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Species composition of birds in converted coastal area of Barru Regency, South Sulawesi, Indonesia

D Priosambodo¹, N Nadiarti², YA La Nafie³, M Jamal⁴

¹Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Hasanuddin, Jalan Perintis Kemerdekaan Km. 10, Tamalanrea, Makassar 90245, South Sulawesi, Indonesia

²Department of Aquatic Resources Management, Faculty of Marine Science and Fisheries, Universitas Hasanuddin, Jalan Perintis Kemerdekaan Km. 10, Tamalanrea, Makassar 90245, South Sulawesi, Indonesia

³Department of Marine Science, Faculty of Marine Science and Fisheries, Universitas Hasanuddin, Jalan Perintis Kemerdekaan Km.10, Tamalanrea, Makassar 90245, South Sulawesi, Indonesia

⁴Department of Fisheries Resources Utilization, Faculty of Fisheries and Marine Science, Universitas Muslim Indonesia, Jalan Urip Sumoharjo Km 5, Makassar 90231, South Sulawesi, Indonesia

Email: d.priosambodo@gmail.com; d.priosambodo@unhas.ac.id

Abstract. Sulawesi, the largest island in Wallacea region is well-known for its avifauna diversity and endemism. The island is mountainous and surrounded by long coastline with mangrove and wetland ecosystems. To date, most of coastal area converted into fishpond, rice field and settlement. As a result, many species are seriously threatened by land conversion. Nevertheless, species composition of birds in the converted coastal area has poorly studied. To fill in the information gaps, we conducted research in Universitas Hasanuddin fishpond. The fishpond situated in Tanjung Kupa, a small peninsula in Mallusetasi subdistrict, Barru regency, South Sulawesi. This research aimed to figure out the species composition, ecological niche, conservation status and feeding guild of the bird at converted coastal area. Data were collected using MacKinnon list method in the morning at 06.30-09.30 and in the afternoon at 15.30-17.30 from August to September 2020. From the observations, we recorded 37 bird species from 25 families consist of 29 resident, 4 migratory, 3 introduce and 1 endemic species. Most of common birds species dominated by open-country specialist which indicates a change in the composition of bird species in the converted coastal areas of Barru Regency.

1. Introduction

Sulawesi is one of the main bird habitats in the Wallacea Region. In contrast to the more fertile northern regions, southern Sulawesi has a drier climate. The inland area is mountainous, while the coastal area has a long coastline. Important area for bird in North Sulawesi consist of Tangkoko-Dua Sudara, Sangihe-Talaud islands, Mount Ambang, Lake Limboto and Bogani-Nani Wartabone national park. Central Sulawesi also have many important bird area i.e., Lore-Lindu National Park, Morowali Nature Reserve and Banggai-Sula islands where many new endemic bird species discovered recently.



Some important bird habitats in South Sulawesi situated in the interior of the peninsula include Mount Bawakaraeng-Lompobattang and Maros-Pangkep limestones [1]. Meanwhile, the coastal area which is an important habitat for birds is the Lampuko-Mampie mangrove area (2000 Ha), the Lantebung-Kuri coast around Makassar-Maros border, mangrove area in Pallime river estuary in Bone district (200 Ha) and estuary in the north of Bone Bay which is consist of 5000 hectares mangrove along Palopo-east Luwu coastline. For lowland areas, lake Tempe is an important habitat for various species of water birds and migratory birds [2]. The areas in general have been researched a lot, but other coastal areas which is highly converted such as the coast of Pangkep-Barru, Pare-Pare-Pinrang, Gowa-Bulukumba and Bone-Sinjai have rarely received attention. Based on this, we conducted bird research in the converted coastal area of Barru regency, which has the longest coastline in western part of South Sulawesi.

2. Material and Method

2.1. Study Site

One of the sites in Barru Regency that is known to be visited by many bird species and has not been studied is Universitas Hasanuddin fishpond. This 21,25 Ha education fishpond is located in Tanjung Kupa, a small peninsula in Bojo', Mallusetasi District, Barru Regency, 10 km before Pare-pare, a small port city in South Sulawesi. Most of the landscape of Universitas Hasanuddin fishpond is dominated by ponds and embankments with shrubs grow on several parts. The fishpond surrounded by thin mangrove belts which is formed a barrier between the foreshore and the fishponds. Settlement with small yard and garden are in the middle. On the south side, there are extensive local community ponds surrounded by large mangrove area and in the eastern part, the pond bordered with the main road. Ornithological observations conducted at four stations (station A: fishpond near main road, Station B: settlement grounds, Station C: fishpond near mangrove and Station D: mangrove area that surrounding the fishpond) during August-September 2020. This research aimed to figure out the species composition, relative abundance, habitat use and conservation status of the bird at Universitas Hasanuddin fishpond.

