Avifauna in the Wehea-Kelay Landscape, East Kalimantan, Indonesia

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Abstract. Wehea-Kelay landscape is an unprotected area, located on the eastern part of Borneo Island. It is managed by 7 unit managements, which were mostly timber companies. We compiled and collated our avifauna data with previous studies.We recorded 273 bird species belonging to 60 families during field work. 61 species were protected based on Indonesian regulations. Among of them were threatened species with small population such as Great argus *Argusianus argus*, Storm's stork *Ciconia stormi,* and Helmeted hornbill *Buceros vigil.* Although Wehea-Kelay is dominated by timber concessions, the landscape can still provide habitat for many species of bird. Nevertheless, anthropogenic pressures i.e. illegal hunting have increased and become a threat for birds particularly commercially traded species such as Leafbirds *Chloropsis* spp, White-rumped Shama *Copsychus malabaricus,* Common hill myna *Gracula religiosa*, and also Helmeted hornbill *Buceros vigil.*

Keywords: Avifauna, conservation, landscape, unprotected forest

1. Introduction

Kalimantan occupies an area of around 73% of the Borneo Island, making it as one of the important habitats of bird species in the Sundaland zoogeographical region [1]. There are 669 species of resident and migrant birds in Borneo, of which 52 are endemic [2]. Kalimantan alone has 523 bird species [3]. Unfortunately, the number of birds in Kalimantan continues to decline and is threatened by extinction due to anthropogenic pressures, such as forest degradation and poaching [4]. This condition is exacerbated by the fact that most of high conservation value areas functioning as an important bird habitat are unprotected [5].

Wehea-Kelay is a tropical rainforest landscape in East Kalimantan with a total area of 532,143 ha [6]. It has high conservation values since it is a home to at least 600 individuals of critically endangered bornean orangutans [7] and other wildlife. Most of Wehea-Kelay's areas are managed by timber companies. Furthermore, the biodiversity management efforts are carried out collaboratively through the Essential Ecosystem Area (EEA) Wehea-Kelay Forum that was legalized by the Governor

of the East Kalimantan Province [6]. The forum plays an important role in managing units and multistakeholders for implementing the best natural resources management practices.

Bird is one of the environmental bioindicators in the Wehea-Kelay landscape. Some of sensitive bird species will respond specifically to the environmental dynamics, such as vegetation structure changes due to logging and land clearing activities, and also human activity. For example, bird species of terrestrial-insectivores and insectivore-understory tends to decrease in abundance in logged forest blocks [8,9,10,11], whereas the nectivorous and frugivorous groups increased [9]. On the other hand, Wehea-Kelay landscape-based collaborative management is expected to provide benefits from ecological aspects. Some of fragmented forests can be interconnected as habitat for the umbrella species such as hornbills and eagles. Currently, database about bird-diversity is available in every management unit [12], but has not been compiled in comprehensively. Thus, this study aims to identify and analyze bird species in the Wehea-Kelay landscape and its implications for conservation effort in unprotected area.

2. Materials and Methods

2.1 Location of the study site

This study was conducted in the Wehea-Kelay landscape, specifically on seven management units which are member of EEAWehea-Kelay Forum, including four timber companies (PT. Karya Lestari/KL, PT. Utama Damai Indah Timber/UDIT, PT. Gunung Gajah Abadi/GGA, PT. Narkata Rimba/NR, PT. Wana Bakti Persada Utama/WBPU, one oil palm plantation (PT. Nusaraya Agro Sawit/NAS), and Wehea Protection Forest (WPF). The Wehea-Kelay landscape is characterized by tropical rain forest ecosystem dominated by Dipterocarpaceae trees. The area is mostly typified by lowland forest with undulating topography. Elevation is between 33-1,700 m ASL [12].

2.2 Procedures

Point-count and transect methods were used in data collection by purposive sampling. All point counts were made along transects of 1,000 - 1,600 m in length. The distance between point counts was 200 m. We established 16-45 point counts for each study location. Birdwatching was conducted during 07:00 to 10:00 am and 03:00 - 05:30 pm (UTC +8). We spent 10-20 minutes at each point to record all bird sighted. Species identification refers to MacKinnon et al. [13] and Phillipps and Phillipps (2011) [2].

