage of family of birds at UMK, Jeli Kelantan

The fourth dominant family present was Columbidae with 15% (2 species). Pigeons and doves (Columbidae) are globally distributed and inhabit a wide range of environments, from deserts and dense forests to bustling urban areas. Despite often being labeled as invasive and dirty, pigeons play vital roles in both ecological and social research. Their presence also helps to track the effects of climate change in urban areas. Pigeons are ideal for citizen science projects because of their widespread presence. As such, this species can

be found in both study areas, namely at UMK Jeli and in the surrounding area of ”Kampung Baru Jalan Malaysia”.

The dominant families, accounting for at least 2% (1 species), were Phasianidae, Sturnidae, and Alcedinidae. The fewest families present may have been severely affected by forest disturbances such as hunting, agriculture, construction, and land encroachment near protected areas, all of which pose a significant threat to bird survival. species (Brooks et al., 1999). A construction project is underway near the forest area of UMK Jeli.

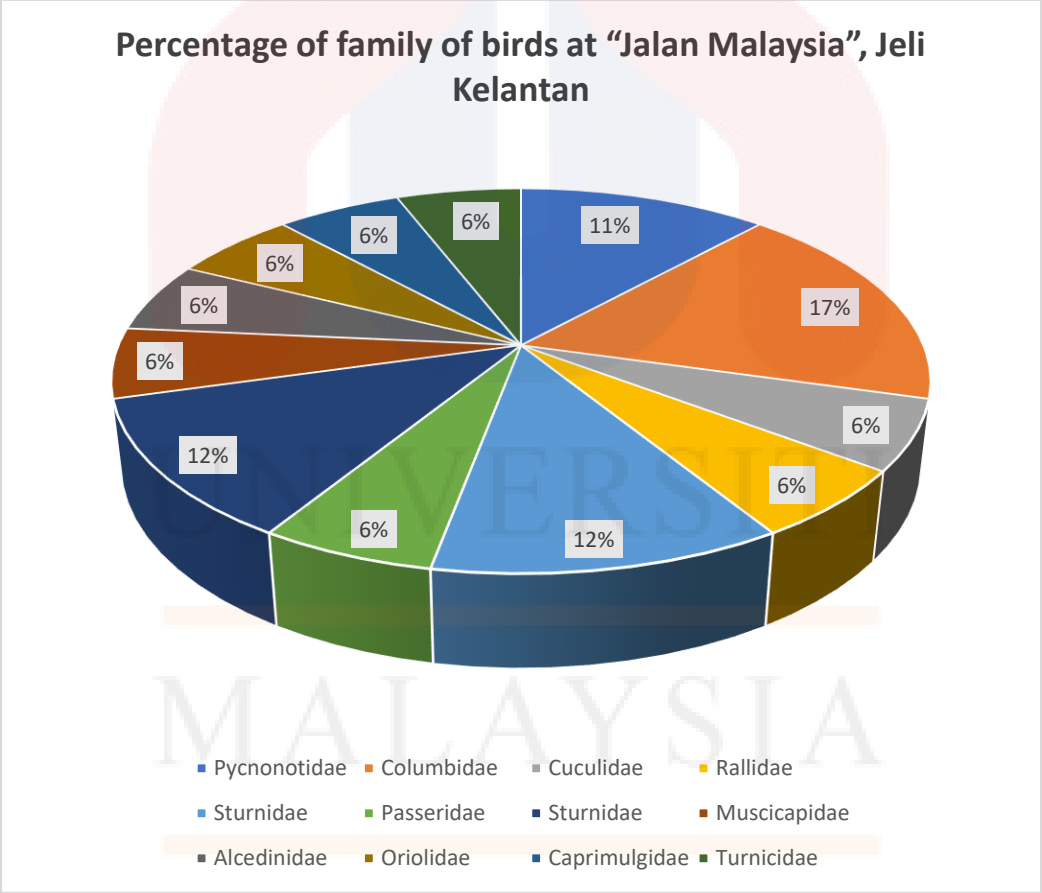


Figure 4.2 Percentage of family of birds at “Kampung Baru Jalan Malaysia”, Jeli Kelantan

For the study area in “Kampung Baru Jalan Malaysia”, 12 families representing 17 species have been identified. According to Figure 4.2, the Columbidae family is also the most dominant species in this study because it has three species and the greatest number of species that can be detected among all of the species discovered during this study. Doves (Columbidae) are found all over the world and live in a variety of habitats, including deserts, dense forests, and bustling cities. Despite being frequently labeled as invasive and filthy, pigeons play important roles in ecological and social research. Ecologically, they are important in urban ecosystems because they serve as a key prey species for many raptors, thereby maintaining food web dynamics. Pigeons also help monitor environmental health by accumulating pollutants, which provide information about local contamination levels. Their presence also helps to track the effects of climate change in urban areas. So, species from this family can be found in both study areas, namely in the area of UMK Jeli and “Kampung Baru Jalan Malaysia”.