2.2. Data Collection

Birds were recorded with MacKinnon list method [3] combined with opportunistically observation [4], and their abundance was assessed from twelve-species lists which contain of 20 species for each list as described in [5], the first twenty bird species encountered in a station in one observation were listed, then a new list was started when more than 20 species found, and so on until 12 lists had been completed. There is not allowed to write a bird name species twice in a list. Observation conducted in certain point for covered all different type of habitat that exist in a station. Photo of the bird taken using a Canon 550D DSLR camera with a 150-300 mm telephoto lens for identification purposes. Identification of bird species based on [1, 5, 6, 7]. Informal discussions about birds in study site were also carried out with local people. Relative abundance determined based on percentage records of each bird species from totally 12 observation list on each station. This method was chosen because it does not depend on the area, duration of observation, the weather [5], provides a greater opportunity to record more bird species, makes easier to observe small and hard-to-identify birds and also easier to observe birds in flock and to observe birds that like to hide in grass, shrubs and trees [3].

3. Result and Discussion

From the observations, we recorded 37 bird species from 25 families consist of 29 resident, 4 migratory, 3 introduce and 1 endemic species. Little Egret, Pacific Swallow, Tree Sparrow, Pink-necked Green Pigeon, Lemon-bellied White-eye and Rainbow Bee-eater are the most abundant species. While Brahminy Kite, Great-billed Heron, Sunda Teal, Ruby-cheeked Sunbird and Slaty-breasted Rail are among the rarest species which is only recorded once during observation. Sulawesi Pygmy Woodpecker is the only endemic bird recorded at the study site (Table 1). Glossy Ibis and

Little Black Cormorant also abundant, however both species only found flying low across the pond from Batukalasi Island as roosting area to the feeding site at the waters around study site.

Table 1. Interval abundance of bird species from twelve observations on each station at Universitas Hasanuddin fishpond. Station A: fishpond near the main road, Station B: settlement ground, Station C: fishpond near the mangrove belt and Station D: mangrove belt.

Bird Species	Common/English Name	Families	Interval abundance of birds in each station			
			A	B	C	D
Resident						
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	Rallidae	1-3	0	1-2	0
<i>Anas gibberifrons</i>	Sunda Teal	Anatidae	0	0	1-5	0
<i>Anthreptes malacensis</i>	Brown-throated Sunbird	Nectariidae	0	0-1	1-3	1-2
<i>Ardea sumatrana</i>	Great-billed Heron	Ardeidae	0	0	0-1	0
<i>Ardeola speciosa</i>	Javan-fishpond Heron	Ardeidae	1-7	0	1-5	0
<i>Artamus leucorhynchus</i>	White-breasted Wood-swallow	Artamidae	4	1	1-4	1-8
<i>Butorides striatus</i>	Striated Heron	Ardeidae	5	0	1-6	1-11
<i>Caprimulgus affinis</i>	Savana Nightjar	Caprimulgidae	1-2	0	1-3	1-2
<i>Chalcoparia singalensis</i>	Ruby-cheeked Sunbird	Nectariidae	0	0-1	0	0
<i>Charadrius javanicus</i>	Javan Plover	Charadriidae	1-4	0	1-7	0
<i>Corvus enca</i>	Slender-billed Crow	Corvidae	0	1-4	0	0
<i>Cynniris jugularis</i>	Olive-backed Sunbird	Nectariidae	1-4	1-6	1-4	1-7
<i>Egretta garzetta nigripes</i>	Little Egret	Ardeidae	3-51	0	1-23	1-9
<i>Gallirallus striatus</i>	Slaty-breasted Rail	Rallidae	0	0	0-1	0
<i>Gerygone sulphurea</i>	Flyeater	Acanthizidae	0	1-4	0	1-4
<i>Halcyon chloris</i>	Collared Kingfisher	Alcedinidae	1-2	1-4	1-2	1-3
<i>Haliastur indus</i>	Brahminy Kite	Accipitridae	0	0	0	0-1
<i>Himantopus leucocephalus</i>	Pied Stilt	Recurvirostridae	1-3	0	1-4	0
<i>Hirundo tahitica</i>	Pacific Swallow	Hirundinidae	6-21	4-16	7-25	8-36
<i>Lalage sueurii</i>	White-shouldered Triller	Camphephagidae	1-2	1-2	1-2	1-2
<i>Leptocoma aspasia</i>	Black Sunbird	Nectariidae	0	1-2	0	1-4
<i>Lonchura atricapilla</i>	Chestnut Munia	Estrildidae	0	1-5	1-2	0
<i>Lonchura pallida</i>	Pale-headed Munia	Estrildidae	0	2-17	2-12	0
<i>Lonchura punctulata</i>	Scaly-breasted Munia	Estrildidae	0	2-9	2-12	0
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	Phalacrocoracidae	6-14	0	2-20	0
<i>Plegadis falcinellus</i>	Glossy Ibis	Threskiornitidae	4-19	0	4-29	0
<i>Sternula albifrons</i>	Little Tern	Sternulidae	0	0	1-4	0
<i>Treron vernans</i>	Pink-necked Green pigeon	Columbidae	5-14	1-4	4-8	8-23
<i>Zosterops chloris</i>	Lemon-bellied White-eye	Zosteropidae	3-9	4-15	5-22	9-31
Migratory						
<i>Actitis hypoleucos</i>	Common Sandpiper	Scolopacidae	1-4	0	1-6	1-3
<i>Nettion pulchellus</i>	Green Pygmy Goose	Anatidae	0	0	2-8	0
<i>Heteroscelus brevipes</i>	Grey-tailed tattler	Scolopacidae	0	0	1-7	0
<i>Merops ornatus</i>	Rainbow Bee-eater	Meropidae	1-9	0	0	7-61
Introduce						
<i>Passer montanus</i>	Tree Sparrow	Passeridae	1-4	7-29	1-4	0
<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul	Pycnonotidae	1-4	2-6	1-2	1-4
<i>Streptopelia tranquebarica</i>	Red Collared Dove	Columbidae	0	0	0	1-4
Endemic						
<i>Dendrocopos temminckii</i>	Sulawesi Woodpecker	Picidae	0	0	0	1-4

