Diversity and spatial use of birds in the Ujung Pangkah coastal area of Gresik Regency, West Java

MAK Budiman1,2, A Fahrudin2,3 and N Santoso4

1 Natural Resources and Environmental Management, Graduate School of Bogor Agricultural University
2 Center for Coastal and Marine Resources Studies, Bogor Agricultural University
3 Departement of Aquatic Resources Management, Faculty of Fisheries and Marine Science, Bogor Agricultural University
4 Departement of Forest Resources Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University

Corresponding author: asyief.khasan@gmail.com (MAK Budiman)

Abstract. Birds are fauna that are widely spread from the coast and the sea to the tops of mountains. Spatial utilization of birds is related to habitat use in accordance with the preferences of each species. Ujung Pangkah is one of the coastal areas in Gresik Regency, East Java and is the estuary of the Bengawan Solo River. This region has extensive mangrove and mudflat habitats. In addition, this region also consists of islands which are formed from sediments of mud which become arising land. Space utilization of birds is closely related to the type of feed, the level of disturbance, and other activities. Ujung Pangkah also serves as a transit area for migratory birds, especially coastal and marine birds. In this study, spatial utilization patterns are needed to map the areas used by birds in their activities. The purpose of this study is to identify and calculate the value of bird diversity and mapping the pattern of spatial use along with the habitat types used. The study was conducted in October - November 2016 in three zones, namely the northern zone, eastern zone and western zone. The investigation was carried out with exploration methods at each observation point. The results showed the diversity of birds in the Ujung Pangkah area consisted of 59 species from 27 families. The species of Common Sandpiper (Actitis hypoleucos) is a bird that uses the most extensive space and found in all study area. Habitat used is quite diverse that is mudflat, mangroves, ponds and residential areas.

1. Introduction

Birds are fauna that are widely spread from the coast and the sea to the tops of mountains. Spatial utilization of birds is related to habitat use in accordance with the preferences of each species. At this stage the existence of birds in various habitat types can be used as bio-indicators of environmental health [1].

Ujung Pangkah is one of the coastal areas in Gresik Regency, East Java and is the estuary of the Bengawan Solo River. The history of the formation of this region began from the colonial era of the Dutch East Indies which made a canal to modify the direction of the flow of the estuary of the Bengawan Solo river which initially headed east (now Bungah Subdistrict) then directed to the north (Banyu Urip Subdistrict, the current estuary) by making a 15 Km of canal.1 The region has extensive mangrove and

1 Muibbin (2015).
mudflat habitats. In addition this region also consists of islands formed from silt and become arising land (mainland delta). The mangrove area and its surroundings become an area that is rich in biota ranging from fish, crabs, birds and other animals that live in this area both settlers and migrants [2].

Spatial utilization of birds is closely related to the type of feed, the level of disturbance, and other activities. What's more, the pip end is also a transit area for migratory birds, especially coastal and marine birds [3]. However, the entry of humans in this region has turned mangrove forests into ponds on most of the land. In addition, the development of land use is accompanied by the creation of community settlements in the Ujung Pangkah area [2].

This location is an important location because it is included in wetland habitats that are included in the essential ecosystem according to PP No. 28 of 2011. Therefore Ujung Pangkah as a wetland is an important ecosystem for bird habitats, especially water birds. In addition internationally the Ujung Pangkah area is also recorded in one of the important areas for birds or IBAs (Important Bird Areas) [4]. This concept was introduced as a program that sought the designation of a location to be an important habitat for bird populations globally. This is what underlies Ujung Pangkah interesting to be studied as a location for research on birds [4].

Spatial utilization patterns in this study are needed to map the areas used by birds in their activities. In the Ujung Pangkah area there are various kinds of ecological pressures from humans. The form of ecological pressure from humans that occurs is usually related to the conversion activities of mangrove forest land into ponds, settlements, destructive tourism, and pollution [5]. This is certainly related to the livelihoods of people in coastal areas who traditionally as fishermen or as fish farmers who are very dependent on natural conditions in coastal areas [6].

