ASSESSMENT OF BIRD DIVERSITY, FEEDING GUILD AND AVITOURISM POTENTIAL IN PULAU TINGGI MARINE PARK, MERSING, JOHOR, MALAYSIA.

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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ABSTRACT

Small islands are known for their fundamental role in providing vital pitstop for migratory birds. Moreover, island birds are important models for Island Biogeography Theory. However, research on birds on Malaysian islands are lacking whereas most research mainly concentrated on marine lives. Thus, a study was conducted in Pulau Tinggi Marine Park (2°18'N; 104°07'E) from March to August 2019 to fill this knowledge gap by fulfilling three objectives which are (i) to determine the bird diversity and relative abundance, (ii) to investigate the feeding guild of the birds in selected macrohabitat and (iii) to assess the potential of avitourism in Pulau Tinggi, Mersing, Johor. Three field methods were applied including mist-netting, direct observation, and camera trapping. Birding hotspots and important bird species according to the seven criteria of good nature tourism product were determined. At the same time, sets of questionnaires were distributed to the target informants to see the potential of having avitourism in Pulau Tinggi. A total of 43 bird species belonging to 24 families were recorded. Among these, 32 species were residents, four species were residents' migrants and seven were migrants. In terms of conservation status, three species were listed as Near Threatened under International Union for Conservation of Nature (IUCN) Red List of Threatened Species. They were Grey-headed Fish Eagle (*Haliaeetus ichthyaetus*), Nicobar Pigeon (*Caloenas nicobarica*) and White-chested Babbler (*Trichastoma rostratum*). Nicobar Pigeon was found endemic to small forested islands. Bird diversity in Pulau Tinggi is also high with Shannon Weiner Index of 2.49. Result shows that coastal area is higher in bird richness with Margalef richness index value of H=2.25 compared to forest area with value of H=1.93. However, birds in the forest area were more evenly distributed with evenness index value of 0.58 over coastal with value of 0.38. Seven feeding guilds were successfully identified including carnivore, insectivore, frugivore, omnivore, carnivore-insectivore, frugivore-insectivore and granivore. The forest zone was mostly occupied by insectivore and frugivore while coastal zone was dominated by carnivore. Besides, there is also

significant correlation between bill size and food size/diet preference (R=0.623, p=0.01). For avitourism prospect, six birding hotspots representing different macrohabitats were identified. Each macrohabitat supports different bird composition which highly influenced by different vegetation and food availability in the ecosystem. In addition, several birds were complied with the seven criteria of good nature tourism product. To conclude, documentation on bird diversity from this survey with birding hotspots recognision will become the baseline data for implementing avitourism in Pulau Tinggi. By accommodating high species richness and migratory species, beside the existance of an island endemic, these will be enough justification for protection and conservation of avian community in Pulau Tinggi. Above all, these components attract avitours with supplementary point on species that complied with good nature tourism product. Thus, Pulau Tinggi has a potential to be lifted as an avitourism site in the near future with a proper management plan.

