Vol. 12(3): 712-740, September 2024 DOI: https://doi.org/10.23960/jsl.v12i3.983

Jurnal Sylva Lestari

P-ISSN: 2339-0913
E-ISSN: 2549-5747

Journal homepage: https://sylvalestari.fp.unila.ac.id

Full Length Research Article

The Response Dynamics of Various Bird Species to Recreational Activities and Nature Tourism in Gunung Gede Pangrango National Park

Ricky Avenzora[1,*], Mafut Munajat[2], Adam Rachmatullah[3], Oktovianus[3], Reno Catelya Dira Oktavia[3], Dina Sri Suprajanti[3], Ansyari Musoman[4]

[1] Department of Forest Conservation and Ecotourism Faculty of Forestry and Environment, IPB University, Bogor, Indonesia
[2] Department of Tourism, Faculty of Information Technology and Communication, Semarang University, Semarang, Indonesia
[3] Department of Tourism, Trisakti Institute of Tourism, Jakarta, Indonesia
[4] Ecotourism Study Program College of Vocational Studies IPB University, Bogor, Indonesia
[*] Corresponding Author. E-mail address: rickyav@apps.ipb.ac.id

ARTICLE HISTORY:

Received:11 June 2024
Peer review completed: 22 July 2024
Received in revised form:30 July 2024
Accepted: 7 August 2024

KEYWORDS:

Avoidance response
Birdwatching
Disturbance response
Ecotourism
Gunung Gede Pangrango National Park

ABSTRACT

Tourist activities in forest areas can potentially disturb wildlife, including bird species. One of the responses to such disturbances is avoidance. This study aimed to investigate and analyze the tolerance levels of various bird species to recreational disturbances in Gunung Gede Pangrango National Park, West Java, Indonesia. The method used in this research involved "dummy tourist activities" that varied by the distance tourists walked to the birds, the number of tourists, and the noise made by tourists. The results showed that forest birds had a maximum tolerance distance for tourist activities of around 10 m, while attractive birds had a maximum tolerance distance of around 20 m. The closest distance for tourists to observe all bird species was 5 m. It is concluded that all bird species had avoidance responses to various human or tourist disturbances. Raptors and colorful birds had low tolerance responses; songbirds had a medium tolerance, and forest birds had a high tolerance. Information on the response dynamics of various bird species to recreational activities is useful for creating tourism site planning and landscape design based on ecological wildlife carrying capacity.

1. Introduction

Wildlife tourism trends continue to increase from year to year, including birdwatching. It needs to be ensured that it can be managed optimally for all interests in managing an object/tourist destination, including visitor satisfaction, the existence of wildlife, and the economic and financial aspects. In the context of the enrichment of tourism objects in a destination, wildlife tourism and birdwatching tourism can become main attractions or potential decorative attractions in the development/empowerment of object recreation/destination. In terms of visitor satisfaction, the certainty of visitors enjoying various resources in the destination needs to be ascertained and can be held optimally in a destination. For ecological indicators, the existence of birds in a destination must always be monitored regularly in its management. In the socio-economic context, birdwatching recreation in a destination needs to be managed optimally, efficiently, and effectively in all interests. In ecotourism, the heterogeneity of bird species and the abundance of individuals of each species at a tourist destination are potential tourist attractions and very useful for predicting

or designing wildlife ecological corridors and community green landscapes. The richness and abundance of species in an area can reflect the quality of the green landscape arrangement.

Dealings with animals have not necessarily been linked just to a targeted use (e.g., food source, guard role, beast of burden), but simply watching animals for fun, of which birdwatching is one example, is increasing worldwide (Callaghan et al. 2018; Kronenberg et al. 2017). One of the most popular wildlife tourism activities in the world is birdwatching. Birdwatching has become an increasingly popular recreational activity (Rutter et al. 2021). Birdwatching is part of nature tourism focused on bird observation to be enjoyed through watching or listening (Belaire et al. 2015). Kurnia et al. (2021) explained that birdwatching or avitourism is a recreational activity of observing birds in the wild with the naked eye or through assistive devices such as telescopes, binoculars, and cameras or simply listening to bird sounds. In developed countries, birdwatching tourism activities have been very commonly carried out by tourists, especially in the United States and the United Kingdom (Kronenberg 2014). Ashari et al. (2019) stated that Indonesia's birdwatching tourism is less developed. However, some references to ecotourism attractions utilizing bird species diversity as an appeal have been made by Putri et al. (2020) and Suana et al. (2020). Choosing birds as a tourism object is a positive step due to their visibility and the ease of hearing their sounds. Meanwhile, Iswandaru et al. (2023) stated that avitourism in villages around the conservation area still needs optimal support to increase welfare and reduce illegal practices like bird hunting.

Birdwatching and experiencing nature may be positive for birdwatchers and beneficial for many people (Tryjanowski et al. 2022). Birdwatching has also been utilized in environmental education (Cheung et al. 2017; White et al. 2018) and citizen science networks (Alexandrino et al. 2019; Zhou et al. 2020). Thus, tourism experiences can be enhanced by the conservation activities within a given community, strengthening a model of economic development based on ecological integrity (Schwoerer and Dawson 2022). The avitourism experience offers visitors education and knowledge about animals/species and contributes to the sustainable management of the environment (Kanta et al. 2021). It will not only add to the education aspect of visitors but also change the behavior of visitors towards wildlife. It can also add to the visitor's satisfaction and attitude towards wildlife.

Various studies on wildlife response patterns, including birds, to human activities (such as tourism) have generally been conducted using qualitative approaches. When quantitative methods are used, they typically involve using species richness as the measurement variable. For example, Akhadah et al. (2018) described the impact of tourism activities on bird populations, Potvin et al. (2023) described the effects of tourists on bird diversity in tourist areas, and then Blinkova and Shupova (2017) described the vegetation moderates impacts of tourism usage on bird communities, while Tu et al. (2022) only provide information on species richness across different habitat types. Steven et al. (2021) stated that some studies on the effects of recreational disturbance on wildlife are still conducted qualitatively, with limited empirical data. However, formulating visitor management concepts for recreational activities involving wildlife requires support from quantitative data studies (Bateman and Fleming 2017). Therefore, research on the response patterns and actions of wildlife, specifically birds, to recreational activities using a quantitative approach is still needed to formulate visitor management strategies that align with the environmental and habitat-carrying capacity.

The novelty of this research is that quantitative methods are used to measure bird responses to tourist disturbances with a combination of movement simulation and sound. This research aims

to optimize visitor management in national parks according to the ecological carrying capacity of wildlife biodiversity. This study aims to investigate and analyze the tolerance levels of various bird species to recreational disturbances in Gunung Gede Pangrango National Park, West Java, Indonesia.

2. Materials and Methods

This study was conducted at Gunung Gede Pangrango National Park, Cisarua Resort, SPTN Region IV Tapos, Bogor Region III National Park Management, and the study area was 253 ha. Geographically, the location of the study is at coordinates 106° 54' 44"–106° 56' 35" longitude and 06°42'5.32"–06°44'7.74" latitude, while administratively in Sukagalih Village, Sukaresmi Village and Kuta Village, Megamendung District, Bogor Regency, West Java Province, Indonesia. The study was conducted from January 2020 to September 2022 with a total observation day of around 278 days, mostly in the moderate intensity rainy season. The location of the study is a conservation area with vegetation conditions in the form of mountain tropical rainforests (**Fig. 1**). The flora at the study site consists of 146 species of plants divided into groups of trees, lower plants, orchids, ferns, liana, and others. The most common species found are 50 species of ground vegetation (shrubs and bushes), followed by 41 species of trees and 23 species of fungi.

