Response of bird community to gradual landscape transformation in Darmaga campus, IPB University, Bogor, Indonesia

S P A Nugroho¹, A Mardiastuti², Y A Mulyani³ and D A Rahman⁴
¹ Tropical Biodiversity Conservation Study Program, Faculty of Forestry and Environment, IPB University, Bogor, Indonesia
² Department of Forest Resources Conservation and Ecotourism, Faculty of Forestry and Environment, IPB University, Bogor, Indonesia

Abstract. When a landscape gradually transforms, the bird community that inhabits the landscape will also adapt and change accordingly. Long-term data on the bird-habitat relationship, however, is still lacking in the sub-urban tropical areas. The objective of this paper was to analyze the response of bird community along with the gradual transformation of the landscape. Darmaga Campus of IPB University (± 2.67 km²) was selected as the study area due to its landscape transformation for campus development/construction, and the availability of bird monitoring data. Data on landscape transformation were gathered from the IPB building construction book published in 2017, and bird community (1982-2020) were gathered from published reports and papers. During the observed period, Darmaga Campus that initially consisted mostly of old rubber plantation has been gradually transformed into various academic-related uses, such as some areas for buildings dan field laboratories. From 1982 to 2020, the cumulative bird species in the study area at least was 124 species. During the observed years, the bird community was highly dynamics (bird species number in 1982 = 41 species, 1985 = 39 species, 1986 = 68 species, 1991 = 68 species, 2001 = 39 species, 2003 = 72 species, 2013 = 52 species, 2020 = 99 species). New incoming species were Chestnut-winged Cuckoo, Asian Brown Flycatcher, Tiger Shrike, and babblers (e.g., Black-capped Babbler); Brown Shrike, White-rumped Shama, Oriental Magpie-Robin and Green Junglefowl have not been observed or have become increasingly rare in the last ten years. Meanwhile, Red-breasted Parakeet, Fulvous-breasted Woodpecker, Sunda Pygmy Woodpecker, Black Drongo, and Sooty-headed Bulbul are always present species. Bird species such as Orange-headed Thrush, White-rumped Shama, White-browed Shortwing, and Velvet-fronted Nuthatch are species that entered to rarely found species. Gradual landscape transformation, from an old rubber plantation into a mosaic of small patches of human-made ornamental plants, shrub, and tree plantation, turns out to be beneficial for some bird species, but could also disadvantageous for others, causing a dynamic bird community composition.

Keywords: feeding guilds, rubber plantation, species composition, sub-urban

1. Introduction
The human population has continued to increase from time to time, and this increase has also been followed by an increase in land requirements [1]. The use of land by humans is carried out to fulfill all interests to maintain life, such as to produce food, use it for shelter, and various other purposes. The increasing human need for land has transformed the shape of a landscape a lot.

Transformations in a landscape have occurred in many areas, e.g., in the Darmaga Campus, IPB University, Bogor. In the past, the Darmaga Campus was founded in 1963, most of its area was an old rubber plantation, and there were only a few buildings. Then to fulfill academic needs, the campus area has gradually continued to develop until now. The
Dramaga Campus landscape has undergone many transformations gradually due to area development by humans. The development of an area can influence the existence of animals, especially birds. Birds are one of the animals that are very sensitive to changes in their environment. If the landscape undergoes transformations or disturbances that affect the bird habitat condition, the bird species composition in the landscape will also change [2,3], hence birds can be used as a bio-indicator to see changes in conditions environment [4] because the bird diversity in a place is closely related to their habitat conditions.

Birds can respond in different ways to the landscape transformations that occurred. There are bird species that can adapt and survive from transformations in their habitat, but there are also bird species that are lost or become extinct due to habitat transformations. This causes the bird community to be dynamic due to transformations in the landscape. This paper aims to determine how birds respond to gradual landscape transformation at the Darmaga Campus.

2. Methods

This paper tries to analyze the shapes of landscape transformation on the Darmaga Campus in several periods and tries to relate to the bird species present in the area whose data is obtained from several research. Darmaga Campus of IPB University (± 2.67 km2) was selected as the study area due to its landscape transformation for campus development/construction, and the availability of bird monitoring data. Landscape transformation data were obtained from the IPB building construction book written by [5] in 2017, then the bird data in this paper were taken from the research results of [6–13]. The data on the bird species presence obtained from several previous research were then grouped into several groups based on presence criteria (Table 1) to find out which bird species can survive from changes in habitat, rarely found on Darmaga Campus, newcomer, and that cannot be found anymore in the last ten years.

