Diversity of raptors at different habitat in Nature Reserve/ Natural Tourism Park of Kawah Kamojang, Garut, West Java

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Abstract. The Nature Reserve/ Natural Tourism Park of Kawah Kamojang has been fragmented and degraded by population growth and regional development, as well as disturbed by illegal logging and poaching. Accordingly, its function as conservation area has largely been decreased. This condition has created differences in the occurring habitat types, from natural forests to secondary natural forests, plantation forests, farmland and grassland. The presence of raptor as top predators can be used as one of indicators in the environmental changes. This study was conducted to determine the diversity and evenness index of eagle in relation to different habitats. The study was conducted in May 2019 using descriptive methods and sampling using the IPA method. The study found five species of raptor: Spilornis cheela, Ictinaetus malayensis, Nisaetus cirrhatus, Accipiter trivirgatus and Falco molluccensis. They spread separately in each habitat type. The habitat that has a highest diversity index value was secondary natural forest (H’ = 1,434) and the lowest was plantation forest (H’ = 0). In addition, the diversity index in plantation forest and grasslands had almost the same value, (H’ = 1,389 for farmland and H’ = 1,386 for grassland). The index value indicated that eagles were more dependent on the existence of natural forests. Eagles used forest habitats to hunt, perch and breed and used open areas (farmland and grassland) for hunting.

1. Introduction
Indonesia is one of mega biodiversity countries and it has extensive area of land and water, which is 8.300.000 km² with the number of islands is approximately ± 17.504. The vast territories in island make Indonesia rich in biodiversity. On the other hand, Indonesia is the fourth most populated country in the world. Consequently, it makes biodiversity in Indonesia increasingly threatened because of this rapid growth of human population. In theory, this problem can be solved by creating conservation areas, and biodiversity conservation can be done either by in-situ or ex-situ. In Indonesia, in-situ conservation includes Nature Reserve and Natural Tourism Park. Nature Reserve/ Natural Tourism Park of Kawah Kamojang is a conservation area that has been experiencing forest fragmentation and degradation by population growth and regional development. In addition to those encroachment, illegal logging and poaching are also become the problem [1]. This condition has created differences in the occurring habitat types, from natural forests to secondary natural forests, plantation forests, farmland and grassland.
Bird concept as a “gateway” in efforts to conserve biodiversity in a place can be an effective approach, especially by using raptor as indicators and object of protection. Almost all species of eagles in Indonesia are protected and included into the IUCN list to categorize their level of existence. Raptors are consumer in the highest peaks in the ecosystem. If the raptors’ population in a natural habitat decreased, the nature balance would be disrupted. Therefore, in order to survive well (i.e. foraging, resting and breeding), raptor has to have their typical habitat types, and according to Sözer, about 60% of raptor types depend on the existence of forests [2].

This study was conducted to determine the diversity and density index by considering the raptor species in several habitat types in Nature Reserve/ Natural Tourism Park area of Kawah Kamojang, Garut, West Java. Data was collected by desk study and field study. Desk study included library study activities, unstructured interviews, and documents from the Kamojang Raptor Center. Field study used descriptive method and point count.

2. Methods
The Study was conducted in May 2019 at the Nature Reserve/ Natural Tourism Park area of Kawah Kamojang. The observations were conducted at 9 a.m. until 3 p.m. The method used was descriptive, it described the results of raptor diversity in nature reserve/ natural tourism park Kawah Kamojang. The sampling was taken by using point count method [3]. Data taken included name of species, habitats and activities in where the raptors seen. Point count adjusted to the results of the analysis of the adequacy of the number of samples by considering accessibility and field conditions so that it gave results 14 observation points (Figure 1) representing 4 habitat types: secondary natural forest, plantations forest, farmland and grassland. The observations points showed in Figure 1. During one month of observation there were few cloudy days and rainy days which were ineffective in doing observation. The study used binoculars, monocular, cameras, area maps, GPS, literature books and compasses.

![Figure 1. Map of Nature reserve/ natural tourism park area Kawah Kamojang](image)

2.1 Diversity Index
Raptor species diversity was determined by using the Shannon-wiener diversity index with the formula:

\[
H^I = \sum \frac{N_i}{N} \times \ln \frac{N_i}{N}
\]

(1)
2.2 Evenness index

For evenness, evenness index (Index of Equitability or evenness) was used, and the formula used to calculate the value of evenness was:

\[
E = \frac{H^I}{Ln S}
\]

Evenness of type has an indicator value \( E = 1 \). If the value of \( E = 1 \) means that in the habitat there are no eagles that dominate.

