Asian Journal of Conservation Biology, December 2020. Vol. 9 No. 2, pp. 258-268 AJCB: FP0142
ISSN 2278-7666 ©TCRP Foundation 2020

Bird diversity in the production forest management unit in North Seram, Central Maluku Regency, Indonesia

Yan E. Persulessy*, J.D. Putuhena

Department Forest Management Study Program, Postgraduate, Pattimura University, Ambon
Jln. Dr.Ir M.Latumeten, PGSD Campus – Ambon 57131, Indonesia

(Received: April 16, 2020; Revised: June 01 & July 08, 2020; Accepted: July 22, 2020)

ABSTRACT

Bird diversity hotspots are important locations for species conservation. Conservation actions at these hotspot locations will protect important forest areas outside the designated conservation areas. This study aimed to measure the importance of the location of bird diversity hotspots in the area of Production Forest Management Unit (PFMU) in the Wae Sapalewa area in North Seram, Central Maluku.The method used was a territorial search survey to determine hotspot locations. Point Count method was used to collect bird species information. The analysis was performed quantitatively and descriptively so that it is easy to understand. There were 7 locations of bird diversity hotspots with important species status. 121 species of birds were found of 9 endemic species of Seram Island (*Gymnophaps mada, Eos semilarvata, Lorius domicella, Cacatua moluccensis, Halcyon lazuli, Rhipidura dedemi, Basilornis corythaix, Philemon subcorniculatus, Myzomela blasii*), 4 endangered species (*Halcyon lazuli, Cacatua moluccensis, Lorius domicella, Eulipoa wallacei*), 6 unique species (*Casuarius casuarius, Charmosyna placenti,s Micropsitta bruijnii, Alisterus amboinensis, Ninox squamipila, Tanysiptera galatea, Rhyticeros plicatus*) and 21 limited distributed species. This type of bird is referred to as the "Indicator Bird Species". Production forest areas such as PFMU have potential bird diversity hotspots that can be applied in management blocks for the conservation and ecotourism purposes.

Key words: Bird, conservation, diversity hotspot, forest management unit.

INTRODUCTION

The concentration location of various bird species that are typical with a high level of endemicity in an area has been designated as an important location for conservation. This location is considered as a part of the concept of the biodiversity hotspot locations for a smaller scale, such as Endemic Bird Area or EBA (Vale *et al.,* 2018) and Key Biodiversity Area or KBA (Dudley *et al.,* 2014; IUCN, 2016 ; Tantipisanuh *et al.,* 2016 ; Donald *et al.,* 2019). With an interest value in the bird species, the concentration location of various bird species with a high level of endemicity can be referred to as an important Bird Diversity Hotspot location. Endemic bird species have been proven to be used in many places as an effective indicator for assessing the overall diversity of communities in an area (Mekonen, 2017). Areas where endemic bird species are found also support a variety of other important animal species and various types of plants (Tanalgo *et al.,* 2015; Şekercioglu *et al.,*2019).

At present, forestry development is directed at forest management in accordance with its main function and designation at the site level, and for this reason the government has issued a Forest Management Unit (FMU) development policy based on Minister of Forestry Decree No.230/Kpts-II/2003. One of them is PFMU Wae Sapalewa which was determined through Minister of Forestry Decree No.336/Menhut-II/2010 dated May 25, 2010, covering an area of 67,057 ha located in North Seram Subdistrict, Central Maluku Regency, Maluku Province.

Production Forest Management Unit (PFMU) Wae Sapalewa is a Forest Management Unit intended for timber forest production businesses (Forest Area Consolidation Center Region IX Ambon, 2013). However, this Forest Management Unit (FMU) has a rich biodiversity that is interesting to study. Therefore, this FMU area is believed to be used to identify biodiversity hotspot locations on a small scale, which can be applied to management blocks according to the work plan of FMU, especially in management blocks intended for protection and other uses, so as to produce simple hotspot locations in the form of bird diversity hotspots. This will facilitate management by the FMU organization responsible for limited forest areas to achieve the goals of conservation and utilization of environmental services in the future. For this purpose, seven bird diversity hotspots in the PFMU Wae Sapalewa area have been identified which are believed to provide value and benefits for achieving sustainable forest management at the site level for the North Seram Island forest area (Persulessy *et al.,* 2019). The aims of this study were to examine the richness and abundance of bird species with an important status that exist at the seven bird diversity hotspots identified in the PFMU Wae Sapalewa area, and to study the conservation values of the seven hotspots.

MATERIALS AND METHODS

Study area

This study was conducted in the PFMU Model Wae Sapalewa area, North Seram Subdistrict, Central

*Corresponding Author's E-mail: yan.elp71@gmail.com

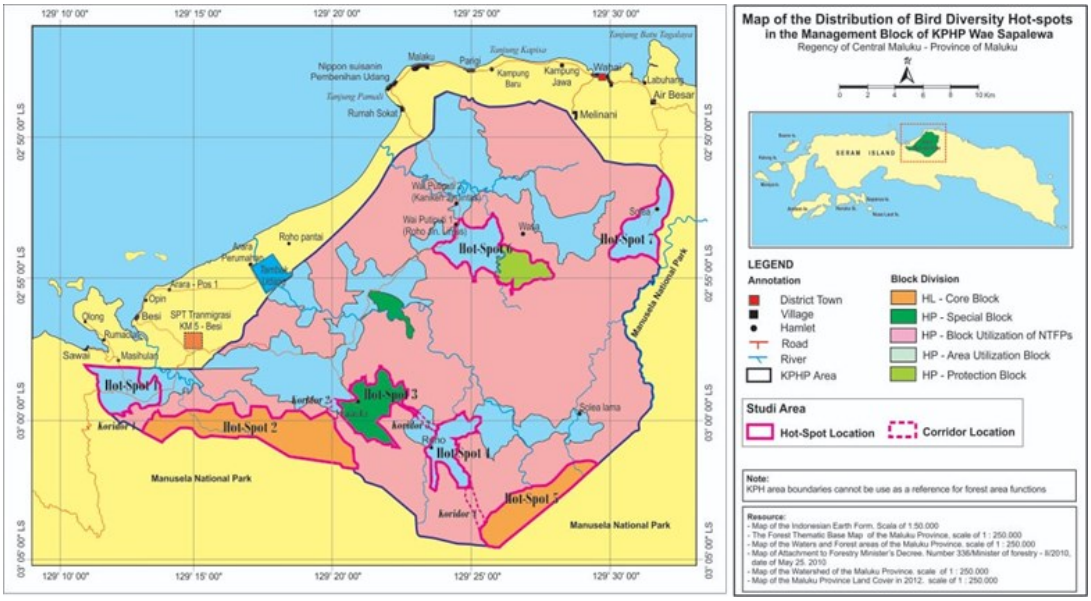

Figure 1. Distribution of hotspot locations in the Wae Sapalewa PFMU management block.

