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BIRD COMPOSITION IN FOREST AND COASTAL ZONE OF PULAU TINGGI, JOHOR, MALAYSIA

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Abstract: Documentation of bird composition on the islands around Peninsular Malaysia is scarce, and the attention is mainly focused on Malaysia's Borneo Islands. Therefore, this study aims to fulfil this knowledge gap by documenting the bird composition in Pulau Tinggi. The study was conducted from March to August 2019 using mist-netting and direct observation methods. A total of 39 bird species belonging to 24 families were recorded. Among these, 28 species were residents, four species were residents migrants, and seven were migrants. Migrant species include Wood sandpipers (*Tringa glareola*), Common Sandpipers (*Actitis hypoleucos*), Malay Hawk-cuckoo (*Hierococcyx fugax*), Arctic-Warbler (*Phylloscopus borealis*), Brown Shrike (*Lanius cristatus*), Siberian Blue Robin (*Luscinia cyane*) and Common Tern (*Sterna hirundo*). Regarding conservation status, only one species was listed as Near Threatened: The White-chested Babbler (*Trichastoma rostratum*). Our result shows that the coastal area is more diverse (H=2.252) than the forest area (H=1.933). However, birds in the forest area were more evenly distributed with an evenness index score (forest = 0.5759) over (coastal=0.3806). Thus, we conclude that despite its small size, Pulau Tinggi accommodates a variety of bird species, where the conservation action plan for the continued survival of birds on this island needs to be implemented.

Keywords: Island bird, tropical rainforest, coastal zone, diversity, Seribuat archipelago, South China Sea.

Introduction

The tropical rainforest in Southeast Asia is one of the world's most abundant forests (Myers *et al.,* 2000). Malaysia is one of the countries in this region, consisting of many bird species despite its small size, with a total of 785 species of birds belonging to 97 families: 670 species occur in Peninsular Malaysia while Borneo Malaysia records 603 species (Wan Ahmad, 2018). Of all species in Malaysia, 168 species are migrants, 80 species are vagrants and 51 species are regionally endemic birds. Unfortunately, 60% of the bird species on the IUCN red list have declined dramatically due to agricultural land expansion (Johnson *et al.,* 2011), deforestation and anthropogenic activities (Nor Hashim & Ramli, 2013).

Birds are indeed significant to the ecosystem. They are a biological indicator of being a good parameter in monitoring forest health (Zakaria *et al.,* 2005). In addition, birds play an essential role as pollinators for certain ecologically important plant species, generally for groups of nectar-feeding birds such as spiderhunter and flowerpecker (Momose *et al.,* 1998; Yumoto, 2000). Furthermore, some birds are agents for seed dispersal (Mehmet, 2010). Birds' dropping contains a high concentration of nitrogen, phosphate and potassium, nurturing plants, thus, being harvested by farmers as

biological fertilisers for their crops (Bird Ecology, 2018). Some birds are also considered keystone species where their existence benefits other living things in the ecosystem (Jahan *et al*., 2018). Moreover, birds play crucial roles as mid-level consumers, predators and scavengers, leaving a balance ecosystem composition and healthy environment (The Institute for Bird Population, 2015).

Studies on birds, particularly in Peninsular Malaysia, mainly concentrate on the mainland. On the other hand, studies on the island around Peninsular Malaysia are still lacking. Most documentation on island birds is outdated. These include Pulau Tioman, where documentation was made between 1966 till 1998 by Medway (1966), Lee *et al.* (1977) and Wells (1986); (1990a); (1990b); Bransbury (1993); Anonymous (1995); Csorba *et al.* (1997) and Sodhi *et al.* (1999) and three islands (Pulau Perak, Jarak and Lalang) along streets of Malacca by Ramli *et al.* (2008). The only recent study was Pulau Bidong, Terengganu by Hamza *et al.* (2018). In addition, Hamza *et al.* (2016), Hamza and Ho (2019) and Hamza *et al.* (2019) only highlighted the seabirds along the east coast of Peninsular Malaysia throughout their survey, where terrestrial birds were excluded.