ABSTRAK

Kepulauan kecil dikenali sebagai kawasan persinggahan yang penting kepada spesis burung. Di samping itu, burung memainkan peranan sebagai model kepada teori biogeografi pulau. Namun begitu, kajian berdasarkan burung di kepulauan Malaysia masih kurang di mana kajian tertumpu terutamanya terhadap hidupan laut. Justeru itu, sebuah kajian telah dijalankan di Taman Laut Pulau Tinggi (2°18'N; 104°07'E) dari bulan Mac sehingga Ogos 2019 bagi mengisi jurang ilmu dengan mencapai tiga objektif utama, (i) untuk menentukan kepelbagaian dan kelimpahan relatif komposisi burung, (ii) untuk mengkaji ekologi kumpulan pemakanan burung di habitat makro terpilih dan (iii) untuk mengkaji potensi perlaksanaan pelancongan burung di Pulau Tinggi, Mersing, Johor. Tiga kaedah utama merekod burung digunakan iaitu penangkapan menggunakan jaring kabut, pemerhatian secara langsung dan jebakan kamera. Dari data tersebut, kawasan titik tumpuan pemerhatian burung dan spesis burung penting di kawasan Pulau Tinggi mengikut kriteria produk pelancongan alam semulajadi yang baik telah ditentukan. Pada masa yang sama, borang soal selidik telah diedarkan kepada kumpulan pemberi maklumat sasaran untuk melihat potensi perlaksanaaan pelancongan burung di Pulau Tinggi. Sebanyak 43 spesies burung yang tersenarai di bawah 24 keluarga telah direkodkan. Di antaranya, 32 spesies adalah bermastautin, empat spesis permastautin migrasi dan tujuh spesis migran. Dari segi status pemuliharaan, hanya tiga spesis yang tersenarai sebagai Terancam di bawah senarai merah IUCN bagi spesis yang terancam. Mereka adalah Helang Kanguk Besar (*Haliaeetus ichthyaetus*), Punai Emas (*Caloenas nicobarica*) dan Kekicau Dada Putih (*Trichastoma rostratum*). Punai Emas dijumpai andemik kepada kepulauan hutan kecil. Kepelbagaian burung di Pulau Tinggi juga tinggi dengan nilai Indeks Shannon Weiner yang diperoleh sebanyak 2.49. Kawasan pantai lebih kaya dengan species dengan nilai skor H = 2.25 berbanding dengan kawasan hutan dengan nilai skor H = 1.93. Walau bagaimanapun, taburan burung di kawasan hutan lebih sama rata dengan nilai indeks iaitu 0.58 melebihi kawasan pantai dengan nilai 0.38. Disamping itu, tujuh

kumpulan makanan berjaya dikenal pasti termasuk karnivor, insektivor, frugivor, karnivor-insektovor, frugivor-insectivor dan omnivor. Zon hutan dipenuhi terutamanya insektivor and frugivor manakala zon pantai dikuasai karnivor. Zon hutan diduduki sebahagian besarnya dengan kumpulan burung insectivor dan frugivor manakala zon pantai dikuasai dengan karnivor. Disamping itu, terdapat korelasi yang signifikan di antara saiz paruh dan saiz makanan / keutamaan diet (R = 0.623, p = 0.01). Manakala di bawah prospek pelancongan burung, enam kawasan titik tumpuan burung telah dikenalpasti mewakili setiap habitat makro. Setiap habitat makro mempunyai komposisi burung yang berbeza dipengaruhi oleh tumbuhan dan sumber makanan yang berbeza di ekosistem berkenaan. Di samping itu, beberapa burung telah memenuhi tujuh kriteria produk pelancongan alam semula jadi yang baik. Sebagai kesimpulan, dokumentasi kepelbagaian burung dari tinjauan ini dengan pengenalpastian kawasan tumpuan melihat burung akan menjadi data asas bagi memacu pelaksanaan pelancongan burung di Pulau Tinggi. Dengan menampung dalam jumlah yang tinggi bagi kekayaan spesis burung dan komuniti migrasi, di samping kewujudan satu spesis endemik pulau, ini akan menjadi alasan yang cukup untuk perlindungan dan pemuliharaan komuniti burung di Pulau Tinggi. Utamanya, komponen-komponen ini akan menjadi daya tarikan untuk lawatan pelancongan burung dengan titik tambahan bagi spesis yang tersenarai di bawah produk pelancongan alam yang baik. Oleh itu, Pulau Tinggi berpotensi untuk diangkat sebagai kawasan pelancongan burung dalam waktu terdekat dengan rancangan pengurusan yang tepat.

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LIST OF ABBREVIATIONS

Car-Ins	-	Carnivores-Insectivores
CFS	-	Central Forest Spine
DWNP	-	Department of Wildlife and National Park
EBAs	-	Endemic Bird Areas
EJIA	-	East Johor Island Archipelagos
FR	-	Forest Reserve
Fru-Ins	-	Frugivores-Insectivores
IBAs	-	Important Bird Areas
IUCN	-	International Union for the Conservation of Nature
JPNC	-	Johor National Parks Corporation
LC	-	Least Concern
MPAs	-	Marine Protected Areas
NFP 1992	-	National Forestry Policy 1992
NFA 1984	-	National Forestry Act 1984
NP	-	National Park
NT	-	Near Threatened
PhD	-	Doctor of Philosophy
PSPC	-	Perak State Parks Corporation
SA	-	Secondary Area
SFD	-	State Forestry Department
STPM	-	Sijil Tinggi Pendidikan Malaysia
TPAs	-	Totally Protected Areas
WR	-	Wildlife Reserve
WTO	-	World Tourism Organization
WWF	-	World Wildlife Fund for Nature
WZO	-	World Zoo Organization

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Journals:

(i) Mokhter, N., Akhsan, M. A., Amran, M. A., Jien, L. T., Abdul-Latiff, M. A. B. & Norazlimi, N. (2020). Bird composition in forest and coastal zones in Pulau Tinggi, Mersing, Johor. *Journal of Sustainability Science and Management* (submitted for publication).