Maluku Regency, Seram Island, Maluku Province, Indonesia. Geographical location is at 129°10'15"- 129° 31'47" East Longitude and 2°47'39"- 3°4'38" South latitude (Forest Area Consolidation Center Region IX Ambon, 2013). The locations of the Biodiversity Hotspots were selected using groups of bird species as indicators, which were then used as criteria in assessing and determining the distribution of Biodiversity Hotspot locations. The map of the location distribution and forms of the Bird Diversity Hotspots is presented in Figure 1. Since it used bird species as an indicator, the Biodiversity Hotspot can also be referred as the Bird Diversity Hotspot.

The dominant type of land cover in the PFMU Wae Sapalewa is a lowland rainforest <300 m, and some of which has experienced exploitation of timber stands in the 1980s to early 2000s. There are also two other types of land cover which are quite extensive, i.e., freshwater swamp forest that experiences periodic inundation, but a small portion experiences permanent inundation, and lowland forest formation on limestone. Physiography of PFMU Wae Sapalewa area consists mostly of sloping and undulating areas, mainly in the North and East; while the West, South and Southeast are more dominated by hilly physiography with narrow valleys. The highest part in the South and Southeast is Mount Kalapahin; 400 m, asl, and the highest part in the West is Morita Hill; 350 m, asl (CoLUPSIA, 2013.) Based on the classification of climate regions by Schmidht and Ferguson, the PFMU Wae Sapalewa area is included in climate zone B (Schmidht and Ferguson, 1951; Lakitan, 2002).

The locations of Bird Diversity Hotspots and the form of the Wae Sapalewa PFMU management block are presented in Table 1. The Bird Diversity Hotspot has the shape and boundaries that follow the form of the Wae Sapalewa PFMU management blocks and the natural boundaries in the form of ridges and river borders as follows: Hotspots located throughout the Protection Forest (PtF) - Core Block, Production Forest (PdF) - Special Block, and Production Forest (PdF) - Protection Block. Hotspot locations whose boundaries cover only part of the form of management blocks, such as hotspot locations in the Production Forest (PdF) - Area Utilization Block. Furthermore, the shape and boundaries of hotspot locations in more detail utilize the boundaries of sub-block distribution, and also the natural boundaries in the form of ridges, valleys and rivers.

The locations of Bird Diversity Hotspots and the form of the Wae Sapalewa PFMU management block are presented in Table 1. The Bird Diversity Hotspot has the shape and boundaries that follow the form of the Wae Sapalewa PFMU management blocks and the natural boundaries in the form of ridges and river borders as follows: Hotspots located throughout the Protection Forest (PtF) - Core Block, Production Forest (PdF) - Special Block, and Production Forest (PdF) - Protection Block. Hotspot locations whose boundaries cover only part of the form of management blocks, such as hotspot locations in the Production Forest (PdF) - Area Utilization Block. Furthermore, the shape and boundaries of hotspot locations in more detail utilize the boundaries of sub-block distribution, and also the natural boundaries in the form of ridges, valleys and rivers.

Table 1. Bird diversity hotspot locations and the Wae Sapalewa PFMU management block forms.

Hotspot Location	Forms in the Wae Sapalewa PFMU Management Block
Masihulan	PdF - Area Utilization Block
Kaluala Mountain	PtF - Core Block
Hualu	PdF - Special Block
Roho	PdF - Area Utilization Block
Kalapain Mountain	PtF - Core Block
Wai Putiputi	PdF - Area Utilization Block, and PdF / Protection Block
Solea	PdF - Area Utilization Block, and PdF / HHBK-HA Utilization Block

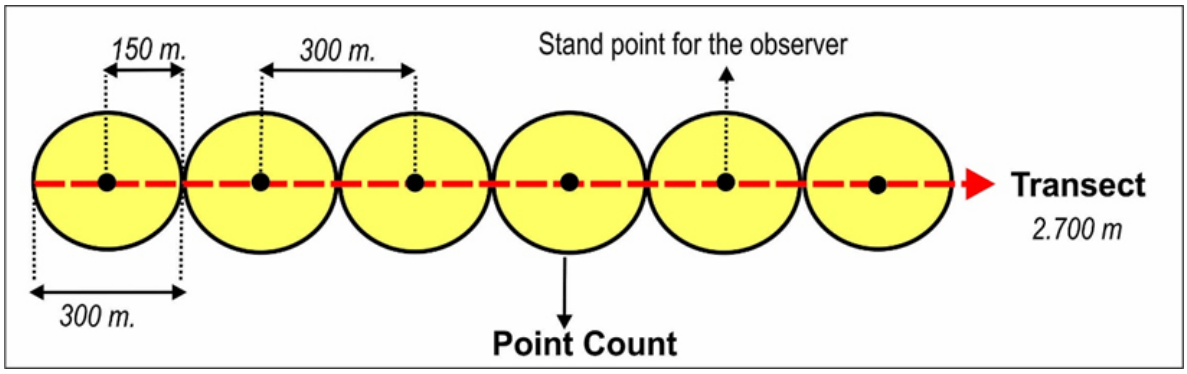

Figure 2. Design of point count on the transects

Methods of study

The research was conducted in March 2015 to December 2018. The bird data collection was the Point Count method (Vergara *et al.,* 2010; Sullivan, 2012; Blackwell*et al.,*2013). Point Count was an imaginary circular area, where the observer stands in the middle while looking in all directions for data collection for 15 minutes. Each Point Count was also called a Data Collection Station.The shape of the Point Count in the field was as follows: the length of the circle area of the Point Count was 300 m and the radius length of the circle was 150 m. Point count was placed on the transect (working line), with a distance between the center of the point count was 300 m. The total length of the transect at the hotspot location was 10.8 Km, divided into 4 transects, each was 2.7 Km long. Each transect had 10 Point Count with a total of 4 transects at each hotspot location, thus there were a total of 40 Point Count at each hotspot location (Figure 2).

Data collection

Data collection was performed based on the point count on the transect that was determined according to the representation of the transect location in the studied habitat, in which the observer stood in the center of the circle while observing in all directions for data collection for 15 minutes, then the observer moved to the next Point Count position by walking slowly. Data collection was performed only once, in the morning between 07.00 CET and 10.00 CET. Each transect was traced only once, and this was intended to obtain truly independent field data. The data variables collected were 1). Type information includes: hours of observation; type; number of contacts; number of individuals; form of observation; 2). Habitat information includes: Land cover type; Land cover conditions; Physiographic form; Place height; 3). Other information includes: Season and weather; and human activities. Factors to be considered in placing observation transects were the diversity of land cover types, land cover forms and variations in altitude, and these factors are important ecosystem gradients in the biodiversity distribution.

