Waterbird Community in A Plantation Forest of An Industrial Area

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Abstract. Waterbird mostly were found in natural wetlands, nesting on mangrove trees. An unusual case was found in a human-made (plantation) forest in an automotive company within an industrial area. The objective of the research was to reveal the species and number of waterbirds that utilized the non-mangrove plantation forest and to record the number of nests and the nest tree preference. Waterbird census was conducted in June and July 2017 (beginning of rainy season) by direct total count of all individuals in the late afternoon (4-6pm). Waterbirds were able to use non-mangrove, plantation forest to roost and nest. On average, there were 4,482 individual resident waterbirds in the study area, consisted of 6 species and occupying 1.77 ha of semi-wetland area (inundated during rainy season), with an average roosting density of 9.4 nests/100m². The dominant waterbird species were Intermediate Egret (30%), Little Egret (20%), and Black-crowned Night Heron (25%). Other observed species were Cattle Egret (15%), Javan Pond-Heron (5%), and Great Egret (5%). Breeding season was in progress and there were 535 active nests. Although the percentage of nests laid on M. leucadendra trees (49.9%) was similar to A. mangium (47.3%), statistical test suggested that M. leucadendra were highly preferred for nesting trees.

Keywords: egrets, KIIC, night heron, man-made forest, melaleuca

1. Introduction
Worldwide, human-made (plantation) has been expanding lately and in regions where little natural forest remains, the biodiversity supported by forest plantations may plays important roles [1]. In Indonesia, reforestation and regreening actions have been practiced nationwide by various stakeholders, although published research related to the biodiversity in plantation forest is still limited.

Plantation forests might still have a high diversity of terrestrial birds by providing suitable habitat for roosting and nesting [2]. For waterbirds, however, the habitat requirements were a much higher compare to the terrestrial birds, especially for the nesting trees that need strength and safety at the same time [3]. Waterbirds have been known to use mangroves to roost and nest [3-5], as the trees in mangrove forest meet the waterbirds’ need. When the mangrove forest decreasing and the non-mangrove plantation forest expanding, this situation might leads to a question whether the waterbirds are able to nest on non-mangrove plantation forest to roost and nest.

To assess whether the non-mangrove forest is able to be used as roosting and nesting sites for waterbirds, a case in an inland non-mangrove plantation forest was selected and analyzed. The objectives of this study were (a) to reveal the species and number waterbirds that utilized the

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plantation forest in an industrial area, and (b) to record the number of nests and the nest tree preference.

2. Study sites and methods

2.1. Description of the study site
The study was conducted in a plantation forest, within an automotive company in Karawang (West Java, Indonesia). The forest in the study area (6°21'12.27"E; 107°17'52.29"S; figure 1) was planted in 2002, as part of the re-greening program of the company to improve the environmental condition of the manufacturing plant, as well as to decrease the impact of a test drive nearby. Of the 100 ha of the total area, 16 ha was planted by trees of various species. Unexpectedly, part of the planted area of 1.77 ha has been used by waterbirds for roosting and nesting. This plantation forest that has been used by waterbirds for roosting and nesting was the focus site for this study.

The study area is surrounded by other companies within the area. The whole areas were managed by various companies, created a large industrial area called Karawang International Industrial City (KIIC), which has an area of 1,200 ha, managed by 110 companies. To the north, the study area borders with the toll road connecting Jakarta and Cikampek/Bandung. Analysis of the map of the surrounding locations by using Google Earth showed that the study site has a closest distance of 29.3 km to the coastline (north), 15.9 km to the large body of water (Jatiluhur Dam; south), 2.8 km to the major river (Citarum River; east), and 8.5 km to the vast rice field complex.

The plantation forest in the study site was systematically planted with a number of tree species; Melaleuca leucadendra, Acacia mangium, and Swietenia macrophylla, creating several monoculture blocks of tree stands, adjacent to each other. In between the tree stands, a small number of other tree species were also found, namely Acacia auriculiformis and Leucaena leucocephala. The size of each blocks varied from 0.56 ha to 1.97 ha. Distance between trees in each blocks was 5x5 m. All trees were mature, creating a canopy of 3 to 11 m (smallest to highest canopy), or averaged 6.9±2.2 m (±SD; n=184) high.

The M. leucadendra trees grew on a waterlogged area of about 0.2 to 1.0 m deep. The waterbirds had been using mainly M. leucadendra trees for nesting areas. Other tree species grew on dry land, although the waterlogged area underneath the M. leucadendra sometimes extended sideways to the adjacent A. mangium tree stands. Some of the A. mangium trees to the right (east) and left (west) of the M. leucadendra stand were also being used for nesting by the waterbirds.

2.2. Methods
Every day the diurnal waterbirds leave the area in the morning (in the evening for the nocturnal waterbirds) to seek food elsewhere. In the evening, the diurnal waterbirds came back to the study area to roost while the nocturnal waterbirds leave the area. Preliminary study revealed that morning counts were less reliable due to the scattered individual departure flight pattern. In the evening, the diurnal waterbirds were flying home mostly in big flocks and easily visible to be counted from a distance. Thus, the population counting was conducted in the evenings only.