The second largest families found were Pycnonotidae (bulbuls), Passeridae (sparrows), and Sturnidae (starlings and mynas), each accounting for 12% of the bird population. This is because bulbuls are known for their presence in tropical regions and diverse habitats, whereas sparrows and starlings are highly adaptable and can be found in both urban and rural settings. This clearly shows that the “Kampung Baru Jalan Malaysia” area is slightly outside the forest area, as opposed to the UMK Jeli area, which has a secondary forest with various species. The Malaysia Road area is also close to human settlements and transportation routes.

Cuculidae (cuckoo) account for 11%, indicating a healthy ecosystem because these birds frequently live in well-maintained environments with abundant insect populations, their primary food source. Other bird families include Muscicapidae (flycatchers), Alcedinidae (kingfishers), Oriolidae (orioles), Caprimulgidae (nightjars), Rallidae (rails), and Turnicidae (buttonquails),

which account for 6% of the bird population. This diversity reflects the diversity of niches and habitats in the area, which supports various feeding and nesting options.

Overall, Figure 4.1 and Figure 4.2 demonstrate the rich diversity of birds in "Kampung Baru Jalan Malaysia", Jeli, Kelantan, emphasizing the region's ecological importance in both study areas. The presence of both common and uncommon bird families indicates that the environment is balanced and supports a diverse range of bird species. Bird species that are normally found in forest areas can be found in the UMK Jeli area, whereas bird species found outside the forest can be found in the "Kampung Baru Jalan Malaysia" region. However, due to their proximity to the forest, both study areas have seen the same bird species. All bird species that were found and recorded were recorded using the mist net method in both study areas. Previous studies seemingly suggested that mist netting is the most efficient technique for sampling birds. But further analysis reveals that direct observation is more effective when success rate and study effort are taken into consideration (Ramli et al., 2009).

Figure 4.3 shows the curve represented rising biodiversity of birds with number of species richness on y-axis and days on x-axis for Universiti Malaysia Kelantan Jeli campus area.

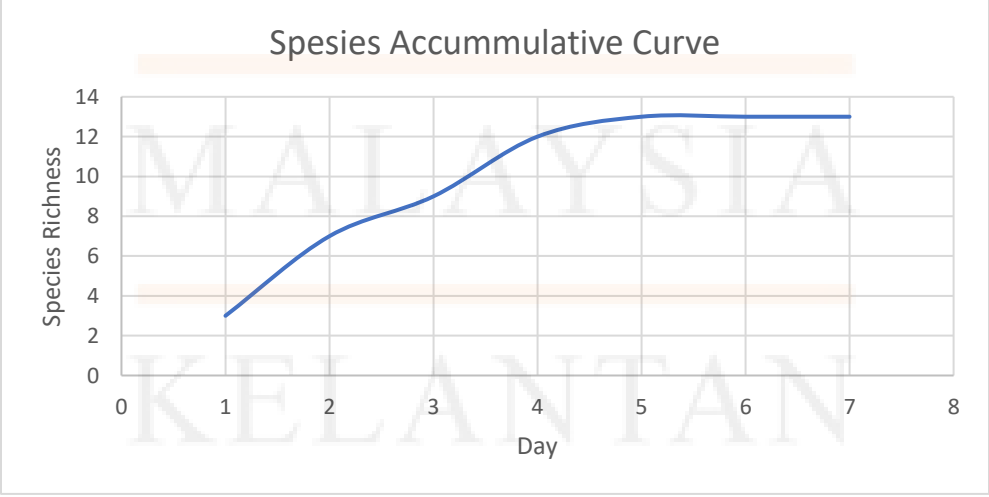


Figure 4.3 Species accumulative curve for Universiti Malaysia Kelantan Jeli campus area.

Figure 4.4 shows the curve represented rising biodiversity of birds with number of species richness on y-axis and days on x-axis for “Kampung Baru Jalan Malaysia” area.

