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DIVERSITY OF BIRDS AND SQURRELS AT VALAYA ALONGKORN RAJABHAT UNIVERSITY UNDER ROYAL PATRONAGE

ICHANGDAW BORUAH

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อ 1) ศึกษาความหลากหลายและสถานะของกลุ่มนกและกระรอกในพื้นที่มหาวิทยาลัยราชภัฏวไลยอลงกรณ์ ในพระบรมราชูปถัมภ์ และ 2) ประเมินที่อยู่อาศัยที่เหมาะสมสำหรับนกและกระรอกในพื้นที่มหาวิทยาลัยฯ ดำเนินการศึกษาข้อมูลนกและกระรอกโดยใช้เทคนิคการนับตามแนวจุดสำรวจในพื้นที่ศึกษา 3 พื้นที่ในเขตมหาวิทยาลัยฯ ได้แก่ พื้นที่ชุ่มน้ำ พื้นที่เกษตรกรรม และพื้นที่นันทนาการ โดยกำหนดจุดสำรวจเป็น 3 เส้นทาง ห่างจากกัน 100 ม. สำรวจและบันทึกชนิดและจำนวนของนกและกระรอก เป็น 2 ช่วงเวลา ได้แก่ 06.00-09.00 และ 15.00 – 17.00 เนื่องจากเวลาดังกล่าวจะสามารถครอบคลุมข้อมูลกลุ่มนกอพยพทั้งเวลากลางวันและกลางคืน ข้อมูลถูกบันทึกแบบเดือนเว้นเดือนระหว่างเดือนพฤษภาคม 2563 ถึงเมษายน 2564 นำข้อมูลที่ได้มาวิเคราะห์ จำแนกสถานะของนกและกระรอกในมหาวิทยาลัยฯ โดยใช้ค่าความถี่ร้อยละของการปรากฏ (FQ) เปรียบเทียบความหลากหลายของนกและกระรอกในพื้นที่มหาวิทยาลัยฯ โดยการวิเคราะห์แบบทางเดียวและใช้การทดสอบทีวิเคราะห์ความแตกต่างของจำนวนชนิดของนกและกระรอก ระหว่างฤดูฝนและฤดูแล้ง

การศึกษาพบนกทั้งหมด 47 ชนิด 12 อันดับ 29 วงศ์ อันดับที่พบจำนวนชนิดนกมากที่สุด คือ Passeriformes จำนวน 22 ชนิด (คิดเป็นร้อยละ 47.7 ของชนิดนกที่พบทั้งหมด) และกลุ่มนกที่มีจำนวนชนิดน้อยที่สุดพบเพียง 1 ถึง 5 ชนิด ผลการวิเคราะห์สถานะของนก พบว่า นกที่พบได้ทั่วไปในมหาวิทยาลัยมี 8 ชนิด มีค่า FQ ร้อยละ 83 ถึง 100 ได้แก่ *Streptopelia tranquebarica*, *Artamus fuscus*, *Ardeola bacchus*, *Pycnonotus blanfordi*, *Columba livia*, *Geopelia striata*, *Passer montanus* และ *Copsychus saularis* กลุ่มพบน้อยที่สุดมีจำนวนจำนวน 22 ชนิด มีค่า FQ ระหว่างร้อยละ 16 ถึง 30 เกือบทั้งหมดเป็นสายพันธุ์อพยพ ส่วนชนิดกระรอกพบเพียง 2 ชนิด 4 สายพันธุ์ย่อย คือ *Callosciurus finlaysonii bocourti*, C.f. *cinnamomeus*, C.f. *floweri* และ *Callosciurus erythraeus* โดยกระรอกทุกชนิดมีสถานะอยู่ในกลุ่มพบได้ทั่วไปในมหาวิทยาลัยมีค่า FQ ร้อยละ 100 จากการประเมินอยู่อาศัย พบว่า ในพื้นที่เกษตรกรรมที่ความเหมาะสมสูงสุด โดยมีจำนวนชนิดนกอยู่อาศัยมากที่สุดเท่ากับ 35 ± 2.3 SD อันดับที่ 2 คือ พื้นที่นันทนาการ (27 ± 1.8 SD) และอันดับสุดท้าย คือ พื้นที่ชุ่มน้ำ (17 ± 2.5 SD) ที่ระดับนัยสำคัญทางสถิติ 0.05 (F-test; $p<0.05$) ไม่พบความแตกต่างของจำนวนชนิดของนกระหว่างฤดูฝน (28±2.0 SD) และฤดูแล้ง (23±1.9 SD; t-test; $p>0.05$) อย่างไรก็ตาม การศึกษาครั้งนี้พบกระรอกได้ในทุกพื้นที่ศึกษา ($p>0.05$) และตลอดปี ($p>0.05$)

องค์ความรู้ที่ได้จากการศึกษานี้ คือ 1) ข้อมูลความหลากหลาย 2) ระยะเวลาที่ปรากฏ 3) สถานะ และ 4) ที่อยู่อาศัยที่เหมาะสม ทั้งของนกและกระรอก สามารถนำไปใช้พัฒนากิจกรรมดูนกและกระรอกเพื่อสนับสนุนกิจกรรมท่องเที่ยวเชิงนิเวศภายในบริเวณมหาวิทยาลัยราชภัฏวไลยอลงกรณ์ ในพระบรมราชูปถัมภ์ ซึ่งเป็นบริบทหนึ่งในการสร้างจิตสำนึกในการอนุรักษ์อีกด้วย

คำสำคัญ : ความหลากหลายทางชีวภาพ อันดับสัตว์ฟันแทะ การดูนก ระบบนิเวศในเมือง การท่องเที่ยวเชิงนิเวศ

Ichangdaw Boruah. (2022). Diversity of Birds and Squirrels at Valaya Alongkorn Rajabhat University under the Royal Patronage. Master of Science (Innovation of Environmental Management). Advisors: Dr.Sasitorn Hasin, Asst. Prof. Dr.Ananya Propradit

ABSTRACT

This study aimed to 1) investigate the diversity and status of bird and squirrel groups at Valaya Alongkorn Rajabhat University (VRU), and 2) assess the habitat suitable for birds and squirrels at VRU. Bird and squirrel data were collected using point count techniques at three research zones in the VRU: natural wetland (NW), agricultural area (AA), and recreation areas (RA). Each research region was assigned three spots that were separated by 100 meters. Birds and squirrels were counted twice a day, in the morning and late afternoon, to document diurnal and prospective nocturnal migration. From May 2020 to April 2021, data were collected every two months. In the VRU, the %age frequency of occurrence (FQ) was used to classify birds into status categories. One-way ANOVA was used to compare the diversity of birds and squirrels across study areas, and the t-test was used to analyze the difference between wet and dry seasons.

A total of 47 bird species were identified, representing 29 families and 12 orders. With 22 species (47.7% of total represented species), Passeriformes was the most prominent order in the research regions, while the other bird orders had 1-5 species in range. According to the results of the bird status survey, the median value of the FQ varied from 83% to 100% for eight species: *Streptopelia tranquebarica, Artamus fuscus, Ardeola bacchus, Pycnonotus blanfordi, Columba livia, Geopelia striata, Passer montanus,* and *Copsychus saularis*. The least dominating species were identified as twenty-two bird species, representing 16% to 30% of the FQ, with the majority of them being migratory species. There are only two squirrel species and four subspecies: *Callosciurus finlaysonii bocourti*, C.f. *cinnamomeus*, C.f. *floweri,* and *Callosciurus erythraeus*. The institution's squirrel species were all categorized within the most common category, with 100% of the FQ. According to the findings of the appropriate habitat evaluation, the AA had the most bird species (35 ± 2.3 SD), followed by the RA (27±1.8 SD) and the NW (17±2.5 SD; F-test; $p>0.05$). There was no statistically significant difference between wet and dry seasons (28±2.0 SD vs. 23±1.9 SD; t-test; $p>0.05$). Nonetheless, squirrels were present in all of the investigated places ($p>0.05$) and at all times of the year ($p>0.05$).

The research knowledge gained includes diversity information, duration of appearance, status, and suitable residence of birds and squirrels, which can be used to develop bird and squirrel watching activities to support ecotourism activities in the Valaya Alongkorn Rajabhat University under the Royal Patronage area, which is also one of the contexts for raising conservation awareness.

Keywords: Biodiversity, Redentia, Birdwatching, Urban Ecosystem, Ecotourism

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Ichangdaw Boruah

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CHAPTER 1
INTRODUCTION

1.1 Background problem and significance of the study

In the present era of global change and urbanization is the primary cause of land–use change and biodiversity loss in particularly Land utilization by a human. This phenomenon is an expanding process worldwide, and it's well known as a causing major threat to biodiversity in present times (Singh and Baghi, 2013). 2015). to successfully manage land use in ways that are least harmful to biodiversity (Kale 2014). For example, deforestation to clear land for human habitation, agriculture harvesting destroys the homes of many species that cannot live anywhere else, forcing them into extinction. Biodiversity is of the most important to humans. Habitat loss has greatly reduced the species (Cardinale et al., 2012). The loss of tropical forests, and particularly of lowland forests, represents one of the greatest threats to species diversity globally (Aratrakorn et al., 2006). Urbanization is also one of the reasons for the destruction. Species died they don't have a habitat to lean (Cardinale et al., 2012). The environmental impacts on birds are typically assessed by recording changes in the population density, abundance, or distribution of species in different habitat types (Tanalgo et al., 2015). Urban areas can support endemic native species and others of conservation concern on a regional and global scale (Lepczyk et al., 2017). In many developing countries, a large number of wildlife survive outside protected areas. Among all wildlife, birds are one of the most common wildlife in urban areas. Many bird populations have been declining as a result of landscape changes due to urban expansion, high rates of land conversion for urban uses, increasing human pressure on biodiversity, and rapid population growth (Gatesire et al., 2014).

Birds are well-known bioindicators, by providing numerous ecological benefits (Tanalgo et al., 2015). By contributing to the health of an ecosystem, birds can provide several direct benefits to humans. Birds are wildlife that can be found easily in almost every environment. Birds are among the key components of biodiversity, and plays a major role in pollination, they are consumers of plant seed and act as a predator of insects (Kiros et al., 2018). However, a few studies have reported that bird diversity play an important role as naturally available resources in the urban area, which can support recreational activities in the ecotourism program (Gatesire et al., 2014).

Squirrels are a member of the Seiuridae family, and they include small or medium-size rodents. They live in almost every habitat from tropical rainforest to semi-arid desert excepted high polar region. Squirrels typically have slender bodies with very long bushy tails and large eyes. Particularly, the forests of Southeast Asia are hotspots of squirrel diversity (Krishna et al., 2016). The ecology of squirrels in Asia has been little studied, hindering conservation and management efforts. The species is omnivorous and feeds on fruits, flowers, nuts, bark, bird eggs, and insects. Preference for nesting trees could depend on nesting material and food, nest safety, and the branching pattern of the tree species. As their management practices directly damage the preferred nesting sites and food resources (Pradhan et al., 2017).

Travel and tourism are expected to play an important role in the improvement of the economic status of a developing country (Maxim 2016). Ecotourism is the most important form of tourism (Diamantis, 2010). It is emphasizing on the preservation of the natural habitat of living beings while attracting tourists to the place. Ecotourism promotes sustainable travel, benefitting local communities, their culture and heritage, and the environment (Chan & Bhatta, 2013). It can help in sustainable protection of the environment Thus, tourism helps in conserving natural resources and in boosting the development of tourism. It increases a sense of responsibility among people. That can provide environmental education, which will contribute towards the conservation of biodiversity (Ahmed, 2015).

Ecology is the study of organismal diversity and the interactions between organisms and their biotic and abiotic environment (Courchamp et al., 2015). The VRU is challenged by environmental degradation and economic growth, for example, land transformation to be agricultural area, manmade pond, resort, and hotel (Alexendar & Poyyamoli, 2014). Most of the earlier studies have reported on the high diversity of bird species is indicative of a potential attraction that can be developed for ecotourism, besides other natural attractions. Bird and animal-watching are among the most popular ecotourism activities (Whelan et al., 2008). They are done using devices or optical aids which help people to see and study wildlife (Puhakka et al., 2015). Thus, a wildlife survey is the best technique, because it can lead to understanding the impact of land utilization on the distribution, abundance, and diversity of living organisms in their native habitat. Birds reside in the Valaya Alongkorn Rajabhat University (VRU) and the natural habitat of such animals is being developed by protecting the environment and boosting ecotourism in the University. Moreover, feeding stations are set up to attract birds, making them easily observable. Further steps include the assessment of the existing bird species, area topology as

the birds' habitat, and appropriate land use for the establishment of bird-watching activity (Muttaqien et al., 2015; Puhakka et al., 2015). Field-based education on the birds and squirrels is one component of active environmental education in school and university students. Our study provides an overview of the urban ecology, especially in the diversity of birds and squirrels (Alexendar & Poyyamoli, 2014). This study helps to identify the various types of birds and squirrels staying on the campus. People know about the benefits of biodiversity in our university.

1.2 Objective

1.2.1 Evaluation on the structural suitable for the birds and squirrels in Valaya Alongkorn Rajabhat University.

1.2.2 Study on diversity and status group of birds in Valaya Alongkorn Rajabhat University.

1.2.3 Study on diversity and status group of squirrels in Valaya Alongkorn Rajabhat University.

1.3 Conceptual framework

In this section, we indicate the research framework. This study focuses on bird and squirrel diversity management and Human-environment interaction at the urban ecosystem in Valaya Alongkorn Rajabhat University. The university is located away from the busy city life and people flock to the university premises to enjoy the natural surroundings in and around the university campus. Knowledge about the natural habitat of birds where they live also imparted to the people. The research framework of my study is indicated in (Figure 1).

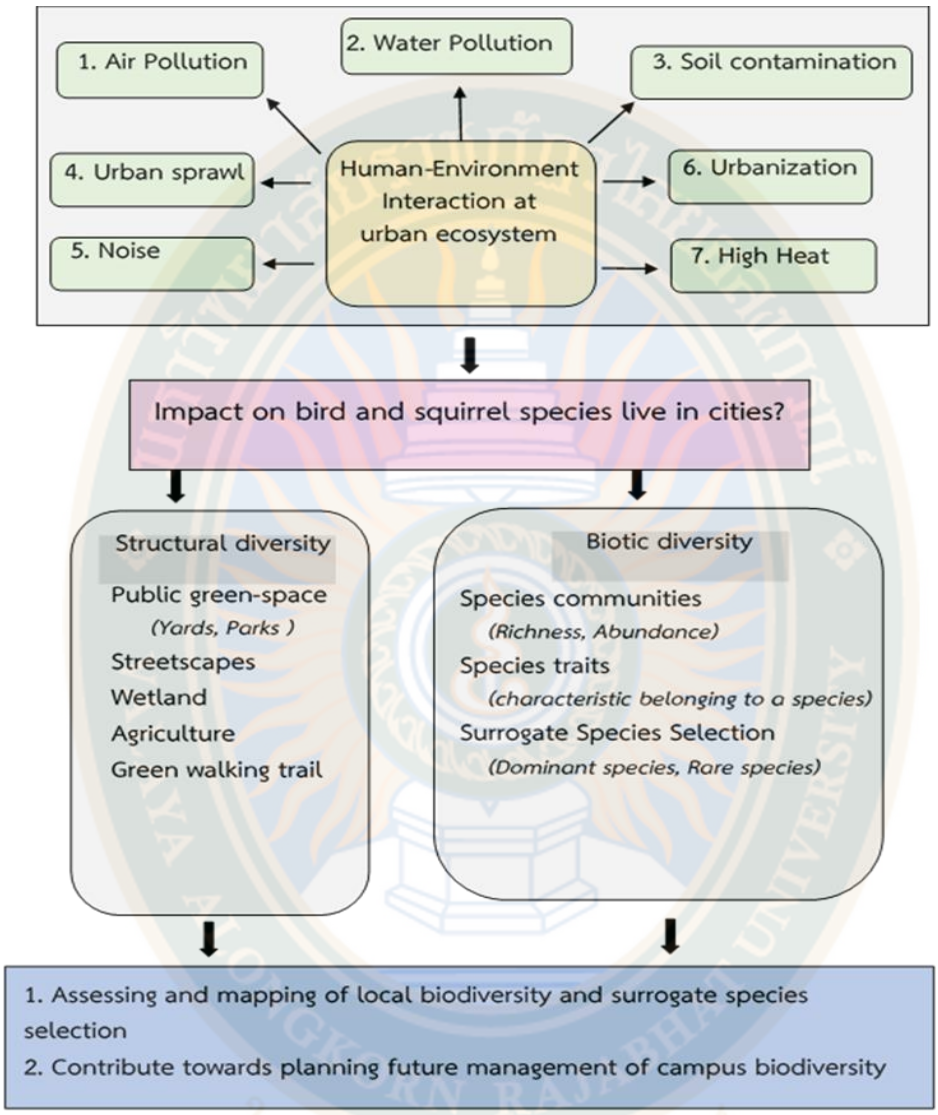

Figure 1 Research framework of my study

1.4 Operational Definition

1.4.1 Structural diversity is the habitat diversity or complexity of vegetation and land utilization with difference vegetation covered, which located in the VRU.