Nevertheless, the island owns its functional ecosystem within a small confined area (Taylor & Kumar, 2016). Islands are known for harbouring species of flora and fauna that are highly endemic (Kier *et al.,* 2009) and providing vital pit-stop sites for migratory species (Turner *et al.,* 2002; David *et al.*, 2016). MacArthur and Wilson (1967) proposed the island biogeography theory, which examines factors influencing species richness and endemism on islands influenced by biogeographical processes (immigration and extinction) as well as physical characteristics of the island (area and isolation). Island birds tend to lack in numbers besides being morphologically and behaviourally different from the mainland. These characteristics appear to be determined by the combination of island sizes, isolation and habitat diversity (Winggins *et al.,* 1998). Thus, it is vital to document bird species present on the island to understand better their community function besides enhancing the conservation effort through surveys and scientific studies.

Therefore, this study aims to fill this knowledge gap in one of the islands on the east coast of Johor to identify bird composition in two habitats: forests and coastal zones. Baseline information from this research is expected to be useful in assisting conservation studies in the future, as there has been no proper bird documentation performed in Pulau Tinggi previously.

Materials and Methods

Study Site

Pulau Tinggi (2°18'N; 104°07'E) was gazetted as a marine Park in 1994, where this tropical island is located approximately 37 km southeast of Mersing on Johor's northeast coast. Pulau Tinggi is the largest island in East Johor Island Archipelagos (EJIA). EJIA comprises 13 small Mersing islands, namely Pulau Harimau, Pulau Mensirip, Pulau Goal, Pulau Tengah, Pulau Hujong, Pulau Rawa, Pulau Sibu, Pulau Mentigi, Pulau Sibu Hujong, Pulau Pemanggil, Pulau Besar and Pulau Aur (Azman *et al.,* 2008). Pulau Tinggi reached a height of up to 610 m and a forest-covered summit (Masni *et al.,* 2011). In addition, this island has several villages, resorts and Marine Park Centre.

The study was run in the Tanjung Balang Village in Pulau Tinggi, covering coastal and forest zones. The Forest zone is made up of tropical rainforest dominated by dipterocarp trees. The lower forest edge degraded into a secondary forest and abandoned plantation land. As it goes upper, the primary forest is filled with tall vegetation reaching up to 30 m or more. It contains typical primary forest species, mainly from *Dipterocarpaceae* and *Myristicaceae*. *Orania sylvicola* from the palm group was also found abundant, as well as patches of the bamboo plant.

The coastal line is structured with sandy beaches, and the mudflat area arises when low and ebb tide approaches. Different microhabitats are noticed in coastal zones based on distinctive

features and vegetation types comprising ponds, grassland, fruit orchard, shoreline and human settlement/resort area. Plants species found include the Coconut tree (*Cocos nucifera)*, Pine tree (*Casuarina equisetifolia),* Cherry tree *(Muntingia calabura)* and Lemon tree (*Citrus aurantifolia*). Fruiting trees in the villagers' orchard include the Mango tree (*Anacardiaceae* spp.), Mata kucing (*Euphoria malaiense*) and Durian (*Durio zibethinus*). Flowering plants introduced widely in the village and resort area such as Hibiscus (*Malvaciae* spp.), (*Bougainvillea* spp.)*,* Telang flower (*Fabaceae* spp.) and *Lilium* spp. Figure 1 shows the location of our study area in Pulau Tinggi.

Bird Sampling

Ten mist nets (36 mm mesh size) were set up randomly for each month from March until August 2019, where five sets were deployed at the forest and coastal zone each. A geographic Position System (GPS) reading was taken for every mist net deployed. 36 mm mesh-sized mist net can capture the bird with sizes ranging from 10 to 450 mm long, equivalent to 2.5 g to 265 g birds (Piratelli, 2003). Mist netting was carried out for 100 days on both sites giving 50 days in the forest and 50 days in the coastal zone. All nets were operated from 0700 hours to 1800 hours. All nets are erected 0.5 m above the ground and minimisation cutting down the undergrowth for installation (Rahman *et al.*, 2002). The nets were inspected regularly. All captured birds were identified until species level by referring to a field guide of birds in Peninsular Malaysia and Singapore by Jeyarajasingam and Pearson (2012), ringed with an aluminium ring bearing a serial number, morphologically measured and weighed. The mist netting method is optimally practised for capturing understory forest birds which are usually inconspicuous and rarely give distinctive calls (Zakaria *et al.,* 2005).

