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DIVERSITY AND DISTRIBUTION OF BIRDS IN TAMAN TASIK TAIPING, PERAK

by

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DECLARATION

I declare that this thesis entitled "Diversity and Distribution of Birds in Taman Tasik Taiping, Perak" is the result of my research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature : .....

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ABSTRACT

This research explores the bird diversity and distribution at Taman Tasik Taiping, an urban park located in Perak, Malaysia. The park was selected for its variety of habitats which was woodlands, wetlands, and open spaces which offer a unique setting for studying avian adaptation in urban landscapes. Point count surveys were utilized to systematically document bird species across different park areas. These survey points were chosen to cover various habitat types, with observations taking place during optimal bird activity periods in the early morning and late afternoon. The study recorded 778 bird observations across 23 species, highlighting the House Sparrow (*Passer domesticus)* and Barn Swallow (*Hirundo rustica*) as the most commonly seen species, indicative of their adaptability to urban environments. The Shannon-Wiener and Simpson's diversity indices showed that woodlands had the highest bird diversity, while open areas had lower diversity due to their simpler vegetation structure. These results are consistent with findings from similar urban park studies worldwide, emphasizing the importance of complex habitats in supporting diverse bird populations. To improve bird diversity, the study recommends establishing buffer zones around critical habitats, adopting sustainable management practices, and involving the community through educational initiatives. Specific actions should include enhancing woodland conservation, adding native vegetation to open areas, and ensuring the quality of wetland habitats. Partnering with local environmental organizations can strengthen these efforts, providing a holistic approach to conservation.

Keyword:Distribution,point count, species, conservation

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ABSTRAK

Kajian ini meneroka kepelbagaian dan taburan burung di Taman Tasik Taiping, sebuah taman bandar yang terletak di Perak, Malaysia. Taman ini dipilih kerana pelbagai habitatnya, iaitu hutan, tanah lembap, dan kawasan terbuka, yang menawarkan suasana unik untuk mengkaji penyesuaian burung dalam landskap bandar. Kajian menggunakan kaedah pengiraan titik untuk mendokumentasikan spesies burung secara sistematik di pelbagai kawasan taman. Titik-titik pengamatan ini dipilih untuk merangkumi pelbagai jenis habitat, dengan pemerhatian dilakukan semasa waktu aktiviti burung yang optimum pada waktu pagi dan petang. Kajian mencatat 778 pemerhatian burung merangkumi 23 spesies, menonjolkan Burung Pipit Rumah (*Passer domesticus*) dan Burung Burung Sualo Api (*Hirundo rustica*) sebagai spesies yang paling kerap dilihat, menunjukkan penyesuaian mereka terhadap persekitaran bandar. Indeks kepelbagaian Shannon-Wiener dan Simpson menunjukkan bahawa hutan mempunyai kepelbagaian burung tertinggi, manakala kawasan terbuka mempunyai kepelbagaian yang lebih rendah disebabkan oleh struktur vegetasi yang lebih sederhana. Keputusan ini konsisten dengan penemuan dari kajian taman bandar serupa di seluruh dunia, menekankan kepentingan habitat kompleks dalam menyokong populasi burung yang pelbagai. Untuk meningkatkan kepelbagaian burung, kajian ini mencadangkan penubuhan zon penampan di sekitar habitat kritikal, mengamalkan amalan pengurusan yang mampan, dan melibatkan komuniti melalui inisiatif pendidikan. Tindakan khusus termasuk meningkatkan pemuliharaan hutan, menambah tumbuhan asli di kawasan terbuka, dan memastikan kualiti habitat tanah lembap. Bekerjasama dengan organisasi alam sekitar tempatan boleh menguatkan usaha ini, memberikan pendekatan holistik kepada pemuliharaan.

Kata kunci:Pengedaran, pengiraan titik, spesies, pemuliharaan

UNIVERSITI
MALAYSIA
KELANTAN

TABLE OF CONTENT

FYP FSB
UNIVERSITI MALAYSIA KELANTAN

FYP FSB

UNIVERSITI MALAYSIA KELANTAN

LIST OF FIGURES

FYP FSB

UNIVERSITI MALAYSIA KELANTAN

LIST OF TABLE

FYP FSB

UNIVERSITI MALAYSIA KELANTAN

LIST OF ABBREVIATION

IUCN	International Union for Conservation of Nature
GPS	Global Positioning System
LC	Least Concern
H′	Shannon-Wiener diversity index
D	Simpson's Diversity Index
R	Margalef's Richness Index

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

This research investigates the bird species richness and distribution in Taman Tasik Taiping, Perak, providing essential insights into the ecosystem's health (Gaston, 2005). By conducting systematic point count surveys across various habitats in the park, the study measures species richness which was the number of different species in an area through recorded sightings and sounds at each survey point. These data are then used to calculate diversity indices like the Shannon-Wiener Index and Simpson's Diversity Index, providing a quantitative analysis of species richness and evenness across different habitats (Magurran, 2004).

To understand bird species distribution, the study maps observation points using GPS coordinates, analyzing species presence and abundance to identify patterns across the park's diverse habitats, including wetlands, woodlands, gardens, and open areas. This spatial data helps identify habitat preferences and the influence of factors like vegetation cover and proximity to water bodies on species distribution (Bibby *et al*., 2000). By conducting surveys during peak bird activity periods in the morning and evening, the study also examines temporal variations in bird behavior and habitat use,

offering a comprehensive understanding of factors affecting bird species richness and distribution in Taman Tasik Taiping (Ralph *et al.*, 1995).

Taman Tasik Taiping, established in 1880 as Malaysia's first public garden, covers 64 hectares and features a variety of habitats ideal for studying bird diversity (Fazamimah *et al*., 2019). Its mature tree canopy, with large trees such as rain trees (*Samanea saman*) and angsana (*Pterocarpus indicus*), provides food and nesting sites for resident and migratory birds. The park's location in the northern Malaysian Peninsula makes it a crucial stopover for migratory birds along the East Asian-Australasian Flyway (Wells, 1999). The park's numerous water bodies attract various waterbirds, offering essential feeding grounds and playing vital roles in their life cycles. The combination of freshwater and riparian zones supports high bird diversity, reflecting the broader regional ecosystem (Davison, 1995). Taman Tasik Taiping's accessibility and well-maintained infrastructure make it suitable for extensive fieldwork and long-term bird population monitoring, with pathways and viewing platforms facilitating systematic data collection with minimal wildlife disturbance. The park's historical significance and popularity also help maintain public interest and potential funding for conservation projects (Mohamed & Rahman, 2017).

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MALAYSIA
KELANTAN

Despite its popularity and ecological significance, Taman Tasik Taiping has not undergone a comprehensive bird survey. Research in similar urban green spaces has highlighted the essential role these areas play in urban biodiversity conservation. For instance, the Singapore Botanic Gardens documented 66 bird species, emphasizing the importance of habitat complexity and vegetation structure (Yong *et al*., 2012). Studies in Hong Kong found that larger parks with diverse habitats supported more bird species (Leong *et al*., 2011). Similarly, a survey of urban green spaces in Kuala Lumpur identified 58 bird species, noting the impact of human activities on bird communities (Nur Hafifah *et al.*, 2018).

This study in Taman Tasik Taiping aims to build on these findings by cataloging bird species richness and abundance and examining the effects of different habitat types on bird distribution and behavior. Using a stratified random sampling design ensures comprehensive coverage of the park's diverse habitats. Advanced tools like the SV28 Plus Spotting Scope Monocular Telescope and GPS tracking with the AllTrails app enhance species identification and documentation accuracy. Statistical analyses using indices such as the Shannon-Wiener and Simpson's diversity indices provide a quantitative assessment of bird diversity.

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Urbanization and environmental changes pose significant threats to Taman Tasik Taiping's bird populations and overall biodiversity. Habitat degradation from urban infrastructure expansion and recreational facilities reduces natural habitats, affecting birds' foraging, nesting, and sheltering opportunities. Pollution, including noise, light, and chemical pollutants, further impacts bird populations (Shanahan *et al.,* 2013; Longcore & Rich, 2004; McKinney, 2008). Changes in land use disrupt bird communities, favoring generalist species over specialists, leading to a decline in biodiversity (Marzluff, 2001).

This study addresses the significant data gap on bird species diversity and distribution in Taman Tasik Taiping. By systematically documenting bird species richness and distribution across different habitats, it provides essential baseline data for monitoring changes in bird populations and assessing ecosystem health (Sodhi *et al*., 2010). Understanding how environmental factors influence bird distribution and behavior will help develop targeted conservation strategies and habitat management plans to enhance biodiversity (Bibby *et al*., 2000). The study aims to support conservation initiatives, such as habitat restoration projects, establishing conservation zones, and guiding public education and community engagement programs. The research data can inform urban planning and policy-making to create bird-friendly spaces that mitigate the impacts of urbanization (Rosenstock *et al*., 2002).

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Point count surveys are chosen for their effectiveness in estimating bird species richness and abundance across various habitats and seasons, enabling systematic coverage of large areas and producing data that is easy to analyze (Ralph *et al.,* 1995). Despite limitations like detection bias and the need for multiple visits to each point, point counts remain a reliable method for monitoring bird populations, particularly when supplemented with other techniques (Bibby *et al*., 2000).

The specific research questions are:

(1) What are the species richness and abundance of birds in different habitats within the garden?

1.2 Problem Statement

Despite the ecological and recreational significance of Taman Tasik Taiping, a well-known urban green space in Perak, Malaysia, the current status of its bird diversity and distribution is unknown due to the lack of comprehensive surveys. This knowledge gap obstructs effective conservation and management initiatives that are needed to address the challenges and threats posed by habitat loss, human influence, and environmental shifts. Therefore, there is a need for a thorough research study to assess the variety and distribution of bird species in Taman Tasik Taiping and provide insights for conservation strategies and promote the harmonious coexistence. The observation was conducted across four specific habitats: wetland, woodland, garden, and open area. Each habitat includes 10 points, making a total of 40 points overall.

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For the bird surveys, the point count method was employed. This technique involved recording observations at fixed points within each habitat. Ten points were systematically positioned in each of the four habitats wetland, woodland, garden, and open area resulting in a total of 40 observation points. During the surveys, smartphones were used to record GPS coordinates at each point to ensure precise location data. Although this study focused on a 20-day observation period and did not specifically address seasonal variations in bird populations, future research could extend the observation period to encompass different seasons, providing a more comprehensive understanding of seasonal effects on bird distribution.