1.4.2 Biotic diversity means living organism, and it live in ecosystems at the VRU.

1.4.3 Squirrels are generally small mammal, contributed in members Family Sciuridae, which can be found in the VRU.

1.4.4 Birds are a group of warm-blooded vertebrates constituting the class Aves, characterized by feathers, toothless beaked jaws, the laying of hard-shelled eggs, which can be found in the VRU.

1.5 Expected benefits

The benefit of this study was to:

15.1 Using the pattern of bird and squirrel diversity in the VRU for creating bird and squirrel watching programs. In addition, typical characteristics of birds, their habitat, and appearing period can develop bird-watching objects, which become interesting attractions for travelers and nature enthusiasts, promoting ecotourism development and efforts to conserve bird diversity. Squirrels provide a good opportunity for field-based behavioral studies and provide information about the abundance, diversity of squirrels. The diversity of squirrel species and their habitats allow for student generated questions such as how especially and urbanization.

15.2 Results of this study can be used as supporting ideas and information sustainable protection of the environment by conserving the natural resources and hence boosting the development of tourism. It increase the sense of responsibility among people. Also can provide environmental education.

CHAPTER 2
LITERATURE REVIEW

2.1 Urban ecology

2.1.1 Definition

Urban ecology is the study of the ecosystem that includes humans living in cities and urban landscapes. Urban ecology focuses on human influence on plant and animal populations in urban settlements and human impacts. The various researchers studied urban ecology, and previous research documented in various directions. McIntyre et al. (2008) reported that the study of ecosystems that include humans living in cities and urbanizing landscapes. It is an emerging, interdisciplinary field that aims to understand how human and ecological processes can coexist in human-dominated systems and help societies with their efforts to become more sustainable. Because of its interdisciplinary nature and unique focus on humans and natural systems, the term "urban ecology" has been used variously to describe the study of humans in cities, of nature in cities, and the coupled relationships between humans and nature. Each of these research areas is contributing to our understanding of urban ecosystems and each must be understood to fully grasp the science of Urban Ecology.

Grineski (2003) reported that urban ecology is an emerging field that addresses one of the most challenging world-wide problems facing humanity: how to manage metropolitan growth, while simultaneously trying to both maximize human wellbeing and minimize impacts on ecosystems.

Grineski (2003) reported that the study of the intersection of capitalist political economy, the social relations of production, material environments, and biological geophysical processes in urbanized spaces. As such it must include history and discursive formations and cultural processes that are imbricated in the production, reproduction, and understandings of the urbanized environment.

Endilicher et al. (2007) reported that urban ecology is the study of environmental impacts, and sustainability of urbanization with value on biodiversity, and ecosystem service. Urban ecology is a multidisciplinary field that supports societies and help to become more sustainable. Urban ecology has been used in various studies of humans in cities, nature in cities.

Different definitions emphasize a different aspect of urban ecology. Urban ecology study of living organism in different environmental situation and their habitat. Although these definitions are very similar. Many Ecologists define an urban

ecology as a dependent ecosystem, environment, human in cities and other living organism. On the other hand, a natural ecosystem generally has a relationship between humanity environment and urbanization.

2.1.2 Characteristics of urban ecology and how to define

Urban ecology analyses the relationships between plant and animal populations and their communities as well as their relationships to environmental factors including human influence (Tanner et al., 2014). Human settlement constitutes the ecosystem on earth. This rapid development of urban ecology is a various approach to improving living conditions for the human population in cities, referring to the ecological functions of urban habitats or ecosystems for people. (Endilicher et al., 2007).

Urban ecology is the study of relationships and interactions between organisms and their environment. It comprises the flora and fauna communities of an area. The ecology differs between the two types of ecosystems rural areas and urban habitat (Niemela, 1999).

Urban ecology study of trees, plants, wildlife, in urban areas. Ecosystems are an essential element for human well-being. Ecosystems and landscapes become increasingly domesticated through urbanization. Ecology is concerned about biodiversity, distribution, and abundance of the living organism in urban areas. It is a scientific study of the processes determining the abundance and distribution of organisms, of the interactions between organisms and the environment, and of the flows energy and materials through ecosystems (Wu, 2014)

Nowadays, most of the world's population lives in urban areas. Therefore, various ecological problems occur in these areas. However, in cities, preserving and maintaining natural habitats, providing a place for living, enjoy, and relax, that is possible for applying the principles and concepts of urban ecology (Altay et al., 2010).

Douglas (2012) studied Ecology in cities how the characteristics of the urban landscape mosaic, and various parts of it, affect human health and well-being. The study found that the ecology of cities assesses the health and well-being benefits of urban green-space, vegetated areas, and water bodies. Human consumption and behavior in one urban area can affect the health and well-being of people in others, such as through the export of waste and Trans boundary emissions, and pollutant flows.

2.1.3 Conceptual history of research in urban ecology

1) In Global scale

The term ‘ecology’, was first used in biological sciences in the 19th century. Urban ecology is the study of ecosystems that includes humans living in cities and urban landscapes. It explores the ecosystem services which are closely linked to urban development (Gandy, 2015). The term ‘ecology’ was introduced by German zoologist Ernst Haeckel (1834–1919), in the nineteenth century. Urban ecology integrates natural and social sciences to study these radically altered local environments and their regional and global effects (Grimm et al., 2008).

Sukopp (2008) reported that urban ecology living organisms in relation concerning their environment in urban areas. The ecological approach considers a city as an ecosystem, characterized by its history, structure, and function, including biotic and abiotic components early studies of the ecology of cities in the tradition of natural history and focused on single biotopes. Ecological studies on whole cities started in the 1970s with investigations on energy flow and nutrient cycling.

Endilicher et al. (2007) reported that urban ecology has many disciplinary roots. Urban habitats and associated environmental processes were analyzed at local and regional scales by different disciplines of natural sciences. This includes biodiversity patterns as well as characteristics of urban soils and climate and their variation in time and space due to changing urban land uses.

2) Thailand

In Thailand, Fraser (2002) studied a community-based urban environmental management project in Bangkok, Thailand. They developed a framework that other communities could follow to establish their urban green programs. This process helps to demonstrate both environmental goals and social development goals. Urbanization threatens the natural environmental areas. Unrestricted and unplanned economic expansion led to serious environmental problems. Therefore, this project has worked with poor urban communities in Thailand to develop urban agriculture and forestry plans and help the community’s environmental problems.

Urbanization is one of the major problems all over the world. There is a direct relationship between environment and landscape change and is caused by a human being. In Thailand, the united nation climate change organization emphasize urban ecosystem and biodiversity conservation. This project highlights increasing biodiversity conservation and ecosystem expanding urban green spaces in cities. This program promotes a livable and sustainable urban environment that supports human, social, conservation of cities, and environmental wellbeing. Also contributed to changing the views of people and consists of multiple educational and training programs around the topic of biodiversity (United nation climate change 21.04.2021).

Phoomirat et al. (2020) studied about assessment of green roof ecosystem service. Green roofs are man-made ecosystems service in an urban landscape and found in cities. Green roofs can provide various ecological and environmental benefits and focused on the regulating aspect of ecosystem services, reduced pollution, and the reduction of energy consumption of buildings and also provide the necessary knowledge, an assessment tool is needed to identify and quantify various types of ecosystem services. Urban ecosystems can provide high values of ecosystem services that are in demand for enhancing human well-being. This study contributes to the growing knowledge on the GRES offered in a tropical region in Thailand.

2.2 Effect of Urbanization on biotic diversity

Many studies have examined the effect of urbanization on species richness and most studies implicate urbanization as the major cause of biodiversity loss. Urbanization threat to biodiversity and is responsible for species extinctions and biotic homogenization. The disturbance created by urbanization destroys the habitat of a wide array of unique endemic species and often creates an attractive habitat for relatively few species able to adapt to urban conditions. Urbanization affected species richness in various ways (Buczkowski & Richmond, 2012).

Biodiversity and urban ecosystems have usually been concerned about the impact of urbanization on biodiversity. Many people live in cities, preservation, and enhancement of biodiversity in urban areas are important. Birds are highly visible and quite sensitive to changes in habitat structure and composition. Bird species richness in urban ecosystems is influenced both by local and landscape characteristics. People–wildlife conflicts are an integral component of wildlife management in urban ecosystems. Enhancement of biodiversity in urban ecosystems can have a positive impact on the quality of life and education of urban dwellers and thus facilitate the preservation of biodiversity in natural ecosystems (Savard et al., 2000).

2.3 Fauna, flora, and biodiversity in the urban environment

Biodiversity plays an important role in an urban environment. The majority of the global population will live in urban areas, biodiversity loss in urban environments is increasing day by day. This, in turn, has many negative effects on the quality of human life and other living organisms in the urban environment. Global research shows that the abundance and richness of the fauna in urban environments depends, to a large extent, on the spatial patterning of different patches of urban

vegetation such as urban forests, woodlands, parks, and gardens (Given & Meurk, 2000). Threats to biodiversity are particularly inherent to such rapid urbanization, which raises concern over the future of the already reduced diversity in surrounding urban neighbor hoods. In many developing countries, flora fauna, and wildlife survive outside of the protected areas of the urban environment. Among all flora fauna are one of the most common habitats in urban areas such as cities, and many species are declining because of landscape changes due to urban expansion. These major changes include high rates of land conversion into urban uses and increasing human pressure on biodiversity due to rapid population growth (Gatesire et al., 2014). Urban green spaces are becoming an increasingly important refuge for native biodiversity. Urbanization is a significant factor in both current and predicted species extinctions. Urban green spaces are important for the provision of ecosystem services and can have a positive impact on quality of life, human health, and wellbeing (Goddard et al., 2010).

Mckinney (2008) studies the effects of urbanization on the species-richness of mammals, reptiles, amphibians, invertebrates, and plants, His study indicated that for all groups extreme urbanization almost always reduces species-richness. Much of this is predictable by a species-area effect via the loss of habitable area, and the degradation of remaining habitat by pollution, traffic, and other human disturbances.

Hassall (2014) reported that ponds contribute a great deal to biodiversity at a regional level of habitat patches to facilitate the movement of species through the landscape. Aquatic urban biodiversity appears to persist despite anthropogenic stressors. An array of anthropogenic pollutants, invasive species, and active mismanagement. Urban wetlands offer an important opportunity to educate the people on natural systems. Urban ponds could play a substantial role in driving sustainable urban development.

2.4 Bird Diversity

2.4.1 Characteristics of Bird

Birds are globally seen as a group for conservation, for ecological, evolutionary reasons, and they occupy a significant place in people's perception of nature. Birds are highly sensitive as well as mobile, and thus eminently suitable to study the impact of anthropogenic disturbance on biodiversity (Kale, 2014; Johannesdottir, 2013). Bird diversity strongly supports the current climate as the main driver of diversity, particularly combined trends in temperature and water availability (Mccain, 2009).

1. Birds are versatile animals. Some birds can live in the tropics and others can live in Polar Regions.

2. All birds are classified in the class of aves.

3. Flight in birds is made possible by their almost hollow but strong skeleton, wings, feathers, strong flight muscles, and an efficient respiratory system.

4. Birds are the only animals that have a feather. Their bodies are covered with two main types of feathers, contour feathers and down feathers.

5. Birds have two lungs. Each lung is connected to balloon-like air sacs that reach into different parts of the body, including some of the bones.

2.4.2 Diversity and Distribution of bird

1) In Global scale

Gatesire et al. (2014) studied the effect of urban fabric layout on bird diversity and distribution in northern Rwanda. This study showed a significant effect of city landscapes on bird richness and relative abundance is the highest species diversity in comparison to other landscape types. Birds can occupy more than one habitat type, diversity and distribution of birds are affected by human activities. This study provides an understanding of bird diversity, distribution, and abundance within natural and human-occupied habitats.

Hakim (2017) studied managing biodiversity for sustainable and competitive ecotourism destinations based on the principles of biology, in developing countries. The tourism status of Indonesia identifies the environment and biodiversity in tourism destinations and explores the challenges involved in supporting the development of ecotourism. The biodiversity faced lots of problems such as pollution, loss of exotic plant species, habitat change, and degradation. Eco-tourists have a high potential to spread ecological awareness, as they help to maintain biodiversity by respecting and preserving the natural environment. Ecotourism generally focuses on areas with rare species of flora and fauna. It can help to improve the nature of this area. Ecotourism can also help to develop and preserve untouched areas and natural resources. Limited research has been carried out on the impact of tourism on bird populations, whereas extensive discussion has been devoted to sustainable development. Also, provide online information and education of the exceptional natural areas and rare birds (Chatzigeorgiou et al., 2015).

Sekercioglu (2002) reported that the rapid growth of bird watching enthusiasts and its high potential in financially motivating the local people to protect natural areas merit a comprehensive review of bird watching from a conservation perspective. The specific objectives of this review are: (1) to outline the economic

potential of bird watching for a community-based conservation; (2) to examine the potential benefits and problems associated with this hobby; and (3) to provide suggestions for improving conservation practices in bird watching.

Birds are incredibly important in the overall functioning of various ecosystems. By contributing in such ways to the health of an ecosystem, birds can provide several direct benefits to humans. Birds are common in most habitats and are ecologically significant. Birds are also capable of stimulating primary productivity in other ways which support the functioning of the ecosystem (Whelan et al., 2008; Deng & Yimam, 2020). The presence of birds in habitats ensures ecosystem functioning, allowing humans to gain benefits from these valuable ecosystems. Birds play an extensive role in controlling insect populations and in agricultural areas, birds can also be beneficial in the regulation of pests. Most birds are migratory and fly from native habitats to other places to either breed or to escape the winter freeze. It is reported that a majority of tourists come to see migrant birds (Sekercioglu, 2006; Whelan et al., 2008; Deng & Yimam, 2020).

Tabur & Ayvaz (2010) reported that there are 10000 bird species in the world. Of all animals and birds are the most well-known classic because human being used them for feeding, communication, etc. Birds are important for some animals for biological control and ecological cycle especially food chain. For the last three centuries, industrial development and pollution have had a direct effect on the habitat degradation of birds. Approximately 200 species of birds had been affected directly or indirectly by this negative change.

