



DETERMINATION OF WATERBIRD DIVERSITY IN SUNGAI KINTA, IPOH, PERAK.

by

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DECLARATION

I declare that this thesis entitled “Determination of Waterbird Diversity in Sungai Kinta, Ipoh, Perak” 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.

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Date : 7 August 2024

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Determination of Waterbird Diversity in Sungai Kinta, Ipoh, Perak

ABSTRACT

A field study on waterbird diversity was conducted in Sungai Kinta, Ipoh, Perak. Sungai Kinta is a major river in Perak, Malaysia where it flows through Ipoh and passes through the Kinta Valley, which is rich in tin mining. The study aims to determine the waterbird diversity in Sungai Kinta, Ipoh, Perak. 14 species from 7 families were recorded from 19 February 2024 to 10 March 2024 using the point count method and visual observation. The point count survey method is the simplest and most uniform way to count birds across the study area over a specified period. This method involved selecting 10 fixed points along the 8 km stretch of Sungai Kinta, where waterbird species and individuals within a 60 m radius were counted and recorded at 10-minute intervals at each point. The bird was identified using a field guidebook. 6 species were recorded as resident migrant, 3 species were migrant, 4 species were recorded as resident, and 1 species was vagrant. Asian Openbill Stork (*Anastomus oscitans*) was recorded as the highest frequency since its appearance is easy to be seen from afar, and the presence of aquatic habitat. Meanwhile, the highest frequency of the waterbird's family was Ardeidae. All waterbird species were listed as Least Concern in the IUCN Red List. The data was recorded and analyzed using Simpson's Index (D), Shannon-Weiner Index (H'), and Pielou's Evenness Index (J). The value of D was 0.87, H' was 2.35, and J was 0.85. The index values for waterbird diversity in Sungai Kinta represent the variety and richness of waterbird species in the area. These indexes contribute to determining the health of the ecosystem and the success of conservation initiatives. In addition, Sungai Kinta, Ipoh, Perak is home to a diverse range of waterbirds, making it valuable for biodiversity conservation and management.

Penentuan Kepelbagaian Burung Air di Sungai Kinta, Ipoh, Perak.

ABSTRAK

Kajian lapangan berkaitan kepelbagaian burung air telah dijalankan di Sungai Kinta, Ipoh, Perak. Sungai Kinta ialah sungai utama di Perak, Malaysia di mana ia mengalir melalui Ipoh dan melalui Lembah Kinta, yang kaya dengan perlombongan bijih timah. Kajian ini bertujuan untuk menentukan kepelbagaian burung air di Sungai Kinta, Ipoh, Perak. Sebanyak 14 spesies daripada 7 famili direkodkan dari 19 Februari 2024 hingga 10 Mac 2024 menggunakan kaedah pengiraan titik dan pemerhatian visual. Kaedah pengiraan titik digunakan untuk memerhati dan mengenal pasti spesies burung air yang terdapat di Sungai Kinta. Kaedah pengiraan titik merupakan cara yang paling mudah dan seragam untuk menghitung burung di seluruh kawasan kajian dalam tempoh yang dinyatakan. Kaedah ini melibatkan pemilihan 10 titik tetap di sepanjang 8 km Sungai Kinta, di mana spesies burung air dan individu dalam radius 60 m dikira dan direkodkan pada selang 10 minit pada setiap titik. Burung itu dikenal pasti menggunakan buku panduan lapangan. 6 spesies direkodkan sebagai pendatang pemastautin, 3 spesies adalah pendatang, 4 spesies direkodkan sebagai pemastautin, dan 1 spesies adalah gelandangan. Burung Botak Siput (*Anastomus oscitans*) dicatatkan sebagai frekuensi tertinggi kerana penampilannya mudah dilihat dari jauh, dan kehadiran habitat akuatik. Sementara itu, kekerapan tertinggi keluarga burung air ialah Ardeidae. Semua spesies burung air telah disenaraikan sebagai Kurang Kebimbangan dalam Senarai Merah IUCN. Data tersebut direkodkan dan dianalisis menggunakan Indeks Simpson (D), Indeks Shannon-Weiner (H'), dan Indeks Keseragaman Pielou (J). Nilai D ialah 0.87, H' ialah 2.35, dan J ialah 0.85. Nilai indeks kepelbagaian burung air di Sungai Kinta mewakili kepelbagaian dan kekayaan spesies burung air di kawasan ini. Nilai ini menyumbang dalam menentukan kesihatan ekosistem dan kejayaan inisiatif pemuliharaan. Selain itu, Sungai Kinta, Ipoh, Perak adalah rumah kepada pelbagai jenis burung air, menjadikannya berharga untuk pemuliharaan dan pengurusan biodiversiti.

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TABLE OF CONTENT

DECLARATION	i
ACKNOWLEDGEMENT	ii
ABSTRACT	iii
ABSTRAK	iv
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF ABBREVIATIONS	ix
LIST OF SYMBOLS	x
CHAPTER 1	1
INTRODUCTION	1
1.1 Background of Study	1
1.2 Problem Statement	2
1.3 Objective	3
1.4 Scope of Study	4
1.5 Significant of Study	4
CHAPTER 2	6
LITERATURE REVIEW	6
2.1 Waterbirds	6
2.2 Diversity of Waterbird in Malaysia	6
2.3 Current status and trends of the waterbird diversity and distribution in Sungai Kinta	7
2.5 The methods and techniques for measuring and monitoring the waterbird diversity and distribution in various habitats and regions	8
2.7 Threats to waterbird diversity	10
CHAPTER 3	11

MATERIAL AND METHOD	11
3.1 Study Area	11
3.2 Material	13
3.3 Data Collection	14
3.3.1 Point Count Survey	14
3.4 Data Analysis	15
3.4.1 Diversity Indices	15
CHAPTER 4	18
RESULTS AND DISCUSSION	18
4.1 Species Richness	18
4.2 Waterbird’s Family	26
4.3 Waterbird’s Diversity Index	28
CHAPTER 5	30
CONCLUSION AND RECOMMENDATIONS	30
5.1 CONCLUSION	30
5.2 RECOMMENDATIONS	31
REFERENCES	32