Waterbirds population number was counted through a total count [6] between 4:00 to 6:00 pm, when the diurnal waterbirds were descending from their arrival flight for roosting in the study site. The counting (n=6) were done from two counting stations at the opposite positions (i.e., west to north and east to south) to cover all possible directions of arrival flight. An hour prior to the counting period (3:00-4:00 pm), all individual waterbirds that were staying in the study site (nocturnal waterbirds, juveniles, and adults that incubated their eggs) were systematically counted from a safe distance (20 m) by using 8x42 mm binoculars. The number of waterbirds staying in the study site was added to the waterbirds flying back to the study site to get a total population number. The census were conducted in June (2 observations) and July 2017 (4 observations). Identification of waterbird names and sequence follows [7].
Due to the color, size, and morphological similarity of the waterbirds, some egret species were unable to be identified from the distance, and thus identified as ‘mixed egret’ during population census. Because of their very close resemblance and their hiding roosting/nesting position, species composition was unable to count precisely, and only presented in a percentage of the total population.

Breeding season was in progress during observation and all nests in the study site were also counted, although the data on the breeding onset was unavailable. Nests were counted and identified from underneath (i.e. under the nesting trees) during the day (9:00 am-12:00 n) when the diurnal waterbirds leave the site, being cautious not to disturb the waterbirds staying on site. As nests have similar appearances, nest identification was based on nestlings and/or fledglings inside or nearby the nests, although some old nests remained unidentified. Tree species of the nesting trees were also identified in order to assess the nest tree preference.

Figure 1. Landsat image of the study area, showing the main focus site of the study in the Melaleuca leucadendra and Acacia mangium tree stands (dashed lines).

3. Results

3.1. Species presence and number

There were 6 waterbird species confirmed to be residents of the study site, all belong to Ardeidae family (table 1). Five waterbird species, all also belong to Ardeidae family, were seen in a very low number and found only temporary, or passing by, and thus considered as non-residents. These non-resident species were Grey Heron Ardea cinerea (1 individual observed in June), Cinnamon Bittern Ixobrychus cinnamomeus (1 individual, June), Striated Heron Butorides striatus (1 individual, June), Oriental Darter Anhinga melanogaster (passing by) and Milky Stork Mycteria cinerea (passing by). In addition, one marsh bird also confirmed occurred in the study site, namely White-breasted Waterhen Amaurornis phoenicurus.

Among the confirmed resident species, diurnal mixed egrets were dominated the waterbird population (70%), consisting of Intermediate Egret. Little Egret, Great Egret, and Cattle Egret. Intermediate Egret and Little Egret combined contributed 50% of the total population. Other dominant species was Black-crowned Night Heron (25%), which has a nocturnal habit. None of the waterbird was known to be migratory.

Based on the population census, on average there were 4,482 individual waterbirds using the area for their roosting and nesting habitat (table 2) during the study period. Population in July was slightly
lower than population in June. About 7.5% of the population stayed during the day, due to their nocturnal habit, being juveniles, or staying on nests to incubate eggs or protect newly hatch chicks, as mentioned previously. Many juveniles were seen foraging in the shallow waterlogged area underneath the *M. leucadendra* trees.

**Table 1.** List of waterbirds of the Ardeidae family presence in the study site; nomenclature of common names and sequence follows [7].

| No | Common Name          | Latin Name             | Composition (%) |
|----|----------------------|------------------------|-----------------|
| 1  | Great Egret          | *Egretta alba*         | 5               |
| 2  | Intermediate Egret²  | *Egretta intermedia*   | 30              |
| 3  | Little Egret         | *Egretta garzetta*     | 20              |
| 4  | Cattle Egret         | *Bubulcus ibis*        | 15              |
| 5  | Javan Pond Heron     | *Ardeola speciosa*     | 5               |
| 6  | Black-crowned Night Heron | *Nycticorax nycticorax* | 25         |

¹Synonym: *Casmerodius albus, Ardea alba*

²Synonym: Yellow-billed Egret

**Table 2.** Abundance (average ± SD) of waterbird population in the study site; mixed egret and night heron were combined.

| Month | Arrival Direction | Stay on Site | Total    |
|-------|-------------------|--------------|----------|
|       | West-North        | East-South   |          |
| June  | 2,999 ± 196       | 1,784 ± 11   | 526 ± 334| 5,308 ± 149|
| July  | 2,764 ± 357       | 1,064 ± 231  | 241 ± 60 | 4,068 ± 610|

3.2. Nest density and nest tree preference

The presence of nests and fledglings suggested that the study site obviously had been used for breeding, as well as for roosting. There were 535 nests in 5,700 m² effective area, giving an average density of 9.4 nests/100 m². Waterbird species which confirmed breeding in the area were all resident species: Intermediate Egret, Little Egret, Black-crowned Night Heron, Cattle Egret, Javan Pond-Heron, and Great Egret.