Bird watching is an ecotourism activity that is rapidly growing around the world. As a tourism activity, it encourages research on ecotourism planning and management models. Bird watching gaining popularity around the world can present significant economic opportunities for countries through sustainable tourism. Bird tourism has been used as a tool for achieving conservation and development outcomes in rural areas. It includes the assessment of existing bird species, habitat, and appropriate land use for the establishment of bird watching activity. Bird watching attractions as a part of ecotourism is expected to build awareness related to conservation and further reduce the impact of agroforestry activities in the local community areas. There is a direct link between the conservation of nature and tourism as tourism can only be promoted if the resources are conserved (Muttaqien et al., 2015). Revenues generated through bird-watching are more than likely to remain concentrated in the local communities, Thus, the bird-watching tourism industry has the potential to meet important criteria of social sustainability. As bird

watchers would need to travel great distances to see the birds, this activity has the potential to generate funds for protected areas and foreign exchange creating employment for thousands of people (Penuela & Winton, 2017).

2) Thailand

Urban parks and landscapes are guided in designing healthy urban ecosystems and their potential to support urban biodiversity and ecological functions. Urban parks in cities are important for improving human life and increasing bird diversity can be of great value for urban biodiversity. Species richness is higher in large urban parks than in small parks. (Rattanawat et al., 2019).

Aratrakorn et al. (2006) describe changes in bird communities following the conversion of lowland forest to commercial oil palm and rubber plantations in Thailand. Conversion of forest to plantations resulted in a reduction in species richness with insectivores and frugivores suffering greater losses than more omnivorous species. Bird communities in oil palm and rubber plantations are similar, and there was a strong positive correlation across species in their relative abundance in each plantation type. They also found that a high proportion of species formerly unable to adapt to the conversion of forest to oil palm and rubber plantations, large losses of bird species and family richness, and the replacement of species with restricted.

2.5 Squirrel diversity

2.5.1 Characteristics of Squirrel

In general, the squirrel fur is soft and silky, though it can be much thicker in some species than others. The squirrel family includes ground squirrels, chipmunks, marmots, prairie dogs, and flying squirrels. Most mammals can descend a tree head-first. They have an excellent sense of vision, which is especially important for a tree-dwelling species. Many also have a good sense of touch, with vibrissae on their limbs as well as heads. Many juvenile squirrels die during the first year of life (https://www.britannica.com/animal/squirrel).

1. Squirrels are small rodent mammals that belong to the Sciuridae family. These animals are strong and resistant. In addition, their bodies are prepared to survive changes and climatic adversities.

2. These rodents are medium size. The color of squirrels is highly variable. Their bodies are light and thin, which allows them to gain speed without losing their dexterity. In addition, they also have very strong legs to scratch the ground and collect fruits and seeds.

3. In most squirrel species, the hind limbs are longer than the fore limbs, and all species have four or five toes on each paw.

4. Squirrel is characterized by the ability to plan and collect food busily. They are predominantly herbivorous, subsisting on seeds and nuts, but also eat insects and even small vertebrates.

5. Another characteristic is their striking long tail. This is covered by voluptuous fur that gives the tail a "fluffy" appearance. The tail of an adult squirrel is almost the same length as its body.

Merrick et al. (2007) Studied the Characteristics of Mount Graham Red Squirrel Nest Sites in a Mixed Conifer Forest. They examined the characteristics of cavity nests. Squirrels selected nest sites with higher canopy cover forest, decayed logs, and living trees. Forest management plans emphasizing thinning must consider how altering these habitat characteristics could affect the availability and suitability of tree stand for nesting squirrels.

2.5.2 Diversity and Distribution of Squirrel

1) Global scale

Southeast Asia is a hotspot of mammalian species richness. Squirrels are the members of the family Sciuridae and are classified under the order of Rodentia. Squirrels are found in almost every habitat, from tropical rainforests to semiarid deserts, only avoiding the high Polar Regions and the driest of deserts (Krishna et al. 2016). Disturbances are important natural factors affecting the diversity, abundance, community composition, and ecosystem structure. The European ground squirrel is a semi-fossorial organism and they achieved a higher species richness and diversity and a distinct species composition compared to the undisturbed areas. European ground squirrel helps to maintain heterogeneity in grassland ecosystems and creates patches of higher diversity and higher structural complexity in the relatively homogenous grassland vegetation (Lindtner et al., 2017). The increase or decrease of mammal species disturbances depends mainly on the biodiversity, habitat type, and disturbance type (Bernstein & Ebensperger, 2012).

Wauters et al. (1997) reported that Gray squirrel species are increasing their population range and distribution in Italy. Grey squirrel competes with the native Eurasian red squirrel Sciurus vulgaris. Red squirrels and grey squirrel's population size in the large forested area, and tested for several woodland characteristics that might affect squirrel densities. The importance of woodlot size, habitat quality and degree of isolation, factors known to affect tree squirrel distribution and densities in fragmented landscapes.

Pradhan et al. (2017) studied about Nesting and feeding habits of the Indian giant squirrel during spring in the Karla pat Wildlife Sanctuary, India. The Indian giant squirrel is one of four species of giant squirrels in the world. This study promotes the effective conservation of the Indian giant squirrel. Evaluating the relationship between density and behavior of gray squirrels, Understanding the relationship between park habitat suitability and gray squirrel density and behavior is important because it may provide insights into the drivers of squirrel abundance in urban habitats. The relationship between density habitat suitability, intraspecific aggression, and reduced fear of humans in urban populations of gray squirrel increased density, increased intraspecific aggression, and reduced fear of humans have been suggested as the more observable and frequently described characteristics of wildlife species, the process of becoming urbanized. (Parker & Nilon, 2008).

2) Thailand

Squirrels are one of the most important groups of small mammals found in Thailand. The family Sciuridae is the highest species richness in Southeast Asia. Finlayson's squirrel *(Callosciurus finlaysonii)*, one of the most variable species in pelage color, is divided into 16 subspecies distributed in the lowland forests of Thailand and other parts of Southeast Asia. Among all the widely distributed squirrels' species 12 are found in Thailand (Boonkhaw et al., 2017).

Kanchanasaka et al. (2014) studied the Color variation of Finlayson's squirrel among populations and individuals in central Thailand. Finlayson's squirrel, and *Callosciurus finlaysonii*, are one of the species having various color types. The habitat selection operating towards the pelage coloration of tree squirrels in tropical forests is expected to be different from that in temperate forests in Thailand. To understand the ecological functions of the unusual pelage coloration. Squirrels in Thailand include *finlaysonii, C. erythraeus, C. f. bocourti, C. f. boonsongi, C. f. floweri, C. f. bocourti. C. f. nox, C. f. cinnamomeus, C. f. trotteri, C. f. folletti, C. f. finlaysonii, C. f. frandseni C. f, C. f. menamicus, C. f. annellatus, C. erythraeus* (Boonkhaw et al., 2017). To all information on the distribution, abundance, and genetic relationships of squirrels distributed in Thailand will be comfortable for the conservation of biodiversity in Southeast Asia.

2.6 Related review

Tan & Hamid (2014) reported that the natural environment change in Singapore is increase day by day it is caused by human activities. Only some people understanding how urbanization has affected the ecology of the city-state. This paper reviewed urban ecological research and how to improve local urban sustainability

and summarized the key findings according to the state factors of an urban ecosystem. The result provided useful information on the state of the ecosystem in Singapore, as well as build ideas from urban ecological research, for example, high-density equatorial urban ecosystem, to consciously treat the built component of the urban environment as a key component of urban ecological studies.

Shi & Yu (2014) focus on environmental resource accounting, which consists of ecosystem services, environment, climate change, water environment resource, and urbanization in China. This paper identifies the strategic significance of conserving biodiversity and maintaining high environmental quality. This paper suggested different scenarios for designing urban ecological corridor to improve urban sustainability for the city. This study provides a quantitative approach for research and practice in urban sustainability, and it should be valuable to other urbanizing regions around the world too.

Devictor et al. (2007) studied the community richness and dynamics of birds in landscapes. Which is affected by urbanization to test the prediction that biotic communities living in degraded landscapes are increasingly composed of generalist species. They analyzed bird communities in different plots. They emphasize that urbanization has a substantial impact on the spatial component of communities and highlighted the cause of urbanization on communities over time. This paper provides that urbanization may be an incentive for functional community composition and that measuring community homogenization is a powerful tool in the assessment of the effects of landscape changes and consequently it helps sustainable urban planning.

Angold et al. (2005) examined the biodiversity of urban habitats in Birmingham (England) using a combination of field surveys of plants and carbide beetles, genetic studies of four species of butterflies, modeling the anthropochorous nature of the floral communities and spatially explicit modelling of selected mammal species. This study tries to understand the ecological characteristics of the biota of cities model, and examine the effects of habitat fragment size and connectivity upon the ecological diversity and individual species distributions, predict biodiversity in cities. The paper suggests that cities provide habitats for a rich and diverse range of plants and animals. Dispersal for most urban species is not a limiting factor in population persistence, although elements of the woodland carbide fauna did appear to have some geographical structuring. This finding indicates the importance of identifying a target species or group of species for urban greenways intended as dispersal route ways rather than as a habitat in their own right.

Bensizerara et al. (2013) reported that Bird diversity is used to assess the functionality of diverse types of habitats around Salt Lake Djendli, Northeast Algeria. This study is an updated assessment of bird populations by addressing some ecological status. The landscape is stratified into different habitat types in a gradient from wetland to forested mountains. The research findings emphasize the importance of using combinations within the birds' ecological status, which would give information on the actual state of avifauna. This approach is relevant for future programs and conservation actions.

Lei et al. (2003) reported that the diversity and distribution patterns of endemic species of birds in China. The distribution patterns were studied in different habitats in China, which are suggested as conservation priorities based on endemism. China is a high species diversity and endemism of birds. The study of endemism is of significance to learn about the traits, components, origin, and evolution of the local avifauna, and biodiversity. The study results are beneficial for further study on both the processing mechanism of the distribution patterns and on the priority of diversity and endemism conservation. This paper suggests to setting up nature reserves around the hotspots to protect more endemics, rare and endangered species as well as the whole diversity, which will be more practical in conservation biology.

Deng & Yimam (2020) studied Ecosystem service. It refers to any service which is provided by the ecosystem to sustain the livelihood of humans. The utilization of these services implies the dependency of humans on ecological resources. Birds provide a good program ecologically and economically also provide a wide range of ecosystem services to sustain the livelihood of humans like pest control, seed dispersal, pollination, soil formation, etc. This study highlights the ecosystem roles of birds and their benefits to humans to foster their conservation.

Lampila et al. (2009) studied micro-satellite variation in four flying squirrel populations in a fragmented landscape in Finland to determine the amount of gene flow and genetic diversity in the populations. This study is examining the decline in growth rate and survival that has affected the genetic variation within the populations, shown as low genetic variation, high inbreeding coefficient, or signs of bottleneck effects and it estimated the genetic differentiation between the studied populations.

This paper suggests problems in dispersal and possible fragmentation effects in the landscape habitat favorable for the flying squirrel is left. Future studies should concentrate on the modeling of the population viability and the effects of inbreeding in these small populations.

Kitamura et al. (2010) studies conducted a camera-trapping survey of terrestrial mammal and bird diversity in a small isolated forest of southern Thailand. The study area including three forest type's primary, logged, and hill forests. A total of 35 mammal species, eight bird species, and one reptile species were recorded in the forest. Observing time, they found similar species in each habitat area. The findings are valuable and important to biodiversity conservation efforts in these small fragmented and human-modified forest landscapes. This research provides essential information for conservation and management efforts also the data can be used to assess loss of diversity elsewhere if isolation/fragmentation occurs similarly.

Wiles (1981) studied the Abundance and habitat preferences of small mammals in Southwestern Thailand. The habitat preferences are within a hilly region of dry, bamboo-mixed deciduous forest. Lowland bamboo forest is the favored habitat type, having the most species and the highest frequency of captures. Habitat preferences and relative abundance were determined by the species of small mammals in three types of dry, bamboo-mixed deciduous forest. This information is necessary before an understanding of the ecology of a species can be developed.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Study area

The study was carried out within Valaya Alongkorn Rajabhat University (VRU), Pathum Thani Province, Thailand. The VRU covers a total area of 61 hectares, a low-lying city with an approximate elevation of 1.7 meters above sea level. Annual mean temperature ranges from 14°C to 45°C at the meteorological station in Pathum Thani, with the average relative humidity being 36 ± 12.4 SD and air temperature 37.65 ± 8.6 SD °C. Inside the VRU, most of the campus roads and buildings along the campus are planted with wood trees, shrubs, herbs, and small yards. The external area consists of a rice field, industrial estate, and main road, at a distance of 30 km from the Bangkok metropolitan area.

Figure 2S Study site of Valaya Alongkorn Rajabhat University (VRU), Pathum Thani Province Thailand.

3.2 Habitat classification

In this study, we separated the study area into three habitat areas. Three study areas were chosen based on the distribution of plots across the micro-landscape, viz., natural wetland (NW), agriculture areas (AA), and recreation zone (RA) (Figure3). Natural wetland (NW) is dominated by sacred lotus (Nelumbo nucifera Gaertn) and is surrounded by residential areas, and a walking trail. Recreation areas (RA) are areas open for recreational purposes, such as walking, riding, boating, exercise education, relaxation, refreshment, coffee shop, open areas for group-activity and sport. Agricultural area (AA) consists of the area used for organic farming, banana plantations, and rice fields, also covered by tall trees and yards.

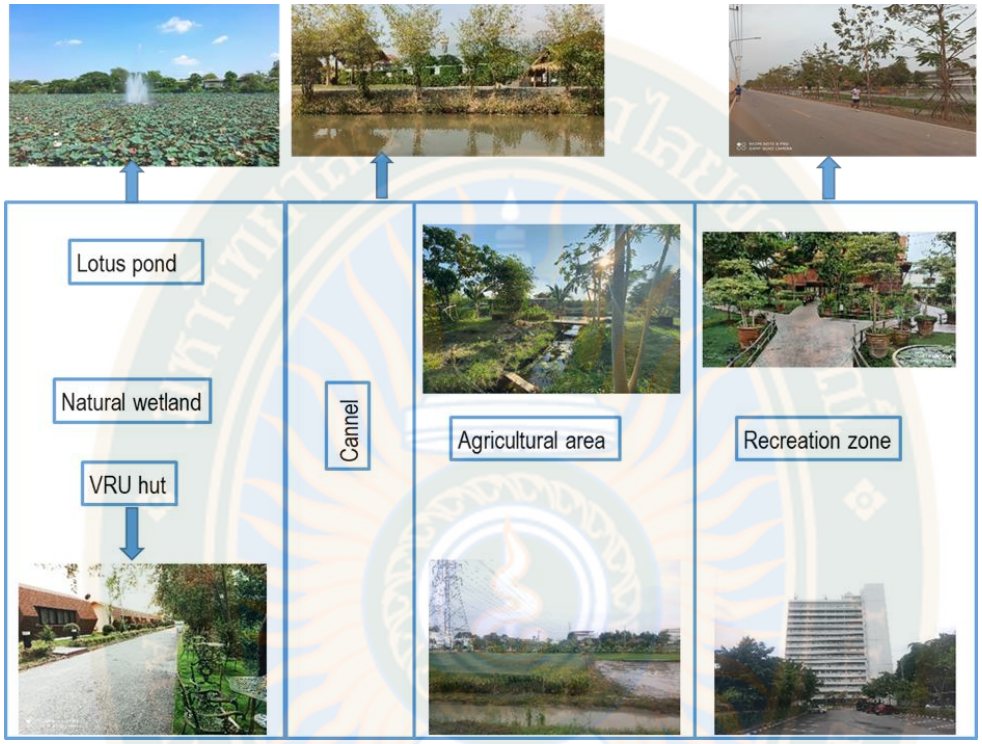

Figure 3 Three habitat classifications in the micro-landscape of the study area: Natural Wetland (NW), Agriculture Areas (AA) and Recreation Zone (RA).

