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Diversity of bird species in Pangheotan grassland and Mount Masigit Kareumbi Hunting Park, West Java, Indonesia

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Abstract. *Withaningsih S, Parikesit, Rakha. 2022. Diversity of bird species in Pangheotan grassland and Mount Masigit Kareumbi Hunting Park, West Java, Indonesia. Biodiversitas 23: 2790-2798.* The diversity of bird species is often used as an indicator of the ecosystem balance of an area. One of the efforts to preserve and protect the diversity of bird species is made by fostering habitat in the Pangheotan I Grassland (*Kebun Rumput Pangheotan*, hereinafter Pangheotan grassland) of PT. Perkebunan Nusantara (PTPN) VIII, West Bandung District, Indonesia and the Wali Pohon Block of Mount Masigit Kareumbi Hunting Park (*Taman Buru Gunung Masigit Kareumbi* herein after TBGMK), Bandung District, Indonesia. This study aims to determine the diversity of bird species in the two areas so that it can be used as basic data in making planning strategies for maintaining and increasing biodiversity. Bird data collection techniques using the point count method and analysis of bird species diversity data were carried out using a quantitative data analysis approach. In the second year of habitat development, 27 species of birds were found in Pangheotan grassland, with a Shannon-Wiener diversity index (H') of 2,479 (medium diversity), an evenness index of 0.814 (even abundance), and *Pycnonotus aurigaster* was the species of bird that had the highest relative frequency and relative abundance. Meanwhile, in the second year of habitat development in TBGMK, 45 species of birds were found with H' of 3,237 (high diversity), and E of 0.926 (even abundance), and *srigunting kelabu* (*Dicrurus leucophaeus)* was the species of bird that had the highest relative frequency and relative abundance. The results of the study show the success of the habitat development carried out in these two locations through the biodiversity by design program.

Keywords: Bird species, biodiversity by design, diversity, habitat development

INTRODUCTION

Species diversity is an important characteristic of a community and ecosystem in a place. Species diversity in an area is related to the number of species it contains (species richness), and the relative abundance of each species (relative abundance), leading to species evenness (Miller and Spoolman 2009). One type of fauna whose species diversity can be measured is birds. Birds have a large number of species in nature and are highly sensitive to environmental changes (Thongsoulin et al. 2019). Birds are one of the ecosystem components that have an important role, and they can be used as seed dispersal agents, indicators of biodiversity, indicators of changes in environmental quality, and indicators in determining conservation areas (Hendrayana et al. 2022; Sudjatnika et al. 1995).

The diversity of bird species is influenced by the diversity of its habitat types, especially in terms of vegetation and availability of food in the habitat (Tortosa 2000; Dewi et al. 2007), meaning that habitats with more diverse vegetation variations will have a higher diversity of bird species than habitats with fewer types of vegetation. For example, generally, mountainous forest areas that have a variety of vegetation will have a relatively higher diversity of bird species compared to grassland with low productivity (Fitri et al. 2015). In addition, birds can use one type of feed or a combination of several types of feed (Widodo 2015).

Bird diversity is the core of the research on bird ecology and the hotspot of conservation biology. The diversity of birds not only reflects the state of birds themselves but also reflects the fine habitat of birds, which can play a better indicator of ecological balance and environmental quality (Thongsoulin et al. 2019). The diversity of habitats acts as a provider of food sources, shelter, resting places, and nesting places for birds. The existence of a bird in a habitat is determined by its success in choosing and creating a special niche for itself. This situation is created through a long process of environmental selection (Peterson 1980).

The species diversity index commonly used in bird research is the Shannon-Wiener index. This index combines the species richness (total number of species) and evenness (the degree to which all species are common) of a bird community (Bibby et al. 2000). The diversity index will be high if the habitat can support various activities and is able to provide a comfortable place for shelter and breeding (Nugroho et al. 2013). The value of the diversity index is closely related to the ecological conditions of an area, and it can be an indicator of the integrity of the ecosystem of a region (Withaningsih et al. 2020).

One of the efforts to preserve and protect the diversity of bird species is the habitat development in the Pangheotan I Grassland (*Kebun Rumput Pangheotan*, hereinafter Pangheotan grassland) of PT. Perkebunan Nusantara (PTPN) VIII, West Bandung District, Indonesia and the Wali Pohon Block of Mount Masigit Kareumbi Hunting Park (*Taman Buru Gunung Masigit Kareumbi* herein after TBGMK), Bandung District, Indonesia. The two locations are part of the PT Biofarma target area in an effort to conserve biodiversity. Pangheotan I Grassland PTPN VIII West Bandung is formerly a tea plantation area that was abandoned for several years and part of the area is now used as grassland. Meanwhile, TBGMK is included in Important Bird Areas (IBA), which is an area identified as globally important for the conservation of bird populations. Rainforest is the most productive and biodiversity terrestrial ecosystem on earth (Leigh 1999). Tropical rainforest accounts for 60% of the total forest area in Southeast Asia. Tropical moist deciduous forests and tropical dry forests each account for 15% and 10% of the total forest area in Southeast Asia (FAO 2001).

Habitat development in Pangheotan and TBGMK is hoped to increase the diversity of bird species in these two areas. In TBGMK, the planting of various tree vegetation is conducted to provide a variety of habitats for birds, and in Pangheotan, the planting of trees and grass is conducted to be used by the local community as animal feed as well as to be used as habitats for birds. In this way, the process of fostering this habitat is sustainable, paying heed to the environmental, social, economic, and cultural aspects. The structure and function of the ecosystem influence the composition of the plant community. For example, species composition and species diversity strongly influence ecosystem processes, such as nutrient cycling, productivity, decomposition rate, and nutrient dynamics, especially when one or more species have strong ecosystem effects (Hooper and Vitousek 1997). Plant diversity is important because species depend on each other. Therefore, the disappearance of one species leads to the loss of others. There has been discussion about the concept of diversity and its measurement. The concept of diversity is well represented in linguistics, sociology and physics (Patil and Taillie 1982).