2.3 Data analysis

Field data was compiled with previous data collated by Atmoko et al. [12]. Bird data were analyzed by grouping into family, species, and conservation status. The conservation status was adjusted to national and international regulations [14,15,16]. Further statistical analysis was carried out to determine species similarities using the Jaccard Similarity Index and visualized using Non-Metric Multidimensional Scaling (NMDS) [17]. Furthermore, Kruskal-Wallis analysis undertaken to determine relative differences in species richness among study sites. All statistical analysis were carried out using the PAST. 3 [18].

3. Result

3.1 Species composition

A total of 273 species was recorded in the Wehea-Kelay landscape (Table 1). This record represented 40.81% of the total species of Borneo's birds (Phillipps & Phillipps 2011). Specifically, the number of bird species in PT. NR, PT. KL, PT. GGA, PT. WBPU, PT. UDIT, PT. NAS, and WPF were 144, 176, 98, 176, 27, 51, 60, respectively. Muscicapidae and Cuculidae, which are commonly insectivorous birds, were dominant families (Table 1). Furthermore, 23 species of migratory birds were also found in Wehea-Kelay landscape. Visualization NMDS of Jaccard similarity coefficient indicates that the bird species in PT. NR, PT. WBPU and PT. GGA have high similarity. In addition, bird species in PT.

NAS has similarities with PT. UDIT. However, the bird species in the WPF are contrast from any study locations (Figure 1). Based on Kruskall-Wallis test showed that there were significant differences in species richness among study site ($X^2 = 170.10$, $p = 0.000$).

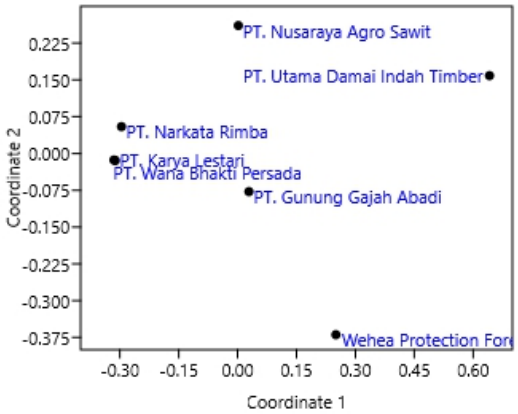

Figure 1. NMDS ordination based on Jaccard similarity coefficient (Stress: 0.1301)

Table 1. List of bird species in Wehea-Kelay landscape

No	Species	No	Species	No	Species
	Acanthizidae		**Anhingidae**	48	*Caprimulgus indicus*
1	*Gerygone sulphurea*	26	*Anhinga melanogaster*	49	*Eurostopodus temmincki*
	Acciptridae		**Apodidae**		**Ciconiadae**
2	*Accipiter gularis*	27	*Aerodramus fuciphagus*	50	*Ciconia stormi*
3	*Accipiter soloensis*	28	*Aerodramus maximus*		**Chloropseidae**
4	*Aviceda jerdoni*	29	*Collocalia esculenta*	51	*Chloropsis cochinchinensis*
5	*Circus melanoleucos*	30	*Hirundapus giganteus*	52	*Chloropsis cyanopogon*
6	*Haliastur indus*	31	*Rhaphidura leucopygialis*	53	*Chloropsis sonnerati*
7	*Ichthyophaga humilis*				**Cisticolidae**
8	*Ichthyophaga ichthyaetus*		**Ardeidae**	54	*Orthotomus atrogularis*
9	*Ictinaetus malaiensis*	32	*Ardea cinerea*	55	*Orthotomus ruficeps*
10	*Nisaetus cirrhatus*	33	*Bubulcus ibis*	56	*Orthotomus sericeus*
11	*Nisaetus nanus*	34	*Butorides striata*	57	*Prinia flaviventris*
12	*Pernis ptilorhynchus*	35	*Egretta garzetta*		**Columbidae**
13	*Spilornis cheela*		**Artamidae**	58	*Chalcophaps indica*
14	*Spilornis kinabaluensis*	36	*Artamus leucoryn*	59	*Ducula aenea*
			Bucerotidae	60	*Ducula badia*
	Acrocephalidae	37	*Anorrhinus galeritus*	61	*Ramphiculus jambu*
15	*Acrocephalus orientalis*	38	*Anthracoceros albirostris*	62	*Streptopelia chinensis*
	Aegithinidae	39	*Anthracoceros malayanus*	63	*Treron capellei*
16	*Aegithina tiphia*	40	*Berenicornis comatus*	64	*Treron curvirostra*
17	*Aegithina viridissima*	41	*Buceros rhinoceros*	65	*Treron fulvicollis*
	Alcedinidae	42	*Rhabdotorrhinus corrugatus*	66	*Treron olax*
18	*Actenoides concretus*	43	*Buceros vigil*	67	*Treron vernans*
19	*Alcedo atthis*	44	*Rhyticeros undulatus*		**Coraciidae**
20	*Alcedo peninsulae*		**Calyptomenidae**	68	*Eurystomus orientalis*