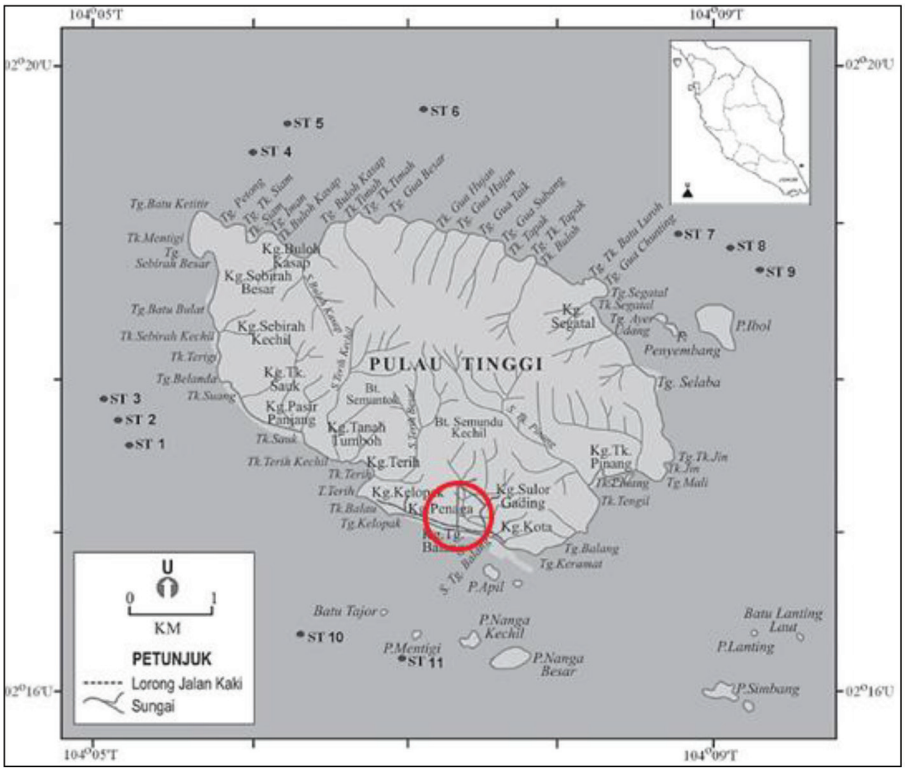

Figure 1: Location of the study area in Pulau Tinggi
(Source: Faiz *et al.,* 2007)

While for canopy level and open area, birds were identified by direct observation technique with added magnifying tools including a spotter scope and binocular.

Data Analysis

Data were organised in excel sheets before being inserted into the software. PAST software (Hammer *et al.*, 2007) was used to generate diversity indices, including the Shannon diversity Index, Margalef richness Index and Evenness Index while EcoSim700 (Gotelli & Entsminger, 2001) computed species accumulation curve data.

Results and Discussion

About 39 species of birds belonging to 24 families under eight orders were censused throughout the study (Figure 2). Kingfisher (Alcedinidae) recorded the highest species presence, composed of four species. Generally, there was no huge difference in species composition for every family listed in Pulau Tinggi. Most of the families quantified with one species each reach up to four species each.

Seven species were identified as migrants and four species as resident migrants consisting of shorebirds and seabirds, namely Collared Kingfisher (*Todiramphus chloris*), Little Heron (*Butorides striata*), Common Tern (*Sterna Hirundo*), Wood Sandpiper (*Tringa glareola*) and Common Sandpiper (*Actitis hypoleucos*), Passerine birds including Brown Shrike (*Lanius cristatus*), Arctic Warbler (*Phylloscopus borialis*), Siberian Blue Robin (*Luscinia cyane*), Black-naped Oriole (O*riolus chinensis*), Malay Hawk-cuckoo (*Eurystomus orientalis*) and Oriental Dollarbird (*Eurystomus orientalis*). Northern region breeding birds migrate south to avoid harsh winter waves causing food scarcity, including insectivorous breeding Warblers in temperate Asia and shorebirds that breed in the far eastern. Migrants arrived in Peninsula Malaysia as early as July and August, with a larger scale in September through November (Jeyarajasingam & Pearson, 2012).