3.1. Species Composition

The coastal area of Sulawesi was once overgrown by mangroves and dense coastal forests. However, currently only a small portion of those communities remains [8, 9, 10]. Most of the vegetation have been logged for timber, charcoal and converted into fishponds, settlements, rice fields and cultivated area [8, 11, 12]. Mangroves are defined by the presence of trees that mainly occur in the intertidal zone, between land and sea, in the tropics and subtropics region [13]. The intertidal zone is characterized by fluctuative and dynamic environment. The complex structure of mangroves root has important role in trapping sediment, stabilize the environment and formed substratum on which many species of plants live. The plants than provide food source and sheltered habitat for animals including birds, insects, mammals and reptiles [13]. Mangroves also increase connectivity among coastal habitats, and may be preferentially used as corridors for movement and as protected roosting or breeding sites [14]. Despite poor in number of floral species, avian species richness in mangroves area is surprisingly high in tropical regions [14].

Bintuni Bay in West Papua for instance have the most extensive (450.000 Ha) and least disturbed mangrove area in Indonesia. On this almost pristine mangrove forest, more than 90 species of bird has been recorded [15]. Avifauna that mostly spent their time in mangrove forest included the Darter, Fruit-Dove, Frogmouth, Kingfisher, Dollarbird, Cuckoo-Shrike, Gerygone, Fantail, Flycatcher, Robin, Whistler, Flowerpecker, Sunbird and the Drongo. All these species might be considered as characteristic of mangrove bird species [15]. Water birds, migratory birds and bird from surrounding non-mangrove forest i.e raptors, cockatoo, parrots, swallows, swiftlets, flycatcher, starling, imperial pigeons, friarbird, Rainbow bee-eater, crow, hornbill, bird of Paradise also observed frequently in Bintuni Bay mangrove.

In contrast, coastal area of Lampoko-Mampie in West Sulawesi has drastically lost its mangrove and coastal forest due to land conversion. This coastal area formerly was designated as a Wildlife Reserve base on the Decree of Minister of Agriculture No. 699/Kpts /Um/11/1978 covering an area of 2000 Ha to protect migratory birds especially from Australia or east Asia. However, recently only 237 hectares of mangrove areas remain as a result of land conversion into fishponds, cultivated area and settlements [16]. From 50 species avifauna reported at Lampoko-Mampie, the birds nowadays dominated by Little Egret, Pied Stilt and Pacific Swallow. Most of the birds derived from Ardeidae, Nectarinidae, Anatidae, Estrildidae and Rallidae followed by Sylviidae, Apodidae, Meropidae and Scolopacidae [17].



Figure 1. Migratory bird at Universitas Hasanuddin fishpond. a. Rainbow Bee-eater. b. Common Sandpiper. c. Grey-tailed Tattler (Photo: Dody Priosambodo)

Composition of bird species in Universitas Hasanuddin fishpond somewhat similar to the bird at coastal of Lampoko-Mampie especially in family structure. We recorded 37 bird species during observation consist of 29 resident, 4 migratory, 3 introduced and 1 endemic species. Mostly derived from the family Ardeidae, Nectariidae, Estrildidae, Scolopacidae, Anatidae, Rallidae and Columbidae (Table 1). Some of the most common bird in Universitas Hasanuddin fishpond also consist of waterbirds including Little Egret, Striated Heron and Collared Kingfisher (Table 2). Four migratory bird were also observed from the study site i.e., Common Sandpiper, Green Pygmy Goose, Grey-tailed

Tattler and Rainbow Bee-eater (Figure 1). The latter is migratory from Australia and formed large flock roosting in mangrove around the fishpond and flying noisily in the air to catch the insects above the fishpond.