The absence of seasonal data in this study might limit the understanding of the full extent of bird diversity and distribution in Taman Tasik Taiping. Many bird species exhibit seasonal variations in their presence and abundance due to factors such as migration, breeding, and changing food availability. Without data from different seasons, the study may overlook species that are only present during certain times of the year or may not fully capture the fluctuations in bird populations that occur due to seasonal changes. This could lead to an incomplete or biased understanding of the bird community within the park, potentially affecting the accuracy of conservation and management recommendations. To address these seasonal variations, future research should extend the observation period to encompass multiple seasons, including both the migratory and breeding periods. This extended timeline would provide a more comprehensive picture of bird diversity and distribution throughout the year. Researchers could conduct point count surveys during different seasons such as spring, summer, autumn, and winter to capture the presence of migratory birds, seasonal

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changes in resident bird populations, and any shifts in habitat use. Additionally, future studies could implement continuous monitoring using automated recording devices or camera traps to collect data consistently over long periods. This approach would allow for the detection of temporal patterns in bird activity and presence, providing insights into how different species respond to seasonal environmental changes. Moreover, collaborating with local birdwatching groups and citizen scientists could enhance data collection efforts by increasing the frequency and coverage of observations. Engaging the community in such projects not only expands the dataset but also raises public awareness about bird conservation.

By incorporating seasonal data, future research can offer a more detailed and accurate assessment of bird diversity and distribution in Taman Tasik Taiping, ultimately leading to more effective and informed conservation strategies. To ensure thorough spatial coverage of Taman Tasik Taiping, observation points were carefully distributed across the entire area, covering all major habitat types. This strategic placement aimed to accurately assess bird distribution across the diverse environments within the park.

1.3 Objective

(1) To conduct point count surveys to record the bird species richness and abundance in different habitats within the garden.

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1.4 Scope of Study

The scope of this study covers the following aspects. The study's focus is limited to Taman Tasik Taiping in Perak, Malaysia, specifically concentrating on the assessment of the variety and distribution of bird species within this environment. The study will conduct two sections of bird observations, one in the morning from 7:00 AM to 10:00 AM, and another in the evening from 5:00 PM to 7:00 PM, aligning with the period of peak avian activity. Bird observations will be primarily conducted using binoculars and point count surveys to record the bird species richness and abundance in different habitats within the garden. The study will also explore how environmental factors, such as different habitat types and vegetation cover, impact bird distribution and behaviour during the observation hours. Collected data will undergo statistical analysis using Microsoft Excel to derive meaningful insights into bird diversity and their interactions with the environment. The study will produce recommendations for the safeguarding and management of bird species and their habitats within Taman Tasik Taiping, grounded in the research outcomes. The study will also disseminate the research findings to enhance public awareness about avian biodiversity in the garden.

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The limitations of this study are:

- The study will not monitor individual bird behaviours, genetic analysis, and track bird migration patterns, which may provide additional information on the avian population dynamics and diversity.
- The study will not conduct bird observations during other times of the day or night, which may capture different patterns of bird activity and distribution.
- The study will not assess the impact of human activities and development on the bird population and habitat quality within the garden, which may pose potential threats or conflicts to the avian community.

1.5 Significant of Study

The significance of this study lies in the following aspects. The study has the potential to enrich the preservation of avian diversity. by creating a comprehensive registry of bird species within Taman Tasik Taiping, the study providing insights into the identification and protection of fragile or endangered species and their habitats, and serving as a solid foundation for targeted conservation initiatives. The study acts as a catalyst for amplifying public awareness concerning the varied birdlife in the garden, cultivating a sense of responsibility among the public for safeguarding these avian inhabitants and the environment at large.

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KELANTAN

The study bears significance for ecosystem health by comprehending their diversity and distribution of bird species that play pivotal roles in ecological equilibrium through actions such as pollination, seed dispersal, and pest control, and contributing to the assessment of the overall well-being and endurance of the local ecosystem. The study has tangible applications in habitat management and strategies for conservation, ensuring the perpetuation of the garden's innate beauty and biodiversity, and offering vital information for the influence of environmental factors, such as different habitat types and vegetation cover, on the distribution of bird species.

The study offers direction to park management and local authorities by illuminating potential conflicts between human activities and bird habitats, thereby enabling the harmonious coexistence of natural and human elements in a sustainable manner, and enriching our knowledge of bird behaviour and adaptation within this particular ecological context. The study has the potential to enhance the experiences of tourists and nature enthusiasts visiting Taman Tasik Taiping, potentially boosting tourism in the area and serving as an educational resource for schools, nature clubs, and local communities, imparting insights into the garden's birdlife and accentuating the significance of conservation.

FYP FSB
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CHAPTER 2

LITERATURE REVIEW

2.1 The importance and benefits of studying bird diversity and distribution in urban green spaces

Urban green spaces, such as parks, gardens, woodlands, and wetlands, are areas of natural or semi-natural vegetation within urban environments that provide significant ecological, social, and economic benefits (Sangwan et al., 2022). Birds, which are among the most diverse and visible wildlife in these areas, have more than 2,000 species recorded in urban settings worldwide (Isaksson, 2018). Noteworthy examples include New York City's Central Park, which attracts over 280 bird species each year, and London’s parks, such as Hyde Park and Kensington Gardens, which host around 180 species. Sydney, known for its varied habitats and proximity to the coast, supports over 200 bird species within its urban green spaces (Aronson *et al*., 2014).

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Taman Tasik Taiping in Perak, Malaysia, although not as species-rich as some of these prominent global cities, still demonstrates considerable bird diversity. This park's diverse habitats, including wetlands, woodlands, gardens, and open areas, are crucial for both resident and migratory birds along the East Asian-Australasian Flyway (Wells, 1999). The bird diversity in Taman Tasik Taiping highlights its ecological significance in Malaysia, emphasizing the need for conservation and management of such urban green spaces (Isaksson, 2018; Sekercioglu *et al.*, 2016).

Studying bird diversity and distribution in urban green spaces is important for several reasons. Birds play critical roles in ecosystem functions such as pollination, seed dispersal, pest control, nutrient cycling, and decomposition, which support human well-being (Sekercioglu *et al*., 2016). They also serve as indicators of environmental quality and change due to their sensitivity to habitat alterations, climate variations, and human disturbances (Environmental Science, 2014). Additionally, birds provide aesthetic, recreational, educational, and cultural benefits, enriching human interactions with nature and fostering conservation awareness (Stanford University, 2020).

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2.2 The methods and techniques for conducting bird surveys

Bird surveys are systematic observations and recordings of bird species and their numbers in a given area and time, using various methods and techniques, such as point counts, transects, and mist nets, depending on the objectives, design, and logistics of the study (Watson,2003). Among these methods, point counts are one of the most widely used and efficient techniques for estimating bird species richness and abundance in different habitats and seasons, especially in urban green spaces where access and visibility may be limited or variable (United States Department of Agriculture Forest Service Pacific Southwest Research Station, 1997). Point counts involve selecting a number of fixed locations or points within the study area, and recording all the bird species seen or heard within a certain radius and duration from each point, usually ranging from 20 to 100 meters and 5 to 10 minutes, respectively (Hostetler & B. Main, 2020).

In the Taman Tasik Taiping study, point counts were methodically used to document bird species richness and abundance across various habitats. Forty observation points were set up, with ten points in each of the four distinct habitats: wetlands, woodlands, gardens, and open areas. This arrangement ensured thorough spatial coverage of the park. Observations at each point lasted 10 minutes within a 25-meter radius and were conducted both in the morning (7:00 AM to 10:00 AM) and evening (5:00 PM to 7:00 PM) to align with peak bird activity times and distance for one point to another point count was 100 meter to avoid double counting. The birds were recorded and counted when they perched on trees or landed on the ground This

FYP FSB
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method provided a representative sample of the bird community in different environmental settings (Fazamimah *et al.*, 2019). Utilizing this approach enabled the study to produce reliable data on bird diversity and distribution, contributing to a better understanding of the ecological dynamics within Taman Tasik Taiping (Hostetler & Main, 2020). Point counts can provide reliable and accurate data on bird diversity and distribution, as they can cover a large and representative sample of the study area, account for the spatial and temporal variations in bird activity and detectability, and allow for the comparison and analysis of bird data across different habitats and seasons, using various statistical tools and models, such as diversity indices, ordination techniques, and regression models (Farnsworth *et al.*, 2005). However, point counts also have some limitations and challenges, such as the need for skilled and experienced observers, the difficulty of identifying cryptic or rare species, the influence of environmental noise and weather conditions, and the assumption of equal detectability of all bird species, which may affect the quality and accuracy of the data (Bibby *et al.*, 2000). To address the limitations of point count surveys in Taman Tasik Taiping, several strategies were implemented to improve data accuracy and reliability. Experienced and trained observers conducted the surveys to reduce identification errors and ensure consistency in data collection. Surveys were scheduled during optimal bird activity periods which was early mornings and late afternoons and avoided during adverse weather conditions to mitigate the impact of environmental noise and weather. The 10-minute observation duration at each point was chosen to balance thorough data collection with the need to cover multiple points effectively.

FYP FSB
UNIVERSITI
MALAYSIA
KELANTAN

2.3 The challenges and threats faced by bird populations and habitats in urban green spaces

Urban green spaces like Taman Tasik Taiping are vital for bird populations, yet they encounter numerous challenges and threats that affect the composition and diversity of bird communities and their ecological roles (Shanahan et al., 2013). Key threats include habitat loss, fragmentation, degradation, pollution, and invasion. Habitat loss happens when natural or semi-natural vegetation is reduced or eliminated due to urban development, such as building structures and infrastructure. In Taman Tasik Taiping, the development of recreational facilities and infrastructure has led to the clearing of forested areas, reducing the availability of nesting and foraging sites for species like the Oriental Magpie-Robin (*Copsychus saularis*) and the Stork-billed Kingfisher (*Pelargopsis capensis*). This reduction in habitat suitability particularly affects species that are specialized or sensitive to habitat changes, causing population declines (Marzluff *et al.*, 2001). Habitat fragmentation involves dividing continuous habitats into smaller, isolated patches due to urban development. In Taman Tasik Taiping, the creation of roads and pathways through natural areas disrupts habitat connectivity, impacting bird species that require large, contiguous areas. Species such as the Greater Racket-tailed Drongo (*Dicrurus paradiseus*), which depend on extensive forested areas, are especially vulnerable to fragmentation. This leads to increased edge effects and isolation, which negatively affect their survival and reproduction (Fahrig, 2003; Levins, 1970; Saunders et al., 1991).