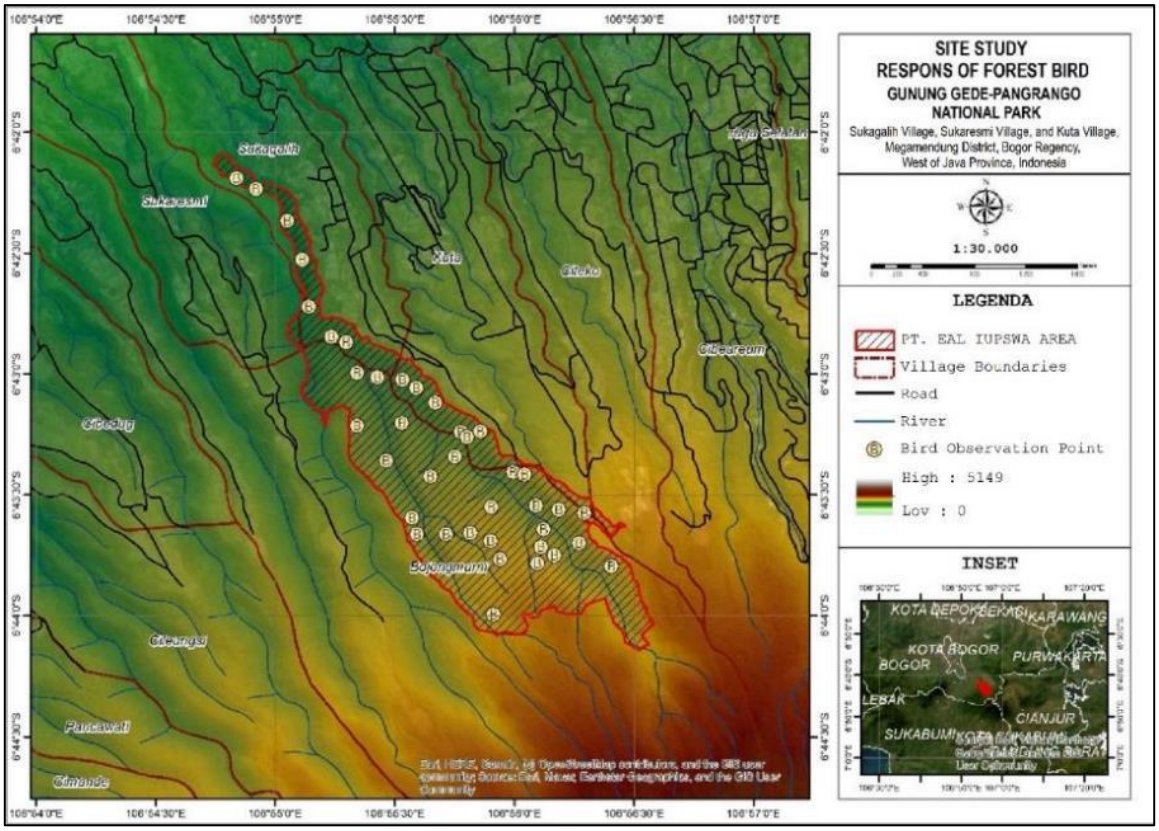
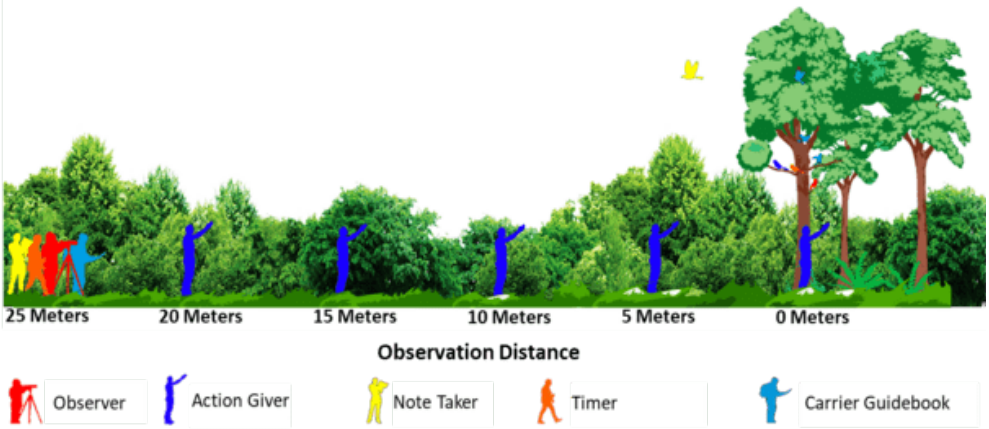


Fig. 1. Study area in Gunung Gede Pangrango National Park.

Bateman and Fleming (2017) mention that there are at least three types of data or approaches to measure the response of wild animals to recreational/tour activities, namely: avoidance responses, animal time budget, and animal physiological and breeding responses. The method for measuring the action and response of birds to visitors is to use the Avoidance Response method. Observers approach birds at varying distances ranging from 25 m to 0 m with intervals of 5 m (25

m, 20 m, 15 m, 10 m, 5 m, 0 m), as shown in **Fig. 2**. In each interval, a simulation of action/disturbance is carried out to respond to birds with human body movements and music. The observation plot is fixed in the edging area, a forest area that comprises trees, seedlings, bushes, and shrubs.



No	Figure	Response Patterns
1		: Looking at the sound
2		: Looking around
3		: Moving position to the same branch
4		: Moving position to another parallel branch
5		: Moving position to one higher level branch
6		: Moving position to two higher levels branch
7		: Flying/moving Far

Fig. 2. Observation method diagram of birds' action and response.

There are three perspectives for applying the 25–20–15–10–5 m intervals in observing bird response patterns: tourist equipment, site design, and minimizing negative impacts. Generally, at common tourist destinations, visitors do not equip themselves with binoculars or telephoto/zoom lens cameras; they usually rely only on the cameras of their mobile phones. From a site design perspective, destination management generally does not have the luxury or freedom to create special plots for bird zones. On the other hand, to minimize the negative impacts of tourism activities, destination management should also avoid allowing tourists to explore natural landscape areas excessively. Therefore, directing birdwatching activities to within 25–5 m of the trekking path, which serves as the observation axis, is important.

Bird abundance data was collected using the Point Count method. This method involves walking and marking specific points, then observing and recording the birds found at those points within a predetermined time (5–10 minutes) before moving on to the next point (Budka et al. 2021). Meanwhile, bird abundance data is calculated as a percentage.

The classification of attractive birds is based on the attractiveness of the tourist attraction. These birds are called attractive because they highly appeal to tourists, whether due to their appearance (color), sound, or character. The guide for bird identification follows MacKinnon et al. (2010). Each bird species' common and scientific names are based on the Handbook of the Birds of the World (HBW) and BirdLife International (HBW and BirdLife International 2023) and Eaton et al. (2021). Observations were made in the morning (05.30–09.00) and afternoon (13.30–16.00). The birds that are the object of research consist of 8 orders (6 orders from forest birds and 2 orders from attractive birds):

1. Forest birds consist of 14 species from 6 orders. Various species of birds are medium-sized birds and represent different categories of birds, including terrestrial birds, woodpeckers, arboreal birds, pigeons, kingfishers, and swallows.
2. Attractive birds consist of 15 species from 2 orders with 3 categories, namely: raptors, colorful birds, and songbirds.

Disturbances in the form of human movement are carried out with varying intensity, ranging from the disturbance of 1 person to 3 people, while the sound of music is low sound and high/loud sound. The type of music used is *Dangdut Koplo* (a local music genre in both West and East Java). We used this genre of music as an example of the negative behavior patterns of tourists when engaging in group recreation in natural environments. At each observation interval, distance is recorded on the duration of changes in bird behavior when experiencing disturbance or threat. At each plot, observations are made with 3 replications. The duration of the response time to the disturbance simulation is cheated in units of seconds and averaged for each test.

Data analysis of changes in the behavior of birds to visitors disturbance is done by creating a diagram of the dynamics of action and response in the form of radar diagrams. Furthermore, the Two Ways Analysis of Variance (ANOVA) was used to determine the significance of the difference between the type of stimulation disturbances and the distance disturbance to the bird.

3. Results and Discussion

3.1. Results

3.1.1. Description of birds

At the study site, there were 50 birds from 8 orders (6 orders from forest birds and 2 orders from attractive birds). In a study of a group of forest birds, 14 species were selected from 6 orders, grouped in the category of terrestrial birds, woodpeckers, arboreal birds, pigeons, kingfishers, and swallows. The attractive bird was chosen as many as 15 from 2 orders, grouped into raptors, colorful birds, and songbirds. A description of the taxonomy of birds from the group of forest birds and attractive birds and their abundance is presented in **Table 1**.

3.1.2. Actions and responses to human activity movement

3.1.2.1. Forest bird

Forest bird's response to disturbance of human activity movement is manifested in behavioral changes in the form of an avoidance response. This threatened response consists of an alert response and a response to flight (flight initiation response). The dynamics of changes in the behavior of forest birds towards stimulation of human movement disturbance can be seen in **Fig. 3** and **Fig. 4**.

In general, the pattern of bird response to human movements in the morning and daytime observations obtained data that at a distance of less than 10 m (intervals of 0 m and 5 m), the response duration is 0 seconds or intolerant, meaning that the birds directly reacts to human disturbance and by flying or disappear immediately. This condition occurs for various scale disturbances ranging from 1–3 people. A distance of 10 m is the distance of the transition between tolerant and intolerant responses where some species of birds still have not reacted to be disturbed. Furthermore, at a distance of 15 m to 20 m, the birds show a tolerant response with various changes in vigilance behavior (alert response) in the form of looking at the sound, looking around, moving

position to the same branch, moving position to another the parallel branch, moving position to one higher level branch, moving position to two higher levels branch, and flying/moving far.

Table 1. Bird species observed in the study area

No.	Scientific name	Local name	Order	Family	Abun	Category
Forest birds						
1	*Spilopelia chinensis*	Tekukur biasa	Columbiformes	Columbidae	1%	Pigeon
2	*Macropygia ruficeps*	Uncal kouran	Columbiformes	Columbidae	2%	Pigeon
3	*Cacomantis merulinus*	Wiwik kelabu	Cuculiformes	Cuculidae	1%	Arboreal
4	*Cacomantis sepulcralis*	Wiwik uncuing	Cuculiformes	Cuculidae	1%	Arboreal
5	*Zanclostomus javanicus*	Kadalan kembang	Cuculiformes	Cuculidae	1%	Arboreal
6	*Apus affinis*	Kapinis rumah	Apodiformes	Apodidae	4%	Swallow
7	*Collocalia linchi*	Walet	Apodiformes	Apodidae	10%	Swallow
8	*Halcyon cyanoventris*	Cekakak Jawa	Coraciiformes	Alcedinide	1%	Kingfisher
9	*Todiramphus chloris*	Cekakak sungai	Coraciiformes	Alcedinide	1%	Kingfisher
10	*Dendrocopos moluccensis*	Caladi tilik	Piciformes	Picidae	1%	Woodpecker
11	*Dendrocopos analis*	Caladi ulam	Piciformes	Picidae	1%	Woodpecker
12	*Psilopogon armillaris*	Takur tohtor	Piciformes	Capitonidae	4%	Woodpecker
13	*Turnix suscitator*	Gemak loreng	Turniciformes	Turnicidae	1%	Terrestrial
14	*Centropus bengalensis*	Bubut alang-alang	Cuculiformes	Cuculidae	1%	Terrestrial
Attractive birds						
1	*Microhierax fringillarius*	Alap-alap capung	Falconiformes	Falconidae	2%	Raptor
2	*Nisaetus cirrhatus*	Elang brontok	Falconiformes	Accipitridae	1%	Raptor
3	*Ictinaetus malaiensis*	Elang hitam	Falconiformes	Accipitridae	1%	Raptor
4	*Nisaetus bartelsi*	Elang Jawa	Falconiformes	Accipitridae	1%	Raptor
5	*Spilornis cheela*	Elang ular bido	Falconiformes	Accipitridae	1%	Raptor
6	*Pericrocotus flammeus*	Sepah hutan	Passeriformes	Campephagidae	1%	Colorful bird
7	*Rhipidura phoenicura*	Kipasan ekor merah	Passeriformes	Rhipiduridae	1%	Colorful bird
8	*Sitta frontalis*	Munguk beledu	Passeriformes	Sittidae	2%	Colorful bird
9	*Hydronis guajanus*	Paok pancawarna	Passeriformes	Pittidae	1%	Colorful bird
10	*Zosterops japonicus*	Kacamata gunung	Passeriformes	Zosteropidae	7%	Colorful bird
11	*Pycnonotus aurigaster*	Cucak kutilang	Passeriformes	Pycnonotidae	12%	Songbird
12	*Pycnonotus goiavier*	Merbah cerukcuk	Passeriformes	Pycnonotidae	2%	Songbird
13	*Prinia inornata*	Perenjak padi	Passeriformes	Silviidae	2%	Songbird
14	*Orthotomus sepium*	Cinenen Jawa	Passeriformes	Silviidae	1%	Songbird
15	*Aegithina tiphia*	Cipoh kacat	Passeriformes	Cloropseidae	2%	Songbird

