Bird Diversity and Its Association in Mangrove Habitats of Teluk Bintuni Regency, West Papua

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Abstract. Birds are one of the most essential components to maintain the stabilization of the ecosystem. Mangroves are one of the most biologically diverse ecosystems providing shelter and feeding sites for many species, but mangrove habitats are under severe land-use pressure throughout the world including Indonesia. The aim of this study was to identify the diversity of birds and their association with vegetation in Mangrove Habitats of Teluk Bintuni Regency. In this study, we assessed bird species diversity within six mangrove habitats that are Weriagar, Tanah Merah, Irarutu, Amutu, Kalipotong, and Muara Retui. This research was conducted in March 2019 with the rapid assessment method. According to our estimate, there were 54 bird species with 28 families which were dominated by Laridae in all sites. Tanah Merah was the location that had the highest number of species diversity (H’2.95). It is caused by diverse vegetation in Tanah Merah. This information could be useful for sustainable development of mangrove habitats.

1. Introduction

Mangrove habitat has important functions to society and ecosystem services such as carbon storage, nutrient processing, socioeconomic goods, retaining soil and sediment trapping, protecting coastal areas and communities including for many bird species [1]. Mangroves are coastal ecosystems which are found in the critical area between marine and terrestrial environments, therefore, those are comprised of unique species [2]. About 20-35% mangrove areas have been destroyed and threatened by anthropic pressures. At mangrove habitats, about 40% of the wildlife species are restricted and elevated risk of extinction based on IUCN Categories and Criteria [3].

Birds are one of the most essential components to maintain the stabilization of ecosystem and as a bioindicator of habitat quality and environmental changing, showing general responses of wildlife to human disturbances, climate changes, and ecosystem changes. Birds have a role in the processing of a dynamic ecosystem in mangrove areas. Birds can release nutrients into the water column through their feces and food waste, therefore they play an important role in the food chain especially in mass and energy fluxes [4]. Mangroves in one of essential habitat for birds species such as breeding, roosting, and feeding, but the stabilization of habitat depends on the structure vegetation [5]. Coexisting and niche are provided by habitat heterogeneity [6]. Thus far, the few studies recorded mangroves bring complexity to the ecosystem, offering microhabitats and specialized niches to occupy bird diversity in mangrove areas, limiting the possible number of coexisting species.

Most studies on the topic have been carried out in the primary forest, but we know much less the ecology of mangroves, meanwhile diversity of birds may also differ in their habitat use,
depending on vegetation structure whether the mangrove meets their requirements for foraging, roosting, or nesting. Many of the species in mangrove forests have made specific adaptations [3]. Teluk Bintuni has the largest mangrove areas in Indonesia. The aim of this study was to identify the diversity of birds and their association with vegetation in Mangrove Habitats of Teluk Bintuni Regency.

2. Method
This study was carried out at six locations which were selected to represent mangrove habitats in the edge coast of Teluk Bintuni Regency. There are Weriagar, Tanah Merah, Irarutu, Amutu, Kalipotong, and Muara Retui.

Bird observations were recorded twice a day during morning (06.00-09.00) and afternoon (15.30-18.00) in March 2019 and thus nocturnal birds were excluded. The methods of this study are rapid assessment and exploration technique. Mangrove structure was characterized by vegetation analysis [7]. The plots were georeferenced the mangrove surface area was determined using Google Earth Pro images, adjusted by ground truth Global Positioning System (GPS) measurements. Additionally, stand structures were described by measuring tree diameter at breast height (DBH) in cm, canopy height (m), and species composition is illustrated by SExI-FS. In this study also used drones to clip the condition of the canopy cover from above the forest.

Bird counts analysis excluded of bird flight, song or call to avoid misrepresentation and double counting. The diversity of bird abundance and richness was compared between areas. Total species diversity was calculated by Shannon Wiener Index (H’). Evenness and dominance Index were also calculated for each habitat (E). Species dominance in each site based on Bray-Curtis analysis which was compared between the proportion of the number of a certain species and the total bird number of all species. Dominant species is categorized by the value number, if that is more than 5%. Bray-curits similarity index were used to examine similarity/dissimilarity of bird community among the six location [7, 8, 9].

3. Result and discussion
This study found 54 species of 28 families in the six habitats (Table 1). The highest number of species was found in Tanah Merah with 30 species of 28 families recorded, meanwhile in Kalipotong was the lowest number of species with 15 species of 10 families.