LIST OF TABLES

No.	TITLE	PAGE
4.1	List of waterbird species found in Sungai Kinta, Ipoh, Perak with its IUCN Red List status.	23
4.2	Values of Simpson's Index (D), Shannon-Weiner Index (H'), and Pielou's Evenness Index (J) for waterbird diversity in Sungai Kinta, Ipoh, Perak.	28

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KELANTAN

LIST OF FIGURES

No.	TITLE	PAGE
3.1	Map of Sungai Kinta, Ipoh, Perak depicting 10 count points at the study site	12
3.2	Some waterbirds found in Sungai Kinta	12
3.3	The observer will stand in the middle and count the waterbird that can be found within a distance radius of 60 m in 10 minutes	15
4.1	Grey Heron (<i>Ardea cinerea</i>)	20
4.2	Asian Openbill Stork (<i>Anastomus oscitans</i>)	20
4.3	Little Cormorant (<i>Phalacrocorax niger</i>)	20
4.4	Chinese Pond Heron (<i>Ardeola bacchus</i>)	21
4.5	White-throated Kingfisher (<i>Halcyon smyrnensis</i>)	21
4.6	Purple Heron (<i>Ardea purpurea</i>)	21
4.7	Black-crowned Night Heron (<i>Nycticorax nycticorax</i>)	22
4.8	Red-wattled Lapwing (<i>Vanellus indicus</i>)	22
4.9	Little Egret (<i>Egretta garzetta</i>)	22
4.10	Percentage of Waterbird's Families in Sungai Kinta, Ipoh, Perak	26
4.11	Vegetation areas in Sungai Kinta	27
4.12	Species Accumulative Curve of Waterbird Families in Sungai Kinta, Ipoh, Perak	28

LIST OF ABBREVIATIONS

IBA	Important Bird Area
MNS	Malaysian Nature Society
NGO	Non-Government Organization
AWC	Asian Waterbird Census
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
RM	Resident Migrant
M	Migrant
R	Resident
V	Vagrant
LC	Least Concern
SAC	Species Accumulative Curve
D	Simpson's Index
H'	Shannon-Weiner Index
J	Pielou's Evenness Index
JPS	Jabatan Pengairan dan Saliran
km	Kilometre
m	Metre

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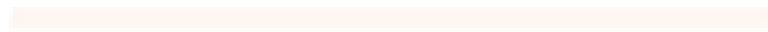
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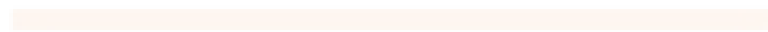
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CHAPTER 1

INTRODUCTION

1.1 Background of Study

This study aimed to determine the diversity of waterbirds in Sungai Kinta, a river in Ipoh, Perak, Malaysia. Waterbirds are a broad group of avian species intimately connected with aquatic habitats and play an important role in the health and sustainability of these ecosystems. One of the most obvious physical characteristics is their webbed or lobed feet, which allow for effective swimming; for example, ducks and swans have webbed feet, whilst coots and grebes have lobed toes that help them navigate soft, uneven ground. In addition, waterbirds have specialised bills adapted to their eating habits, such as ducks' broad, flat bills for sifting water and herons' long, pointed bills for spearing fish.

Previous studies have shown that waterbirds include a diverse range of species, such as beautiful wading herons, magnificent swans, speedy, agile ducks, and attractive flamingos (Aik et al., 2004). They are not only beautiful to look at, but they also serve as important indicators of the general health of aquatic environments such as wetlands, lakes, rivers, and shorelines (Purify et. al., 2020). However, there is a lack of information on the waterbird diversity in Sungai Kinta, a river that flows through the city of Ipoh, the capital of Perak state. Therefore, this study aimed to fill this gap by determining the waterbird diversity in Sungai Kinta and its relationship with the river's ecological conditions.

The research questions that this study aimed answer are:

1. What are the waterbird species present in Sungai Kinta?
2. How abundant and distributed are the waterbirds in Sungai Kinta?

The hypotheses that this study will test are:

1. There is a high diversity of waterbird species in Sungai Kinta.
2. The waterbird abundance and distribution in Sungai Kinta vary according to the season, time of day, and location.

This study is significant because it provide baseline data on the waterbird diversity in Sungai Kinta, a valuable indicator of the river's ecological health and sustainability. This study contributes to the conservation and management of waterbirds and their habitats in Malaysia and beyond.

1.2 Problem Statement

The problem that this study addressed was the lack of comprehensive and updated information on the waterbird diversity in Sungai Kinta, a major river in Perak, Malaysia. Several causes contribute to this problem including the rapid urbanization and industrialization of the Kinta Valley, which has resulted in habitat loss, fragmentation, and degradation for waterbirds and other wildlife (Xu et al., 2022). Additionally, the limited and outdated surveys and monitoring of waterbirds in Sungai Kinta, have failed to capture the current status and trends of the avian populations and their habitat.

The consequences of this problem are considerable and diverse. The potential decline and extinction of waterbird species in Sungai Kinta would reduce the biodiversity and ecosystem services of the river and its surroundings. Furthermore, the difficulty in developing and implementing effective conservation and management strategies for waterbirds and their habitats in Sungai Kinta would jeopardize the ecological and socio-economic value of the river and its resources.

The solution that this study provided was to determine the waterbird diversity in Sungai Kinta and to examine the factors that influenced it. The waterbird species present in Sungai Kinta were identified and their abundance and distribution were estimated. Baseline data and recommendations were provided for conserving and managing waterbirds and their habitats in Sungai Kinta and beyond.

This problem is important because it enhance the scientific knowledge and understanding of the waterbird diversity in Sungai Kinta, which is a valuable indicator of the river's ecological health and sustainability. This problem is relevant because it contributes to the global efforts to conserve and protect waterbirds and their habitats, which are facing multiple threats and challenges from human activities and environmental changes.