Note: Abun = Abundance.

A short group of birds responding to human disturbance is a group of swallows around 2–5 seconds for various observational distances and a combination of the number of observers. The woodpeckers are birds with the longest response to human disturbance, around 2–33 seconds for various observation distances and a combination of the number of observers. The arboreal and kingfisher birds also have a short response duration of < 10 seconds. In comparison, the pigeon

birds have a rather long or medium-level response duration of about 2–12 seconds. The terrestrial and Barred buttonquail birds have shorter response durations than others.

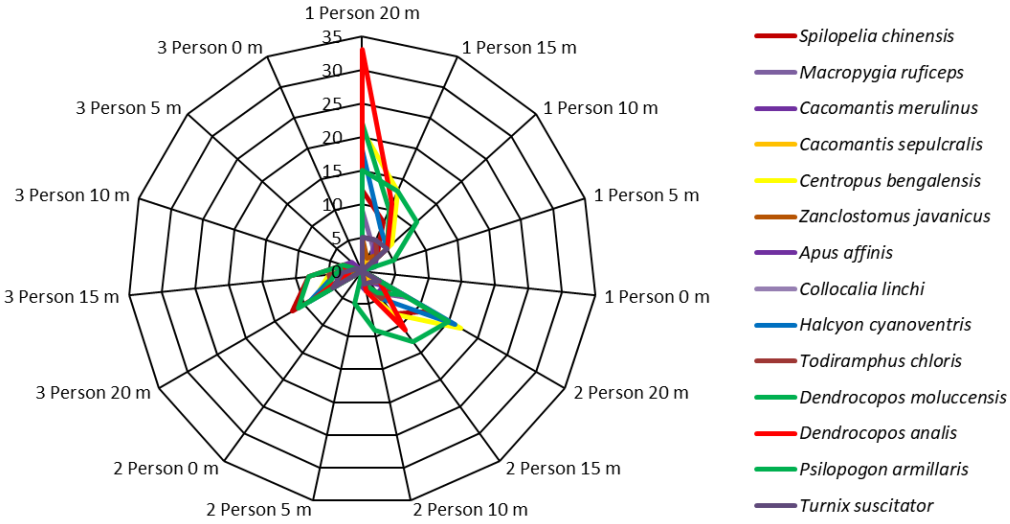


Fig. 3. Response pattern diagram of forest birds to movement disturbance in the morning.

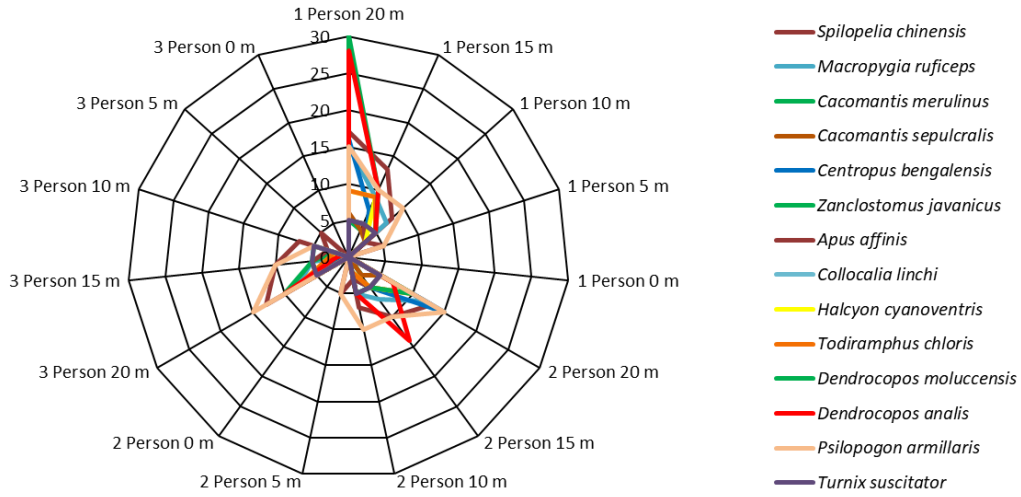


Fig. 4. Response pattern diagram of forest birds to movement disturbance in the daytime.

From various combinations of observational distances, it can be seen that the closer the source of the disturbances and the bird, the shorter the alert response duration will be. The same condition also occurs in the combination of the number of observers, where the more observer the number of observers, the shorter the duration of the bird's alert response. The bird's response is slightly longer in daytime observations than in the morning observation. From the results of the ANOVA test between the distance of the disturbance and the number of observers, it can be concluded that there is a significant difference between the duration of the bird response and the intensity of the disturbance, as presented in **Table 2**. The intensity of birds avoiding tourist disturbances is influenced by the number of tourists and the distance between the tourists and the birds. The more tourists that approach, the sooner the birds leave or avoid them. Even if there are only a few tourists, if the interaction distance with the birds is very close, the birds will also quickly avoid or fly away.

Table 2. The ANOVA results of the response of forest birds to movement disturbance

Source of variation	SS	df	MS	P-value
Number of observers	315.23	2	157.61	0.000
Observer Distance	4525.25	4	1131.31	0.000
Interaction	246.64	8	30.83	0.006
Within	4546.71	405	11.22	
Total	9633.84	419		

Notes: Response has a significant effect on the 95% confidence interval with a significant value (P-value) < 0.05 (α). SS= Sum of Squares; df = Degrees of freedom; MS = Mean Square.

The dynamics of the behavior of forest birds towards disturbance of human movement in various groups of bird species can be seen in **Table 3**.

3.1.2.2. Attractive bird

Attractive bird response to disturbance of human activity movement manifests in behavioral changes as an avoidance response. This threatened response consists of an alert response and a response to flight (flight initiation response). The dynamics of changes in the behavior of attractive birds towards stimulation of human movement disturbance can be seen in **Fig. 5** and **Fig. 6**.

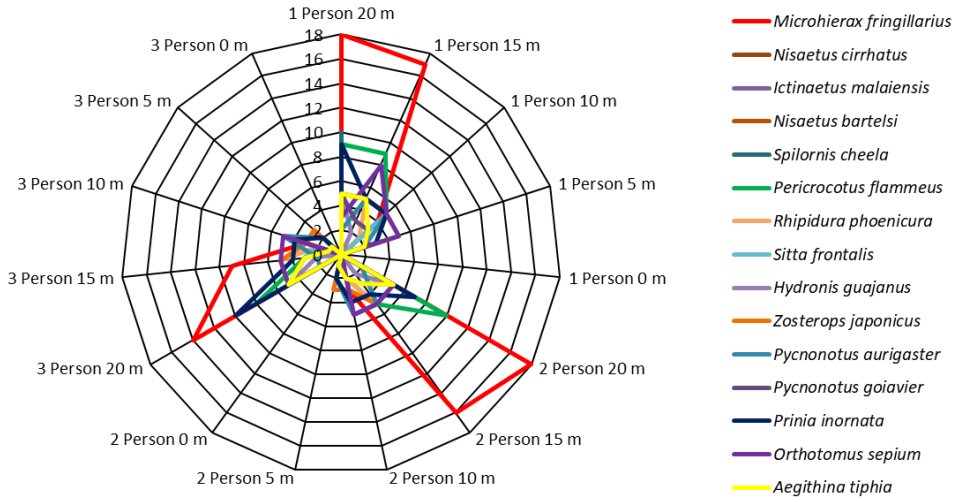


Fig. 5. Response pattern diagram of attractive birds to movement disturbance in the morning.