The highest species diversity was found in Tanah Merah and the lowest number was found in Irarutu. Shannon diversity index showed that the diversity in the study are generally moderate (Figure 1) but Tanah Merah area is closely related to high with the number is about 2.95. Evenness index in the study area showed that the number of species individuals are generally moderate based on the calculated number in each habitat closely related to 1 or stable (Figure 2). Stability of community can be defined by diversity index, the higher number of bird species, the more stable the area. In this study, vegetation structure and habitat heterogeneity caused the difference of bird species. Higher number of bird species diversity tend to have higher vegetation and niche heterogeneity, therefore in general we can conclude that increasing bird species and diversity accommodates more niches. These niches are often distributed vertically in forests [10].

| No. | Family     | Common name         | Bird Species                  |
|-----|------------|---------------------|-------------------------------|
| 1   | Acanthizidae | Mangrove Gerygone   | Gerygone levigaster           |
| 2   | Accipitridae | Brahminy Kite       | Haliastur indus              |
| 3   | Accipitridae | White-bellied Sea Eagle | Haliaeetus leucogaste      |
| 4   | Alcedinidae  | Collared Kingfisher | Halycon chloris             |
| 5   | Alcedinidae  | Azure Kingfisher    | Alcedo azurea                |
| 6   | Anatidae    | Raja Shelduck       | Tadorna radjah               |

Table 1. Bird species found in all locations (continuation)
| No. | Family         | Common name       | Bird Species                  |
|-----|----------------|-------------------|-------------------------------|
| 7   | Apodidae       | Glossy Swiftlet   | Collocalia esculenta          |
| 8   | Ardeidae       | Black Bittern     | Isbyrychus flavicollis        |
| 9   | Ardeidae       | Great-billed Heron| Ardea sumatrana               |
| 10  | Ardeidae       | Pacific Reef Egret | Egretta sacra                 |
| 11  | Ardeidae       | Little Egret      | Egretta garzetta              |
| 12  | Bucerotidae    | Blyth’s Hornbill  | Rhytitcera plicat              |
| 13  | Campephagidae  | White-bellied Cuckoo | Coracina papuensis          |
| 14  | Charadriidae   | Oriental Plover   | Charadrius veredus            |
| 15  | Columbidae     | Black-billed Cuckoo Dove | Macropygia nigrirostris   |
| 16  | Coraciidae     | Oriental Dollarbird| Eurystronius orientalis       |
| 17  | Corvidae       | Torresian Crow    | Corvus orru                   |
| 18  | Cuculidae      | Black-billed Couca| Centropus bernstein           |
| 19  | Cuculidae      | Asian Koel        | Eudynmys scolopaceus          |
| 20  | Cuculidae      | Asian Drongo-Cuckoo| Surniculus lugubris        |
| 21  | Cuculidae      | Brush Cuckoo      | Cacomantis variolosus         |
| 22  | Dicaeidae      | Olive-crowned Flowerpecker | Dicaeum pectoral         |
| 23  | Dicruridae     | Spangled Drongo   | Dicurus bracteatus            |
| 24  | Fregatidae     | Great Frigatebird | Fregata minor                 |
| 25  | Hirundinidae   | Pacific Swallow   | Hirundo tahitica              |
| 26  | Laridae        | Roseate Tern      | Sterna dougalli               |
| 27  | Laridae        | Swift Tern        | Sterna bergii                 |
| 28  | Laridae        | Little Tern       | Sterna albisfons              |
| 29  | Laridae        | Whiskered Tern    | Chlidonias hybridus           |
| 30  | Laridae        | Angel Tern        | Gygis alba                    |
| 31  | Laridae        | Black-naped Tern  | Sterna sumatrana              |
| 32  | Laridae        | Gull-billed Tern  | Gelochelidon nilotica         |
| 33  | Meliphagidae   | Red-headed Myzomela | Myzomela erythrocephala     |
| 34  | Meliphagidae   | Helmeted Friarbird| Philemon buceroides          |
| 35  | Meliphagidae   | Mimic Honeyeater  | Meliphaga analoga             |
| 36  | Nectariniidae  | Black Sunbird     | Leptocoma sericea             |
| 37  | Nectariniidae  | Olive-backed Sunbird| Cinnyris jugularis          |
| 38  | Pachycephalidae| Rusty Pitohui     | Pitohui ferrugineus           |
| 39  | Psittacidae    | Double-eyed Fig Parrot | Opopsitta diopthalma  |
| 40  | Psittacidae    | Sulphur-crested Cockatoo | Cacatua galantia        |
| 41  | Psittacidae    | Black-capped Lory | Loris lory                    |
| 42  | Psittacidae    | Black Lory        | Chalcopsitta atra             |
| 43  | Psittacidae    | Orange-fronted Hanging Parrot | Loriculus aurantifrons |
| 44  | Recurvirostridae| White-headed Stilt| Himantopus leucocephalus      |
| 45  | Rhipiduridae   | Willie Wagtai     | Rhipidura leucophrys          |
| 46  | Scolopacidae   | Bar-tailed Godwit | Limosa lapponica              |
| 47  | Scolopacidae   | Whimbrel          | Numenius phaeopus             |
| 48  | Scolopacidae   | Eastern Curlew    | Numenius madagascariensis     |
| 49  | Scolopacidae   | Common Sandpiper  | Actitis hypoleucus            |
| 50  | Scolopacidae   | Wood Sandpiper    | Tringa glareola              |
| 51  | Scolopacidae   | Asian Dowitcher   | Limnodromus semipalmatus      |
| 52  | Sturnidae      | Yellow-faced Myna | Mino dumontii                 |
| 53  | Sylviidae      | Clamorous Reed Warbler | Acrocephalus stenoreus    |
| 54  | Zosteropidae   | Lemon-bellied White-eye | Zosterops chloris          |
The difference of diversity and evenness Index depends on the vegetation composition in each habitat and other factors might influence the bird community. Birds often prefer to use multiple habitats and depend on the quality and productivity of the habitats (i.e. food availability, cover quality, and nesting sites) to stable viable populations. The dominance criteria index in each habitat showed that the highest number of bird dominance index were *Actitis hypoleucos* in Weriagar habitat, *Hirundo tahitica* in Tanah Merah, *Numenius madagascariensis* in Irarutu, *Actitis hypoleucos* in Amutu, *Rhipidura leucophrys* in Kalipotong, and *Sterna albifrons* and *Hirundo tahitica* in Muara Retui (Table 2). Based on the previous research recorded that it has been a positive correlated between the number of bird species with vegetation complexity and food availability. Food availability, tree size, tree height, and cover percentage is the key aspect for the composition of bird species distribution, relative abundance, and richness are known to be strongly influenced by quality of habitat composition. Diversity of bird communities has been known to be positively correlated with habitat complexity [11].
There were 19 Birds protected by government regulation PP No 7 1999 cq Permen LHK No. P.106/2018 and also 8 bird species were listed in Appendix II CITES such as Haliastur indus, Haliaeetus leucogaster, Rhyticeris plicatus, Opopsis diophthalma, Cacatua galera, Lories lory, Chalcopsitta atra and Loriculus aurantiifrons. The heterogeneity habitat effect is a fundamental concept for absence and presence in community bird species-area [11] and bird diversity has a positive relationship with habitat heterogeneity. Structure of habitat in each habitat area is composed by 28 species of plant (Table 3) and index diversity of each habitat showed that Tanah Merah was the highest number (Table 4). Ecological function in mangrove area is depend on diversity of habitat composition which is influence to species diversity even on a few scale [12]. Habitat heterogeneity support to evolve the diversity of bird species because species can be east to survive in a particular habitat. Based on previous study, the effects of environmental filters were mirrored by the low evenness in each trait (i.e. dominance of few categories in each trait).