Data analysis

Species Richness Index (R_1)

Species richness index is the total number of species in a community, the value depends on the sample size of the area and the time needed to achieve it, as explained in the description of the data collection method above. The calculation of species richness index used the Margalef equation (Bibi and Ali, 2013).

$$R = \frac{(S - 1)}{Ln.\ N}$$

Where, R = Margalef species richness index
S = number of species observed
N = number of individuals of all types
Ln = natural logarithm value

Richness index category:

R < 2.5	Low species richness
2.5 > R < 4	Medium species richness
R > 4	High species richness

Abundance Classes Based on Amount of Observation Time

Analysis of Abundance Classes based on observation time was only intended for indicator bird species groups. This abundance class was based on the length of time or the total time of one bird species observed, then divided the total time into several categories of abundance classes. The classification of abundance classes was made according to the category of abundance classes by (Issa, 2019), which was modified in accordance with the conditions of the field collection data, as presented in Table 2.

Table 2. Categories of abundance classes

Duration of Time Observed	Abundance Value	Abundance Class
< 20 minutes	1	Rare
21 – 50 minutes	2	Uncommon
51 – 100 minutes	3	Often
101 – 200 minutes	4	Common
> 201 minutes	5	Very Common

Relative Abundance Index (RAI)

The relative abundance based on the Relative Abundance Index (RAI) referred to the number of individuals of a bird species compared to the total number of individuals of all bird species at all data collection stations. The Relative Abundance Index value is an indication which states the abundance condition of one bird species population to the population abundance of all bird species in the study location. The relative abundance index used the equation adopted from (Issa, 2019) (Table 3).

$$RAI = \frac{Number\ of\ individuals\ of\ a\ species\ (ni)}{The\ total\ number\ of\ individuals\ found\ (N)}\ x\ 100\ \%$$

Table 3. Categories of relative abundance

Relative Abundance Index Value	Abundance Category
< 15 %	Low
15 – 20 %	Medium
> 20 %	High

RESULTS

Bird Species Diversity at Hotspot Locations

There were 121 species of birds found in 7 Bird Diversity hotspot locations. Based on the species status; there were 9 endemic species of Seram Island, 4 endangered species according to the IUCN list, 21 limited distributed species, and 6 unique species (Table 4 and Figure 3).

Species richness

The Margalef species richness index in Table 5 showed that all hotspot locations had a high species richness index because the resulting richness index was at 7.96515-11.21258, and it means above the high richness index criteria of R > 4. This condition was caused by the high number of bird species found in all hotspot locations, ranging from 65 to 98 species, the number of individual bird species recorded at each hotspot location was quite good, and the total number of individuals recorded at each hotspot location was also good.

As per location, it was shown that the Solea and Masihulan Hotspot locations had a species richness index that was higher than other hotspot locations, each having a value at 11.01675 in Masihulan and 11.21258 in Solea. This was influenced by the number of species and the total number of individuals of all bird species collected at

Table 4. Species of birds found at 7 hotspot locations Expressed by the number of individuals of each species for each hotspot location

Bird Species Family	Scientific Name	Masihulan	Mt. Kaluala	Huaulu	Roho	Mt. Kalapahin	Wai Putiputi	Solea
CASUARIDAE	*Casuarius casuarius* Unique	1	7	1	6			5
FREGATIDAE	*Fregata ariel*	3						
PHALACROCOCIDAE	*Phalacrocorax melanoleucos*						1	2
ARDIDAE	*Egretta picata*						4	6
	Egretta intermedia						2	3
	Egretta garzetta	4					3	5
	Yxobrichus sinensis						1	1
THRESKIORNITHIDAE	*Therkiornis molucca*	1		1			1	3
ACCIPITRIDAE	*Pandion haliaetus*	2	1	1			1	2
	Aviceda subcristata	3	2	2	1	1	1	2
	Haliastur indus	14	9	7	4	3	8	13
	Haliaeetus leucogaster	1		1			1	1
	Accipiter novaehollandiae		1			1		1
	Accipiter erythrauchen En.M - BST	1	2	4	1	3		5
	Accipiter meyerianus	1	1	1				
	Ictinaetus malayensis	6	5	1				
	Aquila gurneyi	2	3	1	1	1		3
FALCONIDAE	*Falco moluccensis*	7	4	5		1	3	5
	Falco severus		2	1				2
ANATIDAE	*Tandorna radjah*							1
	Nettapus pulchellus				2		3	
	Anas gracilis				2			4
MEGAPODIDAE	*Megapodius reinwardt*	2	10	6	8	5	4	4
	Eulipoa wallacei BS T- VU							3
PHASIANIDAE	*Coturnix chinensis*	4		6				6
RALLIDAE	*Gallirallus philippensis*				1		1	2
	Amaurornis olivaceus	2			1		2	2
	Amaurornis phoenicurus						1	1
	Porphyrio porphyrio						1	
SCOLOPACIDAE	*Tringa stagnatilus*				2		2	5
COLUMBIDAE	*Columba livia*	12					10	16
	Streptopelia chinensis	8	4	7	3		4	9
	Macropygia amboinensis	8	7	5	5	3	4	5
	Reinwardtoena		8		6	6		
	Gymnophaps mada En.S,B	28	17	9	25	31	21	18
	Chalcophaps indica	4	4	2	1	2	2	3
	Geopelia striata	4	1	3	2		3	2
	Ptilinopus superbus	76	60	70	36	30	66	69

Table 4 contd.