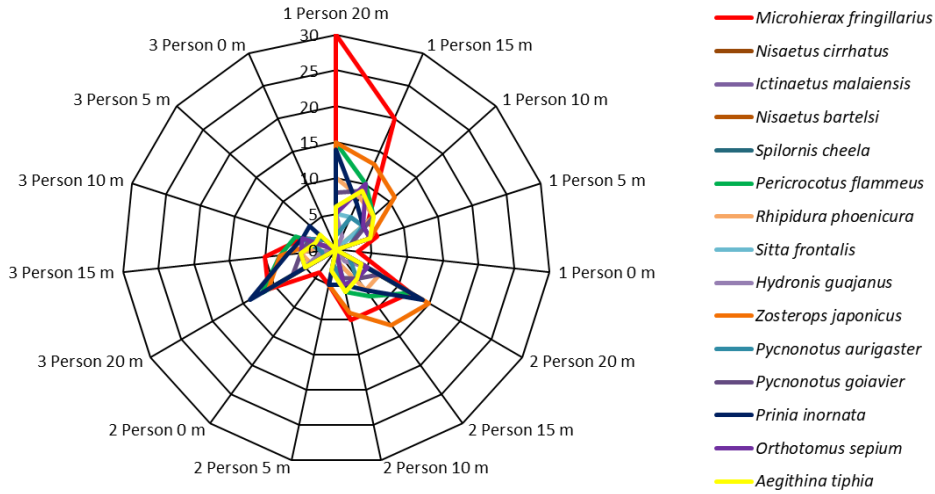


Fig. 6. Response pattern diagram of attractive bird to movement disturbance in the daytime.

Table 3. Action and response dynamic of forest birds to disturbance distance and observer number

No	Species	Time	Action and response duration														
			One person					Two people					Three people				
			20m	15m	10m	5m	0m	20m	15m	10m	5m	0m	2m	15m	10m	5m	0m
1	Tekukur biasa (*Spilopelia chinensis*	Morning	12	8	3	-	-	12	8	3	-	-	12	8	3	-	-
		Daytime	17	13	8	-	-	13	10	7	-	-	13	10	7	-	-
2	Uncal kouran (*Macropygia ruficeps*	Morning	9	4	2	-	-	8	4	2	-	-	6	2	-	-	-
		Daytime	15	9	7	-	-	12	7	5	-	-	8	5	-	-	-
3	Wiwik kelabu (*Cacomantis merulinus*	Morning	5	5	2	-	-	5	2	-	-	-	3	1	-	-	-
		Daytime	5	4	4	-	-	5	3	-	-	-	5	2	-	-	-
4	Wiwik uncuing (*Cacomantis sepulcralis*	Morning	3	2	-	-	-	3	2	-	-	-	2	1	-	-	-
		Daytime	6	4	3	-	-	5	3	-	-	-	5	2	-	-	-
5	Kadalan kembang (*Zanclostomus javanicus*	Morning	5	2	4	-	-	3	2	2	-	-	5	2	1	-	-
		Daytime	5	5	5	-	-	5	5	5	-	-	5	5	2	-	-
6	Kapinis rumah (*Apus affinis*	Morning	5	5	3	2	-	4	4	3	2	-	4	4	3	2	-
		Daytime	5	5	3	5	-	5	5	3	5	-	5	5	3	5	-
7	Walet (*Collocalia linchi*	Morning	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-
		Daytime	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-
8	Cekakak Jawa (*Halcyon cyanoventris*	Morning	18	7	3	-	-	16	5	2	-	-	9	4	1	-	-
		Daytime	9	9	5	-	-	10	5	2	-	-	8	3	2	-	-
9	Cekakak sungai (*Todiramphus chloris*	Morning	5	5	3	-	-	5	5	2	-	-	5	5	1	-	-
		Daytime	9	9	5	-	-	10	5	2	-	-	8	3	2	-	-

No	Species	Time	Action and response duration														
			One person					Two people						Three people			
			20m	15m	10m	5m	0m	20m	15m	10m	5m	0m	2m	15m	10m	5m	0m
10	Caladi tilik (*Dendrocopos moluccensis*	Morning	22	10	5	-	-	7	4	2	-	-	7	4	2	-	-
		Daytime	30	10	5	-	-	10	5	5	-	-	10	5	5	-	-
11	Caladi ulam (*Dendrocopos analis*	Morning	33	11	5	-	-	3	11	3	-	-	8	2	3	-	-
		Daytime	28	10	5	-	-	7	14	5	-	-	10	2	1	-	-
12	Takur tohtor (*Psilopogon armillaris*)	Morning	15	13	11	5	-	15	13	9	5	-	11	8	3	-	-
		Daytime	15	10	10	5	-	15	10	10	5	-	15	10	5	-	-
13	Gemak loreng (*Turnix suscitator*)	Morning	5	5	5	-	-	3	2	2	-	-	5	3	1	-	-
		Daytime	5	5	5	-	-	5	5	5	-	-	5	5	5	-	-
14	Bubut alang-alang (*Centropus bengalensis*)	Morning	21	13	6	-	-	17	8	3	-	-	8	5	1	-	-
		Daytime	16	7	3	-	-	15	5	3	-	-	8	1	-	-	-

Notes: = looking at the sound, = looking around, = moving position to the same branch, = moving position to another parallel branch, = moving position to one level higher branch, = moving position to two levels higher branch, and = flying/moving far.

The raptor group is a bird sensitive to external disturbances or considered intolerant of threats. Of the 5 species of raptor birds, the Javan hawk-eagle has the lowest duration of the response of visitors/tourists. From various observational distances of 0–25 m, this bird can only be observed in a position of 25 m with calm conditions and little movement. Raptor birds are sensitive to various external disturbances and can be described as intolerant to threats. Among the 5 species of raptor birds, the Javan hawk-eagle has the shortest response duration to visitor disturbances. The result of the study shows that distances range from 25 m to 0 m, and only at a distance of 25 m can this bird be observed in a calm state with little movement. According to the IUCN (2015), the Javan hawk-eagle is a protected wildlife species that is classified as endangered (Sitorus and Hernowo 2017). Azmi et al. (2016) stated that the wild population is very small due to hunting and forest stand degradation.

In addition to the Javan hawk-eagle, other raptor groups also showed sensitive behavior from outside disturbance, such as the crested serpent-eagle *(Spilornis cheela),* black eagle *(Ictinaetus malaiensis)* and crested hawk-eagle (*Nisaetus cirrhatus*). These bird species show a short duration of response to human disturbances, about 5 seconds at a distance of 20 m of interference with several disturbances of 1–3 people. As for a distance of 0–15 m, the four species of raptors have a response duration of 0 seconds or cannot be approached at that distance. Furthermore, the species of Black-thighed Falconet is the most tolerant raptor group of disturbances with a relatively long response duration, between 2–30 seconds in various stimulation treatments.

In a colorful bird group, the flame minivet (*Pericrocotus flammeus*) and warbling white-eye (*Zosterops japonicus*) are relatively more tolerant of human disturbance with the duration of response to disturbances ranging from 2–15 seconds in various numbers of disturbances and observation distances, while the Javan banded pitta (*Hydrornis guajanus*) is the most intolerant or sensitive bird of the action of human disturbances with the duration of response to the disturbances action is about 2–5 seconds. In the songbird group, the plain prinia (*Prinia inornata*) is quite tolerant of human disturbances, with the duration of the response action of about 2–14 seconds, in various disturbances and observation distances. The common iora (*Aegithina tiphia*) and the yellow-vented bulbul (*Pycnonotus goiavier*) are categorized as having a level of medium categorized response duration with the duration of the response action around 1–9 seconds. The sooty-headed bulbul (*Pycnonotus aurigaster*) is the most intolerant bird to the action of disruption with the duration of the response action of about 2–5 seconds.

In general, raptor groups have the shortest or most intolerant response duration to the action of human disturbance, especially from the family Accipitridae. The songbird has a duration of the response action at a medium level, while the colorful group is the shortest or most intolerant of the response duration to disturbance. The more colorful a bird species, the more sensitive it is to the response to human disturbance. Furthermore, a small bird species with a small size is more tolerant of disturbance than a bird species with a medium to large body size. From various simulations of observation distance, bird response patterns to human movements in the morning and daytime observations obtained data show that at a distance of less than 10 m (intervals of 0 m and 5 m), the response duration is 0 seconds or intolerant, meaning the bird immediately reacts to human disturbance and immediately fly or disappear. This condition occurs for scale disturbances ranging from 1 person to 3 people. A distance of 10 m is the transition distance between tolerant and intolerant responses where some species of birds still have not reacted to be disrupted. Furthermore, at a distance of 15–20 m, the bird shows a tolerant response with a variety of changes in vigilance behavior (alert response) in the form of looking at the sound, looking around, moving

position to the same branch, moving position to another the parallel branch, moving position to one level higher branch, moving position to two levels higher branch, flying/moving far.

From various combinations of observational distances, it can be seen that the closer the source of the disturbance and the bird, the shorter the alert response duration will be. The same condition also occurs in the combination of the number of observers, where the more observer the number of observers, the shorter the duration of the bird's alert response. The bird's response is slightly longer in daytime observations than in the morning observation. From the results of the ANOVA test between the distance of the disturbance and the number of observers, as presented in **Table 4** it can be concluded that there is a significant difference between the duration of the animal response and the intensity of the disturbance that is simulated by the number of observers/visitors and the distance of the observer interval.

Table 4. The ANOVA results of the response of attractive birds to movement disturbance

Source of Variation	SS	df	MS	P-value
Number of observers	117.44	2	58.72	0.002
Distance of observer	2777.80	4	694.45	0.000
Interaction	41.84	8	5.23	0.806
Within	4023.63	435	9.24	
Total	6960.73	449		

Notes: Response has a significant effect on the 95% confidence interval with a significant value (P-value) < 0.05 (α). SS= sum of Squares; df = degrees of freedom; MS = mean square.

Further, the dynamics of bird behavior towards human movement disturbance in various groups of bird species can be seen in **Table 5**.

3.1.3. Action and response to musical sound disturbance

3.1.3.1. Forest bird

The response of forest birds to sound disturbances, namely musical sounds at low volumes and high volumes, is manifested by changes in behavior that are almost the same as responses due to human movement disturbances. The response given by forest birds to musical sound disturbances is still in the form of a threatened response (avoidance response), which consists of an alert response and a flight initiation response. The dynamics of changes in the behavior of forest birds to the stimulation of musical sound disturbances can be seen in **Fig. 7** and **Fig. 8**.