3.3 Sampling Method

Data collection related to birds and squirrels was done using point count and line transect techniques. Line transects of approximately 2 km, which had ten points, were established as an observation point for bird and squirrel species. At each observation point, bird and squirrel species were observed within 10 minutes by using a binocular with a single observer to avoid inter-observer variability (Buckland et al. 2001), and data of birds' activity were recorded during 10 min in at arrival time, departure time, weather conditions, vegetation cover, and any kind of disturbance (e.g. presence of and noise from humans or vehicles). Point count surveys will use to observe the species of birds and squirrel at each point with 10 × 50BA Leica binoculars and reliable digital resources and books (Figure 4).

Bird observation times were divided in two sessions a day, based on bird activity. The first session was conducted in the early morning (6:00-10:00 a.m.), and the second session in the late afternoon (4:00-6:00 p.m.). The study was conducted six times within a year, from May 2020 to April 2021.

Figure 4 Bird observation equipment's

3.4 Identification of birds and squirrels

Collections data of birds and squirrels in each trek observations will classify into taxonomic levels including order, family genus, and species. In each habitat, birds were counted by sampling points. The same points were used both in dry and wet seasons. Bird species will identify using the systematic keys of birds and the author's taxonomic expertise with these groups. Squirrels species will identify by using the systematic keys and reference to the squirrel's collection at the Natural history Science Museum and reliable digital resources. All birds and squirrels' individuals will be counted for analysis.

3.5 Data Analysis

The total number of bird and squirrel species determines the species richness. The dominant birds express the proportional importance of the assemblage species, indicated by the value of frequency of occurrence (F) of each species at each study area separately, which was calculated as F= ni/N*100. As a result, the birds could be divided into three groups. First, F value between 0%- 35% was considered as uncommon species; second, F value between 36%-70% was considered as common species, and finally, F value between 71%-100% was considered as the dominant species. Univariate ANOVA was conducted to compare the richness among study areas, and pair-wise comparisons (LSD post-hoc tests) were performed when the differences were considered significant at $P<0.05$. All data were transformed to reduce the heteroscedasticity of the analysis. ANOVA statistical analyses were performed with PASW ver. 20.0.0 for Windows (SPSS Inc., Chicago, IL, USA).

CHAPTER 4
RESULTS

4.1 Structural diversity

Structural diversity was separated into three types based on land utilization including natural wetland, an agricultural area, and a recreation zone. There is a human structures and dense such as houses, buildings, roads, and yards. In general, when people come for the walk they enjoy the greenery. Humans are attracted to nature and these areas are important for ecological and environmental education.

4.1.1 Natural wetland

These areas have many natural resources. The wetland habitat is surrounded by a residential area, VRU resort, walking trail, and other types of vegetation. Lotus pond and wetland areas are dominated by sacred lotus (*Nelumbo nucifera* Gaertn).

1) Residential area

The residential area includes professors and workers household area and student dormitory area. These surrounding areas are lots of big trees and various kinds of fruits tree (Figure 5).

Figure 5 Residential areas of VRU

2) Lotus pond

This place is a nearby VRU resort area. In the lotus pond spot, we found here some water dominant species such as lotus, water hyacinth, water lily, and different species of fish and turtle. This pond is the nearest human settlement (Figure 6).

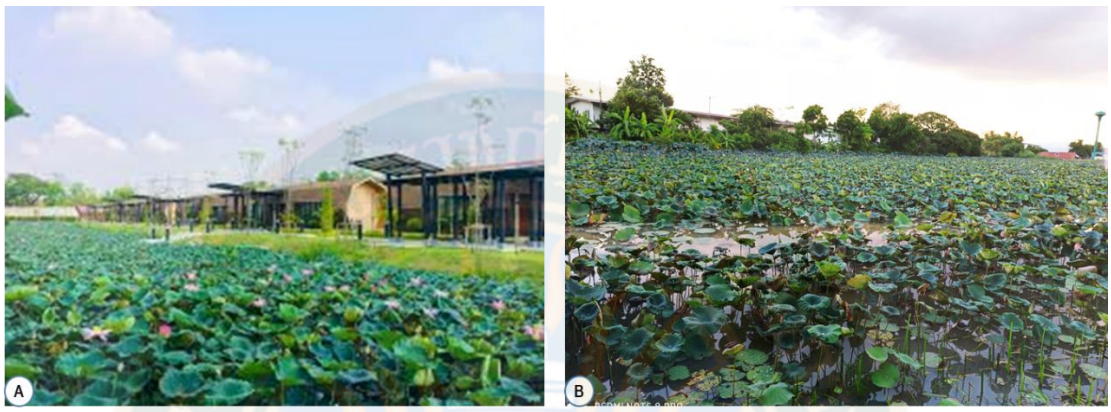

Figure 6 Lotus pond of study site (A-B)

3) VRU resort

VRU resort is the best place for those who love the rest with Nature. It is the best eco-friendly resort for recommendation and is located in a very good atmosphere. Modern accommodation based on nature. There is an open space where socio-cultural events are arranged such as festivals, and other social gatherings. The bank of stream people can sit and boat. Another attraction is a bicycle facility (Figure 7 A-B). People can ride a bicycle and see nature.

Figure 7 VRU resort areas

4.1.2 Agricultural area

In this study, the agricultural area is classified into different parts including rice fields, mango and banana plantations, and vegetable gardens. These areas are the protection of land as they are an important habitat in functioning agricultural systems. The agricultural area is highly sustainable.

1) Paddy field area

The paddy field farmer growing different rice species such as sticky rice, jasmine rice, and many more. During the rice cultivation time, students come here to do agricultural activities for learning. In this area, the farmer does not use chemical fertilizer. This area consists of the area use for organic farming, (Figure 8 A-B). After harvesting many birds come here to pick their food. The agricultural area has a buffalo house and poultry farm.

Figure 8 Rice field area of study site

2) Banana and mango garden

Here different varieties of banana and mango are cultivated. People can come to collect organic fruits (Figure 9 A-B). The place is very beautiful, the time of fruits flower blooms different kinds of insects like Bee, Bucks, and Caterpillar comes to collect their food and enjoy.

Figure 9 Banana (A) and mango garden (B) area

There are many learning resources in an agricultural area. People use this place as a research center to study or other purposes. This area provides suitable habitats and food resources such as insects, fruits, grains, nesting sites. It is comprised of different food crops grown in mixed stands, sharing boundaries with the other habitats.

3) Organic farming

This area is only for organic farming. The vegetable garden is grown with different types of vegetables, herbs, and fruits. The garden area gets the best sun exposure and air circulation. The vegetables are growing several times. The farmer does not use chemicals all vegetables are organic. The vegetable garden can be both enjoyable and productive (Figure 10 A-B). Also, children come to grain their knowledge. People can come and picked up their vegetables.

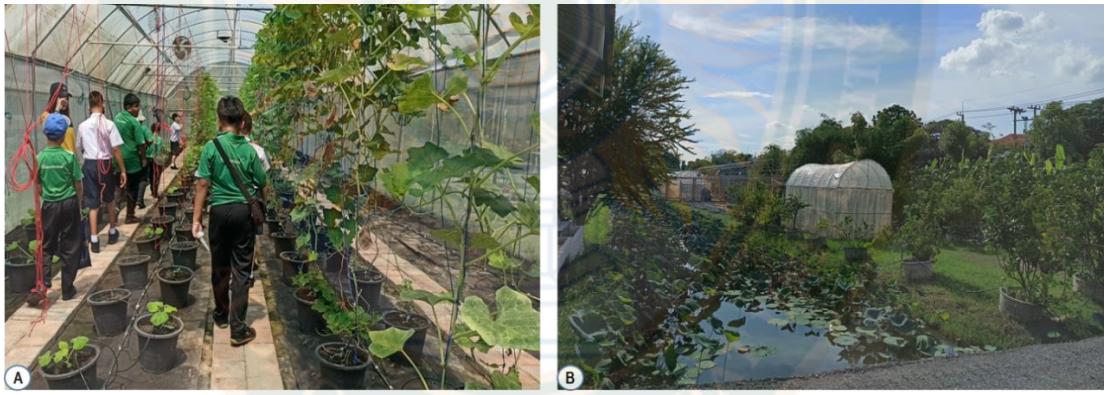

Figure 10 Organic farming of agricultural area

4.1.3 Recreation zone

This area covers the open space of the University such as a walking trail, man-made pond, coffee shop, open area for group activity and sport, and green spaces covered by tall trees and yards. Recreation areas are open for recreational purposes, such as walking, riding, boating, exercise education, relaxation, refreshment, and sport. 1) Walking trail

This area is mostly helping urban dwellers for their relaxation such as walking, running, and jogging. The surrounding area is environmental because there has a lot of preserve trees and animal habitats. This walking area is a peaceful place and provides fresh air for the environment. Both sides of the streetscapes (Figure 11 A-B) have trees and their street lights are using by the solar system. People come here for walking and refreshing and do other activities like cycling.

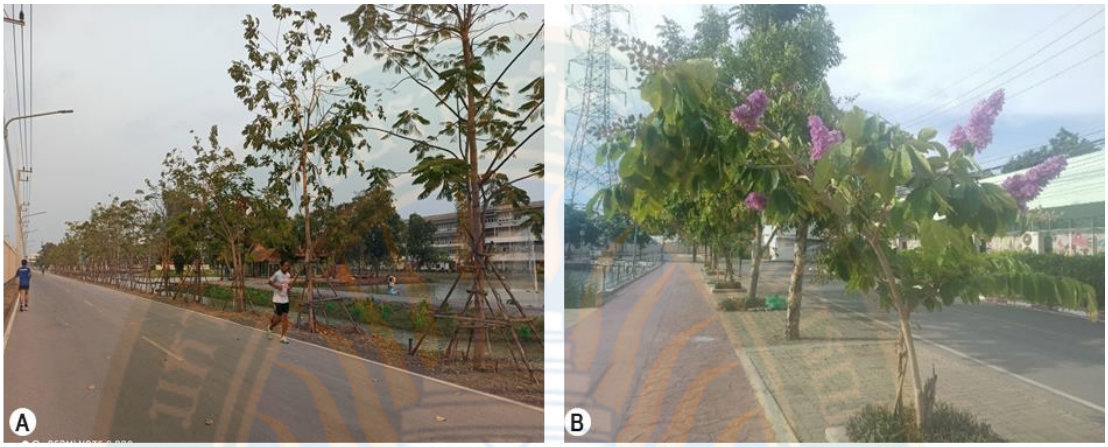

Figure 11 Recreation area of study site

2) Open Space

About this area is provide a good natural condition for a living organism. There is vast open space to play. People can do outdoor activities, children can play, and simply enjoy a green and natural environment. The living organism is comfortable in this area because the area people don't harm anybody (Figure 12A-B).

Figure 12 Open space area of study area

4.2 Bird diversity

4.2.1 The richness of birds

During the present study, various bird species were recorded from the study site. Thailand has a tropical monsoon climate. Across VRU, there are many varieties

of bird species to be spotted. The majority of bird species in VRU were endemic species (Table 1).

Table 1 List of bird species order, family

Order/Family	Number of family	Number of species
Cuculiformes	1	1
Anseriformes	1	1
Apodiformes	1	1
Ciconiiformes	1	2
Columbiformes	1	4
Coraciiformes	1	3
Cuculiformes	1	3
Gruiformes	1	1
Passeriformes	16	22
Passerine	2	2

Table 1 (cont.)

Order/Family	Number of family	Number of species
Pelecaniformes	1	3
Piciformes	1	1
Suliformes	1	1
Total number of order		12
Total number of family		29
Total number of species		47

Passeriformes is the largest order of birds and among the most diverse orders of terrestrial vertebrates, which includes more than half of all bird species. Order Passeriformes was numerically dominant species, while columbiformes, coraciiformes, Cuculiformes, Pelecaniformes, Ciconiiformes, Passerine, is the rare species and Anseriformes, Apodiformes, Gruiformes, Piciformes, Suliformes are very rare.

A total of 47 bird species belonging to 29 families and 12 Orders were observed from the study areas at the VRU (Table 1). Order Passeriformes was numerically the dominant order, represented by 15 families and 22 species,

accounting for 49% of the identified species, followed by Columbiformes (9%) and Cuculiformes (9%); other orders were found with the least diversity with 1-2 species (Table 1). Significantly high bird richness was recorded in the AA with 35 ± 2.3 SE, vis-a-vis RA (27 ± 1.8 SE), and the NW (17 ± 2.5; SE Fig. 1; $p > 0.05$).

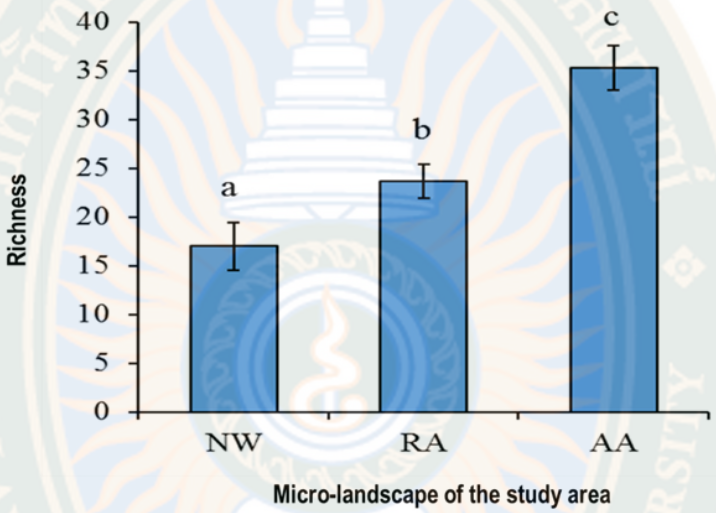

Figure 13 Mean (±SD) of richness of birds in three micro-landscapes in the study area, Natural Wetland (NW), Recreation area (RA) and Agricultural area (AA). Significant values are indicated with difference in letters with = $p < 0.001$

Figure 13 shows the highest richness of bird species per plot visit. The highest richness of bird species was found in AA, RA, and NW. The AA area is an agricultural field with less interference, with grain crops, agricultural products such as rice, etc., while the NW is a large lotus pond without other plants. Therefore, only some species of bird species are available around the wetland (Table 2).

4.2.2 Status of bird in VRU

The point count method was used to identify the bird species from three habitat types: Natural wetland, Recreation zone, and Agricultural areas. The VRU areas play an important role for the bird. VRU promoted bird abundance and species richness by providing additional food resources and nesting sites. The higher bird diversity was recorded in an agricultural area. In this area, people don't use chemicals. This area provides suitable habitats and food resources such as insects, fruits, grains, nesting sites. It is comprised of different food crops grown in mixed stands, sharing boundaries with the other habitats. In flowers blooming time, there

are so many bees come to collect their food. Here we found one migratory species Green Bee-eater.