The result of the similarity index in bird communities in each habitat is shown in the three classes (Figure 3). Structure habitat profile describes the compositions of vegetation in their habitat. Based on this study, there were three clusters of mangroves. Cluster I was growing mangrove in Irarutu, Cluster II was stable mangrove without disturbance in Amutu and Cluster III was stable mangrove with disturbance in Tanah Merah (Figure 4,5,6). Plant productivity is among the most important factors

### Table 2. Dominance among each habitat

| Location   | Total Individuals | Bird Species          | Dominansi (%) |
|------------|-------------------|-----------------------|---------------|
| Weriagar   | 5                 | Sterna albifrons      | 9,68          |
|            |                   | Gygis alba            | 9,68          |
|            |                   | Gelochelidon nilotica | 12,90         |
|            |                   | Actitis hypoleucus    | 14,52         |
|            |                   | Collocalia esculenta  | 12,90         |
| Tanah merah| 6                 | Sterna albifrons      | 7,93          |
|            |                   | Tadorna radjah        | 6,17          |
|            |                   | Collocalia esculenta  | 7,49          |
|            |                   | Hirundo tahitica      | 20,70         |
|            |                   | Actitis hypoleucus    | 5,73          |
|            |                   | Egretta sacra         | 6,17          |
| Irarutu    | 4                 | Actitis hypoleucus    | 16,04         |
|            |                   | Numenius madagascariensis | 38,68        |
|            |                   | Limosa lapponica      | 10,38         |
|            |                   | Collocalia esculenta  | 11,32         |
| Amutu      | 4                 | Chalcopsitta atra     | 12,05         |
|            |                   | Opopsis diophthalma   | 15,66         |
|            |                   | Actitis hypoleucus    | 20,48         |
|            |                   | Limosa lapponica      | 7,23          |
| Kalipotong | 6                 | Meliphaga analoga     | 7,14          |
|            |                   | Actitis hypoleucus    | 14,29         |
|            |                   | Numenius madagascariensis | 10,71        |
|            |                   | Collocalia esculenta  | 7,14          |
|            |                   | Rhipidura leucophrys  | 21,43         |
|            |                   | Centropus bernsteini  | 7,14          |
| Muara retui| 5                 | Sterna albifrons      | 12,70         |
|            |                   | Chlidonis hybridus    | 7,94          |
|            |                   | Gelochelidon nilotica | 11,11         |
|            |                   | Hirundo tahitica      | 12,70         |
|            |                   | Sterna sumatrana      | 9,52          |
shaping species diversity and evenness [13]. This habitat structure was in line with the diversity of bird species.

