

**ECOLOGY OF AVIAN COMMUNITY OF PULAU RAMBUT:
Population, Nest Site Distribution, and Foraging Sites**

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PREFACE

There is only a few heronry of waterbirds in Indonesia, and one of them is Pulau Rambut Wildlife Sanctuary. Various waterbird species in a huge number use the island as their home, despite the fact that the sanctuary is now under various threat.

The research is a result of an ecological study on the waterbird community in the island of Pulau Rambut. Similar study was conducted in 1989-1992, providing a good base for a comparative study.

Many institutions and individuals have been contributed in the research. Funding was generously provided by the Nagao Natural Environmental Foundation, Japan, and I am extremely grateful for their trust and support. Balai KSDA DKI Jakarta was kindly give me a permission to use the site for my study. I also greatly thankful to my assistant, Imanuddin, who helped me in all stages of the study, including the field work, data analysis, and report writing. Thanks are also due to my students, Erni Jumilawati, Dijan Sunar Rukmi and Afif Azhar, who assisted me in some field works. I would also extend my thanks to Warsa Jaya, the forest ranger (Jagawana), for his help during my field study.

I do hope that the information in this report would serve as an additional knowledge of the avian community of Pulau Rambut, as well as a source of information for anyone who need it.

Ani Mardiasuti

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I. INTRODUCTION

A. Background

Pulau Rambut is a small 45 ha island ("pulau" means island) located in Jakarta Bay area, Indonesia. This island is a very special site because it has been used as a breeding site for waterbirds from surrounding areas. Realizing the importance of the island for waterbird conservation, since 1939 the island has been gazetted as Nature Reserve. later on, in 1999 the status of nature reserve was changed into a Wildlife Sanctuary.

There are thousand of waterbirds nesting on the island, belonging to 14 species. Indonesian government protected most of waterbirds and some of them (e.g., Milky Stork) has been listed under Birds to Watch 2 and IUCN Red List Category. A decade ago, Mardiasuti (1992) conducted an intensive study on the biodiversity and population of waterbirds and provided as baseline data on various aspect. Some other research that has been conducted during the past ten years were related to habitat mapping the island using Geographical Information System (Fitriana 1999), breeding biology of the Milky Stork (Imanuddin 2000), breeding biology of the Little Egret (Sulistiani 1991), and distribution and diversity of waterbirds (Mahmud 1992).

The island is located near the Jakarta Metropolitan area, which undergone a very fast human development. The distance of the island to the nearest coast of Java is only 3 km. Further, there is also a neighbouring island (1 km apart) inhabited by large number of human population. Therefore, the island has been receiving a strong human pressure.

The waterbirds use Pulau Rambut as breeding and roosting site. They have to go out from the island to find food in the wetland of Java mainland. The vast conversion of wetland into other uses (e.g., housing, recreation areas, airport, industrial areas) has been severely reduced the foraging areas of the waterbirds, and might lead to decrease the population.

B. Objectives

This objectives of the study was to reveal the number of waterbirds and monitor the population number during one-year period, compared with the 1990 data, and analysed the population trend. This study also investigated the potential threat during feeding activities and spatial nest site distribution and, not least important, was identified the exact location of feeding sites. The main feeding grounds were located along the coastline of the closest mainland of Java. Field observations were conducted between November 2000 and October 2001.

II. STUDY AREA DESCRIPTION

A. History and Location

It was long recognized that Pulau Rambut (Fig. 1) was a habitat for various waterbirds and some unique corals. Recognizing its highly valuable resources, Pulau Rambut was gazetted as a Nature Reserve on May 3, 1937 by Dutch Governor Decree No. 7/1937. Later, the Government of Indonesia reinstated its status by issuing a Government Decree No. 11/1/20 dated May 28, 1970. More recently, it has been identified as one of the most important waterbird breeding sites in Java (Silvius *et al.* 1987) and the only known for breeding sites of Milky Stork in Java (Allport & Wilson 1984). In 1999 status of Pulau Rambut was change into a Wildlife Sanctuary.

Pulau Rambut Wildlife Sanctuary (106°31'30"E, 5°57'S) was chosen as the study area because of its large heronry. When gazetted as a Nature Reserve in 1937, the island had an area of 25 ha. Later, a more careful measurement revealed that the size of the island is about 45 ha. During the lowest tide the size of Pulau Rambut is 65.2 ha, while during the highest tide it covers an area of 44.0 ha. According to Fitriani (1999) the size of the island is only 45,17 ha.