In general, the pattern of the response of forest birds to music disturbance in the morning and daytime observations obtained data that at a distance of less than 10 m (intervals of 0 m and 5 m), the response duration is 0 seconds or intolerant, meaning that the bird immediately reacts to the disturbance the sound of music and immediately fly or disappear. This condition occurs both for low sound and high sound. A distance of 10 m is the distance of the transition between tolerant and intolerant responses where some species of birds still have not reacted to be disturbed. Furthermore, at a distance of 15 m to 20 m, the bird shows a tolerant response with various changes in vigilance behavior (alert response) in the form of looking at the sound, looking around, moving position to the same branch, moving position to another the parallel branch, moving position to one higher level branch, moving position to two higher levels branch, and flying/moving far.

Table 5. Action and response dynamic of attractive birds to disturbance distance and number of observers

No	Species of bird	Time	Action and duration response														
			One person					Two people					Three people				
			20 m	15 m	10 m	5 m	0 m	20 m	15 m	10 m	5 m	0 m	20 m	15 m	1 m	5 m	0 m
1	Alap-alap capung (*Microhierax fringillarius*)	Morning	18	17	4	-	-	18	16	3	-	-	14	9	3	-	-
		Daytime	30	20	6	6	3	12	10	10	5	4	11	10	5	2	-
2	Elang brontok (*Nisaetus cirrhatus*)	Morning	10	-	-	-	-	5	-	-	-	-	5	-	-	-	-
		Daytime	10	-	-	-	-	5	-	-	-	-	5	-	-	-	-
3	Elang hitam (*Ictinaetus malaiensis*)	Morning	5	-	-	-	-	5	-	-	-	-	5	-	-	-	-
		Daytime	5	-	-	-	-	5	-	-	-	-	5	-	-	-	-
4	Elang Jawa (*Nisaetus bartelsi*)	Morning	5	-	-	-	-	5	-	-	-	-	5	-	-	-	-
		Daytime	5	-	-	-	-	5	-	-	-	-	5	-	-	-	-
5	Elang ular bido (*Spilornis cheela*)	Morning	10	-	-	-	-	5	-	-	-	-	5	-	-	-	-
		Daytime	10	-	-	-	-	5	-	-	-	-	5	-	-	-	-
6	Sepah hutan (*Pericrocotus flammeus*)	Morning	9	9	5	-	-	10	5	2	-	-	8	3	2	-	-
		Daytime	15	10	7	-	-	12	8	6	-	-	12	8	6	-	-
7	Kipasan ekor merah (*Rhipidura phoenicura*)	Morning	5	5	2	-	-	5	5	2	-	-	5	5	2	-	-
		Daytime	10	8	7	-	-	7	7	2	-	-	4	5	2	-	-
8	Munguk beledu (*Sitta frontalis*)	Morning	5	5	5	-	-	5	5	5	-	-	5	3	2	-	-
		Daytime	5	5	5	-	-	5	5	5	-	-	5	5	5	-	-
9	Paok pancawarna (*Hydronis guajanus*)	Morning	5	2	-	-	-	5	2	-	-	-	5	2	-	-	-
		Daytime	5	2	-	-	-	5	2	-	-	-	5	2	-	-	-

No	Species of bird	Time	Action and duration response														
			One person					Two people					Three people				
			20 m	15 m	10 m	5 m	0 m	20 m	15 m	10 m	5 m	0 m	20 m	15 m	1 m	5 m	0 m
10	Kacamata gunung (*Zosterops japonicus*)	Morning	5	5	5	5	-	5	5	3	3	-	5	5	3	3	-
		Daytime	15	13	11	5	-	15	13	9	5	-	11	8	3	-	-
11	Cucak kutilang (*Pycnonotus aurigaster*)	Morning	2	5	5	2	-	2	5	5	2	-	2	2	5	2	-
		Daytime	2	5	5	2	-	2	5	5	2	-	2	2	5	2	-
12	Merbah cerukcuk (*Pycnonotus goiavier*)	Morning	5	3	3	2	-	5	3	2	-	-	5	3	1	-	-
		Daytime	8	9	7	2	-	7	5	4	-	-	7	5	4	-	-
13	Perenjak padi (*Prinia inornata*)	Morning	9	5	5	3	-	7	4	4	2	-	10	4	4	2	-
		Daytime	14	7	5	5	-	14	7	5	5	-	14	7	5	5	-
14	Cinenen Jawa (*Orthotomus sepium*)	Morning	3	8	5	5	-	5	5	5	-	-	5	5	5	-	-
		Daytime	5	10	5	5	-	5	5	5	-	-	5	5	5	-	-
15	Cipoh kacat (*Aegithina tiphia*)	Morning	5	5	3	2	-	5	3	2	1	-	5	3	1	1	-
		Daytime	6	9	7	5	-	4	5	6	3	-	5	5	3	3	-

Notes: = looking at the sound, = looking around, = moving position to the same branch, = moving position to another parallel branch, = moving position to one level higher branch, = moving position to two levels higher branch, and = flying/moving far.

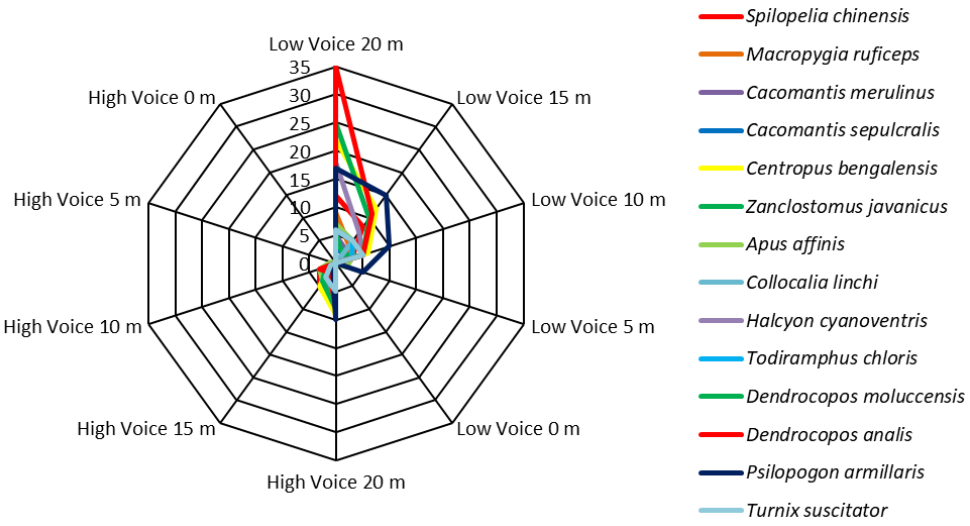


Fig. 7. Response pattern diagram of forest birds to musical sound disturbance in the morning.

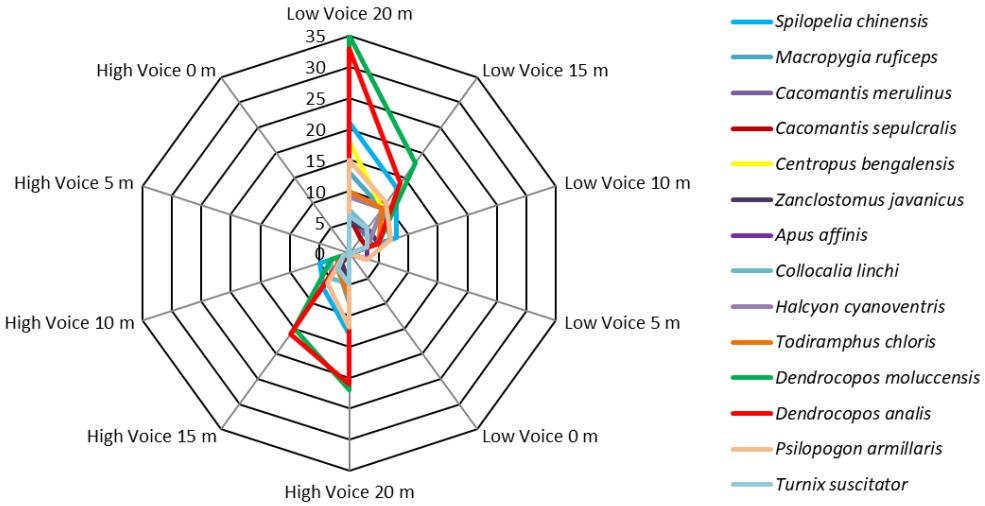


Fig. 8. Response pattern diagram of forest birds to musical sound disturbance in the daytime.

A short group of arboreal birds from the order of Cuculiformes, namely plaintive cuckoo (*Cacomantis merulinus*), rusty-breasted cuckoo (*Cacomantis sepulcralis*) and red-billed malkoha (*Zanclostomus javanicus*) have a duration of about 1–5 seconds for low sound stimulation and height at various observation distance intervals. The terrestrial bird of barred buttonquail (*T. suscitator*) is also categorized as intolerant of sound disturbance with a short duration of 1–5 seconds. The woodpecker group has the longest response to the sound disturbance of music, which is around 2–35 seconds for various observation distances and the level of music disturbance. The kingfisher and swallow have a short response duration of 1–10 seconds, while the pigeon group has a rather long or medium-level response duration of around 3–21 seconds. In the group of terrestrial birds, barred buttonquail *(T. suscitator)* is shorter in response duration than the Lesser coucal *(Centropus bengalensis)*.