**Table 3. Vegetation in study area**

| No. | Plant species       | Familia           |
|-----|---------------------|-------------------|
| 1.  | *Acanthus ebracteatus* | Acanthaceae       |
| 2.  | *Acrostichum speciosum* | Pteridaceae     |
| 4.  | *Aegiceras corniculatum* | Primulaceae     |
| 5.  | *Avicennia alba*      | Acanthaceae       |
| 6.  | *Avicennia officinalis* | Acanthaceae     |
| 7.  | *Barringtonia racemosa* | Lecythidaceae |
| 8.  | *Bruguiera cylindrica* | Rhizophoraceae   |
| 9.  | *Bruguiera sexangula* | Rhizophoraceae   |
| 10. | *Bruguiera gymnorrhiza* | Rhizophoraceae |
| 11. | *Calophyllum macrophyllum* | Clusiaceae   |
| 12. | *Cryptocarya infectoria* | Lauraceae     |
| 13. | *Cryptocarya sp.*     | Lauraceae        |
| 14. | *Cryptocoryne ciliata* | Araceae         |
| 15. | *Derris trifoliata*   | Leguminoseae     |
| 16. | *Dolichandra spathacea* | Leguminoseae   |
| 17. | *Heritiera littoralis* | Lauraceae   |
| 18. | *Intsia bijuga*       | Leguminoseae     |
| 19. | *Metroxylon sagu*     | Arecales         |
| 20. | *Nypa fruticans*      | Arecales         |
| 21. | *Pandanus tectoria*   | Pandanaceae      |
| 22. | *Rhizophora apiculata* | Rhizophoraceae |
| 23. | *Rhizophora mucronata* | Rhizophoraceae |
| 24. | *Rhizophora stylosa*  | Rhizophoraceae   |
| 25. | *Sonneratia alba*     | Lythraceae       |
| 26. | *Sonneratia caseolaris* | Lythraceae   |
| 27. | *Xylocarpus moluccensis* | Meliaceae   |
| 28. | *Xylocarpus granatum* | Meliaceae       |

**Table 4. Diversity Index of Vegetation**

| No | Location     | Diversity Index Value |
|----|--------------|-----------------------|
|    |              | Seedling  | Sapling | Tree  |
| 1. | Weriagar     | 0.80      | 0.88    | 0.85  |
| 2. | Muara Retui  | 0.69      | 0.75    | 0.53  |
| 3. | Amutu        | 1.38      | 1.32    | 1.32  |
| 4. | Irarutu      | 0.73      | 0.69    | 0.84  |
| 5. | Kalipotong   | 1.08      | 1.49    | 1.32  |
| 6. | Tanah Merah  | 1.54      | 1.83    | 2.04  |

Bird species diversity and richness was strongly associated with habitat productivity. Habitat factors greatly affect the composition of the mangrove ecosystem. Changes in habitat quality may result the ecosystem composition [14] even may affect to the diversity of bird species. Variation zone vegetation may cause the differences of bird species distributions [15]. Abiotic factors (salinity, tidal regimes, strong winds, and wave action) influence habitat quality and availability by inhibiting plant development [16]. Generally, existing of species do not respond directly to the elevational gradient, but correlated with multiple spatial and temporal scales such as local climate, ecotones, competition, habitat structure and heterogeneity play a essential role in determining species diversity [11, 17, 18].
Figure 3. Dendrogram of similarity index

Figure 4. Growing mangrove in Irarutu
Figure 5. Stable Mangrove without disturbance in Amutu

Figure 6. Stable Mangrove with disturbance in Tanah Merah
4. Conclusion

In this study, the differences in diversity of bird species in Teluk Bintuni mangrove area were explained by habitat heterogeneity. There were 54 bird species and 28 families. Tanah Merah was the location that had the highest number of species diversity (H’2.95), so there was a positively strongly correlated with vegetation structure which divided into three clusters of mangrove habitats, growing mangrove, stable mangrove without disturbance and stable mangrove with disturbance. This study highlights the importance of mangrove areas for the life cycles of birds especially for protected birds in Indonesia. Thus, it is important to improve the quality and quantity of mangrove vegetation, and prevent their loss, as they provide positive correlated with bird conservation.

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