The right management approach to the end region will result in a synergy between space use by birds and land use by humans. The purpose of this research is to identify and measure the value of bird species diversity and map the pattern of spatial use along with the type of habitat used.

2. Material and Methods

2.1. Time and place
Data collection in the field was carried out in October - November 2016. From October to November is a month that is usually crowded with migratory birds so researchers can collect data on settler birds and migrate at the same time. The study was conducted in three zones, namely the northern zone, east zone, and west zone. Each observation zone was carried out by collecting data in three sample locations, all of which spread in the mudflat land area located at Ujung Pangkah.

The tools used in this study are binoculars to observe the species of birds located in Ujung Pangkah, watches are used for time indicators, Field guide book of MacKinnon et al. [7], Global Passing System (GPS), and digital cameras for documenting the activities. Materials used in the study are books and stationery used to record the required data, observation tally sheets, mangrove distribution map of Ujung Pangkah, and Ujung Pangkah area map. While observation objects are birds located in the Ujung Pangkah area, habitat types used by birds, and substrate used by birds in Ujung Pangkah.
2.2. Collecting data methods

The research was conducted by exploration method at each point of observation location as a sample location for each zoning. Each zone is represented by three observation points. This is based on the concentration count method. This method is basically as a census calculation in each observation location, besides this method is used to determine the structure of a community in a group [8, 3]. Observations were carried out concentrated at a point that was thought to be a place with a high chance of encountering animals such as where food is available, water for drinking and where to sleep [9]. In this study the concentration of observation points was carried out in three observation zones. Each observation zone is represented by three concentration points as representatives of each zone. Observations were made from morning to evening (7:00 a.m. - 5:00 p.m.), this was done to adjust the time of the tide in the Ujung Pangkah area which began in the afternoon (around 3:00 p.m.) and began to recede in the early morning (around 9:00 p.m.).

2.3. Data analysis

Data analysis was carried out in two stages, namely diversity analysis and analysis of spatial utilization. Diversity analysis is seen from the species richness index, species diversity index, evenness index, and dominance index. Data analysis on spatial utilization is carried out by spatial analysis by mapping spatial distribution and describing habitat type utilization.

Bird diversity of species richness is determined using the Shannon-Wiener Diversity Index ($H'$) [10] with the formula:

$$H' = - \sum p_i \ln p_i$$  

Information:
- $H'$ = species diversity index
- $p_i$ = important value proportions = \frac{Number of species i}{Number of species of encounters
- $\ln$ = natural logarithms

![Observation zoning map in Ujung Pangkah area](image)
Evenness index serves to find out the equality of each type in the community that is found. The proportion of species abundance is calculated using the evenness index (E) (Index of Evenness) [11] that is:

$$E = \frac{H'}{\ln S}$$

(2)

Information:
- S = Number of species

Determination of the evenness index value serves to find out the equality of each type of bird in the community that is found. This index value ranges from 0 - 1. The more values close to 1, the more stable the bird community in a habitat. If the value of E is close to 0 it can be said that the condition of the spread of the type is unstable, whereas if the value of E is close to 1 it can be said that the condition of spread is stable [11].

Species dominance is used to determine the dominant species in a community. The calculation results will show the dominant species or not. Determination of the value of dominance serves to determine or not. The dominant species in a community is determined by using a formula according to van Helvoort [12], that is:

$$D_i = \frac{N_i}{N} \times 100\%$$

(3)

Information:
- Di = dominance index of a species
- Ni = number of individuals of a species
- N = number of individuals of all species

Criteria:
- Di = 0 - 2% = species are not dominant
- Di = 2% - 5% = species are subdominant
- Di = > 5% = species are dominant

3. Results and Discussion
The results showed the richness of bird species in the Ujung Pangkah area consisting of 59 species from 27 families. The Scolopacidae family (Sandpiper) is the most commonly family. These families are birds that live in various places with the character of wetlands. While the Ujung Pangkah area is one of the important wetland habitats in Indonesia [3]. This is in line with the findings of Elfidasari and Junardi [13] research in Peniti beach, Pontianak who encountered most of the types their found were water birds. The species of birds and families found at Ujung Pangkah are presented in the Appendix 1.

