

AVIFAUNA DIVERSITY AT CENTRAL HALMAHERA NORTH MALUKU, INDONESIA

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ABSTRAK

Irham, M. Keanekaragaman Avifauna at Weda Bay, Halmahera, Indonesia. 2012 Zoo Indonesia 21(1), 17-31. Survei burung dengan menggunakan metode titik hitung dan jaring telah dilakukan di Halmahera, Maluku Utara di empat lokasi utama yaitu Wosea, Ake Jira, Tofu Blewen dan Bokit Mekot. Sebanyak 70 spesies burung dari 32 famili dijumpai selama penelitian lapangan. Keragaman burung tertinggi ditemukan di Tofu Blewen yaitu 50 spesies (Indeks Shannon = 2.64) kemudian diikuti oleh Ake Jira (48 spesies, Indeks Shannon = 2,63), Wosea (41 spesies, Indeks Shannon = 2,54) dan Boki Mekot (37 spesies, Indeks Shannon = 2,52). Berdasarkan Indeks Kesamaan Jaccard, komunitas burung di Wosea jauh berbeda dibandingkan lokasi lain. Gangguan habitat dan ketinggian memperlihatkan pengaruh pada keragaman burung terutama pada jenis-jenis endemik dan terancam seperti komunitas di Wosea. Beberapa jenis burung, terutama paruh bengkok seperti Kakatua Putih, menunjukkan hubungan negatif dengan ketinggian.

Kata Kunci: keragaman burung, Halmahera, gangguan habitat, ketinggian

ABSTRACT

Irham, M. Avifauna diversity at Weda Bay, Halmahera, Indonesia. 2012 Zoo Indonesia 21(1), 17-31. Bird surveys by point counts and mist-nets were carried out in Halmahera, North Moluccas at four locations i.e. Wosea, Ake Jira, Tofu Blewen and Bokit Mekot. A total of 70 birds species from 32 families were recorded during fieldworks. The highest bird diversity was found in Tofu Blewen with 50 (Shannon index= 2.64) species then followed by Ake Jira (48 species, Shannon index=2.63), Wosea (41 species, Shannon index= 2.54) and Boki Mekot (37 species, Shannon index=2.52). Jaccard Similarity Index showed that bird communities in Wosea were the most different. Habitat disturbance and change in elevation influenced birds diversity and abundance, especially to endemic birds and threatened species. Some parrots, such White Cockatoo, showed negative relationship with high elevation.

Keywords: birds diversity, Halmahera, habitat disturbance, elevation

INTRODUCTION

Wallacea region consists of the main island of Sulawesi, group of islands forming Moluccas and Lesser Sunda. Because of its geographic location between Oriental to the west and Austro-papua realms to the east, the avifauna within these region had been influenced from both sides. Moreover, due to the complex origin and geology, many unique species evolve independently and are different from either oriental nor Austro-papua forms. Therefore, this area become the center of endemism with an estimated of more than 256 species are restricted ranged to the islands (Whitten *et al.* 2005).

Halmahera of North Moluccas is the biggest island in Moluccas Archipelago. It has 254 species of birds from which 64 species are endemic to Moluccas. Twenty-eight endemic species of Moluccas, including four endemic genera, have restricted range on North Moluccas only (Coates & Bishop 1997, Dickinson 2003). By having such endemism, Halmahera and its neighboring islands are recognized by BirdLife International as North Maluku Endemic Bird Areas (EBA) (Stattersfield *et al.* 1998).

Apart from having high endemism, North Maluku EBA is also a home of ten threatened species of which three species are Endangered

(Japanese Night-heron (*Gorsachius goisagi*), Moluccan Woodcock (*Scolopax rochussenii*) and Chattering Lory (*Lorius garrulous*)); and seven species are Vulnerable (Moluccan Megapode (*Eulipoa wallacei*), Invisible Rail (*Habroptila wallacii*), Carunculated Fruit-dove (*Ptilinopus granulifrons*), White Cockatoo (*Cacatua alba*), Sombre Kingfisher (*Todiramphus funebris*), Purple Dollarbird (*Eurystomus azureus*) and Dusky Friarbird (*Philemon fuscicapillus*)) (BirdLife International 2003).

This fascinating island had attracted many naturalists and ornithologists since the era of Alfred Russel Wallace. During the Dutch administration, De Haan departed to Moluccas and collected some specimens that published on the paper of Van Bemmelen and Voous (1953) (Mees 1982). After him, several other visitors subsequently came to the North Moluccas including Heinrich A. Bernstein who contributed significantly on the knowledge of birds of Moluccas and Papua. Not only European naturalist, this island also attracted Japanese famous ornithologist, Nagamichi Kuroda who made notes of 27 species and subspecies based on the collection of Mr. Watanabe (Kuroda 1938).

Most of the earlier exploration and collection were made around coastal area such as Weda, Kao, Lelilef, and neighboring islands of Ternate, Obi, Batjan and Morotai. Very few records come from the area of Central Halmahera. This survey was carried out to explore the birds of Halmahera from central region between Ake Tajawe and Lolobata National Park. Habitat characters such as disturbance and altitude were explored if these could influenced birds communities in Central Halmahera. The results from this study were important to bridge the avifauna paucity information from central area of Halmahera and to be incorporated into environment management for stakeholders as this area was potentially exploited by mining and logging company.

