

URBAN HABITAT FOR BIRD SPECIES IN MAJOR PARKS OF PUTRAJAYA,  
MALAYSIA

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## **DEDICATION**

Alhamdulillah, Thank you Allah. I did it!

This thesis is dedicated to my beloved family members, Abah, Mak, Arin, Jila, Akim and Iqa. A special dedication goes to my dear husband, Saufiq Othman who kept supporting and encouraging me to finish my study.

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## ABSTRACT

Habitat loss and fragmentation are the key factors in the process of urbanization which seriously impedes the habitat availability and movement of species, leading to a significant decrease in population viability. Hence, park has been recognized as the most significant urban green space for urban wildlife conservation especially the bird species. Particularly, park offers habitat necessities by providing food resources, foraging substrates, and nesting site for birds to survive amidst the urbanization process. However, there is lack of studies on how birds select parks as their habitat. Therefore, this study explored park habitat attributes that influence bird abundance, richness, and diversity in two different scales. Park size and park distance to the mainland were examined within the landscape scale. While habitat structure including habitat complexity, habitat openness, and anthropogenic disturbances were evaluated within the patch scale. Eighteen major parks were selected for the survey, including Metropolitan Park, Urban Park, and Local Park. Observation through point count and transect sampling method recorded 46 bird species, of which 42 were residents and four were migratory birds. Quantitatively, the data were analysed using index analysis, habitat score analysis, statistical analysis, and ArcGIS analysis. Pearson's correlation test for landscape scale demonstrated that bird abundance, richness, and diversity were not influenced by the park size and park distance from the mainland in total. Only cavity nester was reported to associate with park size positively ( $P = 0.031$ ,  $R = 0.999$ ). Its abundance was high in the larger park. Meanwhile, analysis in patch scale showed that the presence of many bird guilds were associated with the habitat structure. Urban avoiders, adapters, and specialist bird increased in the more complex patch but decreased in the less complex patch. Contrary, urban exploiters only increased in more open patch with higher anthropogenic disturbances. Accordingly, main diet guild, frugivores and insectivores were increased in higher complexity level of patch but became lower in the more open patch with a higher level of anthropogenic disturbances. Other than that, the majority of bird guilds reduced in abundance, richness, and diversity in higher anthropogenic disturbances level but not for exploiters and carnivores which increased in higher disturbances level. The overall findings suggest that birds in the urban require parks that meet their basic needs including food materials, foraging substrates, and nesting site. The findings thus contribute to a better understanding of birds' needs and preferences in a park environment and highlight the importance of such environments in promoting more diverse bird species. Finally, the findings suggest that the park design should consider not only its size (minimum of 8 ha) and connectivity (minimum of 150 m from mainland) but also the local improvements in habitat structure through the increased in vegetation complexity, reduced openness, and reduced anthropogenic disturbances to attract more specialist birds than generalist birds and more avoiders birds than exploiters birds.

## ABSTRAK

Kehilangan habitat dan fragmentasi adalah faktor utama dalam proses urbanisasi yang akan menghalang ketersediaan habitat dan pergerakan spesies, yang membawa kepada penurunan populasi secara mendadak. Oleh itu, taman telah diiktiraf sebagai kawasan hijau yang paling penting untuk pemuliharaan hidupan liar di bandar terutama spesies burung. Secara amnya, taman menawarkan pelbagai keperluan habitat dengan menyediakan sumber makanan, bahan membuat sarang dan tempat bersarang untuk burung kekal dan terus hidup di kawasan bandar. Walau bagaimanapun, terdapat kekurangan kajian tentang bagaimana burung memilih taman sebagai habitatnya. Oleh itu, kajian ini meninjau ciri-ciri habitat taman yang mempengaruhi spesies, komposisi dan taburan burung dalam dua skala habitat yang berbeza. Saiz taman dan jarak taman dari sumber utama habitat dikaji pada skala lanskap manakala struktur habitat termasuk kompleksiti, keterbukaan serta gangguan antropogenik dinilai dalam skala lebih kecil. 18 taman utama dipilih untuk kajian ini, termasuk Taman Metropolitan, Taman Bandar dan Taman Tempatan. Pemerhatian melalui kaedah persampelan telah mencatatkan 46 spesies burung, dengan 42 spesies ialah burung penduduk dan empat spesies ialah burung hijrah. Secara kuantitatif, data di analisis menggunakan analisis indeks, analisis skor habitat, analisis statistik dan analisis ArcGIS. Ujian korelasi Pearson untuk skala lanskap menunjukkan bahawa kelimpahan, kekayaan dan kepelbagaian burung tidak dipengaruhi oleh saiz taman dan jarak dari kawasan sumber utama. Hanya burung yang membuat sarang di rongga pokok sahaja dilaporkan mempunyai hubungan positif dengan saiz taman ( $P = 0.031$ ,  $R = 0.999$ ). Kelimpahannya tinggi di taman yang bersaiz lebih besar. Sementara itu, analisis dalam skala yang lebih kecil menunjukkan bahawa kehadiran banyak kesatuan burung dikaitkan dengan struktur habitat. Burung pengelak bandar, burung penyesuai dan burung pakar meningkat dalam taman yang lebih kompleks, tetapi menunjukkan penurunan dalam taman yang kurang kompleks. Sebaliknya, pengeksploitasi bandar meningkat lebih banyak di taman terbuka dengan gangguan antropogenik yang lebih tinggi. Oleh itu, kesatuan diet utama, burung pemakan buah dan serangga telah meningkat dalam tahap kompleksiti yang lebih tinggi tetapi menjadi lebih rendah dalam taman yang lebih terbuka dengan tahap gangguan antropogenik yang lebih tinggi. Selain itu, majoriti kesatuan burung menunjukkan penurunan dalam kekayaan, kelimpahan dan kepelbagaian pada tahap antropogenik yang lebih tinggi tetapi bukan untuk golongan pengeksploitasi dan burung karnivor yang meningkat pada tahap gangguan yang lebih tinggi. Penemuan keseluruhan mencadangkan bahawa burung di bandar memerlukan taman yang memenuhi keperluan asas mereka termasuk bahan makanan, kawasan mencari makanan dan tempat bersarang. Penemuan ini menyumbang kepada pemahaman yang lebih baik tentang keperluan dan keutamaan burung di persekitaran taman dan menekankan betapa pentingnya persekitaran taman yang baik dalam mempromosikan pelbagai spesies burung. Akhirnya, penemuan kajian ini mencadangkan agar reka bentuk taman harus mempertimbangkan bukan sahaja saiz taman (minimum 8 hektar) dan jarak taman dari kawasan sumber utama (minimum 150 m), tetapi juga perlu menambah baik struktur habitat melalui penanaman pokok yang lebih kompleks, pengurangan kawasan terbuka dan pengurangan gangguan antropogenik supaya dapat menarik lebih banyak burung pakar daripada burung biasa dan lebih banyak burung pengelak bandar daripada burung pengeksploitasi bandar.