B. Meteorology

In Indonesia, the monsoons (known as West and East Monsoons) have a strong impact on the weather and the climate. During the West Monsoon (December March), the winds come from the west and blow eastward. The West Monsoon is marked by high precipitation (the highest precipitation occurs in January) and is, therefore, also called the wet season (Nontji 1987). Average precipitation in Jakarta Bay reaches about 330 mm in January. In the East Monsoon (May September) the winds come from the east and move westward. Precipitation in this monsoon is low, and it is, therefore, called the dry, season. Minimum precipitation occurs in July and August.

In between these two monsoons is a period called the Transition Period. March through May is called Transition Period I (transition from West to East

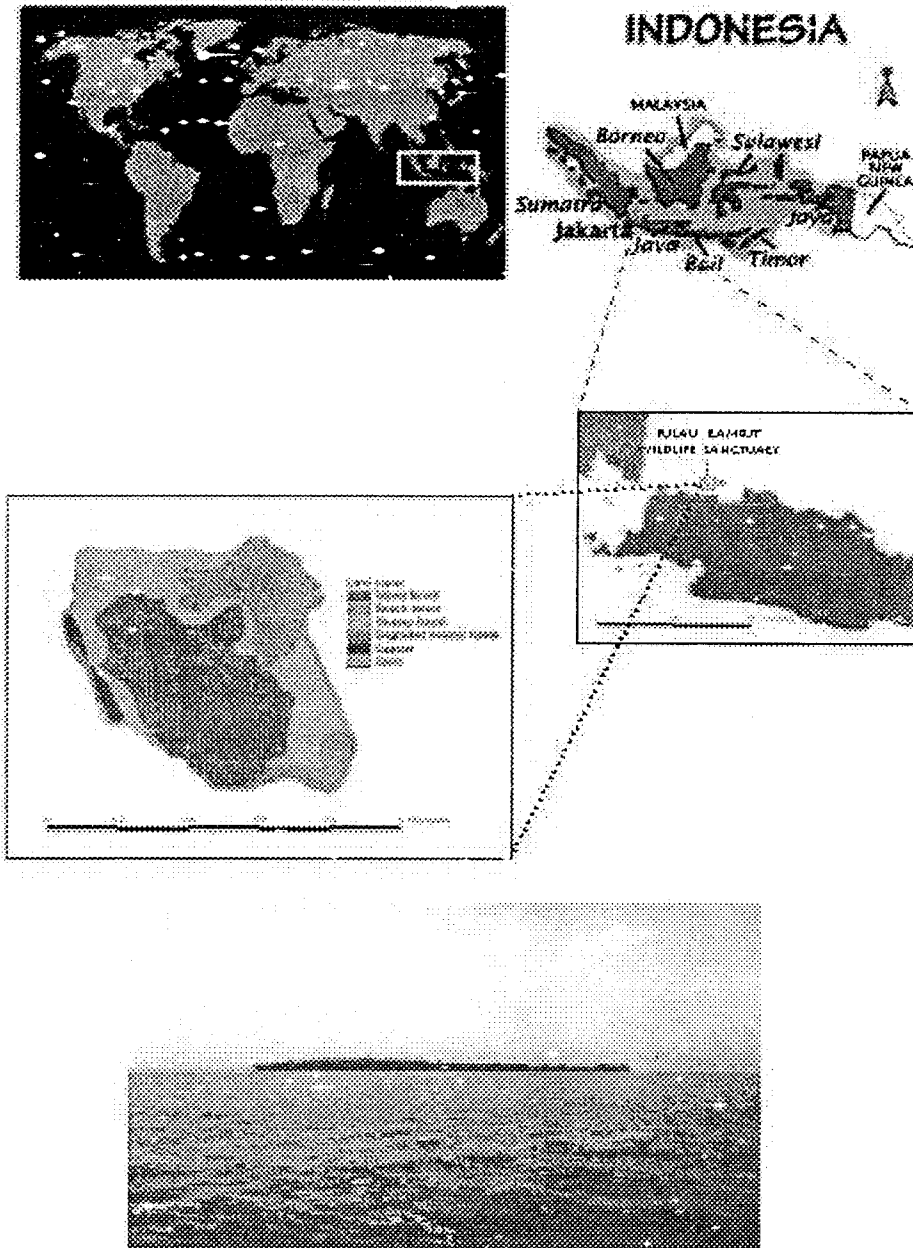


Figure 1. Map of Pulau Rambut Wildlife Sanctuary, Jakarta Bay, Indonesia.