This study aims to determine the diversity of bird species in two different habitat development areas in Pangheotan and TBGMK which is expected to be used as a basis for making the planning strategies for the maintenance and the efforts to increase the biodiversity in both areas through the concept of "biodiversity by design."

MATERIALS AND METHODS

Study area

The research at both locations was carried out for 2 years each, at the Pangheotan I Grassland of PT. Perkebunan Nusantara (PTPN) VIII, West Bandung District, Indonesia (herein after Pangheotan grassland) from 2020 to 2021 and Wali Pohon Block of Mount Masigit Kareumbi Hunting Park (*Taman Buru Gunung Masigit Kareumbi* herein after TBGMK), Bandung District, Indonesia from 2019 to 2020 (Figure 1). This research was explorative in nature and carried out in three stages: a preliminary survey, data collection, and data analysis. A preliminary survey was conducted to determine the research site and general description of field conditions. Bird data collection techniques in both regions used the point count (PC) method: observations were conducted at the predetermined point count locations of a certain time and distance point corresponding to the condition of the sites (Bibby et al. 2000). This method is suitable for studying highly visible, and/or vocal bird species, in a wide variety of habitats (Gibbons et al. 1996). Data analysis of species diversity index, evenness index, species similarity index, relative frequency, relative abundance, and changes in bird species diversity was carried out using a quantitative data analysis approach.

The observation path in the Pangheotan habitat development area followed a path that passed through several types of vegetation. Observations started from *PC* 1, located in the border area between the residential areas and the tea plantations, through the pine forest (*Pinus merkusii*), which was the location of *PC* 2-4. This was then followed by *PC* 5-10 with the dominant vegetation of saliara (*Lantana camara*) and white teak (*Gmelina arborea*), which were quite bald because a lot of the leaves were taken for animal feed. *PCs* 11 and 12 were the observation locations which were the border areas between areas dominated by white teak and pine forests, and *PC* 13-14 were dominated by grass grown for animal feed purposes (Figure 2).

The observation path in the TBGMK habitat development area was through three routes located in the *Wali Pohon* Block. Path one entered through the road across the river dam in Kareumbi, determining three observation points (PC 1-3). This path was PT Biofarma's *Wali Pohon* Block that had been planted. The vegetation around the observation point was dominated by shrubs, namely *saliara* (*L. camara*) and *kirinyuh* (*Chromolaena odorata*). Path two entered through camping ground A, determining as many as 4 observation points (PC 4-7) with vegetation dominated by pine (*P. merkusii*) and *tepus* (*Etlingera hemisphaerica*). The pine forest in path two was an area directly adjacent to the *Wali Pohon* Block. Pathway three entered through the middle lane of the research site with vegetation dominated by *rasamala* (*Altingia excelsa*) (PC 8-10) and ended at the *Hadun* Block, which was dominated by saliara (*L. camara*) (PC 11-14) (Figure 2). *Hadun* Block was a part of the *Wali Pohon* Block which was affected by the forest fire in 2015.