No	Species	No	Species	No	Species
21	*Alcedo meninting*	45	*Calyptomena viridis*		**Corvidae**
21	*Ceyx erithaca*		**Campephagidae**	69	*Corvus enca*
23	*Halcyon pileata*	46	*Pericrocotus flammeus*	70	*Platysmurus leucopterus*
24	*Lacedo pulchella*	47	*Pericrocotus igneus*		**Cuculidae**
25	*Pelargopsis capensis*		**Caprimulgidae**	71	*Cacomantis merulinus*
72	*Cacomantis sepulcralis*	109	*Hirundo rustica*	142	*Cyornis umbratilis*
73	*Cacomantis sonneratii*	110	*Delichon dasypus*	143	*Cyornis unicolor*
74	*Carpococcyx radiceus*	111	*Hirundo tahitica*	144	*Muscicapa griseisticta*
75	*Centropus bengalensis*		**Indicatoridae**	145	*Enicurus leschenaulti*
76	*Centropus sinensis*	112	*Indicator archipelagicus*	146	*Enicurus ruficapillus*
77	*Chrysococcyx xanthorhynchus*		**Irenidae**	147	*Eumyias indigo*
78	*Surniculus lugubris*	113	*Irena puella*	148	*Eumyias thalassina*
79	*Clamator coromandus*		**Laniidae**	149	*Ficedula dumetoria*
80	*Cuculus fugax*	114	*Lanius tigrinus*	150	*Ficedula mugimaki*
81	*Cuculus micropterus*		**Leiotrichidae**	151	*Ficedula narcissina*
82	*Cuculus saturatus*	115	*Alcippe brunneicauda*	152	*Ficedula parva*
83	*Hierococcyx vagans*	116	*Garrulax palliatus*	153	*Ficedula zanthopygia*
84	*Phaenicophaeus curvirostris*			154	*Muscicapa dauurica*
85	*Phaenicophaeus diardi*	117		155	*Saxicola caprata*
86	*Rhinortha chlorophaea*		**Megalaimidae**	156	*Trichixos pyrropygus*
87	*Rhopodytes sumatranus*	118	*Caloramphus fuliginosus*	157	*Saxicola torquata*
88	*Zanclostomus javanicus*	119	*Psilopogon australis*		**Nectariniidae**
	Dicaeidae	120	*Psilopogon henricii*	158	*Aethopyga siparaja*
89	*Dicaeum chrysorrheum*	121	*Psilopogon mystacophanos*	159	*Anthreptes malacensis*
90	*Dicaeum cruentatum*	122	*Psilopogon chrysopogon*	160	*Anthreptes rhodolaemus*
91	*Dicaeum monticolum*	123	*Psilopogon rafflesii*	161	*Anthreptes simplex*
92	*Dicaeum trigonostigma*		**Meropidae**	162	*Arachnothera affinis*
93	*Prionochilus maculatus*	124	*Nyctyornis amictus*	163	*Arachnothera crassirostris*
94	*Prionochilus percussus*	125	*Merops viridis*	164	*Arachnothera flavigaster*
95	*Prionochilus thoracicus*		**Monarchidae**	165	*Arachnothera hypogrammica*
96	*Prionochilus xanthopygius*	126	*Hypothymis azurea*	166	*Arachnothera longirostra*
	Dicruridae	127	*Terpsiphone paradisi*	167	*Arachnothera robusta*
97	*Dicrurus aeneus*		**Motacillidae**	168	*Chalcoparia singalensis*
98	*Dicrurus paradiseus*	128	*Anthus novaeseelandiae*	169	*Cinnyris jugularis*
	Eurylaimidae	129	*Motacilla cinerea*	170	*Leptocoma sperata*
99	*Corydon sumatranus*	130	*Motacilla flava*		**Oriolidae**
100	*Cymbirhynchus macrorhynchos*		**Muscicapidae**	171	*Coracina fimbriata*
101	*Eurylaimus javanicus*	131	*Copsychus malabaricus*	172	*Oriolus xanthonotus*
102	*Eurylaimus ochromalus*	132	*Copsychus saularis*	173	*Oriolus xanthornus*
	Estrildidae	133	*Culicicapa ceylonensis*		**Passeridae**
103	*Lonchura fuscans*	134	*Cyanoptila cyanomelana*	174	*Passer montanus*
104	*Lonchura leucogastra*	135	*Cyornis banyumas*		**Pellorneidae**
105	*Lonchura malacca*	136	*Cyornis brunneatus*	175	*Kenopia striata*
	Falconidae	137	*Cyornis concretus*	176	*Malacocincla abbotti*
106	*Microhierax fringillarius*	138	*Cyornis olivaceus*	177	*Malacopteron affine*
107	*Hemiprocne coronata*			178	*Malacopteron albogulare*