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# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Urbanization is a process describing the increase in human settlement density and the associated growth in land use which progressively transfers wildlands unpopulated by human into lands containing some degree of permanent human presence (Marzluff, 2001). An examination of data on the urbanization level of Malaysia has recorded an increasing around 10.0% in 1911 to 28.4% in 1970 and 61.8% in 2000 (Masron, Yaakob, Ayob, and Mokhtar, 2012). Since the beginning of 2010, Malaysia recorded a strong increase in urbanization rate by 2.66% each year until 2015. The highest growth rate was recorded in big cities like Kuala Lumpur, and that contributed to the opening of Putrajaya due to the population congestion (Figure 1.1). The process is nonstop, and the urban settings are typically embedded with structures and buildings that cause limitation of natural resources for urban wildlife.

Furthermore, intense urbanization causes native land conversion threatening biodiversity and contributes to higher local animal extinction including birds. In 1970, a report by the Global Conservation Organization indicated that the planet was loaded with twice the pressure and more than 33% of natural resources declined. Nevertheless, recent years indicate that extinction rates fluctuated to nearly 100 to 1000 times greater than prehuman rates. Around 5%–20% of the species within major taxonomic groups, especially mammals and avifauna have gone extinct (Chapin III et al., 2000). Malaysia possibly faces the extinction of 45 bird species with five of the species are critically endangered, five are endangered and thirty-five has been classified as vulnerable by BirdLife International in the next five to ten years if it fails to initiate protected areas and breeding programmes for endangered species (Malaysia Nature Society, MNS, 2007).

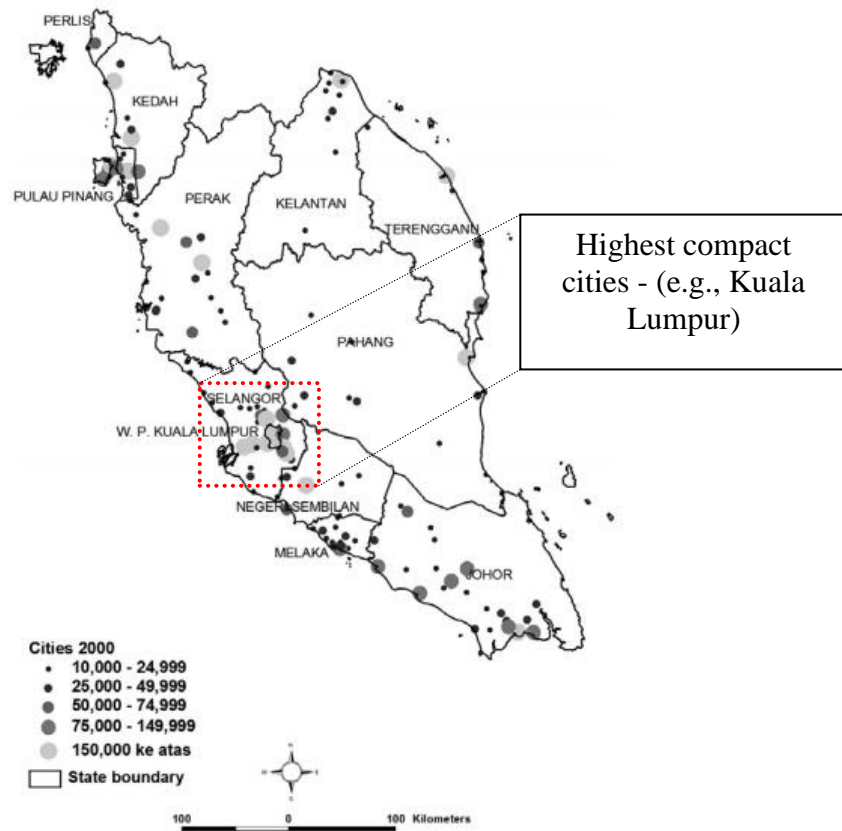


Figure 1.1 Distribution of urban areas in Peninsular Malaysia in 2000

Previous studies show that species are constantly going extinct and species community structures are changing due to the impact of urbanization. Urbanization contributes to major negative effects towards biodiversity system mainly habitat fragmentation, habitat degradation, habitat loss, ecosystem function loss, exotic species competition, climate change, and land-use change. Continuous changes in biodiversity directly affect human population by corrupting ecological services and limiting function and socioeconomic growth, particularly in the urban ecosystem. A well-studied example is the occurrence of large omnivorous and tree nester species in Singapore that is the Javan Myna. The abundance of Javan Myna reflects the opportunistic exploitation of urban resources in Singapore (Lim and Sodhi, 2004). As with many invasive species, they out-compete native birds by attacking other birds to get the best nesting holes. The socioeconomic impacts of invasive bird, like Javan Myna infestations, include the loss and degradation of natural resources that communities rely on for their living needs and requirements.



Unfortunately, the impacts of biodiversity loss are often not as simple and perceptible as the Javan Myna example. The biodiversity loss and disappearance process are far more complicated which can take years to distinguish. Particularly, the use of invasive and exotic plant species in urban landscaping also reduces native bird richness by promoting higher presences of alien pests than native insects (Tallamy, 2004). In the context of urban areas, bird diversity is very important not only for the ecosystem services they provide which include seed dispersal, insect pest control, ecosystem engineers and other benefits for human society (Wenny, Devault, Johnson, Kelly, and Sekercioglu, 2011) but they are also a highly observable taxa, which facilitates easy identification of species diversity. Bird species occur world-wide in nearly all habitat and are best known class of vertebrate animals which represent many trophic levels that can reveal a lot about the health of the environment through their presence and absence (Sekercio-glu, 2006). Thus, preparing the native birds as an ideal group to help examine and monitor ecosystem service and habitat quality measurement, particularly in an urban environment is a great effort and should be given priority (Fontana, Sattler, Bontadina, and Moretti, 2011).

The great degradation of habitat causes many species loss and increased fragmentation occurs when suburbs keep sprawling and city centers facing higher development density (Marzluff et al., 2001). The city centers are usually embedded with human-made structures and buildings that limits natural resources for urban wildlife such as birds. Accordingly, habitat loss is a direct result of habitat alteration from the wide use of impervious surfaces. Therefore, many efforts have been done to achieve better environmental quality in the city, for which the Malaysian Town and Regional Planning Department requires each development to allocate at least 10% from the development progress for green space reservation (JPBD, 2011). Green space in the urban context constitutes parks, garden, pocket space, road corridor, playground, playfield, agricultural land, secondary forest, and orchard that are important for ecosystem resilience (Chiesura, 2004). Each of the green spaces can be described as part of the ecosystem as they contain a variety of species biodiversity that makes up an ecological service. Hence, park is seen as a valuable component of a city to be conserved for a better future. However, the structure and composition of these designed landscapes would also differ from former native habitats, with lawns making up 75%–95% of urban parks and 52%–80% of residential green space (Stewart et al.,

2009), with ignorance of enough tree plantings as one of the important elements for foraging, nesting, and breeding site. Landscape design in Malaysia is particularly lacking in variety including both in species and composition of tree-planting scheme creating a landscape of sameness (Ismail Said, 2004). Kelat Paya with dense multicolored of olive green and red foliage can be easily seen everywhere in the streets, urban parks, playgrounds, and house garden creating the homogeneity of the urban landscape (Ismail Said, 2004). Furthermore, the sameness landscape would not benefit the animal species much because it limits shelter and food resources.