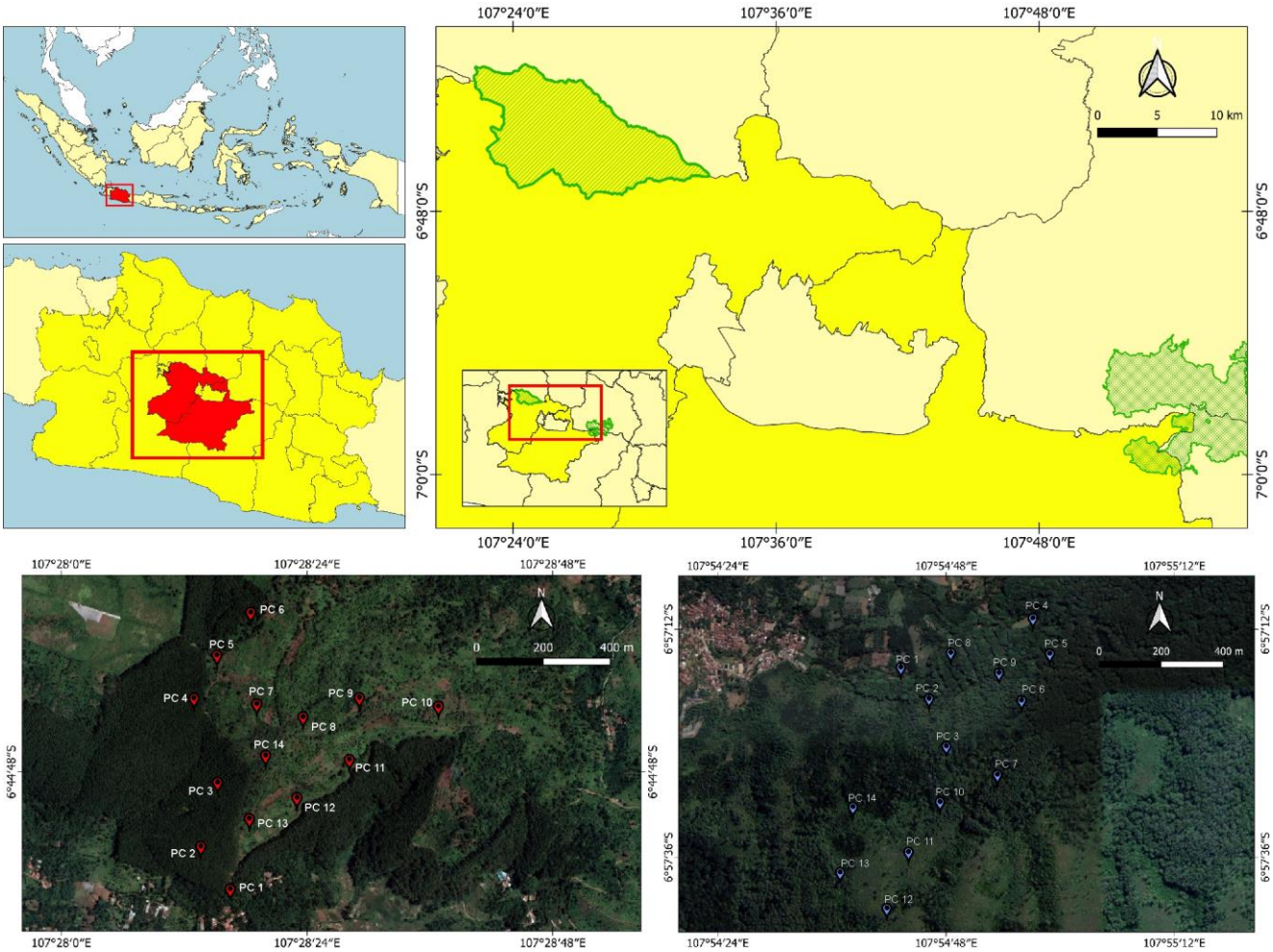

Figure 1. Location of the research area in Pangheotan I Grassland of PT. Perkebunan Nusantara (PTPN) VIII, West Bandung District, Indonesia (herein after Pangheotan grassland) and Wali Pohon Block of Mount Masigit Kareumbi Hunting Park (*Taman Buru Gunung Masigit Kareumbi* herein after TBGMK), Bandung District, Indonesia. Point Count Location Map in Pangheotan Grassland (*left-below*) and TBGMK (*right-below*)

RESULTS AND DISCUSSION

Bird species richness and conservation status

Bird surveys are the best method to understand species distribution, abundance and diversity (Issa 2019). Based on observations in 2020 and 2021, as many as 34 species of birds belonging to 19 families in the Pangheotan grassland habitat development area were found (Table 1). The number of bird species found is closely related to the habitat conditions at the research site which provides resources for the survival of various bird species, such as the availability of food, places to rest, play, breed, nest, perch, and shelter from the predators and from the bad weather. To live in a habitat, birds need certain conditions to be met, such as suitable, good, and safe habitat conditions from all disturbances (Ontario et al. 1990).

Based on the number of bird species in each family, Cuculidae and Cisticolidae were the families with the highest number of species found, each with three bird species. Birds belonging to the Cuculidae, Cisticolidae, and Pycnonotidae families are forest-dwelling birds that can adapt to new landscapes outside the forest, such as vegetable plantation habitats and areas with only a few shade plants (Widodo 2015). Thus, birds from this family can be found in various land uses at the research site. Bird species belonging to the Cuculidae family were the *wiwik kelabu* (*Cacomantis merulinus*), *wiwik uncuing* (*Cacomantis sepulcralis*), and *kedasi hitam* (*Surniculus lugubris*), while the bird species belonging to the Cisticolidae family were *cinenen kelabu* (*Orthotomus ruficeps*), *cinenen pisang* (*Orthotomus sutorius*), and *cinenen jawa* (*Orthotomus sepium*).

There are two species of birds protected by the Indonesian government through the Ministry of Environment and Forestry Regulation Number 106 of 2018: *elang-ular bido* (*Spilornis cheela*) and *elang brontok* (*Nisaetus cirrhatus*). Both species of birds are also included in Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). Raptors are often used as indicators of good habitat quality because of their sensitivity to human disturbances and environmental pollution. Thus, the

presence of raptors at the research site is important to be included in the management and conservation plans. The conservation of raptors in an effort to protect and maintain the health of the wider ecosystem, which in turn will have a direct impact on environmental sustainability, and which is important in maintaining human well-being (Withaningsih et al. 2019). In addition, these two eagles are included in the Appendix II category, meaning that they are animals, not species threatened with extinction, but it is possible to become endangered if the trade continues without regulations.

In addition to these two species of eagles, there was also *burung puyuh-gonggong biasa* (*Arborophila orientalis)*, which is included in the vulnerable category according to the International Union for Conservation of Nature meaning that this species becomes endangered unless the circumstances threatening its survival and reproduction improve. It is therefore considered to be facing a high risk of extinction in the wild (IUCN 2022). Meanwhile, 28 other bird species were categorized as least concern (low risk).

There are differences in bird species found in the 2020 and 2021 research periods: 27 bird species were found in the 2020 research, and 29 bird species were found in the 2021 research. This shows that there was an increase in the number of bird species found at the research site. Table 1 shows 22 bird species found in the two research periods, five bird species found only in the 2020 research period, and seven bird species found only in the 2021 research period. These changes in species composition found could be caused by the changes in the habitat conditions within that one-year period.