Table 2. Percentage Occurrence of Bird Species in Twelve Observation List. A: fishpond near the main road, B: settlement and yard, C: fishpond near the mangrove belt and D: mangrove belt

Bird Species	Common/English Name	Category	Percentage Occurrence in 12 Observation List (%)			
			A	B	C	D
Resident						
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	Rare	8.33	0.00	16.67	0.00
<i>Anas gibberifrons</i>	Sunda Teal	Rare	8.33	0.00	8.33	0.00
<i>Anthreptes malacensis</i>	Brown-throated Sunbird	Uncommon	0.00	25.00	25.00	16.67
<i>Ardea sumatrana</i>	Great-billed Heron	Rare	0.00	0.00	8.33	0.00
<i>Ardeola speciosa</i>	Javan-fishpond Heron	Occasional	41.67	0.00	25.00	16.67
<i>Artamus leucorhynchus</i>	White-breasted Wood-swallow	Common	100.00	100.00	100.00	100.00
<i>Butorides striatus</i>	Striated Heron	Common	100.00	0.00	100.00	50.00
<i>Caprimulgus affinis</i>	Savana Nightjar	Frequently	41.67	0.00	100.00	33.33
<i>Chalcoparia singalensis</i>	Ruby-cheeked Sunbird	Rare	0.00	8.33	0.00	0.00
<i>Charadrius javanicus</i>	Javan Plover	Occasional	33.33	0.00	50.00	0.00
<i>Corvus enca</i>	Slender-billed Crow	Occasional	25.00	41.67	8.33	0.00
<i>Cynnis jugularis</i>	Olive-backed Sunbird	Common	100.00	100.00	100.00	100.00
<i>Egretta garzetta nigripes</i>	Little Egret	Abundant	100.00	0.00	100.00	33.33
<i>Gallirallus striatus</i>	Slaty-breasted Rail	Rare	0.00	0.00	8.33	0.00
<i>Gerygone sulphurea</i>	Flyeater	Frequently	33.33	50.00	50.00	33.33
<i>Halcyon chloris</i>	Collared Kingfisher	Common	100.00	100.00	100.00	33.33
<i>Haliastur indus</i>	Brahminy Kite	Rare	8.33	0.00	8.33	8.33
<i>Himantopus leucocephalus</i>	Pied Stilt	Frequently	58.33	0.00	58.33	0.00
<i>Hirundo tahitica</i>	Pacific Swallow	Abundant	100.00	100.00	100.00	100.00
<i>Lalage sueurii</i>	White-shouldered Triller	Common	0.00	0.00	100.00	58.33
<i>Leptocoma aspasia</i>	Black Sunbird	Frequently	83.33	100.00	66.67	66.67
<i>Lonchura atricapilla</i>	Chestnut Munia	Frequently	25.00	33.33	25.00	0.00
<i>Lonchura pallida</i>	Pale-headed Munia	Abundant	75.00	100.00	100.00	0.00
<i>Lonchura punctulata</i>	Scaly-breasted Munia	Abundant	83.33	100.00	100.00	0.00
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	Abundant	91.67	0.00	100.00	0.00
<i>Plegadis falcinellus</i>	Glossy Ibis	Common	91.67	0.00	100.00	0.00
<i>Sternula albifrons</i>	Little Tern	Frequently	41.67	0.00	58.33	0.00
<i>Treron vernans</i>	Pink-necked Green pigeon	Abundant	75.00	0.00	100.00	100.00
<i>Zosterops chloris</i>	Lemon-bellied White-eye	Abundant	100.00	100.00	100.00	100.00
Migratory						
<i>Actitis hypoleucos</i>	Common Sandpiper	Common	100.00	0.00	100.00	0.00
<i>Nettapus pulchellus</i>	Green Pygmy Goose	Uncommon	0.00	0.00	33.33	0.00
<i>Tringa brevipes</i>	Grey-tailed tattler	Frequently	0.00	0.00	75.00	0.00
<i>Merops ornatus</i>	Rainbow Bee-eater	Abundant	100.00	0.00	100.00	100.00
Introduce						
<i>Passer montanus</i>	Tree Sparrow	Abundant	100.00	100.00	100.00	0.00
<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul	Common	91.67	100.00	100.00	75.00
<i>Streptopelia tranquebarica</i>	Red Collared Dove	Frequently	0.00	0.00	0.00	50.00
Endemic						
<i>Dendrocopos temminckii</i>	Sulawesi Woodpecker	Occasional	0.00	0.00	0.00	50.00

Abundant: recorded 10-12 times in large population Common: recorded 10-12 times solitary or in small flock
 Frequently: recorded 7-9 times in 12 list Occasional: recorded 5-6 times in 12 list
 Uncommon: recorded 3-4 times in 12 list Rare: only recorded once or twice during observation

3.2. Ecological Niche

The conversion of mangroves and coastal forests into ponds has resulted in habitat changes. Mangrove forests generally play an important role in the ecosystem as a source of food, shelter, roosting and nesting [14]. Mangroves lack seed resources to attract rice field dwelling granivorous birds, and very few mangroves produce fleshy fruits that attract rain forest frugivores [14]. However, mangrove provide nectar that will attract the insects. The presence of these nectar source and insect population will attract insectivore and nectarivore birds to visit the mangrove area. The bottom of the mangrove forest which are rich in polychaeta worms, shellfish, crabs and other types of animals will be exposed during low tide [18,19]. This will attract many waterbirds such as Great Egret, Little Egret, Striated Heron, Pied Stilt and migratory shorebird to explore and forage for food in muddy mangroves floor.