Despite all species, the White-chested Babbler (*Trichastoma rostratum*) is the only species listed as Near-threatened under IUCN Redlist while the rest are listed as Least Concern. Degradation of forest habitat was the main factor affecting the population decline of babblers due to low tolerance to habitat change (Yong, 2009). Factors responsible for low tolerance include the inability to adapt to a new habitat and a change in the dietary guild (John, 1991). White-chested Babbler ranges within the small globe area from Peninsula to Sumatra and Borneo (Wells, 2010). Despite the small range, recently Wells (2007); Lim *et al.* (2008) and Lim (2009) reported that White-chested Babbler had been periodically

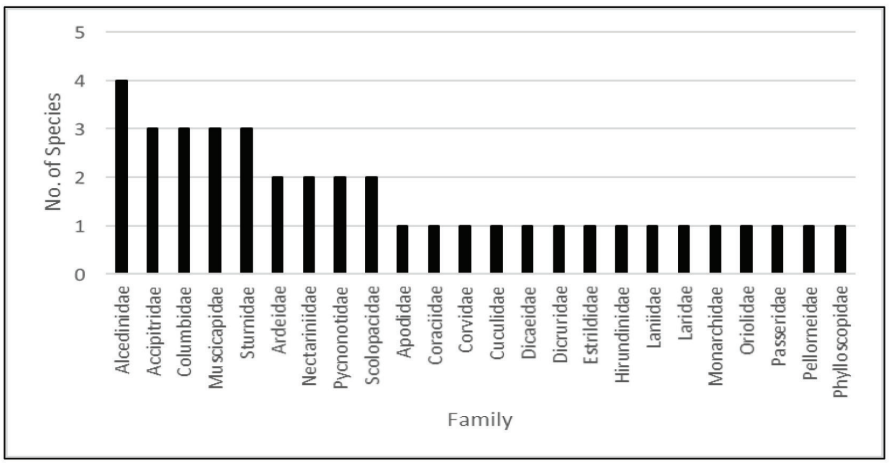

Figure 2: Number of species for each family

utilising less specialised habitat preference, which is found in the mangrove forest and wooded marshes. Table 1 below shows an overview of birds censused in Tanjung Balang Village, Pulau Tinggi, Mersing, Johor.

Table 1: List of birds species in Kampung Tanjung Balang, Pulau Tinggi, Mersing, Johor

Family	Scientific Name	Common Name	MN	OB	Status	IUCN
Accipitridae	*Haliastur indus*	Brahminy Kite	-	+	R	LC
	Haliaeetus leucogaster	White-bellied Sea-Eagle	-	+	R	LC
	Nisaetus cirrhatus	Changeable Hawk Eagle	+	+	R	LC
Alcedinidae	*Halcyon smyrnensis*	White-throated Kingfisher	+	+	R	LC
	Alcedo meninting	Blue-eared kingfisher	+	+	R	LC
	Alcedo athhis	Common Kingfisher	+	-	R	LC
	Todiramphus chloris	Collared Kingfisher	+	+	M, R	LC
Apodidae	*Apus nipalensis*	House Swift	+	+	R	LC
Ardeidae	*Egretta sacra*	Pacific Reef-egret	-	+	R	LC
	*Butorides striat*a	Little Heron	+	+	M, R	LC
Columbidae	*Chalcopaps indica*	Emerald Dove	+	+	R	LC
	Ducula aenea	Green Imperial-pigeon	-	+	R	LC
	Streptopelia chinensis	Spotted Dove	+	+	R	LC
Coraciidae	*Eurystomus orientalis*	Oriental Dollarbird	+	+	M, R	LC
Corvidae	*Corvus enca*	Slender-billed Crow	-	+	R	LC
Cuculidae	*Hierococcyx fugax*	Malay Hawk-cuckoo	+	-	M	LC
Dicaeidae	*Dicaeum cruentatum*	Scarlet-backed Flowerpecker	+	+	R	LC
Dicruridae	*Dicrurus remifer*	Lesser Racquet-tailed Drongo	+	+	R	LC
Estrildidae	*Lonchura punctulata*	Scaly-breasted Munia	+	-	R	LC
Hirundinidae	*Hirundo Tahitica*	Pacific Swallow	+	+	R	LC
Laniidae	*Lanius cristatus*	Brown Shrike	+	-	M	LC
Laridae	*Sterna hirundo*	Common Tern	-	+	M	LC
Monarchidae	*Hypothymis azurae*	Black-naped Monarch	+	+	R	LC
Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin	+	+	R	LC
	Luscinia cyane	Siberian Blue Robin	+	-	M	LC
	Copsychus malabaricus	White-rumped Shama	+	+	R	LC
Nectariniidae	*Anthreptes malacensis*	Brown-throated Sunbird	+	+	R	LC
	Cinnyris jugularis	Olive-backed Sunbird	+	+	R	LC
Oriolidae	*Oriolus chinensis*	Blacked-naped Oriole	-	+	M, R	LC
Passeridae	*Passer montanus*	Eurasian Tree Sparrow	+	+	R	LC
Pellorneidae	*Trichastoma rostratum*	White-chested Babbler	+	+	R	NT