RESEARCH METHODS

Survey sites

Bird surveys were conducted in Halmahera, North Moluccas from January to February 2010. There were four main sites i.e. Wosea (N0 29.716 E127 56.782), Ake Jira (N0 36.937 E127 54.990), Tofu Blewen (N0 48.210 E128 01.924) and Boki Mekot (N0 36.659 E128 02.437) (Figure 1). These four sites varied in elevation: 40-75 m asl for Wosea, 50-125 m asl for Ake Jira, 450-660 m asl for Tofu Blewen and the highest sites were Boki Mekot that located at 750-900 m asl. Forest type in all sites generally consisted of primary forest, secondary forest and open area from flat landscape to hilly area.

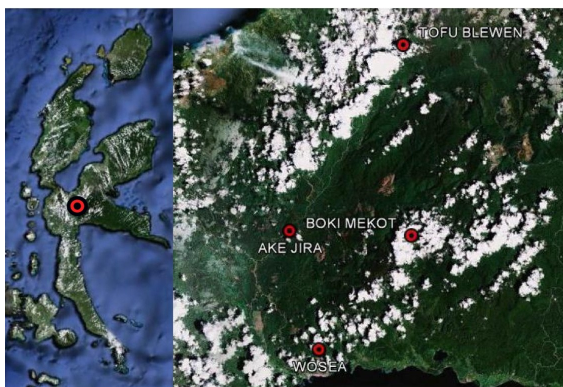


Figure 1. Survey sites located in central Halmahera which administratively divided by Central Halmahera District and East Halmahera District (Source: Google Earth 2012)

Wosea and Ake Jira were flat covered with mozaic of primary forest, secondary forest and cultivated area. The largest open area was the riverbank of Wosea that was cleared just before the survey was conducted. Local people cleared the area by slash and burn techniques. Tofu Blewen and Boki Mekot were hilly with predominantly primary forest. Tofu Blewen had relatively large open road connecting some villages around the area. There were some area closed to the study sites that had been logged. Boki Mekot was inaccessible by road so most of the area were still intact hill primary forest.

Data Collection

I applied two methods in order to obtain a comprehensive bird list i.e. observation by means of opportunistic surveys and point count; and mist-netting (Bibby et al. 1998). Opportunistic surveys were done to allow as many species as possible to be found. I searched for birds in a range of terrestrial habitat following main roads, tracks, and forest trails across the area. While opportunistic surveys were done randomly, point counts were conducted in systematic manner. During the walk following tracks, I set a point count every 200 m between points. The total point counts on every site were nine for Wosea (1.6 km transect length, one transect), 17 for Ake Jira (3.2 km transect length, two transects), 16 for Tofu Blewen (three km transect length, two transects) and 13 for Boki Mekot (2.4 km transect length, two transects).

I observed birds with Nikon 12x25mm Trave-lite binocular. Observation was conducted for 10 minutes at every point counts. I recorded the birds that encountered within and beyond 50 m radius. Only birds found within 50 m were included in the analysis of species richness. Upon an encounter with birds, the following data were collected i.e. species, number of individuals, habitat type, behavior, and location. Whenever possible, bird calls were recorded with Sony PCM-Recorder and bird photographs were taken with Canon Powershot S3 IS.

For catching birds, I used 15 mist-nets of 12 x 2.6 m mesh 34 on each location for three days replicates. Because of the field restriction and limitation, I set up 15 mist-nets only at Wosea and Ake Jira while on the other sites I put only 10 mist-nets. All caught birds were identified, photographed and measured. Several bird species were taken for specimens. All samples and specimens were deposited at Museum Zoologicum Bogoriense (MZB) Cibinong.

Additional data collections were conducted by interviewing local people. I showed pictures of

birds to them. Fieldworks started at 05.30 – 18.00 everyday. Bird identification followed Coates and Bishop (1997) and scientific names followed Suk-mantoro dkk. (2007).

Analysis

Shannon and Jaccard index was applied for evaluating bird species richness by quantifying index of diversity and similarity index, respectively (Nur *et al.* 1999). Since the effort of point counts were different among sites, rarefaction function was used to examine a total species across all study sites. The abundance of birds was taken as the maximum number of individuals of a species present in each habitat types during three observations replicates. Regression analysis was carried out to examine the influence of elevation to birds distribution. All data were checked whether or not they departed significantly from a normal distribution. If the data was not normally distributed, it was transformed to approach a normal distribution more closely (Sokal & Rohlf 1995). Statistical analysis conducted with SPSS software (SPSS Inc. 2002).

RESULTS & DISCUSSION

Species Account

A total of 70 birds species from 32 families were recorded during fieldworks (Appendix 1). The highest number of bird species was found in Tofu Blewen (50 species) then followed by Ake Jira (48 species), Wosea (41 species) and Boki Mekot (37 species). Most of the birds were recorded from observation. There were only five species of which obtained from mist-netting. These species account represent 29% of the whole known species occurred on Halmahera.

Of these species account, 16 birds were endemic to Halmahera (North Moluccas) from which three endemic genera out of four were observed i.e. *Semioptera wallacei* (Standardwings Birds of Paradise), *Lycocorax pyrrhopterus* (Paradise Crow) and

Melitograis gilolensis (White-streaked Friarbird). The endemic genera missing from observation was *Habroptila wallacii* (Invisible Rail). Combine with other endemic birds which had larger distribution area, a total of endemic birds found were 27 species. Based on the conservation status, there were 23 species that protected by Indonesian law (UU No.5/1990 and PP.No. 7/1999), 19 species were under Appendix II CITES and two species were on the red list of IUCN. The distribution of species under regulation apparently were not too different across survey sites nevertheless Tofu Blewen held more species than others (Figure 2). However, it was very obvious that endemic bird diversity and numbers of threatened species were lower in Wosea.