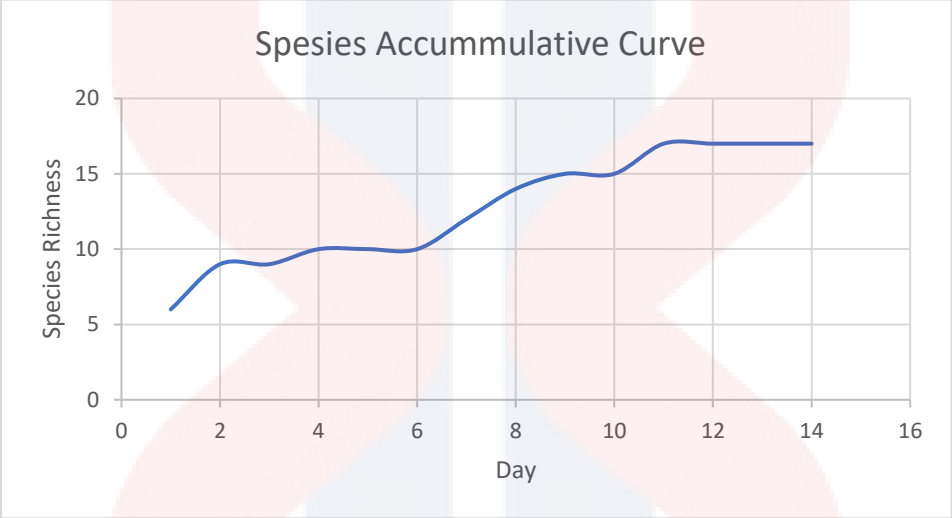


Figure 4.4 Species accumulative curve for “Kampung Baru Jalan Malaysia” area

These two curves are based on the data collected during this study. This curve depicts how species richness increases with the number of days. However, the graph's failure to reach the asymptote may be attributed to two factors: a short sampling period and the uncertainty of weather conditions such as rain. Wet and dry seasons have an indirect effect on bird populations' food resources and habitat suitability (Beerens et al., 2015). It implies that additional surveys and research can be conducted to create a comprehensive bird list for the study area, as there are more bird species to be discovered, observed, and identified.

4.3 Bird Diversity Index

The diversity index item uses the Shannon-Wiener Index (H') and the Pielou's Evenness Index (J'). Tables 4.3 and 4.3 below, respectively, show the diversity indexes of birds at Universiti Malaysia Kelantan Jeli Campus and in the area of "Kampung Baru Jalan Malaysia", Jeli.

		=B5/$B$19	=LN(C5)	
Species name	Frequency	pi	ln pi	pi*ln pi
Yellow-vented bulbul (Pycnonotus goiavier)	3	0.100	-2.303	-0.230
Little spiderhunter (Arachnothera longirostra)	6	0.200	-1.609	-0.322
chestnut-headed bee-eater (Merops leschenaulti)	4	0.133	-2.015	-0.269
brown quail (Synoicus ypsilophorus)	1	0.033	-3.401	-0.113
Common myna/Indian myna (Acridotheres tristis)	2	0.067	-2.708	-0.181
white-throated kingfisher (Halcyon smyrnensis)	2	0.067	-2.708	-0.181
Olive-backed Sunbird (Cinnyris jugularis)	3	0.100	-2.303	-0.230
Purple-naped Spiderhunter (Kurochkinegramma hypogrammicum)	3	0.100	-2.303	-0.230
little bee-eater (Merops pusillus)	1	0.033	-3.401	-0.113
Asian red-eyed bulbul (Pycnonotus brunneus)	1	0.033	-3.401	-0.113
Long-billed spiderhunter (Arachnothera robusta)	2	0.067	-2.708	-0.181
Spotted dove/Eastern spotted dove (Spilopelia chinensis)	1	0.033	-3.401	-0.113
Emerald dove/ Common emerald dove (Chalcophaps indica)	1	0.033	-3.401	-0.113
	30	1		-2.390
			H'=	**2.390**
			Effective number of species (ENS) = EXP (H')	10.911
	N=30		**J'=**	**0.932**

Table 4.3 Shannon-Wiener Index (H') and Pielou's Evenness Index (J') for UMK Jeli

		=B28/$B$46	=LN(C28)	
Species name	**Frequency**	**pi**	**ln pi**	**pi*ln pi**
Yellow-vented bulbul (Pycnonotus goiavier)	6	0.081	-2.512	-0.204
Spotted dove/ Eastern spotted dove (Spilopelia chinensis)	6	0.081	-2.512	-0.204
Green-billed malkoha (Phaenicophaeus tristis)	2	0.027	-3.611	-0.098
White-breasted waterhen (Amaurornis phoenicurus)	1	0.014	-4.304	-0.058
Common myna/ Indian myna (Acridotheres tristis)	4	0.054	-2.918	-0.158
Eurasian tree sparrow (Passer montanus)	7	0.095	-2.358	-0.223
Metallic starling (Aplonis metallica)	18	0.243	-1.414	-0.344
Asian glossy starling (Aplonis panayensis)	13	0.176	-1.739	-0.306
Javan myna (Acridotheres javanicus)	3	0.041	-3.205	-0.130
Zebra dove (Geopelia striata)	3	0.041	-3.205	-0.130
Asian red-eyed bulbul (Pycnonotus brunneus)	2	0.027	-3.611	-0.098
Oriental magpie-robin (Copsychus saularis)	1	0.014	-4.304	-0.058
White-throated kingfisher (Halcyon smyrnensis)	1	0.014	-4.304	-0.058
Emerald dove/ Common emerald dove (Chalcophaps indica)	3	0.041	-3.205	-0.130
Black-naped oriole (Oriolus chinensis)	1	0.014	-4.304	-0.058
Large-tailed nightjar (Caprimulgus macrurus)	2	0.027	-3.611	-0.098
Barred Buttonquail (Turnix suscitator)	1	0.014	-4.304	-0.058
				-2.411
Total	74		**H'=**	**2.411**
			Effective number of species (ENS) = EXP (H')	11.145
	N=74		**J'=**	**0.851**