1.3 Objective

The objectives of this research are:

- to determine the waterbird diversity in Sungai Kinta, Ipoh, Perak.

1.4 Scope of Study

The scope of this study was to determine the waterbird diversity in Sungai Kinta and to examine the factors that influence it. This study focused on waterbird diversity along the Sungai Kinta, a river that flows through the city of Ipoh, the capital of Perak state in Malaysia. The main method used to identify and count the waterbird species present in Sungai Kinta was a point count survey. This study covered 21 days, from 19 February to 10 March 2024.

This study was based on the assumption that Sungai Kinta was a representative and accessible river in Perak that hosts a variety of waterbird species and habitats. The point count survey was considered a reliable and efficient method to estimate the waterbird diversity and distribution in Sungai Kinta. Additionally, 21 days was deemed a sufficient and feasible duration to conduct the study and obtain meaningful and accurate results.

The scope of this study is measured by the number and diversity of waterbird species identified and counted in Sungai Kinta and the temporal patterns of waterbird abundance and distribution in Sungai Kinta. Several indicators and criteria were used for this scope. The number and diversity of waterbird species were calculated using species richness, evenness, and diversity indices, such as the Shannon-Wiener index, the Simpson index, and the Pielou index.

1.5 Significant of Study

The significance of this study was to enhance the scientific knowledge and understanding of the waterbird diversity in Sungai Kinta, which is a valuable indicator

of the river's ecological health and sustainability. The study's relevance to the identified problem statement and research gap became clear after learning that waterbird diversity in Sungai Kinta has been declining due to various human and environmental factors such as urbanization, industrialization, pollution, habitat loss, and degradation. Moreover, the study addressed the existing research gap characterized by a lack of comprehensive and updated information on the waterbird diversity in Sungai Kinta, which makes it difficult to develop and implement effective conservation and management strategies for waterbirds and their habitats.

Furthermore, the significance of this study was measured by the number and diversity of waterbird species identified and counted in Sungai Kinta as well as the temporal patterns of waterbird abundance and distribution. The indicators or criteria for this significance were the number and diversity of waterbird species calculated using species richness, evenness, and diversity indices, such as the Shannon-Wiener index, Simpson's index, and the Pielou index.

CHAPTER 2

LITERATURE REVIEW

2.1 Waterbirds

Waterbirds are bird species that spend a significant portion of their lives in or near water for breeding, nesting, and feeding (Basaula et al., 2023). Waterbirds are sometimes defined as those that flutter about freshwater. Additionally, some waterbirds appear around bodies of water depending on the season and spend the rest of the year on land. Then, there are the full-time dwellers, whose biological composition has adapted for underwater existence.

Waterbirds are important components of freshwater wetlands and have a variety of behavioral features that make them relevant to study in both their different habitats (Rajpar, 2009). Waterbirds also play crucial roles in many aquatic ecosystems as predatory creatures, herbivores, and carriers of seeds, invertebrates, and nutrients (Green & Elmberg, 2013). According to Green (2015), waterbirds have been recognized as important vectors of invaders since Darwin's time, but pioneering research has been overlooked in the creation of current invasion biology, which tends to disregard this route of dispersal.

2.2 Diversity of Waterbird in Malaysia

Waterbirds are classified into three categories: true aquatic waterbirds, semi-aquatic waterbirds, and migratory aquatic waterbirds (Birds, 2018). Out of 815 bird species, 170 waterbird species can be found in Malaysia (Zakaria & Rajpar, 2013).

There are now 91 wetlands in Malaysia, 55 of which are in Peninsular Malaysia and 18 each in Sabah and Sarawak. These wetlands comprise numerous islands, coastal wetlands, and interior wetlands that sustain diverse types of waterbirds and migratory birds, as well as other flora and wildlife (Rahman & Ismail, 2018).

2.3 Current status and trends of the waterbird diversity and distribution in Sungai Kinta

The current status and trends of waterbird diversity and distribution in Sungai Kinta, a river that flows through the city of Ipoh, the capital of Perak state in Malaysia, are unknown and under-studied. There is a lack of comprehensive and updated information on waterbird diversity in Sungai Kinta, making it difficult to develop and implement effective conservation and management strategies for waterbirds and their habitats. Existing studies on waterbirds in Sungai Kinta are limited and outdated, failing to capture the current status and trends of avian populations and their habitats. According to the Asian Waterbird Census, a survey conducted in 2015 recorded 23 species belonging to 11 families in Sungai Kinta. However, this survey was conducted at only four sampling sites and did not include any information on the water quality and habitat characteristics of Sungai Kinta. Therefore, this study aims to fill these gaps overcome these challenges, and contribute to the conservation and management of waterbirds and their habitats in Sungai Kinta and beyond. This study will also provide new insights and information on waterbird diversity, ecology, and evolution in Sungai Kinta and other similar regions.

2.4 Ecosystems and Habitat

All waterbirds are wetland-dependent birds that primarily use wetlands for breeding, nesting, and foraging. Wetlands in Malaysia are among the most varied and

diverse ecosystems in the country, characterized by rich of plant diversity and composition, unpredictable rainfall patterns, and the presence of various surrounding landscapes (Rajpar & Zakaria, 2014). The size of a wetland also affects waterbird richness and abundance. Furthermore, several non-habitat-related variables, such as nest predation, competition within and between species, intraspecific attraction, and food constraints, influence habitat selection in waterbird species (Rajpar, 2009).

2.5 The methods and techniques for measuring and monitoring the waterbird diversity and distribution in various habitats and regions

Measuring and monitoring the diversity and distribution of waterbirds in various habitats and regions require appropriate methods and techniques, such as point count surveys, remote sensing, and visual observations. Each method and technique has its own advantages and disadvantages and faces different challenges and limitations.