There was a change in the area of *odot* grassland (*Pennisetum purpureum*), originally 1 ha in 2020 to 3 ha in 2021. The addition of this *odot* grassland areas changed the land use from a tea plantation and saliara shrubs (*L. camara*) to *odot* grassland. This-land use change could affect various bird species such as *bubut jawa* (*C. nigrorufus)*. In addition, the discovery of new bird species in the 2021 research period could be caused by the fact that these bird species were not detected during observations in the 2020 research period, as well as differences in the environmental factors in these two research periods.

Table 1. Comparison of Bird Species Richness in the 2020 and 2021 data collection period in Pangheotan Grassland, West Bandung District, Indonesia in the 2020 and 2021research periods

Species name		Family	Year	
Indonesian name	**Scientific name**		**2020**	**2021**
Elang-Ular Bido	*Spilornis cheela*	Accipitridae	✓	✓
Elang Brontok	*Nisaetus cirrhatus*	Accipitridae	-	✓
Cipoh Kacat	*Aegithina tiphia*	Aegithinidae	✓	✓
Cekakak Jawa	*Halcyon cyanoventris*	Alcedinidae	✓	✓
Cekakak Sungai	*Todiramphus chloris*	Alcedinidae	✓	✓
Kekep Babi	*Artamus leucoryn*	Artamidae	✓	✓
Kepinis Rumah	*Apus affinis*	Apodidae	✓	✓
Walet Linci	*Collocalia linchi*	Apodidae	✓	✓
Cinenen Kelabu	*Orthotomus ruficeps*	Cisticolidae	✓	✓
Cinenen Pisang	*Orthotomus sutorius*	Cisticolidae	-	✓
Cinenen Jawa	*Orthotomus sepium*	Cisticolidae	-	✓
Tekukur Biasa	*Spilopelia chinensis*	Columbidae	✓	✓
Kadalan Birah	*Phaenicophaeus curvirostris*	Cuculidae	✓	-
Bubut Jawa	*Centropus nigrorufus*	Cuculidae	✓	-
Wiwik Kelabu	*Cacomantis merulinus*	Cuculidae	✓	✓
Wiwik Uncuing	*Cacomantis sepulcralis*	Cuculidae	✓	✓
Kedasi Hitam	*Surniculus lugubris*	Cuculidae	-	✓
Cabai Jawa	*Dicaeum trochileum*	Dicaeidae	-	✓
Bondol Jawa	*Lonchura leucogastroides*	Estrildidae	✓	✓
Layang-Layang Batu	*Hirundo tahitica*	Hirundinidae	✓	-
Bentet Kelabu	*Lanius schach*	Laniidae	✓	✓
Cica-Koreng Jawa	*Megalurus palustris*	Locustellidae	-	✓
Takur Tenggeret	*Psilopogon australis*	Megalamidae	✓	-
Burung-Madu Sriganti	*Cinnyris jugularis*	Nectariniidae	✓	✓
Pelanduk Semak	*Malacocincla sepiaria*	Pellorneidae	✓	✓
Puyuh Batu	*Synoicus chinensis*	Phasianidae	✓	✓
Puyuh-Gonggong Biasa	*Arborophila orientalis*	Phasianidae	✓	✓
Caladi Tilik	*Picoides moluccensis*	Picidae	✓	✓
Caladi Ulam	*Dendrocopos macei*	Picidae	✓	✓
Cucak Kutilang	*Pycnonotus aurigaster*	Pycnonotidae	✓	✓
Merbah Cerukcuk	*Pycnonotus goiavier*	Pycnonotidae	✓	✓
Ceret Gunung	*Horornis flavolivaceus*	Scotocercidae	✓	-
Munguk Beledu	*Sitta frontalis*	Sittidae	-	✓
Tepus Pipi-Perak	*Cyanoderma melanothorax*	Timaliidae	✓	✓
Total			27	29

Note: ✓: Presence, -: Absence

There were 45 species belonging to 27 families found in the TBGMK habitat development area. Thirty-three species of birds were observed at the count points, while 12 other bird species were observed outside the count point. This number was higher than the richness of bird species in the Pangheotan habitat development area, which could be caused by the fact that TBGMK had more diverse vegetation providing more recesses/*niches* for many species of birds. This is in line with Alikodra's (1990) statement, which states that a secondary forest is a good habitat for bird communities because it tends to have heterogeneous vegetation types. The variety of vegetation structures enabled TBGMK to have various sources of food and to become a shelter from predators or bad weather; thus, many birds were found at that location.

The family with the highest number of bird species found in TBGMK was the Cuculidae family, with five species of birds (*wiwik kelabu, wiwik uncuing, kadalan birah, kadalan kembang*, and *kangkok ranting*). A large number of species from the Cuculidae family found might be due to the availability of the abundant insects fed in TBGMK. In addition, *wiwik kelabu* (*C. merulinus), wiwik uncuing* (*C. sepulcralis),* and *kangkok ranting* (*Cuculus saturatus)* belong to the group of true *kangkok* birds that reproduce parasitically by laying eggs in the nests of other species of birds which are then hatched and raised by these birds.

Protected bird species found in the TBGMK habitat development area *elang brontok* (*N. cirrhatus*) and *elang hitam* (*Ictinaetus malaiensis*). The two birds are protected according to the Ministry of Environment and Forestry Regulation Number 106 of 2018 and are included in the CITES category of Appendix II. Other species of birds found in the research site which were included in the IUCN Red List were *cucak gunung* (*Pycnonotus bimaculatus*), which falls into the category of near threatened, *kerak kerbau* (*Acridotheres javanicus*), falling into the category of vulnerable (vulnerable), and 43 other bird species belonging to the category of low-risk (least concern).