The cutting down of mangrove areas into ponds has reduced mangrove stands and created extensive open areas. The decline in mangrove trees is causing the loss of flowers and insects that provide food for insectivore and nectarivore birds. As a result, the population of insectivore and nectarivore birds will decrease. Ponds which has been made in a former mangrove forest area will develop into new habitats for birds and other animals. Some of the embankments will be overgrown with grass and shrubs, a vegetation previously not found in the mangrove ecosystem. This new habitat provides a distinct food source consist of grass seeds, small bush fruit and insects. Thus, the new habitat, supporting avifauna species which is different from the previous when the area is still in the form of mangrove forest. Therefore, the composition of avifauna species will change with changing types of food available due to changes in habitat.



Figure 2. Most abundant avifauna in study site dominated by open-country specialist bird. a. Pacific Swallow, b. Lemon-bellied White-eye, c. Pink-necked Green Pigeon (Photo: Dody Priosambodo)

The composition of birds in a certain area is influenced by many factors, i.e habitat diversity, flora and fauna diversity, topography, climate and anthropogenic influences such as: land use change, and poaching. Clearing land in coastal areas into settlements, fishpond and cultivation areas has an impact on the avifauna species composition [20]. This can be seen from the dominance of open-country specialist birds at Universitas Hasanuddin fishpond. From 37 species that we observed at study site, 24 bird species classified as open-country specialist, 11 bird species grouped into mangrove specialist and only 2 bird species belong to forest specialist (Table 3). Anthropogenic factors through urbanization, shrimp pond, garbage disposal, as well as oil palm plantation in Malaysia also causes the high abundance of open country birds such as *Treron vernans*, *Hirundo tahitica* and *Merops philippinus*, compared to the mangrove-dependent birds [18]. Our observations also show similar results where the most abundant spesies bird were found in *Treron vernas*, *Hirundo tahitica*, *Merops ornatus*, *Passer montanus*, *Lonchura pallida*, *Lonchura punctulate* and *Zosterops chloris* (Figure 2). Species composition also influenced by surrounding different habitat type [14, 21]. The low number of forest specialist birds is probably due to the absence of nearby forests or lack of food sources needed by

forest birds at the study site. The absence of a vegetation corridor connecting the forest to the study site may also be the reason for the leastwise of forest birds at Universitas Hasanuddin Fishpond. Extensive rice fields are likely to be the cause of the difficulty of forest specialist bird species to reach the coastal areas.

Table 3. Feeding Guild, Ecological Niche, Conservation Status and Protected Bird at Study Site.

Bird Species	Common/English Name	Feeding Guild	Eco. Niche	IUCN Status	Regulation No.106/2018
Resident					
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	OM	O	LC	Not Protected
<i>Anas gibberifrons</i>	Sunda Teal	OM	O	NT	Not Protected
<i>Anthreptes malacensis</i>	Brown-throated Sunbird	NE	M	LC	Not Protected
<i>Ardea sumatrana</i>	Great-billed Heron	CA	M	LC	Protected
<i>Ardeola speciosa</i>	Javan-fishpond Heron	CA	M	LC	Not Protected
<i>Artamus leucorhynchus</i>	White-breasted Wood-swallow	IN	O	LC	Not Protected
<i>Butorides striatus</i>	Striated Heron	CA	M	LC	Not Protected
<i>Caprimulgus affinis</i>	Savana Nightjar	IN	O	LC	Not Protected
<i>Chalcoparia singalensis</i>	Ruby-cheeked Sunbird	IN	F	LC	Not Protected
<i>Charadrius javanicus</i>	Javan Plover	CA	O	NT	Protected
<i>Corvus enca</i>	Slender-billed Crow	OM	O	LC	Not Protected
<i>Cynnis jugularis</i>	Olive-backed Sunbird	IN	M	LC	Not Protected
<i>Egretta garzetta nigripes</i>	Little Egret	CA	O	LC	Not Protected
<i>Gallirallus striatus</i>	Slaty-breasted Rail	CA	O	LC	Not Protected
<i>Gerygone sulphurea</i>	Flyeater	OM	O	LC	Not Protected
<i>Halcyon chloris</i>	Collared Kingfisher	CA	M	LC	Not Protected
<i>Haliastur indus</i>	Brahminy Kite	CA	O	LC	Protected
<i>Himantopus leucocephalus</i>	Pied Stilt	CA	O	LC	Protected
<i>Hirundo tahitica</i>	Pacific Swallow	IN	O	LC	Not Protected
<i>Lalage sueurii</i>	White-shouldered Triller	OM	M	LC	Not Protected
<i>Leptocoma aspasia</i>	Black Sunbird	NE	M	LC	Not Protected
<i>Lonchura atricapilla</i>	Chestnut Munia	GR	O	LC	Not Protected
<i>Lonchura pallida</i>	Pale-headed Munia	GR	O	LC	Not Protected
<i>Lonchura punctulata</i>	Scaly-breasted Munia	GR	O	LC	Not Protected
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	CA	M	LC	Not Protected
<i>Plegadis falcinellus</i>	Glossy Ibis	CA	M	LC	Protected
<i>Sternula albifrons</i>	Little Tern	CA	O	LC	Protected
<i>Treron vernans</i>	Pink-necked Green pigeon	FR	O	LC	Not Protected
<i>Zosterops chloris</i>	Lemon-bellied White-eye	OM	M	LC	Not Protected
Migratory					
<i>Actitis hypoleucos</i>	Common Sandpiper	CA	O	LC	Not Protected
<i>Nettapus pulchellus</i>	Green Pygmy Goose	OM	O	LC	Not Protected
<i>Tringa brevipes</i>	Grey-tailed tattler	CA	O	NT	Not Protected
<i>Merops ornatus</i>	Rainbow Bee-eater	IN	O	LC	Not Protected
Introduce					
<i>Passer montanus</i>	Tree Sparrow	OM	O	LC	Not Protected
<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul	OM	O	LC	Not Protected
<i>Streptopelia tranquebarica</i>	Red Collared Dove	GR	O	LC	Not Protected
Endemic					
<i>Dendrocopos temminckii</i>	Sulawesi Woodpecker	IN	F	LC	Not Protected