	Ptilinopus rivoli	31	26		22	29		
	Ptilinopus viridis	112	96	81	84	57	58	67
	Ptilinopus melanospila		7		5	3		
	Ducula perspicillata BST	126	121	110	112	111	90	123
	Ducula concina BST	30	16	26				30
	Ducula bicolor	6					8	
PSITTACIDAE	*Eos bornea* En.M – BST	320	302	184	243	190	205	145
	Eos semilarvata En. S – BST		7			9		
	Trichoglossus haematodus	223	190	177	135	112	231	257
	Lorius domicella En.S - BST - VU	3						
	Charmosyna placentis Unique	57	32	74	37	36	78	81
	Micropsitta bruijnii Unique	7	30			12		
	Cacatua moluccensis En.S,KI-BST - VU	26	21	16	22	30	6	14
	Eclectus roratus	28	29	26	18	12	23	32
	Geoffroyus geoffroyi	96	81	88	76	53	77	90
	Tanygnathus megalorhynchos	108	78	95	68	56	81	87
	Alisterus amboinensis Unique	17	47	15	37	10	40	23
CUCULIDAE	*Cuculus saturates*		1		2			1
	Cacomantis sepulcralis	8	5	6	4	2	8	5
	Cacomantis variolus	2	1	1	1	1	2	3
	Chrysococcyx minutillus	2					1	
	Eudynamys scolopacea	18	6	20	12		10	16
	Eudynamys cyanochepala	12	5	10	6		4	7
	Scythrops novaehollandiae	36	37	22	17	5	28	33
CENTROPODIDAE	*Centropus bengalensis*	48		34			20	28
TYTONIDAE	*Tyto sororcula*		4		5			
STRIGIDAE	*Otus magicus*	22	14	18	13	7	13	19
	Ninox squamipila BST	6	2	4	4	1	5	3
CAPRIMULGIDAE	*Caprimulgus macrurus*	8		5			3	14
APODIDAE	*Collocalia vanikorensis*	280	240	310	110	275	255	305
	Collocalia infuscata	45	30	60		25	40	55
	Collocalia esculenta	920	860	990	720	660	825	1060
	Apus pasificus	26		18			12	37
HEMIPROCINIDAE	*Hemiprocne mystacea*	33	8	27	5		21	34
HALCYONIDAE	*Tanysiptera galatea* Unique	5	3		6		4	8
	Halcyon lazuli End.S,A,H - BST - VU	2	2		3		2	
	Halcyon chloris	24	24	8	21	2	18	20
	Halcyon sancta	14	13	10	12	5	11	18
ALCEDINIDAE	*Ceyx lepidus*	2	3	1	4		3	
	Alcedo atthis	1	3		3		2	2
MEROPIDAE	*Merops ornatus*	44	16	38	8		24	36
CORACIDAE	*Eurystomus orientalis*	9	2	10	1	2	7	12
BUCEROTIDAE	*Rhyticeros plicatus* Unique	86	60	58	70	56	49	47
PITTIDAE	*Pitta erythrogaster*		1		1	2		
	Pitta elegans		1			1		
HIRUNDINIDAE	*Hirundo rustica*	120	30	140			60	80
	Hirundo tahitica	55		40			25	45
MOTACILLIDAE	*Motacila flava*	6		9			7	11
	Motacila cinerea	12	3	18	2	2	12	9
CAMPEPHAGIDAE	*Coracina novaehollandiae*	7	13	16			12	10
	Coracina atriceps En.M - BST	33	21	18	14	17	26	20
	Coracina ceramensis En.M - BST	15	16	7	10	11	7	10

Table 4 contd.

PYCNONOTIDAE	*Ixos affinis affinis*	66	78	71	55	40	53	58
DICRURIDAE	*Dicrurus bracteatus*	207	201	199	115	92	188	231
CORVIDAE	*Corvus enca*	23	8	25			17	31
SYLVIIDAE	*Locustella fasciolata*	13		10				8
	Acrocephalus orientalis	3		1				3
	Phylloscopus borealis	11	5	9		4		9
CISTICOLIDAE	*Cisticola exilis*	14		8			6	15
MUSCICAPIDAE	*Muscicapa griseisticta*	28	22	26	13	16	26	23
	Ficedula buruensis En.M - BST	4	4	2	1	8		
MONARCHIDAE	*Monarcha trivirgatus*	26	48	8	21	27	29	21
	Myagra galeata BST	31	30	32	21	22	18	18
RHIPIDURIDAE	*Rhipidura leucophrys*	21		12	8		15	28
	Rhipidura rufiventris	18	28	5	18	14	16	3
	Rhipidura dedemi En.S - BST	7	14	2	14	15	5	9
PACHYCEPHALIDAE	*Pachycephala pectoralis*		5			3		
	Pachycephala griseonota BST	11	10	5	14	14	7	15
ARTAMIDAE	*Artamus leucorhynchus*	14	8	19		10	13	21
STURNIDAE	*Aplonis mysolensis*	425	365	330	215	175	380	525
	Aplonis metallica	355	315	190	260	180	310	330
	Basilornis corythaix En.S-BST	60	48	58	41	45	29	47
MELIPHAGIDAE	*Philemon subcorniculatus* En.S - BST	93	173	187	129	121	128	155
	Myzomela blasii End.S,B,A - BST	1	2			3		
	Myzomela sanguinolenta		5			6		
NECTARINIIDAE	*Nectarinia aspasia*	128	112			1	1	1
	Nectarinia jugularis	128	112	106	99	90	110	130
DICAEIDAE	*Dicaeum vulneratum* En.M - BST	154	123	164	164	110	104	146
ZOSTEROPIDAE	*Zosterops montanus*		65			47		
	Zosterops atrifrons	110	145	80	120	240		75
ESTRILDINAE	*Erythrura trichroa*	16		35	18		22	32
	Lonchura molucca	135		155	95		120	155
	Lonchura Malacca	26	7	15	11	10	27	32
Total Number of Individual Species		**5.470**	**4.588**	**4.721**	**3452**	**3.174**	**4.232**	**5.293**
Number of Species		**97**	**87**	**85**	**75**	**65**	**90**	**98**

Note: End.S=Endemic Seram, End. S, Br= Endemic Seram and Buru, BST= Limited Distributed Bird, End.S,Kl= Endemic Seram and Lease, End. S, A=Endemic Seram and Ambon, VU= Vulnerable Bird, End.S,A,H= Endemic Seram, Ambon, and Haruku, End. M= Endemic Maluku, U= Unique Bird

the two hotspots which were higher when compared to other hotspots. Then it was followed by Wai Putiputi Hotspot at 10.54128, Mt. Kaluala Hotspot at 10.18233, Huaulu Hotspot at 9.88933, and Roho Hotspot at 9.02990; while Mt. Kalapahin Hotspot had the lowest species richness index, which was 7.96515.

Relative Abundance Index of Indicator Bird

The Relative Abundance Index (RAI) of indicator birds at the hotspot locations according to Table 4 are as follows: 4 species with high RAI in all locations, between 10.29% - 27.21%, were *Eos bornea*, *Philemon subcorniculatus*, *Dicaeum vulneratum* and *Ducula perspicillata*. One species with medium RAI in all locations was *Rhyticeros p*., with RAI value of 5.41% - 7.19%. While 22 other species of indicator birds had low RAI values, between 0.08% - 4.90%. Recapitulation per RAI category at each hotspot location in Table 6 showed that bird species that had high RAI values were spread evenly in all hotspot locations as many as 4 species, bird species medium RAI were spreading slightly varied between 1-3 species, as well as bird species with low RAI spread varied between 13-20 species.