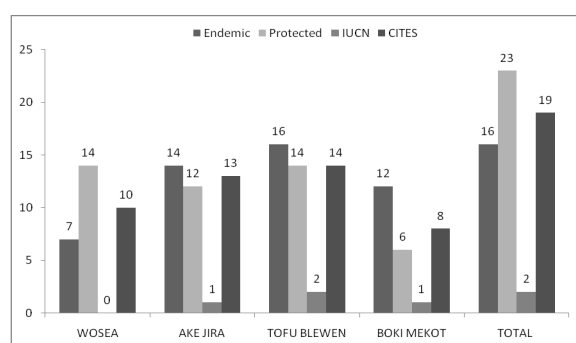


Figure 2. Distribution of recorded birds that holds specific status across survey sites

In the following I presented information on species which had special interest from an ornithological perspective and conservation.

Accipitridae

Six species of birds of prey were detected on survey sites i.e. Moluccan Goshawk (*Accipiter henricogramus*), Chinese Goshawk (*Accipiter soloensis*), Osprey (*Pandion haliaetus*), Brahminy Kite (*Haliastur Indus*), Gurney's Eagle (*Aquila gurneyi*) and Black Eagle (*Ictinaetus malayensis*). Moluccan Goshawk is an endemic raptor in Halmahera and Gurney's Eagle holds Near Threatened status by IUCN. All the raptors are resident except Chinese Goshawk is a winter visitor from northern hemisphere.

Moluccan Goshawk was recorded at all sites in various kind of habitat from forest edge of Wosea until primary forest of Boki Mekot. Mostly, they were observed in pairs. Their presence was rather easy to detect due to their vocal behaviour, especially during breeding season.

Osprey and Brahminy Kite are known as wetland raptors because they mostly hunt on fish at the river bank or coastal area. A single osprey, apparently sub-adult individual stage, was detected perched on the dead tree next to the Wosea River at dawn. Meanwhile, Brahminy Kite was observed at Ake Jira and Tofu Blewen. The largest flock of Brahminy Kite was counted at Tofu Blewen as 8 individuals were soaring over hilly terrain close to the Camp 8.

A Chinese Goshawk, a Black Eagle and three Gurney's Eagle were observed only at Tofu Blewen. All of them were seen around weather station, logging road and Camp 4 soaring above the forest and headed up to the west. While Chinese Goshawk was the only migratory raptor present at the site which could be identified convincingly, another unidentified raptor that looked like a migratory Harrier was detected in Tofu Blewen.

Megapodidae

Halmahera is inhabited by two megapodes i.e. Moluccan Scrubfowl (*Eulipoa wallacei*) and Dusky Scrubfowl (*Megapodius freycinet*). However, during this survey the first megapode which is vulnerable endemic species to Moluccas was not found. Dusky Scrubfowl is common in Halmahera and they probably prefer flat terrain on low elevation over undulating landscapes. In addition, they were encountered mostly at secondary or primary forest and sometimes wandering up till the forest edge.

The most abundant scrubfowl was recorded at Ake Jira. They were very vocal so that their presence was easily detected. Their mound were rather abundant and easily found in the forest.

Wosea was also a habitat for Dusky Scrub-fowl. However, since the forest around Wosea River was severely disturbed, they were found only at the remaining fragmented forest and up river. This species was not observed in Tofu Blewen and Boki Mekot.

Columbidae

Nine species of Columbidae had been recorded on surveyed area. Three of them have restricted distribution only on North Moluccas i.e. Cinnamon-bellied Imperial Pigeon (*Ducula basilica*), Scarlet-breasted Fruit-dove (*Ptilinopus bernsteini*) and Grey-headed Fruit-dove (*Ptilinopus hyogastra*). The White-eye Imperial Pigeon (*Ducula perspicillata*) has extended distribution to Papua. The other five species: Emerald Dove (*Chalcophaps indica*), Pied Imperial Pigeon (*Ducula bicolor*), Superb Fruit-dove (*Ptilinopus superbus*), Slender-billed Cuckoo-dove (*Macropygia amboinensis*) and Spotted-turtle Dove (*Streptopelia chinensis*) were widely distributed in Indonesia and some of its extremities.

Most of the pigeons and doves were observed in the forested area. It was only Spotted-turtle Dove, which is adaptive to open area, encountered in Wosea. Emerald Dove was seen only at Wosea and Ake Jira, and it was absent in Tofu Blewen and Boki Mekot. The undulating landscapes at the latest two locations probably were the restriction features for Emerald Dove as it was fast flyers on low level ground. Pied Imperial Pigeon has the most wide-spread altitudinal distribution among others, although it was absent in Wosea presumably due to recently forest disturbance around the area.

Some species such as Pied Imperial Pigeon and Grey-headed Fruit Dove could be found in a flock of five individuals up to 15 individuals. However, the other species were spotted singly or in pairs.