It is an important part of the process to create a wildlife-friendly environment that can provide resourceful habitat for urban wildlife through the enrichment of basic survival requirements. It is believed that the complexity of the urban fabric could provide potential foraging and breeding sites for bird species to survive (Chiesura, 2004 and Paton et al., 2012). To address this concern, the research presented in this thesis was designed to explore birds which are the common species that inhabit most parts of urban areas as an ecological indicator to measure habitat quality (Koskimies, 1989; Reale and Blair, 2005; Sandstrom et al. 2006; Heyman, 2010). Furthermore, it is easy to observe birds because they are familiar with the human presence in the urban environment (Imai and Nakashizuka, 2010). Hence, this chapter covers on the overall structure of the study, which begins with a brief introduction of the research by reviewing the problems that trigger the research, followed by discussing the gap of knowledge, and stating the aim and objectives. This chapter also outlines the limitation and significance of the study.

## **1.2 Statement of Problem**

### **1.2.1 Urbanization**

Urbanization describes the increase in the proportion of people living in town and cities because people move from rural to urban areas (Waugh, 1990). It causes several problems such as congestion, lack of housing, and environmental degradation. This phenomenon is happening in Malaysia cities since the early 1970s until now

where the country is witnessing the rise of extended mega urban regions focusing on the Klang Valley, Penang–Kulim industrial area, and Johor Bahru–Pasir Gudang (Abdul Samad Hadi, 2009). The United Nations Environment Programme (UNEP) reported that environmental hazards occur by the destruction of forests and other nature reserves around cities for settlements and agriculture. Moreover, urban development can expand the threat of environmental hazards to the animal populations especially birds. The Blue Tits, *Cyanistes caeruleus*, and the blue Swallow, *Hirundo atrocaerulea*, are among the birds that had bad experiences because of air pollutions. They have low breeding success and low capacity to forage in the urban (Isaksson and Sumasgutner, 2016). Therefore, strong city planning is essential in managing these and other difficulties.

### **1.2.2 Extinct of Wildlife**

The International Union for the Conservation of Nature suggests that 25% of all mammal species may become extinct soon. As for birds, a total of 11% of all identified bird species was officially classified as near threatened since 1996 (IUCN, 2012). Nevertheless, the recent trend for bird preservation is not encouraging where more and more bird species are in decline throughout the world. All these occur due to various causes, including exploitation, habitat degradation and change, habitat loss, climate change, invasive species, pollution, and disease (Figure 1.2). Exploitation through hunting and fishing and habitat degradation are the primary threats to wildlife by far. Climate change is the next most common primary threat with 7.1% (McLellan, 2014), and is likely to put more pressure on the population of specific groups of birds including migratory, mountain, island, wetland, and seabirds. Indeed, the greatest threat to bird species, particularly in the urban environment is habitat alteration consisting of loss, degradation, and conversion of the natural habitat (Johnson, 2007). World Wildlife Fund (WWF) also reported that terrestrial species comprises bird population declined by 39% between 1970 and 2010, a trend that shows no sign of slowing down (Figure 1.3).

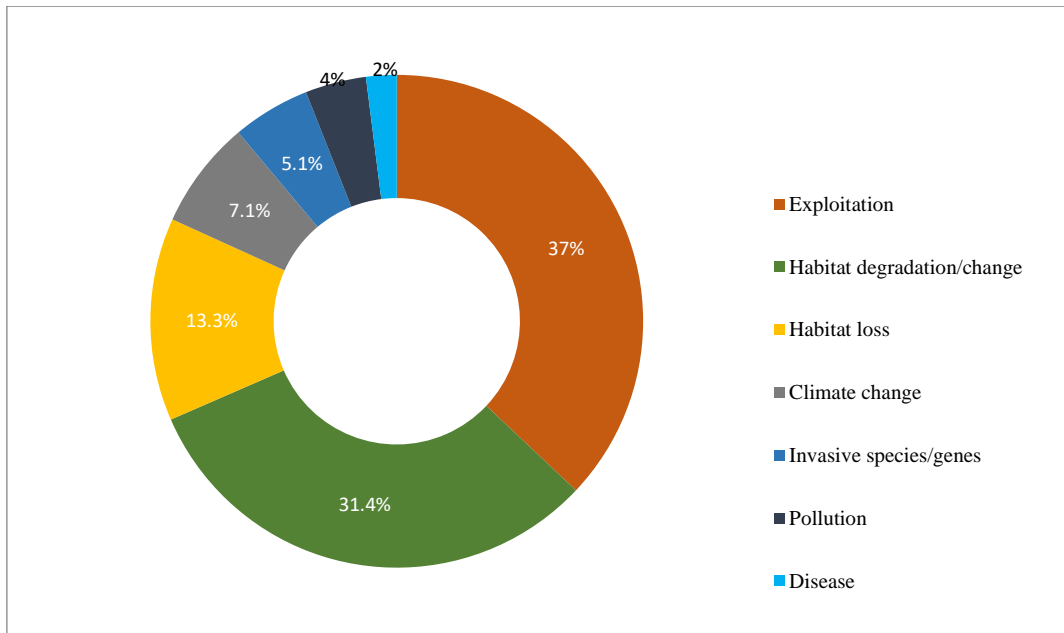


Figure 1.2 Threats to wildlife and population decline in 1970–2010 (World Wildlife Fund - WWF International, 2014)

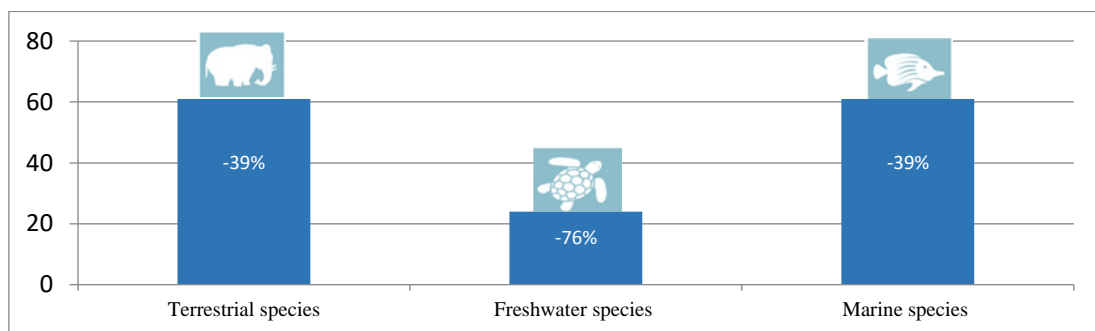


Figure 1.3 Species population decline in 1970–2010 (WWF International, 2014)

### 1.2.3 Adaptability, Survivability and Change of Behavior

To avoid extinction, it is a must for any urban wildlife including birds to modify their behavior to be able to survive in cities. Otherwise, they will become extinct at the mercy of urban growth. Like many other animals and plants, birds' habitat also changes and fragments due to urbanization. Moller and Ibanez-Alamo (2012) showed that urban birds had changed their behavior by adapting to new threats like cats and dogs as their main predators in the city. They were observed to be less aggressive, produced more alarm calls, and they remain paralyzed when cats or dogs attacked them. Birds are forced to either accept or avoid the new conditions to survive

in the city. As the city begins to disrupt more and more, many species disappear to where only most general species and urban-friendly species can survive. Birds are not communal in the same way people are and each species have their requirements for survival. Nevertheless, evolving in the city has taught many bird species to be adaptable and resilient.