The present study concerns the bird diversity of the VRU. VRU was suitable for being foraging and resting areas for the bird. This area has big trees and people don't disturb. According to the seasonal status, five migrant bird species and 35 resident species were observed, and the seasonal status of 10 bird species was recorded both as migrant and resident species. Most of the bird species are listed of low concern, and only one species, Mycteria leucocephala was listed as near-threatened (Table 2)

Table 2 Species richness and the frequency of bird occurrence within the study areas - Natural wetland (NW), Recreation areas (RA), Agricultural area (AA) -, and a seasonal status

Order/Family/species	frequency of occurrence (%; N=6)			Total	Status in VRU	Seasonal status	Conservation status
	NW	RA	AA	(N=18)			
Anseriformes							
Anatidae							
Dendrocygna javanica (Horsfield, 1821)	0	100	0	33	US	RS	Least Concern
Apodiformes							
Apodidae							
Cypsiurus balasiensis (Gray, 1829)	0	100	100	67	CS	RS	Least Concern
Ciconiiformes				0			
Ciconiidae				0			
Anastomus oscitans (Boddaert, 1783)	RS	RS	RS	RS	RS	RS	Least Concern

Table 2 (cont.)

Order/Family/species	frequency of occurrence (%; N=6)			Total	Status in VRU	Seasonal status	Conservation status
	NW	RA	AA	(N=18)			
Mycteria leucocephala (Pennant, 1769)	0	100	100	67		RS	Near-threatened
Columbiformes				0			
Columbidae				0			
Columba livia (Gmeline, 1789)	100	100	100	100	DS	RS	Least Concern
Geopelia Striata (Linnaeus, 1766)	50	100	100	83	DS	RS	Least Concern
Streptopelia chinensis (Scopoli, 1768)	33	100	67	67	CS	RS	Least Concern
Streptopelia tranquebarica (Hermann, 1804)	67	100	100	89	DS	RS	Least Concern
Coraciiformes				0			
Alcedinidae				0			
Alcedo atthis (Linnaeus, 1758)	0	100	50	50	CS	MS	Least Concern
Halcyon pileata (Boddaert, 1783)	0	0	100	33	US	MS	Least Concern
Meropidae				0			
Merops Orientalis (Latham, 1801)	0	100	100	67	CS	RS	Least Concern
Cuculiformes				0			
Cuculidae				0			

Table 2 (cont.)

Order/Family/species	frequency of occurrence (%; N=6)			Total	Status in VRU	Seasonal status	Conservation status
	NW	RA	AA	(N=18)			
Cacomantis merulinus (Scopoli, 1786)	0	0	100	33	US	RS	Least Concern
Centropus sinensis (Stephens, 1815)	50	0	0	17	US	RS	Least Concern
Chrysococcyx maculatus (Gmelin, 1788)	50	0	50	33	US	RS/MS	Least Concern
Eudynamys scolopaceus (Linnaeus, 1758)	33	83	83	67	CS	RS	Least Concern
Phaenicophaeus tristis (Lesson, 1830)	50	17	0	22	US	RS	Least Concern
Gruiformes				0			
Rallidae				0			
Amaurornis phoenicurus (Pennant, 1769)	33	0	100	44	CS	RS	Least Concern
Passeriformes				0			
Artamidae				0			
Artamus fuscus (Vieillot, 1817)	0	50	17	22	US	RS	Least Concern
Campephagidae				0			
Pericrocotus cinnamomeus (Linnaeus, 1766)	0	100	0	33	US	RS	Least Concern

Table 2 (cont.)

Order/Family/species	frequency of occurrence (%; N=6)			Total	Status in VRU	Seasonal status	Conservation status
	NW	RA	AA	(N=18)			
Cisticolidae				0			
Prinia inornata (Sykes, 1832)	0	0	100	33	US	RS	Least Concern
Corvidae				0			
Corvus macrorhynchos (Wagler, 1827)	33	67	100	67	CS	RS	Least Concern
Dicaeidae				0			
Dicaeum cruentatum (Bonaparte, 1853)	67	0	100	56	CS	RS	Least Concern
Dicruridae				0			
Dicrurus leucophaeus (Vieillot, 1817)	33	0	0	11		RS/MS	Least Concern
Dicrurus macrocercus (Vieillot, 1817)	0	0	100	33	US	RS/MS	Least Concern
Estrildidae				0			
Lonchura punctulata (Linnaeus, 1758)	17	17	100	44	CS	RS	Least Concern
Lonchura striata (Linnaeus, 1766)	33	33	100	56	CS	RS	Least Concern
Hirundinidae				0			

Table 2 (cont.)

Order/Family/species	frequency of occurrence (%; N=6)			Total	Status in VRU	Seasonal status	Conservation status
	NW	RA	AA	(N=18)			
Hirundo rustica (Linnaeus, 1758)	17	50	0	22	US	RS/MS	Least Concern
Laniidae				0			
Lanius cristatus (Linnaeus, 1758)	0	0	50	17	CS	MS	Least Concern
Motacillidae				0			
Anthus hodgsoni (Richmond, 1907)	17	0	0	6	US	MR	Least Concern
Muscicapidae				0			
Copsychus saularis (Linnaeus, 1758)	100	100	100	100	DS	RS	Least Concern
Muscicapa dauurica (Pallas, 1811)	33	0	100	44	DS	RS/MG	Least Concern
Nectariniidae				0			
Cinnyris jugularis (Linnaeus, 1766)	33	33	67	44	DS	RS	Least Concern
Passeridae				0			
Passer domesticus (Linnaeus, 1758)	0	100	100	67	CS	RS	Least Concern
Passer montanus (Linnaeus, 1758)	100	100	100	100	DS	RS	Least Concern
Ploceidae				0			
Ploceus hypoxanthus (Sparrman, 1788)	50	0	100	50	CS	RS	Least Concern

Table 2 (cont.)

Order/Family/species	frequency of occurrence (%; N=6)			Total	Status in VRU	Seasonal status	Conservation status
	NW	RA	AA	(N=18)			
Pycnonotidae				0			
Pycnonotus blanfordi (Finsch, 1873)	100	100	100	100	DS	RS	Least Concern
Pycnonotus goiavier (Scopoli, 1786)	50	0	0	17	US	RS	Least Concern
Sturnidae				0			
Acridotheres grandis (Cabanis, 1850)	100	100	100	100	DS	RS	Least Concern
Acridotheres tristis (Linnaeus, 1766)	100	100	100	100	DS	RS	Least Concern
Sturnus contra (Gmelin, 1789)	0	100	100	67	CS	RS	Least Concern
Passerine				0			
Oriolidae				0			
Oriolus chinensis (Linnaeus, 1766)	0	0	50	17	US	RS/MG	Least Concern
Rhipiduridae				0			
Rhipidura javanica (Sparrman, 1788)	0	100	100	67	CS	RS/MG	Least Concern
Pelecaniformes				0			
Ardeidae				0			
Ardeola bacchus (Bonaparte, 1855)	100	100	100	100	DS	MG	Least Concern

Table 2 (cont.)

Order/Family/species	frequency of occurrence (%; N=6)			Total	Status in VRU	Seasonal status	Conservation status
	NW	RA	AA	(N=18)			
Egretta garzetta (Linnaeus, 1766)	100	0	100	67	CS	RS	Least Concern
Ixobrychus sinensis (Gmelin, 1789)	0	0	100	33	US	RS	Least Concern
Piciformes				0			
Megalaimidae				0			
Psilopogon haemacephalus (Statius Müller, 1776)	0	100	100	67	CS	RS	Least Concern
Suliformes				0			
Phalacrocoracidae				0			
Microcarbo niger (Vieillot, 1817)	100	0	100	67	CS	RS	Least Concern
Total number of species	29	29	39				
Total number of order: 12 order							
Total number of family: 29 family							

Remark: A seasonal status were indicated by Treesucorn and Limparungpatthanakij (2018), which RS = Resident species, MS = Migrated species, RM = both status; resident species and migrated species.

Detail information of each bird family and species are described below Family Anatidae

The Anatidae are the biological family of water birds that includes ducks, geese, and swans. Plump bodies, broad, flattened bills, and webbed feet. They are

excellent swimmers, most feed on aquatic plants and animals though some species graze vegetable food on the land. Order Anseriformes. We found one species of this family as follow:

Lesser Whistling Duck *(Dendrocygna javanica)*

The lesser whistling duck is a small, well-proportioned, tree-nesting duck. Pale brown overall with a darker brown crown and nape, warmer chestnut underparts, and chestnut-fringed feathers on the back. The faint orange-yellow eyering and the dark gray bill and legs. Sexes similar; juveniles duller. Flies with rapid wing beats on broad dark wings. We found it in the wetland, and lotus pond. It is a common resident.

Family Apodidae

Superficially resemble swallows but have longer, thinner, usually crescent-shaped wings, fly with rapid wingbeats, interspersed with long glides. Many species have screaming calls. Aerial insectivores, never perch on trees or wires like swallows but with their short claws can only hang from a vertical surface. Order Apodiformes. We found one species of this family as follow:

Asian Palm Swift *(Cypsiurus balasiensis)*

The Asian palm swift is a small swift. It is very similar to the African palm swift. This species is mainly pale brownr. It has long swept-back wings that resemble a crescent or a boomerang. The body is slender, and the tail is long and deeply forked, although it is usually held closed. Habitat we found it in agricultural areas and human settlements. Very common resident.

Family Ciconiidae

Very large wading birds with long, heavy bills, long necks, and legs. Fly with head and neck extended and legs trailing. Frequently soar. Feed on a variety of small animals both aquatic and terrestrial. They belong to the order Ciconiiformes**.** We found two species of this family as follow:

Asian openbill *(Anastomus oscitans)*

The Asian openbill is a large wading bird greyish or white with glossy black wings and tail and the adults have a gap between the arched upper mandible and recurved lower mandible. Young birds do not have this gap. The cutting edges of the mandible have a fine brush-like structure that is thought to give them a better grip on the shells of snails. The tail consists of twelve feathers and the preen gland has a tuft. The mantle is black and the bill is horn-grey. We found it in wetlands, lotus ponds, and rarely seen agricultural landscapes.

Painted Stork *(Mycteria leucocephala)*

Painted stork is a large water bird, with head and pink face. Dark, long mouth, curved at the end of yellow body. The body is white with a black band and white fur. The distinctive pink tertial feathers of the adults give them their name. They forage in flocks in shallow waters along rivers or lakes. They immerse their half-open beaks in water and sweep them from side to side and snap up their prey of small fish that are sensed by touch. We found in the wetland, and agricultural areas.

Family Columbidae

Columbidae is a bird family consisting of pigeons and doves. Plump-bodied birds, with small heads, short bills, and legs. Flight strong and direct. Most are gregarious, feeding on fruit, seeds, and buds. Some species make seasonal. We found four species of this family these are

Red color dove (*Streptopelia tranquebarica)*

The red collared dove is also known as the red turtle dove, is a small pigeon thatis a resident breeding bird in the tropics of Asia. This dove is essentially a plains species. The male is red with a bluish-gray head and the female is brown overall. Both sexes have a dark collar. Female may be confused with other collared-doves, but is smaller with a shorter tail. We found it in the garden, park, agricultural areas, and human settlements.

Rock dove, Rock pigeon (*Columba livia)*

Plump bird with a small head and straight, thin bill. The plumage is variable, but the most common form has a gray back, black bars in the wing, and a blue-gray head. Plump bird with short legs and a small head. The plumage is variable; some birds are dark gray with green-purple iridescence on the neck. We found in agricultural areas and other cultivated areas, gardens, parks, streetscape, and human settlements. Very common resident.

Spotted dove *(Streptopelia chinensis)*

The spotted dove is a small and somewhat long-tailed buff-brown with a white-spotted black collar patch on the back and sides of the neck. The tail tips are white and the wing coverts have light buff spots. The wing feathers are dark brown with grey edges. The center of the abdomen and vent are white. Sexes are similar, but juveniles are duller than adults and do not acquire the neck spots until they are mature. We found it in agricultural areas, gardens, parks, streetscapes, and human settlements. Very common resident.

Zebra dove *(Geopelia Striata)*

The birds are small and slender with long narrow tails. The upper parts are brownish-grey with black-and-white barring. The underparts are pinkish with black bars on the sides of the neck, breast, and belly. The face is blue-grey with bare blue skin around the eyes. There are white tips to the tail feathers. Juveniles are duller and paler than adults. They can also have brown feathers. We found in agricultural areas and other cultivated areas, gardens, parks, streetscape, and human settlements. Very common resident.

Family Alcedinidae

Alcedinidae is a family of small to medium-sized, brightly colored birds in the order of Coraciiformes. Long, dagger-like bills, large heads, and compact bodies with short legs and tails. Most have brilliant plumage. Typically perch upright in exposed situations. Many species hunt on water bodies, catching fish and other aquatic animals by plunge-diving. We found two species of this family these are

Black-Caped kingfisher *(Halcyon pileata)*

Kingfisher with a jet-black head, white-collar, and blood-red bill. It has purple-blue upperparts and pale orange-rufous underparts. The throat is white, the blue tail has a black underside, and in flight, white flashes on the underwings are conspicuous. The juvenile is duller blue with a small rufous-buff spot in front of the eye, a buffy collar, and dusky scaling on the breast. Similar to White-throated Kingfisher, but Black-capped's are slightly higher-pitched. We found it in wetland areas, lotus ponds, agricultural areas, and closed to freshwater.

Common kingfisher *(Alcedo atthis)*

The common kingfisher, also known as the Eurasian kingfisher, is a small kingfisher fairly common but small, often rather shy, and inconspicuous, and typical short-tailed, large-headed. It has blue upperparts, orange underparts, and a long bill. It feeds mainly on fish, caught by diving, and has special visual adaptations to enable it to see prey underwater. We found it in wetland areas, lotus ponds, agricultural areas, and closed to freshwater.

Family Meropidae

This family has long, curved, narrow bills, slender bodies, and long pointed wings. Plumages are usually predominantly green through the show a coppery underwing in flight. Feed on bees and other insects. Order Coraciiformes. We found one species of this family and that is

Green Bee-Eater / Little Green bee-eater *(Merops Orientalis)*

The green bee-eater is a near passerine bird in the bee-eater family. A small dainty bee-eater that is intensely green overall with a greenish-blue throat, a thin black throat band, and long central tail feathers. In flight, note the dark edge along the lower border of the wings. Juveniles are duller than adults and lack long tail feathers. In some parts of its range, birds may have a rusty crown or a bright blue throat. We found in open areas, agricultural areas. Very common resident.

Family Cuculidae

The cuckoos are a family of birds, Cuculidae, the sole taxon in the order Cuculiformes. Characterized by slender bodies and long graduated tails. Bills are slightly decurved and feet zygodactylous with two toes pointing forward to back. A highly varied family. Most are insectivorous. We found three species of this family these are.

Asian Emerald Cuckoo *(Chrysococcyx maculatus)*

The Asian emerald cuckoo grows to a length of about 18 cm. The adult male has an iridescent dark green head, upper parts and upper breast, a white lower breast, and a green barred belly. The adult female has coppery-green upper parts, rusty brown crown, and nape and green-barred underparts. We found it in agricultural areas, gardens, and human settlements. Uncommon residents and winter visitors.

Asian koel *(Eudynamys scolopaceus)*

The Asian koel is a large, long-tailed, the male of the nominate race is glossy bluish-black, with a pale greenish grey bill, the iris is crimson, and it has grey legs and feet. The female of the nominate race is brownish on the crown and has rufous streaks on the head. The back, rump, and wing coverts are dark brown with white and buff spots. The underparts are whitish but are heavily striped. We found it in agricultural areas, wetland areas, gardens, and human settlements. Common resident.