Monsoon), whereas September through November is called Transition Period II (transition from East to West monsoon). Winds in this period are irregular and wind speeds low. Average wind speed during the entire season varies between 3

and 30 km/hr. However, high wind speeds can reach 50 km/hr.

Total annual rainfall in this area is in accordance with the movements of the above winds, with the higher rainfall (usually in January) during the West Monsoon period. During the East Monsoon period (usually in August), the lowest rainfall occurs. The total rainfall starts increasing in the second Transitional Period, i.e., in September. Furthermore, the total annual rainfall in this area is only 1152,9 mm although in the northern part of the area the total rainfall may reach up to 5,000 mm.

The monthly average temperature in the Jakarta Bay area ranges between 23°C - 32°C, and the temperature during the dry season is higher than during the rainy season. The relative humidity level is between 50% - 90%.

C. Topography

The shape of Pulau Rambut is almost round and consists of dry lowland and inundated mangrove area. The whole island is more or less flat, with the altitude between 0 - 1.75 m from the sea surface. The highest site at the southeast the middle island is less than 1 m high, while the north is about 0.75 - 1 m high. The soil basically consists of decayed corals.

D. Terrestrial Flora and Fauna

Vegetation of the island can be categorized into 3 formations: coastal/beach forest, mixed dryland forest, and mangrove forest (Fig. 2). The coastal/beach forest is covered with grasses, shrubs, and trees such as *Ipomoea pes caprae*, *Sesuvium portulacastrum*, *Wedelia biflora*, *Acacia auriculiformis*, and *Leucaena glauca*.

The secondary mixed forest located at the central part of the island, covers about 20 ha of land. The upper canopy is dominated by *Sterculia foetida* and the middle canopy is dominated by *Dysoxylum caulostachyum*. Other tree species in the middle canopy are *Schleichera oleosa*, *Adenanthera pavonina*, *Ficus timorensis*, *Diospyros maritima*, *Guettarda speciosa*, and *Melia azedarach*. The lowest canopy is a thick layer of *Triphasia trifolia*.