| Criteria            | Presence                  |
|---------------------|---------------------------|
| Always present      | Found in 7 to 8 survey period |
| Intermittently present | Found at least 2 to 6 survey period |
| Rarely found        | Found only once           |
| Newcomer            | Found in the last 10 years |
| Extirpated          | Cannot be found anymore in the last 10 years |

3. Results

3.1 Landscape transformation in Darmaga Campus, IPB University

The Darmaga Campus landscape has undergone many transformations since it was used as a campus until now. In 1963, when it was built as a campus, the Darmaga Campus area was an old rubber plantation from the Dutch colonial era. During the period 1963 - 2017, many building constructions were carried out for academic, laboratory and residential purposes. Previously, at the beginning of the campus, almost the entire of Darmaga Campus area was the green area, namely forest or garden with very few buildings. As time goes by, to fulfil all academic needs, more and more developments are being made at the Darmaga Campus and further reducing the green area. The number of people is increasing and academic needs are increasing, the more building construction is being carried out. The following is a list of building construction carried out at Darmaga Campus, IPB University from 1963 - 2017 (Table 2).
Table 2 The buildings built from 1963 - 2017 in Darmaga Campus, IPB University [5]

| Period       | Building                                                                 |
|--------------|--------------------------------------------------------------------------|
| 1963 - 1970  | • Main building of forestry faculty and forest product department (2.419 m²)  |
|              | • Silviculture laboratory building (2.629 m²)                            |
|              | • Sylvasari and sylvalestari dormitory building (2.256 m²)               |
|              | • Housing for lecturers and employees (± 60 unit)                        |
|              | • Al-Hurriyah mosque (332 m²)                                           |
|              | • The building of fisheries faculty (3.016 m²)                           |
|              | Total: 10.652 m² +                                                      |
| 1971 - 1978  | • Gymnasium (1.854 m²)                                                  |
|              | • Aerial portrait building (1.019 m²)                                   |
|              | • Forest engineering laboratory (902 m²) and wood engineering laboratory (154 m²) |
|              | • Facilities of Food Technology Development Center (FTDC) (4.370 m²)     |
|              | • Area of Agricultural Product Processing Plant (AP4) (1.754 m²)         |
|              | Total: 10.053 m²                                                       |
| 1979 - 1987  | • The central building of agricultural technology faculty (23.189 m²)    |
|              | • The building of information resources institute (12.361 m²) dan center for environmental research (PPLH) (5.133 m²) |
|              | • Sylvapinus dormitory (3.856 m²) and Darmaga female dormitory (667 m²) |
|              | • 3 Faperta greenhouse units                                             |
|              | • Seed lecture room (252 m²)                                            |
|              | • I and II analytical laboratory building (585 m²)                      |
|              | • Agricultural cultivation department building (652 m2)                 |
|              | • Kornita senior high school (252 m²)                                   |
|              | Total: 46.947 m² +                                                     |
| 1988 - 1998  | • Inter-university central building (9.000 m²)                          |
|              | • Graha Widya Wisuda (GWW) building (4.195 m²)                          |
|              | • Fisheries and marine science faculty building (39.971 m²)              |
|              | • The building of animal husbandry faculty (47.682 m²)                   |
|              | • Sawmill laboratory (613 m²) and forest product harvesting laboratory (1.176 m²) |
|              | • Lecture room of forestry faculty (216 m²) and forest resources conservation building (2.768 m²) |
|              | • Household section building-A (655 m²) and household section building-B (675 m²) |
|              | Total: 106.951 m²                                                      |
| 1999 - 2010  | • Student dormitory (6.504 m²)                                          |
|              | • Sylva Pertamina auditorium (400 m²)                                   |
|              | • Animal closed house building (1.869 m²)                               |
3.2 Bird communities in Darmaga Campus, IPB University based on several previous research

There are at least 124 bird species founded in the study location based on several previous research results, which is relatively high for a tropical urban periphery. The number of bird species from several previous research results at Darmaga Campus can be seen in Figure 1. All of the species founded, then are grouped into several groups based on presence criteria (Table 3). Prescribed presence criteria are always present, intermittently present, rarely found, newcomer, and extirpated. There are 26 species included in the always present, 58 species intermittently present, 39 species rarely found, 103 newcomer and 23 extirpated species.