Table 4.4 Shannon-Wiener Index (H') and Pielou's Evenness Index (J') for Kampung Baru Jalan Malaysia

The Shannon-Wiener index assumes that all species represented in the sample are individuals taken at random from a large population (Shannon & Weaver, 1949). Shannon-Wiener diversity index values typically fall between 1.5 and 3.5 and rarely exceed 4.5; a value close to 4.6 indicates that the number of individuals in a species is equal among all species (Bibi & Ali, 2013). These two sets of data, the Shannon-Wiener Index (H') and Pielou's Evenness Index (J') for UMK Jeli and "Kampung Baru Jalan Malaysia" areas, show interesting snapshots of the diversity of birds in two different environments. They show species richness, total number of individuals, Shannon-Weiner diversity index (H'), maximum diversity (Hmax), and evenness. The "Kampung Baru Jalan Malaysia" area has a higher species richness, with 17 species compared to UMK Jeli's 13 species, indicating a more diverse bird community in the area surveyed. "Kampung Baru Jalan Malaysia"'s significantly larger sample size of 74 individuals, compared to Universiti Malaysia Kelantan Jeli Campus's 30 individuals. So, Table 4.3 shows that the 2.39 Shannon-Wiener index value, which is all the bird species at Universiti Malaysia Kelantan Jeli Campus, shows a big difference in the composition, which could be because people are destroying habitats for these species. Table 4.4 reveals the presence of 2.411 Shannon-Wiener index values, which represent all bird species in the Malaysia Road area. The data shows a slightly higher value compared to the Shannon-Wiener index, which represents all bird species at the Universiti Malaysia Kelantan Jeli Campus. Despite the slight difference, the "Kampung Baru Jalan Malaysia" area exhibits a slightly higher species diversity due to longer bird data collection with five mist nets, spanning two weeks, compared to the UMK Jeli area, which only records data for a week.

However, the maximum diversity (Hmax) is also higher in "Kampung Baru Jalan Malaysia" area (2.833) compared to UMK Jeli (2.565), indicating a greater potential for diversity if all species were equally abundant, where to use the LN (Number of Species) formula. This brings

us to the measure of evenness, where UMK Jeli surpasses “Kampung Baru Jalan Malaysia” area with a value of 0.932 compared to 0.851. Higher evenness in UMK Jeli means that the ecosystem is more balanced and that individuals are spread out more evenly among the species that are present. On the other hand, lower evenness in “Kampung Baru Jalan Malaysia” area means that the distribution is skewed and dominated by a few species, especially the metallic starling and the Asian glossy starling, which together make up a large portion of the total individuals.

The dominance of these starling species in “Kampung Baru Jalan Malaysia” area reduces evenness and hints at potential ecological imbalances or specific environmental conditions favouring these species. In contrast, UMK Jeli's higher evenness portrays a more stable and balanced community structure, with species more evenly represented. This contrast highlights important ecological differences between the two areas surveyed, suggesting that “Kampung Baru Jalan Malaysia” area’s environment might be more prone to disturbances affecting community stability.

In summary, while “Kampung Baru Jalan Malaysia” area exhibits higher species richness and diversity, UMK Jeli shows greater evenness, indicating a more balanced distribution of individuals across species. These differences underscore the importance of considering multiple aspects of biodiversity, such as richness, evenness, and total abundance, to fully understand and compare ecological communities. We recommend further studies, such as longitudinal monitoring and environmental impact analyses, to delve deeper into the factors driving these biodiversity patterns and to inform effective conservation strategies.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Overall, the research plot and direct observation achieved the study's objectives, which were to compare the diversity of species and abundance in the study region, specifically Jeli. A variety of factors, including food availability, migration, and disturbance, heavily influence the diversity and quantity of birds in the study region. The diversity of rainfall, seasonal variations in the amount of food resources, and forest vegetation all contribute to the richness of bird species (Gaston et al., 2000; Hurlbert, 1971).