Abundance Classes of Indicator Birds Based on Amount of Observation Time

The results of the abundance class study of the indicator bird species at Hotspot locations are presented in Table 5. In the abundance class column, it appears that the indicator bird species is in the Rare to Very Common abundance class. The explanation was that six species were in the Rare abundance class with the observed amount of time between 3 - 20 minutes, i.e. *Accipiter erythrauchen*, *Halcyon lazuli*, *Myzomela blasii*,

Figure 3. Important bird species found at bird diversity hotspot locations

Table 5. Richness index of bird species at hotspot locations and physiographic conditions

Hotspot Location	Species Number	Individual Number	Richness Index	Land cover	Topography
Masihulan	97	5.470	11.01675	Primary lowland forest Secondary lowland forest Fields, mixed farms	Wavy Hilly < 300 m Hilly > 300 m
Mt. Kaluala	87	4.588	10.18233	Primary lowland forestPrimary freshwater swamp forest	Wavy Hilly 300 Hilly > 300 m
Huaulu	85	4.721	9.88933	Primary lowland forest Logged forest Fields, mixed farms	Wavy Hilly 300
Roho	75	3.452	9.02990	Primary lowland forest Logged forest Fields, mixed farms	Wavy Hilly 300
Mt. Kalapahin	65	3.174	7.96515	Primary lowland forest Primary hilly forest	Hilly < 300 m Hilly > 300 m
Wai Putiputi	90	4.233	10.54128	Secondary lowland forest Fields, mixed farms	Wavy Hilly < 300 m
Solea	98	5.293	11.21258	Secondary lowland forest Fields, mixed farms	Wavy Hilly < 300 m

Eos semilarvata, *Eulipoa wallaceii* and *Lorius domicella*. Seven species were in the Rare to Uncommon abundance class with an observed amount of time between 5 - 50 minutes, i.e. *Gymnophaps mada*, *Rhipidura dedemi*, *Ninoxsquamipila s*, *Pachycephala griseonota*, *Casuarius casuarius*, *Ficedula Rushensis* and *Micropsitta bruijnii*.One species was in the Uncommon abundance class with an observed amount of time between 22 - 40 minutes, i.e., *Tanysiptera galatea*. Four species were in the Uncommon to Often abundance class with an observed amount of time between 21 - 95 minutes, i.e., *Ducula concina*, *Alisterus amboinensis*, *Coracina atriceps*, *Coracina ceramensis*. Two species were in the Uncommon to Common abundance class with an observed amount of time between 24-110 minutes, i.e., *Cacatua moluccensis* and *Charmosyna plancenthis.*

Three species were included in the Often to Common abundance class with an observed amount of time between 70 - 162 minutes, i.e., *Rhyticeros plicatus*, *Myagra galeata* and *Basilornis corythaix*. Two species were in the Common to Very Common abundance class with an observed amount of time between 117 - 322 minutes, i.e., *Dicaeum vulneratum* and *Eos bornea*. Two species were in the Very Common abundance class with an observed amount of time between 207 - 441 minutes, i.e., *Ducula perspicillata* and *Philemon subcorniculatus*.

Figure 4 shows that the indicator bird species at hotspot locations were mostly in the Uncommon abundance class that spread dominantly at 5 hotspot locations (Masihulan, Mt. Kaluala, Roho, Mt. Kalapahin and Solea). Then it was followed by Rare abundance class that spread a lot at 4 hotspot locations (Masihulan, Huaulu, Mt. Kalapahin and Wai Putiputi), then the Often abundance class was spread at 2 hotspot locations (Roho and Solea), while the distribution of Common and Very Common abundance classes were low in all hotspot locations.

Table 6. Relative abundance index value of indicator bird species at hotspot locations

Bird Species	Masihulan	Mt. Kaluala	Huaulu	Roho	Mt. Kalapahin	Wai Putiputi	Solea
Eos bornea End. M - BST	26.14	27.21	18.85	24.82	22.22	24.78	15.61
Philemon subcorniculatus En.S - BST	15.77	15.59	19.16	13.18	14.15	15.48	16.68
Dicaeum vulneratum End. M - BST	12.58	11.08	16.80	16.75	12.87	12.58	15.72
Ducula perspicillata BST	10.29	10.90	11.27	11.44	12.98	10.88	13.24
Rhyticeros plicatus U	7.03	5.4	5.94	7.15	6.55	5.93	5.06
Charmosyna placentis U	4.66	2.88	7.58	3.78	4.21	9.43	8.72
Basilornis corythaix End.S - BST	4.90	4.32	5.94	4.19	5.26	3.50	5.06
Myagra galeata BST	2.53	2.70	3.28	2.15	2.57	2.18	1.94
Gymnophaps mada End.S,B - BST	2.29	1.53	0.92	2.55	3.63	2.54	1.92
Cacatua moluccensis End.S,Kl – BST – VU	2.12	1.89	1.64	2.25	3.51	0.72	1.51
Alisterus amboinensis U	1.39	4.23	1.54	3.78	1.17	4.84	2.47
Coracina atriceps End. M - BST	2.70	1.89	1.84	1.43	1.99	3.14	2.15
Ducula concina BST	2.45	1.44	2.66	0.00	0.00	0.00	3.23
Pachycephala griseonota BST	0.90	0.90	0.51	1.43	1.64	0.85	1.61
Coracina ceramensis End. M - BST	1.23	1.44	0.72	1.02	1.29	0.85	1.08
Rhipidura dedemi End.S - BST	0.57	1.26	0.20	1.43	1.75	0.60	0.97
Micropsitta bruijnii U	0.57	2.70	0.00	0.00	1.40	0.00	0.00
Ficedula buruensis End. M - BST	0.33	0.36	0.20	0.10	0.94	0.00	0.00
Casuarius casuarius U	0.08	0.63	0.10	0.61	0.00	0.00	0.54
Tanysiptera galatea U	0.41	0.27	0.00	0.61	0.00	0.48	0.86
Ninox *squamipila* BST	0.49	0.18	0.41	0.41	0.12	0.60	0.32
Accipiter erythrauchen End. M - BST	0.08	0.18	0.41	0.10	0.35	0.00	0.54
Myzomela blasii End.S,B,A - BST	0.08	0.18	0.00	0.51	0.35	0.36	0.43
Halcyon lazuli End.S,A,H – BST - VU	0.16	0.18	0.00	0.31	0.00	0.24	0.00
Eos semilarvata End.S - BST	0.00	0.63	0.00	0.00	1.05	0.00	0.00
Eulipoa wallaceii BST - VU	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Lorius domicella End.S– BST - VU	0.25	0.00	0.00	0.00	0.00	0.00	0.00
Total	100	100	100	100	100	100	100
High RAI category > 10,1 %	4	4	4	4	4	4	4
Medium RAI category 5,1 % – 10 %	1	1	3	1	2	2	3
Low RAI category < 5 %	20	20	13	17	15	13	15
Total Species	25	25	20	22	21	19	22