Figure 1 Bird species number found from several previous research from 1982 - 2020 in Darmaga Campus, IPB University [6-13]
Table 3 Bird species presence from several previous research [6-13] which has been grouped based on several presence criteria (bird name and sequence based on [14])

| Category             | Common Name                                                                 |
|----------------------|-----------------------------------------------------------------------------|
| Always present       | White-breasted Waterhen, Pink-necked Green Pigeon, Spotted Dove, Red-breasted Parakeet, Lesser Coucal, Javan Kingfisher, Collared Kingfisher, Fulvous-breasted Woodpecker, Sunda Pygmy Woodpecker, Pied Triller, Small Minivet, Common Iora, Sooty-headed Bulbul, Long-tailed Shrike, Bar-winged Prinia, Common Tailorbird, Great Tit, Scarlet-headed Flowerpecker, Brown-throated Sunbird, Olive-backed Sunbird, Oriental White-eye, Javan Munia, Scaly-breasted Munia, Black-naped Oriole, Black Drongo, White-breasted Woodswallow |
| Intermittently present | Javan Pond Heron, Black-crowned Night Heron, Cinnamon Bittern, Crested Honey Buzzard, Crested SERpent Eagle, Crested Goshawk, Besra, Spotted Kestrel, Green Jungleowl, Barred Buttonquail, Island Collared Dove, Zebra Dove, Chestnut-winged Cuckoo, Banded Bay Cuckoo, Plaintive Cuckoo, Rusty-breasted Cuckoo, Asian Drongo-Cuckoo, Greater Coucal, Barn Owl, Indian Scops-Owl, Collared Scops Owl, Savanna Nightjar, Edible-nest Swiftlet, Cave Swiftlet, House Swift, Asian Palm-Swift, Blue-eared Kingfisher, White-throated Kingfisher, Chestnut-headed Bee-eater, Barn Swallow, Pacific Swallow, Striated Swallow, Black-winged Flycatcher-shrike, Yellow-vented Bulbul, Brown Shrike, Oriental Magpie-Robin, Black-capped Babbler, Horsfield's Babbler, Striped Tit-Babbler, Striated Grassbird, Brown Prinia, Olive-backed Tailorbird, Arctic Warbler, Yellow-bellied Warbler, Asian Brown Flycatcher, Hill Blue Flycatcher, Golden-bellied Geryone, Pied Fantail, Ruby-cheeked Sunbird, Sunbird, Little Spiderhunter, Java Sparrow, Eurasian Tree Sparrow, Black-winged Starling, White-vented Myna, Ashy Drongo, Slender-billed Crow, Large-billed Crow |
| Rarely found         | Grey Heron, Purple Heron, Great Egret, Little Egret, Cattle Egret, Brahminy Kite, Chinese Sparrowhawk, Japanese Sparrowhawk, Black Eagle, Crested Hawk-Eagle, Slaty-legged Crane, Oriental Pratincole, Imperial Pigeon, Brown Cuckoo Dove, Common Emerald Dove, Yellow-crested Cockatoo, Long-tailed Parakeet, Yellow-throated Hanging Parrot, Moustached Hawk-Cuckoo, Chestnut-breasted Malkoha, Barred Eagle-Owl, Spotted Wood Owl, Sunda Frogmouth, Large-tailed Nightjar, Black-nest Swiftlet, Black-banded Barbet, Grey Wagtail, Tiger Shrike, White-browed Shortwing, White-rumped Shama, Sunda Robin, Orange-headed Thrush, Black-capped Babbler, Velvet-fronted Nuthatch, Plain Flowerpecker, Mountain White-eye, Asian Glossy Starling, Pied Myna, Common Hill Myna |
| Newcomer             | Grey Heron, Purple Heron, Great Egret, Little Egret, Cattle Egret, Javan Pond Heron, Black-crowned Night Heron, Cinnamon Bittern, Crested Honey Buzzard, Brahminy Kite, Crested SERpent Eagle, Crested Goshawk, Chinese Sparrowhawk, Japanese Sparrowhawk, Besra, Black Eagle, Crested Hawk-Eagle, Spotted Kestrel, Barred Buttonquail, Slaty-legged Crane, White-breasted Waterhen, Pink-necked Green Pigeon, Island Collared Dove |
Common Name