Based on the results recorded in this study, while “Kampung Baru Jalan Malaysia” area exhibits higher species richness and diversity, UMK Jeli shows greater evenness, indicating a more balanced distribution of individuals across species. These differences underscore the importance of considering multiple aspects of biodiversity, such as richness, evenness, and total abundance, to fully understand and compare ecological communities. In this study, the appearance of the Bulbul and Spiderhunter families demonstrates that the study area at UMK Jeli is in the midst of regeneration and is highly disturbed. This is due to the species' commensal presence around human settlements (Ramli et al., 2009). Certain studies suggest that long-untouched forest reserves can significantly contribute to large-scale conservation.

According to the results of a comparison between two different study areas in the Jeli area, there is a diversity of the same and different bird species in each area. Research at UMK Jeli takes place in hill dipterocarp forest, lowland dipterocarp forest, and secondary forest. Researchers

conduct their research in forest areas near human settlements in the “Kampung Baru Jalan Malaysia” area. This demonstrates the differences in the bird species found in both areas (Sains, 2005).

5.2 Recommendation

We can improve the list of birds in this study by adding a method of direct observation. Direct observation appears to be a more effective method for recording the variety of birds in the study region than mist-netting. On the other hand, direct observation has a better success rate than the mist net technique, yet each method has pros and cons (Ramli et al., 2009). Extending the sample survey period can also guarantee data consistency, which will enable the best interpretation of the evenness, diversity, and richness of studies on avifauna in a particular area. We advise conducting more surveys to compile an exhaustive list of birds for the research region. However, given that this study took place in the first part of May, the current bird migration is somewhat limited. It is possible to do additional research in the future regarding the diversity of migrating birds in the study area. However, given that this study took place in early May, the current bird migration is relatively low. In the future, perhaps, we can conduct further research on the diversity of migratory birds in the study area. Rich vegetation is the key factor that allows for the existence of numerous species. As a result, ecosystem management must raise awareness of the negative effects of bird diversity and the pressing need to preserve bird diversity by safeguarding protected areas' natural habitats. In other words, this activity both indirectly improves the quality of human and animal populations in the study area and increases the diversity of birds in that area (Clergeau et al., 2001).

Furthermore, local communities in Jeli are unaware of the value of these species because they kill them for food or hunt game birds, and they are ignorant of sustainable management because of high rates of illiteracy and a lack of exposure to significant bird species. Campaigns or activities aimed at addressing the issue should involve people of all ages. Therefore, we can use special days like World Migratory Bird Day and Bird Day, observed every January 5, to raise awareness and encourage people to practice sustainability in their daily lives.Cooperation between a variety of stakeholders, including land surveyors, ecologists, social scientists, environmentalists, communities, and birdwatching organizations, is therefore necessary to guarantee the maintenance of bird diversity. The ultimate goal of this work is to develop standard monitoring protocols, which will aid in assessing the environmental stability of the area and predicting the impact of tropical forest degradation on avifauna population structure.

REFERENCE

Arizaga, J., Deán, J. I., Vilches, A., Alonso, D., & Mendiburu, A(2011, August). Monitoring communities of small birds: a comparison between mist-netting and counting. *Bird Study*, *58*(3), 291–301. https://doi.org/10.1080/00063657.2011.586415

Azman, N. M., Latip, N. S. A., Sah, S. A. M., Akil, M. A. M. M., Shafie, N. J., & Khairuddin, N. L(2011). Avian diversity and feeding guilds in a secondary forest, an oil palm plantation and a paddy field in riparian areas of the Kerian River Basin, Perak, Malaysia. Tropical Life Sciences Research, 22(2), 45.

Bird Pictures & Facts (2012). National Geographic. https://www.nationalgeographic.com/animals/birds

Beerens, J. M., Noonburg, E. G., & Gawlik, D. E(2015). Linking dynamic habitat selection with wading bird foraging distributions across resource gradients. PloS one, 10(6), e0128182.

Bibi, F., & Ali, Z(2013). Measurement of diversity indices of avian communities at Taunsa Barrage Wildlife Sanctuary, Pakistan. The Journal of Animal & Plant Sciences, 23(2), 469-474.

Chandler, A(2020, January). The Oxford handbook of the Oxford Movement. Edited by Stewart J. Brown, Peter B. Nockles and James Pereiro. Pp. xx + 646. New York–Oxford: Oxford University Press, 2017. £95. 978 0 19 958018 7. *The Journal of Ecclesiastical History*, *71*(1), 210–211. https://doi.org/10.1017/s0022046919001829

Clergeau, P., Jokimäki, J. & Savard, J-P.L(2001).Are urban bird communities influenced by thebird diversity of adjacent landscapes. Journal of Applied Ecology, 38: 1122–1134.

Duncan, A.I.L., David. B., and Maketab.M(2014). A National Red List for The Birds of Malaysia. Journal of Wildlife and Parks, 28: 41-49.