From the various combinations of observational distances, it can be seen that the closer the source of the disturbance and the wildlife of the forest birds, the shorter the alert response duration will be. The same condition also occurs at the level of sound disturbance, where the higher the

sound disturbance, the shorter the duration of the bird's alert response. The bird's response is slightly longer in daytime observations than in the morning observation. From the results of the ANOVA test between the distance of the disturbance and the sound level of music, it can be concluded that there is a significant difference between the duration of the animal response and the intensity of the disturbance, as presented in **Table 6**.

Table 6. The ANOVA results of the response of forest birds to musical sound disturbance

Source of Variation	SS	df	MS	P-value
Sound level	435.00	1	435.00	0.000
Observer distance	4154.62	4	1038.65	0.000
Interaction	297.87	4	74.46	0.001
Within	4113.46	270	15.23	
Total	9000.96	279		

Notes: Response has a significant effect on the 95% confidence interval with a significant value (P-value) < 0.05 (α). SS= sum of Squares; df = degrees of freedom; MS = mean square.

Furthermore, the dynamics of forest bird behavior towards musical disturbances in various groups of bird species can be seen in **Table 7**.

Table 7. Action and response dynamic of forest birds to musical sound disturbance and observer distance

No	Species	Time	Action and response duration									
			Low sound					High sound				
			20 m	15 m	10 m	5 m	0 m	20 m	15 m	10 m	5 m	0 m
1	Tekukur biasa (*Spilopelia chinensis*)	Morning	12	8	3	-	-	8	5	3	-	-
		Daytime	21	13	8	-	-	13	7	5	-	-
2	Uncal kouran (*Macropygia ruficeps*)	Morning	9	4	2	-	-	2	2	-	-	-
		Daytime	13	9	7	-	-	8	3	-	-	-
3	Wiwik kelabu (*Cacomantis merulinus*)	Morning	5	3	2	-	-	2	1	-	-	-
		Daytime	5	4	4	-	-	5	2	-	-	-
4	Wiwik uncuing (*Cacomantis sepulcralis*)	Morning	3	2	-	-	-	2	1	-	-	-
		Daytime	6	3	3	-	-	5	2	-	-	-
5	Kadalan kembang (*Zanclostomus javanicus*)	Morning	5	2	4	-	-	3	1	1	-	-
		Daytime	5	5	5	-	-	5	2	1	-	-
6	Kapinis rumah (*Apus affinis*)	Morning	7	5	3	2	-	4	4	3	1	-
		Daytime	7	5	3	-	-	5	3	1	-	-
7	Walet (*Collocalia linchi*)	Morning	6	5	-	-	-	5	4	-	-	-
		Daytime	7	5	3	-	-	5	5	3	-	-

No	Species	Time	Action and response duration									
			Low sound					High sound				
			20 m	15 m	10 m	5 m	0 m	20 m	15 m	10 m	5 m	0 m
8	Cekakak Jawa (*Halcyon cyanoventris*)	Morning	18	7	5	-	-	8	3	1	-	-
		Daytime	9	9	3	-	-	7	3	1	-	-
9	Cekakak sungai (*Todiramphus chloris*)	Morning	6	5	3	-	-	5	3	1	-	-
		Daytime	10	9	5	-	-	7	3	2	-	-
10	Caladi tilik (*Dendrocopos moluccensis*)	Morning	25	10	5	-	-	8	4	2	-	-
		Daytime	35	18	5	-	-	22	15	3	-	-
11	Caladi ulam (*Dendrocopos analis*)	Morning	35	11	5	-	-	8	2	3	-	-
		Daytime	33	14	5	-	-	21	16	1	-	-
12	Takur tohtor (*Psilopogon armillaris*)	Morning	17	15	10	-	-	10	1	-	-	-
		Daytime	15	10	7	3	-	12	6	1	5	-
13	Gemak loreng (*Turnix suscitator*)	Morning	6	5	5	-	-	5	3	1	-	-
		Daytime	6	5	3	-	-	5	3	1	-	-
14	Bubut alang-alang (*Centropus bengalensis*)	Morning	22	12	6	-	-	9	5	1	-	-
		Daytime	18	9	3	-	-	7	3	1	-	-

Notes: = looking at the sound, = looking around, = moving position to the same branch, = moving position to another parallel branch, = moving position to one level higher branch, = moving position to two levels higher branch, and = flying/moving far.

3.1.3.2. Attractive bird

The attractive bird response to sound disturbance is that the sound of music with low volume and high volume is realized by changes in behavior that are almost the same as the response due to disturbance of human movement. The response of attractive birds to music disturbance is threatened (avoidance response), consisting of an alert response and a response to flight (flight initiation response). The dynamics of changes in the behavior of attractive birds against stimulation of music disturbance can be seen in **Fig. 9** and **Fig. 10**.

The response pattern of raptor and colorful bird groups to sound disturbances is almost the same as in human motion disturbances. In groups of songbirds, the duration of response to the sound of music appears longer than the response of motion disturbances. In other words, it can be mentioned that the group of songbirds is more tolerant of musical sound disturbance than human movement disturbance. Of the three groups of bird species, it can be mentioned that the raptor group is the most intolerant of music disturbance, while songbirds are the most tolerant group of birds of music disturbance. The colorful bird groups have a tolerance level with the medium category of music disturbances.

In the combination of sound levels and observational distances, the observation shows that the response pattern to music disturbances is almost the same as that of human movement

disturbances. At a distance of less than 10 m (intervals of 0 m and 5 m), the response duration is 0 seconds or intolerant, meaning that the bird immediately reacts to the sound disturbances of music and immediately flies or disappears. This condition occurs both for low sound and high sound. A distance of 10 m is the transition distance between tolerant and intolerant responses where some species of birds still have not reacted to be disrupted. Furthermore, at a distance of 15 m to 20 m, the bird shows a tolerant response with a variety of changes in vigilance behavior (alert response) in the form of looking at the sound, looking around, moving position to the same branch, moving position to another the parallel branch, moving position to one higher level branch, moving position to two higher levels branch, and flying/moving far. In the raptor group, there are exceptions where at a distance of 0 m to 20 m, the response is only in the form of flying/moving far.

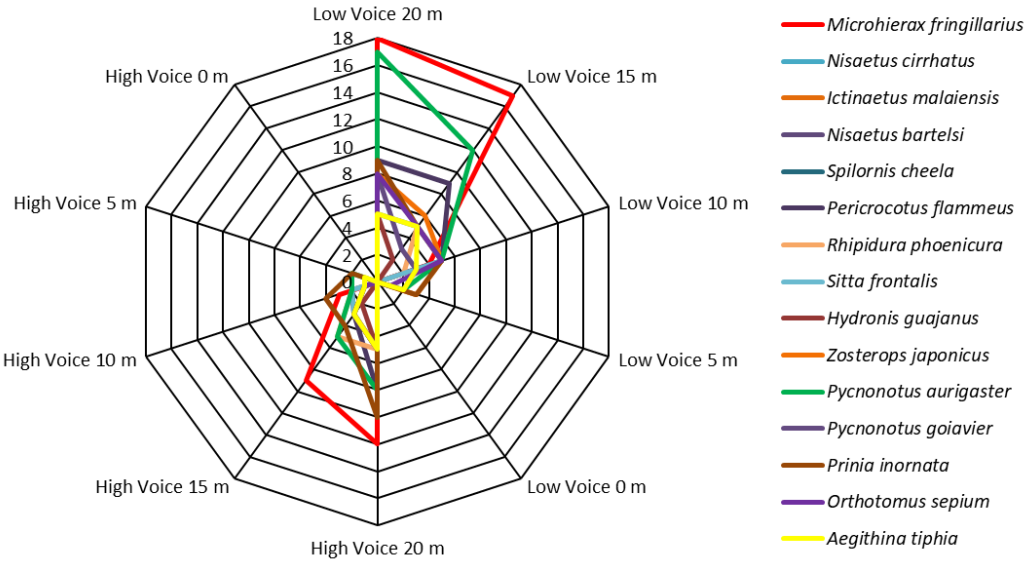


Fig. 9. Response pattern diagram of attractive birds to the musical sound disturbance in the morning.

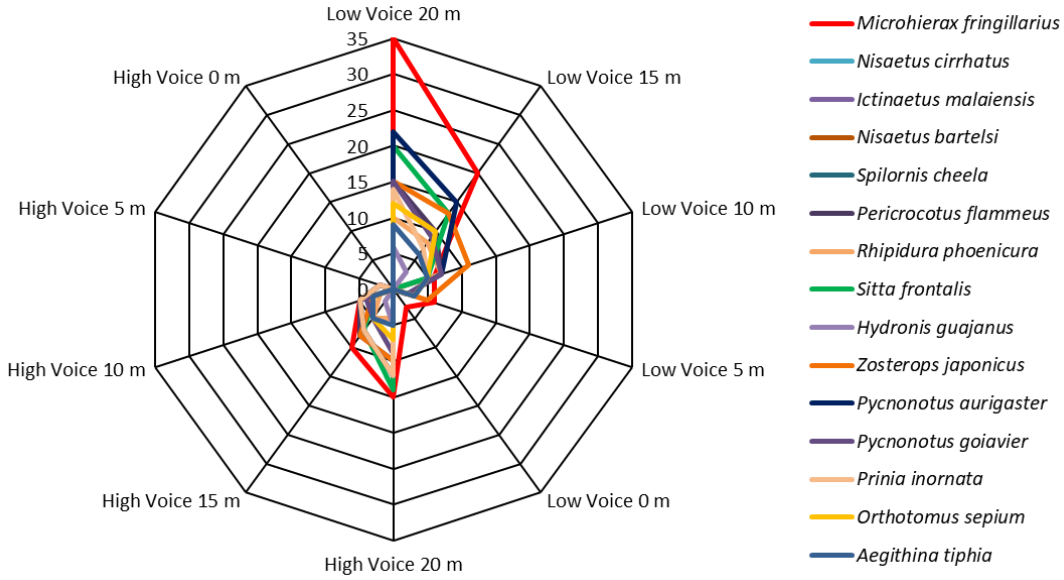


Fig. 10. Response pattern diagram of attractive birds to the musical sound disturbance in the daytime.