Plaintive cuckoo *(Cacomantis merulinus)*

The plaintive cuckoo is fairly small. The adult male is grey-brown above and orange below with a grey head, throat, and upper breast, tail feathers have white tips, legs and feet are yellow, the eye is red and the bill is black above and yellow below. The adult female is sometimes similar to the male but often occurs in a "hepatic" morph. This form is reddish-brown above with dark bars. The underparts are paler with fainter barring. There is a pale stripe over the eye and the tail has dark

bars along its whole length. We found in agricultural areas and other cultivated areas, gardens, and human settlements. Very common resident.

Family Rallidae

Terrestrial wading birds with long legs and toes. Walk with characteristic horizontal body posture, tail usually cocked or jerked upwards. Most are capable of swimming. Inhabit dense vegetation of marshes or waterside vegetation in both open country and wooded areas. Shy and difficult to observe except at dawn and dusk. Order Gruiformes, we found one species of this family, that is

White-breasted Waterhen *(Amaurornis phoenicurus)*

The white-breasted waterhen is a water bird. They are dark grey upperparts and flanks, and a white face, neck, and breast. The lower belly and under tail are cinnamon colored. The body is flattened laterally to allow easier passage through the reeds or undergrowth. They have long toes, a short tail, and a yellow bill and legs. They are somewhat bolder than most other rails and are often seen stepping slowly with their tail cocked upright in open marshes. We found in wetlands, lotus ponds, nearby fresh water areas, and rarely agricultural areas.

Family Artamidae

Artamidae is a family of passerine birds found in Australia. Stocky, aerial feeding birds with thick based, pointed bills. Glide on stiff, broad-based, triangular wings and have a short square tail. We found one species of this family, which is

Ashy Wood Swallow (*Artamus fuscus*)

The ashy wood swallow has a short curve bill and a short square tail and long wings. A chunky, large-headed bird of open areas, usually found perched on wires or flying around in search of insects. Soft gunmetal gray with white underparts. Often found pressed together in pairs or tight groups when at rest. Sometimes flies in the same areas as swallows and swifts, but has a much thicker build, with triangular, somewhat starling-like wings. We found in a range of habitats from the plains to about 2000 m, agricultural area. Common resident.

Family Muscicapidae

A large and diverse family, characterized by flattened, broad based bills with long rectal bristles and short, slender legs. Sexes often differ, with bright plumaged males being more readily identifiable than duller, brownish females. Mainly insectivores. Order Passeriformes. We found one species of this family bird, which is

Asian brown flycatcher *(Muscicapa dauurica)*

The Asian brown flycatcher is a small passerine bird. Plain brown flycatcher with a large-eyed appearance. Bright white eyering and unmarked throat and

underparts. Appears shorter and plainer-winged than other similar brownish flycatchers. We found it in agricultural areas, gardens, and park areas. Very common winter visitor. Local and uncommon resident.

Family Ploceidae

Similar to sparrows in shape with heavy conical bills adapted for eating seeds and grain. The Thai species all have rounded tails. Sexually dimorphic the males having a distinctive nuptial plumage. Order Passeriformes. We found one species of this family, that is

Asian golden weaver *(Ploceus hypoxanthus)*.

Asian Golden Weaver is bright yellow finch with a thick, powerful bill. The male is daffodil-yellow with a black mask, dark bill, and scaly speckling on the back. Asian golden weavers are considered medium-sized birds with yellow and black upperparts, along with yellow underparts. They possess a black face, yellow crown, a strong black bill. Habitat we found in an agricultural area, garden, parks, and human settlements. Local and uncommon resident.

Family Hirundinidae

Aerial feeding insectivores, like swifts but quite unrelated and distinguished by shorter, broader wings and more fluttering flight. Frequently perch on branches or wires. Most species are a winter visitors to Thailand. Order Passeriformes. We found one species of this family, that is

Bam swallow *(Hirundo rustica)*

The barn swallow is the most widespread species of swallow in the world. It is a distinctive passerine bird with blue upperparts and a long, deeply forked tail, and a rufous forehead, chin, and throat, which are separated from the off-white underparts by a broad dark blue breast band. There is a line of white spots across the outer end of the upper tail. The female is similar in appearance to the male, but the tail streamers are shorter, the blue of the upperparts and breast band is less glossy, and the underparts paler. We found it in open areas, streetscapes, even on electric wires. Very common winter visitors.

Family Dicruridae

The drongos are a family, Dicruridae, of passerine birds. Usually black plumage, diagnostic tail shapes, but beware of molting birds. Eyes are often red in adults. Arboreal and conspicuous. Usually hunting from exposed perches and catching insects on the wing. Found mostly in pairs when territorial. Order Passeriformes we found one species of this family that is

Black drongo *(Dicrurus macrocercus)*

The black drongo is glossy black with a wide fork to the tail. Adults usually have a small white spot at the base of the gape. The iris is dark brown. Juveniles are brownish and may have some white barring or speckling towards the belly and vent, and can be mistaken for the white-bellied drongo. We found it in an agricultural area and other cultivation areas. Very common winter visitor.

Family Laniidae

Medium-sized, predatory passerine birds with stout hooked bills, large heads, and long tails. Inhabit mainly open country and prey on insects, frogs. Many species impale their prey on thorns. Solitary and territorial, even in winter quarters. Order Passeriformes. We found one species of this family that is

Brown shrike *(Lanius cristatus)*

The brown shrike is mainly brown on the upper parts and the tail is rounded. The black mask can be paler in winter and has a white brow over it. The underside is creamy with rufous flanks and a belly. The wings are brown and lack any white "mirror" patches. Females tend to have fine scalloping on the underside and the mask is dark brown and not as well marked as in the male. We found them in open areas, agricultural areas, and garden areas. Very common winter visitors.

Family Sturnidae

Stocky, medium-sized passerine birds with strong bills and legs and relatively short tails. Order Passeriformes we found one species of this family that is

Common myna *(Acridotheres tristis)*

The common myna is an omnivorous open woodland bird with a strong territorial instinct. The common myna is readily identified by the brown body, black hooded head, and the bare yellow patch behind the eye. The bill and legs are bright yellows. There is a white patch on the outer primaries and the wing lining on the underside is white. This bird is found in agricultural areas, human habitation, and garden area. Very common resident.

Family Passeridae

Small to medium size birds with compact bodies and short, conical bills adapted to feeding on seeds and grain. Have notched tails. Build loose, dome shaped nests placed either in holes or crevices or in the branches of trees. Order Passeriformes we found two species of this family these are

Eurasian tree sparrow *(Passer montanus)*

The Eurasian tree sparrow is a passerine bird in the sparrow family with a rich chestnut crown and nape, and a black patch on each pure white cheek. This sparrow

is smaller than the house sparrow. The upper parts are light brown, streaked with black, and the brown wings have two distinct narrow white bars. The legs are pale brown, and the bill is lead-blue in summer, becoming almost black in winter. We **f**ound in an urban area, human habitation, agricultural areas, and park area.

House sparrow *(Passer domesticus)*

The house sparrow is a small bird. Females and young birds are colored pale brown and grey, and males have brighter black, white, and brown markings. Flocks cluster in dense bushes, bustling around and chattering to one another. Males have smart black bibs, bright rufous napes, and stunningly patterned wings with brilliant buffs and browns. Underparts are pale pearly-gray. The house sparrow is found in strongly human habitation, an agricultural area, and a park area.

Family Corvidae

Large perching birds with fairly long tails. Noisy and gregarious. Crows are black and frequent open areas and human habitation while jays and magpies are usually more brightly colored and Omnivorous. Many species rob the nests of other birds. Order Passeriformes we found one species of this family that is

Jungle crow, Large-billed crow *(Corvus macrorhynchos)*

The jungle crow is a widespread Asian species of crow. All taxa have dark greyish plumage from the back of the head, neck, shoulders, and lower body. Their wings, tail, face, and throat are glossy black. The depth of the grey shading varies across its range. We found it in agricultural areas, wetlands, and human settlements. Common resident.

Family Nectariniidae

Small active arboreal bird with long curved bills. Males of many species show bright, orange or yellow pectoral tufts. Eat both nectar and small insects, spiders. Order Passeriformes we found one species of this family that is

Olive-backed sunbird, Yellow-bellied sunbird *(Cinnyris jugularis)*

The Olive-backed sunbirds are small in size. The underparts of both male and female are bright yellow and the backs are a dull brown color. The forehead, throat, and upper breast of the adult male are blue-black. Their flight is fast and direct on their short wings. We found it in agricultural areas, gardens, parks. Very common resident.

Family Muscicapidae

A large and diverse family, characterized by flattened, broad based bills with long rectal bristles and short, slender legs. Sexes often differ, with bright plumaged

males being more readily identifiable than duller, brownish females. Mainly insectivorous. We found one species of this family that is

Oriental magpie robin *(Copsychus saularis)*

The Oriental magpie-robin is a small passerine bird. They are distinctive black and long tails with a broad white wing bar running from the shoulder to the tip of the wing. Note white outer tail feathers, particularly when in flight. Males sport black-and-white plumage while the females are grayish brown and white. We found in agricultural areas and other cultivated areas, gardens, and parks.

Family Sturnidae

Stocky medium sized birds with strong bills and legs and relatively short tails. Strong, direct flight on pointed wings, or broader, more rounded wings. Includes arboreal, woodland species as well as terrestrial, open country species. Order Passeriformes, we found one species of this family that is

Pied starling *(Sturnus contra)*

The Pied Myna is strikingly marked in black and white and has a yellowish bill with a reddish bill base. The bare skin around the eye is reddish. The upper body, throat, and breast are black while the cheek, lore's, wing coverts, and rump are contrastingly white. We found in agricultural areas and open areas with scattered trees near water, often near human habitation.

Family Cisticolidae

Small resident warblers with long, strongly graduated tails which are sometimes held cocked. Order Passeriformes we found one species of this family that is

Plain Prinia *(Prinia inornata)*

The plain prinia have short rounded wings, a longish tail, strong legs, and a short black bill. In breeding plumage, adults are grey-brown above, with a short white supercilium and rufous fringes on the closed wings. The underparts are whitish-buff. We found it in wetland areas, lotus ponds, canals, agricultural areas, and other cultivated areas. Very common resident.

Family Estrildidae

Mainly small and strikingly marked. Fly in close packed flocks. Feed almost exclusively on seeds and can make local movements to areas of greatest food abundance, enabling them to breed year-round. Order Passeriformes. We found two species of this family that is

Scaly-breasted munia *(Lonchura punctulata)*

This bird stubby dark bill is typical of grain eating birds, brown upperparts and a dark brown head. The underparts are white with dark scale markings. The sexes are similar, although males have darker markings on the underside and a darker throat than females. We found it in agricultural areas and household areas. Very common resident.

White-rumprd Munia *(Lonchura striata)*

The white-rumped munia is in its range with white on the lower back and rump. It has a blackish-brown head and back with pure white underparts and rump. Its back is finely streaked with pale shafts. Juvenile is rufous-brown with indistinct streaks above, rump buffy gray, breast light rufous, and underparts buffy gray. Races differ in the amount of white-and-gray streaking on the underparts and the extent of the blackish-brown on the head. We found in agricultural areas and household areas. Very common resident.

Family Dicaeidae

Mostly very small birds with short tails and short bills. Most species are sexually dimorphic, the females being duller and more difficult to identify. Juveniles and most species show pale or bright orange bills. Order Passeriformes we found one species of this family that is

Scarlet-backed flowerpecker *(Dicaeum cruentatum)*

These birds sexually dimorphic, the male has navy blue upperparts with a bright red streak down its back from its crown to its tail coverts, while the female and juvenile are predominantly olive green. We found it in the garden area and agricultural area. Very common resident.

Family Campephagidae

The cuckoo shrikes and allies in the family Campephagidae. Arboreal birds with medium to long, rather pointed wings and longish, somewhat graduate tails, strong bills, and short legs. Feed chiefly on insects and builds shallow, cup shaped nests often in forks of exposed branches of the tree. Order Passeriformes. We found one species of this family that is

Small Minivet *(Pericrocotus cinnamomeus)*

The small minivet is a small passerine bird. Males have a slaty gray crown, cheeks, and back. Throat and wings black, tail black with pale yellow edges. Breast orange, gradually fading into yellowish-white underparts. Black wings show a patch of orange. Female is duller than male, with light gray upperparts, cheeks, and crown;

dark gray wings; white throat; and light-yellow underparts. Common resident birds, we found open areas, garden.

Family Pycnonotidae

Medium sized arboreal birds with soft plumage frequently crested. Very vocal, most have pleasant songs and harsher calls. Feed to a great extent upon fruit and several species can often be found together in fruiting trees. Order Passeriformes. We found one species of this family that is

Streak-eared Bulbul *(Pycnonotus conradi)*

The streak-eared bulbul is a dull brown bulbul with paler underparts and gray streaking behind the ear. Burmese birds are substantially browner than populations in other parts of Southeast Asia, which have olive-tinged wings and a pale-yellow vent. We found it in an agricultural area, parks, and gardens.

Family Sturnidae

Stocky, medium sized birds with strong bills and legs and relatively short tails. Strong direct flight on pointed wings, or broader, more rounded wings. Feed on fruits and insects. Order Passeriformes we found one species of this family that is

White-vented Myna *(Acridotheres grandis)*

The white-vented myna is mainly black. The wings are brownish-black, and the primaries have white bases. The under tail-coverts are white. There is a short crest on the forehead. The beak legs and feet are yellow. The eyes are lemon-yellow. The immature is browner. We found it in agricultural and other cultivated areas, parks, gardens, and human habitation. Very common resident.

Family Pycnonotidae

Medium-sized arboreal birds with soft plumage frequently crested. Very vocal, most have pleasant songs and harsher calls. Feed to a great extent upon fruit and several species can often be found together in fruiting trees. Order Passeriformes we found one species of this family that is

Yellow-vented Bulbul *(Pycnonotus goiavier)*

The yellow-vented bulbul is brown above and whitish below with a bright yellow vent and a thick black line between the bill and the eye. The front edge of the weak, slightly peaked crest is also dark. We found it in an agricultural area, garden, and human settlements. Common resident.

Family Oriolidae

Robust arboreal birds with colorful plumage. Swift, slightly undulating flight. Usually seen in single pairs. All species have similar, mellow and fluty songs. The

phrases of which are highly variable. Feed on fruit and insects. Order Passerine we found one species of this family that is

Black-naped Oriole *(Oriolus chinensis)*

The black-naped oriole typical yellow and black Old-World oriole. Male entirely golden-yellow apart from black wings and tail and a broad black band through the eyes. The tail and wings have yellow tips. The bill is deep pinkish. Female similar to the male but with more yellowish-green upper parts. Juveniles show streaked underparts. We found in evergreen areas, gardens, and agricultural areas.

Family Rhipiduridae

Have long broad tails, often held cocked and fanned, and short rounded wings. Inhabit undergrowth and middle storey and often found among bird waves. Sexes similar. Order Rhipiduridae we found one species of this family that is

Malaysian pied fantail ***(****Rhipidura javanica)*

The Malaysian pied fantail is a species of bird in the fantail family. Dark above and white below; note slender white eyebrows, black chest band, and white-tipped black tail. A combination of all-white belly and plain back separates this species from similar dark fantails within its range. We found it in wetlands, gardens, lotus ponds, usually close to water. Very common resident.