Feeding Guild:

CA (Carnivore); FR (Frugivore); GR (Graminivore); IN (Insectivore); NE (Nectarivore); OM (Omnivore). Conservation Status: LC (Least Concern); NT (Near Threatened).

Ecological Niche:

O (Open-country specialist); M (Mangrove specialist); F (Forest specialist).

3.3. Feeding Guild

Six functional feeding guild consist of carnivore, frugivore, granivore, insectivore, nectarivore and omnivore were found in study site during observation (Table 3). Most of bird in Universitas Hasanuddin fishpond classified as Carnivore (14 species) which prey on fish, worms, crabs, shellfish, reptiles, amphibians and other animals. Omnivore that feeds on plants and animal also dominated with 9 species. This category including generalist birds that eat fruit and insect or nectar and insect. In the next position there are birds that only eat insects (insectivore) with 6 species. We also found four seed eater species (granivore) which is mostly dominated by *Munias*, three nectarivore species and one frugivore species.

The composition of feeding guild in Universitas Hasanuddin fishpond was similar to those in Lampoko-Mampie [17] and Rawa Aopa Watumohai [22] but slightly different with Pallime Estuary and Tempe Lake which is consists of less species in granivore and nectarivore [23].



Figure 3. Waterbirds attracted to visit dried fishpond at study site for foraging food. a. Little Egret and Javan Pond Heron, b. Pied Stilt, c. Striated Heron (Photo: Dody Priosambodo)

Most of study site landscape dominated by extensive open area consist of pond and embankments. Waterbirds such as Little Egret, Striated Heron, Javan-pond Heron and other piscivore (fish eater) has the largest proportion in this carnivore feeding guild (Figure 3). Brahminy Kite is the only bird of prey (raptor) that found during observation. The bird encountered when grabbing and catching a needlefish around mangroves. Carnivore which are dominated by water birds are also reported to be found in Pallime estuary, an extensive fishpond surrounded with patchy mangroves in the coastal of eastern Bone Regency, South Sulawesi [23]. The vast mudflats which is absent at study site also found and support many migratory bird species. The long distance from the rice fields may cause the absence of seed eater species in this area which is abundant at study site. This shows that the diversity of habitat, flora and fauna affects the species composition and feeding guild of the bird [14].

Drained pond areas also attract more shorebirds and wetland birds to visit. These carnivore birds mainly forage for fish, shellfish, crabs, worms and other animals on muddy beaches at low tide. Shallow water surface causes the fish in the dried pond to gather at certain points so that they are easier to catch [24]. Research on small egrets at the commercial fishpond in Hong Kong shows that these birds spend more time in dried fishponds than other habitat types because they find it easier to catch fish trapped in shallow water in ponds [24].

The omnivore at the study site mostly consists of generalist species such as frugivore-nectarivore and frugivore-insectivore. Waterhen, Teal and Pygmy Goose were omnivore that observed when foraging for food in the fishpond. Although there are quite a lot of species, most of these birds are solitary or form small flocks. Omnivore bird which is encounter in large groups is Lemon-bellied

White-Eye. This bird is common and widespread in lowland and coastal forest, feed on nectar, fruit and insects. Common introduced species at study site i.e Sooty-headed Bulbul and Tree Sparrow. Both of species derived from feral species that spread successfully in Sulawesi. Small flock of Slender-billed Crow encountered when eating ripe papaya fruit on a tree. Many food choices cause omnivore species to have a high adaptability to different habitat conditions.