There are differences in the number of bird species found in the 2019 and 2020 research periods. The number of bird species in the habitat development area in 2019 was 39 bird species, while in 2020 45 bird species were found, marking an increase of six bird species. Based on the results obtained, there were 31 species of birds found in both the 2019 and 2020 studies. The species of birds found in the 2019 study but not in the 2020 study were eight bird species, while 14 bird species were found in the 2020 study but not found in the 2019 study. Changes in bird species richness in the TBGMK habitat development area can be seen in Table 2.

Frequency and relative abundance

Based on the results obtained in the Pangheotan grassland, *cucak kutilang* (*Pycnonotus aurigaster)* was the bird species with the highest relative frequency value in the research site with a value of 71.43%, followed by *tekukur biasa* (*Spilopelia chinensis)* with a value of 64.29%, and *caladi tilik* (*Picoides moluccencis)*, *bentet kelabu* (*Lanius schach*), and *cekakak jawa* (*Halcyon cyanoventris*) with a value of 35.71%. The complete relative frequency value of each bird species can be seen in Figure 3.

There were five species of birds belonging to the relatively dominant abundance category (Di>5%), namely *cucak kutilang* (*P. aurigaster*, Di=30,43%), *bondol jawa* (*Lonchura leucogastroides*, Di=10,14%), *tekukur biasa* (*S. chinensis*, Di=8,70%), *bentet kelabu* (*L. schach*, Di=5,07%), and *cinenen kelabu* (*O. ruficeps*, Di=5,07%). Ten bird species were categorized as sub-dominant (Di=2%-5%), and six other bird species were categorized as non-dominant (Di<2%). The relative abundance of bird species in an area is usually related to the availability of main life requirements (food, water and shelter) as well as suitable weather conditions (Issa 2019). The complete relative abundance value of each bird species can be seen in Figure 4.

There were four species of birds that had the highest relative frequency in the TBGMK habitat development area: *cinenen kelabu* (*O. ruficeps*), *srigunting kelabu* (*Dicrurus leucophaeus*), *caladi tilik* (*Picoides moluccensis*), and *merbah cerukcuk* (*Pycnonotus goiavier*) with a relative frequency value of 43. 86%, followed by *tekukur biasa* (*S. chinensis*) with a relative frequency of 28.57%, *caladi ulam* (*Dendrocopos macei*), and *munguk beledu* (*Sitta frontalis*) with a relative frequency of 21.43%. Ten bird species had a relative frequency value of 14.29%, and 16 other bird species had a relative frequency value of 7.14%. The complete frequency value of each bird species can be seen in Figure 5.

There are seven species of birds belonging to the dominant category. The most dominant bird species in the TBGMK habitat development area were the *srigunting kelabu* (*D. leucophaeus)* and *munguk beledu* (*S. frontalis)* with a relative abundance value of 8.13%. Other bird species classified as dominant (Di=>5%) were *cinenen kelabu* (*O. ruficeps*), *pelanduk semak* (*Malacocincla sepiaria*), *caladi tilik* (*P. moluccensis*), *merbah cerukcuk* (*P. goiavier*), and *ceret gunung* (*Horornis flavolivaceus*). Eight bird species included sub-dominant (Di=2-5%) were *cekakak jawa* (*H. cyanoventris*), *sepah kecil* (*Pericrocrotus cinnamomeus*), *tekukur biasa* (*S. chinensis*), uncal buau (*Macropygia emiliana*), *tepekong jambul* (*Hemiprocne longipennis*), *sikatan belang* (*Ficedula westermanni*), *caladi ulam* (*D. macei*), and *jingjing batu* (*Hemipus hirundinaceus*). The other 18 bird species were included in the non-dominant category (Di=0-2%). The complete relative abundance value of each species can be seen in Figure 6.

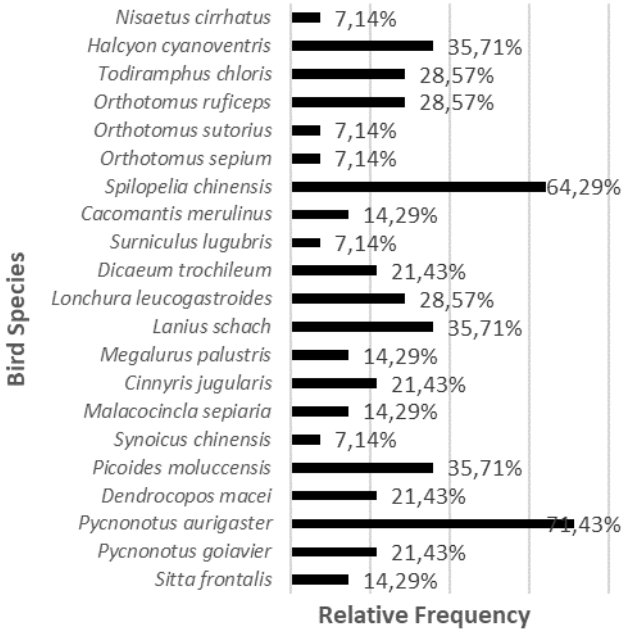

Figure 3. Relative frequency of each bird species in Pangheotan Grassland, West Bandung District, Indonesia