	Hempirocnidae	139	*Cyornis ruficauda*	179	*Malacopteron cinereum*
108	*Hemiprocne longipennis*	140	*Cyornis superbus*	180	*Malacopteron magnirostre*
	Hirundinidae	141	*Cyornis turcosus*	181	*Malacopteron magnum*

No	Species	No	Species	No	Species
182	*Pellorneum capistratum*		**Podorgidae**		**Sturnidae**
183	*Trichastoma bicolor*	218	*Batrachostomus stellatus*	252	*Acridotheres cristatellus*
184	*Trichastoma malaccense*		**Psittacidae**	253	*Aplonis panayensis*
185	*Trichastoma pyrrogenys*	219	*Loriculus galgulus*	254	*Gracula religiosa*
186	*Trichastoma rostratum*	220	*Psittinus cyanurus*	255	*Pityriasis gymnocephala*
	Phalacrocoracidae		**Pycnonotidae**		**Tephrodornithidae**
187	*Phalacrocorax sulcirostris*	221	*Alophoixus bres*	256	*Hemipus hirundinaceus*
	Phasianidae	222	*Alophoixus finschii*	257	*Tephrodornis virgatus*
188	*Argusianus argus*	223	*Alophoixus ochraceus*		**Timaliidae**
189	*Polyplectron schleiermacheri*	224	*Alophoixus phaeocephalus*	258	*Macronous ptilosus*
190	*Lophura bulweri*	225	*Brachypodius atriceps*	259	*Mixornis gularis*
191	*Lophura ignita*	226	*Euptilotus eutilotus*	260	*Pomatorhinus montanus*
192	*Rollulus rouloul*	227	*Ixos malaccensis*	261	*Stachyris erythroptera*
193	*Synoicus chinensis*	228	*Brachypodius melanoleucos*	262	*Stachyris leucotis*
	Phylloscopidae	229	*Pycnonotus aurigaster*	263	*Stachyris maculata*
194	*Phylloscopus borealis*	230	*Pycnonotus brunneus*	264	*Stachyris nigricollis*
195	*Phylloscopus trivirgatus*	231	*Pycnonotus cyaniventris*	265	*Stachyris poliocephala*
196	*Phylloscopus montis*	232	*Pycnonotus erythropthalmos*	266	*Stachyris rufifrons*
	Picidae	233	*Pycnonotus goiavier*		**Trogonidae**
197	*Blythipicus rubiginosus*	234	*Pycnonotus melanicterus*	267	*Harpactes diardii*
198	*Chrysocolaptes lucidus*	235	*Pycnonotus plumosus*	268	*Harpactes duvaucelii*
199	*Chrysophlegma mentale*	236	*Pycnonotus simplex*	269	*Harpactes kasumba*
200	*Chrysophlegma miniaceus*	237	*Pycnonotus squamatus*	270	*Harpactes oreskios*
201	*Dinopium rafflesii*	238	*Setornis criniger*	271	*Harpactes orrhophaeus*
202	*Dryocopus javensis*	239	*Tricholestes criniger*		**Vangidae**
203	*Meiglyptes tristis*		**Rallidae**	272	*Philentoma pryhoptera*
204	*Meiglyptes tukki*	240	*Amaurornis phoenicurus*	273	*Philentoma velata*
205	*Hemicircus concretus*	241	*Zapornia fusca*		**Vireonidae**
206	*Micropternus brachyurus*		**Rhipiduridae**	274	*Erpornis zantholeuca*
207	*Mulleripicus pulverulentus*	242	*Rhipidura javanica*		
208	*Picus chlorolophus*	243	*Rhipidura perlata*		
209	*Reinwardtipicus validus*		**Sittidae**		
210	*Sasia abnormis*	244	*Sitta frontalis*		
	Pittidae		**Scotocercidae**		
211	*Erythropitta granatina*	245	*Abroscopus superciliaris*		
212	*Hydrornis baudii*	246	*Phyllergates cucullatus*		
213	*Pitta moluccensis*		**Strigidae**		
214	*Pitta sordida*	247	*Bubo sumatranus*		
215	*Erythropitta arquata*	248	*Ketupa ketupu*		
	Platylophidae	249	*Ninox scutulata*		
216	*Platylophus galericulatus*	250	*Otus lempijii*		
217	*Batrachostomus cornutus*	251	*Strix leptogrammica*		