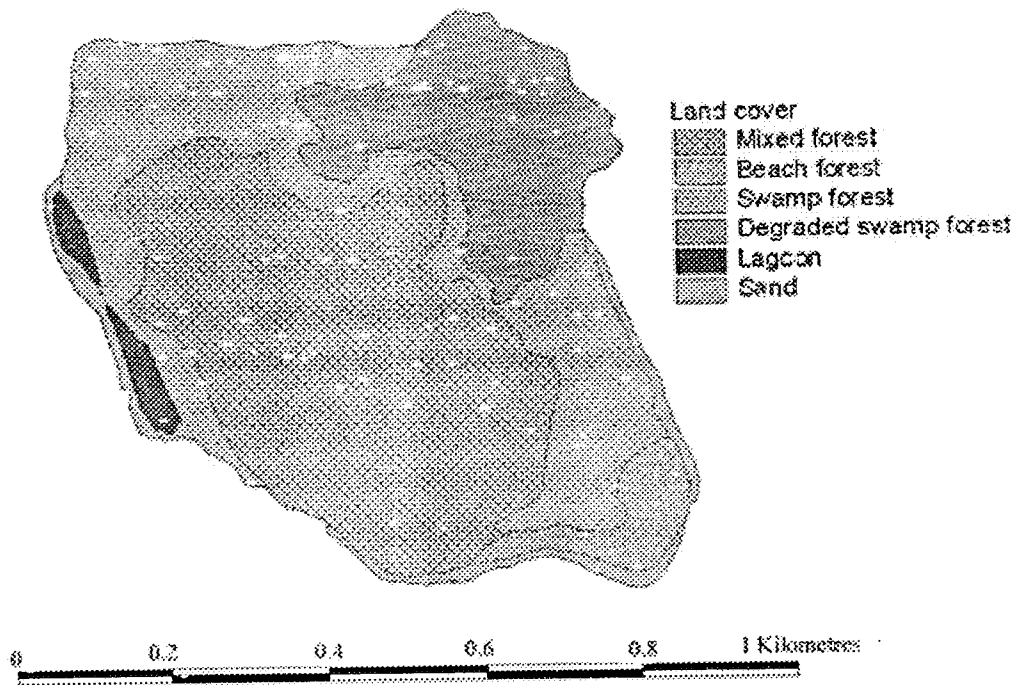


Figure 2. Landcover of Pulau Rambut Wildlife Sanctuary

The mangrove forest consists of a primary ('true') mangrove, which is always inundated by tides, and secondary ('back') mangrove, which is inundated only by high tides. Primary mangrove is dominated by *Rhizophora mucronata* and *R. stylosa*. Other species of mangroves are *Sonneratia alba*, *Bruguiera gymnorrhiza*, and *Avicennia alba*. The secondary mangrove mostly consists of *Ceriops tagal*, *Xylocarpus granatum*, *X. moluccensis*, *Scyphiphora hydrophyllacea* and *Excoecaria agallocha*.

Waterbirds are the main inhabitants of the island. The heronry during the study was inhabited by Grey Heron (*Ardea cinerea*), Purple Heron (*Ardea purpurea*), Black crowned Night Heron (*Nycticorax nycticorax*), Great Egret (*Egretta alba*), Plumed Egret (*E. intermedia*), Pacific Reef Egret (*E. sacra*), Little Egret (*Egretta garzetta*), Little Black Cormorant (*Phalacrocorax sulcirostris*), Pygmy Cormorant (*Phalacrocorax niger*), Indian Darter (*Anhinga melanogaster*), Milky Stork (*Mycteria cinerea*), Black headed Ibis (*Threskiornis melanocephallus*), and Glossy Ibis (*Plegadis falcinellus*). All herons, egrets, cormorants and ibises used either mixed

dryland forest or mangrove forest as their nesting site during the study.

Other birds (non waterbirds) were also found in the island, e.g., Brahminy Kite (*Haliaeetus indus*), White-bellied Sea Eagle (*Haliaeetus leucogaster*), Whimbrel (*Numenius phaeopus*), Black napped Oriole (*Oriolus chinensis*), Pied Imperial Pigeon (*Ducula bicolor*), Small Blue Kingfisher (*Alcedo caerulescens*), Magpie Robin (*Copsychus saularis*), and Brown throated Sunbird (*Anthreptes malacensis*). In addition, the island also supports monitor Lizards (*Varanus salvator*), Reticulated Python (*Python reticulatus*), Mangrove Snakes (*Boiga dendrophila*), and Flying Foxes (*Pteropus vampyrus*).

III. METHODS

A. Bird Diversity and Population Size

The diversity of waterbird species was assessed through direct sighting of the species, both on their nests and during population counting. No capture was made and the identification was solely based on the visual contacts. In addition, observations were also conducted for the terrestrial birds, based on visual contact, song, or call. Nomenclature followed MacKinnon & Phillipps (1993). Morisita's Index of Similarity (Krebs 1984) was calculated to reveal the change in composition of the waterbird species during 1990-1990 and this year's observation.

The waterbird of Pulau Rambut search food (mainly fish) outside the island, especially along the northern coast of western Java (i.e., south and southeast of Pulau Rambut). The estimates of the number of waterbirds in Pulau Rambut, therefore, were based on counts of birds (census) leaving the island early in the morning and coming back to the island in late afternoon.

One or two observers, made individual counts from a fixed station at the southern side of the island, where the visual contact to the waterbirds was optimum. All counts were based on the direct visual, as they were large enough to be spotted from the distance. The main characters as guidance for identification were grouping (solitary or group), flight patterns (techniques, flapping rate), size, and plumage colour. If the bird could not be identified up to species level due to very similar appearance or poor light at early dawn and late dusk, the records were based on the genus or group of the waterbird species (e.g., cormorants, egrets).