| Newcomer                    | Spotted Dove, Zebra Dove, Common Emerald Dove, Red-breasted Parakeet, Long-tailed Parakeet, Yellow-throated Hanging Parrot, Chestnut-winged Cuckoo, Moustached Hawk-Cuckoo, Banded Bay Cuckoo, Plaintive Cuckoo, Rusty-breasted Cuckoo, Asian Drongo-Cuckoo, Chestnut-breasted Malkoha, Greater Coucal, Lesser Coucal, Barn Owl, Collared Scops Owl, Barred Eagle-Owl, Spotted Wood Owl, Sunda Frogmouth, Large-tailed Nightjar, Savanna Nightjar, Edible-nest Swiftlet, Black-nest Swiftlet, Cave Swiftlet, House Swift, Asian Palm Swift, Blue-eared Kingfisher, White-throated Kingfisher, Javan Kingfisher, Collared Kingfisher, Chestnut-headed Bee-eater, Black-banded Barbet, Fulvous-breasted Woodpecker, Sunda Pygmy Woodpecker, Barn Swallow, Pacific Swallow, Striated Swallow, Grey Wagtail, Pied Triller, Small Minivet, Black-winged Flycatcher-shrike, Common Iora, Sooty-headed Bulbul, Yellow-vented Bulbul, Tiger Shrike, Long-tailed Shrike, Black-capped Babbler, Horsfield's Babbler, Striped Tit-Babbler, Striated Grassbird, Brown Prinia, Bar-winged Prinia, Common Tailorbird, Olive-backed Tailorbird, Arctic Warbler, Yellow-bellied Warbler, Asian Brown Flycatcher, Yellow-rumped Flycatcher, Hill Blue Flycatcher, Golden-bellied Geryone, Pied Fantail, Great Tit, Velvet-fronted Nuthatch, Plain Flowerpecker, Scarlet-headed Flowerpecker, Brown-throated Sunbird, Ruby-cheeked Sunbird, Olive-backed Sunbird, Crimson Sunbird, Little Spiderhunter, Oriental White-eye, Javan Munia, Scaly-breasted Munia, Eurasian Tree Sparrow, Black-naped Oriole, Black Drongo, Ashy Drongo, White-breasted Woodswallow, Slender-billed Crow |
| Extirpated                  | Green Junglefowl, Oriental Pratincole, Imperial-pigeon, Brown Cuckoo Dove, Yellow-crested Cockatoo, Indian Scops-Owl, Brown Shrike, White-browed Shortwing, Oriental Magpie-Robin, White-rumped Shama, Sunda Robin, Orange-headed Thrush, Plain Flowerpecker, Sunbird, Crimson Sunbird, Mountain White-eye, Java Sparrow, Asian Glossy Starling, Pied Myna, Black-winged Starling, White-vented Myna, Common Hill Myna, Large-billed Crow |

4. Discussion
The Dramaga Campus landscape has changed gradually and can affect the bird communities in the landscape. In the past, the Darmaga Campus landscape was initially built by a campus as an old rubber plantation. Gradually, the Darmaga Campus has undergone a lot of development until now to fulfill academic needs. Transformations in a landscape can impact the animals in it, especially birds, because they are sensitive to changes in their habitat.

Regional development gradually will make the shape of landscape mosaic and heterogeneous. The development of the area can create threats in the form of fragmentation and habitat loss for animals, which forces them to determine whether they will emigrate to the new places, more suitable habitats, or survive and adapt to new conditions [15,16]. Birds will respond differently to any development in their habitat. There are bird species that can survive changes in their habitat, and others choose to avoid or disappear.
Some shy bird species will require large patches of habitat and forest-resembled habitat (e.g., thick canopy, dense shrub), some bird species that can live in open forests or areas with humans will be able to adapt to changes in their habitat. Bird responses can vary according to the bird species’ characteristics and how they use the resources around them.

Most of the bird species that are included in the always present group like open habitats and habitats that are close to the presence of humans. Bird species such as the Red-breasted Parakeet, Fulvous-breasted Woodpecker, Sunda Pygmy Woodpecker, Black Drongo, and Sooty-headed Bulbul like open areas or open forests [17]. Besides, the Javan Munia species are seed-eating, usually founded in rice fields, and the Javan Kingfisher species are always founded in the Darmaga Campus landscape because this landscape can provide habitat for them in the form of rice fields and wet areas.

Meanwhile, in the rarely found group, species encountered such as Orange-headed Thrush, White-rumped Shama, White-browed Shortwing, and Velvet-fronted Nuthatch are shy bird species to human presence and require forested habitats [17]. Therefore, the increasing number of developments and the more human activities will have an impact on this type of bird.

In the newcomer group or new species that enter, there are bird species such as the Chestnut-winged Cuckoo, Asian Brown Flycatcher, Tiger Shrike, and babblers (e.g., Black-capped Babbler). Meanwhile, species such as the Brown Shrike, White-rumped Shama, Oriental Magpie-Robin, and Green Junglefowl have not been observed or have become increasingly rare in the last ten years. The existence of bird species in a place is closely related to the conditions of the place to support birdlife. According to [18] that there are several factors determine the presence of birds in a place, namely the availability of food, a place to rest, play, breed, nest, perch, and take shelter. If bird habitat is disturbed, newcomer species may disappear or no longer be found, such as extirpated species.