3.2 Feeding guild

We noticed that birds of the Wehea Kelay landscape had a broad spectrum of feeding guild (Figure 2). Insectivorous birds were the most abundant guild (53.48%; 146 species). This finding is consistent with numerous studies of tropical forest birds of Borneo [11,19]. Insectivorous birds could be classified into terrestrial (*Pitta* spp.), understory (some species of flycatchers), and arboreal (woodpecker) based on vegetation layer. In ecosystem, insectivorous birds have a role in controlling insect population [20]. Unfortunately, this bird is prone to declining population because of habitat changes and competition. A study conducted by Azman et al. [21] reported that there was a decrease in the population of insectivorous birds as forest quality decreases.

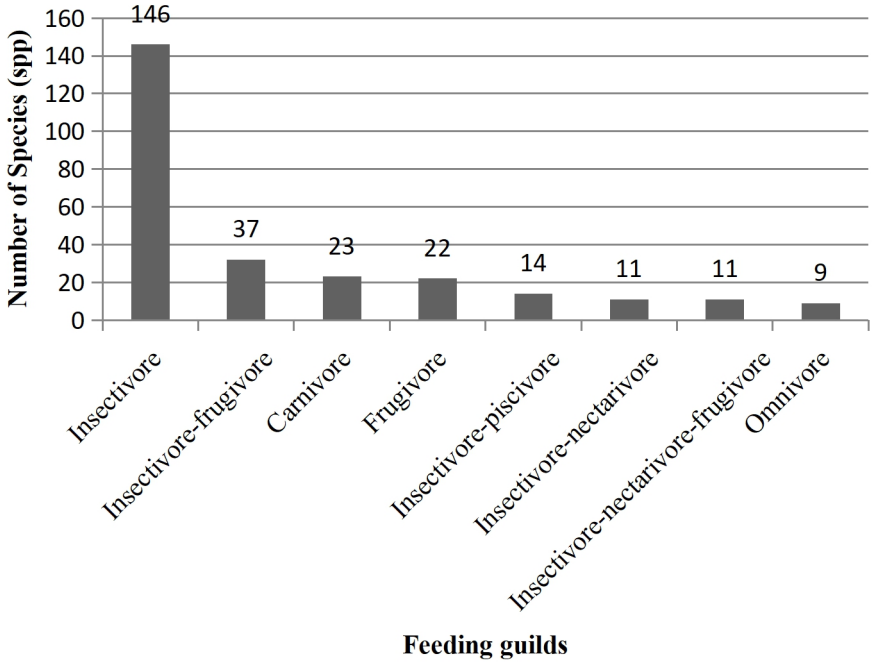

Figure 2. The number of bird species based on feeding-guilds

3.3 Conservation status and significant records

There were 61 species of protected birds in the Wehea-Kelay landscape based on the Indonesian government regulation [14]. In addition, there were 18 species listed by IUCN: Critically Endangered (1 species), Endangered (5 species), and Vulnerable (12 species). Furthermore, referring to the CITES, three species were listed in Appendix I, and 28 species were listed in Appendix II.

Protected and high conservation priority bird species according to Indonesian government regulation were sensitive to habitat changes. Thus, they are assigned as bioindicators. Costantini et al. [22] reported that birds with vulnerable and near threatened status were likely to have a low abundance on logged forest across Borneo island. Furthermore, some studies also pointed out several groups of birds sensitive to logging activities, which were hornbills, barbets, trogons, woodpeckers, pittas, and pheasants [9,23,24].

Helmeted Hornbill *Buceros vigil*

Critically Endangered: This bird is an umbrella species because its territory covers large area. Helmeted hornbill is also an active seed disperser. The bird is sensitive to forest degradation. Low densities of large-diameter trees and forest fragmentation significantly influence bird population [4,25]. In addition, poaching also contributes to population decline of this species in Kalimantan. The current study recorded 6 helmeted hornbills: 1 individual in PT. KL and 5 individuals in PT. GGA. Overall, the Wehea-Kelay landscape holds 8 hornbill species.