The western zone is the highest type of richness zone among the three zones. In the western zone found 42 species of birds from 23 families. While in the northern zone found 36 species of birds from 13 families and in the eastern zone there were only 27 species from 11 families. These three observation zones have the same three types of habitat, namely mangrove, mudflat, and pond habitats. But in the western zone there are land that has been converted into other functions such as built land (residential areas), rocky beaches, shrubs, tourist areas, and agricultural land. This causes the western zone to be more diverse in its habitat types with higher bird species diversity than the other two zones.

In the northern zone, in addition to the three habitat types mentioned, there are sandy beach habitat types. While in the eastern zone there are only three mentioned habitat types. This diversity of habitat types has a significant effect on bird species diversity [14]. This is influenced by the diversity of vegetation types and land cover. So that variations in spatial patterns and availability of feed provided by each habitat type will invite different bird species in each zone.
There are 15 species of birds found throughout the observation zoning in the Ujung Pangkah area. The species is Golden-bellied Gerygone (*Gerygone sulphurea*), Clamorous Reed-warbler (*Acrocephalus stentoreus*), Cerulean Kingfisher (*Alcedo coerulescens*), Sunda Teal (*Anas gibberifrons*), Cave Swiftlet (*Collocalia linchi*), Javan Pond-heron (*Ardeo speciosa*), Great White Egret (*Ardea alba*), Little Egret (*Egretta garzetta*), Javan Plover (*Charadrius javanicus*), Bar-winged Prinia (*Prinia familiaris*), Greater Crested Tern (*Sterna bergii*), Little Tern (*Sterna albifrons*), Sunda Pied Fantail (*Rhipidura javanica*), Far Eastern Curlew (*Numenius madagascarensis*), and Common Sandpiper (*Actitis hypoleucos*). Far Eastern Curlew and Common Sandpiper is a species of bird that migrates annually. According to MacKinnon et al. [7] Far Eastern Curlew and Common Sandpiper are visitor birds (migration) for tropical areas that are routinely every year from the breeding sites in the northern hemisphere to avoid winter. Even migration to Australia and a small part to New Zealand. Far Eastern Curlew and Common Sandpiper are spread fairly evenly throughout the beaches and coastal of Indonesia, especially in areas with abundant food sources such as the Mangrove area [15]. A few of this species have visited the wetlands in the inland or highlands. Findings of Hidayat et al. [16] states that Common Sandpiper has been found up to an altitude of 2000 masl far in the interior of the Dieng plateau. This is also reinforced by the findings of Bishop [17] and van Gils et al. [18] who encountered this species at an altitude of 3500 masl in Papua and 4000 in masl in Turkey.
Bird diversity index ($H'$) in each observation zone is not significantly different. The western zone has a value of 2.61, the northern zone has a value of 2.82, and the eastern zone has a value of 2.54. Diversity index values only have a slight difference between the observation zones. According to Magurran [10] the calculation of diversity was calculated using the Shannon-Wiener formula so that the index value could be seen to compare the diversity of each location. The results of the calculation of this diversity index are related to species richness in certain locations, but also influenced by species abundance distribution [10]. So that the results that appear illustrate the diversity of species in a particular place. The relation to biodiversity conservation is that this index is sensitive enough to estimate environmental conditions in a bird community [10].