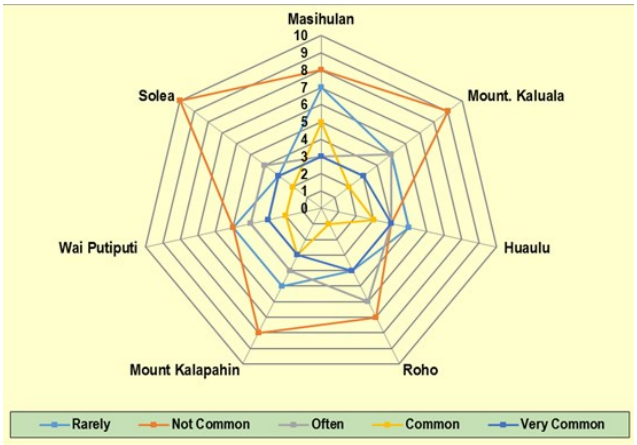

Figure 4. Condition of abundance class distribution of indicator bird species at Hotspot locations

DISCUSSION

A total of 121 bird species were found at 7 hotspot locations (Table 4), with a total encounter of bird species at hotspot locations between 65 to 98 species, and important indicator bird species were between 19 to 25 species (Figure 3). The number of species is sufficient for a forest area, especially forests in an archipelago. This showed that the hotspot locations studied in the PFMU Wae Sapalewa area have a good level of species Richness and diversity, and have a high species conservation value. This condition was confirmed by the high species richness index value (R1) of bird species at 7 hotspot locations with a species richness index value exceeding R > 4, which was between 7.96515 and 11.21258 (Table 5).

This species richness index value showed that forest areas in bird hotspot locations are forest areas with good ecological conditions as shown by the data in Table 5, and are a suitable habitat for the lives of various species of birds. (Wilcoxen *et al.,* 2015) stated that habitat that is still in good condition and contains a variety of food sources has the possibility of many bird species. Habitat found at hotspot locations was quite diverse and consisted of variations of land cover ranging from open areas in the form of cultivation land (Li et al., 2011), grasslands with high bushes (Lee and Martin, 2017), then secondary forests to primary forests (Ayat & Tata, 2015; Prabowo *et al.,*2016; Duraisamy *et al.,*2018). In addition, hotspot locations also had physiographic variations from lowland wavy areas, low hilly areas to high hilly areas. There were also mixed productive community farms and old farms that are already in the form of dusung (heritage traditional farms). This condition provides a good opportunity for bird activities according to their niche in the variety of habitat, which is associated with foraging, shelter and reproduction activities (Tryjanowski *et al.,* 2015; Wiedarti *et al.,* 2016; Baxter, 2019).

Table 7. Abundance classes of indicator bird species at Hotspot locations expressed by the observed amount of time

Bird Species Scientific name	Total Observed Time (/Minute)							Abundance Class Category
	Masihulan	Mt. Kaluala	Huaulu	Roho	Mt. Kalapahin	Wai Putiputi	Solea	
Ducula perspicillata BST	441	345	355	322	283	220	345	Very Common
Philemon subcorniculatus En.S – BST	330	222	270	259	207	212	245	Very Common
Dicaeum vulneratum En.M - BST	322	205	274	286	150	210	227	Common - Very Common
Eos bornea bornea En.M - BST	157	187	202	205	151	117	141	Common - Very Common
Rhyticeros plicatus U	125	100	170	125	90	99	125	Often - Common
Myagra galeata BST	162	125	108	99	90	90	80	Often - Common
Basilornis corythaix En.S-BST	130	86	125	70	78	80	95	Often - Common
Cacatua moluccensis En.S,Kl-BST – VU	110	101	80	90	85	24	50	Uncommon – Common
Charmosyna placentis U	55	40	90	60	33	110	100	Uncommon – Common
Alisterus amboinensis U	50	86	54	80	28	95	40	Uncommon - Often
Coracina atriceps En.M - BST	85	52	45	35	45	40	25	Uncommon - Often
Gymnophaps mada En.S,B	40	20	30	39	45	30	30	Uncommon - Often
Coracina ceramensis En.M - BST	55	34	22	25	25	23	24	Uncommon - Often
Ducula concina BST	45	30	54	0	0	0	54	Uncommon - Often
Rhipidura dedemi En.S - BST	30	42	10	50	48	24	36	Rare - Uncommon
Pachycephala griseonota BST	30	32	17	40	35	18	25	Rare - Uncommon
Ninox squamipila BST	25	25	24	25	5	15	25	Rare - Uncommon
Tanysiptera galatea U	22	25	0	30	0	25	40	Rare – Uncommon
Casuarius casuarius U	10	25	5	24	0	0	35	Rare – Uncommon
Ficedula buruensis En.M - BST	25	18	15	6	25	0	0	Rare – Uncommon
Micropsitta bruijnii U	15	0		0	15	0	0	Rare – Uncommon
Accipiter erythrauchen En.M - BST	5	7	18	3	20	0	14	Rare
Halcyon lazuli End.S,A,H - BST – VU	18	15	0	10	0	16	0	Rare
Myzomela blasii End.S,B,A - BST	3	7	0	0	8	0	0	Rare
Eos semilarvata En. S - BST	0	15	0	0	17	0	0	Rare
Eulipoa wallaceii BS T- VU	0	0	0	0	0	0	12	Rare
Lorius domicella En.S - BST - VU	12	0	0	0	0	0	0	Rare
Total Observed Time	2.302	1.876	1.968	1.883	1.483	1.448	1.768	
S Very Common Abundance Class	3	3	4	4	1	3	3	
S Common Abundance Class	5	3	3	1	3	2	2	
S Often Abundance Class	3	4	4	5	4	4	4	
S Uncommon Abundance Class	8	10	4	8	8	5	10	
S Rare Abundance Class	6	5	5	4	5	5	3	

In Table 6, there are 4 known bird species with high Relative Abundance Index (RAI) at 7 hotspot locations, i.e., *Eos bornea*, *Philemon subcorniculatus*, *Dicaeum vulneratum*, and *Ducula perspicillata*. One species with medium RAI at all hotspot locations was *Rhyticeros plicatus*, and another species with medium RAI, but only recorded at 4 hotspot locations was *Basilornix corythaix*. The other 21 species of bird indicators had a low RAI. Recapitulation per RAI category at each hotspot location shows that 4 species of birds with high RAI were spread evenly in all hotspot locations, while species of birds with medium RAI were spread between 1 to 3 species, and species of birds with low RAI were spread between 13 to 20 species. This condition shows that the abundance of indicator bird species in hotspot locations is very varied. There were species with high abundance, and there were those with low abundance, and even very low (Marchese, 2015; Araneda *et al*., 2018).