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Habitat degradation refers to the decline or alteration of habitat quality from urban activities such as noise, light, traffic, recreation, and waste. In Taman Tasik Taiping, frequent human activities, including boating and jogging, introduce noise and pollution that degrade habitat quality. This is particularly problematic for sensitive species like the Black-naped Oriole (*Oriolus chinensis*), which require quiet, undisturbed areas for nesting and foraging. Degradation impacts bird behavior and physiology, affecting activities like foraging, nesting, communication, and stress levels (Isaksson, 2018).

Pollution involves the contamination of air, water, or soil with harmful substances such as chemicals, metals, plastics, and pathogens due to urban activities like industry, agriculture, and waste disposal. In Taman Tasik Taiping, water bodies have been contaminated by runoff from surrounding urban areas, affecting aquatic bird species such as the Purple Heron (*Ardea purpurea*) and the Little Egret (*Egretta garzetta).* Pollution compromises habitat health and safety, particularly affecting bird species vulnerable to these pollutants, leading to increased mortality, disease, and mutations (Shanahan *et al*., 2013). Invasion happens when non-native or exotic species are introduced or spread due to urban activities such as trade, transport, and gardening. In Taman Tasik Taiping, invasive plant species like the Water Hyacinth (*Eichhornia crassipes*) have proliferated in water bodies, altering habitat structure and affecting native bird species that rely on open water or native vegetation for feeding. These invasive species reduce habitat diversity and stability, threatening native or endemic bird species through competition, predation, displacement, exclusion, and hybridization (Martin-Albarracin *et al*., 2015).

FYP FSB
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These challenges significantly impact bird communities in Taman Tasik Taiping by altering the abundance, distribution, and interactions of bird species. This affects their ecosystem functions and services, such as pollination, seed dispersal, and pest control, which are essential for human well-being and livelihoods (Gt & Ia, 2020).

There are a few specific measures and initiatives currently in place at Taman Tasik Taiping to help preserve the diversity of birds in the area. Taman Tasik Taiping is a protected wetland area managed by the Department of Wildlife and National Parks. As a protected area, it likely has regulations and enforcement in place to limit threats like habitat destruction, hunting, and disturbance. However, the effectiveness of protection and enforcement is not always clear, as exemplified by the Lambir Hills National Park in Sarawak where 90% of protected species were extirpated despite formal protection (Koh & Sodhi, 2010). The Taiping Municipal Council (MPT) in collaboration with Tourism Perak Management Berhad and the Natural Ecosystem Sustainability Organization (NEST) organizes an annual Taiping Bird Week event. This event promotes birdwatching, nature photography, and environmental education. While not a direct conservation measure, raising awareness and appreciation for birds can indirectly support conservation efforts (MPT, 2023). Several rare bird species have become permanent residents of Taman Tasik Taiping and Bukit Larut in recent years, including the Rhinoceros Hornbill, Long-tailed Parakeet, Cattle Egret, and Hudhud. The presence of these species suggests the habitats are still suitable to support them. However, more data would be needed to determine if their populations are stable or increasing over time (BirdLife International, 2022).

FYP FSB
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2.4 The strategies and recommendations for the conservation and management of bird species and their habitats in urban green spaces

The conservation and management of bird species and their habitats in urban green spaces, such as Taman Tasik Taiping, require various strategies and recommendations, such as habitat restoration, enhancement, and protection, public education and awareness, and policy and planning, that can contribute to the sustainable development and coexistence of natural and human elements in the urban environment (Smith, 2019; Jones *et al.*, 2020). Habitat restoration refers to the recovery or reestablishment of natural or semi-natural vegetation in degraded or lost habitats due to urban development, that can increase the availability and suitability of habitats for different bird species, especially those that are specialized or sensitive to habitat changes, and enhance the diversity and abundance of these species. Replanting native vegetation along pathways and water bodies is essential. For example, reintroducing species like the Malayan Rain Tree (*Samanea saman*) and native shrubs can create a more suitable environment for birds such as the Oriental Magpie Robin (*Copsychus saularis*) and the Black-naped Oriole (*Oriolus chinensis*). These native plants provide food sources like fruits and insects and offer nesting sites (Miller & Hobbs, 2007). Habitat enhancement refers to the improvement or modification of habitat quality in existing or created habitats due to urban activities, such as noise, light, traffic, recreation, and waste, that can increase the functionality and diversity of habitats for different bird species, especially those that are sensitive or intolerant to human disturbance and presence, and improve the behaviour and physiology of these species, such as foraging, nesting, communication, and stress.Installing bird-friendly structures is another practical measure. Nesting boxes tailored for cavity-nesting birds

like the House Sparrow (*Passer domesticus*) can be placed in trees or on poles in open areas, which currently show lower diversity indices. Bird baths can be added to provide water sources, attracting more species and improving habitat functionality and bird behavior (Snep & Clergeau, 2013). Creating insect-friendly zones with flowering plants can boost the insect population, benefiting insectivorous birds like the Barn Swallow (*Hirundo rustica*).

Habitat protection refers to the preservation or conservation of natural or semi-natural vegetation in intact or diverse habitats due to urban activities, such as industry, agriculture, and waste, that can increase the health and safety of habitats and resources for different bird species, especially those that are exposed or vulnerable to pollution, and prevent the survival and reproduction of these species, such as mortality, disease, and mutation. Establishing buffer zones around sensitive wetland areas can minimize pollution and human disturbance. For instance, erecting fences or planting dense vegetation barriers around wetland habitats can protect species like the Great Egret and the Black-crowned Night-Heron (*Nycticorax nycticorax*) from disturbances that could affect their feeding and nesting activities (Adam *et al*., 2005). Additionally, designating certain areas as no-entry zones for tourists and park visitors can help maintain the ecological balance in these critical habitats. Public education and awareness refers to the dissemination or promotion of knowledge and information about the importance and benefits of bird diversity and conservation in urban green spaces, such as Taman Tasik Taiping, that can increase the appreciation and responsibility of the public for safeguarding these avian inhabitants and the environment at large, and encourage the participation and support of the public in conservation and management initiatives, such as citizen science, volunteerism, and

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advocacy. Organizing bird-watching tours and educational workshops can significantly raise awareness about bird conservation. Collaborating with local schools and community groups for activities like guided bird-watching tours, educational talks about the ecological roles of different bird species, and workshops on creating bird-friendly gardens at home can be beneficial (Silvertown *et al.*, 2013). Policy and planning refers to the development or implementation of rules and regulations, guidelines and standards, and strategies and actions for the conservation and management of bird species and their habitats in urban green spaces, such as Taman Tasik Taiping, that can increase the direction and coordination of the stakeholders and actors involved in the urban environment, such as park management, local authorities, developers, and residents, and balance the needs and interests of human and wildlife in a sustainable manner, and address the potential conflicts or trade-offs between them, such as development, recreation, and conservation. Enforcing regulations that limit urban development around Taman Tasik Taiping is crucial. Collaborating with local authorities to establish and enforce zoning laws that prevent construction near critical bird habitats ensures these areas remain undisturbed. Additionally, integrating bird-friendly designs into urban planning can include creating green roofs, installing green walls, and preserving existing trees and vegetation in new developments (Sharifi, 2020).These strategies and recommendations can have significant contributions to the sustainable development and coexistence of natural and human elements in the urban environment, by maintaining and enhancing the ecological, social, and economic benefits of bird diversity and conservation in urban green spaces, such as Taiping Lake Garden, and ensuring the long-term viability and resilience of these environments.

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CHAPTER 3: MATERIAL AND METHOD

3.1 Study Area

The study area is Taman Tasik Taiping (4.85386N, 100.7492E), which is a popular tourist attraction and the oldest and largest public garden in Malaysia, located in the district of Taiping, Perak. The garden was established in 1880 as the first public garden in the country, and spans over an area of approximately 64 hectares. The garden features diverse habitats, such as wetlands, woodlands, gardens, and open areas, that provide a rich source of food and shelter for various bird species. The garden attracts both resident and migratory birds due to its varied habitats and resource availability. Woodlands in Taman Tasik Taiping are distinguished by their dense canopy of tall trees, including mahogany (*Swietenia macrophylla*) and meranti (*Shorea spp.),* which create a multi-layered environment with lush undergrowth. This habitat supports a wide range of bird species, such as the Black-naped Oriole (*Oriolus chinensis*) and the Oriental Magpie Robin (*Copsychus saularis*), which benefit from the plentiful food sources and nesting sites available. The undergrowth features various shrubs like wild ginger (*Zingiber zerumbet*) and ferns, offering additional cover and feeding areas for insect-eating birds.

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Wetlands within the park are characterized by shallow, sometimes brackish water bodies with emergent plants like reeds (*Phragmites australis*) and water lilies (*Nymphaea spp.).* These wetlands are crucial for species such as the Great Egret (*Casmerodius albus)* and the Purple Heron (*Ardea purpurea*), which depend on the abundant fish and amphibians found here. The wetlands also support a variety of invertebrates and aquatic plants, attracting both migratory and resident birds that use these areas for feeding and breeding. Gardens in Taman Tasik Taiping are composed of a variety of ornamental plants, including flowering shrubs like hibiscus (*Hibiscus rosa-sinensis*) and fruit trees such as papaya (*Carica papaya*). These gardens are essential for fruit-eating birds like the Pink-necked Green-Pigeon (*Treron vernans*) and the Zebra Dove (*Geopelia striata),* which feed on the fruits and seeds. The gardens feature manicured lawns and scattered trees, providing a less complex but still valuable habitat for different bird species.

Open areas in the park consist of grassy expanses and minimal vegetation, with some sections planted with low shrubs and grasses. Although these areas support fewer bird species, they are frequented by adaptable birds like the Common Myna (*Acridotheres tristis*) and the Asian Glossy Starling (*Aplonis panayensis*), which thrive in more open, disturbed environments. These open spaces offer essential foraging opportunities and are used for nesting by species that prefer less vegetated areas.

