Community structure studies of birds as component evaluation of habitat and ecosystem condition at water sources in Malang Raya

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Abstract. The study of bird community structure was carried out in the water sources area in “Malang Raya”. Birds have an important role in sustaining habitat conditions and ecosystem stability. The purpose of this study is to evaluate the condition and characters of habitats and ecosystems of water sources, based on the bird’s community structure. In this present study, visual observation was used by the cruising method, then counting the number of species and number of individuals within a radius of 200 meters from the water source as a focal point of observation. Those methods were performed with three times replications a day during March 2019. Data collection was done at eight water sources, including Kendedes, Waras, Taman, Sira, Jenon, Wendid, Brantas, and Cangar. The analyses showed that the diversity index ($H'$) gain 2.88 scores, 0.92 scores for evenness (E), and 5.25 for species richness (R). Based on the results, We interpret that the ecosystem condition at eight sites of the water source can still support as a bird habitat under the carrying capacity. Overall, habitat and ecosystem conditions in the Malang Raya water sources still tend to be stable, with low ecological pressure.

1. Introduction

In an ecosystem, bird community has multiple ecological functions such as maintaining balanced population levels of predator and prey organisms, and assisting the process of plant reproduction as seed dispersers or direct pollinators. To a greater extent, according to Sujatnika (1995), the existence of a bird can be used as an indicator of biodiversity because the group of birds has the supporting characteristics of living in all habitats, sensitive to changes in the environment, and the life and its distribution are well known [1]. Therefore, the bird community in a specific area needs to be maintained as Arumsari (1989) stated that birds are pivotal part of the ecosystem component that has interactions and is interdependent with the environment so that the presence of birds in the ecosystem needs to be preserved [2].

One area requiring careful attention to the state of bird habitat and ecosystems is the area around the source of water. In general, the availability of water in an ecosystem is essential to multiple aspects such as the cultural, spiritual and physical wellbeing. Water source in the environment determines the specific outcome for animals or plant by its role in providing certain amount of water for feed, breed, and grow. Malang has numerous water sources that are used to fulfill the water needs both for daily consumption and for irrigation purposes. The location water source in Malang was well-spread in the district of Malang with an area directly adjacent to the residents’ houses as well as agriculture and...
The study of the community structure of birds was carried out in the water sources area in "Malang Raya" to determine the condition of the habitat and the ecosystem that supports the water source area.

Bird community research is undertaken because it has a crucial role to play in preserving habitat conditions and ecosystem stability. The existence of birds shows good environmental quality since birds become an important part of suitable ecological conditions [3]. The purpose of this study is to evaluate the condition of habitats and ecosystems of water sources based on the community structure of birds.

2. Experimental details

Data collection was conducted in eight water sources including Kendedes, Waras, Taman, Sira, Jenon, Wendit, Brantas, and Cangar. The tools used in this study such as dark clothes, hats/headgear, personal notebooks, stationery, binoculars, bird identification guide book of Sumatra, Kalimantan, Java, and Bali birds (Mackinnon), and cameras (prosumer: Canon sx 430 is).

The experimental approach used in this study is the cruising method [4], then counts the number of species and the number of individuals within a radius of 200 meters from a water source as the focal point of observation. The method is carried out by repeating three times a day during March 2019. Analysis of research data using the calculation of Diversity Index, Evenness Index, and Species Richness using the formula below.

**Diversity Index (H')**
The bird diversity is determined using the Shannon-Wiener Diversity Index with the formula:

\[
H' = - \sum p_i \ln p_i
\]

\(H'\) = Diversity index  
\(p_i\) = Proportion of important values (number of encounters individuals/number of encounters of all species)  
\(\ln\) = Natural logarithm

**Evenness Index (E)**
The proportion of species abundance is calculated using the Index of Evenness, with the formula:

\[
E = \frac{H'}{\ln S}
\]

\(H'\) = Diversity index  
\(S\) = Number of species

**Species Richness (R/Dmg)**
Species richness of birds is determined using the Margalef species wealth index with the formula:

\[
R/Dmg = \frac{(S-1)}{\ln N}
\]