Psittacidae

The numbers of Psittacidae family recorded were eight species i.e. Moluccan King Parrot (*Alisterus amboinensis*), Red-cheeked Parrot (*Geoffroyus geoffroyi*), Eclectus Parrot (*Eclectus roratus*), White Cockatoo (*Cacatua alba*), Moluccan Hanging-parrot (*Loriculus amabilis*), Chattering Lory (*Lorius garrulus*), Violet-necked Lory (*Eos squamata*), Great-billed Parrot (*Tanygnathus megalorhynchus*). All of them are listed on the CITES Appendix II, Eclectus Parrot is protected by Indonesian law (PP No.7/1999) and Chattering Lory is categorized as Endangered species by IUCN.

All species were found in Ake Jira, whereas, in other sites, one or two species were missing from observation. Encountered birds were recorded, most of the time, in a flock of four up to ten or more individuals. This flock was not only formed by small sized parrots but also larger size such as Cockatoo or Eclectus Parrot. They foraged on the fruiting trees and usually perched at the top of canopy.

Bucerotidae

Blyth's Hornbill (*Rhyticeros plicatus*) is the only member of Bucerotidae that present in Moluccas and it occurs from Moluccas to Papua. Blyth's Hornbill was found in a flock of 15 individuals at Ake Jira. They were perching and foraging on the fruiting fig tree next to the river. On the other occasion they were usually seen flying alone or in a pair. This hornbill was not encountered in Boki Mekot.

Pittidae

Three species of Pittas are present on the Moluccas archipelago from which one of them, Elegant Pitta (*Pitta elegans*), occurs from Sulawesi down to Lesser Sunda. The North Moluccan record of Elegant Pitta came from the neighbouring island, Ternate, and, up to now, none of them had ever been observed on Halmahera. Therefore, none of this in-

dividual was put up on the record list. Whereas two other species, Red-bellied Pitta (*Pitta erythrogaster*) and Ivory-breasted Pitta (*Pitta maxima*), were observed on the area.

A Red-bellied Pitta was caught in the mistnet over a small hill close to the Wosea River. It was the only record for this species as neither sound nor sight was made afterwards. An Ivory-breasted Pitta was also caught in Ake Jira. Unlike Red-bellied Pitta, Ivory-breasted Pitta was rather vocal birds. Most observation of its presence was based on calls. One individual was seen perching at fallen logs holding worm on its beak at Tofu Blewen. Another individual was seen at Boki Mekot.

Meliphagidae

Two species of Meliphagidae, White-streaked Friarbird (*Melitograis gilolensis*) and Dusky Myzomela (*Myzomela obscura*), were recorded at Ake Jira, Tofu Blewen and Boki Mekot. The latest was common all over the area, although, it was not observed in Wosea. They were usually foraging on the flowers in the canopy together with the sunbird. Like sunbird, they sometimes flew down to middle stratum where some of them were caught in the mist-nets at Tofu Blewen.

White-streaked Friarbird is the endemic genus of Friarbirds in Halmahera. Other Friarbird from another genus occurs in North Moluccas is Dusky Friarbird (*Philemon fuscicapillus*). This species is also endemic to North Moluccas but occurs only in Morotai Island, north tips of Halmahera.

White-streaked Friarbird was rather common at survey sites. Some of the sightings were made at Ake Jira where a pair foraging around the bushes down to the ground. Whereas another pair, still at Ake Jira, was observed flying back and forth from a tree to another the opposite next to the road. In Tofu Blewen, a pair of White-streaked Friarbird was caught on mist-net at the forest edge.

Oriolidae

There is only one species of oriole present in Halmahera i.e. Dusky Oriole (*Oriolus phaeochromus*) which is endemic to this island, while the other orioles occur in South Moluccas. They are common birds which can be found at all sites. Like other oriole, Dusky Oriole is vocal bird and usually takes higher up on the canopy.

Paradisidae

From about forty-three species of birds of paradise that are mainly present in Papua island and Australia, two endemic genera of birds of paradise are disjunctly inhabited North Moluccas skipping South Moluccas due to the tectonic action in the past (Heads 2002). They are Standardwings Birds of Paradise (*Semioptera wallacei*) and Paradise Crow (*Lycocorax pyrrhopterus*).

Both species were found in all sites but Standardwings was absent in Wosea. They usually flew in flock of two to four of each species. These species were rather common and could be present from secondary forest to primary forest. BirdLife surveys showed that Paradise Crow and Standardwing were the most fifth and sixth frequently recorded passerine on Halmahera (Frith & Poulsen 1999). They were found both at primary and logged forest, and their density were c. 0.4 birds per ha (Frith & Poulsen 1999).

Mist-netting and Observation Records

Current research indicated that from a total numbers of recorded birds, data obtained from direct observation were of the most prominent than those of mist-netting. Mist-netting could only cover around 41 % of total birds recorded meanwhile observation yielded 92%. Although mist-nettings have been used many decades for counting relative abundance, some disadvantages occur that the proportion of avian community examined were restricted to many factors (Remsen & Good 1996). Capture rates

as the basic information may have been different according to forest structure, community structures or season. Moreover, this methods were suited for specific and long term monitoring such as understory communities and demography studies (Redfern & Clark 2001). Nonetheless, using mist-nets allowed us to get species that skulk around bushes, shrubs or nocturnal birds that normally difficult to be observed such members from Kingfishers family and Moluccan Owlet-nightjar (*Aegotheles crinifrons*). Mist-nets data from current study were not suitable to be incorporated onto abundance assessment rather than complementary effort for inventory, collecting specimens and samples for molecular works.