Crows are a good example of a bird or animal that is a fearless problem solver. Crows in Sendai, Japan, were observed putting walnuts on roads so that vehicles will drive over them, crushing the shells and allowing the crows to get to the food inside (Worrall, 2018). That shows crows as one of the urban wildlife have successfully found new ways of making use of the human inhabitants of the city. The clever way of cracking walnuts by the crows has something to do with problem solving, curiosity, and being tolerant of people. There are many new foods, resources, and nesting opportunities for the birds to explore and make use of. In Singapore, common myna has been replaced by Javan myna. The existence of more Javan myna causes common myna to disappear from Singapore city because Javan myna have found ways to adapt to the urban landscape of Singapore where they can build their nests anywhere (Meng, 2011) besides being able to feed on not just insects and fruits but also the human leftover food (Yangchen, 2016). Therefore, every bird in the city must find their ways to adapt and survive within the urban landscape by altering or changing their common behavior into more creative actions.

#### **1.2.4 Public Perception on Birds**

Birds are invaluable in the sense that they provide direct benefits to humans and help in ecosystem resilience. They are observed as biological indicators for wildlife and to overall ecosystem health (Donnelly and Marzluff, 2004) and are critical links within the huge food webs (Gatti, 2010). Birds consist of a diverse group where each species has specialized requirements. Some birds like swallows and swifts help in controlling pest populations by consuming hundreds of insects through the air. The presence of these types of bird in a city, especially in the agricultural land, gives many benefits. Besides, due to their ability to traverse vast distances in short time, birds can

act as agents of dispersal where they transport a variety of things including seeds through the environment (Blackwell et al., 2005; Nik Hanita, 2012 and Maron et al., 2013). Perhaps, birds are among the most effective of all animal seed dispersers. Unfortunately, it is difficult to change public perception who believes that the birds are not much benefit to the ecosystem (Sekercioglu, 2006).

### **1.2.5 Extinct of Natural Resources and Habitat**

Conclusively, urban development, agriculture, and energy production are human land uses that continue to be a major threat to the bird population. Areas of high ecological values such as secondary forest and abandoned spaces are destroyed because of too much land opening in the urban. Human land use has limited spreading of native vegetation and replaced by exotic groundcover, pavement, and roads that limit resources for birds utilization, confirming the degradation of native habitat as the major threat that complicates bird survival (Marzluff, 2001). Furthermore, the declining number continues when the size of habitat patches becomes smaller (Hanasaki, 1994) and leads to an incredible distraction of ecosystem in the urban. The distraction of ecosystem occurs when birds as the key factor ensuring the continuity of food chain process (Groot, 2003) as well as assisting for successful ecosystem process (Tabur and Ayvaz, 2010) declines through times and scales. Moreover, the habitat degradation and change is a real threat because it causes difficulty for the birds to find shelter while escaping predators, for breeding and nesting, and even during foraging period (Jongman & Pungetti, 2004).

Supposedly, a habitat must be a resourceful place in both physical and biotic conditions, where a plant or animal usually occurs and is fundamentally linked to the distribution and abundance of species. In a habitat, birds need food, water, and shelter as basic habitat necessities. Birds probably will be home when a habitat provides a lot of these necessities. However, despite providing plenty of natural resources, habitat in urban areas missing many resources for birds utilization. Though the disappearance of these species may not be too much of a concern, it is still risky for the ecosystem cycle if constantly being mistreated especially in the city.

### **1.2.6 Green Space Planning and Design**

A city constitutes a proportion of green spaces which offer numbers of natural and human-made resources that help cater to the basic needs of bird species. Local design and planning in Malaysia nowadays emphasizes more on the principle of landscape ecology and this is the rationale to the idea of wildlife conservation in the urban (Nik Hanita Nik Mohamad, 2012). The urban green spaces consist of (1) natural landscape that involves the remnant patches of original ecosystem such as forest and riparian zone (Forman and Godron, 1986 and Abdullah et al., 2006); (2) human-altered landscape created and designed by men such as park, green corridor, and garden (Tamara and Eva, 2004 and Abdullah et al., 2006); and (3) areas where natural succession occurs due to the absence of direct human influence such as abandoned space and areas of destroyed buildings (Tamara and Eva, 2004). After all, the human-altered landscape which had been created and designed by men begins to be recognized as an important medium for conserving biodiversity, including bird species in the urban. However, the performance of the human-altered landscape in promoting diverse species is rather poor and requires improvement (Sara Izrar Aziz, 2014). Moreover, strongly modified landscape such as park would probably differ in terms of their landscape ecology value from that in less modified landscapes.

Limited plantings varieties, severe level of openness, and higher human disturbances disrupt the process of habitat making among birds (Larsen, 2005). Several studies suggest that there is an obvious relation between structure and volume of vegetation associated with bird diversity and species richness (Chace and Walsh, 2006). Palm trees are commonly planted in park even though it provides no branches and a mass of large wide leaves at the top are completely not suitable for the birds as they can neither give shade nor even the necessities for migrating birds (Idris, 2012). Hence, the selection of vegetation types is also very important in providing basic supplies that support bird habitat requirements. Therefore, there is a need to address the issues on designs and planning of park concerning the importance of birds' healthy development. Increasingly, this will help to improve and provide substantial input aligned with sustainable landscape initiatives in Malaysia. It is important to consider how the park is designed and planned to improve the urban landscape design.

Locally, Malaysia started its journey on sustainable development since the 1970s. In 2015, Sustainable Development Goals (SDGs) which is also known as the Global Goals were adopted by all the United Nations Member States as a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030. There are 17 goals in SDGs where Goal 15 highlights life on land as environmental conservation efforts which include maintaining more than 50% forest cover and 10.76% as terrestrial protected areas (Voluntary National Review, 2017). However, according to Dr. Mahathir, the 15<sup>th</sup> goal always get constraints by other goals achievement (New Straits Times, 2019). For example, good infrastructure sometimes causes some loss of land and negatively impacts the environment as many trees are forced to be cut down. To some extent, this scenario creates conflicts between goals achievements. On the other hand, the green city concept is one of the guidelines that support SDGs achievement. Many cities in Malaysia including Kuala Lumpur, Putrajaya, and Melaka are heading towards green city movement. However, knowledge and practices of going green must be pursued so that more environmentally friendly and ecologically responsible decisions and lifestyles can be enjoyed. Thus, it is a must to enhance the existing city development guidelines to be as green and sustainable as possible.