Phylloscopidae	*Phylloscopus borealis*	Arctic Warbler	+	-	M	LC
Pycnonotidae	*Pycnonotus plumosus*	Olive-winged Bulbul	+	+	R	LC
	Pycnonotus goiavier	Yellow-vented Bulbul	+	+	R	LC
Scolopacidae	*Tringa glareola*	Wood Sandpiper	+	-	M	LC
	Actitis hypoleucos	Common Sandpiper	-	+	M	LC
Sturnidae	*Acridotheres tristis*	Common Myna	+	+	R	LC
	Gracula religiosa	Hill Myna	-	+	R	LC
	Aplonis panayensis	Asian Glossy Starling	+	+	R	LC
Total			**30**	**32**		

*MN=Mist Net, OB=Direct Observation, R=Resident, M=Migrant, LC=Least Concern, NT=Near Threatened, +=Presence, -=Absence

In Figure 3, half of the total species censused during the first month of March with 20 species indicates that the highest capture happened during the earlier trapping stage. This is due to the birds' inexperience in trapping previously. Before this, no inventory of birds was carried out in Pulau Tinggi. Mist netting may represent a dangerous occasion for birds. In dangerous situations, animals learn from experience to anticipate risks during similar subsequent occasions (Linhart *et al.,* 2012). Then, slight increment in April, May and June with an additional three species each month. In July, another six new species were censused, given a steeper slope. Finally, in August, there were no additional species. Thus, total bird censuses in Pulau Tinggi equal 39 species of birds.

Diversity is a major element of a species' structure in a bird's community. Generally, Pulau Tinggi supports a relatively high diversity of birds with high diversity richness yet quite low in evenness distribution. On the other hand, the Coastal zone gave a higher species diversity and richness than the forest zone. However, birds in the forest zone are distributed more evenly than coastal zone. Table 2 shows the score given by different diversity indices in Pulau Tinggi.

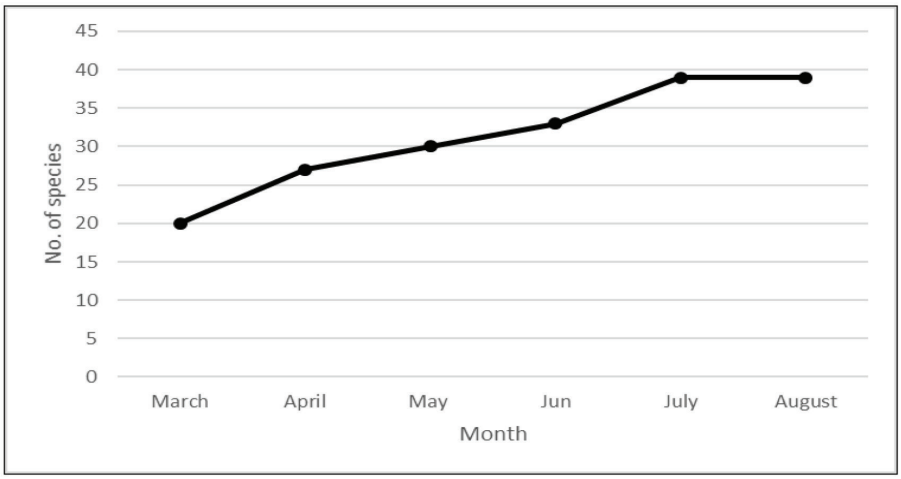

Figure 3: Species accumulation curve throughout six months of sampling duration

Table 2: Table shows generated value from past software for diversity indices in both zones in Pulau Tinggi