Bird Communities

The observed bird species and index of species richness on every habitat types were relatively similar (Table 1). Nevertheless, the results showed the indication that bird diversity at Tofu Blewen and Ake Jira was slightly higher than other locations.

Table 1. Comparison of observed species richness, Shannon diversity index and Shannon Evenness

NOMINATOR	WOSEA	AKE JIRA	TOFU BLEWEN	BOKI MEKOT
Species Richness	41	48	50	37
Family Richness	23	25	24	21
Shannon	2.54	2.63	2.64	2.52
Evenness	0.95	0.93	0.94	0.96

While the overall communities did not show the significant differences between sites, rarefaction function showed that expected number of species could reach the plateau as the numbers of birds increase (Figure 4). From this plots, it was seen that the birds diversity in Tofu Blewen was higher and it seemed that the number of species still increase. Bird diversity in Ake Jira was less rich compare to Tofu Blewen and it almost reached the plateau already compared to bird community in Tofu Blewen. Similar trend was showed in Boki Mekot. While the point counts was differ for only three points, ex-

pected numbers of species were far less as the number of birds counts were fewer than those in Tofu Blewen and Ake Jira. Interesting results was shown in Wosea.

Although number of point counts were only nine and the number of expected species was the lowest, the rarefaction plots showed that the birds richness in Wosea could be higher. The rarefaction plot did not reach the plateau yet as the other three sites and the expected number was just a little higher than in Boki Mekot. This results gave the indication that Wosea as the lowland area could contained the most diverse birds communities if the habitat were still intact.

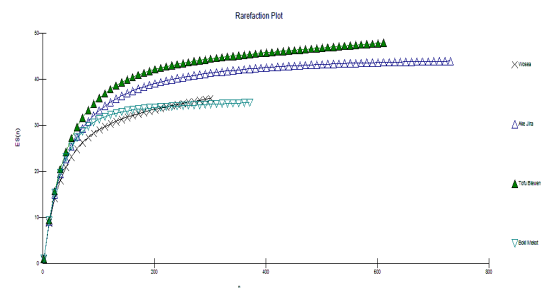


Figure 4. Rarefaction plot showed the expected species as function of numbers of birds counts

Several species demonstrated the tendency of changed in abundance towards the gradient of altitude despite of low correlation values. Three species of parrots: White Cockatoo (*Cacatua alba*), Eclectus Parrot (*Eclectus roratus*) and Red-cheeked Parrot (*Geoffroyus geoffroyi*) decreased in numbers as the altitude increasing ($R^2=0.25$, $R^2=0.16$, $R^2=0.12$, $p<0.05$, respectively). The other species that showed similar trend were Dusky Megapode (*Megapodius freycinet*) ($R^2=0.31$, $p<0.05$) and Blyth's Hornbill (*Rhyticeros plicatus*) ($R^2=0.11$, $p<0.05$). On the other hand some species increased in abundance towards the higher elevation. Superb Fruit Dove (*Ptilinopus superbus*) showed positive relationship in high altitude ($R^2=0.20$, $p<0.05$). Standardwing (*Semioptera wallacei*), Spectacled Imperial Pigeon (*Ducula perspicillata*) and Ivory-

breasted Pitta (*Pitta maxima*) showed similar trend as Superb Fruit Dove.

Shared species varied between sites (Figure 5). The biggest numbers of shared species were shown between Ake Jira - Tofu Blewen and Tofu Blewen – Boki Mekot which more than 50% of species were present at each sites. However, less than half of the species from Tofu Blewen and Boki Mekot were similar to those in Wosea.

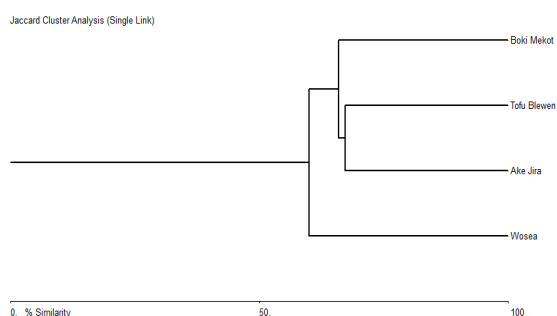


Figure 5. Shared species across survey sites. Wosea showed less similar communities in comparison to the other three sites

Breeding and Migratory Birds

Some species were observed to have eggs on their nest such as Willy Wagtail and Spangled Drongo. One specimen of female Scarlet-breasted Fruit Dove still had an egg on its reproductive tracks. However, other species were still at the stage of building nest such as Red-cheeked Parrots. Several recruits were recorded to join the flock, especially, from the group of monarchs and flycatchers such as Spectacled Monarch (*Monarcha trivirgatus*) and Shinning Monarch (*Myiagra alecto*).

The recent records of migratory birds in Halmahera were scarce. If it was available, it could probably be based on the migratory waterbirds. However, since these surveys did not cover coastal and swampy area, the chance to records them was none. However, two migratory passerine, one kingfisher and at least one species of raptor were detected in Wosea, Ake Jira, Tofu Blewen and Boki Mekot. An individual of Yellow Wagtail (*Motacilla flava*) was

recorded both in Ake Jira and Tofu Blewen and the individual from Ake Jira was caught on the mist-net. A Common Kingfisher (*Alcedo atthis*) was trapped on the mist-net at Wosea. Grey-streaked Flycatchers (*Muscicapa griseisticta*) were frequently seen on the open area of Tofu Blewen and Boki Mekot.