For instance, point count surveys are a reliable and efficient methods to estimate the diversity and distribution of waterbirds in a given area, but they require trained observers, standardized protocols, and adequate sampling design. This approach is the simplest and most consistent way to count birds in the study area on a regular basis (Aainaa, 2023). A stationary observer conducts point counts by recording all birds spotted from a certain place over a specified time period (Pascoe et al., 2019). According to Wetlands International (2010), waterbird counting equipment is basic, consisting of visual aids for proper identification and precise counting, as well as a way of documenting observations, namely the number of birds of various species observed. This method is carried out in the first three hours after sunrise because their

movement is highly active (Volpato et al., 2009; Rajpar & Zakaria, 2014; Pasang, 2017; Aainaa, 2023).

Remote sensing is a method that uses satellite or radar images to detect and map waterbirds and their habitats, but it is limited by the resolution, accuracy, and availability of the images. The findings support the use of remote sensing to identify possible markers of waterbird variety that supplement logistically difficult ground studies and provide fresh theories on variables affecting community distributions (Dronova et al., 2016).

Binoculars are excellent tools for observing and identifying waterbird species. For clear vision, choose a pair of binoculars with an 8x or 10x magnification and an objective lens diameter of 42mm or larger. This will provide an excellent balance of magnification and field of vision (White, 2021).

2.6 Conservation efforts

Important Bird Area (IBAs) are locations of worldwide significance for bird conservation at the global, regional, or sub-regional levels that are selected following standardized criteria. BirdLife International's IBA program seeks to locate, monitor, and preserve a global network of IBAs for the protection of the world's birds and other biodiversity (Aik et al., 2004). The Malaysian Nature Society (MNS) is the country's oldest and biggest membership-based environmental NGO. MNS strives to promote the preservation of Malaysia's natural heritage by advocating for the conservation of species, ecosystems, and landscapes through public engagement (North-Central, 2021). The Asian Waterbird Census (AWC) was created to provide recent data on the conservation status of waterbird species and raise awareness of the value of waterbirds and their wetland habitats at all levels (Tahir & Yong, 2015).

2.7 Threats to waterbird diversity

Waterbirds encounter a number of threats that have the potential to reduce their variety and population size. Natural changes in habitat due to urbanization can result in the loss of critical wetlands, coastal regions, and other habitats used by waterbirds (Rajpar & Zakaria, 2014; Luo et al., 2019). Additionally, the population of waterbirds decreases due to pollution, infrastructure development, human activities, and recreational activities (Rajpar & Zakaria, 2014; Basaula et al., 2023).



CHAPTER 3

MATERIAL AND METHOD

3.1 Study Area

The study area for this research was Sungai Kinta (4.5756940N, 101.0669986E) a major river in Perak, Malaysia, through which it flows the state capital of Ipoh. Sungai Kinta traverses the Kinta Valley, renowned for its tin mining riches. The study area spanned approximately 8 km, extending from Pengkalan, Ipoh to Kampung Temiang, Ipoh.

This study area was chosen due to its diverse waterbird species and habitats, as well as its accessibility and suitability for conducting point count surveys. It is pertinent and indicative of the research objectives and inquiries, mirroring the ecological and socio-economic dynamics of the river and its environs.

The study area's assessment revolves around the number and diversity of waterbird species in Sungai Kinta. Species richness, evenness, and diversity indices are selected for analyzing waterbird diversity since they offer a comprehensive view of the ecosystem's health. Species richness counts the number of different species, indicating biodiversity, while evenness measures how evenly individuals are distributed among species, indicating balance in the ecosystem. Diversity indices, such as the Shannon-Weiner and Simpson's Index, combine these aspects to reflect overall diversity and dominance. The tally and variety of waterbird species are assessed using indices of species richness, evenness, and diversity, such as the Shannon-Wiener index, the Simpson index, and the Pielou index.

The study area was substantiated by literature evidence including a report from MNS Perak Branch which providing insights into the waterbird diversity in Sungai Kinta (Report: *MY Garden Birdwatch – Kinta River Nature Walk*, 2013).

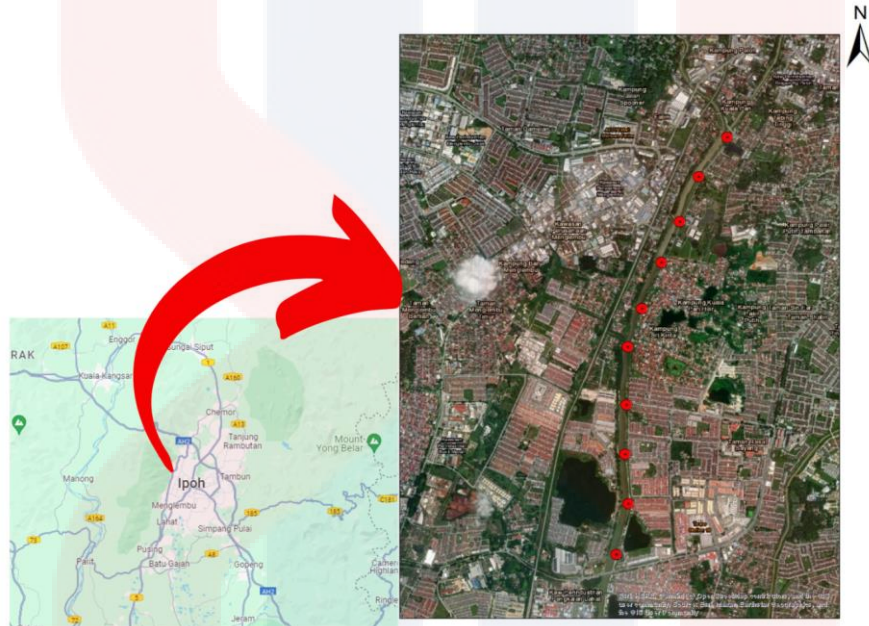


Figure 3.1: Map of Sungai Kinta, Ipoh, Perak depicting 10 count points at the study site.

(Source: Google Maps, 2023 and ArcMap 10.8, 2020)



Figure 3.2: Some waterbirds found in Sungai Kinta.