Indices	Forest	Coastal	Total
Shannon_H	1.933	2.253	2.488
Margalef	2.572	4.617	5.06
Evenness_e^H/S	0.5759	0.3806	0.4152

Based on Table 3, the total number of individuals captured by the mist net in the coastal zone was higher than in the forest zone, with 209 and 44 individuals, respectively. Asian Glossy Starling (*Aplonis panayensis*) dominated the coastal zone, with 73 individuals captured while Olive-winged Bulbul in the forest zone with 23 individuals. Eight species occupied both zones while the remaining species only occupied neither, with eight species in the forest and another 23 on the coast (Figure 4).

Table 3: Species censused from the mist netting method in the forest and coastal zone of Pulau Tinggi

Common Name	Forest	Coast	Total
Changeable Hawk-eagle	0	1	1
House Swift	2	2	4
Wood Sandpiper	0	1	1
Little Heron	0	1	1
Emerald Dove	5	7	12
Spotted Dove	0	2	2
White-throated Kingfisher	0	2	2
Blue-banded Kingfisher	0	1	1
Collared Kingfisher	0	3	3
Oriental Dollarbird	0	1	1
Malay Hawk-cuckoo	1	0	1
Common Myna	0	5	5
Eurasian Tree Sparrow	0	3	3
Lesser Racquet-tailed Drongo	3	0	3
Oriental Magpie Robin	0	7	7
Arctic Warbler	0	1	1
Asian Glossy Starling	1	73	74
Brown Shrike	0	1	1
Brown-throated Sunbird	3	20	23
Olive-backed Sunbird	0	12	12
Olive-winged bulbul	23	20	43
Pacific Swallow	0	6	6
Scaly-breasted Munia	0	1	1
Scarlet-backed Flowerpecker	1	0	1

Siberian Blue Robin	1	0	1
White-chested Babbler	10	1	11
White-rumped Shama	18	2	20
Yellow-vented Bulbul	0	6	6
Black-naped Monarch	4	2	6
Total	**44**	**209**	**248**

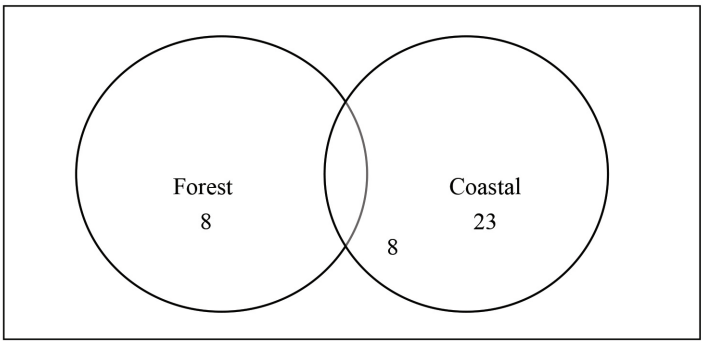

Figure 4: The Venn diagram shows shared and unshared species between coastal and forest zones

Urban and water birds mostly inhabit the coastal zone as the ecosystem comprises human settlement and wetland areas. Waterbirds are bird species that depend on wetlands for various activities, including foraging, nesting, loafing and moulting. In contrast, terrestrial birds do not rely on wetland habitats but may utilise the wetland areas for food, shelter and loaf (Rajpar & Zakaria, 2010). Waterbirds found in this study were from the family of Accipitridae (White-bellied Sea-eagle *Halieaatus leucogaster*), Alcedinidae (White-throated Kingfisher *Halcyon smyrnensis*, Collared Kingfisher *Todiramphus chloris* and Common Kingfisher *Alcedo atthis*), Ardeidae (Pacific Reef-egret *Egretta sacra* and Little Heron *Butorides striata*), Scolopacidae (Wood Sandpiper *Tringa glariola* and Common Sandpiper *Actitis hypoleucos*) and Laridae (Common Tern *Sterna hirundo*). The coastal zone varied in vegetation structure, composition and productivity (food resources), thus, making it more diverse than the forest zone. The White-bellied Sea-Eagle is a raptor that occurs widely in coastal habitats (Makbul & Wong, 2016). It flies from the coastal line close to the water surface to catch prey. Common tern lives in small flock, nesting on a destructed jetty building and plunging steeply on the water surface to hunt targeted fish in the open sea. Sandpipers and Pacific Reef-egret are bottom feeders. They preferred to forage during low tide, where their prey among crustaceans and fish are more accessible when the water level is shallower, exposing mudflat areas. Norazlimi and Ramli (2014) mention that shorebird population distribution is higher during low tide than at high tide due to higher food availability. Small ponds are another option for Sandpipers and Little Heron to find food. Common Kingfisher was captured in the pond area as well. Antonia *et al*. (2012) mentioned that the benthic and pelagic ecosystem offered here gave Common Kingfisher the most optimal ecosystem for finding their prey of fish. Hence, many factors influence the habitat selection for water birds, including species morphology, foraging behaviours and prey availability affecting the distribution and reproduction success (Grawlik, 2002).