Conservation and Threat

Bird communities in Central and Eastern Halmahera were the most abundant and diverse at the lowland. Some species were declining in numbers as the elevation increased. However, immediate threats were very apparent at the lowland for example the land clearing in Wosea area. Deliberate land clearing had taken place just recently around the rivers. These activities obviously pushed the birds moving upstream where the forest was still in good condition. Therefore, the number of birds being observed was low compare to Ake Jira which had similar landscape and vegetation features. Moreover, habitat disturbance in Wosea negatively influenced the presence of birds with specific status such as endemic and threatened species. Endemic species observed in Wosea were only half of numbers of other sites.

The loss of fruiting trees showed immediate impact on bird communities in this area especially during breeding season where birds need more food either for reproduction or rearing chicks. In the long term, forest ecosystem will suffer from the lack of seeds dispersal agents by which, in some degree, can speed up forest regeneration. This situation was best explained by the birds' community in Ake Jira where many birds, especially the frugivores such as Parrots, Hornbill, Doves and Pigeons, congregated on Figs and other fruiting trees.

On the other places such as Tofu Blewen and Boki Mekot, fruiting trees might also be strong factors for bird's richness and distribution. If the forest was good, undulating landscapes and higher altitude influenced the vegetation communities. The rarity of fruiting trees due to, possibly, altitudinal effect,

might have the role to restrict the size of frugivores flocks. Since Halmahera was formed by different type of rock formation, it influenced the vegetation structures as such rainforest on ultrabasic rock appeared to be impoverished in comparison with rainforest on other rock formations, in particular supporting very low numbers of two species of threatened parrot (Poulsen & Lambert 1999).

Whilst the frugivores less numerous in Tofu Blewen and Boki Mekot, the diversity in bird of preys was the opposite. Primary forest in the hill and mountainous area were safe heaven for raptors for nesting and roosting due to the difficulty of being raid by nest raiders. Many records showed that raptors, especially large species such as Black Eagle and Gurney's Eagle, usually take the upper branch on trees that grow on steep hills for nesting. High place was also meant that they would get enough warm air and height for long-distance flying, either for migrating or searching food.

Some birds of Halmahera especially parrot were the most eftersought birds for market. In the past, White Cockatoo, Chattering Lory (*Lorius garulus*) and Violet-eared Lory (*Eos squamata*) were the most psittacine pet in the North Moluccas for both domestic and international trade (Lambert 1993). Since the outbreak the Avian Influenza, legal international trade were stopped so birds from this area were mostly trade for domestic market although many of them were still smuggled to other country. Although during fieldwork, no hunting activities were observed, according to locals parrots were still the main target for bird collectors especially for cockatoo. Hunters would observe the nesting tree and collected either the young or adult birds. Nowadays, the level of hunting may have decrease due to stronger law enforcement applied by the police.

Conservation action is the best applied both for slowing the rate of forest conversion and stop illegal trading of parrots and other birds. Land conversion for mining, plantation and logging will di-

minish all forest resources needed by birds and other animals. In addition, it will also influence the hydrology of the island since good forests were almost around the riparian area. Appropriate habitat management were strongly needed and urgent to be applied in Halmahera since many stakeholders both government and private have their agenda to exploit the land for short-term profit. Threats from hunting would give immediate impact on bird populations and in the long term, combine with land conversion, local extinction could be predicted. It will need a lot of effort and energy by all stakeholders and local communities to prevent biodiversity loss by well land management and strong law enforcement.

Conclusion

Bird communities in Central and East Halmahera were considerably rich. All study sites showed similar trend of bird diversity, however, disturbed and high elevation area showed less diversity. Several species, especially parrots, showed significant relationship with elevation gradient where the abundance would decrease as the altitude increase. Migratory birds and breeding birds were detected in several sites. Threats to birds of Halmahera mainly come from land conversion to mining, cultivation and logging. Hunting activities were not observed but it still goes on by the locals. Conservation action should focus on reducing land conversion and hunting to prevent biodiversity loss in Halmahera, especially at the lowland area.

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Appendix 1. Checklist of birds observed in the region around Weda Bay up to East Halmahera (W: Wosea, AJ: Ake Jira, TB: Tofu Blewen, BM: Boki Mekot, D: Distribution, N: Migratory, EH: Endemic of Halmahera, E: Endemic of Indonesia, I: IUCN status, C: CITES status, RI: Indonesian protected status, A: UU No.5/1990, B: PP No. 7/1999, C: PP No.8/1999)