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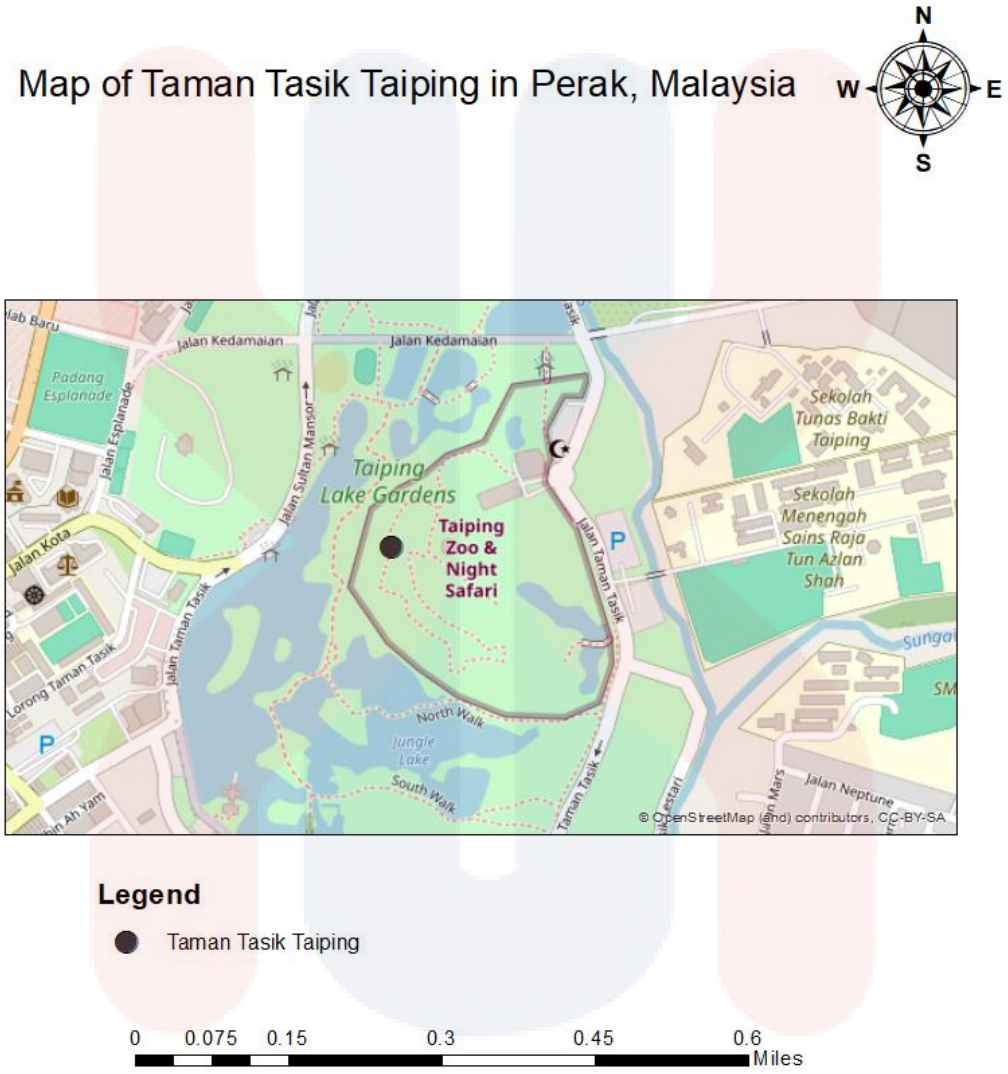

Figure 3.1 Location map of Taman Tasik Taiping in Perak, Malaysia. (Source Google Map)

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Table 3.1 Habitat types and characteristics in Taman Tasik Taiping.

Habitat type	Characteristic
Wetland	The zones of land saturated with water, either on a permanent or seasonal basis, are known as wetlands. They are identified by soil flooding or saturation, resulting in low-oxygen conditions that support a unique collection of plants, animals, and microbes.
Woodland	Woodlands are defined by their thick tree canopy and frequently act as transitional areas between distinct ecosystems, including grasslands, true forests, and deserts. Within these woodlands, there are venerable trees that have surpassed the age of 100 years.
Garden	A garden habitat is an area designed to support a variety of animals and plants, offering a residence for diverse species. Typically, it features well-maintained lawns and flower beds, creating an aesthetically pleasing and tranquil setting for visitors.
Open area	Open areas encompass any expanse that lacks enclosure or covering.

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3.2 Material

The materials and equipment utilized for this research included the SV28 Plus 15-45x50mm Spotting Scope Monocular Telescope, which was employed for observing and identifying bird species across various habitats. The scope underwent testing under diverse weather conditions to ensure its consistent performance. It was evaluated in clear skies, rainy conditions, foggy mornings, high humidity, and sunny, hot environments. The scope delivered excellent image clarity and brightness during clear weather. Its waterproof feature prevented internal fogging and water damage in rainy conditions, while its fogproof capability ensured clear visuals on foggy mornings. The scope performed well in high humidity, with no issues of moisture accumulation or clarity loss. Under intense sunlight, the anti-reflective coating effectively reduced glare, maintaining clear visibility. These tests demonstrated the scope's reliability, durability, and high-quality imaging across different weather conditions, making it a dependable tool for long-term bird observation and identification in Taman Tasik Taiping.The SV28 Plus offered several advantages over standard binoculars. Its higher magnification and larger objective lens allowed for more accurate bird identification from a distance, essential for a thorough evaluation of the avian community in various habitats. The SV28 Plus was also compact and lightweight, making it convenient for field surveys. Its waterproof and fogproof features ensured reliable performance in various weather conditions, crucial for tracking seasonal changes in bird diversity and distribution. By integrating the spotting scope with the point count method, researchers could gather detailed information on bird species presence, abundance, and spatial distribution within the park.

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The AllTrails app on smartphones was used to measure distances of 100 meters between each observation point. The accuracy of the AllTrails app was assessed to ensure reliable spatial data. The app's "Measure" tool, which calculates distances by plotting points on a map, typically provided accurate measurements suitable for fieldwork, with a margin of error generally within 5-10 meters under optimal conditions. This level of accuracy was sufficient for the study, allowing reliable placement and spacing of observation points in Taman Tasik Taiping's diverse habitats. To further ensure precision, distances measured by the AllTrails app were cross-referenced with Google Maps coordinates and verified through multiple measurements. Google Maps was also used to record coordinates at each observation point. Coordinates were captured using Google Maps on a smartphone, which provided reasonably accurate location data. The precision of the coordinates was validated through repeated checks at each point, despite not using additional GPS devices for cross-verification. This data was then used to calculate diversity indices such as the Shannon-Wiener diversity index (H') and Simpson's diversity index (D) to measure and compare bird diversity across different habitats.A smartphone camera was used for taking photos of bird species as a supplementary method of identification and documentation. A pen and notebook were utilized for recording bird species richness and abundance at each point count location. To assess bird species richness and abundance in various habitats within Taman Tasik Taiping, researchers conducted systematic point count surveys. A stratified random sampling approach was employed, dividing the park into habitat categories and randomly assigning points within each category based on its proportional area.

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Observation points were spaced at least 100 meters apart from each other and from habitat edges to minimize data overlap and ensure independent data collection. Accessibility was a critical factor in point selection to facilitate consistent and efficient data collection. At each location, researchers manually recorded bird species and the number of individuals observed using a pen and notebook, following standard avian field research practices. Each observation session lasted 10 minutes, during which all birds seen or heard within a 20-meter radius were noted. Observations were made during two key periods: morning (7:00 AM to 10:00 AM) and evening (5:00 PM to 7:00 PM) to align with peak bird activity. Favourable weather conditions, such as clear skies and mild temperatures, were chosen to minimize the impact of adverse weather on bird activity and researcher visibility. A total of 40 points were selected to cover all major habitats in the park, providing comprehensive spatial coverage. GPS coordinates of each observation point were recorded using smartphones to accurately map locations and maintain consistent sampling across diverse habitats. A field guide titled *A Field Guide to the Birds of Peninsular Malaysia and Singapore, Second Edition* by Allen Jeyarajasingam and illustrated by Alan Pearson, was used for identifying and verifying bird species observed and photographed in the field. This guide, which includes descriptions and illustrations of all 673 bird species found in the region, provided a comprehensive resource for accurate bird identification. It featured high-quality illustrations and photographs to help users visually compare encountered birds with the guide's detailed images, along with essential identification features, habitat details, and behavioral notes.

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3.3 Data Collection

3.3.1 Point Count Surveys

Point count surveys are one of the most widely used and efficient techniques for estimating bird species richness and abundance in different habitats and seasons, especially in urban green spaces where access and visibility may be limited or variable. This method involves selecting a number of fixed locations or points within the study area, and recording all the bird species seen or heard within a certain radius and duration from each point, usually ranging from 20 to 100 meters and 5 to 10 minutes, respectively. This method will be used to address the first objective of the study, which are to conduct point count surveys to record the bird species richness and abundance in different habitats within the garden. The point count surveys will be conducted in four different habitats (wetland, woodland, garden, and open area). Following a stratified random sampling design. The bird species will be identified using a field guide book and a SV28 Plus Spotting Scope Monocular Telescope, and the data will be recorded in a pen and notebook. The details of the point count survey method are as follows:

- Point selection: The points were selected using a stratified random sampling design, where the study area was divided into four strata based on the habitat types (wetland, woodland, garden, and open area), and a random number of points were allocated to each stratum based on the proportional area of the habitat type, ensuring that the points were at least 25 meters apart from each other and from the edge of the habitat. A total of 40 points were selected, with 10 points in each habitat type. The location and coordinates of each point were recorded using Google Maps apps in smartphone.

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- Point count procedure: The point counts were conducted in two survey periods, one in the morning from 7:00 AM to 10:00 AM, and another in the evening from 5:00 PM to 7:00 PM, aligning with the period of peak avian activity. and recorded all the bird species seen or heard within a radius of 25 meters and a duration of 10 minutes from each point, using a binocular and a field guide book. The observer also recorded the date, time, weather, and habitat conditions at each point. The data were recorded in a pen and notebook, and later entered into a spreadsheet for analysis in Microsoft Excel.