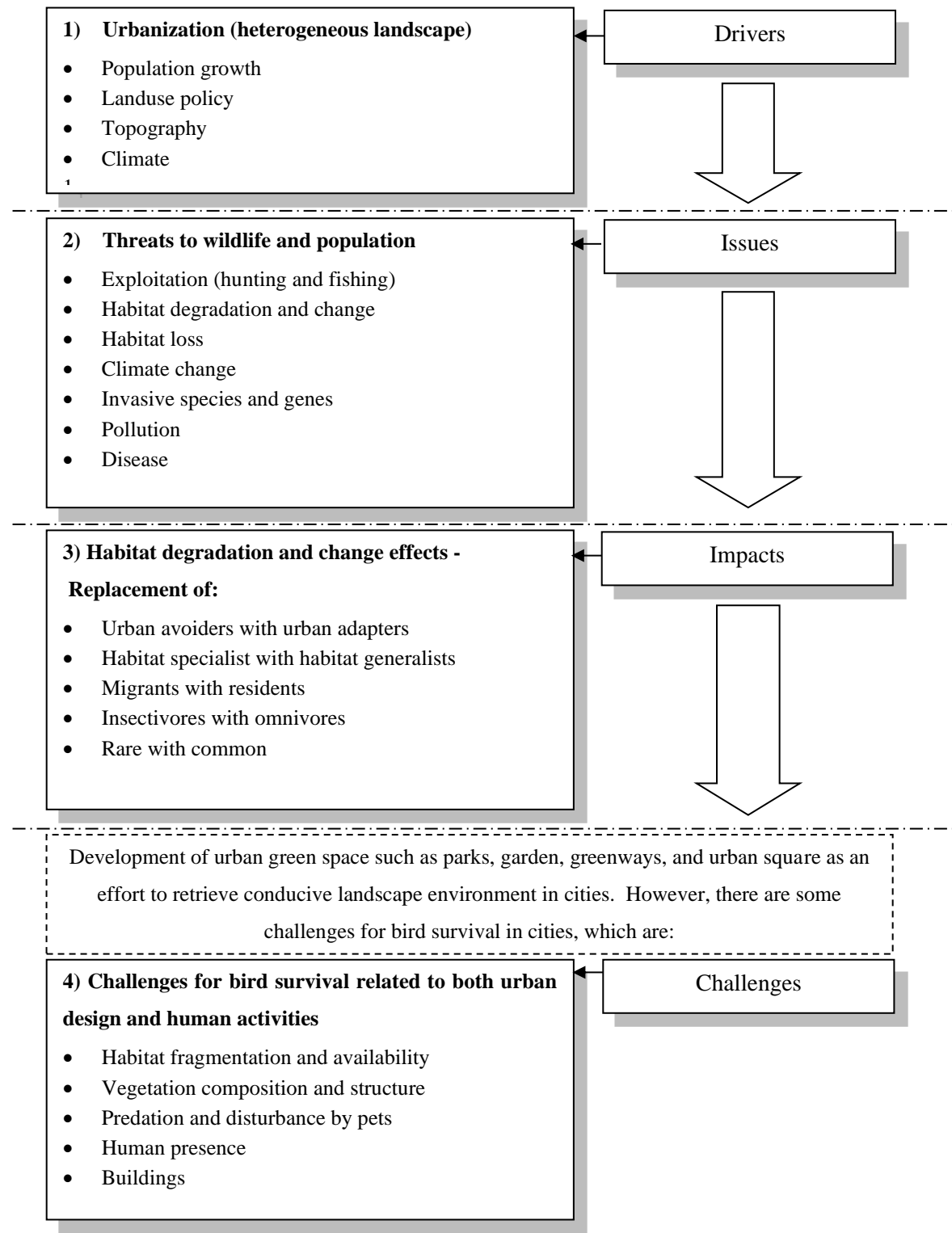


Figure 1.4 Research problem formulation related to the declining of bird population

Figure 1.4 summarizes the research problem formulation for this study relating to the declining of the bird population. There are several threats to wildlife and population retrieved from the urbanization process of a city. The study emphasized more on the issues of habitat degradation and change as major threats to bird species in the urban. The degradation and change of habitat replaced urban avoiders with urban adapters, habitat specialist with habitat generalist, migrants with residents, insectivores with omnivores, and rare species with common species. Development of park is an effort to retrieve a conducive landscape environment in cities, but there are some challenges that need to be encountered to obtain wildlife-friendly city in the future. In sum, the research addressed some challenges for bird survival in the park which is due to poor urban design and aggressive human activities. The research attempted to develop some design approaches emphasizing park as a place and space for urban wildlife including bird population to live and survive within the urban landscape.

### **1.3 Research Gap**

Recently, there has been various studies about the importance of urban green spaces, but most local studies focus on the aspects of human needs and preferences towards the park. Most studies emphasized park as a public social space (Mazlina & Ismail, 2008), relief place (Ulrich, 1986; Rohde & Kendle, 1994 and Kuo & Sullivan, 2001), comfort place that allows people to have proximity to the nature (Kaplan & Kaplan, 1989; Cordell et al., 1998), and healthy place which reduces mental exhaustion (Korpela et al., 2001) rather than a place inhabited by birds and other wildlife. Even though plants and wildlife inhabit park most of the time, many studies emphasized more on the aspects of human as park users who visit only at certain hours which leads to little attention from built environment practices towards biodiversity (Karuppanan et al., 2013). There are some studies related to biodiversity in Malaysia, but with very limited research dealing with wildlife (Karuppanan, Baharuddin, Sivam, & Daniels, 2014). Instead of selecting urban environments as the study context, there is numerous local studies concerned on the biodiversity and habitat study in the natural context within rural settings. For example, Johns (1989), Rosli Ramli, (2004), Peh et al.

(2005), Saiful Mansor et al. (2011), and Nur Azirah Arif & Mohd-Azlan (2014) selected forest as the habitat type which comprises a rich and diverse range of plants and animals. Peh et al. (2006) and Munira et al. (2014) studied the relationship between bird diversity and habitat attributes accessible in agricultural lands. There were also some studies done in the context of natural wetlands Zakaria et al., (2009) and Rajpar & Zakaria, (2011) and habitat gradients from primary forest to urban (Soh, Sodhi, & Lim, 2006).

As shown in Table 1.1, the studies in the urban context were mostly carried out in the western setting. Very few were found in non-Western countries except in India (e.g. Khera, Mehta, & Sabata, 2009) and Japan (e.g. Imai & Nakashizuka, 2010). In Malaysia, the studies were mostly directed towards natural habitat namely forest as study site and context (Sara Izrar Aziz, 2014). Hence, little is known on how urban green space particularly park performs as urban habitat to serve species needs and preferences for birds. Thus, this study attempted to fill in the gap by investigating the possibility of park as an urban habitat which is often considered to be less important than their wild or rural counterparts.

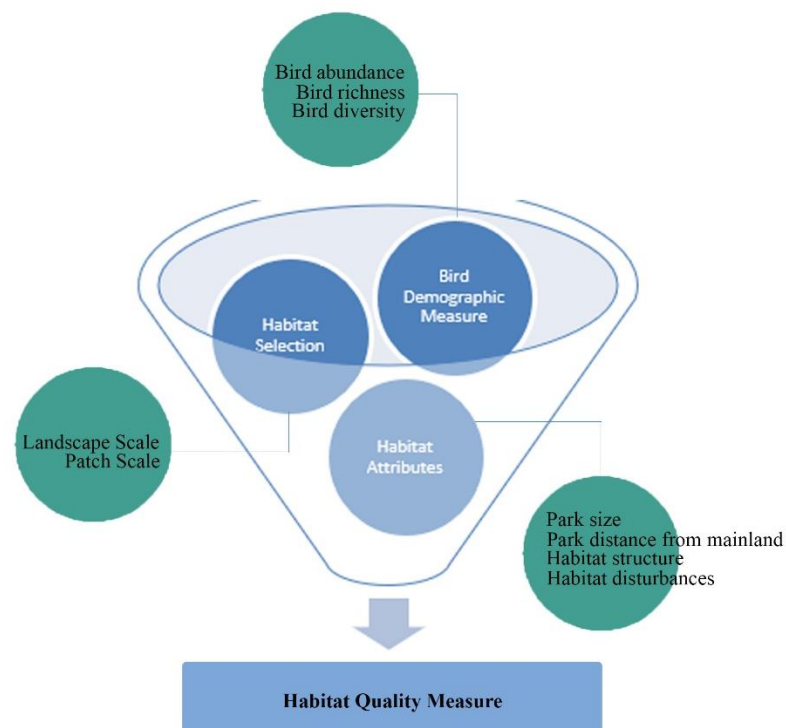


Figure 1.5 Combination of three approaches create gap with previous research that usually used one or two approaches only to measure habitat quality