No	Species	Indonesia	English	Locations						RI	
				W	AJ	TB	BM	D	I		C
Accipitridae											
1	<i>Pandion haliaetus</i> (Linnaeus, 1758)	Elang Tiram	Osprey	P				N		II	AB
2	<i>Haliastur indus</i> (Boddaert, 1783)	Elang Bondol	Brahminy Kite		P	P				II	AB
3	<i>Accipiter soloensis</i> (Horsfield, 1821)	Elangalap Cina	Chinese Sparrowhawk			P		N		II	AB
4	<i>Accipiter henricogrammus</i> (G.R. Gray, 1860)	Elangalap Halmahera	Moluccan Goshawk	P	P	P		EH		II	AB
5	<i>Ictinaetus malayensis</i> (Temminck, 1822)	Elang Hitam	Black Eagle			P				II	AB
6	<i>Aquila gurneyi</i> G.R. Gray, 1860	Rajawali Kuskus	Gurney's Eagle			P			NT	II	AB
Falconidae											
7	<i>Falco moluccensis</i> (Bonaparte, 1850)	Alapalap Sapi	Spotted Kestrel			P				II	AB
Anatidae											
8	<i>Tadorna radjah</i> (Lesson, 1828)	Umukia Raja	Raja Shelduck				P				
Megapodidae											
9	<i>Megapodius freycinet</i> Gaimard, 1823	Gosong Kalam	Dusky Megapode			P	P	E			AB
Columbidae											
10	<i>Ptilinopus bernsteinii</i> (Schlegel, 1863)	Walik Dada-merah	Scarlet-breasted Fruit Dove			P	P	P	EH		
11	<i>Ptilinopus superbus</i> (Temminck, 1810)	Walik Raja	Superb Fruit Dove				P	P			
12	<i>Ptilinopus hyogastra</i> (Temminck, 1824)	Walik Kepala-kelabu	Grey-headed Fruit Dove			P	P	P	EH		
13	<i>Ducula perspicillata</i> (Temminck, 1824)	Pergam Mata-putih	Spectacled Imperial Pigeon			P	P	P	E		
14	<i>Ducula basilica</i> Bonaparte, 1854	Pergam Boke	Cinnamon Imperial Pigeon			P	P	P	EH		
15	<i>Ducula bicolor</i> (Scopoli, 1786)	Pergam Laut	Pied Imperial Pigeon			P	P	P			
16	<i>Macropygia amboinensis</i> (Linnaeus, 1766)	Uncal Ambon	Brown Cuckoo Dove			P	P	P			
17	<i>Streptopelia chinensis</i> (Scopoli, 1786)	Tekukur Biasa	Spotted Dove			P					
18	<i>Chalcophaps indica</i> (Linnaeus, 1758)	Delimukan Zamrud	Common Emerald Dove			P	P	P			

No	Species	Indonesia	English	Locations						C	RI
				W	AJ	TB	BM	D	I		
Psittacidae											
19	<i>Eos squamata</i> (Boddaert, 1783)	Nuri Kalung-ungu	Violet-necked Lory		P	P		E		II	
20	<i>Lorius garrulus</i> (Linnaeus, 1758)	Kasturi Ternate	Chattering Lory		P	P		EH	EN	II	
21	<i>Cacatua alba</i> (P. L. S. Müller, 1776)	Kakatua Putih	White Cockatoo		P	P		EH	VU	II	
22	<i>Ecluctus roratus</i> (P. L. S. Müller, 1776)	Nuri Bayan	Ecluctus Parrot		P					II AB	
23	<i>Geoffroyus geoffroyi</i> (Bechstein, 1811)	Nuri Pipi-merah	Red-cheeked Parrot		P	P		P		II	
24	<i>Tanygnathus megalorynchos</i> (Boddaert, 1783)	Betekelapa Paruh-besar	Great-billed Parrot		P					II	
25	<i>Alisterus amboinensis</i> (Linnaeus, 1766)	Nuriraja Ambon	Moluccan King Parrot		P	P		P	E	II	
26	<i>Loriculus amabilis</i> Wallace, 1862	Serindit Maluku	Moluccan Hanging Parrot		P	P		P	E	II	
Cuculidae											
27	<i>Cuculus saturatus</i> Blyth, 1843	Kangkok Ranting	Oriental Cuckoo		P				N		
28	<i>Surniculcus lugubris</i> (Horsfield, 1821)	Kedasi Hitam	Asian Drongo-Cuckoo			P					
29	<i>Centropus goliath</i> Bonaparte, 1850	Bubut Goliath	Goliath Coucal		P	P			EH		
Strigidae											
30	<i>Ninox squamipila</i> Bonaparte, 1850	Pungguk Maluku	Moluccan Boobook					P	E	II	
Aegothelidae											
31	<i>Aegotheles crinifrons</i> Bonaparte, 1850	Atoko Maluku	Moluccan Owllet-Nightjar					P	E		
Caprimulgidae											
32	<i>Caprimulgus macrurus</i> Horsfield, 1821	Cabak Maling	Large-tailed Nightjar		P						
Apodidae											
33	<i>Collocalia fuciphagus</i> Thunberg, 1821	Walet Sarang-putih	Edible-nest Swiftlet		P						
34	<i>Collocalia esculenta</i> (Linnaeus, 1758)	Walet Sapi	Glossy Swiftlet		P	P		P	P	P	
Hemiprocidae											
35	<i>Hemiprocne mystacea</i> Lesson, 1827	Tepekong Kumis	Moustached Treeswift		P	P		P	P	P	