Frugivorous and nectarivorous birds dominated the village and resort areas due to villagers' planting of fruit and flowering trees. Some of the trees were a Cherry tree *(Muntingia calabura),* Banana *(Musa spp.),* Mango *Anacardiaceae spp.*, Mata kucing (*Euphoria malaiense),* Hibiscus (*Malvaciae spp.*), (*Bougainvillea spp.)*, Telang flower *(Fabaceae spp.)* and (*Lilium spp.)*. Asian Glossy Starling (*Aplonis panayensis*) was recorded with the highest capture in the coastal zone, with 73 individuals. Sunbirds and Flowerpeckers were among frequent visitors as well. Sunbirds feed on nectars in flower sap and glean small invertebrates on twigs and foliage (Jeyarajasingam & Pearson, 2012). The presence of Muntingia trees in the gardens attracts Scarlet-backed Flowerpecker (*Dicaeum cruentatum*) into the village and resort areas, which is their favourite food for them (Jeyarajasingam & Pearson, 2012). Human commensal species such as Slender-billed Crow (*Corvus enca*), Common Myna (*Acridotheres tristis*), Eurasian Tree Sparrow (*Passer montanus*) and Spotted Dove (*Streptopelia chinensis*) are found abundant along the coast too.

Some species overlap between the two zones. Most of them were forest edge residents, including Emerald Dove (*Chalcopaps indica*), Brown-throated Sunbird (*Anthreptes malacensis*), Olive-winged Bulbul (*Pycnonotus plumosus*), White-chested Babbler (*Trichastoma rostratum*), White-rumped Shama (*Copsychus malabaricus*) and Black-naped Monarch (*Hypothymis azurae*). Birds from the family Pycnonotidae are abundant along the forest edge and forest zone; thus, this family group is a colonising species in the forest (Zakaria *et al.,* 2005). They were comprised of two species: Yellow-vented Bulbul (*Pycnonotus goiavier*) and Olive-winged Bulbul (*Pycnonotus plumosis*). Bulbul is commonly found in secondary forests, oil palm plantations (Azman *et al.,* 2011) and logged forests (Zakaria *et al.,* 2005) as they are highly tolerant to areas exposed to high light intensity and temperature (David, 2014). Also, an individual Arctic Warbler captured beside Dollarbird was spotted lingering around the grassy area.

As the trail went deeper into the forest, a primary forest with a taller canopy level was encountered. Species assemblage on the lower and middle strata was almost the same as in the secondary forest. On the other hand, Hill Myna (*Gracula religiosa*) and Green Imperial-pigeon (*Ducula aenea*) started to dominate on the canopy level. Hill Myna is a cavity-nester and eats on invertebrates such as termites (Jeyarajasingam & Pearson, 2012). Two holes of the nest are made up inside a giant tree's bark identified in the primary forest. Sakai *et al.* (1999) mentioned that lowland dipterocarp forest accommodates high tree species diversity and Dipterocarpaceae represents a significant component of the canopy and emergent layer. Trees with taller and large basal areas provide optimal moist conditions and dense foliage for insects to stay. By being so, a high abundance of insects attracts more insectivorous birds to prey, for instance, Hill myna, Bulbul, White-chested Babbler, Black-naped Monarch and White-rumped Shama. The presence of abundant fig trees provides continuous food resources for the frugivorous bird. Fig family exhibits asynchronous fruiting season and is referred to as a "keystone species", as this species has become an important food source for tropical frugivorous vertebrates, especially birds and primates. Figs that produce ripe crops make them reliable food sources during general food scarcity (Kinnaird & O'brien, 2005). Figs are also rich in edible carbohydrates, even though protein and lipid concentrations are relatively low (Conklin & Wrangham, 1994).