From various combinations of observational distances, it can be concluded that the closer the source of the disturbance and the bird, the shorter the alert response duration will be. The same condition also occurs at the level of sound disturbance, where the higher the sound disturbance, the shorter the duration of the bird's alert response. The bird's response is slightly longer in daytime observations than in the morning observation. From the results of the ANOVA test between the distance of the disturbance and the sound level of music, it can be concluded that there is a significant difference between the duration of the attractive bird's response and the intensity of the disturbances, as presented in **Table 8**.

Table 8. The ANOVA results of the response of attractive birds to musical sound disturbance

Source of Variation	SS	df	MS	P-value
Sound level	241.20	1	241.20	0.000
Observer	2545.52	4	636.38	0.000
Interaction	124.74	4	31.18	0.049
Within	3736.16	290	12.88	
Total	6647.63	299		

Notes: Notes: Response has a significant effect on the 95% confidence interval with a significant value (P-value) < 0.05 (α). SS= sum of Squares; df = degrees of freedom; MS = mean square.

Furthermore, the dynamics of bird behavior towards musical disturbances in various groups of bird species can be seen in **Table 9**.

Table 9. Action and response dynamic of attractive birds to musical sound disturbance and observer distance

No	Species	Time	Action and response duration									
			Low sound					High sound				
			20 m	15 m	10 m	5 m	0 m	20 m	15 m	10 m	5 m	0 m
1	Alap-alap capung (*Microhierax fringillarius*)	Morning	18	17	4	-	-	12	9	3	-	-
		Daytime	35	20	6	6	3	15	10	5	2	-
2	Elang brontok (*Nisaetus cirrhatus*)	Morning	5	-	-	-	-	1	-	-	-	-
		Daytime	5	-	-	-	-	1	-	-	-	-
3	Elang hitam (*Ictinaetus malaiensis*)	Morning	3	-	-	-	-	1	-	-	-	-
		Daytime	3	-	-	-	-	1	-	-	-	-
4	Elang Jawa (*Nisaetus bartelsi*)	Morning	1	-	-	-	-	1	-	-	-	-
		Daytime	1	-	-	-	-	1	-	-	-	-
5	Elang ular bido (*Spilornis cheela*)	Morning	5	-	-	-	-	1	-	-	-	-
		Daytime	5	-	-	-	-	1	-	-	-	-
6	Sepah hutan (*Pericrocotus flammeus*)	Morning	9	9	5	-	-	8	3	2	-	-
		Daytime	15	10	7	-	-	10	8	5	-	-

No	Species	Time	Action and response duration									
			Low sound					High sound				
			20 m	15 m	10 m	5 m	0 m	20 m	15 m	10 m	5 m	0 m
7	Kipasan ekor merah (*Rhipidura phoenicura*)	Morning	5	5	2	-	-	5	5	2	-	-
		Daytime	10	8	7	-	-	4	5	2	-	-
8	Munguk beledu (*Sitta frontalis*)	Morning	5	5	5	-	-	5	3	2	-	-
		Daytime	20	13	5	-	-	14	7	3	-	-
9	Paok pancawarna (*Hydronis guajanus*)	Morning	5	2	-	-	-	5	2	-	-	-
		Daytime	6	3	-	-	-	5	2	-	-	-
10	Kacamata gunung (*Zosterops japonicus*)	Morning	8	6	5	3	-	5	3	1	-	-
		Daytime	15	13	11	5	-	10	8	3	-	-
11	Cucak kutilang (*Pycnonotus aurigaster*)	Morning	17	12	5	2	-	8	5	2	2	-
		Daytime	22	15	7	2	-	12	7	5	2	-
12	Merbah cerukcuk (*Pycnonotus goiavier*)	Morning	8	3	3	2	-	5	3	1	-	-
		Daytime	15	9	7	2	-	9	5	4	-	-
13	Perenjak padi (*Prinia inornata*)	Morning	9	5	5	3	-	10	4	4	2	-
		Daytime	14	7	5	3	-	12	7	5	2	-
14	Cinenen Jawa (*Orthotomus sepium*)	Morning	8	5	5	1	-	5	3	1	-	-
		Daytime	12	10	5	3	-	7	5	3	-	-
15	Cipoh kacat (*Aegithina tiphia*)	Morning	5	5	3	2	-	5	3	1	1	-
		Daytime	9	6	5	3	-	5	5	3	-	-

Note: = looking at the sound, = looking around, = moving position to the same branch, = moving position to another parallel branch, = moving position to a higher level branch, = moving position to two higher levels branch, and = flying/moving far.

3.2. Discussion

The existence of wildlife can be said to be a pull factor (pull factor motivation) that makes tourists willing to travel to national parks. The more unique and variety of wildlife in natural attractions, the higher the satisfaction and experience in traveling. A bird is one of the wildlife that has become of special interest in national parks. Birds are one of the favorite tourist attractions in natural tourism activities in the conservation area. Birdwatching activities are recreational/tourism activities that are in great demand by tourists, especially those from the upper middle class, who are highly educated and concerned about preserving natural resources. Studies show that birding tourists tend to be highly educated, rich, and committed to their choice of tourist activities (Carver 2019). Birdwatching has recently become one of the world's fastest-growing tourist activities. In China, the recreation value of the ecological birdwatching industry is about 189 million Yuan. In

comparison, general ecotourism is about 182 million Yuan, more than three times the number of birders. The recreation value of eco-birdwatchers per capita is 5,688.72 Yuan (Liu et al. 2021).

Birds have become interesting to be used as attractions for recreational activities because of their uniqueness, beauty, rarity, and various important values these birds possess, both in terms of ecological, economic, and socio-cultural values. In general, a person will be attracted to birds because of their melodious singing sound, beautiful body color, unique body shape, or the nature of rarity that makes them endangered. For birdwatching activities to continue to be carried out, the bird's sustainability must be maintained, and the quality of its biodiversity must be improved. The richness of these bird species can be capital for tourism development, where birds are used as flag species or icons (Garnett et al. 2018), and the existence of popular birds becomes the main symbol to attract the wider community (Veríssimo et al. 2014). Birds have a very important function in maintaining biodiversity ecosystems and diversity, especially when birds are initioned with various plants (Sekercioglu et al. 2016). However, those ecological services are threatened by human disturbance and climate change (Grobler and Campbell 2022). For example, frugivorous birds avoid foraging in highly disturbed habitats, which could harm the ecological services they provide (Grobler and Campbell 2022). Birds provide important ecosystem services for both the natural and built environments (Sekercioglu et al. 2016), and consequently, knowledge of species diversity could be used to predict the potential ecological functions in local habitat maintenance (Mao et al. 2023; Morante-Filho and Faria 2017).

It is known that the activities of wildlife tourism and birdwatching in the national park area not only have a positive impact but will also harm the area. Human sports activities and recreation often occur in nature and may negatively impact wildlife (Bötsch et al. 2017; Larson et al. 2016). On the one hand, financial benefits from tourism expenditure, the growth of the tourism industry, and an increase in awareness of the importance of conservation activities of biodiversity resources are examples of the positive impact of natural tourism activities in the national park. However, the potential negative effects must also be aware of, such as degradation of the quality of biodiversity resources, forest fragmentation, and disruption to wildlife. One negative impact is that disturbance to wildlife habitats should be a serious concern to both the manager of the tourism business and the tourist itself.

Disturbance of wildlife in conservation areas must be studied in depth so that a tourism management method can be formulated, especially the management of visitors that do not cause a massive disturbance to wildlife, especially birds. In China, the main action to protect endangered bird species is to determine the protected area (Liang et al. 2021). On this basis, the action and response of visitors to several species of forest and attractive birds in the Gunung Gede Pangrango National Park area, West Java Province, is a very interesting issue about the management of visitors, in addition to the still limited literature on the study of the relationship between disturbances tourists against birds, especially for tropical rainforest birds in the national park.

From the results of studies, it is concluded that almost all species of forest birds and attractive birds show the same response to various human or tourist disturbance activities. The disturbance response scale varies from low (tolerant) to high (intolerant). Although the same response is shown to the disturbance of traveling activities (stimulation of interference with the action of human movement and the sound of music), there are differences in tolerance distance between the two groups of birds. Forest birds on the site have a tolerance distance between visitors and wildlife animals in recreational/tourism activities of 10 m from the animal's position. If visitors try to approach again at a distance of less than 10 m, the animal will certainly react in the form of a

behavior change that indicates a state of alertness or threat. Meanwhile, the attractive bird is categorized as sensitive to tourism/recreation activities because, from the data obtained at various levels of disturbance distance, it was found that the tolerance distance of attractive birds is a maximum of 20 m.

At this maximum distance, tourists can still engage in birdwatching activities without disturbing their existence. A study conducted by Prestes et al. (2018) reported that at the distance of human disturbance of 20 m, there were differences in bird escaping strategy; the "flying" strategy was associated with higher alert distance, flight initiation distance and flight distance than the "walking" strategy. Morelli et al. (2022) reported that the mean values of urban birds' flight initiation distance across the five European cities ranged from 4.1 m to 11.6 m. The maximum distance of 20 m is essentially very short compared to the recommendation from a study by Martin et al. (2014) on shorebirds, stating that the safe distance between tourists and birds should be at least 80 m.