Settlements and gardens only cover a small portion of the entire study site. However, most of the large trees are concentrated in this area. Granivore are easily found at surrounding settlement. Even, this seed eaters, which are dominated by *Munias*, build nests in these trees (Figure 4). The presence of large number of granivore at the study site may be due to several reasons. Lack of trees around the ponds and rice fields makes the large trees in the yards an ideal place for nesting. The birds also visit the study site forage for grass seed that overgrown on the embankments due to the dried of rice field after harvest. The large trees also served as shelter from the predators. From this information, we know that composition of bird species can describe the type of flora, fauna and availability of food sources [24]. However, the availability of food is not the only reason to describe the presence of a bird species at study site [14].



Figure 4. Seed eater birds (granivore) collecting nest material around settlement (Station C). a. Scaly-breasted Munia. b. Chestnut Munia. c. Pale-headed Munia (Photo: Dody Priosambodo)

In least disturbed mangrove at Northern Territory, Australia, avian assemblage structure in mangroves is determined by the type and diversity of mangrove zones, the timing of mangrove flowering and the nature of the matrix surrounding mangroves. Insectivore and nectarivore reported as the most abundant bird. The species mostly derived from *Gerygone*, *Myzomela*, *Lichmera* and *Zosterops* [14]. In contrast, our result in heavily converted mangrove showed that carnivore and omnivore has many more species compared to previous habitat. Common insectivore at study site mostly prefer to hunt in open areas.



Figure 5. Introduced bird in Universitas Hasanuddin fishpond. a. Sooty-headed Bulbul. b. Eurasian Tree Sparrow. c. Red Collared Dove (Photo: Dody Priosambodo)

Pink-necked Green Pigeon is the only frugivore bird encountered at study site during observation. The bird diet mainly consists of fruit especially fig (*Ficus* spp). It is unclear whether the bird foraging

for food in mangrove forest due to only few mangrove species that produce edible flesh fruit. It is possible that the Green Pigeon uses the mangrove habitat as roosting area. Lack of edible flesh fruit causes less frugivore bird species presence in study site. Frugivore is a forest specialist bird that is mostly found in primary and secondary forests such as Bantimurung-Bulusaraung National Park [25] or forest around limestone hills at Barru Regency. These habitats are generally found in the interior of Sulawesi, far from the study site and separated by extensive rice fields.

3.4. Conservation Status

Birds in Indonesia are currently facing threat of extinction due to habitat loss, climate change, poaching, small populations and limited distribution areas [26]. Therefore, the government issued a regulation to protect the remaining. From totally 37 bird species recorded at Universitas Hasanuddin fishpond, six species are protected according to Minister of Environment and Forestry Regulation No. P.106 of 2018 [29]. The protected bird species consists of Javan Plover, Little Tern, Pied Stilt, Glossy Ibis, Great-billed Heron and Brahminy Kite. According to IUCN redlist [30], most of bird species at Universitas Hasanuddin fishpond classified as Least Concern. However, the status of three species i.e: Sunda Teal, Javan Plover and Grey-tailed Tattler fall into Near Threatened [7].

Three individuals of Javan Plovers were recorded during observation in Universitas Hasanuddin fishpond. This small birds forage for food in the middle of fishpond along with Little Tern. Javan Plover was once considered an endemic species of Java. However, in recent years, Javan Plover bird has also been reported to be present in Sumatra, Sulawesi, Nusa Tenggara and Timor Leste [26]. Javan Plover has been recorded in coastal lowlands, sandy beaches, intertidal, saline lagoons, feeding and breeding near dry aquaculture ponds. They have also been recorded breeding on dry saline land in Sape Sumbawa [1]. It has also been recorded feeding and breeding in dry cleared rice-fields before seeding or after harvesting. Javan Plovers prefer beaches or dry land above the shoreline in coastal habitats. However, the bird sometimes forages on sandy tidal flats. This bird also observed hunting crabs on beach at low tide. Population of Javan Plover was declined due to habitat pressure and limited population [26].



Figure 6. Protected bird at study site based on Minister of Environment and Forestry Regulation No. P.106 of 2018. a. Javan Plover. b. Little Tern. c. Brahminy Kite (Photo: Dody Priosambodo)

A pair of Little Tern was observed resting on the rocks in the middle of a shallow water fishpond at study site (Figure 6). Little tern is recorded to breed locally (race *sinensis*), but in certain months (September-May), there is a population of migrants from the northern hemisphere visiting large lakes and marshes in the interior, lagoons, fishponds and fishponds, estuaries rivers to small islands [1].