Regardless the tree species, the average number of nests on one tree was 4.3±7.2 nests. Most trees (81.7%) had 1 to 4 nests, although there was one tree that had 16 nests on it (figure 2). Nests were laid on *M. leucadendra* (49.9%), *A. mangium* (47.3%), *A. auriculiformis* (1.9%) and *L. leucocephala* (0.9%) trees. Although the percentage of nests on *M. leucadendra* and *A. mangium* was quite similar, statistical test revealed that the waterbirds highly preferred *M. leucadendra* compared to *A. mangium* tree ($\chi^2 = 12.60, P<0.001; df=1$ with Yates correction).

4. Discussion

Plantation forest has been created in the study site and surprisingly the site was able to support waterbirds for roosting and even nesting. Although study on the breeding success was not conducted yet, the presence of many juveniles in the study area was a good indication of a growing waterbird population. Unfortunately, there has been no published report in Indonesia regarding the success of tree plantation as breeding site for waterbirds, except for mangroves along coastline or on small islands, which was irrelevant comparison in this case. The case that waterbirds have been able to utilize plantation (non-mangroves) in inland areas within an industrial complex could be the first example in Indonesia, and perhaps also elsewhere.

Clearly the study site had been used by waterbirds for roosting and nesting only and the waterbirds had to seek food outside the area, a typical situation for waterbird colony worldwide, including in Indonesia, for example in Pulau Rambut Wildlife Sanctuary in Jakarta Bay [3],
Sukamandi in West Java [8], Pulau Dua in Banten [4], and Percut Sei Tuan in North Sumatra [5]. The exception was in Nusa Dua (Bali), where waterbirds were reported to seek food in a human-made wetland which happened to be a sewage treatment pond, packed with fishes and other aquatic invertebrates [9].

Distances from the study site to the potential foraging areas indicated that the waterbirds had to travel quite far to seek food. In addition, the fact that there has been no report on the existence of other breeding colony nearby demonstrating that the study area played an important role as a refuge for breeding/roosting waterbirds in the surrounding landscape.
Referring to the waterbird guild classification by [10], the study area was used by birds (i.e. genera of Egretta, Ardea, Bubulcus, and Nycticorax) of Guild 5 (stalking herons). Other guilds, namely Guild 1 (ducks and cormorants), Guild 2 (visual surface foraging waders), Guild 3 (tactile surface foraging waders), Guild 4 (pelagic foraging waders), Guild 6 (fishing pelicans), and Guild 7 (fishing terns), were absent. The absence of deep water and the high distance from coastline did not create a good habitat for cormorants (Guild 1) that usually common along the northern coast of West Java.

As for nest tree selection, it was surprising that the *M. leucadendra* trees and *A. mangium* trees were able to be used by the waterbirds for nesting, which never reported published literatures before. Cattle Egret has been known to be easily adapted in using various tree species for nesting [3, 11], but the *M. leucadendra* and *A. mangium* were never previously listed.

The waterlogged area planted with *M. leucadendra* tree was a preferred nest site for the waterbirds. The tree species was relatively small and bushy, creating a suitable area for nesting small Ardeids, but apparently not so suitable for large Ardeids such as Great Egret and Grey Heron. *M. leucadendra* trees in the study area were relatively small (maximum height 13.0 m, maximum canopy diameter 10.7 m), with small lanceolate leaves. Analysis of nest site characteristics by [3] revealed that these two large-bodied species required strong, less wind, and wide tree canopy to nest.

*M. leucadendra* has been known to be tolerant of periodic or even continuous waterlogging [12]. As for *A. mangium*, this non-native species were also used for alternative nesting trees. Unfortunately, some trees of *A. mangium* on the waterlogged areas have been dying, proving that this species need a dried soil to survive in the long term.

Many young Black-crowned Night Herons and egrets were observed stalking for food at the waterlogged area, indicating that the area - to some extent – also functioning as feeding area. Study in Greece reported that Little Egret nestlings consumed mainly fish, insects, and amphibians, while the night heron nestlings/young were mainly fed on insects, crustacean, small mammals and reptiles [13].

The impressively large numbers of waterbirds found in the study area clearly means that the study site is an extremely important habitat for waterbirds of the Ardeidae family, and thus the site need to be protected and managed accordingly. In the long term, the species richness and composition of waterbird community in the study site would be determined by two important factors: colonization followed by the establishment of breeding populations, and species loss through local extinction, as predicted by the theory of island biogeography [14].

Previous study revealed that factors that determine the waterbird species presence in a certain habitat were size, connectivity (distance to the nearest foraging areas) and habitat quality [15]. Obviously, more research need to be done to find out more about more aspect related to breeding and population growth (e.g. breeding season, breeding success, nest site selection, predation identification and rate, foraging areas outside the study site). Factors that attract various waterbirds to roost and nest in the site need to be revealed as well. It would also possible to enlarge the existing roosting/nesting sites, and create habitat for other waterbird guilds, for instance through the creation of new wetland areas with various depth, adjacent to the study site.

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