Family Ardeidae

Long-legged long-necked wading birds with dagger like bills. Fly slowly with regular wingbeats, on broad, rounded wings, head and neck held folded close to body and legs trailing. Many utter harsh, deep croaking notes. Order Pelecaniformes we found three species of this family these are

Chinese pond heron *(Ardeola bacchus)*

The Chinese pond heron is a comparatively short necked and compact heron that shows white wings contrasting with dark mantel in flight with legs projecting only a short way beyond the tail, brownish with buffy, dark streaked head, neck and, breast dark chestnut-maroon head, neck and breast and blackish back. Facial skin yellow green legs may be flushed red. We found in open areas, usually near water, paddy fields, household area. Common resident

Little egret *(Egretta garzetta)*

This bird depending on the environment it will migrate to warmer places over winter Black bill. Lores yellow, yellow-orange, or reddish during the onset of breeding, otherwise greyish. Adults and juveniles lack head, breast, and back plumes.

Breeds and roosts colonially. We found in the wetland area, rice fields. Common resident.

Yellow bittern *(Ixobrychus sinensis)*

The yellow bitten is a small species with a short neck and longish bill. The male is uniformly dull yellow above and buff below. The head and neck are chestnuts, with a black crown. The female's crown, neck, and breast are streaked brown, and the juvenile is like the female but heavily streaked brown below, and mottled with buff above. The Yellow Bittern occurs in fresh water marshes and swamps, shrubs, or other dense vegetation around paddy fields, agricultural areas. Very common resident.

Family Megalaimidae

Heavy bodied birds with large heads and stout bills. The body plumage is usually green but has distinctive colored facial patches. Slow-moving mainly frequent the canopy and can often be difficult to see. Order Piciformes we found one species of this family that is

Copersmith barbet *(Psilopogon haemacephalus)*

The coppersmith barbet is green with a redhead, yellow cheeks, and a yellow throat. Its underparts are streaked in grey and black. During the nesting season, the wear and tear on the feathers can cause the plumage of the upper back to appear bluish. We found it in the garden, park, and agricultural areas. Very common resident.

Family Phalacrocoracidae

Large blackish aquatic birds with webbed feet and strong hook tipped bills. Bill often held slanted upwards when swimming on the surface, dive beneath surface for fish. Strong and direct flight on short broad wings, neck held outstretched. Order Suliformes we found one species of this family that is

Little cormorant, Javanese cormorant *(Microcarbo niger)*

The little cormorant is slightly smaller than the Indian cormorant with a distinctive short bill, and a comparatively short neck with a heavy jewel. The adult bird has a glistening all black plumage with some white spots and filoplumes on the face. There is also a short crest on the back of the head. The eyes, gular skin and face are dark. We found in wetlands, canals, and agricultural areas. Common resident.

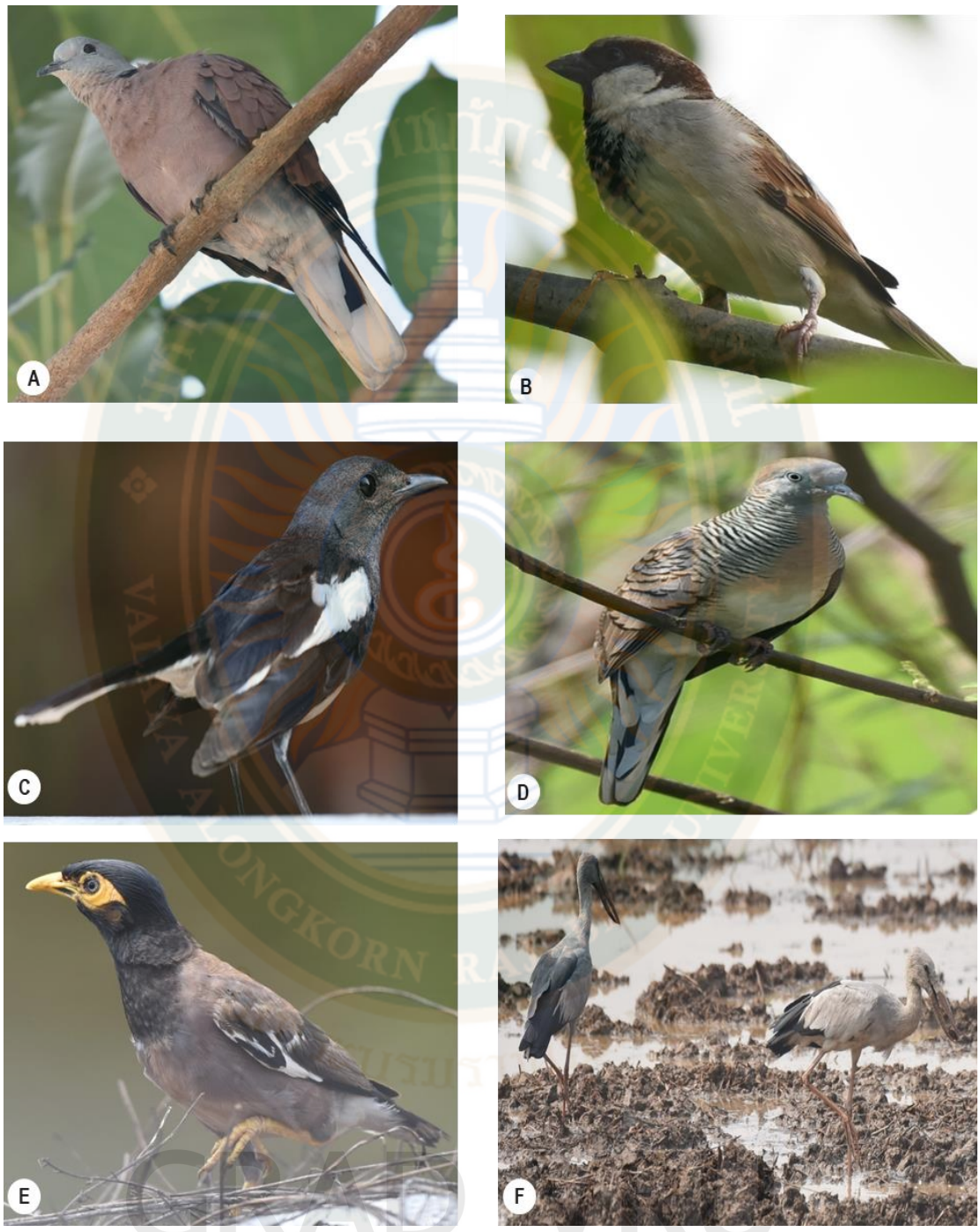

Figure 14 Bird species at the VRU. A. *Streptopelia tranquebarica*, B. *Passer montanus*, C. *Copsychus saularis*, D. *Sturnus contra*, E. *Passer montanus,* F. *Sturnus contra*

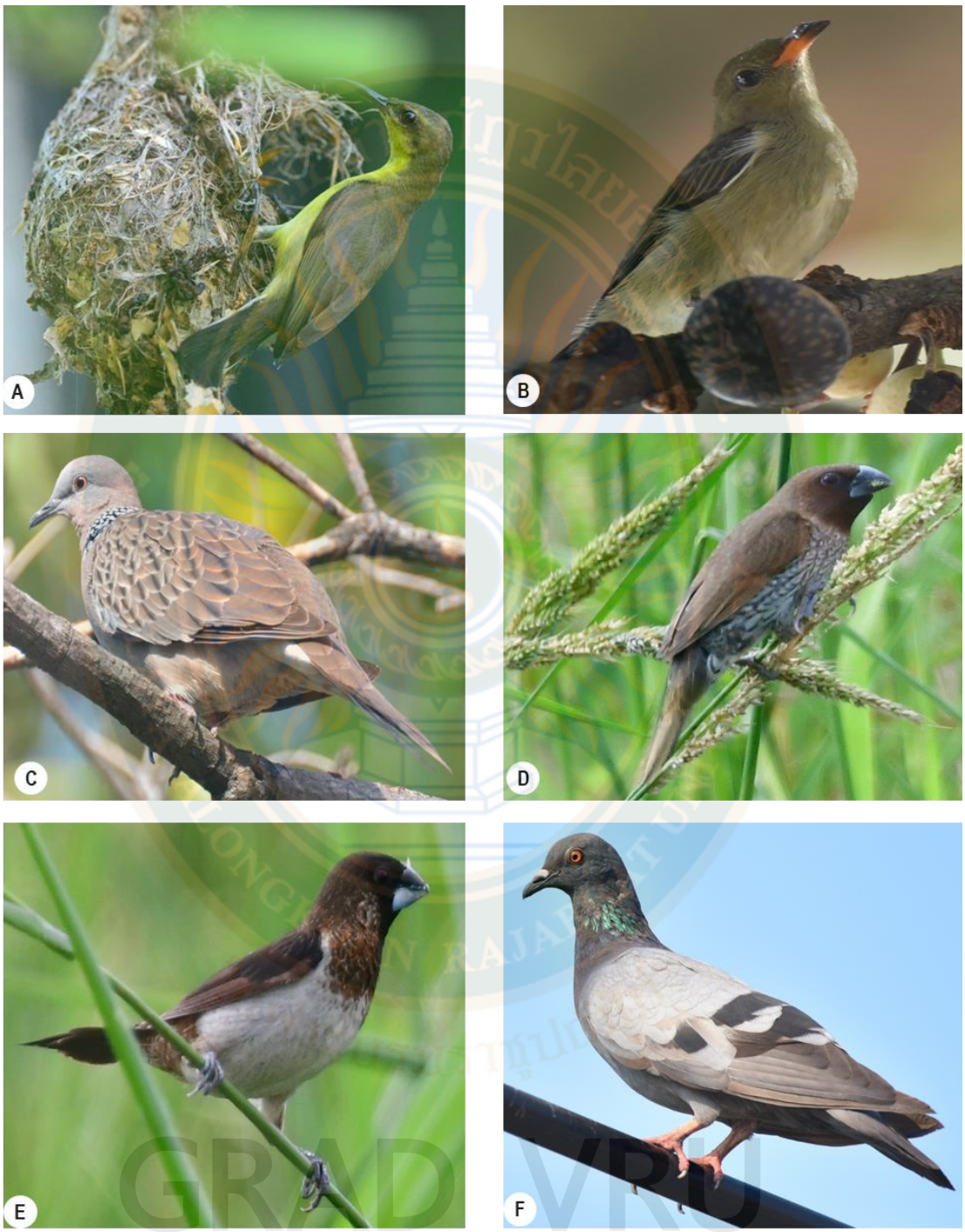

Figure 15 Bird species at the VRU. A. *Cinnyris jugularis*, B. *Dicaeum cruentatum*, C. *Streptopelia chinensis*, D. *Lonchura punctulata*, E. *Lonchura striata*, F. *Columba livia.*

Figure 16 Bird species at the VRU. A. *Rhipidura javanica,* B. *Lanius cristatus,* C. *Psilopogon haemacephalus,* D. *Hirundo rustica,* E. *Ixobrychus sinensis,* F. *Artamus fuscus.*

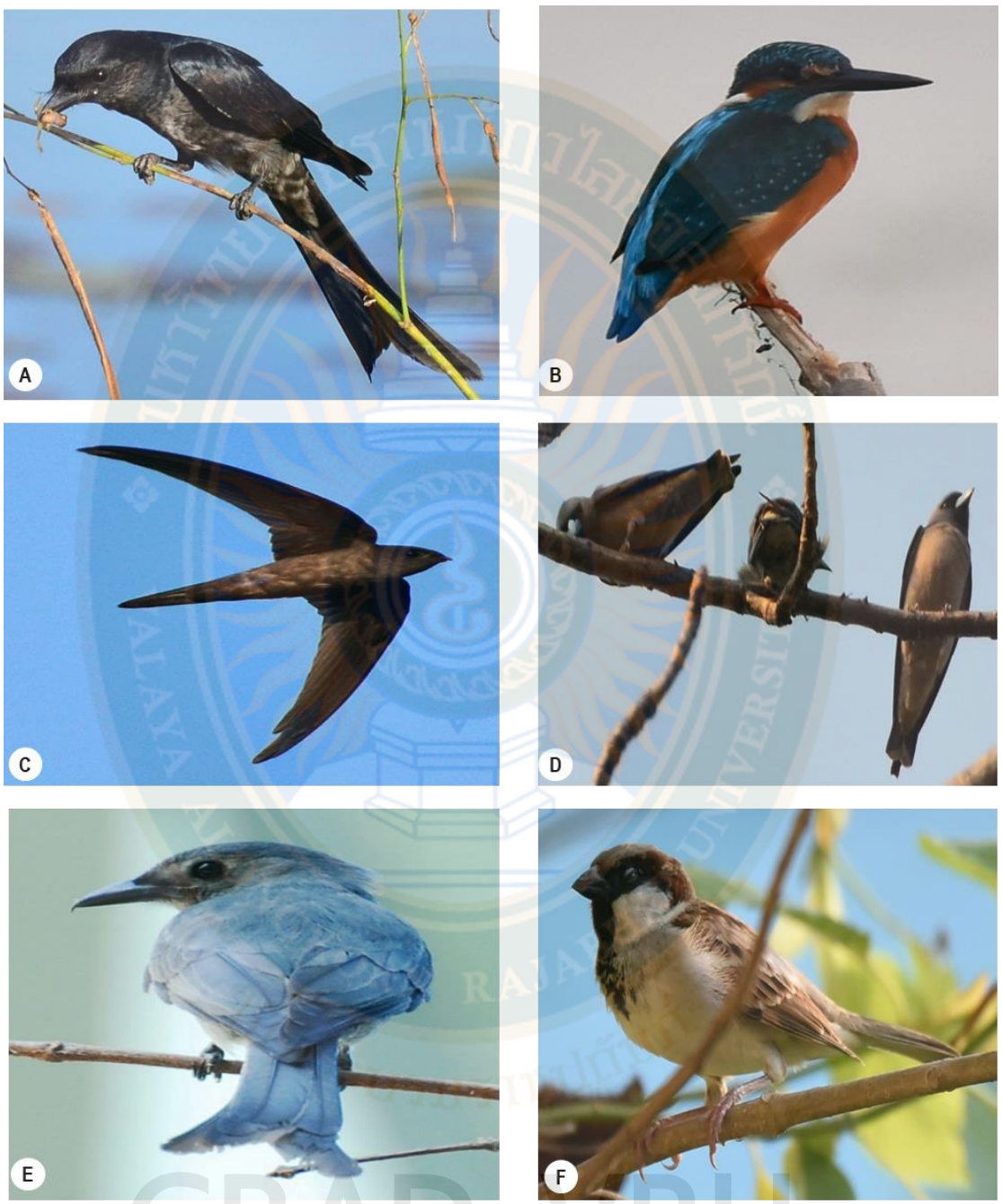

Figure 17 Bird species at the VRU. A. *Dicrurus macrocercus,* B. *Halcyon pileata,* C. *Cypsiurus balasiensis,* D. *Artamus fuscus,* E. *Dicrurus leucophaeus* F. *Passer domesticus.*

Figure 18 Bird species at the VRU. A. *Halcyon pileata,* B. *Ploceus hypoxanthus,* C. *Pycnonotus goiavier,* D. *Halcyon pileata,* E. *Mycteria leucocephala*, F. *Dendrocygna javanic*

Figure 19 Bird species at the VRU. A. *Sturnus contra,* B. *Microcarbo niger,* C *Amaurornis phoenicurus,* D. *Ardeola bacchus,* E. *Merops Orientalis.*

4.2.3. The Frequency of Occurrence (F)

Frequency of occurrence (F) was used to evaluate the bird status in the VRU, classifying birds as uncommon species, common species, and dominant species. Nine bird species - *Columba livia* (100%), *Copsychussaularis* (100%), *Passer montanus* (100%), *Pycnonotusblanfordi* (100%), *Acridotheres grandis* (100%), *Acridotheres tristis* (100%), *Ardeolabacchus* (100%), *Streptopeliatranquebarica* (89%) and *GeopeliaStriata* (83%) - were classified as common species in the VRU with > 80 % of the F. There are differences in the proportion of the bird groups found in each study area. Natural wetland had a larger value of uncommon and dominant species with 39 % and 36 % respectively and 25 % was recorded for common species. Interestingly, few values of the uncommon species were found in the NW and the AA (Figure 20).