3.2 Material

The materials included in this research based on the objectives, were:

- Binoculars, used to observe and identify the waterbird species present in Sungai Kinta.
- Smartphone cameras, employed to capture photos and record videos of the waterbirds and their habitats.
- GPS devices, utilized to mark the coordinates and distances of the point count survey sites along Sungai Kinta.
- Notebooks and pens, employed for recording the data and observations of the waterbird diversity and distribution in Sungai Kinta.
- “A Field Guide to The Birds of Malaysia Including Sabah and Sarawak” by Lim Kim Seng, Yong Ding Li & Lim Kim Chuah, which served as a reference for the identification and description of the waterbird species in Malaysia.

These materials were deemed suitable and necessary for achieving the research objectives as they provided accurate and reliable data on the waterbird diversity and the influencing factors in Sungai Kinta. Furthermore, these materials were portable, affordable, and user-friendly, suitable for application in various seasons, times, and locations along the river. Additionally, their selection was supported by evidence from the literature, such as the “Field Protocol For Waterbird Counting” report prepared by Wetlands International (2010) which provided insights into the advantages and disadvantages of different materials for waterbird surveys.

3.3 Data Collection

3.3.1 Point Count Survey

The point count survey method utilized to observe and identify the waterbird species present in Sungai Kinta. This method involved selecting 10 fixed points along the 8 km stretch of Sungai Kinta, which counted and recorded the waterbird species and individuals within a 60 m radius and a 10-minute interval at each point. The points were spaced at least 500 m apart and covered different habitat types and conditions along the river. This method is carried out in the first three hours after sunrise (7 a.m. – 10 a.m.) and three hours before sunset (4 p.m. – 7 p.m.). This is because birds are in their most active mode at this time.

The equipment and materials used for this method included binoculars, smartphone cameras, GPS, notebooks, and pens. The data and observations recorded for this method included the waterbird species' name, number, behavior, and location at each point, as well as the date, time, weather, and visibility conditions. The data analysis and interpretation for this method included calculating the waterbird species' richness, evenness, and diversity at each point, as well as the waterbird abundance and distribution along the river. Statistical methods and spatial analysis tools, such as counts, indices, models, and maps were used. This method addressed the research objectives and questions by providing data on the waterbird diversity in Sungai Kinta. It was suitable and necessary because it was reliable and efficient for estimating the waterbird diversity and distribution in a given area, but it requires trained observers, standardized protocols, and adequate sampling design.

The method was supported by evidence from the literature, such as the book “*Teknik Kerja Lapangan Dalam Sains Sumber Asli*”, by Aainaa et. al. (2023), and the

journal “Density and Diversity of Water Birds and Terrestrial Birds in Man-made Marsh, Malaysia” by Zakaria et. al. (2014) which provided information on the advantages and disadvantages of the point count survey method for waterbird surveys.

The method was also illustrated by a diagram as shown below:

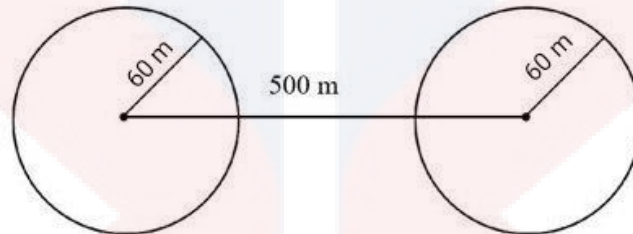


Figure 3.3: The observer will stand in the middle and count the waterbird that can be found in a distance radius of 60 m in 10 minutes.

3.4 Data Analysis

3.4.1 Diversity Indices

The data analysis methods used for this research are diversity indices, which quantify the waterbird diversity in Sungai Kinta. These indices include the Shannon-Wiener index, the Simpson index, and the Pielou index which measure waterbird species diversity based on their number and relative abundance, and facilitate comparison among different points and along the river. Several steps are involved in conducting these methods.

First, data collected from point count surveys was entered and organized in a spreadsheet program, such as Excel, including waterbird species' names, numbers, locations at each point, as well as date, time, weather, and visibility conditions.

Second, the data were calculated and compared using diversity indices like the Shannon-Wiener index, Simpson's index, and Pielou evenness index. These indices provided numerical values of waterbird species diversity at each point and along the river, based on their number and relative abundance. For instance, the Shannon-Wiener index considers both the number and evenness of waterbird species, while Simpson's index measures the probability of finding two individuals of the same species, and Pielou evenness index evaluates the ratio of observed diversity to the maximum possible diversity.

Third, the results of diversity indices were presented and interpreted using graphs, charts, tables, and written explanations. These methods aid in visualizing and communicating data analysis findings, explaining their meaning and implications. Graphs and charts illustrate the variation and distribution of waterbird species diversity, while tables display numerical values and statistical tests. Written explanations and discussions describe and evaluate the results, addressing research objectives and questions.

These methods were suitable and necessary for the research objectives and questions, providing accurate and reliable data on waterbird diversity in Sungai Kinta, and facilitating comparison among different points and along the river. Literature evidence, from the literature, such as Zakaria's (2014) study on "Density and Diversity of Water Birds and Terrestrial Birds in Man-made Marsh, Malaysia" supports these methods, offering insights into the advantages and disadvantages of diversity indices methods for waterbird surveys.

Simpson's Index (D)

$$D = \sum_{i=1}^S \left(\frac{n_i}{N} \right)^2$$

Where:

D = Index

n = the total number of organisms of a particular species

N = the total number of organisms of all species

Shannon-Weiner Index (H')

$$H = - \sum_{i=1}^S p_i * \ln p_i$$

Where:

H' = Diversity index

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

S = Species count

ln = Natural logarithm

Pielou's Evenness Index (J)

$$J = \frac{H}{H_{\max}}$$

Where:

H' = Shannon-Weiner Index

Hmax = Maximum value in a diversity index

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Species Richness

A total of 14 waterbird species from 7 families have been observed at Sungai Kinta, Ipoh, Perak, using point count surveys over 21 days from February 19, 2024 to March 10, 2024 (Table 4.1). The waterbird species diversity may have been underestimated due to fearful and secretive waterbirds sheltering in dense shrubs near the riverbank. Multiple observations were conducted at every point to ensure that secretive waterbirds were not skipped during surveys. Repeatedly, visiting each survey area in 21 days improved the chance of finding secretive species that may have been missed or mute during the first visit.