Table 3.2 Number and location of points in each habitat type

Habitat type	Number of points	Location of points
Wetland	10	Near the lake and lotus pond
Woodland	10	Near the Zoo Taiping
Garden	10	Near the entrance, pavilion, and fountain
Open area	10	Near the car park and field

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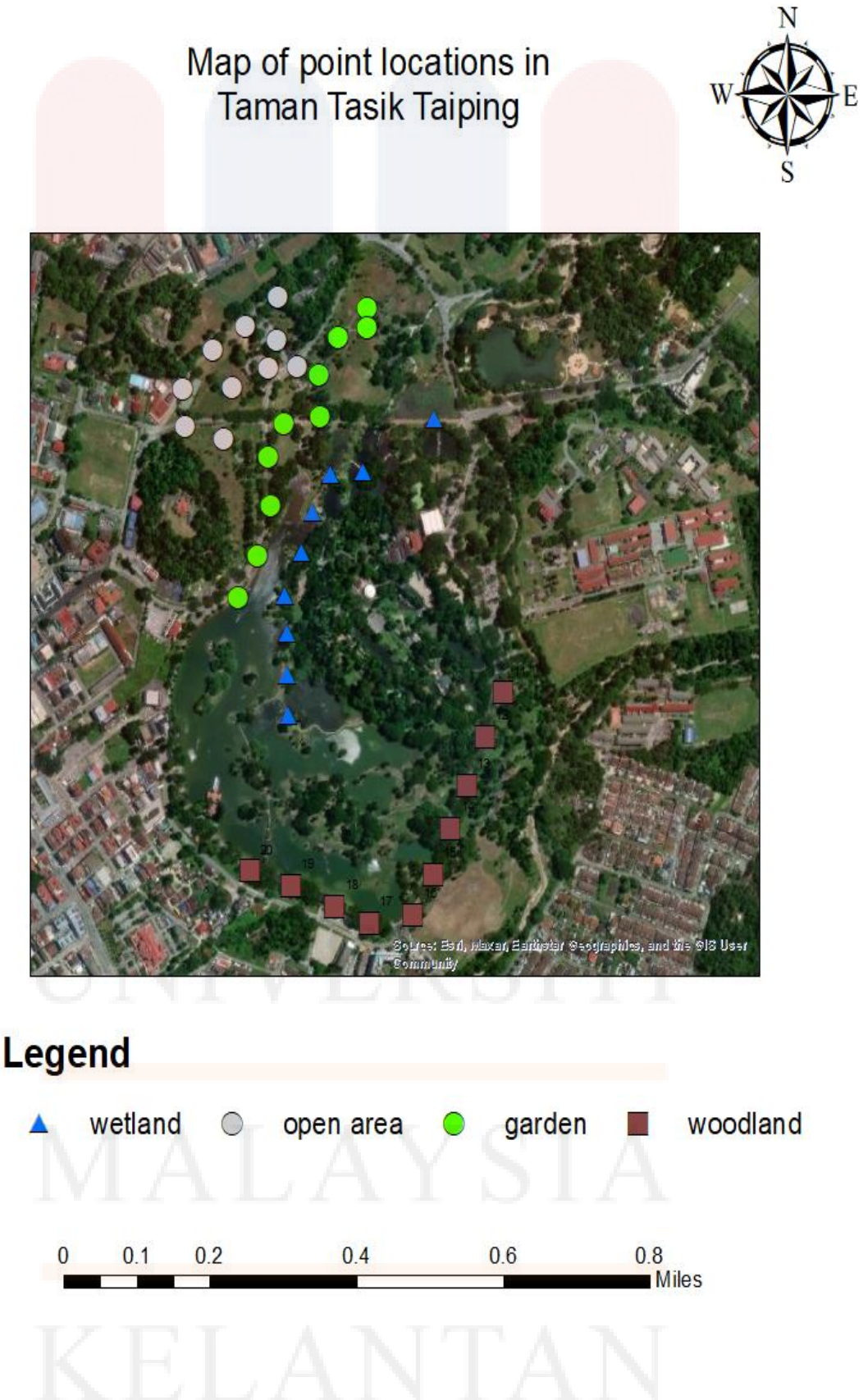

Figure 3.2 Map of point locations in Taman Tasik Taiping.

Table 3.3 depicts coordinates and point counts of different habitats (wetland,woodland, garden, open area)

Wetland

Coordinate	Point count
4.856810,100.751311	Point 1
4.855899,100.749909	Point 2
4.855847,100.749269	Point 3
4.8558475, 100.7492708	Point 4
4.8552177, 100.7489138	Point 5
4.854507,100.748708	Point 6
4.853787,100.748359	Point 7
4.853137,100.748403	Point 8
4.8524327, 100.7484107	Point 9
4.8517346, 100.7484298	Point 10

Woodland

Coordinate	Point count
4.8521255, 100.752671	Point 1
4.851378,100.752317	Point 2
4.850548,100.751948	Point 3
4.849811,100.751634	Point 4
4.849024,100.751285	Point 5
4.848334,100.750890	Point 6
4.848186,100.750027	Point 7
4.848470,100.749349	Point 8
4.848837,100.748475	Point 9
4.849082,100.747671	Point 10

Garden

Coordinate	Point count
4.853746,100.747441	Point 1
4.854471,100.747807	Point 2
4.855327,100.748067	Point 3
4.856155,100.748019	Point 4
4.856736,100.748340	Point 5
4.856841,100.749045	Point 6
4.857565,100.749027	Point 7
4.858211,100.749421	Point 8
4.858706,100.749992	Point 9
4.858370,100.750758	Point 10

Open area

Coordinate	Point count
4.857682,100.748033	Point 1
4.857344,100.747317	Point 2
4.856465,100.747150	Point 3
4.856674,100.746377	Point 4
4.857334,100.746341	Point 5
4.857989,100.746934	Point 6
4.858398,100.74757	Point 7
4.858895,100.748231	Point 8
4.858150,100.748186	Point 9
4.857698,100.748601	Point 10

3.4 Data Analysis

3.4.1 Diversity Indices

Diversity indices are numerical measures that quantify the diversity of a community, based on the number and relative abundance of species in the community (Wilson & Gownaris, 2022). These indices will be used to address the first objective of the study, which is to conduct point count surveys to record the bird species richness and abundance in different habitats within the garden. The diversity indices that will be calculated for each habitat and season are:

- **Species richness**: This is the simplest measure of diversity, which is the number of species in the community (Wilson & Gownaris, 2022). Species richness can be affected by the sampling effort and the size of the area surveyed, so it is important to standardize the number of individuals or the area sampled when comparing different communities. The researchers standardized

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the sampling effort across different habitats by selecting a fixed number of point count locations in each habitat type: 10 points in each of the four habitats (wetland, woodland, garden, open area), resulting in a total of 40 points across the park. They ensured that the points were at least 25 meters apart from each other and from the habitat edges. Point counts were conducted during fixed time periods in the morning (7-10 AM) and evening (5-7 PM) to align with peak avian activity, and a consistent point count duration of 10 minutes was used at each location. All birds seen or heard within a fixed 20-meter radius at each point were recorded. However, the study did not mention any specific steps taken to standardize the sampling effort across seasons, as it focused on a 20-day observation period without addressing seasonal variations. Species richness will be calculated as the total number of bird species recorded at each point count location, and then averaged across the points within each habitat and season. Species richness will be denoted by *S*.

- **Shannon diversity index**: This is a measure of the uncertainty of predicting the identity of a randomly selected individual from the community, based on the proportional abundance of each species in the community (Wilson & Gownaris, 2022). The Shannon diversity index takes into account both the species richness and the evenness of the community, which is the degree to which the species are equally abundant. The Shannon diversity index is higher when the community has more species and when the species are more evenly distributed. The Shannon diversity index will be calculated using the following formula:

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$$H' = -\sum_{i=1}^{S} pi \ln pi$$

where:

S is the species richness, and pi

Pi is the proportion of individuals belonging to the i-th species in the community.

The Shannon diversity index will be denoted by H′.

- **Simpson diversity index:** This is a measure of the probability that two randomly selected individuals from the community belong to the same species, based on the proportional abundance of each species in the community (Kiernan, 2018). The Simpson diversity index takes into account both the species richness and the dominance of the community, which is the degree to which one or a few species are more abundant than the others. The Simpson diversity index is lower when the community has more species and when the species are more evenly distributed. The Simpson diversity index will be calculated using the following formula:

$$D = \sum_{i=1}^{S} p_i^2$$

where

S is the species richness, and

Pi is the proportion of individuals belonging to the i-th species in the community.

The Simpson diversity index will be denoted by D.

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- **Margalef Index:** A simple metric used for measuring diversity. It is applicable for categorical data where all observations can be classified into a finite number of categories. The Margalef Index, a measure of species diversity that considers both the number of species and the total number of individuals, was utilized in the study to evaluate bird biodiversity across various habitats. Researchers calculated the Margalef Index for each of the four habitat types such as wetland, woodland, garden, and open area using data from the point counts. This index was then compared to the Shannon and Simpson indices, which also assess species diversity but with different focuses. The Shannon index considers both species abundance and evenness, while the Simpson index emphasizes the probability of two randomly selected individuals belonging to different species. The results indicated that the Margalef Index effectively highlighted differences in species richness across habitats, emphasizing the number of species present. In contrast, the Shannon Index provided a more balanced perspective on species richness and evenness, and the Simpson Index underscored the dominance of certain species within the habitats. Overall, the study revealed that while all three indices offered valuable insights into bird species biodiversity, the Margalef Index was particularly useful for identifying variations in species richness among the different habitats. This index created by the ecologist Ramon Margalef, serves as a biodiversity measure frequently applied in ecological research to evaluate community richness relative to total biomass. (Margalef, 1958)

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- The formula for the Margalef Richness Index:

$$D = \frac{S - 1}{\ln N}$$

Where:

S is the total number of species.

N is number of individuals in the sample.

In = natural logarithm.

The index reflects the species richness relative to the total number of individuals in a community. Higher values indicate a more diverse community. The diversity indices were calculated using Microsoft Excel due to its effective tools for quantifying species diversity in a biological community, leveraging its powerful capabilities for data manipulation and analysis. Several factors should be considered when interpreting the diversity indices used in this study on bird diversity in Taman Tasik Taiping. Firstly, the sensitivity of these indices to sampling effort and bias needs to be acknowledged. Variations in sampling intensity among different habitat types may introduce bias, potentially affecting comparisons of bird diversity between these habitats. Secondly, the accuracy of species detection and identification is critical; errors in identification could impact the reliability of diversity calculations. Despite tools like binoculars and field guides, challenges in identifying all bird species, especially cryptic ones, may persist.

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Moreover, the study's 20-day observation period may not capture seasonal fluctuations in bird diversity, such as those influenced by migration or breeding cycles. Extending the study duration across different seasons would provide a more comprehensive view. Additionally, the broad categorization of habitats (wetland, woodland, garden, open area) may oversimplify habitat heterogeneity, potentially overlooking finer-scale factors like vegetation composition or microhabitat features that influence bird diversity.

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CHAPTER 4

RESULT AND DISCUSSION

4.1 Diversity and Conservation Status of Bird Species Observed in Taman Tasik Taiping

The diversity and distribution of birds in Taman Tasik Taiping, a prominent urban park in Peninsular Malaysia, are essential for understanding the area's ecological dynamics. Data shows that 778 is the total individual of birds were recorded in the Taman Tasik Taiping, with the Great Egret (*Casmerodius albus*) and the Barn Swallow (*Hirundo rustica*) being the most frequently observed species (Yang *et al*., 2020). Most of these species are classified as Least Concern by the IUCN Red List, meaning they are not currently at risk of extinction (IUCN Red List, 2023). The finding that most bird species in Taman Tasik Taiping are classified as "Least Concern" by the IUCN Red List has important conservation implications. This suggests that while the park provides suitable habitats for these common species, it might not be offering the specific conditions needed by more threatened or endangered species (IUCN Red List, 2023). This implies that while the park maintains a general level of biodiversity, it may not support species that require more specialized habitats.