White-rumped Woodpecker *Meiglyptes tristis*
Endangered: Woodpeckers are generally able to survive on logged forest [24], but its abundance will decrease dramatically [9,24]. Ecologically, woodpeckers have a role in conserving both tropical vertebrates and invertebrates because of its ability to make a hole useful for a nesting site of another taxon [24]. In term of feeding guild, woodpeckers can be classified as bark gleaning insectivorous bird. This bird was found in logged-over forest areas of PT. NR, PT. KL, and PT. WBPU.

The Bornean Peacock-Pheasant *Polyplectron schleiermacheri*
Endangered: Small-sized peacocks are rarely found in Borneo. This species prefers primary forest, sometimes it percheson trees and walks on the ground. The bird is highly sensitive to habitat changes and human presence [26], so most of the observation was done through acoustic identification. The Bornean Peacock-Pheasant was only recorded in PT. GGA.

Bulwer's Pheasant *Lophura bulweri*
Vulnerable: Bulwer's Pheasant is endemic to Borneo and only inhabits forest interior. The population of this species in the wild tends to decline due to habitat changes and poaching. The species was recorded in PT. NR. Furthermore, there was also identified Bornean Crested Fireback *Lophura ignita* in PT. GGA and WPF.

Blue-headed Pitta *Hydrornis baudii*
Vulnerable: Pitta is the terrestrial insectivorous bird inhabiting the primary forest interior. Excessive timber harvesting in the concession area leads to the loss of Pitta species, especially *Hydrornis baudii*. In fact, timber harvesting possibly reduces the availability of potential food sources for the bird as well as influence microclimate condition which can affect forest floor [9,10,22]. Blue-headed Pitta was found in PT. KL and WPF.

Fulvous-chested Jungle Flycatcher *Cyornis olivaceus*
Vulnerable: Flycatchers are obligate insectivorous birds (the majority of sallying insectivore). Our study identified 19 species of flycatchers in the Wehea-Kelay landscape, but it is the most vulnerable. Like *Pitta* spp., abrupt microclimate changes on logged forest will reduce food sources, diminishing its population [9,10,22]. However, in line with the process of forest succession, the population of this species is recovered. Fulvous-chested Jungle Flycatchers are recorded in the WPF.