Morning counts were made between 5:15 and 7:00 am. Almost all diurnal waterbirds leave the island during that time, except the incubating parents and bird species that relied on thermal for soaring flight. Waterbirds coming home were also counted between 5:15 pm until dark, usually about 6:30 pm, which were done on the southeast of the island. Counts were not conducted during the worst monsoons and whenever winds were too strong. During these times, most birds preferred to stay on the island. Counting was done in a five-minute interval; totalling about 80 times during the study in November 2000 until June 2001. The diurnal

rhythm of the Milky Storks was slightly different than the others. The storks relied on thermal column to perform soaring flight and, therefore, they surely would not be detected during the morning and evening counts. Calculation of the Milky Stork population was made by intensive search for their nests in the secondary mixed forest.

Population number in general, regardless the time, were used to estimate the species composition and to identify dominance among waterbird species presence in Pulau Rambut. Furthermore, the population data for each species were plotted against time of the year and were analyzed for their patterns and population trend. Previous data of Mardiastuti (1992) were used as contrast and comparison.

B. Breeding Season

Waterbird breeding periods were monitored throughout this study. A species was considered to be in a high breeding season when more than 25% of the population (i.e., more than 50% of breeding pairs) were nesting. A species was considered to be in a low breeding season when fewer than 10% of the population were nesting. In this study, breeding season was considered to be started when the majority of the waterbirds were building nests, and over when their young were not observed on the nests anymore.

The same trails for the distribution study were also used to check breeding status. The time when a waterbirds species bred was noted and drawn in a simple graph. Rainfall might have a major impact on breeding herons (Lowe McConnel 1976) and thus was of concern here. Rainfall patterns in Pulau Rambut also collected.

C. Nest Site Distribution

The distribution of birds' nests (or roosts) in the entire colony was observed directly every two weeks or whenever the previous pattern of distribution changed. Selected plots of 20 x 20 were used to monitor the presence and absence of breeding groups. Maps were used to record the location of breeding groups.

However, symbols used in the maps did not reflect the abundance of the waterbirds.

To reveal nesting association three representative locations were chosen within the heronry. These locations were: (a) secondary mixed forest, (b) primary mangrove forest (which were always inundated by tides), and (c) secondary mangrove forest (which were inundated only by a high tide). Using a nesting tree as a sample unit, species nesting in the tree were recorded. For the purposes of this study, it was assumed that any bird species occupying the same tree as another species was nesting in association with that species. Because the parents always flew away upon human approach, identification of nests was based on its general appearance, its chicks, and/or its eggs. These observations were done during February April 2000.

The associations between pairs of species were tested using a Chi square (Pielou 1974). The hypothesis was that there were no associations between species. A 2 x 2 table was set up in order to make the calculation. The calculated Chi square was compared with the Chi square distribution table with 1 degree of freedom (i.e., 3.84 for a 5% significant test and 6.63 for a 1% significant test).

D. Foraging Site

Foraging site study define as an area of 30 km distances from Pulau Rambut, based the fact that the most waterbirds have a home range within this distances. A map generated from aerial photo used as the starting point to identify the potential foraging site. Some known wetland types as foraging sites for the waterbirds are rice fields, shrimp ponds, fish ponds, swampy areas, rivers, mudflats, grassland located near waterbodies and lakes. Intensive ground surveyed conducted to find out the feeding site for each waterbird species.

IV. RESULTS AND DISCUSSION

A. Diversity of Waterbirds

A.1. Species Present and Composition

There were 15 species of waterbirds nesting in Pulau Rambut during the study period (Table 1; Figure 4), mostly belonging to the Heron family (Ardeidae, 8 species) and Cormorant family (Phalacrocoracidae, 3 species). Other species were Darter (family Anhingidae, 1 species), Stork (Ciconiidae, 1 species), and Ibises (Threskiornithidae, 2 species). All waterbird species are diurnal, except the Black-crowned Night-Heron.

The dominant waterbirds were two species of cormorants (Little and Little Black Cormorants), followed by Black-crowned Night-Heron, and the mixed egret (4 species), each contributed approximately one third of the total population and, therefore, the three groups comprised almost the entire community of waterbirds in Pulau Rambut (Fig. 3). For estimation of species dominance, there is no doubt that the most dominant species in Pulau Rambut during 2000-2001 was the Black-crowned Night-Heron, followed by the Little Black Cormorant as the co-dominant species.

Two species, namely Milky Stork and Black headed Ibis were considered seasonal resident birds. Between these two seasonal residents, the Milky Stork had the highest abundance, followed by Black headed Ibis. During the research period, it was also found a single individual of Rufous Night-Heron (*Nycticorax caledonicus*) and a single nest of Little Pied Cormorant (*Phalacrocorax leucocephalus*). However, the Rufous Night-Heron and Little Pied Cormorant were excluded from the figure due to their small number.