According to the IUCN Red List, the total of 14 species observed were listed as Least Concern. The result showed that the Asian Openbill Stork (*Anastomus oscitans*) was the most abundant waterbird species in Sungai Kinta, Ipoh, Perak with the highest frequency of waterbirds observed was 118. The frequency of waterbirds is measured by the number of individual waterbirds observed. Common Sandpiper (*Actitis hypoleucos*) and Red-wattled Lapwing (*Vanellus indicus*) were the less abundant waterbird species recorded with lower frequencies of 14 and 6, respectively. Furthermore, six common waterbird species can be seen almost every day along Sungai Kinta, Ipoh, Perak, which are the Cattle Egret, Grey Heron, Purple Heron, White-throated Kingfisher, Little Egret, and Asian Openbill Stork.

The highest frequency of the Asian Openbill Stork (*Anastomus oscitans*) in Sungai Kinta, Ipoh, Perak was recorded since its size is quite bigger than the Grey

Heron, which makes it easy to be seen from a further distance without using binoculars. The Asian Openbill Stork is mostly greyish white, with glossy black wings and a tail that has a greenish-purple glow. According to Bohara (2019), the idea of its name refers to the obvious gap between the curved lower and arched upper mouth parts of mature birds' beaks.

Next, followed by the Grey Heron with 63 frequencies observed. Since it has a striking look with a grey back, white head and neck with a black stripe, and long yellow beak and legs that make them easy to identify for a far. In addition, Grey Heron are easily identified because they frequently remain steady and straight when hunting. Instead of actively looking for prey, they would stay still for lengthy periods, waiting to catch it (Eden Rivers Trust, 2024). Since Grey Herons prefer aquatic habitats, Sungai Kinta is one of the suitable habitats for foraging, nesting, and breeding.

The least abundant waterbird was the Red-wattled Lapwing (*Vanellus indicus*) with a frequency of 6. There are several reasons that make it hard to find. The birds' plumage is cryptically patterned, making them difficult to see, especially when they are not actively feeding or exhibiting (Dûrzan, 2024). Other than that, they are known as nocturnal, active at night, making them difficult to detect during the day when most humans are active. To address these issues during surveys, desktop surveys were used to collect information about the project site and nearby areas (Pobprasert, 2019). This involved evaluating existing data and literature on bird species and their habitats, which helped identify expected species that may be present in this area.



Figure 4.1: Grey Heron (*Ardea cinerea*)



Figure 4.2: Asian Openbill Stork (*Anastomus oscitans*)



Figure 4.3: Little Cormorant (*Phalacrocorax niger*)



Figure 4.4: Chinese Pond Heron (*Ardeola bacchus*)



Figure 4.5: White-throated Kingfisher (*Halcyon smyrnensis*)



Figure 4.6: Purple Heron (*Ardea purpurea*)



Figure 4.7: Black-crowned Night Heron (*Nycticorax nycticorax*)



Figure 4.8: Red-wattled Lapwing (*Vanellus indicus*)



Figure 4.9: Little Egret (*Egretta garzetta*)

Table 4.1: List of waterbird species found in Sungai Kinta, Ipoh, Perak with its IUCN Red List status.

Family	Species	Distribution Status	Frequency	IUCN Status
Ardeidae	Great Egret (<i>Ardea alba</i>)	RM	24	LC
	Grey Heron (<i>Ardea cinerea</i>)	R	63	LC
	Purple Heron (<i>Ardea purpurea</i>)	RM	30	LC
	Chinese Pond Heron (<i>Ardeola bacchus</i>)	M	23	LC
	Little Heron (<i>Butorides striata</i>)	RM	17	LC
	Cattle Egret (<i>Bubulcus ibis</i>)	RM	41	LC
	Little Egret (<i>Egretta garzetta</i>)	RM	23	LC
	Black-crowned Night Heron (<i>Nycticorax nycticorax</i>)	R	17	LC
Ciconiidae	Asian Openbill Stork (<i>Anastomus oscitans</i>)	V	118	LC
Charadriidae	Red-wattled Lapwing (<i>Vanellus indicus</i>)	R	6	LC
Halcyonidae	White-throated Kingfisher (<i>Halcyon smyrnensis</i>)	R	19	LC
Phalacrocoracidae	Little Cormorant (<i>Phalacrocorax niger</i>)	M	20	LC
Rallidae	White-breasted Waterhen	RM	18	LC

Scolopacidae	(<i>Amaurornis phoenicurus</i>) Common Sandpiper (<i>Actitis hypoleucos</i>)	M	14	LC
		Total =	443	

Note: R: Resident, M: Migrant, RM: Resident Migrant, V: Vagrant LC: Least Concern

According to Bird Watching Asia (2022), Malaysia's migratory waterbird season normally lasts from October to March, with the peak season being between December and February. The study time frames, February 19 to March 10, align with Malaysia's peak migration time for migratory waterbirds, which normally occurs between October and March. In addition, the period of study in February and March aligned with Malaysia's dry season, which may have afforded better birding circumstances, such as clearer skies and more accessible habitats.

The result showed that there were three species listed as migrant waterbirds which are the Chinese Pond Heron (*Ardeola bacchus*), Little Cormorant (*Phalacrocorax niger*), and Common Sandpiper (*Actitis hypoleucos*). Migrant waterbirds migrate periodically between different geographic locations to nest or eat, following regular and predictable patterns that fit into variations in temperature and food availability (Viana et al., 2012).