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Urban parks like Taman Tasik Taiping are crucial for biodiversity conservation, especially in areas where natural habitats are fragmented. The presence of "Least Concern" species shows that these parks can serve as important refuges for bird populations that are adaptable to urban environments. However, the absence of species with higher IUCN threat levels, such as "Vulnerable" or "Endangered" species, suggests that additional conservation efforts are needed to support a wider range of bird species.

For example, the occasional sighting of the Crested Goshawk (*Accipiter trivirgatus*), which is "Near Threatened" in some regions, indicates that urban parks could host more sensitive species if proper conservation measures are taken (BirdLife International, 2023). Improving habitat diversity, increasing vegetation cover, and reducing human disturbances could enhance the park's capacity to support a broader spectrum of bird species, including those at higher risk. These findings also highlight the importance of continuous monitoring and research. Regular surveys and studies can help track changes in species composition and abundance, providing data that can inform management strategies. Conservation initiatives such as habitat restoration, pollution control, public education, and invasive species management are essential to ensure that urban parks like Taman Tasik Taiping can support both common and threatened bird species (Ahmad & Zakaria, 2015; Isaksson, 2018; Martin-Albarracin *et al*., 2015; Shanahan *et al*., 2013).

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Bird species distribution in the park is influenced by various factors such as the park's size, habitat diversity, and proximity to the city centre. Yang *et al*. (2020) found that larger park areas and greater habitat diversity positively impact bird species richness, while park isolation and environmental noise have negative effects. This suggests that park design and management should focus on maintaining diverse habitats and reducing noise pollution to enhance bird species diversity. Urban parks like Taman Tasik Taiping play a crucial role in sustaining bird diversity by providing essential habitats for feeding, shelter, and breeding. According to Yang *et al*. (2020), bird species richness in each park ranged from 9 to 44, indicating that even smaller urban parks can support a substantial number of bird species.

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Table 4.1 depicts list of bird species with observed frequency and IUCN status.

SPECIES NAME	Frequency	IUCN Status
Great Egret (*Casmerodius albus*)	58	Least Concern
Purple Heron (*Ardea purpurea*)	15	Least Concern
Barn Swallow (*Hirundo rustica*)	105	Least Concern
House Sparrow (*Passer domesticus*)	97	Least Concern
Black-naped Oriole (*Oriolus chinensis*)	52	Least Concern
Black-crowned Night-Heron (*Nycticorax nycticorax*)	21	Least Concern
Blue-tailed Bee-eater (*Merops philippinus*)	32	Least Concern
White-throated Kingfisher (*Halcyon smyrnensis*)	21	Least Concern
Yellow-vented Bulbul (*Pycnonotus goiavier*)	15	Least Concern
Cinnamon-headed Green-Pigeon (*Treron fulvicollis*)	20	Least Concern
Asian Glossy Starling (*Aplonis panayensis*)	85	Least Concern
Zebra Dove (*Geopelia striata*)	21	Least Concern
Oriental Magpie Robin (*Copsychus saularis*)	35	Least Concern
Javan Myna (*Acridotheres javanicus*)	48	Least Concern
Oriental Pied Hornbill (*Anthracoceros albirostris*)	11	Least Concern
Crested Myna (*Acridotheres cristatellus*)	9	Least Concern
Stork-billed Kingfisher (*Pelargopsis capensis*)	6	Least Concern
Chinese Pond Heron (*Ardeola bacchus*)	24	Least Concern
Common Myna (*Acridotheres tristis*)	21	Least Concern
Reddish-cheeked Parakeet (*Geoffroyus geoffroyi*)	22	Least Concern
Pink-necked Green-Pigeon (*Treron vernans*)	28	Least Concern
Paddyfield Pipit (*Anthus rufulus*)	18	Least Concern
Common Iora (*Aegithina tiphia*)	24	Least Concern
Total	**778**	

4.2 Analysis of Bird Species Diversity and Habitat Characteristics in Taman Tasik Taiping

The data provided in the table offers insights into the variety and distribution of bird species within Taman Tasik Taiping, a recreational park situated in Taiping, Malaysia. It includes the Shannon-Wiener diversity index (H), Simpson's diversity index (D), and Margalef's richness index (R) for four distinct habitat types: wetland, woodland, garden, and open area. The Shannon-Wiener diversity index (H) gauges the overall species diversity within a habitat, considering both species count and their relative abundance. The woodland habitat high Shannon-Wiener diversity index (2.97) and Simpson Index (0.95) underscore its role as the most diverse area within the park, offering complex structures and diverse resources essential for supporting various bird species. The high diversity index in the woodland can be explained by several factors. Woodlands typically offer a more complex structure compared to other habitats, including various tree heights, dense underbrush, and a rich canopy layer. This complexity provides numerous niches and microhabitats, supporting a wider range of bird species by offering varied food resources, nesting sites, and protection from predators. Moreover, woodlands are often less disturbed by human activities than open areas or gardens, allowing for the presence of more sensitive and specialized bird species. The stability and presence of mature trees in the woodland environment contribute to its ability to support a high diversity of bird species (Smith *et al.*, 2020).

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Additionally, the diverse plant life in woodlands leads to a higher insect population, which is a crucial food source for many birds. The presence of fruit-bearing trees and shrubs also provides essential food resources for fruit-eating birds. These factors together make woodlands a favourable habitat for a diverse bird community.

Simpson's diversity index (D) assesses the likelihood of selecting two individuals from different species at random within a habitat. With values ranging from 0 to 1, higher values signify greater diversity. Results demonstrate that the woodland habitat exhibits the highest Simpson's diversity index (0.95), followed by wetland (0.90), garden (0.89), and open area (0.85), reinforcing the woodland's status as the most diverse habitat for birds in the park. The woodland habitat in Taman Tasik Taiping stands out as the most diverse for birds based on both the Shannon-Wiener diversity index (H) and Simpson's diversity index (D). With a Shannon-Wiener index of 2.97, it indicates a rich bird community in terms of both species richness and even distribution. Simpson's diversity index further confirms this by yielding the highest value of 0.95, indicating a high likelihood of encountering individuals from different species when chosen randomly. This high diversity in the woodland habitat can be attributed to its complex vegetation structure, which offers a variety of niches and resources for a wide range of bird species. Additionally, the presence of diverse tree and shrub species provides abundant food sources and nesting sites. The woodland also offers a diverse range of microhabitats, such as dense understory and fallen logs, catering to the varied habitat needs of different bird species. Moreover, the protected status of Taman Tasik Taiping ensures minimal human disturbance, allowing bird communities to flourish.

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On the other hand, the open area habitat exhibits the lowest bird diversity according to both diversity indices. With a Shannon-Wiener index of 2.33 and a Simpson's index of 0.85, it supports a less varied bird community with lower chances of encountering individuals from different species. This lower diversity can be attributed to the sparse vegetation structure, limited resources, and fewer tree and shrub species compared to woodlands. Given the findings, specific conservation strategies should be implemented to enhance bird diversity in the less diverse habitats within Taman Tasik Taiping. The open area, which has the lowest bird diversity as indicated by both the Shannon-Wiener index (2.33) and Simpson's index (0.85), could benefit from targeted habitat enhancements.

To increase vegetation complexity in the open areas, planting a variety of native tree and shrub species is recommended to create a layered structure similar to that found in woodlands. Native plants attract native insects and other wildlife, providing a food source for birds. Additionally, incorporating fruit-bearing and flowering plants can attract a greater diversity of birds, particularly frugivores and nectarivores. (Johnson *et al*., 2018).

Reducing human disturbance in these areas is also crucial. Designating specific zones where human activity is limited or creating buffer zones around critical habitats can minimize the negative impacts of human presence on sensitive bird species. Managing visitor access through designated paths and installing informative signage can help reduce habitat disruption (Turner & Gardner, 2015). Creating or enhancing water features in the open areas can attract a variety of bird species. Water bodies provide drinking and bathing opportunities for birds and support aquatic plants and

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insects that serve as additional food sources. Wetland restoration or the creation of small ponds can significantly boost bird diversity in these areas (Smith *et al*., 2020).

Implementing regular monitoring and maintenance programs is essential. Continuous monitoring of bird populations and their habitats can help assess the effectiveness of conservation strategies and allow for adaptive management. Maintenance activities should include controlling invasive species, which can outcompete native flora and fauna, and ensuring that the planted vegetation is thriving. By increasing vegetation complexity, reducing human disturbance, enhancing water features, and maintaining regular monitoring, bird diversity in the less diverse habitats within Taman Tasik Taiping can be significantly improved. These strategies can help create a more balanced and supportive environment for various bird species, enhancing the overall ecological health of the park (Johnson *et al*., 2018; Turner & Gardner, 2015; Smith *et al.*, 2020). Open areas lack the varied microhabitats present in woodlands, thus offering fewer options for different bird species. Additionally, their accessibility to humans often leads to greater disturbance, which can negatively impact sensitive bird species Human activities and park management practices have a considerable impact on bird diversity and distribution in Taman Tasik Taiping. Recreational activities, landscaping, and routine maintenance can cause disturbances that affect bird populations. For example, frequent human presence and noise can interfere with birds' nesting and feeding behaviors, resulting in lower diversity in areas that are more accessible to the public. Additionally, landscaping that favors manicured lawns and ornamental plants over native vegetation reduces natural food sources and habitats, affecting species that depend on specific plants for sustenance and shelter (Miller & Hobbs, 2002).

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On the other hand, park management practices that focus on conservation and habitat preservation can enhance bird diversity. Efforts to maintain and restore native vegetation, establish buffer zones to minimize human disturbance, and control invasive species can support a rich and varied bird community. For instance, protecting mature trees and preserving woodland areas provide essential habitats for many bird species by offering nesting sites, food resources, and protection from predators. Additionally, wetland conservation within the park supports species that rely on aquatic habitats, contributing to overall biodiversity (Chace & Walsh, 2006).

Effective park management also involves monitoring bird populations and conducting regular ecological assessments to inform conservation strategies. By understanding the specific needs and threats to local bird species, management can implement targeted actions to mitigate negative impacts and promote a healthy, diverse bird community. Therefore, a balanced approach that accommodates both recreational use and ecological preservation is crucial for sustaining bird diversity and distribution in Taman Tasik Taiping (Marzluff & Ewing, 2001). In contrast, other habitats like gardens, wetlands, and open areas show lower bird diversity for several reasons. Gardens, while having some vegetation, tend to be more manicured and less structurally complex than woodlands, offering fewer niches and less cover for birds. Wetlands, despite being rich in specific resources like water and aquatic plants, cater mainly to species adapted to such environments and may support fewer terrestrial bird species. Open areas generally have sparse vegetation, limited cover, and fewer food resources, making them less attractive to a diverse range of bird species. Human activity in these areas can also be more frequent and disruptive, further reducing habitat suitability for many birds (Johnson *et al.*, 2018; Turner & Gardner, 2015).