The existence of area development carried out at the Darmaga Campus should be balanced with the fulfilment of bird habitat components to support birdlife. Some activities that can be carried out are protecting forested habitats for birds, intensifying the planting of bird feed sources, and planting trees.

5. Conclusion
The conclusion of this paper is the gradual landscape transformation that occurred at Darmaga Campus, IPB University, from previously forest and old rubber plantations to many building constructions, turns out to be beneficial for some bird species, but can also be detrimental for others, causing a dynamic bird community composition. There are several recommendations for area development activities so that the development can also consider the birdlife needs, such as protecting forested habitats for birds, intensifying the planting of bird feed sources, and planting trees.

Acknowledgment
The authors would like to thank the Deputy for Strengthening Research and Development, Ministry of Research and Technology-National Research and Innovation Agency to provide funds so that can carry out research and publication. Similar remarks are also addressed to people who have helped the author to compile this paper. Moreover, the authors are also grateful to the Department of Landscape Architecture, Faculty of Agriculture, IPB University, which has arranged The 5th International Symposium for The Sustainable Landscape Development 2020.

References
[1] Kusrin, Suharyadi and Hardoyo S R 2011 Perubahan penggunaan lahan dan faktor yang mempengaruhinya di Kecamatan Gumungpati Kota Semarang Maj. Geogr. Indones. 25(1):24–40
[2] Canterbury G E, Martin T E, Petit L J and Bradford D F 2000 Bird communities and habitat as ecological indicator of forest condition in regional monitoring Conserv. Biol. 14(2):544–58
[3] Lee T M, Soh M C K, Sodhi N, Koh L P and Lim S L H 2005 Effects of habitat disturbance on mixed species bird flocks in a tropical sub-montane rainforest Biol. Conserv. 122(2):193–204
[4] Schultze C H, Wälltter M, Kessler P J A, Pitopang R, Shahabuddin, Veddeeler D et al 2004 Biodiversity indicator groups of tropical land use systems: comparing plants, birds, and insects Ecol. Appl. 14(5):1321–33
[5] Nugroho N, Mansjoer S, Djananezara O, Arsyad S, Suryokusumo S, Sutarahardja S et al 2017 Pembangunan gedung-gedung IPB Bogor: IPB Press
[6] Putro H R 1982 Keragaman jenis burung di lingkungan kampus IPB Darmaga Institut Pertanian Bogor
[7] Mulyani Y A 1985 Studi keanekaragaman jenis burung di lingkungan Kampus IPB-Darmaga Institut Pertanian Bogor
[8] van Balen S, Hernowo J B, Mulyani Y A and Putro H R 1986 The birds of Darmaga Media Konserv. 1(2):1–5
[9] Hernowo J B, Soekmadi R and Ekarelawan 1991 Kajian pelestarian satwaliar di Kampus IPB Darmaga Media Konserv. 3:43–65
[10] Mulyani 2001 Keragaman jenis burung di Kampus IPB Darmaga Bogor Institut Pertanian Bogor
[11] Kurnia I 2003 Studi keanekaragaman jenis burung untuk pengembangan wisata birdwatching di Kampus IPB Darmaga Institut Pertanian Bogor
[12] Mulyani Y A, Ulfah M and Sutopo 2013 Bird use of several habitat types in an academic campus of Institut Pertanian Bogor in Darmaga, Bogor, West Java Media Konserv. 18(1):18–27
[13] Mustari A H 2020 Biodiversitas Kampus IPB, Bogor Bogor: IPB Press
[14] Sukmantoro W, Irham M, Novarino W, Hasudungan F, Kemp N and Muchtar M 2007 Daftar Burung Indonesia No.2 Bogor: Indonesian Ornithologists’ Union
[15] Marzluff J M and K E 2001 Restoration of fragmented landscapes for the conservation of birds: a general framework and specific recommendations for urbanizing landscapes Restor. Ecol. 9(3):280–92
[16] McKinney M L 2002 Urbanization, biodiversity, and conservation Bioscience 52(10):883–90
[17] MacKinnon J, Phillips K and van Balen S 2010 Seri Panduan Lapangan Burung-Burung di Sumatera, Jawa, Bali, dan Kalimantan Bogor: Burung Indonesia
[18] Ontario J, Hernowo J B, Haryanto and Ekarelawan 1990 Pola pembinaan habitat burung di kawasan pemukiman terutama di perkotaan Media Konserv. 3(1):15–28