**Table 2.** Diversity index, evenness, and number of dominant species in each observation zone.

| No. | Observation zone | $H'$ | $E$     | $\Sigma$ Dominant species |
|-----|------------------|------|---------|---------------------------|
| 1   | Western          | 2.614603 | 0.699528 | 6                          |
| 2   | Northern         | 2.82213  | 0.78753  | 5                          |
| 3   | Eastern          | 2.541267 | 0.771054 | 8                          |

In the diversity index in these three zones, the northern zone is the zone with the highest diversity index value. However, bird species richness is not always directly proportional to the diversity of bird species. It can be seen in this case that the highest species richness is in the western zone, while the highest diversity index is in the northern zone. This is because the number of types and composition of the number of individuals in the northern zone gets the highest score. Therefore, the calculation results indicate that diversity in the northern zone is the highest zone. But in this case the highest species wealth is found in the western zone. So it can be concluded that the richness and diversity of species in a location does not always show results that are directly proportional because in the calculation of the diversity index there are a number of individuals per species for the dividing factor. While the type of wealth is only done by calculating the number of species found in a location without considering the number of individuals of a species [10].

The species evenness index ($E$) functions to determine the evenness of the type in a location. Seen in Table 2 the highest evenness of species is in the northern zone. This shows the northern zone has a type that tends to be more evenly distributed. This equality shows the stability of an ecosystem. The closer the index value is to a value of 1, that this community is more stable than the others [11]. The values shown by these figures show that in all zones, the stability of the community is not yet stable, but the tendency to be closer to stability. A value of 0.699 in the western zone, a value of 0.787 in the northern zone, or a value of 0.771 in the eastern zone in a decimally number that values is closer to the number 1 than to the number 0. So the stability in the entire research zone has a tendency towards stable.

Species dominance index in each research zone is used to determine the species that dominate in each research zone [12]. In the western zone is dominated by six species of birds, namely Little Egret (*Egretta garzetta*), Javan Plover (*Charadrius javanicus*), Javan Pond-heron (*Ardeola speciosa*), Common Sandpiper (*Actitis hypoleucos*), Great White Egret (*Ardea alba*), and Far Eastern Curlew (*Numenius*).
In the northern zone is dominated by five species of birds, namely Little Egret (*Egretta garzetta*), Javan Pond-heron (*Ardeola speciosa*), Common Sandpiper (*Actitis hypoleucos*), Sanderling (*Calidris alba*), and Far Eastern Curlew (*Numenius madagascarensis*). While in the eastern zone is dominated by eight types namely Little Egret (*Egretta garzetta*), Javan Plover (*Charadrius javanicus*), Javan Pond-heron (*Ardeola speciosa*), Common Sandpiper (*Actitis hypoleucos*), Great White Egret (*Ardea alba*), Little Tern (*Sterna albifrons*), Far Eastern Curlew (*Numenius madagascarensis*), and Bar-tailed Godwit (*Limosa lapponica*). All of species that dominate in each observation zone are the species of water birds or coastal birds and seabirds either resident or migratory.

Species Common Sandpiper (*Actitis hypoleucos*) are birds that use the most extensive space are found in all study locations. Not only in all observation zones, but at all observation points. The existence of this Common Sandpiper was analyzed able to occupy all types of habitat in the Ujung Pangkah areas. This is because this species has been can be founded in extreme areas such as Ranu Pani Bromo Tengger Semeru National Park (TNBTS) East Java which has an average temperature of 10oC - 28oC and with poor water quality conditions due to domestic waste and eutrophication [16]. So that it is normal if the distribution of Common Sandpiper is the type with the most extensive use of space in Ujung Pangkah area.

Ujung Pangkah has at least nine types of habitat based on findings in the field. The habitat type found at each observation point is quite different. Mangroves are habitat types found at all observation points, so that the proportion of all habitats at each observation point reaches 29%. Then followed by mudflat as the most common habitat type with a proportion of 24%. The existence of vast mangroves and mudflats is very supportive for the life of migratory and resident water birds. In line with the statement of Arini and Nugroho [19] the suitability of fauna habitat is very dependent on the presence of feed, water, and guarantees for the continuation of the breeding of these fauna and security guarantees. This means that Mangrove and mudflat guarantee the life of water birds in Ujung Pangkah.