A bird's tolerance level to different types of disturbance is strongly influenced by its species, size, habits, and habitat conditions. In general, tourist activities that give rise to noise and crowds interfere with the activities of birds in the whole series of life activities ranging from finding food, breeding, resting, and so forth. The noise is negative with bird species richness, total abundance, and pellet-feeding species richness (Perillo et al. 2017). Locations adjacent to tourism facilities, such as the place of the mirror, resorts, and tracking paths, will have a significant level of disturbance to birds. However, not all bird species are bothered by being in a crowd with a high intensity of tourist activities. Several species of birds are tolerant of tourist recreational activities and benefit from the existence of these tourist activities. Studies conducted by Huhta and Sulkava (2014) stated that tourism activities in the Pallas-Yllastunturi National Park do not affect the sustainability of certain bird groups.

The physical size of a bird affects the level of animal response to disturbances. Various studies reported that the greater the physical size of the bird, the more intolerant of human disturbance. Larger birds are more intolerant of human presence than smaller birds as they have longer flight distances (Cooper and Blumstein 2015; Samia et al. 2015a). But surprisingly, we found that large birds had the greatest reduction in flight initiation distance as human disturbance increased. There are at least two other reasons why body size may be associated with increased tolerance of humans in birds: larger birds may also be less likely to be killed by predators because of their body size, and this reduced risk may select for increased tolerance of non-threatening humans in areas where humans are commonly encountered, and larger birds with relatively larger brains may have greater cognitive abilities and might be able to assess risk better (Samia et al. 2015b). Optimal escape theory states that animals must counterbalance costs and benefits when making escape decisions (Cooper and Blumstein 2015). Regarding bird physical measurement, raptor groups having large sizes, such as Javan hawk-eagle (*Niscaetus bartelsi*), crested serpent-eagle (*Spilornis cheela*), black eagle (*Ictinaetus malaeiensis*), and crested hawk-eagle (*Niscaeetus cirrhatus*).

Furthermore, the type of food also affects the level of tolerance for disturbances from outside, where carnivore birds and live animal predators (live food) will be more easily disturbed or intolerant than the species of plant-eating birds and all omnivores. Birds with high social levels (living in groups) will be more easily disturbed than solitary birds. Piratelli et al. (2015) stated that birds' physical size correlates with their level of alertness from flight initiation to final flight distance. Larger species have higher flight initiation distances than smaller ones. They are

generally more vulnerable to human presence and more visible to predators, and their vulnerability increases the cost of staying. Mikula et al. (2023) reported that larger species and species with larger clutches and enhanced flight ability are less tolerant to human approaches. Body size affects about 4–7% of the variation of the response to avoiding (flight initiation distance). Large bird sizes will allow predators or humans to see and find it. Based on this, the large bird will have a high level of vigilance for various species of disturbances.

The origin/generic nature of the bird influences the level of a bird's tolerance for disruption of human activity. in this case, the forest bird from the category of swallow, namely the species of cave swiftlet (*Collocalia linchi*) and the little swift (*Apus affinis*), and the category of birds from the order of cuculiformes namely plaintive cuckoo (*Cacomantis merulinus*), rusty-breasted cuckoo (*Cacomantis sepulcralis*) and red-billed malkoha (*Zanclostomus javanicus*) are an intolerant/sensitive species because it has a habit of flying with high frequencies. Mikula et al. (2023) study suggested that some patterns in birds' tolerance towards human disturbance may be universal, such as earlier escapes in larger birds or when approached from longer initial distances and in areas with lower human disturbance. In contrast, other associations may show higher geographic, taxonomic or temporal variation. Whereas from the attractive bird, the bird from the raptor category, as a bird of prey, is the most intolerant bird/sensitive to human disturbance. The colorful birds have a level of tolerance with the medium category of the action of human disturbance. As for the category of songbirds, the birds are the most tolerant category of human disturbance.

Species of birds lodged in open areas will not be too disturbed and threatened even though their areas are near the centers of travel activities such as tracking/hiking paths and camping places. Wildlife responses to human recreation will focus not only on the characteristics of the animals involved (e.g., species, sex) and on the type of human disturbance (e.g., noise level, number of people) but also on the environmental conditions and on the specific period in an animal's life history in which the encounter with humans occurs (Tablado and Jenni 2017). Some species of birds accustomed to living with humans are relatively more tolerant of disturbances. The bird species whose habitat is in a dense forest will be more intolerant or easily disturbed by human activities and other natural tourism activities (Huhta and Sulkava 2014). The species of birds used for recreational activity and tourism are relatively abundant in the number of birds due to the availability of feed from the remains of tourist food. The condition of the vegetation, which is still tight, will also affect the level of bird tolerance for disruption of human activity. The tighter the condition of the vegetation cover, the more tolerant of the interruption of human activity. In this case, alert distance will be reduced in a dense area of the forest stands, while in some paths of the path, this alert distance will be further away because of the high intensity of human activity.

In this case, the alert distance decreases in areas with dense forest stands, whereas on some trails, this distance increases due to the high intensity of human activity. The type and intensity of human activity greatly influence the level of alertness of birds. Mikula et al. (2023) reported that avian tolerance towards human activity was lower (i.e., escape distance was longer) in rural rather than urban areas. Furthermore, Morelli et al. (2022) stated that birds preferred tree refuges over artificial and bush refuges as the destination to escape from human disturbances. Birds were more timid in suburban than core areas of cities, cemeteries than parks, and in areas with higher bush cover but lower built-up cover. Samia et al. (2017) stated that urban birds took longer than rural birds to be alerted to human approaches, and urban birds tolerated closer human approach than rural birds. The response pattern to stand density aligns with the statements of Tätte et al. (2017),

which mention that the denser the stand, the more tolerant birds are to disturbances, as well as Blumstein (2016) mentions that the denser the stand, the more tolerant birds are to disturbances. Furthermore, Osorio-Beristain et al. (2018) stated that the higher the forest stand diversity and the more complex the stand structure, the shorter the bird's alert distance to human disturbances, as these birds have spaces to hide from visitors.

Based on the results of a study of action patterns and responses to forest birds (terrestrial birds, woodpeckers, arboreal birds, pigeons, kingfishers, and swallows) and attractive birds (raptors, colorful birds and songbirds) as described in the previous section, it is necessary to take several tactical and strategic steps towards the management of natural tourism in the Gunung Gede Pangrango National Park so that birds from the two groups are maintained its sustainability thus tourism activities are continuous for a long time. Some of the efforts that can be made include: limiting the number of visitors and safe distances of interaction with birds, placement of natural tourism facilities and facilities not in the habitat/home range of birds, and maintaining the abundance and diversity of bird by supplying feed and enrichment vegetation.

Limiting the number of visitors can be done by selecting only tourists with enough knowledge of recreational wildlife/bird ecology. Lay tourists are highly recommended to be accompanied by a professional guide and obey all rules related to recreational activities with wildlife. The number of visitors and the distance of visitors' interactions with birds must be limited to the tolerance of bird behavior changes to disturbances, which, in this case, are at a distance of more than 10 m. A distance of 10 m to approach the position is forbidden for tourists. This must be considered because tourists will try to be close to wildlife to maximize experience and satisfaction in tourism.

The construction of natural tourism facilities and infrastructure in the national park area, which is a habitat for wildlife, needs to pay serious attention from the construction period to the use of these facilities and infrastructure by tourists. At the construction stage, there will certainly be mobilization of building materials that will cause noise and other disturbances to animals. Land clearing and building foundation construction will also result in the effects of disturbance to wildlife. If the tourism business manager cannot reduce the disturbance by constructing facilities and infrastructures, there must be compensation for efforts to save the birds. Standing density and adequate feed sources for birds will guarantee the conservation of birds, which are the main attraction for recreational/tourism activities in the national park. Efforts to improve the quality of forests that become bird habitats can be made by enriching plants with the selection of species of trees that are a feed source and a nesting place for birds. This effort can be done by involving tourists in conservation activities in the national park.

4. Conclusions

Upon study results, it is concluded that almost all bird groups in the study area show avoidance responses to various human or tourist disturbances. The scale of response to these disturbances varies from low (tolerant), medium, to high (intolerant). Raptors and colorful birds have low tolerance patterns, songbirds have a medium level of tolerance pattern, and forest birds have a high level of tolerance. The study also found that the physical size of birds affects their response level to disturbances, and carnivorous and predatory birds are more intolerant than herbivorous and omnivorous birds. Further, birds with high social levels (living in groups) and birds whose habitats are in dense forests tend to be more intolerant or easily disturbed by human

activities, contrary to some bird species accustomed to living alongside humans that are relatively more tolerant of disturbances; meanwhile, aerial birds that enjoy flying have a low tolerance. All those response patterns of birds in the national park are valuable assets in ecotourism activities and important to sustain the carrying capacity management for tourism activities and the ecosystem in the national park. Further, the results of this study will not only enrich the knowledge of animal behavior and visitor management but also be highly useful in aspects of site planning and landscape design. In site planning, knowledge about bird distribution in the relevant area can be important in developing the network pattern of circulation facilities within the destination. As for landscape designing, understanding bird response patterns in a specific destination can serve as a basis for selecting vegetation types related to the birds' food needs and for determining types for forming layers of vertical ground cover vegetation. Additionally, in line with the vast and diverse nature conservation areas and ecotourism sites in Indonesia, similar research should be replicated in various types of conservation areas and natural tourism sites so that increasingly valid and reliable knowledge can be obtained to create more harmonious natural and cultural landscapes, which are rich in biodiversity, ensuring the sustainability of tropical rainforest ecosystems and optimizing the benefits of tourism.

Acknowledgments

Part of this study was funded by PT Eiger Adventure Land.

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