(ii) Mokhter, N., Akhsan, M. A., Amran, M. A., Jien, L. T., Abdul-Latiff, M. A. B. & Norazlimi, N. (2020). Feeding ecology of birds in selected macrohabitat in Pulau Tinggi, Mersing, Johor. *Journal of Sustainability Science and Management* (submitted for publication).

(iii) Mokhter, N., Akhsan, M. A., Amran, M. A., Jien, L. T., Abdul-Latiff, M. A. B. & Norazlimi, N. (2020). Birding hotspot and important bird species as tools to promote avitourism in Pulau Tinggi, Mersing, Johor. *Journal of Sustainability Science and Management* (submitted for publication).

Proceedings:

(i) Normaisharah, M & Norazlimi, N. (2019). Review on avian diversity in Johor state, Malaysia. In *IOP Conf. Series: Earth and Environmental Science.* (Vol.269, p. 012038). IOP Publishing.

CHAPTER 1

INTRODUCTION

1.1 Research background

Birds are warm-blooded vertebrate under the class Aves, characterized by feathers, toothless beaked jaw, egg-laying ability, high metabolic rate and a strong yet lightweight skeleton (Attenborough, 1998). Most birds can fly and this differentiates them from other vertebrates. Flight is the primary locomotion means for foraging, migrating and escaping from predators. Among adaptations owned by birds to support flight includes lightweight skeleton, two large flight muscle, the pectoralis and the supracoracoideus, as well as modified forelimbs that serves as an aerofoil (Frank, 1995).

Most birds are diurnal, but some, such as from the group of owl and nightjar, are nocturnal or crepuscular (active during twilight hours), and many coastal waders feed when tides are appropriate, by day or night (Robert, McNeil & Leduc, 1989). Birds are social, communicating with visual signals, calls and songs during breeding, hunting, flocking and mobbing of predators. In breeding, 95% of birds are monogamous (one male for one female) usually for one breeding season at a time, sometimes for years, but rarely for life (Freed, 1987). On the other hand, some species are polygamous (one male with many females) and rarely polyandrous (one female with many males) (Frank, 1995). During the breeding season, many birds actively defend their territory from others of the same species, protecting their food source for chicks. However, some families undergo colonial breeding such as seabirds and swifts, to defend nesting from predators, hence, competition between species for nesting sites can be intense. (Koko, Haris & Wanless, 2004)

Birds live and breed in most terrestrial habitat and all seven continents. The highest bird diversity occurs in tropical regions. Previously, this high diversity was the result of a higher speciation rate in the tropics. Nevertheless, a recent study found higher speciation rates in the high latitudes resulting in higher extinction rates than in tropics (Weir & Schluter, 2007).

The tropical rainforest in Southeast Asia is one of the world's most abundant forests (Myers *et al.*, 2000). Malaysia lies in this region, consisting of a high number of bird species despite its small size, with a total count of 785 species of birds belonging to 97 families. 670 species occur in Peninsular Malaysia (Wan Ahmad, Ahmad & Mohammad, 2018) while Borneo Malaysia recorded 673 species (Phillipps & Phillipps, 2014). From all the species in Malaysia, 168 species are migrants, 80 species are vagrant, and 51 species are regionally endemic birds. Unfortunately, 60% of the Malaysia birds on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species have declined dramatically as a result of agricultural land expansion (Johnson *et al.*, 2011) as well as deforestation and anthropogenic activities (Nor Hashim & Ramli, 2013).