![Proportion of habitat type ratio](image)

Figure 4. Diagram of Habitat type ratio in Ujung Pangkah area

This habitat component is very important for the preservation of birds in the Ujung Pangkah area. According to Alikodra [20] the habitat component is an important component to be managed well, so that the fauna population will continue. There are at least two main components that compose and are directly related to habitat conditions of a fauna, namely the physic-chemical and biological components [21]. The physic-chemical component consists of rainfall, climate, air temperature, humidity, salinity, altitude, slope, water availability (including tides), and acidity. Biological components consist of the availability of feed and other biological disturbances (predators, diseases, and pests) [21, 3].
Table 3. Distribution of habitat types for each point and observation zone.

| No. | Habitat type        | Western zone | Northern zone | Eastern zone |
|-----|---------------------|--------------|---------------|--------------|
| 1   | Mangrove            | ✓            | ✓             | ✓            | ✓            | ✓            | ✓            | ✓            | ✓            |
| 2   | Mudflat             | ✓            | ✓             | ✓            | ✓            | ✓            | ✓            | ✓            | ✓            |
| 3   | Ponds               | ✓            | ✓             | ✓            | ✓            | ✓            | ✓            | ✓            | ✓            |
| 4   | Settlements         | ✓            | ✓             | ✓            | ✓            | ✓            | ✓            | ✓            | ✓            |
| 5   | Rocky beaches       | ✓            |               | ✓            | ✓            | ✓            | ✓            | ✓            | ✓            |
| 6   | Shrubs              |              |               | ✓            | ✓            | ✓            | ✓            | ✓            | ✓            |
| 7   | Tourist area        | ✓            |               | ✓            | ✓            | ✓            | ✓            | ✓            | ✓            |
| 8   | Agricultural land   | ✓            |               | ✓            | ✓            | ✓            | ✓            | ✓            | ✓            |
| 9   | Sandy beaches       |              |               | ✓            | ✓            | ✓            | ✓            | ✓            | ✓            |

The management of Ujung Pangkah area is needed in detail to create synergies between various kinds of interests that allow threatening habitat damage. Direct stakeholders in the Ujung Pangkah region consist of the government, the community (including non-governmental organizations), and the private sector. According to Fahrudin et al. [22] community elements consist of fishermen, fish farmers and fishery products traders. The government element consists of village government, local government (related agencies) and the central government (relevant ministries centers or units). The private element consists of several industries around the Ujung Pangkah area.

4. Conclusion

Bird diversity in Ujung Pangkah region consists of 59 species from 27 families, the highest species richness is in the western zone with 42 species of birds found. The highest diversity index is in the northern observation zone with an index value of 2.822. Evenness of the highest species is in the northern zone with a value of 0.787 which means the community has a tendency to be stable. The dominance of bird species is found in eight species that dominate the eastern zone. The most extensive use of space is the type of Common Sandpiper found at all observation points. The most evenly distributed habitat types in all observation points and zones are mangroves (29%) and mudflat (24%).