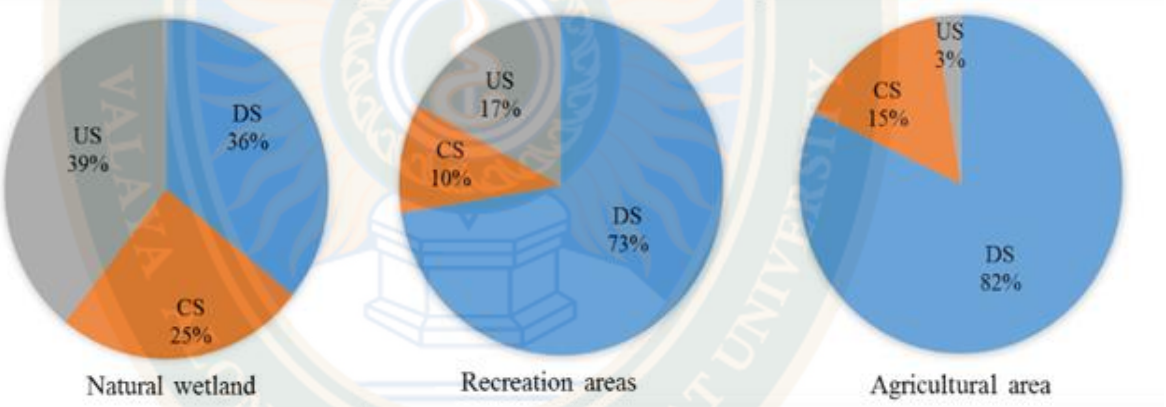

Figure 20 The proportion of three bird species groups - uncommon species (US), common species (CS) and dominant species (DS) - found in each study areas

The study area has fruiting trees and wetlands and is rich in the diversity and abundance of insects, which provide food to a variety of bird species. Seasonal and perennial fruit-bearing trees, plants, and rice fields. Some species of birds were observed in residential areas.

4.3 Squirrels diversity and their habitat in VRU

Our study result showed that the area is rich in the user environment. A total of 4 subspecies of *Callosciurus finlaysonii* were found in the VRU. Here is the list

Finlayson's squirrel *Callosciurus finlaysonii* (Thomas Horsfield, 1823)

Order: Rodentia Family: Sciuridae

Finlayson's squirrel or the variable squirrel is a species of rodent in the family Sciuridae. *C. finlaysonii* is native to Cambodia, Laos, Myanmar, Thailand, and Vietnam. The subspecies *C. f. floweri*, which is adapted to urban parks and gardens around Bangkok has been introduced in the Serangoon area of Singapore. *C. finlaysonii* habitat preferences aside from broad descriptions that link the species to a wide range of forest habitats, such as open woods, coconut plantations, and dense forest. *C. finlaysonii* eats *Canarium euphyllum* fruits and seeds, and is a short distance seed disperser for Aglaia spectabilis in moist evergreen forests in Thailand (https://www.cabi.org/isc/datasheet/91203 Boonkhaw et al. 2017).

Subspecies of Callosciurus finloysonii

Callosciurus finloysonii cinamomeus

C. f. cinnamomeus is a sub-specie of Callosciurus finlaysonii. This species occurs in a wide range of wooded habitats, including gardens and parks in cities. *C. f. cinnamomeus* is overall reddish with a dark mid-back (https://www.cabi.org/isc/datasheet/91203 Boonkhaw et al. 2017).

Callosciurus finlaysonii bocourti

This species is a wide range of forest habitats, such as open woods, coconut plantations, gardens, and dense forest areas. *C. f. bocourti* is whitish below with highly variable color of the upperparts whitish, grey, blackish, olive-brownish, or reddish (https://www.cabi.org/isc/datasheet/91203 Boonkhaw et al. 2017).

Callosciurus finlaysonii floweri

The subspecies *C. f. floweri*, which is adapted to urban parks and gardens and city parks. This Squirrels with various pelage colors. However, this subspecies was included as *C. f. bocourti* (https://www.cabi.org/isc/datasheet/91200).

Pallas's squirrel *Callosciurus erythraeus* (Pallas, 1779)

Order: Rodentia Family: Sciuridae

Pallas's squirrel *Callosciurus erythraeus*, also known as the red-bellied tree squirrel, is a species of squirrel native to Greater China, India, and Southeast Asia. *C. erythraeus* occurs naturally in north-eastern India, Myanmar, Thailand, peninsular Malaysia, Indochina, southern China, and Taiwan. Pallas's squirrel is a medium-sized tree squirrel, both sexes are of similar size and appearance *C. erythraeus* is found in various types of wooded habitat like a natural forest, conifer plantations, orchards, bushes, and city parks. But it prefers mixed-species broad-leaved evergreen forests (https://www.cabi.org/isc/datasheet/91200).

Figure 21 Squirrel sub-species of VRU A. *Callosciurus erythraeus,* B. *Callosciurus finlaysonii bocourti,* C. *Callosciurus finlaysonii cinnamomeus,* D. *Callosciurus finlaysonii floweri.*

CHAPTER 5
CONCLUSION

5.1 Discussion

According to the findings of the research, the environment of the campus was suitable for both studied species. We studied that three habitats in the VRU, in these areas provide various recreational services, ecosystem services. In general, people get the benefit of an ecosystem as well as maintaining biodiversity. The study result indicated the prevalence of large bird diversity in the AA. This may be due to the AA in this study representing the cultivating area of various food sources such as floral plants, banana, rice seed, papaya, and being is a habitat for the birds due to the use of organic farming systems, with s small pond and canals with insects, fish, small rodents, amphibians, and reptiles. The agricultural area does not use chemical for pesticides and inorganic fertilizers, therefore bird survived and species richness and abundance is higher. Thus, the presence of abundant food resources and habitat complex, with various microhabitats might be the determining factor for the relatively high diversity in the AA, especially since the birds' feeder group being dominant in the area comprises Insectivorous, Nectarous, and frugivorous birds (Figure 22).

Figure 22 Bee nest in an agricultural area

Organic farming balanced ecosystem, insect pest, and disease problems. Birds are indicators of the ecosystem and providing important benefits such as pest control, pollination, and seed dispersal. Farmers can take advantage and at the same time provide birds with habitat. The study area has a vast diversity of trees, which

provide food to a variety of bird species. Therefore, different habitats areas attract and support a variety of bird species. For example, Asian golden weaver (Figure 23 A) and (Figure 23 B) Painted stork

Figure 23 Bird habitat (A) Asian golden weaver (B) Painted stork in agricultural area

We survey household areas and found many birds come to eat their food as well as squirrels in the household area (Figure 24). People in the residential areas are encouraging behavior and they feed birds and squirrels. This university provides good habitats for the bird and squirrels and no more people attract them. For example, humans provide supplementary resources in university areas through feeding and habitat. Humans don't disturb them therefore they don't scare to live here. Here also we don't find natural predators.

Figure 24 Bird habitat in household areas

People can easily see and observe the local birds and squirrels, and enjoy the scenic beauty. Morning and evening time is the best for watching birds and squirrels. The result highlighted most of the bird species from the order pelecaniformes. The result of this study concurs with the findings of Miller et al. (2003) concluded that human-disturbed areas provide different habitats which attract human-tolerant bird species. Higher abundance per species count and density in the settlement could have had been contributed by bird and squirrel species that can coexist with humans such as House Sparrow *(Passer domesticus)*, Spotted dove *(Streptopelia chinensis)*, Rock pigeon *(Streptopelia tranquebarica),* and Common myna *(Acridotheres tristis)*. Other studies elsewhere in human settlements (Jokimaki and Suhonen, 1998) also found similar results and concluded that higher abundance in the settlement by habitat heterogeneity such as buildings, trees, and gardens.

Natural Wetland habitat with less human disturbance. Lotus pond is important for water bird habitats, this site birds use for their breeding, nesting, and rearing. Also, they use as a source of food, drinking water, resting, and shelter. In the lotus pond, we found endemic species or water birds usually the water bird is so weak, on the conditions of their habitats disturb by human must and they might not survive because they lost food habitats and also nesting sites. VRU lotus pond undisturbed by human, therefore bird stay here. The surrounding area has big trees therefore, the birds and squirrels get their shelter and food from the trees. The

places are very much eco-friendly. This area has a freshwater ecosystem and more varieties of water plant species. The natural condition of the natural wetland area is very good. This place might be good for making the station for bird watching because this area has high ecological potential. For example, the seed of lotus flower, leaves, and parts of underground steam is used to make medicine, tea, and much more product. Lotus pond birds provide us nature's most wonderful sights from vast flocks wheeling overhead to newly hatched chicks dying in sun and their nesting site (Figure 25).

Figure 25 Natural wetland area of the study site

In general, a habitat and food source can determine bird diversity, as suggested by Johnson (2001) Mansor et al. (2012) Peh et al. (2006) and Tu et al. (2018). This observation revealed that bird diversity is different among habitats in green space area in the urban ecosystem, which might correspond to the human disturbance environment (e.g., building area, small park, rural area, road, organic farming areas, and pond) to the natural environment (i.e., lotus pond) (Gatesire et al., 2014; Kiros et al., 2018).

The distribution and abundance of many bird species are determined by the compositions of the vegetation that form a major element of their habitat. The study area VRU campus with green vegetation, plantation, garden, rice field, wetland, residential area, structurally provides a complex landscape and that support a high diversity of bird species (Figure 26)

Figure 26 Bird enjoying with their food

The agricultural area is most important in promoting bird species richness and we found this information used to make recommendations for the management of these areas. Mayorga et al. (2020) reported that bird abundance and species richness were higher in a larger garden. Bird abundance differed in urban areas by providing food and nesting habitat. Although urban areas were important for the composition and trait distribution of birds, and promote bird species richness, or abundance of functionally important birds in gardens. (Kiros et al., 2018).

The distribution and abundance of squirrel's species are determined by the compositions of the vegetation that form a major element of their habitat. The surrounding natural habitat is currently the majority of conservation efforts to make the green university. This study indicates the importance of protecting not only the natural habitats but also the university ecosystem where squirrels in particular are more commonly existing. In observation time our study found four species of squirrels. This area has a variety of food sources for squirrels (Figure 27).

Figure 27 Habitat area of squirrels

According to Tobias et al. (2013) and Tanalgo et al. (2015) the distribution patterns of bird species normally follow the spatial structure of the environment and habitat requirement of the bird species. It is important to study bird and squirrel diversity on the university campus to help to monitor and conserve the biological diversity of the green vegetation. This study provided information about the diversity and structure of bird and squirrel communities in a different landscape, and the result suggests that the availability of diverse food sources, foraging and roosting sites are essential factors for the diversity and abundance of bird and squirrels species in certain habitat types. In a similar case in Northern Rwanda, (Gatesire et al., 2014) concluded that the significant effect of city landscape on bird richness and relative abundance, residential area, playground, and informal settlements are highest species diversity in comparison to other landscape types. It is necessary to address the impact of human activities that have increase extinctions and continue to threaten the bird population. Conservation of birds in fragments of habitats is increasingly important due to the diverse uses of the environment. Understanding the population is important for taking proper conservation measures for any species (Ogunsusi & Adeleke, 2017).

The results relating to the status of birds in the VRU can support the idea of birds tolerating human intrusions into the habitat. The larger portion of dominant bird species was found in the AA (82%) and the RA (73%), which comprised birds that can be found throughout the year. Thus, the daily activity of humans has possibly no influence on the presence of birds in the AA and the RA, even of migrated species. In summary, the bird species dominant in the study area were generalist species and

belonging to Insectivorous, Nectarous, and frugivorous groups, while a few species were special species such as water birds, bee-hunting birds, etc. The hypothesis of some that bird species inhabit open field's more than built-up areas, was not supported in this study. This may be since some built-up areas, including institutional grounds and residences, were specifically designed with plant communities to attract birds. Alternatively, some micro-landscapes within open fields have a low number of species such as NW, which is a wetland habitat and does not facilitate airplane landing. This habitat offers little food and is unsuitable habitat for most bird species (Gatesire et al., 2014).

5.2 Conclusion and recommendation

Valya Alongkorn Rajabhat University campus supports a rich diversity of birds and squirrels. My study was to explore and evaluate the bird and squirrel species on the VRU campus. The purpose of this research was to identify and evaluate the birds and squirrel species and investigate the structural diversity for monitoring, distribution, and abundance of the diversity of birds and squirrels. The study is based on a quantitative and qualitative analysis of collected data and observation. The results included the potential benefits of birds and squirrels for supporting eco-tourism activity in VRU campus, for example, bird watching program.

In the introduction part, we discussed the human-environment interaction in the urban ecosystem. Urban ecology is imperative to maintaining ecological balance and protecting living organisms. The increase in environmental pollution has contributed to the decrease in aquatic wildlife as well as other living organisms. All urban areas are essentially dependent on surrounding ecosystems to provide them with necessary resources. Based on the result we studied structural diversity in three habitat areas in VRU these are natural wetland, agriculture areas, and recreation zone.

This research has clearly shown that bird species diversity was higher in the agricultural area than in the other areas. The higher diversity suggests higher ecological stability compared to human-disturbed habitats where few species occur. Although many of the birds were insectivores, food competition was reduced by the utilization of different habitat types, feeding behaviour, and food items. During harvesting time lots of insects, particularly during winter, insectivore birds were observed feeding on fruits and seeds, thus reducing the extent of food competition. The diversity of birds in the VRU might be possibly influenced by the land use by humans and the kind of food and nest establish for the bird. Thus, the conservation

of the diversity of birds and their food sources such as insects, amphibians, and reptiles should be done on a broader scale at the VRU. The pattern presenting bird diversity in the VRU, in general, follows the natural condition of green area space in the VRU. Typical characteristics of birds, their habitat, and appearing period can develop bird watching objects, which become interesting attractions for travellers and nature enthusiasts in ecotourism development and efforts to conserve bird diversity. The study also confirmed that farmers don't use pesticides in agricultural areas. Agricultural birds are indicators of the quality of the farmed environment and are well monitored.

Callaghan et al. (2018) reported that all areas of green space are the most important predictors of bird biodiversity, underlining the critical importance of habitat area for increasing bird biodiversity and mitigating loss from urbanization. Landscape-scale habitat predictors are less related to bird biodiversity than local-scale habitat predictors. Eventually, bird biodiversity loss could be mitigated by protecting and developing large green spaces with varied habitats in the world's cities. The study describes in the current paper benefits, who visit the area to observe the birds, ecologists, students, visitors in general. Their benefits can be grouped in

- Understanding the relationship between the human and nature and their interaction.
- Environmental education and research
- Documentation of rare species

The result should be applicable for the further study also the findings have a potential for other activities. To better understand the implications of these results, future studies could provide effective economic intensive for conserving and enhancing biodiversity. Natural resources can be utilized as a specialized tool for developing biodiversity. Expending the potential ecotourism program to attract people to VRU by evaluating the structural diversity based on bird and squirrel diversity. VRU campus supports a rich diversity of birds and squirrels. Our study provides structural habitat for monitoring the diversity of bird species on the campus.

VRU has to serve good habitat for the bird and squirrel community. The observation in the present study is quite important as it highlights the importance of the VRU campus as preferred habitat for birds and squirrels. It emphasizes the importance of the VRU campus in maintaining the bird biodiversity of the area.

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