Additionally, many studies show a surprisingly high number of species and individuals present in cities (Marzluff, 2001; Palomino & Carrascal, 2006; Sattler et al., 2010 and Sattler et al., 2010). The moderately urbanized areas often support higher species richness than rural areas (Blair, 1996; and Blair & Launer, 1997), with species richness and diversity are considered to be good indicators of ecosystem health (Rapport, 1999). However, these indicators do not necessarily provide a full picture of species composition and community dynamics (Jost, 2006). This study, therefore, attempted to focus on investigating the factors that influence habitat selection and use pattern through assessment of habitat quality of park through combination of three approaches, namely (1) demographic measure of bird species, (2) distributional measure of habitat selection, and (3) direct habitat attributes measurement (Figure 1.5).

Table 1.1 Previous research concern on habitat study

Location	References	Habitat types and context	Approach to measure habitat quality	Research gap
Local research	Johns (1989), Rosli Ramli (2004), Peh et al. (2005 & 2006), Saiful Mansor et al. (2011), Nur Azirah and Mohd Azlan (2014)	Forest habitat <ul style="list-style-type: none"> <li>• Tropical dipterocarp forest</li> <li>• Forest fragments in urban area</li> <li>• Logged forest in rural area</li> <li>• Limestone forest</li> </ul>	<ul style="list-style-type: none"> <li>• Demographic measure</li> </ul>	<p>Little current local research concern on habitat quality assessment that encounters urban as the habitat types and context. Thus, this study was carried out to highlight the urban as a study context with a combination of three approaches to measuring the habitat quality. Hence, it could directly provide better design and planning of urban green space as a resourceful habitat that responds well to the wildlife species needs particularly birds.</p>
	Peh et al. (2005 & 2006), Nur Munira et al. (2014)	Agricultural lands <ul style="list-style-type: none"> <li>• Oil palm and rubber tree plantation</li> <li>• Rice field</li> </ul>	<ul style="list-style-type: none"> <li>• Habitat attributes and demographic measure</li> <li>• Demographic and temporal distributional measure</li> </ul>	
	Zakaria et al. (2009), Rajpar and Zakaria (2011)	Natural wetlands	<ul style="list-style-type: none"> <li>• Habitat attributes and demographic measure</li> </ul>	
	Soh et al. (2006)	Habitat gradients <ul style="list-style-type: none"> <li>• from primary forest - secondary forest - tea plantation - rural - urban</li> </ul>	<ul style="list-style-type: none"> <li>• Habitat attributes and demographic measure</li> </ul>	
Global research	Motroni (1984), Moskat and Waliczky (1992), Debinski et al. (1999), Lauer et al. (2002), Wu et al. (2013)	Forest Habitat <ul style="list-style-type: none"> <li>• Riparian forest</li> <li>• Beech and oak forest</li> <li>• Yellowstone ecosystem</li> <li>• Reserve forest</li> <li>• Mountainous island</li> </ul>	<ul style="list-style-type: none"> <li>• Demographic measure</li> <li>• Habitat attributes</li> </ul>	
	Fuller et al. (2005), Gottschalk et al. (2010), Muhlner et al. (2010)	Agricultural lands <ul style="list-style-type: none"> <li>• Farmlands</li> <li>• Orchard</li> </ul>	<ul style="list-style-type: none"> <li>• Habitat attributes and demographic measure</li> </ul>	
	Degraaf and Wentworth (1985), Grant et al. (2008)	Suburban matrix	<ul style="list-style-type: none"> <li>• Habitat attributes and demographic measure</li> </ul>	
	Fernandez-Juricic (2000), Sandstrom et al. (2006), Sanesi et al. (2009), Imai and Nakashizuka (2010), Pellissier et al. (2012), Peris and Montelongo (2014)	Urban environments <ul style="list-style-type: none"> <li>• Parks</li> <li>• Urban green space</li> <li>• City centers</li> </ul>	<ul style="list-style-type: none"> <li>• Demographic measure</li> <li>• Habitat attributes and demographic measure</li> </ul>	
	Marone (1991), Heieman et al. (2007), Hong et al. (2013)	Habitat gradients <ul style="list-style-type: none"> <li>• Urban gradient</li> <li>• Forest to urban gradient</li> </ul>	<ul style="list-style-type: none"> <li>• Demographic measure</li> </ul>	

## 1.4 Research Questions

The focus of this study includes an exploration of the habitat structures in both landscape and patch scale, as the influential factors of habitat selection by birds in an urban environment. This study involves three steps. First, it is necessary to explore the use of park patches for birds' daily survival activities, suggesting factors that influence their distribution. Second, it explores the connection of birds abundance and habitat selection in each park patch in the context of the urban environment. Finally, it interprets the interdependency between patches quality and types of bird's presence in the park areas. Based on this process, the primary research question and assumptions were formulated as the driving force of the study.

It is assumed that the park physical environment plays an important role in enhancing diversity and richness among bird species, as the park is proven to be richer in bird species diversity and richness than other urban habitats like roadside, green linkage, garden, and cemetery (Tilghman, 1987; Jokimaki and Suhonen, 1993; Hadidian et al., 1997). It is also assumed that physical and surrounding landscape contexts of park areas may significantly influence the opportunity for birds to engage in daily activities and gain their basic survival needs. The influence can be seen from the bird's preference and survival behavior patterns towards physical features of park patches in the urban environment. Based on the assumptions, the objectives and research questions were formulated, and they were divided into three parts: (i) overall responses, (ii) landscape-scale responses, and (iii) patch-scale responses.

For the landscape-scale part, the focus was on the island biogeography theory which consists of only one research question (MacArthur and Wilson, 1967). It deals with the decision making process of bird's habitat selection regarding the area and mobility character of a park in an urban environment. The second part focuses on the patch-scale responses of park design and structure that may influence birds abundance and their ideal free distributions in an urban environment. It consists of three research questions that seek to explore the potentials and barriers of park patches for birds' habitat use according to their preference and needs to survive in the urban environment. Table 1.2 illustrates the relationship of the research questions to the aim, assumptions, and objectives of the study.