Another waterbird that has striking appearance is the Pied Stilt. This very long leg bird often visit dried fishpond in the morning, afternoon and evening in small flock consist of 1-4 individuals. The Pied Stilt explore the inside of the pond area, feeds in shallow water, probing into the sediment with its beak. It feeds largely on aquatic insects and on small molluscs. When foraging for food, a common Sandpiper observed follow along beside. Pied Stilt can be found on shallow wetlands, breeding in lake edges, marshes, swamps, riverbeds, dried fishponds and freshwater sites. This bird is resident and breeding in southern Sumatra, Java, Sulawesi, Papua New Guinea, Australia and New Zealand [1].

Large populations of Glossy Ibis and Little black cormorant were found on the island of Batukalasi, a roosting area near to the study site. These birds observed every morning passing over the fishponds, flying to feeding area in large flocks consist of 15-50 birds. Glossy Ibis reported occurs in fairly large numbers in both lowland and upland localities in Sulawesi, but breeding sites are unknown [27]. One survey recorded flocks of up to 1000 individuals travelling across Lake Tempe or feeding in the short grass and along the muddy shoreline. Small flocks of up to 20 individuals were observed at Lake Sidenreng [27]. In the Mampie Nature Reserve, the presence of the species in small numbers was confirmed, but local people reported large flocks. This bird is resident in Java, Sulawesi and Papua but considered as visitor in Sumatera, Borneo, Lesser Sunda and other part of Indonesia [27].

The only bird of prey found during the observation was the Brahminy Kite. This raptor was recorded once while hunting needlefish around the mangrove. Brahminy Kite is generally found in coastal areas and freshwater wetlands. Its diet mainly consists of fish, birds, bats, lizard and other animals. Sometimes these birds eat the carcasses of fish that have died. Brahminy Kite is widespread in India, Southeast Asia, to Papua New Guinea and Australia [28]

Several bird species found in Universitas Hasanuddin fishpond are relatively rare. The Great-billed Heron, for instance, was only encountered once during observation. The bird perched in the highest treetops around the fishpond. When approached, this bird emitted several very loud warning tones before flying away. Great-billed Heron is a shy, very alert solitary bird which is hard to approach. This bird specializes in catching large fish in intertidal area near mangrove. Feeding site in shallow water that visited by large fish is specific habitat that probably scarce and difficult to find [27]. This may explain why this bird is rare.

Rails such as the White-breasted Waterhen and the Slaty-breasted Rail are among the rarest species in study site for different reasons. Both include crepuscular birds which are more active in exploring the fishponds in the early morning or late afternoon. On one occasion, Slaty-breasted Rail was observed crossing the embankment of the fishpond in study site as the sun was almost setting. This bird passed quickly and immediately disappeared behind the thick grass that grew on the embankment. Slaty-breasted Rail are notorious for their skulking habits and are rarely flushed, and are thus comparatively little known [31]. This bird is resident but rarely found in Wallacea region [1].



Figure 7. Sulawesi Woodpecker (a-c), the only endemic bird that is found during observation at Universitas Hasanuddin fishpond. Photo: Dody Priosambodo

Sulawesi Woodpecker is the only endemic bird species found at study site during observation (Figure 7). This bird often seen alone or in groups of 2-3 in the morning, perched on dry mangrove bark in search of caterpillars, larvae and insects. Sulawesi Woodpecker is quite common in high primary and secondary forest, forest edges, cultivated land with few trees, to urban areas with a lot of trees from sea level to 2.400 m [1]

Grey-tailed Tattler is migratory birds that found resting, alone or in pairs, in the early morning and late afternoon on the rocks in the fishpond. When the observation was made until sunset, 7 individuals were found resting on a rock in the middle of the fishpond. Most likely, this bird spent the night in the fishpond. Lightly streaked and barred underparts showed that the bird still in breeding plumage. This indicates that this bird had just arrived from the northern hemisphere. The Gray-tailed Tattler breeds in

Siberia and the Kamchatka Peninsula (far eastern Russia) and carries out regular annual migrations to Malaysia, the Philippines, Indonesia, Papua New Guinea and Australia [6]. The global population is currently estimated at 44,000 individuals [2].

4. Conclusion

From the observations at Universitas Hasanuddin fishpond, we recorded 37 bird species from 25 families consist of 29 resident, 4 migratory, 3 introduce and 1 endemic species. All bird species are scattered in six functional feeding guild categories (14 species carnivore, 9 species omnivore, 6 species insectivore, 4 species granivore, 3 species nectarivore and 1 species frugivore). Based on IUCN red list, three species consist of Sunda Teal, Javan Plover and Grey-tailed Tattler classified as near threatened. Furthermore, six species i.e., Glossy Ibis, Great-billed Heron, Pied Stilt, Little Tern, Javan Plover and Brahminy Kite including protected species based on Minister of Environment and Forestry Regulation No.P.106 of 2018. Sulawesi Woodpecker is the only endemic bird species found at study site during observation. The dominance of carnivore and omnivore bird species shows that the study site experienced significant habitat changes. This is indicated by the lack of nectarivores and insectivores which is characterize mangrove specialist bird.

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