\(R/Dmg\) = Species richness  
\(S\) = Number of species  
\(\ln\) = Natural logarithm  
\(N\) = Total number of individual species

The criteria for each index are explained in detail in table 1.

| Table 1. Diversity, Species Richness and Evenness Index Scores and Criteria [5] |
|---------------------------------|------|-----------------------------------|
| **Index**                       | **Score** | **Criteria**                        |
| Diversity Index (H')            | <1    | Low diversity, low distribution of individual |
species, low community stability, high ecological pressure

1-3

Moderate level of diversity, moderate level of species distribution, moderate community stability, moderate ecological pressure

>3

High diversity, high distribution of each species, high community stability, low ecological pressure

| Species Richness (R) | Evenness (E) |
|----------------------|-------------|
| < 3.5                | 0 < E ≤ 0.4 | Low species richness | Low evenness, depressed community |
| 3.5 – 5.0            | 0.4 < E ≤ 0.6 | Moderate species richness | Moderate evenness, unstable community |
| > 5.0                | 0.6 < E ≤ 1.0 | High species richness | High evenness, stable community |

3. Results and discussion

Data analysis showed that the diversity index (H'), evenness (E), and species richness (R) obtained a score of 2.88, 0.92, and 5.25, respectively. Based on these findings, the state of the environment can still be assisted as a bird sanctuary in eight water source locations. Our findings showed that the study locations still supported by several trees that are used as a place to find food, perch, and nest. Importantly, in their habitat, birds use various types of plants as a source of food, a nest, and a physiological shelter [6]. According to Welty and Baptista (1988), the distribution and population of birds in a habitat are influenced by physical/environmental factors such as soil, water, temperature, sunlight, and biological factors which include vegetation and other animals [7]. Wiens (1992) states that the availability of feed in a habitat is one of the main factors for the presence of bird populations [8]. Several species that are always found in eight water sources in Malang Raya are shown in the Figure 1 – Figure 4.

In addition, birds' ability to select a specific habitat is dependent on the resource availability for their needs. Habitat with more diverse vegetation variations will have a higher diversity of bird species when compared to habitats that have fewer types of vegetation [9]. This condition is very suitable, because the tree is a place for birds to do activities, such as foraging, drinking, sheltering, playing, and breeding grounds [5, 9]. Specifically for food, the variety of vegetation types found in a habitat supports the availability of food for birds, so with the diversity of vegetation types, the birds will get more choices to choose the type of feed [11]. This is related to plant preferences such as *Ficus racemosa, Ficus sp., Albizia chinensis*, and Bamboo as their plant preferences [12]. According to Howes et al. (2003), the presence of a particular bird species is generally adjusted to its preference for specific habitats [13]. In general, bird habitats can be divided into agroforestry areas, agrosilvopastura, galam forest, dense forest, and shrubs and grasses [14]. A stable and suitable habitat (community) will produce a high diversity of birds [15].

Habitat and ecosystem conditions in Malang Raya water sources which still tend to be stable are supported by a habitat profile capable of supporting bird activity. So that various species of birds feel comfortable in the habitat and ecosystem around Malang Raya water sources. The profile of the habitat in Malang Raya water sources is inseparable from the condition of the vegetation that supports bird life as an area for feeding, playing and sleeping. Some of the plant vegetation that are often used as bird preferences for foraging, playing and sleeping in water sources in Malang Raya are “eloo” or *Ficus racemosa* L., “Beringin” or *Ficus* sp., Bamboo, and *Albizia chinensis*. Overall, it can be concluded that the bird diversity index is more influenced by the diversity of tree species in the area than by the area itself. Because one of the things that supports the existence of birds is the food available in the area, where the diversity of trees can provide food such as fruit, seeds, nectar, and insects to birds [12].
4. Summary
Based on the research and data analysis, the bird community, the bird habitat, and the ecosystem conditions in Malang Raya water sources still tend to be stable, with low ecological pressure. The stability of ecosystems can be seen from the index value of diversity from medium to the high level. Moreover, it shows that there is no dominant species. Furthermore, the evenness index value approaches an average of 0.92, with the value of the species richness index is relatively high with the 5.25 score in averages.

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