Emmitt, S(2023, August 18). *Building Health and Wellbeing*. Taylor & Francis.

Fernández, M. S., Wang, X., Vremir, M., Laurent, C., Naish, D., Kaiser, G., & Dyke, G(2019, February 13). A mixed vertebrate eggshell assemblage from the Transylvanian Late Cretaceous. *Scientific Reports*, *9*(1). https://doi.org/10.1038/s41598-018-36305-3

Fox, R. J., Fromhage, L., & Jennions, M. D(2019, January 28). Sexual selection, phenotypic plasticity and female reproductive output. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *374*(1768), 20180184. https://doi.org/10.1098/rstb.2018.0184

Gaston, K. J., Blackburn, T. M., Greenwood, J. J., Gregory, R. D., Quinn, R. M., & Lawton, J. H(2000). Abundance–occupancy relationships. Journal of Applied Ecology, 37, 39-59.

Ghasemi, S(2015). A rapid assessment of logging effects on bird species in Kelantan forests areas, Malaysia (No. e1487). PeerJ PrePrints.

Gibbons, J(1994). *An Introduction to the Bird− Meertens Formalism*. https://www.cs.ox.ac.uk/publications/publication2330-abstract.html

Hammers, M., Kingma, S. A., Spurgin, L. G., Bebbington, K., Dugdale, H. L., Burke, T., Komdeur, J., & Richardson, D. S(2019, March 21). Breeders that receive help age more slowly in a cooperatively breeding bird. *Nature Communications*, *10*(1). https://doi.org/10.1038/s41467-019-09229-3

Hardy, C., de Rivera, C., Bliss-Ketchum, L., Butler, E., Dissanayake, S., Horn, D., Huffine, B., Temple, A., Vermeulen, M., Wallace, H., & Karps, J. (2022). Ecosystem Connectivity for Livable Cities: a Connectivity Benefits Framework for Urban Planning. Ecology and Society, 27(2). https://doi.org/10.5751/es-13371-270236

Hawa, A., Azhar, B., Top, M. M., & Zubaid, A(2016, August 9). *Depauperate Avifauna in Tropical Peat Swamp Forests Following Logging and Conversion to Oil Palm Agriculture: Evidence from Mist-netting Data*. Wetlands. https://doi.org/10.1007/s13157-016-0802-3

Hendy, J., Welker, F., Demarchi, B., Speller, C., Warinner, C., & Collins, M. J(2018, March 26). A guide to ancient protein studies. *Nature Ecology & Evolution*, *2*(5), 791–799. https://doi.org/10.1038/s41559-018-0510-x

Hildén, O(1965). Habitat selection in birds: A review. Annales Zoologici Fennici, 2(1), 53–75. https://www.jstor.org/stable/23730835

Jeyarajasingam, A(2012). A field guide to the birds of Peninsular Malaysia and Singapore. Oxford University Press.

Jetz, W., Thomas, G. H., Joy, J. B., Hartmann, K., & Mooers, A. O(2012, October 31). The global diversity of birds in space and time. *Nature*, *491*(7424), 444–448. https://doi.org/10.1038/nature11631

Klaver, J. M. I(2020, December 26). The Oxford Handbook of the Oxford Movement. Edited by Stewart J.Brown, Peter B.Nockles, and JamesPereiro. Pp. xx, 646, Oxford University Press, 2017, £95.00/$150.00. *The Heythrop Journal*, *62*(1), 128–130. https://doi.org/10.1111/heyj.13696

Kozma, J. M., Kroll, A. J., & Lucas, K. S(2022, September 29). Annual survival of adult White-headed Woodpeckers (Dryobates albolarvatus) in ponderosa pine forest with a history of forest management. *The Wilson Journal of Ornithology*, *134*(3). https://doi.org/10.1676/22-00014

Kratter, A. W(2005, April 1). The Howard and Moore Complete Checklist of the Birds of the World. *The Auk*, *122*(2), 712–714. https://doi.org/10.1093/auk/122.2.712

La Sorte, F. A., Horton, K. G., Nilsson, C., & Dokter, A. M(2018, December 9). Projected changes in wind assistance under climate change for nocturnally migrating bird populations. *Global Change Biology*, *25*(2), 589–601. https://doi.org/10.1111/gcb.14531

Lang, D. A. I., D.Bakewel, and Mohamed, M(2014). A National Red List for the Birds of Malaysia. Journal of Wildlife and Parks, 28, 41–49.