3. Results and Discussion

The diversity of birds varied in habitat types depending on environmental condition and influencing factors. Table 1 describes the habitat proportion of observation locations. The natural forest which was relatively intact was located in the middle of the nature’s reserve, with dominant tree species like Lithocarpus sundaicus, Castanopsis argentea, Podocarpus imbricatus, Engelhardia rigida, Schima wallichii, and Slonea sigun. The quality of the tree species occurring in and around the area boundaries and around geothermal wells had been reduced because of illegal logging. The tree species occurring in the area were secondary forest trees with low quality of timber being dominated by Engelhardia rigida and Slonea sigun [1], then plantations forest had the following tree species Pinus merkusii and Altingia excelsa. The farmland had Coffea sp., Daucus carota, Brassica sp., Capsicum frutescens, Nicotiana tabacum, Zea mays and Solanum tuberosum.

Table 1. Types of habitat and raptors data in the observation point

| Point | Habitats       | SNF | PF | FL | GL | Raptors Information |
|-------|----------------|-----|----|----|----|---------------------|
| 1     |                | √   |    |    |    | Found               |
| 2     |                | √   |    |    |    | Found               |
| 3     |                | √   | √  |    |    | Found               |
| 4     |                | √   |    |    | √  | Not Found           |
| 5     |                | √   |    |    |    | Not Found           |
| 6     |                | √   |    |    | √  | Not Found           |
| 7     |                | √   |    |    |    | Not Found           |
| 8     |                | √   | √  |    |    | Found               |
| 9     |                | √   | √  |    |    | Found               |
| 10    |                | √   |    |    | √  | Found               |
| 11    |                | √   |    |    |    | Found               |
| 12    |                | √   |    |    | √  | Found               |
| 13    |                | √   |    |    |    | Found               |
| 14    |                | √   |    |    |    | Found               |

Note: SNF (secondary natural forest), PF (plantations forest), FL (farmland) and GL (grassland)

There were five species of raptors identified and five individuals unidentified with total number of encounters was 41 times (Table 2). The first species was Crested Serpent-Eagle (Spilornis cheela) that was recorded in Nature Reserve/ Natural Tourism Park of Kawah Kamojang [4]. During observation, the eagle found in all types of habitats except in plantations forest and recorded at all observation points 1,3,8,10,11 and 12. The activities seen during filed observation were perching, hunting, eating and soaring. Then encounters with Black Eagle (Ictinaetus malayensis) in the Nature Reserve/ Natural Tourism Park of Kawah Kamojang area were mostly in secondary natural forests and grassland and more soaring activities were found in the Nature Reserve/ Natural Tourism Park area. So, the eagle was found at the observation points 3, 10 and 13. Further, Changeable Hawk-Eagle (Nisaetus cirratus) recorded in the secondary natural forest, plantation forest, farmland and grassland. The
activities seen during the observation were flying (a pair) and vocalization in the Rasamala (*Altingia excelsa*) tree. The species was found in Kawah Kamojang area in the points 1, 3, 8, 9, 12, 13, and 14. The Crested Goshawk (*Accipiter trivirgatus*) was mostly found in the plantation forest at the Nature Reserve/Natural Tourism Park of Kawah Kamojang area. They often displayed low-flying activities between trees. Thus, this Crested Goshawk was often found in the Nature Reserve/Natural Tourism Park area Kawah Kamojang at point 9. Finally, Spotted Kestrel (*Falco molluccensis*) was found in the farmland in the Nature Reserve/Natural Tourism Park of Kawah Kamojang. They were often seen flying around farmland and carrying branches, and they are found at the points 2, 10 and 11.

### Table 2. Species of raptors found on habitat types with IUCN status and the total number of encounters

| No | Common Name                  | Scientific name       | IUCN     | SNF | PF | FL  | GL |
|----|------------------------------|-----------------------|----------|-----|----|-----|----|
| 1  | Crested Serpent – Eagle      | *Spilornis cheela*    | LC       | 7   | 1  | 1   |    |
| 2  | Black Eagle                  | *Ictinaetus malayensis* | LC       | 5   | 1  | 1   |    |
| 3  | Changeable Hawk – Eagle      | *Nisaetus cirrhatus*  | LC       | 6   | 5  | 4   | 1  |
| 4  | Crested Goshawk              | *Accipiter trivirgatus* | LC       | 1   |    |     |    |
| 5  | Spotted Kestrel              | *Falco molluccensis*  | LC       | 4   |    |     |    |
| 6  | UNE (unidentified Eagle)     |                       |          | 2   |    |     |    |
| 7  | UNF (unidentified Falcon)    |                       |          | 1   | 1  | 1   |    |

| Total | 21 | 5  | 11 | 4  |

- **IUCN** = International Union for Conservation of Nature
- **LC** = Least Concern
- **SNF** = Secondary Natural Forest
- **PF** = Plantation Forest
- **FL** = Farmland
- **GL** = Grassland

Bird diversity index can determine species diversity in an area. From the observations, it is known that the diversity of secondary natural forest habitat was 1,434, plantations forest was 0, farmland was 1,389 and grasslands was 1,386. According to the Shannon-Wieners species diversity category, if the index value >3 falls into the high category, 1-3 categories were medium and <1 category was low. So, in the secondary natural forest habitat type, farmland and grassland were included in the medium category and in the plantation forest habitat type were included in the low category. Among the habitat types included in the medium category, the secondary natural forest habitat had the highest diversity index value, it was also proved by the highest encounter records with various species of birds of prey found in this habitat. Furthermore, evenness index obtained in secondary natural forest was 0.891, plantation forest was 0, plantation was 0.863 and grassland was 1. Evenness index value if it has a value of E=1 means that in the habitat there is no bird species which is dominant.