The results of the Abundance Class analysis based on the total observed time in Table 5 shows that there were 4 species of birds in the Common to Very Common abundance class, i.e., *Ducula perspicillata*, *Philemon subcorniculatus*, *Dicaeum vulneratum*, and *Eos bornea*. There were 3 species in the Often to Common abundance class, i.e., *Rhyticeros pilicatus*, *Myagra galeata*, and *Basilornix corythaix*. While 20 other species were in the Rare to Uncommon class abundance. This condition shows that some species of indicator birds were easily found, some other species were rather difficult to find, while most species were difficult to find and some were very difficult to find in hotspot locations (Sussman *et al.,* 2019; Bellanthudawa *et al.*, 2019).

Based on the value of Relative Abundance Index (RAI) and Abundance Class, it was shown that 4 species of birds with high RAI value were in the Common to Very Common abundance class, whereas 2 species with the medium RAI value were in the Often to Common abundance class. From these two study methods, it is found that there were 6 species of birds, i.e., *Ducula perspicillata*, *Philemon subcorniculatus*, *Dicaeum vulneratum*, *Eos bornea*, *Rhyticeros pilicatus*, and *Basilornix corythaix* that can be found in all hotspot locations with a significant level of encounter certainty. Relative Abundance Index values and Abundance Class categories can be indicators of the status and presence of important indicator bird species at hotspot locations (Mueller *et al*., 2014; Bellanthudawa *et al*., 2019; Persulessy *et al.,* 2019). The combination of these two forms of abundance studies provides reasonably good information about interesting indicator bird species as tourist attraction objects and ecotourism at bird diversity hotspot locations (Nicolaides, 2014; Hakim, 2017).

Endemic bird species need attention because they are often the basis for consideration in conservation issues (Indrawan *et al.,* 2007; Mittermeier & Rylands, 2017). Endemic bird species such as those in the PFMU Wae Sapalewa area have become an attractive tourist

attraction in Seram Island, especially at the Manusela National Park area (Manusela National Park Center, 2016). This promising condition is an indication about the conservation value and the ecotourism selling value of bird diversity hotspots in the PFMU Wae Sapalewa area. Overall, 9 endemic bird species of Seram Island were found in 7 hotspot locations (Table 4), endemic birds found in these hotspot locations ranged from 5 to 8 species of 14 endemic bird species in Seram Island and surrounding islands. Eight species were found at hotspot locations of the Masihulan and Gunung Kaluala; 7 species were found at hotspot locations of Roho, Mount Kalapahin, and Wai Putiputi; 6 species were found at the hotspot location of Solea; and 5 species were found at hotspot locations of Huaulu. This finding revealed that the identified locations of bird diversity hotspots in the PFMU Wae Sapalewa area can be defined as the endemic bird hotspots. A research in Taiwan stated that an observed hotspot can be defined as an 'endemic hotspot' if there are at least 5 out of 17 species of endemic birds were found (Ko *et al.,* 2014).

CONCLUSION

This research showed that overall 121 species of birds were found in 7 hotspot locations, with the total number of bird encounters in hotspot locations between 65 to 98 species, and important indicator bird species numbered between 19 to 25 species. This number of species is sufficient for a forest area, especially forests in an archipelago.

REFERENCES

Araneda, P., Sielfeld, W., Bonacic, C. and Ibarra,J.T. 2018. Bird diversity along elevational gradients in the Dry Tropical Andes of northern Chile: The potential role of Aymara indigenous traditional agriculture. *PLoS ONE.*13(12): 1–21. DOI : 10.1371/journal.pone.0207544

Ayat, A. amd Tata LH, 2015. Diversity of Birds Across Land Use and Habitat Gradients in Forests, Rubber Agroforests and Rubber Plantations of North Sumatra. *Indonesian Journal of Forest Research*. 2(2): 103–120. DOI: 10.20886/ijfr.2015.2.2.829.103-120

Manusela National Park Center. 2016. Nature Tourism Information Book. Ministry of Environment and Forestry. Directorate General of Forest Protection and Nature Conservation. Masohi, Central Maluku.

Baxter, C. 2019. Bird Species. In *Birds of Kangaroo Island*. DOI : 10.2307/j.ctvpb3vwx.12

Bellanthudawa, B.K.A., Nawalage, N.M.S.K., Subanky, S., Panagoda, P.A.B.G., Weerasinghe, H.W.G.A.S., Tharaka, L.K.D.N. and Abeywickrama, M.S.J, 2019. Composition and Diversity Variation of Avifauna, along Different Vegetative Habitat Types in a Human-Modified Area, University of Kelaniya, Sri Lanka. *International Journal of Zoology.* 1–16. DOI: 10.1155/2019/9727609

Bibi, F. and Ali, Z. 2013. Measurement of diversity indices of avian communities at Taunsa Barrage Wildlife Sanctuary, Pakistan. *Journal of Animal and Plant Science*. 23(2): 469–474.

Blackwell, B.F., James, S., Martin. and Paige, A. 2013. USDA National Wildlife Research Center-Staff Publications. *USDA National Wildlife Research Center - Staff Publications*, (1449). 1-14.

Forest Area Consolidation Center Region IX Ambon. 2013. PFMU Forest Management Model of Wae Sapalewa. Final report. The Ministry of Forestry of the Republic of Indonesia. Directorate General of Forestry Planology.

CoLUPSIA. 2013. Land Cover Map of Central Seram Island, Central Maluku Regency. CIFOR – CIRAD, Bogor

Donald, P.F., Fishpool, L.D.C., Ajagbe, A., Bennun, L.A., Bunting, G., Burfield, I.J. and Wege, D.C. 2019. Important Bird and Biodiversity Areas (IBAs): the development and characteristics of a global inventory of key sites for biodiversity. *Bird Conservation International.*29(2): 177–198. DOI: 10.1017/S0959270918000102

Dudley, N., Boucher, J.L, Cuttelod, A., Brooks,T.M. and Langhammer,P.F. 2014. Applications of Key Biodiversity Areas: End-user consultations Applications of Key Biodiversity.IUCN, Gland, Switzerland, Cambridge, UK.

Duraisamy, V., Bendapudi,R., and Jadhav, A. 2018. Identifying hotspots in land use land cover change and the drivers in a semi-arid region of India. *Environmental Monitoring and Assessment.* 190 (535): 1-21. DOI :10.1007/s10661-018-6919-5

Hakim, L. 2017. Managing biodiversity for a competitive ecotourism industry in tropical developing countries: New opportunities in biological fields. AIP Conference Proceedings, 1908: 1–11. DOI : 10.1063/1.5012708

Indrawan, M., Richard, B. Primack, and Supriatna, J. 2007. Conservation Biology. Revised edition – Jakarta: Yayasan Obor Indonesia.