Studies related to birds around Peninsular Malaysia are largely documented particularly in Important Bird Area sites (IBAs). However, studies on islands around the mainland are still lacking. Most documentation on island birds are outdated. These include in Pulau Tioman ran by Bullock & Medway (1966), Lee *et al.* (1977), Wells (1986), Wells (1990a), Wells, (1990b), Bransbury (1993), Csorba, Fuisz & Kelen (1997) and Sodhi *et al.* (1999), and another three Islands (Pulau Perak, Jarak and Lalang) along Straits of Malacca by Ramli, Azirun & Hashim (2008). The only recent studies were along the east coast archipelago by Hamza, Wong & Ahmad (2016), Hamza *et al.* (2018), Hamza & Ho (2019) and Hamza, Mamat & Abdullah (2019). Nevertheless, these studies focused on seabirds where terrestrial birds were excluded. In addition, surveys had been carried out within a short sampling duration implying insufficient sampling effort.

Nevertheless, islands have their own functional ecosystem within a small confined area (Taylor & Kumar, 2016). Islands are known for harboring species of flora and fauna that are highly endemic (Kier *et al.*, 2009) and providing vital pit stop site for migratory species (Turner *et al.*, 2002; David *et al.*, 2016). This is based on the theory of Island Biogeography proposed by MacArthur & Wilson (1967) that examined factors causing differences in species richness and endemism on island were

influenced by two biogeographical processes (immigration and extinction) and physical features of the island (area and isolation). Island birds tend to be lacking in numbers besides morphologically and behaviorally different from the mainland where these characteristics appear to be determined by the combination of island sizes, island isolation and habitat diversity (Winggins *et al.*, 1998).

Thus, it is important to document the bird community on an island for a better understanding besides reinforcing the conservation effort through surveys and scientific studies. Hence, a bird survey was conducted in Pulau Tinggi (16 km^2) located on the east coast side of Peninsular Malaysia to identify bird diversity and relative abundance in two different habitat; forest interior and coastal zones. Samplings were carried out for six months from March to August 2019, using mist-netting, direct observation and camera trapping field techniques. Baseline information from this research is expected to be useful in assisting conservation studies in the future as there is no proper bird documentation performed in Pulau Tinggi before.

Besides, this study also aims to investigate the feeding guild of the birds in selected macrohabitats and to examine the correlation between beak size and food size/diet preference of the birds in Pulau Tinggi, Mersing. Feeding guild, morphology, and diet preference are important factors in order to understand the feeding ecology of the birds in specific ecosystems. In order to avoid conflict in comparing communities that are too large, feeding guild was used to analyze the feeding behavior of birds. Birds can be distinguished based on eight types of feeding guild. They are carnivorous (CR), insectivorous (IN), frugivorous (FR), nectarivorous (NEC), omnivorous (OM), granivorous (GR), carnivorous-insectivorous (Car-Ins) and frugivorous-insectivorous (Fru-Ins) (Myers, 2009; Phillipps & Phillipps, 2014).

Birds identified from this survey were measured in terms of their potential to be lifted as an avitourism icon in Pulau Tinggi. Avitourism is a part of the ecotourism industry specialized in avian-based product. It is applied globally, particular by lower and middle-income countries, to promote development outcomes. Avitourism contributes to environmental conservation, development of education and awareness towards the environment and promoting the involvement of local people in the ecotourism industry.

The potential of avitourism was measured through seven criteria of organism-based tourism including the (i) endemism, (ii) rarity, (iii) reliability of sightings, (iv) morphological attractiveness, (v) behavioral enticement, (vi) safety and (vii) linkage

to the local culture (Kueh *et al.*, 2006). A set of questionnaires was distributed to the target informants among tourists, natives, and resorts staff to look upon assess their collective perspective and information on birds and avitourism in Pulau Tinggi. The marked hotspot and innovation of avitourism product in Tanjung Balang village would be beneficial to assist and formulate in implementing avitourism in Pulau Tinggi.

1.2 Problem statement

Development benefits should have an overflow effect toward the local population including their well being, comfort of life, good standard of living, quality of life, harmony and cohesion (Asnarulkhadi Abu Samah, 2003). Declaration of Pulau Tinggi as a Marine Park has honoured the efforts to protect natural heritage as well to enhance the economy of the locals. However, problems arised to the local community. According to Manaf, Samsuddin & Omar (2011), after being announced as a Marine Park, Pulau Tinggi has automatically become restricted area for fishing activities especially within two nautical miles from the coast. In addition, the mainland area of the island also prohibits any forestry activities. This move makes the locals no longer free to carry their daily economic activities either at the sea or in land. Thus making the locals faced with obstacles to the rules and regulations set by Marine Park. Instead, they have been given with one hope to be involved in tourism activities, offered through the declaration of Marine Park. The development of tourism in Pulau Tinggi in the short term has succeeded in bringing a positive impact to the locals. In its early stages, many locals involved and served in the resorts and chalets built thus earn extra income from this new industry. In fact, some of the locals have the opportunity to increase their income through renting boats to tourists for fishing purposes.