Leonard, M. P., & Pauli, B. P(2019, April 9). Red-bellied Woodpeckers (Melanerpes carolinus) scavenging: A possible alternate dietary substrate. *The Wilson Journal of Ornithology*, *131*(1), 187. https://doi.org/10.1676/18-48

MacArthur, R. H., MacArthur, J. W., & Preer, J(1962, May). On Bird Species Diversity. II. Prediction of Bird Census from Habitat Measurements. *The American Naturalist*, *96*(888), 167–174. https://doi.org/10.1086/282219

MacArthur, R. H., & MacArthur, J. W(1961). On Bird Species Diversity. Ecology, 42(3), 594–598. https://doi.org/10.2307/1932254

Medway, L(1973). A ringing study of migratory Barn Swallows in West Malaysia. Ibis, 115(1), 60-86.

MNS-Bird Conservation Council(2010). A checklist of the birds of the Peninsular Malaysia. Kuala Lumpur: Malaysian Nature Society(MNS Conservation Publication No.10).

Ng, W. H., Fink, D., La Sorte, F. A., Auer, T., Hochachka, W. M., Johnston, A., & Dokter, A. M(2022, February 20). Continental-scale biomass redistribution by migratory birds in response to seasonal variation in productivity. *Global Ecology and Biogeography*, *31*(4), 727–739. https://doi.org/10.1111/geb.13460

Nectariniidae | Sunbirds, Hummingbirds & Flowerpeckers(1998, July 20). Encyclopedia Britannica. https://www.britannica.com/animal/Nectariniidae

Safford, R., Skerrett, A., & Hawkins, F(2019, December 12). *Birds of Madagascar and the Indian Ocean Islands*. Bloomsbury Publishing.

Peh, K. S-H., De jong, J., Sodhi, N. S., Lim, S. L-H., and Yeap, C., A-M(2005). Lowland rainforest avifauna and humam disturbance: persistence of primary forest birds in selectively logged forests and mixed- rural habitat of Southern Peninsular Malaysia. Biological conservation, 123, 489-505

Ramli, R., Ya'cob, Z., & Hashim, R(2009). Diversity of Birds In Kenaboi Forest Reserve, Jelebu, Negeri Sembilan, Malaysia. Malaysian Journal of Science, 28(4), 465-480.

Richardson, G. T(1985). Illustrations: Everybody's Complete and Practical Guide Springer Science & Business Media.

Sains, S(2005). http://eprints.usm.my/29285/1/Kajian_perbandingan_komuniti_burung_di_kawasan_hutan_dibalak.pdf

Sarma, P., & Das, D(2015). Application of Shannon's Index to Study Diversity with Reference to Census Data of Assam. Asian Journal of Management Research, 5(4), 620-628.

Shannon, C. E. & W. Weaver (1949). The Mathematical Theory of Communication. University of Illinois Press, 4p Urbana, Illinois. 14p.

Sutherland, W. J., Newton, I., & Green, R(2004). Bird ecology and conservation: a handbook of techniques (No. 1). Oxford University Press.

Tellería, J. L., Hernández-Lambraño, R. E., & Carbonell, R(2021, August 3). Ecological and geographical marginality in rear edge populations of Palaearctic forest birds. *Journal of Biogeography*, *48*(10), 2538–2549. https://doi.org/10.1111/jbi.14219

Vallejo, B., Aloy, A. B., & Ong, P. S(2009, February 1). *The distribution, abundance and diversity of birds in Manila's last greenspaces*. Landscape and Urban Planning; Elsevier BV. https://doi.org/10.1016/j.landurbplan.2008.10.013

Wells, D.R(2007). The birds of the Thai-Malay Peninsular Passerines. A&C Black. London (Vol.2).

Yeap, C.A., Sebastian, A.C. and Davison, G.W.H(2007). Directory Of Important Bird Areas In Malaysia: Key Sites For Conservation. Kuala Lumpur. Malaysian Nature Society.(MNS Conservation Publication No.8).

Zahidin, M. A., Bartholomew, C. V., & Abdullah, M. T(2017). Fauna in Setiu Wetland Forest. Kenyir Research Institut 16p.

ZOU, F., CHEN, G., & YANG, Q(2010, December 30). Impacts of bird abundance, activity height and light intensity on the number of birds captured by mist netting. *Chinese Birds*, *1*(4), 221–229. https://doi.org/10.5122/cbirds.2010.0017