Issa, M.A.A. 2019. Diversity and abundance of wild birds species' in two different habitats at Sharkia Governorate, Egypt. *The Journal of Basic and Appllied Zoology*. 80(1): 1-7. DOI: 10.1186/s41936-019-0103-5

IUCN. 2016. A global standard for the identification of key biodiversity areas and recommendations on China's practice (U. © IUCN, Gland, Switzerland and Cambridge, ed.). DOI: 10.19741/j.issn.1673-4831.2017.0847

Ko, C.-Y., Murphy, S. C., Root, T. L., and Lee, P.-F. 2014. An assessment of the efficiency of protection status through determinations of biodiversity hotspots based on endemic bird species, Taiwan. *Journal for Nature Conservation*. 22(6): 570–576. DOI:10.1016/j.jnc.2014.08.012

Lakitan, B. 2002. Basic of Climatology. PT. Raja Grafindo Persada. Jakarta.

Lee, M.B. and Martin,J.A. 2017. Avian species and functional diversity in agricultural landscapes: Does landscape heterogeneity matter? *PLoS ONE.*12(1): 1–21. DOI: 10.1371/journal.pone.0170540

Li, D., Chen, S., Guan, L., Lloyd, H., Liu, Y., Lv, J. and Zhang, Z. 2011. Patterns of waterbird community composition across a natural and restored wetland landscape mosaic, Yellow River Delta, China. *Estuarine Coastal and Shelf Science.*91(2): 325–332. DOI: 10.1016/j.ecss.2010.10.028

Marchese, C. 2015. Biodiversity hotspots: A shortcut for a more complicated concept. *Global Ecology Conservation*3: 297–309. DOI: 10.1016/ j.gecco.2014.12.008

Mittermeier, R.A. and Rylands, A.B. 2017. Biodiversity Hotspots. Reference Module in Earth Systems and Environmental SciencesEncyclopedia of the Anthropocene. 2018, Pages 67–75 Volume 3 Conservation International, Arlington, VA, United States.

Ministry of Forestry. 2010. Keputusan Menteri Kehutanan No. 336/Menhut- II/2010, tanggal 25 Mei 2010, tentang pembentukan PFMU Model Wai Sapalewa [Minister of Forestry Decree no. 336 / Menhut-II / 2010, dated May 25, 2010, regarding the establishment of PFMU Model Wai Sapalewa]. Ministry of Forestry, Jakarta.

Mekonen, S. 2017. Birds as Biodiversity and Environmental Indicator. *Advances in Life Science and Technology*61(21): 16–22.

Muelle, M., Pander,J. and Geist, J. 2014. A new tool for assessment and monitoring of community and ecosystem change based on multivariate abundance data integration from different taxonomic groups. *Environmental System Research. 3*(1): 12. DOI: 10.1186/2193-2697-3-12

Nicolaides,A. 2014. Stakeholders, purposes and responsibilities: Avitourism in South Africa. *African Journalof Hospitality Tourism and Leisure*3(32: 1–14.

Persulessy, Y.E., Oszaer, R. and Putuhena, J.D. 2019. Hot-Spot Biodiversity Approach by using Birds as Indicators for Development of Ecotourism. *International Journal of Current Microbiology and Applied Science*. 8(2): 1675–1692. DOI:10.20546/ijcmas.2019.802.197

Prabowo, W., Darras, K., Clough, Y., Toledo-Hernandez, M., Arlettaz, R. andMulyani, T. 2016. Bird responses to lowland rainforest conversion in Sumatran smallholder landscapes, Indonesia. *PLoS ONE.*11(5): 1-17. DOI: 10.5061/ dryad.g77m8

Schmidt, F. H. and J. A. Ferguson. 1951. Rainfall Type Based on Wet and Dry Period Ratios for Indonesia with Western New Guinee. Ministry of Transportation, Department of Meteorology and Geophysics, Djakarta. Venhandl. No. 24.

Şekercioglu, Ç.H., Mendenhall, C.D., Oviedo-Brenes, F., Horns, J.J., Ehrlic,. P.R. andDaily, G.C.2019. Long-term declines in bird populations in tropical agricultural countryside. Proceedings of the National Academy of Sciences of the United States of America, 116(20): 9903–9912. DOI: 10.1073/pnas.1802732116

Sullivan, J.J. 2012. Recording birds in real time: A convenient method for frequent bird recording. *New Zealand Journal Ecology*.36(3): 1–9.

Sussman, A.L, Gardner, B,, Adams, E.M., Salas, L., Kenow, K.P., Luukkonen,D.R. andZipkin, E.F. 2019. A comparative analysis of common methods to identify waterbird hotspots. Methods *Ecology Evolotion.*10(9):1454–1468. DOI: 10.1111/2041-210X.13209

Tanalgo KC, Pineda JAF, Agravante ME and Amerol ZM, 2015. Bird diversity and structure in different land-use types in lowland south-central Mindanao, Philippines. *Tropical Life Science Research*. 26 (2): 85–103.

Tantipisanuh, N., Savini, T., Cutter, P. and Gale, G.A. 2016. Biodiversity gap analysis of the protected area system of the Indo-Burma Hotspot and priorities for increasing biodiversity representation. *Biology Conservation* 195: 203–213. DOI : 10.1016/j.biocon.2015.12.043

Tryjanowski, P., Skórka, P., Sparks, T.H., Biaduń, W., Brauze, T., Hetmański, T. and Wysocki, D. 2015, Urban and rural habitats differ in number and type of bird feeders and in bird species consuming supplementary food. *Environmental Scienceand Pollution Research*22(19): 15097–15103. DOI : 10.1007/s11356-015-4723-0

Vale, M.M., Tourinho, L., Lorini, M.L., Rajão. H. and Figueiredo MSL, 2018. Endemic birds of the Atlantic Forest: traits, conservation status, and patterns of biodiversity. *Journal of Field Ornithology*. 89(3): 193–206. DOI : 10.1111/ jofo.12256

Vergara, P.M., Jiménez, J.E. and Schlatter, R.P.2010. Effective Point-count duration for estimating bird species' richness in Chilean forests. *Zoology Studies*. 49(3): 381–391.

Wiedarti, S., Moerfiah., Sudrajat, C. and Iqbal, G.M. 2016. The diversity of bird species that are traded in the bird market in the city of Bogor, Indonesia. AIP Conference Proceedings, 1744. DOI: 10.1063/1.4953530

Wilcoxen, T.E., Horn, D,J, Hogan, B.M., Hubble, C.N., Huber, S.J., Flamm, J. And Wrobel, E.R. 2015. Effects of bird-feeding activities on the health of wild birds. *Conservation Physiology*. 3(1): 1–13. DOI: 10.1093/conphys/cov058