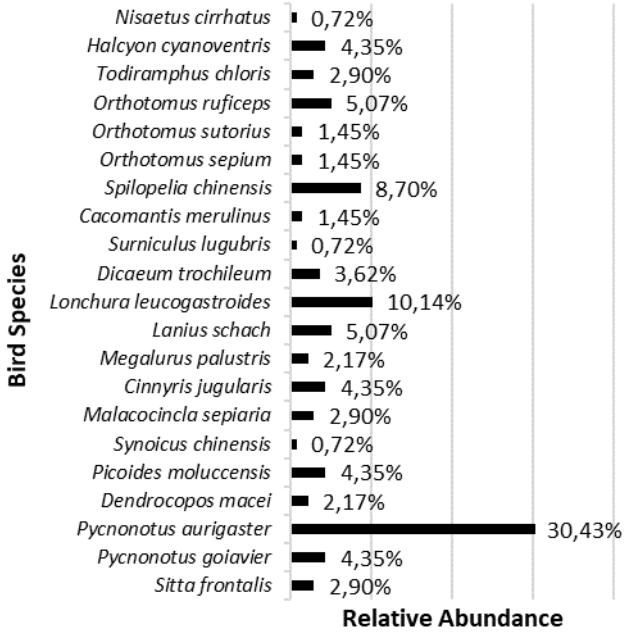

Figure 4. Relative abundance of each bird species in Pangheotan Grassland, West Bandung District, Indonesia

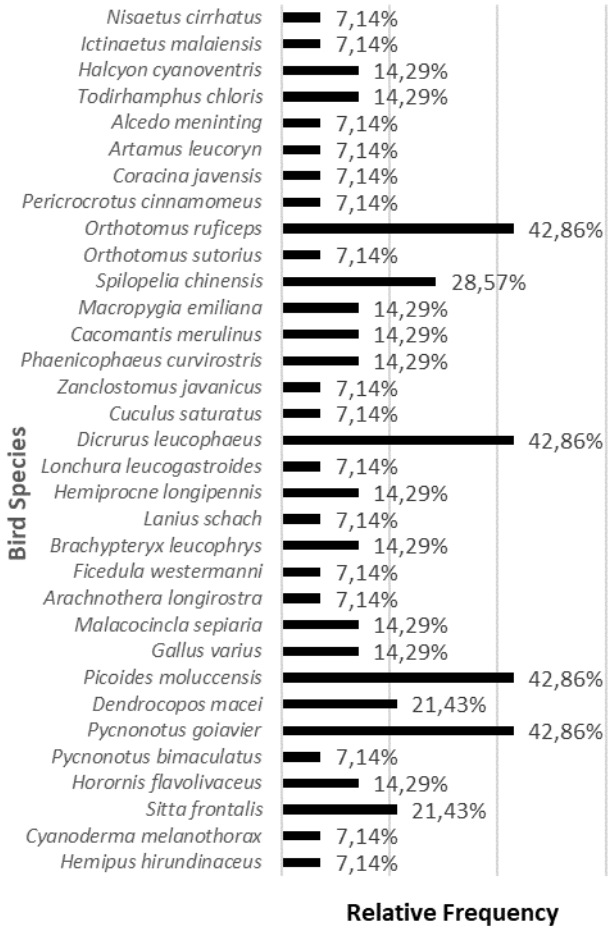

Figure 5. Relative frequency of each bird type in TBGMK habitat development area

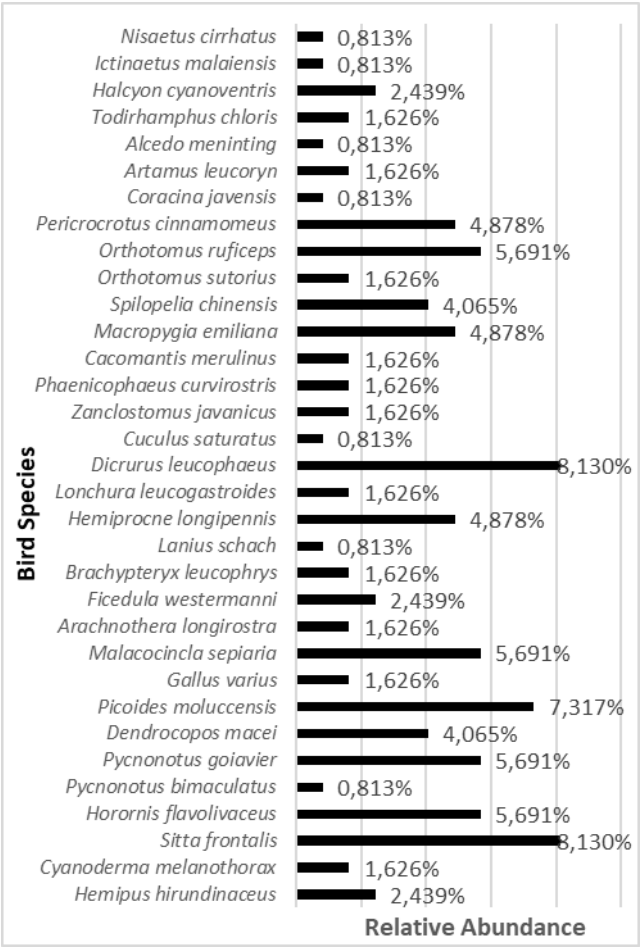

Figure 6. Relative abundance of each bird species in TBGMK habitat development area, Bandung District, Indonesia

Table 2. Changes in bird species richness in the TBGMK Habitat Development Area, Bandung District, Indonesia in the 2019 and 2020 research periods