Apparently, Pulau Tinggi unable to compete with Pulau Tioman. The majority of the island's population in Pulau Tinggi started to migrate out in search of a better life in Mersing mainland (Manaf, Samsuddin & Omar, 2011). Nevertheless, The scientific research conducted in Pulau Tinggi are more focused on the marine ecosystem rather than the terrestrial ecosystem. Thus, most tourism activities included in tourism packages from the chalets and resorts are confined to marine activities such as snorkeling and island tours, offers breathtaking scenery of the marine ecosystems

around the Archipelagos of Mersing. On the other hand, land-based activities also have a lot of potential that is poorly explored.

Tropical biology on terrestrial habitat should be assessed to enhance the conservation value of Pulau Tinggi. Besides being an important fueling stations for migratory birds in Southeast Asia, the forested islands also host a high number of endemic species (Turner *et al.*, 2002) and also becoming important models for ecological theory of Island biogeography (Mac Arthur & Wilson, 1967). From the theory of island biogeography, islands tend to have unique emergence of species richness and endemism influenced by two biogeographical processes (immigration and extinction) and physical features of the island (area and isolation). Interesting outcomes and findings from such studies can be presented to the tourists through recreational activities highlighting the island's biodiversity.

To date, there is no comprehensive survey of the avian community conducted in Pulau Tinggi. In the future, the tourism industry in Pulau Tinggi can be expanded into another scope of tourism which is avitourism on top of the pre-existing marine-based tourism. Comprehensive data from this survey will guide the implementation of avitourism in this area with proper planning. Thus, this new recreational activity will provide more job opportunities for the locals and welcome more tourists to the island.

1.3 Research objectives

This study embarks on several objectives as follows:

(i) To determine diversity and relative abundance of birds at forest interior and coastal zones in Pulau Tinggi, Mersing, Johor.

(ii) To investigate the feeding guild of the birds in selected macrohabitats inhabiting Pulau Tinggi, Mersing, Johor.

(iii) To assess the potential of avitourism in Pulau Tinggi, Mersing, Johor.

1.4 Significance of study

The diversity of birds documented in this study will be the baseline data for future references of birds in Pulau Tinggi. This data should help in assisting future conservation efforts since there is no prior documentation of birds in this island. A combination of data collected from various techniques including mist-netting, direct observation, camera trapping and distributions of the questionnaire to the local informants are beneficial for the development of avitourism industry in Pulau Tinggi through implementation of birdwatching activities. Hotspots for birds focusing on feeding areas can be the main attraction for tourists. Indirectly, this industry will create more job opportunities for the local community of Pulau Tinggi.

1.5 Scope of project

The scope of this project was to evaluate the birds in Tanjung Balang Village, Pulau Tinggi, Mersing, Johor in terms of diversity and feeding ecology. Three field methods were used to survey birds including mist-netting, direct observation and camera trapping. Multiple sets of surveys were done for six months starting from March to August 2019. For each month, sampling was done for ten days. Data collected were organized and analyzed using different statistical softwares such as Microsoft excel, SPSS and PAST Version 3.01 (Hammer, Harper & Ryan, 2001) to calculate the diversity indices. Graphs and tables were constructed with the aid of ECOSIM700 Version 7 (Gotelli & Entsminger, 2001) software for an efficient and easily understood data representation.

From the surveys, six birding hotspots representing different macrohabitats in Pulau Tinggi were determined. These areas were then established as potential avitourism centers in Tanjung Balang Village. Besides, all birds surveyed were also evaluated based on the seven criteria of good organism-based tourism product proposed by Kueh *et al.* (2006). The potential development of avitourism was also studied through qualitative and quantitative approaches. A total of 38 sets of questionnaires were distributed, and interviews were held with head villagers and manager of Shaz Resort in Tanjung Balang Village, Pulau Tinggi.

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