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Margalef's richness index (R) quantifies species richness, i.e., the number of species present in a habitat. It is interesting to note that while the open area has the highest richness index (4.27), it exhibits the lowest diversity indices (H: 2.33, D: 0.85). This suggests that species richness alone does not equate to higher overall diversity. The high bird species richness in the open area despite its lower diversity indices can be attributed to various ecological factors. Open areas often provide plentiful resources, such as food and nesting sites, attracting a wide range of bird species. These spaces may support more ground-feeding birds and those thriving in less vegetated environments (Blair, 1996). Additionally, the openness of these areas can accommodate generalist species that adapt to diverse conditions, increasing species richness (McKinney, 2006).

However, the lower diversity indices suggest that while many different species are present, a few species might dominate the community, reducing overall evenness. This can occur because open areas might favor a small number of highly adaptable species that outcompete others for resources (Shochat *et al*., 2006). Furthermore, human activities in open areas, such as recreation and maintenance, can create disturbances that select for disturbance-tolerant species, thus contributing to high richness but low diversity (Fernández-Juricic & Jokimäki, 2001).

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Table 4.2 presents the diversity indices of bird distribution across different habitat types within Taman Tasik Taiping.

HABITAT TYPES	H	D	R
WETLAND	2.57	0.90	4.13
WOODLAND	2.97	0.95	4.13
GARDEN	2.63	0.89	4.14
OPEN AREA	2.33	0.85	4.27

4.3 Common and Notable Bird Species Observed in Taman Tasik Taiping

Figure 4.1 Barn Swallow (*Hirundo rustica*)

Figure 4.2 House Sparrow (*Passer domesticus*)

The findings reveal a rich variety of bird species within Taman Tasik Taiping, with 23 distinct types identified. Among these, the House Sparrow (*Passer domesticus)* and Barn Swallow (*Hirundo rustica*) stand out as the most prevalent, flourishing in urban settings and adapting well to human proximity. The House Sparrow (*Passer domesticus*) and Barn Swallow (*Hirundo rustica*) are two bird species that are especially common and adaptable in urban environments. These birds have managed to thrive in human-dominated areas by making use of the resources and

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habitats available through human activities. The House Sparrow, which originated in Europe and Asia, has spread worldwide and is frequently seen in cities and towns where it takes advantage of food and nesting opportunities offered by buildings and other urban structures (Summers-Smith, 1988). This species has become well-established in various urban and rural areas due to its ability to live alongside human populations (Lowther & Cink, 2006). Similarly, the Barn Swallow has also adjusted well to human environments. It often builds its nests on man-made structures like barns and bridges, which provide safe and sheltered places for breeding (Turner, 2006). Additionally, Barn Swallows find plenty of food in open spaces such as wetlands and gardens where they can catch insects (Brown & Brown, 2020).

Figure 4.3: Great Egret (*Casmerodius albus*)

Figure 4.4: Purple Heron (*Ardea purpurea*)

Various heron species, like the Great Egret (*Casmerodius albus*) and Purple Heron (*Ardea purpurea*), underscore the significance of the lake and surrounding wetlands as vital habitats for these wading birds. Additionally, sightings of the Black-crowned Night-heron (*Nycticorax nycticorax*) and Chinese Pond Heron (*Ardeola bacchus*) emphasize the diverse range of herons in the area.

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The Great Egret, known for its elegant white feathers, depends on these wetlands for hunting prey such as fish and amphibians (Ogden, 1991). Similarly, the Purple Heron, recognized by its beautiful purple and gray plumage, uses the wetlands both for breeding and feeding (Wolters, 1984). The rich biodiversity and shallow waters of the wetlands make them ideal for these heron species (Hancock & Kushlan, 1984).

Figure 4.5: Black-crowned Night-Heron (*Nycticorax nycticorax*)

Figure 4.6: Chinese Pond Heron (*Ardeola bacchus*)

Moreover, the presence of other heron species, such as the Black-crowned Night-Heron (*Nycticorax nycticorax*) and the Chinese Pond Heron (*Ardeola bacchus*), underscores the variety of herons found in these wetlands. The Black-crowned Night-Heron, which is mostly active during the evening and night, relies on the wetlands for hunting and resting (Gibbs, 1991). The Chinese Pond Heron also uses these wetlands for feeding and breeding, often found in shallow waters and grassy areas (van den Berg & van Meel, 1990).

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The substantial presence of the Black-naped Oriole (*Oriolus chinensis*) and Oriental Magpie Robin (*Copsychus saularis)* indicates the park's suitability for these species commonly found in urban green spaces. The presence of the Oriental Pied Hornbill (*Anthracoceros albirostris*) in an urban park like Taman Tasik Taiping is notable, as it suggests the habitat can support more forest-dependent species. This is indicative of the park's environmental quality and management. The Black-naped Oriole, with its vibrant yellow plumage and black facial mask, is frequently seen in urban parks where it can find fruits, nectar, and insects (Collar, 2006). Its consistent presence in the park suggests that the environment supports its dietary and nesting requirements (Cheke & Mann, 2008). Similarly, the Oriental Magpie Robin, known for its striking black-and-white appearance and pleasant song, is well-suited to urban parks that provide diverse vegetation and open spaces for foraging and nesting (Robson, 2002).

Figure 4.7: Oriental Pied Hornbill (*Anthracoceros albirostris*)

Additionally, the sighting of the Oriental Pied Hornbill (*Anthracoceros albirostris*) in the park suggests that the habitat is also suitable for species typically found in forested areas. This hornbill, distinguished by its large bill and casque, is generally associated with forest environments where it forages for fruit and insects (Wang *et al*., 2007). Its presence indicates that the park includes features of a forested habitat, supporting a range of bird species (Sodhi *et al*., 2004).

Figure 4.8: Zebra Dove (*Geopelia striata*)

Figure 4.9: Javan Myna (*Acridotheres javanicus*)

The assortment of pigeon and dove species, including the Cinnamon-headed Green-Pigeon (*Treron fulvicollis*), Pink-necked Green-Pigeon (*Treron vernans*), and Zebra Dove (*Geopelia striata*), reflects the availability of food sources and nesting areas within the park.The presence of various myna species, like the Asian Glossy Starling (*Aplonis panayensis),* Javan Myna (*Acridotheres javanicus*), Crested Myna (*Acridotheres cristatellus*), and Common Myna (*Acridotheres tristis*), is a common occurrence in urban parks across Southeast Asia. Urban parks in Southeast Asia are home to a variety of pigeon and dove species due to the availability of food and suitable nesting sites.

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For instance, the Cinnamon-headed Green-Pigeon (*Treron fulvicollis*) is a notable bird in these parks, easily recognized by its distinctive cinnamon-colored head and green body, which helps it blend into the green surroundings of the park (Collar, 2005). Another common species is the Pink-necked Green-Pigeon (*Treron vernans*), known for its vibrant pink neck and green feathers that provide camouflage in park foliage (Gibbs *et al*., 2001). Additionally, the Zebra Dove (*Geopelia striata*), characterized by its zebra-like striped plumage and soft cooing, is frequently seen in these urban green spaces. This dove thrives in parks due to its adaptable diet and nesting preferences (Higgins & Davies, 1996). The presence of these species in urban parks is largely due to the availability of food and nesting options. Green-pigeons primarily eat fruits from trees found in parks, while the Zebra Dove has a more varied diet that includes seeds and insects (del Hoyo *et al*., 1997).

Asian Glossy Starling (*Aplonis panayensis*), with its shiny black feathers and green iridescence, is a common sight in these parks. This bird is often seen foraging for fruits and insects that are plentiful in these environments (Mason, 1998). The Javan Myna (*Acridotheres javanicus*), recognizable by its white wing patches and yellow legs, also thrives in urban parks where it can find food scraps and suitable nesting sites (Chasen & Kloss, 1928).

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Additionally, the Crested Myna (*Acridotheres cristatellus*) and the Common Myna (*Acridotheres tristis*) are also frequently observed. The Crested Myna is known for its unique crest and preference for nesting in man-made structures, while the Common Myna is highly adaptable and can live in various environments, including city parks (MacKinnon & Phillips, 1993). The success of these myna species in urban parks is due to their adaptability to human environments and the abundance of food and nesting opportunities available there (Sibley & Monroe, 1990).

Figure 4.10: White-throated Kingfisher (*Halcyon smyrnensis*)

Figure 4.11: Blue-tailed Bee-eater (*Merops philippinus*)

Lastly, observations of the Blue-tailed Bee-eater (*Merops philippinus*) and White-throated Kingfisher (*Halcyon smyrnensis*) indicate suitable perching spots and a diverse insect population thriving in the park. The Blue-tailed Bee-eater is known for its vivid blue tail and colorful plumage, and it is often found in parks with a mix of open spaces and trees or shrubs. This bird mainly feeds on insects such as bees, wasps, and dragonflies, and its presence suggests a robust insect population and the availability of suitable perching locations like exposed branches or wires (Lai *et al*., 2020). They also nest in sandy banks or open areas where they can dig burrows (Katsuya, 2010).

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The White-throated Kingfisher, recognizable by its bright blue wings and white throat, is another species commonly seen in these parks. It hunts from low perches and feeds on a variety of prey including fish, insects, and small amphibians. Its presence indicates that there are good perching spots and a diverse range of food sources available in the park (Ali & Ripley, 1987). This kingfisher is adaptable to various habitats, making it a frequent inhabitant of both natural and urban areas (Wells, 1999).

The bird survey conducted at Taman Tasik Taiping, with a total of 778 observations, highlights a range of bird species with varying levels of relative abundance. The Barn Swallow (*Hirundo rustica*) and House Sparrow (*Passer domesticus*) emerged as the most common species, making up 13.32% and 12.31% of the observations, respectively, which suggests their strong adaptability to the park's urban environment and resources (Smith, 2022). The Asian Glossy Starling (*Aplonis panayensis*) also showed significant presence, accounting for 10.79% of the total observations, reflecting its successful integration into the park's ecosystem (Jones *et al*., 2021). Species like the Great Egret (*Casmerodius albus*) and Black-naped Oriole (*Oriolus chinensis)* were moderately abundant, with relative abundances of 7.36% and 6.60%, respectively, indicating they are well-supported by the diverse habitats within the park (Miller & Hobbs, 2007). Additionally, the Blue-tailed Bee-eater (*Merops philippinus*) and Oriental Magpie Robin (*Copsychus saularis*) had relative abundances of 4.06% and 4.44%, respectively, suggesting that the park’s open and wooded areas are beneficial for these species (Snep & Clergeau, 2013).