Resident waterbirds in Malaysia are waterbird species that stay and nest in wetland areas throughout the season (Martins et al., 2021). Unlike migratory waterbirds, they only stop by Malaysia during the non-breeding season, which normally occurs from October to March (Ashraf, 2023). There were four waterbird species listed as residents in this research such as Grey Heron (*Ardea cinerea*), Black-

crowned Night Heron (*Nycticorax nycticorax*), Red-wattled Lapwing (*Vanellus indicus*), and White-throated Kingfisher (*Halcyon smyrnensis*).

In this study, there were six resident migrant species such as Great Egret (*Ardea alba*), Purple Heron (*Ardea purpurea*), Little Heron (*Butorides striata*), Cattle Egret (*Bubulcus ibis*), Little Egret (*Egretta garzetta*), and White-breasted Waterhen (*Amaurornis phoenicurus*). Resident migrant waterbirds travel between different habitats within a particular region, whereas migrant waterbirds migrate across continents or hemispheres. Resident migrant waterbirds might have developed from centred populations that have adapted to the local environment, whereas migrant waterbirds have evolved to travel across great distances (Morelli et al., 2022).

Asian Openbill Stork (*Anastomus oscitans*) was recorded as vagrant waterbird. Vagrant waterbird species are those that are not endemic to the area but frequently visits or travels through it in Malaysia. Vagrant species are sometimes considered rare or uncommon sightings, and their presence can be important to note for birdwatchers and ornithologists (Ain et al., 2023).

The absence of extensive data on bird movements and behaviours might make it difficult to identify waterbird species correctly. This can be especially challenging for species with complicated or changeable migratory habits (Brandis et al., 2021). Furthermore, populations of the same waterbird species may display various behaviours in different places, resulting in mixed classification. This can be due to a variety of variables, including local adaptations, genetic variances, and environmental impacts (Nicol et al., 2024).

4.2 Waterbird's Family

A total of 7 families of waterbirds representing 14 species of waterbird were recorded in Sungai Kinta, Ipoh, Perak. Figure 4.10 shows that the 8 species of waterbird population belongs to the family Ardeidae. The remaining six families is represented by exactly one species among the 14 observed waterbird species.

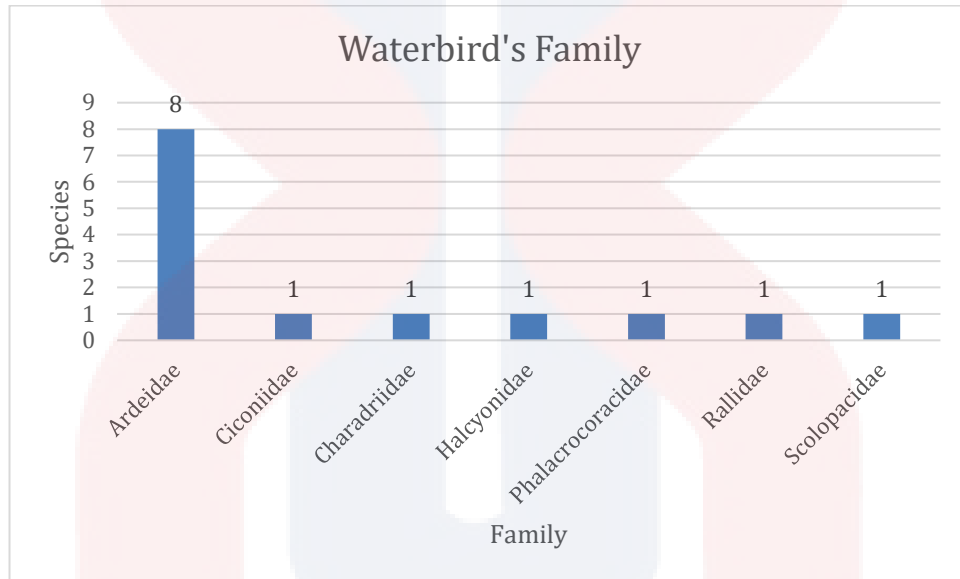


Figure 4.10: Percentage of Waterbird's Families in Sungai Kinta, Ipoh, Perak.

The 8 species recognized under the family Ardeidae were Great Egret (*Ardea alba*), Grey Heron (*Ardea cinerea*), Purple Heron (*Ardea purpurea*), Chinese Pond Heron (*Ardeola bacchus*), Little Heron (*Butorides striata*), Cattle Egret (*Bubulcus ibis*), Little Egret (*Egretta garzetta*), and Black-crowned Night Heron (*Nycticorax nycticorax*). Ardeidae species are common waterbirds found in various wetland habitats such as rivers, lakes, and coastal areas due to their general feeding habits, which enable them to adapt to different aquatic conditions and prey types (Rajashekara et. al, 2010). This adaptability allows them to survive in diverse riverine settings as they consume a wide range of aquatic creatures including fish, reptiles, amphibians, crustaceans, molluscs, and aquatic insects. Dense vegetation, particularly along water

bodies, is vital for providing cover and nesting sites (Richard, 2021). Ardeidae species often favor areas with overhanging vegetation, which offers shade and protection from predators. In Sungai Kinta, the availability of such vegetation can enhance the habitat's suitability for these birds. Moreover, this study revealed that Ardeidae birds may habituate to human presence over time, becoming less sensitive to human disturbance as they become more familiar with it (Diogo et al., 2015). During observations, Ardeidae birds were observed engaging in normal behaviors such as feeding, nesting, and resting even in areas with varying degrees of human presence.



Figure 4.11: Vegetation areas in Sungai Kinta

The species accumulative curve (SAC) shown in Figure 4.11 represents the cumulative species richness against sampling effort. SAC is a useful tool to evaluate biodiversity and sampling efforts, indicating the point at which continued sampling yields few or no new species, known as asymptotes.

The SAC in this study reached an asymptote between days 18 and 21, suggesting that the sampling effort was sufficient to identify most of the waterbird species present in Sungai Kinta. This gives confidence that the observed species diversity reflects the total diversity.