### Table 3. Index of diversity and evenness of raptors by habitat type

| Habitat                  | H'  | E'  |
|--------------------------|-----|-----|
| Secondary natural forest | 1.434 | 0.891 |
| Plantation forest        | 0   | 0   |
| Farmland                 | 1.389 | 0.863 |
| Grassland                | 1.386 | 1   |

Our field observations identified five species of raptors in the Nature Reserve/ Natural Tourism Park of Kawah Kamojang namely *Spilornis cheela, Ictinaetus malayensis, Nisaetus cirrhatus, Accipiter trivirgatus* and *Falco molluccensis* which spread separately in different habitats. As classified by
IUCN (2020), the five types of raptors fell into the Least Concern category, which means that this species has a population that is still large in nature, therefore does not approach the vulnerable threshold according to the wide habitat range and population size [5]. Among the five species recorded, the encounter with Nisaetus cirrhatus was the highest. That was because the habitat in the Nature Reserve/ Natural Tourism Park of Kawah Kamojang was a suitable habitat for the life of the Nisaetus cirrhatus. According to [2] this species was found in forested meadows, wooded gardens, water sources overgrown with trees, generally below 1,500 m asl, but also at an altitude of 2.200 m asl. For breeding, it usually in pasang, puspai, pine, while for raising their young it use tree with a height of 10-50 m on the edge of hills, sometimes in the interior of the forest or on the edge of the village.

Habitat diversity is an important factor that acts as a provider of food sources, shelter, resting places, and nesting places for birds. The success of a bird to live in a habitat is determined by its success in selecting and creating special niches for itself. The secondary natural forest habitat was the highest level of encounter although the diversity index was moderate and almost the same as the index of farmland and grassland habitats. The presence of large-sized trees was required by eagles both for perching and nesting [6]. The secondary natural forest in the Kawah Kamojang area was dominated by large tress of Englerhardia rigida and Slonea sigun. Canopy opening can increase eagle detectability towards prey, thereby increasing hunting success [7]. Farmland and grassland areas are open areas. In addition, the proportion of undesirable habitat in where many tall trees (plantation forest areas) turned into farmland areas made the encounter in farmland habitats was quite high [8] Although eagles exhibited a high tolerance for forest degradation and fragmentation, the main threat was a high rate of deforestation that could eliminate their habitat. According to a study conducted by [9] in the Salak Corridor Halimun, 108 encounters of Crested Serpent-Eagle were recorded both in the forest area and open areas around the forest. The preferred condition was the mixed forest. Crested Serpent-Eagle was observed 49 times at the edge of the forest (0-350 m distance from the forest boundary) and 11 times in the middle of the forest (350-700 m distance).

A study held in Gunung Halimun Salak National Park, in Loji and Pongkor area in particular, Changeable Hawk-Eagle found to nest and fed in there, therefore those area acted as its nesting dan feeding sites, either fed on mammals, birds, reptiles, and amphibians [10]. The changing habitat of the eagles’ nest in the Loji area was in the form of mixed forests dominated by Pinus merkusii. In the Pongkor area, the habitat for Changeable Hawk-Eagle’ nest was a primary forest dominated by Maesopsis eminii and species of Altingia. In the Kawah Kamojang nature reserve/ natural tourism park where the plantation forest area was dominated by Pinus merkusii and Altingia trees, only one species was found, namely Changeable Hawk-Eagle. This study was in agreement with the previous studies conducted that Changeable Hawk-Eagle found in plantations forest due to the suitability of eagle nesting habitat. Ecological pressure towards the birds’ species diversity in Kawah Kamojang nature reserves/ natural tourism parks area identified to come from clearing area for agriculture and geothermal facilities developed by several companies. These factors indirectly have affected the diversity and evenness of birds species in Kawah Kamojang area [11].

4. Conclusion
The diversity of raptors in nature reserve/ natural tourism park Kawah Kamojang area in three types of habitat were categorized in medium and the one type of habitat (plantations forest) was in low category ($H^I = 0$). The diversity index in farmland ($H^I = 1.389$) and grassland ($H^I = 1.386$) have similar value to the diversity index value in secondary nature forest ($H^I = 1.434$). Those index value showed that an eagle was more dependent on natural forest existence. Eagles used forest habitat for hunting, perching and breeding and used an open areas (farmland and grassland) for hunting. Although those eagles were tolerant with the environmental changes occurred and included in the least concern category [IUCN], however, it is important to increase the conservation area management because human intervenes will give influence to raptor diversity in that area.
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