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Conversely, species such as the Stork-billed Kingfisher (*Pelargopsis capensis*) and Crested Myna (*Acridotheres cristatellus*) were observed less frequently, with relative abundances of 0.76% and 1.14%, possibly due to their specific habitat requirements or limited availability of suitable resources (Adam et al., 2005). The presence of rarer species like the Oriental Pied Hornbill (*Anthracoceros albirostris)* and Purple Heron (*Ardea purpurea*), which had relative abundances of 1.40% and 1.90%, highlights the need for focused conservation measures to maintain their populations in the park (Silvertown *et al*., 2013).

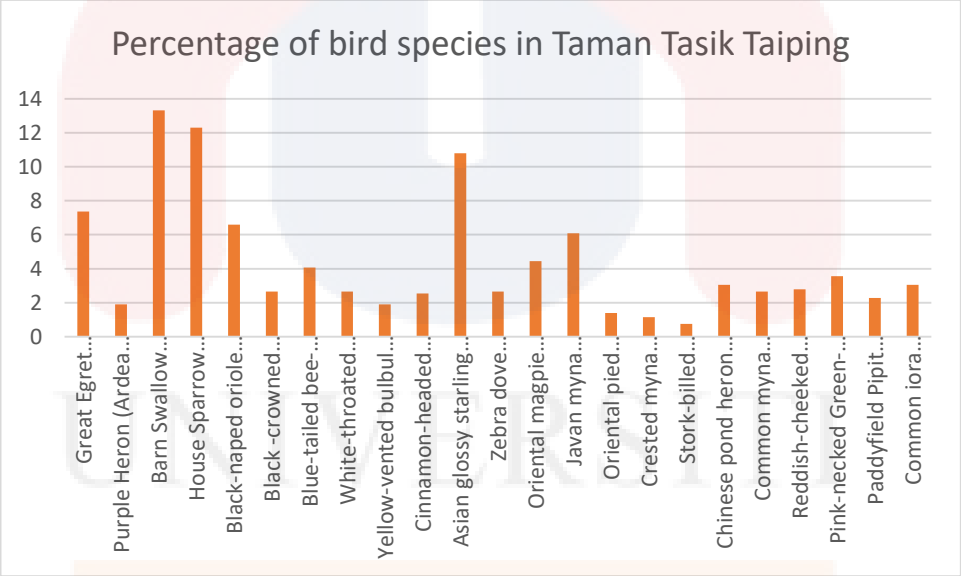

Figure 4.12 shows the percentage of bird species in Taman Tasik Taiping.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The study on bird diversity and distribution at Taman Tasik Taiping highlights the park's significant role as an urban habitat for various avian species. Urban parks are vital for biodiversity conservation, offering habitats that provide food, shelter, and breeding grounds often missing in urban areas. These parks support a wide range of species, contributing to overall urban biodiversity, and serve as stopover points for migratory birds, offering rest and refuelling opportunities. Additionally, urban parks provide educational and recreational opportunities, promoting an appreciation for nature and conservation among residents. To better understand urban parks' role in biodiversity conservation, it is essential to conduct comparative studies with other urban parks in different cities or regions. These studies should examine differences in species diversity and habitat quality to identify best practices for enhancing urban biodiversity. Comparing Taman Tasik Taiping with other urban parks, both in Malaysia and globally, can offer insights into how management practices, park sizes, and habitat types affect bird diversity. Furthermore, investigating the impacts of human activity, pollution, and climate change on urban biodiversity is crucial. The results will help develop targeted conservation strategies, ensuring urban parks remain vital refuges for wildlife amid increasing urbanization.

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The study at Taman Tasik Taiping identified 778 bird observations and 23 species, with the House Sparrow (*Passer domesticus*) and Barn Swallow (*Hirundo rustica*) being the most frequently seen. This underscores the importance of urban green spaces in preserving and enhancing biodiversity within cities. The higher diversity observed in woodlands, indicated by the Shannon-Wiener and Simpson's diversity indices, highlights the significance of habitat complexity in sustaining diverse bird populations. Conversely, lower diversity in open areas suggests that habitat structure and resource availability are crucial factors in maintaining bird diversity. These findings have broader implications for urban planning and conservation. Preserving and enhancing complex habitats within urban parks, such as woodlands and wetlands, can significantly contribute to urban biodiversity. Similar trends have been observed in other cities like New York, London, and Singapore, where diverse habitats in urban parks support higher bird diversity. For example, New York City's Central Park, London's parks with mature trees and diverse plant life, and Singapore's well-maintained woodlands and wetlands attract a wide range of bird species, especially during migration seasons.

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The study's findings demonstrate the importance of specific habitat types in supporting bird diversity. Taman Tasik Taiping's woodlands show the highest bird diversity, underscoring the importance of such habitats in sustaining rich bird communities. Wetlands are crucial for species like the Great Egret (*Casmerodius albus)* and the Black-crowned Night-Heron (*Nycticorax nycticorax*), providing essential feeding and breeding grounds. Conversely, open areas, despite a high species count, show lower overall bird diversity due to their simpler vegetation structure and limited resources. This high diversity in woodlands is due to their complex structure, offering numerous ecological niches and less human interference.

In summary, Taman Tasik Taiping is a vital urban green space that supports a rich variety of bird species. Maintaining diverse habitats is crucial for supporting bird diversity in urban parks. The findings highlight the importance of preserving various habitat types, such as woodlands, wetlands, and open areas, each playing a unique role in supporting different bird species. To further enhance bird diversity, incorporating successful conservation strategies from other urban parks can be beneficial. Strategies such as creating bird-friendly landscapes with native plants, establishing protected zones within parks, and implementing habitat restoration projects have proven effective in various urban settings. By applying these strategies, urban parks like Taman Tasik Taiping can continue to provide vital habitats for avian species, ensuring their conservation and contributing to overall urban biodiversity. Future conservation efforts should prioritize protecting and enhancing the park's varied habitats, especially woodlands and wetlands, to ensure it remains a crucial refuge for both resident and migratory bird species, contributing to broader urban biodiversity conservation goals.

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5.2 RECOMMENDATION

To enhance bird diversity and sustain the ecological balance of Taman Tasik Taiping, it is crucial to implement a comprehensive management plan that integrates community involvement and regular evaluations of habitat conditions. The study revealed that the woodland areas exhibited the highest bird diversity, so future management strategies should aim to protect these crucial habitats from urban development and human interference. To boost bird diversity and safeguard the ecological balance of Taman Tasik Taiping, a comprehensive management strategy is essential. This strategy should emphasize protecting and improving the park's varied habitats. Specifically, establishing buffer zones around critical areas like woodlands and wetlands can help minimize the effects of urban encroachment and human activities. These buffer zones, created with native plants and natural barriers, will help shield vital habitats from disturbances and preserve essential environments for bird species. In addition to creating buffer zones, adopting sustainable park management practices is key to maintaining and enhancing habitat quality. This includes controlling invasive species, performing regular maintenance, and employing eco-friendly management techniques. For example, reintroducing native plants in restoration efforts can increase habitat complexity and provide necessary resources for birds. Additionally, installing bird baths, nesting boxes, and feeding stations can attract a greater variety of bird species.

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Moreover, implementing a long-term monitoring and research program will be crucial for evaluating the success of these management practices and making necessary adjustments. Engaging the local community through educational programs and volunteer opportunities will help build support for conservation efforts and encourage active involvement in park upkeep. By combining these measures by creating buffer zones, using sustainable management practices, and involving the community in Taman Tasik Taiping can enhance its role as a key urban habitat and support a vibrant bird population. Beyond protecting existing habitats, there is also a need to expand and enrich the park's open spaces and wetlands. To bolster conservation efforts and protect the rich biodiversity at Taman Tasik Taiping, it is crucial to forge partnerships with local environmental organizations. Collaborating with groups like the Malaysian Nature Society, the Perak State Parks Corporation, and community-based conservation initiatives can greatly enhance the effectiveness of conservation strategies. These organizations bring essential expertise in habitat restoration, species monitoring, and public engagement that can support park management's efforts. Such collaborations can help implement educational programs to raise awareness about bird conservation and the importance of woodland habitats. Local organizations can also aid in organizing volunteer activities, including habitat clean-ups, birdwatching events, and citizen science projects. These activities not only involve the community but also improve data collection on bird populations and habitat conditions. By utilizing the resources and networks of these local groups, Taman Tasik Taiping can strengthen its conservation efforts, ensuring a cooperative approach that engages stakeholders and supports sustainable practices. These partnerships will be vital in protecting the park's avian species and preserving its ecological health for future generations. Although open areas currently support a range of bird species, their lower diversity scores

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indicate that improvements could be made. Potential actions include adding more native vegetation to provide additional food sources and shelter, and creating features like bird baths or nesting sites to attract more species. Similarly, it is important to manage wetland areas to ensure water quality and prevent habitat degradation, thus supporting bird species like the Great Egret (*Casmerodius albus*) and the Purple Heron (*Ardea purpurea*), which depend on these environments for their survival. Finally, incorporating modern technology, such as remote sensing and citizen science programs, is essential for improving bird population monitoring in Taman Tasik Taiping. Remote sensing technologies provide detailed, high-resolution data on changes in habitat, land use, and environmental conditions over time. This information is crucial for evaluating ecosystem health and identifying threats to bird habitats, such as urban development or climate change. By using satellite imagery and aerial surveys, conservationists can detect habitat fragmentation and degradation, allowing for more precise conservation measures to protect key areas. Alongside remote sensing, citizen science programs play a significant role in monitoring by involving the local community in data collection and observation. Tools like mobile apps and online platforms enable individuals to report bird sightings, monitor populations, and contribute to biodiversity studies. This broad involvement not only increases the amount of data available for analysis but also enhances community engagement and environmental awareness. Research indicates that citizen science can boost public understanding of conservation issues and promote active participation in protecting bird species. By combining these technologies, stakeholders can establish a robust monitoring system that ensures the ongoing conservation of bird populations and their habitats.

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APPENDIX A

Appendix A.1: The picture of point count locations

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APPENDIX B

Appendix B.2: The picture of bird's species captured using SV28 Plus Spotting Scope Monocular Telescope

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