In Figure 5, species accumulation curves at both zones posed an increasing trend with steeper coastal curves than forest zones. Both sites did not reach the asymptote indicating more unrecorded species present with a higher expectation from the coastal zone. Thus, additional sampling should be done in the future to record all remaining species.

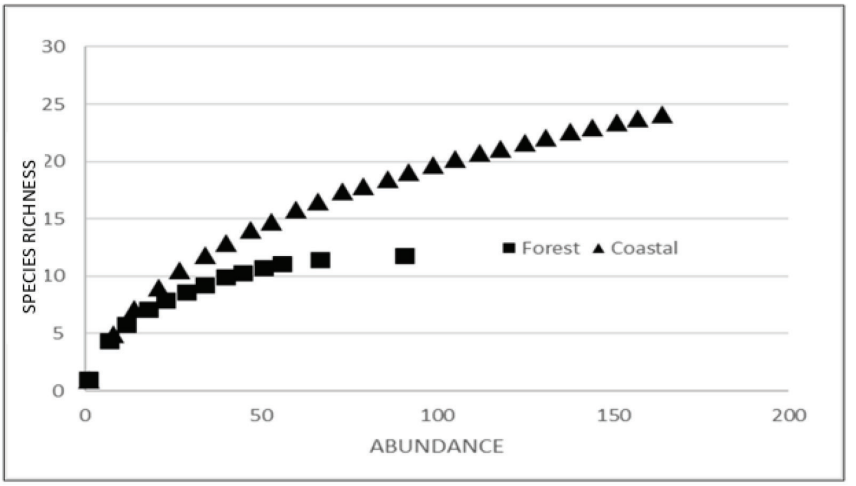

Figure 5: Species accumulation curve of birds in coastal and forest zones

A total of 23 species were censused using mist-netting and direct observation methods (Figure 6). Nevertheless, certain species can only be censused using either technique, where nine are directly observed while seven are captured using mist nets. In this study, 59% of bird species were censused using mist-netting and direct observation methods. However, the remaining 41% can only be censused using one method. Ramli *et al.* (2009) stated that direct observation is much more time-efficient in recording species of birds. Huge birds from the family of raptors, canopy level and some waterbirds that inhabit open areas can be seen through direct observation.

On the other hand, species captured through mist net were smaller yet hard to observe directly. They usually forage at the understorey and ground level, which generally comes from Passeriformes groups. According to Wang and Finch (2002), mist net and point count (one of the direct observation method) were chosen based on vegetation and forest structure to ensure the effectiveness of implementation. All birds observed and heard within a 50-meter radius were recorded.

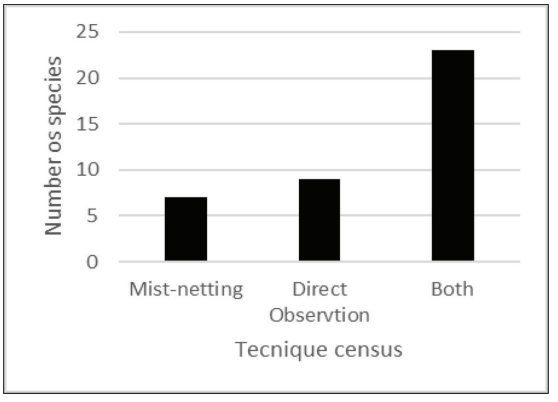

Figure 6: Number of species censused using a different method

Conclusion

In conclusion, Pulau Tinggi accommodates birds from various families of terrestrial birds and waterbirds. Diverse vegetation supports different groups of birds equivalent to their morphology and resources available, including food, shelter, and breeding ground. Meanwhile, the forest ecosystem needs to be preserved as it supports important Near-threatened forest-dependent species of White-chested Babbler for continuous survival ship. On the other hand, this island also supports a few migratory species, indicating that it is probably an important stopover along the migration route. Hence, Pulau Tinggi should be preserved from overdevelopment for the continuous presence of birds on the island.

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