Storm's Stork *Ciconia stormi*
Endangered: Its population is predicted less than 200 individuals [27]. This species is sensitive to habitat changes, especially in wetlands and rivers. We recorded twice during observation: 1 individual in PT. GGA and 1 individual in PT. KL. We considered that these two concessions might be a suitable habitat for this species although the number of populations is small. Storm's Stork has also been recorded in the Gunung Lumut Protection Forest of East Kalimantan Province [28].

4. Discussion

Wehea-Kelay landscape is one of the remaining lowland rainforests in East Kalimantan with a high number of bird species. However, the number of species in our study area is lower than the number of birds in the Kutai National Park (KNP), East Kalimantan, which are 368 species [29]. Nevertheless, management at the landscape level at Wehea-Kelay provides better habitat for bird species than concession-based partial management. Previous studies reported 188 bird species in logging concessions in Sabah, Malaysia [30] and 117 bird species in Central Kalimantan [31].The future study might have the potential to identify other species of birds that have not yet been identified, including the presence of migrant birds.

Insectivorous bird groups corresponded to bird habitat conditions which are dominated by secondary forest, particularly in selective logging concessions. Selective logging activities are able to create open canopy which finally stimulates the growth of the insect population. Therefore, insectivorous birds are more dominant. This finding is consistent with numerous studies of tropical forest birds of Borneo [11,19]. In the ecosystem, insectivorous birds have a role in controlling insect population [20]. Unfortunately, this bird is prone to population decline because of habitat changes and competition. A study conducted by Azman et al. (2011) [21] reported that there was a decrease in the population of insectivorous birds as forest quality decreases. On the other hand, the negative effects of selective logging on birds sensitive to habitat change will decrease gradually along with the process of forest regeneration. The timber harvesting rotation system every 25-30 years is quite powerful to create an interval of forest succession. Meanwhile, the remaining area of intact forest in production forest concessions is beneficial for recovery area that could maintain bird diversity [9].

The underlying factor of declining population of avifauna in the selective logging area is not only caused by habitat changes, but also because of illegal hunting. This is also confirmed by Collar [4]. He found that hunting causes a decrease in hornbill population and diversity in comparison to timber harvesting. During the study, many signs of hunting either for trading or consumption of meat were found. Unfortunately, hunted birds are also species with protected status. Beastall et al. [32] reported that the trade in casque heads from Kalimantan and Sumatra during the 2012-2014 was estimated to reach 2,170 specimens, which mostly came from hunting.

The Wehea-Kelay landscape is managed collaboratively under EEA Wehea-Kelay Forum. The forum consists of multi-stakeholders from local communities, government institutions, private companies and non-governmental organizations. This management model is one of the new breakthroughs for sustainable natural resource management emphasizing biodiversity conservation efforts outside of protected areas by implementing best management practices, where avifauna conservation is one of the important aspects on it. The Wehea-Kelay landscape can provide a good habitat as well as a suitable corridor for birds, although there are changes in land cover due to selective logging activities. In fact, Wehea-Kelay protects birds with umbrella species status, such as Helmeted Hornbills *Buceros vigil* whose large home range to maintain viable minimum population [2].

One of the bird conservation efforts that should be implemented intensively in the Wehea-Kelay landscape are habitat and biodiversity protection from illegal activities, such as hunting and encroachment, through collaborative management programs among EEA Wehea-Kelay Forum members. Periodical monitoring of habitat and abundance of avifauna is needed, especially for bioindicator bird-species. To support this activity, further ecological studies like a comprehensive assessment of the benefits of bird-conservation should be conducted. In fact, information on ecology and behaviour of most important bird-species, such as Bornean peacock-pheasant *Polyplectron schleiermacheri*, Bulwer's pheasant *Lophura bulweri*, and *Pitta* spp, found in Wehea-Kelay is limited [26].

5. Conclusion

Avifauna in Wehea-Kelay landscape has been identified as many as 273 species. The concession area of timber companies has an ecological role as bird habitat. Avifauna conservation efforts at landscape scale can provide more habitat variability. In order to protect endangered species, it is necessary to maintain forest fragments as habitat corridors.

Acknowledgements

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