References

[1] Welty C J. 1982. The Life of Bird. 3rd Edition. Philadelphia (US): Saunders College Publishing.
[2] Zakiyah D M. 2014. Pengembangan Perikanan Budidaya: Efektivitas Program Minapolitan dalam Pengelolaan Perikanan Budidaya Berkelanjutan di Kabupaten Gresik. Biro Penerbit Planologi Undip (10-4): 453 – 465.
[3] Sutopo. 2017. Pola penggunaan ruang dan waktu kelompok burung air pada ekosistem mangrove muara Bengawan Solo – Kabupaten Gresik. [tesis]. Bogor (ID): Sekolah Pascasarjana Institut Pertanian Bogor.
[4] [Birdlife International]. 2018. Important Bird Areas factsheet: Ujung Pangkah [internet]. [cited 2018 October 10] available at http://www.birdlife.org.
[5] Pratiwi R. 2009. Komposisi Keberadaan Krustasea di Mangrove Delta Mahakam Kalimantan Timur. Jakarta (ID): Makara-Sain-LIPI.
[6] Satria A. 2015. Pengantar Sosiologi Masyarakat Pesisir. Jakarta (ID): Fakultas Ekologi Manusa IPB dan Yayasan Pustaka Obor Indonesia.
[7] MacKinnon J, Phillipps K, van Balen B. 2010. Seri Panduan Lapangan: Burung - Burung di Sumatera, Jawa, Bali dan Kalimantan. Bogor (ID): Pusat Penelitian dan Pengembangan Biologi LIPI.
[8] Rinaldi D. 1992. Penggunaan metode triangle dan concentration count dalam penelitian sebaran dan populasi Gibbon (Hylobatidae). Media Konservasi Vol IV(1) 9-21.
[9] Bismark M. 2011. Prosedur operasi standar (SOP) untuk survei keragaman jenis pada kawasan konservasi. Bogor (ID): Pusat Penelitian dan Pengembangan Perubahan Iklim dan Kebijakan – Badan Penelitian dan Pengembangan Kehutanan.

[10] Magurran A. 2004. Ecological diversity and its measurement. London (UK): Croom Helmed Limited.

[11] Krebs C J. 1978. Ecological Methodology. New York (US): Harper dan Row Publisher.

[12] van Helvoort B. 1981. Bird Population in The Rural Ecosystem of West Java. Wageningen (NL): Nature Conservation Departement Agricultural University.

[13] Elfidasari D and Junardi. 2005. Keragaman burung air di kawasan hutan mangrove Peniti, Kabupaten Pontianak. Biodiversitas vol VII(1) 63-66.

[14] Wiens J A. 1989. The Ecology of Birds Communities (Volume 2, Processes and Variations). Cambridge (UK): Cambridge University Press.

[15] [BirdLife International]. 2017. Numenius madagascariensis (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22693199A118601473 [internet]. [cited 2018 Oktober 15] http://www.iucnredlist.org/.

[16] Hidayat A, Artaka T, Taufiqurrahman I, Basyari S, and Fadrikal R. 2017. Records of Common Sandpiper Actitis hypoleucos at High Elevation Wetlands on Jawa, Indonesia. Stilt Vol 71 45-46.

[17] Bishop K D. 2006. Shorebirds in New Guinea: their status, conservation and distribution. Stilt Vol 50 103-134.

[18] van Gils, Wiersma J P, and Kirwan G M. 2017. Common Sandpiper (Actitis hypoleucos). in: del Hoyo, Elliott J A, Sargatal J, Christie D A, and de Juana E (editors). Handbook of the birds of the World Alive. Barcelona (ES): Lynx Editions [internet]. [cited 2018 October 15] http://www.hbw.com/node/53912.

[19] Arini D I D and Nugroho A. 2016. Preferensi habitat Anoa (Bubalus spp.) di Taman Nasional Bogani Nani Wartabone. Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia Vol 2(1) 103-108.

[20] Alikodra H S. 2012. Konservasi sumber daya alam dan lingkungan. Yogyakarta (ID): Gadjah Mada University Press.

[21] Ribai, Alikodra H S, Masy’ud B, and Rahmat U M. 2015. Tingkat kesesuaian Suaka Margasatwa Cikepuh sebagai Habitat kedua Badak Jawa (Rhinoceros sondaicus Desmarest, 1822). Media Konservasi Vol 20(2) 108-116.

[22] Fahrudin A, Al Amin M A, Kodiran T, Hamdani A, Afandy A, and Trihandoyo A. 2015. Pemetaan Sosial (social mapping) di Wilayah Pesisir Kabupaten Gresik. Bogor (ID): PKSPL-IPB.