No	Species	Indonesia	English	Locations			D	I	C	RI
				W	AJ	TB				
Alcedinidae										
36	<i>Alcedo atthis</i> (Linnaeus, 1758)	Rajaudang Erasia	Common Kingfisher	P						AB
37	<i>Alcedo azurea</i> Latham, 1801	Rajaudang Biru-langit	Azure Kingfisher	P						AB
38	<i>Ceyx lepidus</i> Temminck, 1836	Udangmerah Kerdil	Chameleon Dwarf Kingfisher	P	P					AB
39	<i>Haleyon diops</i> Temminck, 1824	Cekakak Biru-putih	Blue-and-white Kingfisher			P			EH	B
40	<i>Tanyptera galatea</i> G. R. Gray, 1859	Cekakakpita Biasa	Galatea Paradise Kingfisher	P	P	P				AB
Bucerotidae										
41	<i>Rhyviceros plicatus</i> J. R. Forster, 1781	Julang Irian	Blyth's Hornbill	P	P	P				II AB
Pittidae										
42	<i>Pitta erythrogaster</i> Temminck, 1823	Paok Mopo	Red-bellied Pitta	P						AB
43	<i>Pitta maxima</i> Müller & Schlegel, 1846	Paok Halmahera	Ivory-breasted Pitta		P	P	P		EH	AB
Hirundinidae										
44	<i>Hirundo tahitica</i> Gmelin, 1789	Layanglayang Batu	Pacific Swallow	P						
Motacillidae										
45	<i>Motacilla flava</i> Linnaeus, 1758	Kicuit Kerbau	Western Yellow Wagtail			P				
Campepagidae										
46	<i>Coracina papuensis</i> (Gmelin, 1788)	Kepudangungu Kartula	White-bellied Cuckoo-shrike	P	P	P				
47	<i>Coracina tenuirostris</i> (Jardine, 1831)	Kepudangungu Miniak	Common Cicadabird	P	P	P				P
48	<i>Lalage aurea</i> (Temminck, 1827)	Kapasam Halmahera	Rufous-bellied Triller						EH	
Pycnonotidae										
49	<i>Thapsimillas affinis</i> (Hombrom & Jacquinot, 1841)	Brinji Emas	Golden Bulbul	P	P	P				E
Muscicapidae										
50	<i>Muscicapa griseisticta</i> (Swinhoe, 1861)	Sikatan Burik	Grey-streaked Flycatcher			P				P

No	Species	Indonesia	English	Locations							D	I	C	RI
				W	AJ	TB	BM							
Monarchidae														
51	<i>Monarcha pileatus</i> Salvadori, 1878	Kehicap Tengkek-putih	White-naped Monarch	P	P	P	P	P	P	P	E			
52	<i>Monarcha trivirgatus</i> (Temminck, 1826)	Kehicap Kacamata	Spectacled Monarch	P	P	P	P	P	P	P	E			
53	<i>Myiagra galeata</i> G. R. Gray, 1860	Sikatan Kelabu	Moluccan Flycatcher											
54	<i>Myiagra alecto</i> (Temminck, 1827)	Sikatan Kilap	Shining Flycatcher	P	P	P	P	P	P	P				
Rhipiduridae														
55	<i>Rhipidura leucophrys</i> (Latham, 1801)	Kipasan Kebun	Willie-wagtail	P	P									
56	<i>Rhipidura rufifrons</i> (Latham, 1801)	Kipasan Dada-hitam	Rufous Fantail											
Pachycephalidae														
57	<i>Pachycephala phaionotus</i> (Bonaparte, 1850)	Kancilan Pulau	Island Whistler	P	P	P	P	P	P	P	E			
58	<i>Pachycephala pectoralis</i> (Latham, 1801)	Kancilan Emas	Australian Golden Whistler	P	P	P	P	P	P	P				
Nectarinidae														
59	<i>Leptocoma sericea</i> (Lesson, 1827)	Burungmadu Hitam	Black Sunbird	P	P	P	P	P	P	P				AB
60	<i>Cinnyris jugularis</i> (Linnaeus, 1766)	Burungmadu Sriganti	Olive-backed Sunbird	P										AB
Zosteropidae														
61	<i>Zosterops atriceps</i> G. R. Gray, 1860	Kacamata Halmahera	Cream-throated White-eye											EH
Meliphagidae														
62	<i>Myzomela obscura</i> Gould, 1843	Myzomela Remang	Dusky Myzomela											AB
63	<i>Melitograis gilolensis</i> (Bonaparte, 1850)	Cikukua Halmahera	White-streaked Friarbird											AB
Ploceidae														
64	<i>Passer montanus</i> (Linnaeus, 1758)	Burunggereja Erasia	Eurasian Tree Sparrow											P

No	Species	Indonesia	English	Locations						RI	
				W	AJ	TB	BM	D	I		C
Sturnidae											
65	<i>Aplonis mysolensis</i> (G. R. Gray, 1862)	Perling Maluku	Moluccan Starling			P				E	
Oriolidae											
66	<i>Oriolus phaeochromus</i> G. R. Gray, 1861	Kepudang Halmahera	Dusky-brown Oriole	P	P	P	P			EH	
Dicruridae											
67	<i>Dicrurus bracteatus</i> Gould, 1843	Srigunting Lencana	Spangled Drongo	P	P	P	P				
Paradisidae											
68	<i>Lycocorax pyrrhopterus</i> (Bonaparte, 1850)	Cendrawasih Gagak	Paradise-crow	P	P	P	P			EH	ABC
69	<i>Semioptera wallacei</i> (G. R. Gray, 1859)	Bidadari Halmahera	Standardwing		P	P	P			EH	ABC
Corvidae											
70	<i>Corvus validus</i> Bonaparte, 1850	Gagak Halmahera	Long-billed Crow	P	P	P	P			EH	