Species name		Family	Year	
Indonesian name	**Scientific name**		**2019** *	**2020**
Elang Brontok	*Nisaetus cirrhatus*	Accipitridae	✓	✓
Elang Hitam	*Ictinaetus malaiensis*	Accipitridae	✓	✓
Elang-Alap Cina	*Accipiter soloensis*	Accipitridae	✓	-
Cipoh Kacat	*Aegithina tiphia*	Aegithinidae	✓	-
Cekakak Jawa	*Halcyon cyanoventris*	Alcedinidae	✓	✓
Cekakak Sungai	*Todirhamphus chloris*	Alcedinidae	✓	✓
Raja-Udang Meninting	*Alcedo meninting*	Alcedinidae	✓	✓
Kepinis Rumah	*Apus affinis*	Apodidae	✓	✓
Walet Linci	*Collocalia linchi*	Apodidae	✓	✓
Kekep Babi	*Artamus leucoryn*	Artamidae	✓	✓
Kepudang-Sungu Jawa	*Coracina javensis*	Campephagidae	✓	✓
Sepah Kecil	*Pericrocrotus cinnamomeus*	Campephagidae	-	✓
Sepah Hutan	*Pericrocotus flammeus*	Campephagidae	✓	✓
Cinenen Kelabu	*Orthotomus ruficeps*	Cisticolidae	✓	✓
Cinenen Pisang	*Orthotomus sutorius*	Cisticolidae	-	✓
Tekukur Biasa	*Spilopelia chinensis*	Columbidae	✓	✓
Uncal Buau	*Macropygia emiliana*	Columbidae	✓	✓
Gagak Kampung	*Corvus macrorhynchos*	Corvidae	✓	✓
Bubut Alang-Alang	*Centropus bengalensis*	Cuculidae	✓	-
Wiwik Kelabu	*Cacomantis merulinus*	Cuculidae	✓	✓
Wiwik Uncuing	*Cacomantis sepulcralis*	Cuculidae	-	✓
Kadalan Birah	*Phaenicophaeus curvirostris*	Cuculidae	-	✓
Kadalan Kembang	*Zanclostomus javanicus*	Cuculidae	✓	✓
Kangkok Ranting	*Cuculus saturatus*	Cuculidae	-	✓
Srigunting Kelabu	*Dicrurus leucophaeus*	Dicruridae	✓	✓
Tepekong Jambul	*Hemiprocne longipennis*	Hemiprocnidae	-	✓
Layang-Layang Batu	*Hirundo tahitica*	Hirundinidae	-	✓
Bentet Kelabu	*Lanius schach*	Laniidae	✓	✓
Sikatan Besi	*Muscicapa ferruginea*	Muscicapidae	✓	-
Sikatan Mugimaki	*Ficedula mugimaki*	Muscicapidae	✓	-
Sikatan Belang	*Ficedula westermanni*	Muscicapidae	✓	✓
Sikatan Bubik	*Muscicapa dauurica*	Muscicapidae	✓	✓
Cingcoang Coklat	*Brachypteryx leucophrys*	Muscicapidae	-	✓
Burung-Madu Sriganti	*Cinnyris jugularis*	Nectariniidae	✓	-
Pijantung Kecil	*Arachnothera longirostra*	Nectariniidae	-	✓
Pelanduk Semak	*Malacocincla sepiaria*	Pellorneidae	✓	✓
Ayam-Hutan Hijau	*Gallus varius*	Phasianidae	✓	✓
Caladi Tilik	*Picoides moluccensis*	Picidae	✓	✓
Caladi Ulam	*Dendrocopos macei*	Picidae	-	✓
Pelatuk Besi	*Dinopium javanense*	Picidae	✓	✓
Bondol Jawa	*Lonchura leucogastroides*	Ploceidae	-	✓
Merbah Cerukcuk	*Pycnonotus goiavier*	Pycnonotidae	✓	✓
Cucak Gunung	*Pycnonotus bimaculatus*	Pycnonotidae	✓	✓
Ceret Gunung	*Horornis flavolivaceus*	Scotocercidae	-	✓
Tesia Jawa	*Tesia superciliaris*	Scotocercidae	✓	✓
Munguk Beledu	*Sitta frontalis*	Sittidae	✓	✓
Jalak Putih	*Acridotheres melanopterus*	Sturnidae	✓	-
Kerak Kerbau	*Acridotheres javanicus*	Sturnidae	-	✓
Tepus Pipi-Perak	*Cyanoderma melanothorax*	Timaliidae	-	✓
Berencet Kerdil	*Pnoepyga pusilla*	Timaliidae	✓	✓
Luntur Harimau	*Harpactes oreskios*	Trogonidae	✓	-
Jingjing Batu	*Hemipus hirundinaceus*	Vangidae	✓	✓
Kacamata Biasa	*Zosterops palpebrosus*	Zosteropidae	✓	✓
Total			39	45

Note: ✓ : Presence, - : Absence

Bird species diversity and evenness index

Species diversity is the number of species and abundance of each species that live in a specific location. A diversity index is a quantitative measure of how many different species are in a community (species richness) and how individuals are distributed within those species (species abundance) (Vasscur et al. 2009). Therefore, the diversity index is considered a calculation of variety, which is a useful tool for understanding the profile of biodiversity across the study area (Bibi and Ali 2013).

Based on the results of data analysis in the Pangheotan grassland in 2021, the Shannon-Wiener diversity index value in the area was 2.540. This index value was included in the medium diversity criteria. The evenness index value at the research site was 0.835 indicating that the abundance of each bird species was almost evenly distributed.

In the 2020 research period, the Shannon-Wiener diversity index value in the area was 2.285 (medium diversity) and the evenness index value was 0.763. Thus, it can be seen that there was an increase in the value of the two indices. Changes in the index value of bird species diversity and evenness in the research site in the period 2020 and 2021 can be seen in Figure 7.