Table 1.2 The relationship of research questions to aim and objectives

<p><b>Aim:</b> To investigate how park with different hierarchies and qualities served as urban habitat for bird communities.</p>		
<p><b>Key research question:</b></p> <p>How different types of parks in the urban served as urban habitat for many kinds of bird communities?</p>	<p><b>Assumption:</b></p> <p>As park is considerably richer in bird species diversity and richness than other urban habitats, it signifies the importance of park areas for bird habitat use in the urban environment. The design and structure of park areas may significantly influence the birds abundance and their distributional pattern.</p>	
<p><b>Research question (RQ)</b></p>		<p><b>Objective</b></p>
<p>Overall responses</p>		
<p>RQ</p>	<p>Sub-RQ</p>	
<p>1. What kind of bird species that inhabit the parks?</p>	<p>1. How similar are the bird species found between all parks?</p> <p>2. What are the responses of species groups to the park types?</p>	
		<p>3</p>
<p>Landscape-scale responses</p>		
<p>RQ</p>	<p>Sub-RQ</p>	
<p>2. How the island biogeography theory relates to the habitat selection by birds in landscape scale?</p>	<p>1. How do birds respond to the park size?</p> <p>2. How do birds respond to the park distance from the mainland?</p>	
		<p>1</p>
<p>Patch-scale responses</p>		
<p>RQ</p>	<p>Sub-RQ</p>	
<p>3. What are the criteria of habitat in the park that birds prefer?</p>	<p>1. What kind of habitat structure that birds need?</p> <p>2. Do anthropogenic disturbances influence birds' habitat selection?</p>	
		<p>2</p>

## **1.5 Research Aim**

This study aimed to investigate how park with different hierarchies and qualities served as an urban habitat for bird communities in Putrajaya. Specifically, the study analyzed how the park characteristics such as park size, connectivity, vegetation structure, and those of the adjacent landscape including anthropogenic disturbances affected bird species abundance, richness, and diversity in the park. The study reveals the attributes and properties of the park as an urban habitat that support birds basic survival needs and preference in the human-influenced landscape settings.

## **1.6 Research Objectives**

To achieve the research aim, the following objectives were formulated:

- i) to determine habitat selection by birds at landscape scale involving park size and park distance from the mainland in Putrajaya,
- ii) to determine habitat selection by birds at patch scale involving habitat structure and anthropogenic disturbances in Putrajaya, and
- iii) to investigate bird community attributes including abundance, richness, and diversity across three different urban habitats in Putrajaya.

## **1.7 Scope and Limitation**

The study investigated the species–habitat relationship of birds. It explored the behavioral and preference responses of the bird community in park as resourceful urban habitat. The study was conducted in three types of parks in Putrajaya, Malaysia, which represented different qualities in terms of size, function, and landscape context. This study attempted to investigate habitat selection preferred by birds through habitat quality measurements. According to ornithologist studies, there are numerous ways to measure habitat quality (Table 1.2). There are two basic approaches, one of which was subdivided into three general categories (demographic, distributional, and



individual condition measurements) and the other one was to measure habitat attributes directly. Percentages often combine to more than 100% because many studies used more than one habitat quality measurement.

Table 1.3 Approaches for habitat quality measurements (derived and modified from Johnson (2007))

Measurements of habitat quality		% of studies
Approach 1	Measure habitat attributes directly	37
	Resources	23
	Environmental constraints	6
	Crude correlates	15
Approach 2	Measure birds to reveal habitat quality	74
	Demographic measures	53
	Density or abundance	26
	Reproduction	37
	Survival	10
	Distributional measures	31
	Habitat selection (spatial patterns)	19
	Occupancy (temporal patterns)	7
	Arrival or departure patterns	2
	Behavioral or age class distribution	6
	Individual condition measures	9
	Morphological variables	7
	Physiological variables	3

Despite the various approaches to measure habitat quality, the study used only three approaches in measuring habitat quality as the basis to investigate how park attributes and the adjacent landscape character as independent variables influenced bird abundance and distribution pattern as dependent variables. The three approaches were (1) vegetation as a means to describe the habitat, (2) abundance of bird species, and (3) their habitat selection through the identification of habitat selection. These approaches influenced food and nest sites for the birds. This study eliminated other approaches like occupancy also known as temporal patterns since it usually requires multiple seasons of data and creates a limitation to the study which was conducted for a short period. Furthermore, the study did not focus on the individual condition measures because these approaches can be problematic for species that are difficult to observe or capture and for birds that are using habitat temporarily such as migratory species (Johnson, 2007). Conclusively, this study targeted to establish a set of planning and design guidelines that improve habitat attributes in the park to cater to bird species needs.

## **1.8 Significances of Study**

The study is significant to respond to the problem statement and research gap:

- (i) The study adds to the body of knowledge that the physical attributes of park play an important role in attracting more diverse urban wildlife especially bird species,
- (ii) The study increases awareness on the appropriate park planning and design by initiating conservation efforts for birds, and
- (iii) The study improves the knowledge of design and planning in the park for professionals use such as landscape architect, landscape designer, and landscape planners to form a wildlife-friendly environment in the future.

## **1.9 Outline of Research Methodology**

The focus of this research is to understand the birds' needs and preference through community attributes, distributional measurement, and habitat attributes that attract bird presence to the park. The study was conducted in four stages to achieve the aim and objectives:

- (i) issues and problem statements,
- (ii) literature review on theories and concepts of the bird–habitat relationship as well as knowledge and understanding of urban ecology,
- (iii) primary data collected from the case study, and
- (iv) documentation and analysis of findings.

### **1.9.1 Stage 1: Formulation of Problem Statements**

This research was carried to find out the design and planning of habitat attributes in the parks resourceful to the bird species through the process of secondary

and primary data. It began with understanding the issues and problem statements regarding needs of physical planning and design criteria for parks development particularly in promoting wildlife-friendly environment. The problem statement explains the current issues of habitat study from global and local contexts.

### **1.9.2 Stage 2: Literature Review**

In the second stage, literature gathered gives an insight into the criteria of ideal park design for urban habitat. The literature review is divided into two categories. First, the literature review focuses on the history and theories of the species–habitat relationships. The second part reviews on birds preference and utilization behavior towards park environments, methods of habitat quality measurements, parks as urban habitat for bird species, and the Malaysian urban green space planning and initiative for a green city. This preliminary stage involved gathering literature from several fields including biodiversity and conservation, animal behavior, bird study, urban forestry and urban greening, landscape and urban planning, landscape ecology, and landscape architecture.

### **1.9.3 Stage 3: Primary Data Collection**

Stage three was carried out to find out primary data from the case study through observation records. The purpose of doing the case study was to get primary data from existing physical attributes of parks that can be utilized by bird species to survive in the urban area. Data were measured on certain standard measurements such as diversity index, percentage, types, and quantity. The physical form was analyzed through digital mapping using geographic information system (GIS). Besides, the community attribute measures of bird (abundance, richness, and diversity) were statistically analyzed using Microsoft Excel and IBM SPSS.

#### **1.9.4 Stage 4: Documentation of Findings**

Stage four involved the synthesis of the research findings based on the analysis process. The results were directed to the physical planning and design criteria of parks which contributed to the attributes of habitat for bird species. The synthesis indicates important habitat determinants in developing physical planning and design of parks. The documentation of findings is presented in the following format:

- i. Landscape scale
  - a) Grouped in three park types classification (Metropolitan Park, Urban Park, and Local Park) - to compare the community attributes according to the functional groups and distributional pattern of birds in each park hierarchy.
  - b) to measure the habitat attributes available in each park hierarchy.
  