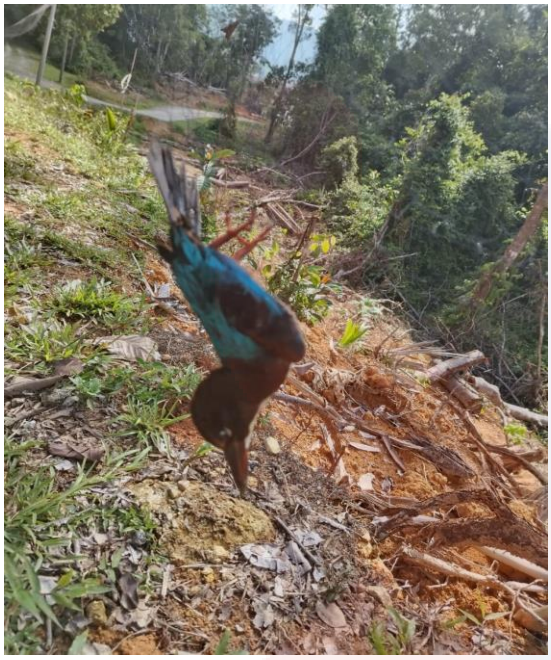
APPENDIX A

Figure of Final Years Project

Figure A.1 Study area 1: UMK Jeli

Chestnut-headed bee-eater *(Merops leschenaulti)*

Brown quail *(Synoicus ypsilophorus)*



white-throated kingfisher *(Halcyon smyrnensis)*

Long-billed spiderhunter *(Arachnothera robusta)*

Purple-naped Spiderhunter *(Kurochkinegramma hypogrammicum)*

Yellow-vented bulbul *(Pycnonotus goiavier)*

Figure A.2 Study area 2: “Kampung Baru Jalan Malaysia”

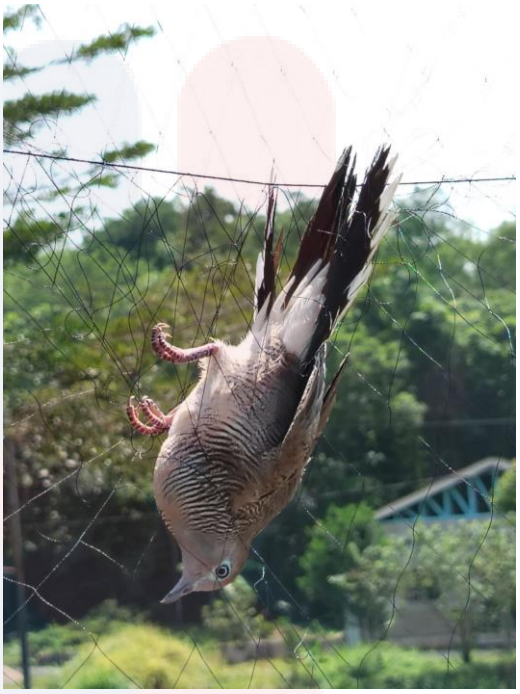
Brown quail *(Synoicus ypsilophorus)*

Black-naped oriole *(Oriolus chinensis)*

Emerald dove *(Chalcophaps indica)*

Spotted dove *(Spilopelia chinensis)*

oriental magpie-robin *(Copsychus saularis)*



Zebra dove *(Geopelia striata)*

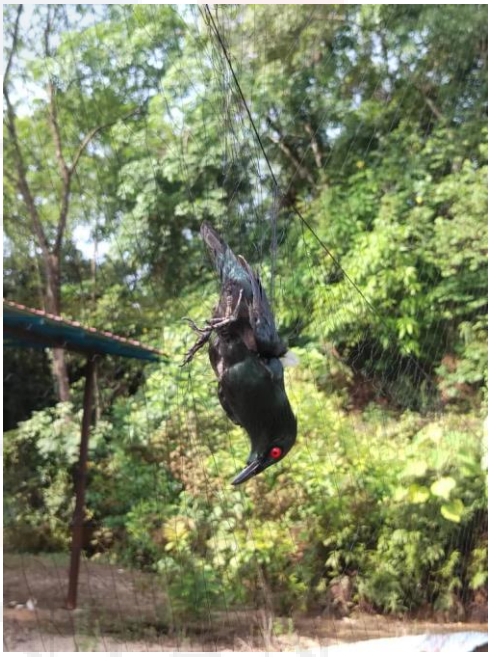
Asian red-eyed bulbul *(Pycnonotus brunneus)*

Javan myna *(Acridotheres javanicus)*

White-breasted waterhen (Amaurornis phoenicurus)

Green-billed malkoha (Phaenicophaeus tristis)

yellow-vented bulbul *(Pycnonotus goiavier*)



Metallic starling *(Aplonis metallica)*

APPENDIX B

Table of Final Year Project Planning

Date	Activity
FYP I	
08/10/2023-25/11/ 2023	Selection of Project Title Writing Research Proposal Completing (Chapter 1,2,3)
11-12/12/ 2024	Research Proposal Presentation
20 /01/2024	Final Draft Proposal Submission (Chapter 1,2,3)
FYP II	
25/7/2024- 01/04/2024	Preparing materials for sampling Mist-net
02/05 2024 -02/06/ 2024	Conducting Research Work Identification species of birds
06/ 06/ 2024	Final Report Writing submission (Chapter 4,5)
25-27/06/2024	Final Presentation FYP II
27/07/2024	Hardbound submission