Based on the results of data calculations, the Shannon-Wiener diversity index value in the TBGMK habitat development area in 2020 was 3.237. The index value was included in the criteria for high diversity. The evenness index value at the research site was 0.26 which indicated that the abundance of each bird species was almost evenly distributed.

In the 2019 research period, the TBGMK habitat development area had a Shannon-Wiener diversity index value of 2.856 (medium diversity) and an evenness index value of 0.877. Therefore, it could be concluded that there was an increase in the value of the two indexes. Changes in the index value of the bird species diversity and evenness in the TBGMK habitat development area in the 2019 and 2020 research periods can be seen in Figures 8.

The results of the diversity index for the total numbers of wild birds in two different habitats were in line with Mengesha and Bekele (2008). They mentioned that avian diversity is an indication of habitat heterogeneity and the number of species and individuals in an area implies the importance of the area. Each habitat has a specific set of micro-environment that is suitable for a species. Bibi and Ali (2013) cleared that the values of Shannon-Weiner diversity index usually fall between 1.5 and 3.5, only rarely does it surpasses 4.5. Kiros et al. (2018) mentioned that the variation in bird species diversity, richness, and abundance is associated with the vegetation composition that makes changes in food sources, nesting, and protection based on birds' habitat preference and feeding.

Bird community similarity

The community similarity index was used to see the similarity of bird species communities between the Pangheotan habitat development area and TBGMK. The results of the community similarity index obtained from the data in 2020 showed that the two locations had moderate similarity with an index value of 0.528, meaning that the Pangheotan and TBGMK habitat development areas have 52.8% similarity in bird species. There were 19 bird species found in the two research sites. This similarity was due to the fact that the two habitat development sites both had pine forests, open vegetated areas, and shrubs, so some of the same bird species were found, among others *cinenen kelabu* (*O. ruficeps*), *tekukur biasa* (*S. chinensis*), *bentet kelabu* (*L. schach*), and *merbah cerukcuk* (*P. goiavier*).

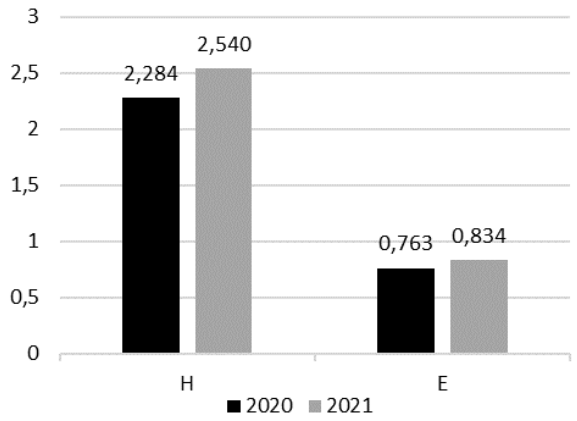

Figure 7. Comparison of the Diversity Index (H) and Evenness Index (E) in 2020 and 2021 in the Pangheotan grassland, West Bandung District, Indonesia

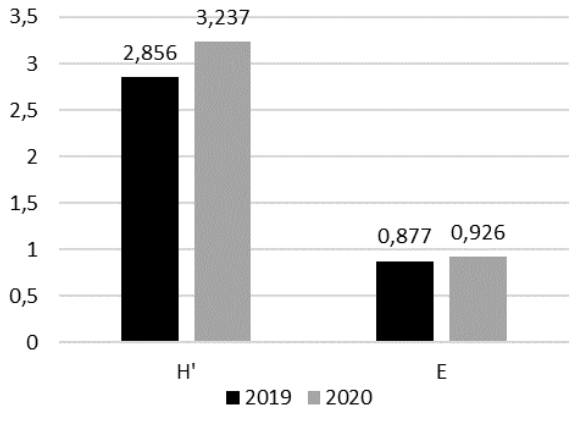

Figure 8. Comparison of the Diversity Index (H) and Evenness Index (E) in 2019 and 2020 in the TBGMK, Bandung District, Indonesia

In addition to the bird community similarity, there were also some differences/ dissimilarities of bird species between the two research sites. Eight bird species were only found in the Pangheotan habitat development area, and 26 bird species were only found in the TBGMK habitat development area. This can happen because birds have feed preferences and preferences for certain habitats, so the two research sites with different types of vegetation have different types of birds. The Pangheotan habitat development area is generally dominated by bird species that like open vegetation and some bush birds, while the TBGMK habitat development area was not exclusively for birds that like open vegetation and bush birds, but there were also various species of forest birds that were not found in the Pangheotan habitat development area.

TBGMK habitat development area had a secondary forest habitat type that had more diverse habitat variations, thus providing habitats for various forest birds such as *sikatan bubik* (*Muscicapa dauurica*), *sikatan belang* (*F. westermanni*), *berencet kerdil* (*Pnoepyga pusilla*), and *tesia jawa* (*Tesia superciliaris)*. Most of forest-dwelling birds are not able to adapt to new landscape conditions, so they are very dependent on the integrity of the forest and are relatively less tolerant of human presence (Widodo 2015). Therefore, forest birds found in the TBGMK habitat development area were not found in Pangheotan.

In conclusion, the number of bird species in Pangheotan grassland was lower than the number of species in TBGMK. This was because the vegetation cover in TBGMK was more diverse than in the Pangheotan grassland. Based on the results of data analysis, it could be seen that there was an increase in the number of bird species, species diversity index, and evenness index in the two research sites after planting in the first year and second year of the area. This shows that the habitat development program through the biodiversity by design program increases the vegetation cover in the two areas, and it has succeeded in increasing the number of bird species in both locations.

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