- ii. Patch scale
  - c) Selection of only two patches of each park that are most favorable and unfavorable (least diverse and richness) - to be compared in terms of the community attributes and distributional measure to the habitat attributes available in the two selected park patches.

#### **1.10 Thesis Findings**

The study is expected to produce these findings:

- i. A community attributes and distributional pattern of birds present in the park areas,
- ii. bird–habitat relationship particularly in the context of urban environments, and

- iii. physical planning and design strategies towards creating a high-quality bird-friendly environment for the park in the urban.

### **1.11 Structure of Thesis**

The thesis is organized in a logical way by addressing the research objectives. It comprises six chapters as illustrated in Figure 1.6.

**Chapter 1** introduces the research background and problems. This chapter also includes the research aim and objectives in response to identifying the research gap, that is, the need to understand bird species behavior and needs, and their relations towards the habitat attributes in the parks. The scope and limitation of the study, the significance of the study, the research design and the overall thesis structure are also presented in this chapter.

**Chapter 2** reviews the theories and concepts related to species–habitat relationships and the habitat attributes for birds utilization. It defines the environment of parks as an urban habitat for birds basic requirements. It also reviews the factors that are able to attract birds attention to the park areas. This chapter also comprehensively discusses the roles of park as urban habitat from a review of ornithologist study, landscape architecture, biodiversity and conservation, and urban ecology. Then, it discusses the types of parks and their impacts on birds needs and preference to survive in the urban. Finally, the chapter synthesizes all reviews that formulated how parks are important to promote higher density, diversity, and richness of bird species in the context of urban environments.

**Chapter 3** presents the research methodological approach taken in the study with the bird species and habitat quality measurements. It also explains the measurement strategies which were designed to address the three research objectives, including demography measurement which concentrated on bird abundance and distributional pattern as dependent variables, and habitat attributes measurement that highlighted vegetation as beneficial resources for bird species as the independent

variables. This is followed by the types of analysis used in this study for quantitative data interpretation. The analyses include descriptive analysis, correlation analysis, statistical index analysis, and spatial analysis.

**Chapter 4** contextually explains the background of the case study. This chapter derives the selection criteria for study sites and stratification of the park according to the hierarchy. This chapter records several justifications of selecting Putrajaya as the studied site. It discusses the planning chronology, planning concept, land use planning of green space, and neighbouring habitat which are important to bird species in Putrajaya. The chapter ends with a conclusion related to the validity and reliability of site selection.

**Chapter 5** describes the results, findings, and recommendations of appropriate physical planning and design of parks that highlight birds need and preference. The findings are divided into the landscape- and patch-scale analysis. The findings from the landscape scale indicate the decision-making process (second-order) of habitat selection by birds from the perspectives of size and isolation of parks. Meanwhile, the patch-scale analysis indicates landscape attributes and design of natural and human-made elements that influence the birds present in the park. At the end of this chapter, the general conclusion about the research is presented.

**Chapter 6** concludes the thesis with a discussion on the overall findings, including the theoretical and design implications of the body of work. In details, it explains the overall process into the significant findings based on the overall research and provides some limitations and suggestions for the future research about the strategies of physical planning and design of parks with consideration of bird species as the park users. In addition, this chapter provides statements regarding some weaknesses and potential developments that are found out through the overall study process.

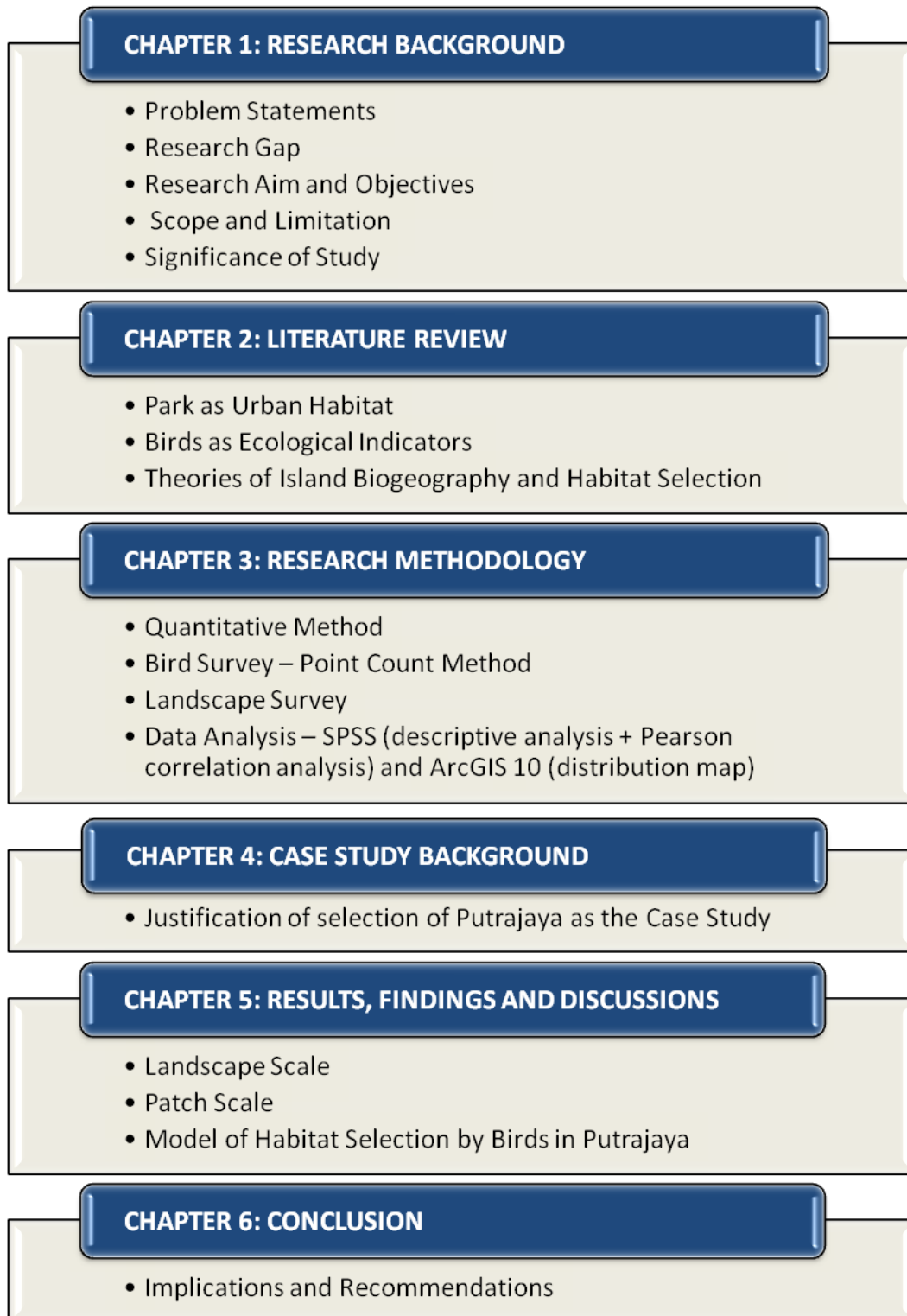


Figure 1.6 Thesis structure outline

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