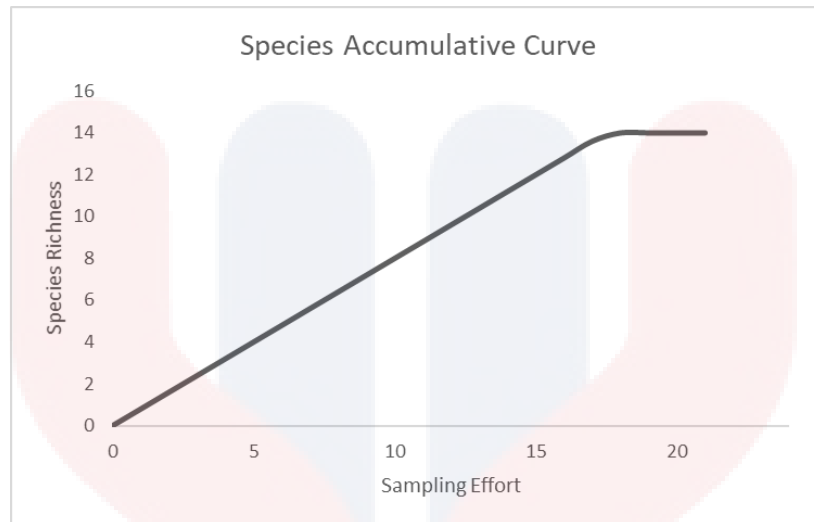


Figure 4.12: Species Accumulative Curve of Waterbird’s Families in Sungai Kinta, Ipoh, Perak.

4.3 Waterbird’s Diversity Index

Table 4.2 displays the value of Simpson’s Index (D), which was 0.86, the Shannon-Weiner Index (H’), which was 2.24, and Pielou’s Evenness Index (J), which was 0.85, representing waterbird diversity in Sungai Kinta, Ipoh, Perak.

Table 4.2: Value of Simpson’s Index (D), Shannon-Weiner Index (H’), and Pielou’s Evenness Index (J) for waterbird diversity in Sungai Kinta, Ipoh, Perak.

Site	D	H’	J
Sungai Kinta, Ipoh, Perak.	0.87	2.35	0.85

The Simpson’s Index (D) ranges from 0 to 1. A result of 0.87 indicates low diversity, suggesting that the waterbird community in the sample is dominated by a few species with large populations, rather than a more balanced distribution of numerous waterbird species. The Shannon-Weiner Index (H’), with a value of 2.35

indicates that the community is diverse, with a wide range of waterbird species present and a nearly even distribution of individuals among them. Pielou's Evenness Index (J), with a value of 0.85, shows that the community is evenly distributed, featuring a diverse range of waterbird species and a generally even distribution of individuals among them. Additionally, Sungai Kinta, Ipoh, Perak harbors a diverse range of waterbirds, making them valuable for biodiversity conservation and management.

The Simpson's Index calculates the chance that two randomly selected individuals in the group belong to the same species by adding the squares of each species' relative abundance, where a species' relative abundance is defined as the proportion of individuals in the community. In contrast, the Shannon-Weiner Index assesses the population's average uncertainty or unpredictability by multiplying each species' relative abundance by the logarithm of that abundance and then adding these results. This index evaluates the diversity of the community, with higher values indicating greater diversity. The Pielou's Evenness Index compares the population's observed diversity to the greatest achievable diversity for the same number of species by multiplying the logarithm of abundance with the total number of species. This index measures the waterbird population's evenness, higher values indicate better evenness.

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CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This study identified 14 waterbird species from 7 families in Sungai Kinta, with the Grey Heron being the most prevalent. The Grey Heron is often considered an indicator species, reflecting the health of aquatic ecosystems. Its presence suggests that the habitat is supportive of diverse aquatic life, which is essential for the heron's diet. The point count survey method was utilized to observe and identify the waterbird species present in Sungai Kinta. This method involved selecting 10 fixed points along the 8 km stretch of Sungai Kinta, where waterbird species and individuals within a 60 m radius were counted and recorded at 10-minute intervals at each point. The points were spaced at least 500 m apart, covering different habitat types and conditions along the river. While Simpson's Index (D) of 0.87 indicates low diversity dominated by a few species, Shannon-Weiner Index (H') of 2.35 and Pielou's Evenness Index (J) of 0.85 shows a diversified community with a wide range of species and an even distribution of individuals. This combination of data shows the need of taking consideration numerous diversity indices in order to obtain a thorough knowledge of Sungai Kinta's natural processes. The existence of a few dominating species among a varied variety of other species highlights the importance of continued monitoring and conservation efforts to ensure the general health and resilience of the waterbird ecosystem.

5.2 RECOMMENDATIONS

I recommend that the findings of my study can further conservation efforts and ecological management of waterbirds in Sungai Kinta by aiding the IUCN Red List in updating their data related to waterbird species, for instance, the Asian Openbill Stork still doesn't have enough data about its population. There are a few steps to share the findings with the IUCN Red List. First of all, write a formal email describing the value of this research and how it will assist in updating the Red List, particularly for species such as the Asian Openbill Stork. Attach the report to the email and follow up with the organization after a few weeks. I will keep maintaining contact to give updates as needed to ensure that my findings support successful conservation and management initiatives. The number of waterbird species in Sungai Kinta, Ipoh, Perak could be more varied if this study were conducted over a long period since the season of migratory birds occur between November and March.

Sungai Kinta is a beautiful and peaceful place known for biking, jogging, and recreational activities. To ensure that Sungai Kinta maintains a safe home for waterbird species, the Jabatan Pengairan dan Saliran (JPS) Perak State should use an integrated approach that includes frequent water quality monitoring, habitat restoration, and biodiversity assessments. Controlling erosion and pollution, as well as engaging local populations, are essential efforts towards improving river stewardship. Learning from effective conservation methods, such as the artificial Wetland in Putrajaya as a potential habitat for waterbirds in Malaysia (Rajpar et. al., 2013).

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