The species of waterbirds reported to breed on Pulau Rambut had been studied by many workers, i.e., Mardiasuti (1992), Mahmud (1991), Lambert & Erfteimeijer (1988), Wiriosoepartho *et al.* (1986), Milton & Marhadi (1984), van Strien (1981), Lembaga Ekologi Universitas Nasional PPA (1917), and Suwelo &

Tobrani (1972). However, these observations showed a lack of agreement on the species present in Pulau Rambut.

Lambert & Erftemeijer (1988) observed Little Green Herons (*Butorides striatus*) in the island, Milton & Marhadi (1984) added Great billed Heron (*Ardea sumatrana*), Suwelo & Tobrani (1972) mentioned about the presence of Rufous Night-Heron (*Nycticorax caledonicus*), while Wiriosoepartho *et al.* (1986) and Suwelo & Tobrani (1972) spotted many Javan Pond-Heron (*Ardeola speciosa*) in Pulau Rambut.

Table 1. Waterbird species nesting in Pulau Rambut Wildlife Sanctuary, Jakarta Bay, Indonesia, 2000-2001. Birds with asterisks were seasonal resident species. Sequence and species names follow MacKinnon & Phillipps (1993).

No	Family	Species	Common Name
1	Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant
2	Phalacrocoracidae	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant
3	Phalacrocoracidae	<i>Phalacrocorax niger</i>	Little Cormorant
4	Anhingidae	<i>Anhinga melanogaster</i>	Oriental Darter
5	Ardeidae	<i>Ardea cinerea</i>	Grey Heron
6	Ardeidae	<i>Ardea purpurea</i>	Purple Heron
7	Ardeidae	<i>Bubulcus ibis</i>	Cattle Egret
8	Ardeidae	<i>Egretta sacra</i>	Pacific Reef-Egret
9	Ardeidae	<i>Egretta alba</i>	Great Egret
10	Ardeidae	<i>Egretta intermedia</i>	Intermediate Egret
11	Ardeidae	<i>Egretta garzetta</i>	Little Egret
12	Ardeidae	<i>Nycticorax nycticorax</i>	Black-crowned Night-Heron
13	Ciconiidae	<i>Mycteria cinerea</i> *	Milky Stork
14	Threskiornithidae	<i>Threskiornis melanocephalus</i> *	Black-headed Ibis
15	Threskiornithidae	<i>Plegadis falcinellus</i>	Glossy Ibis

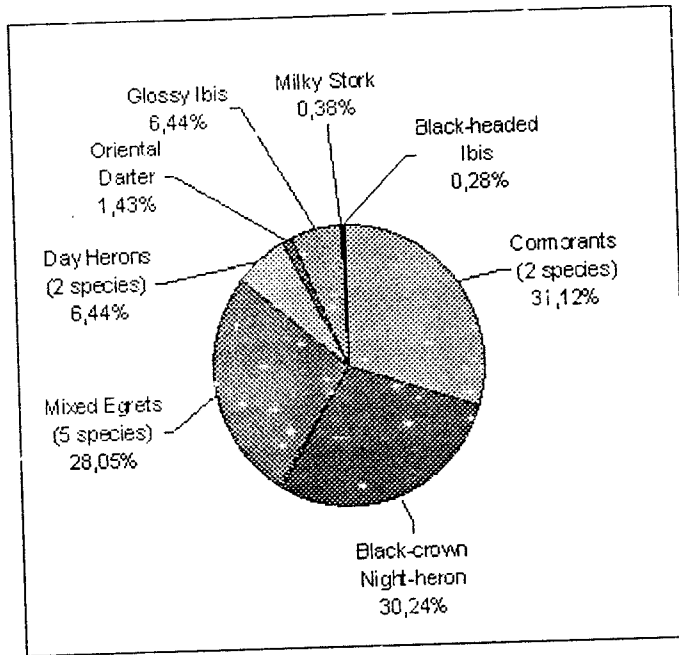


Figure 3. Waterbirds composition in Pulau Rambut Wildlife Sanctuary Jakarta Bay, Indonesia, 2000-2001 (in percent).

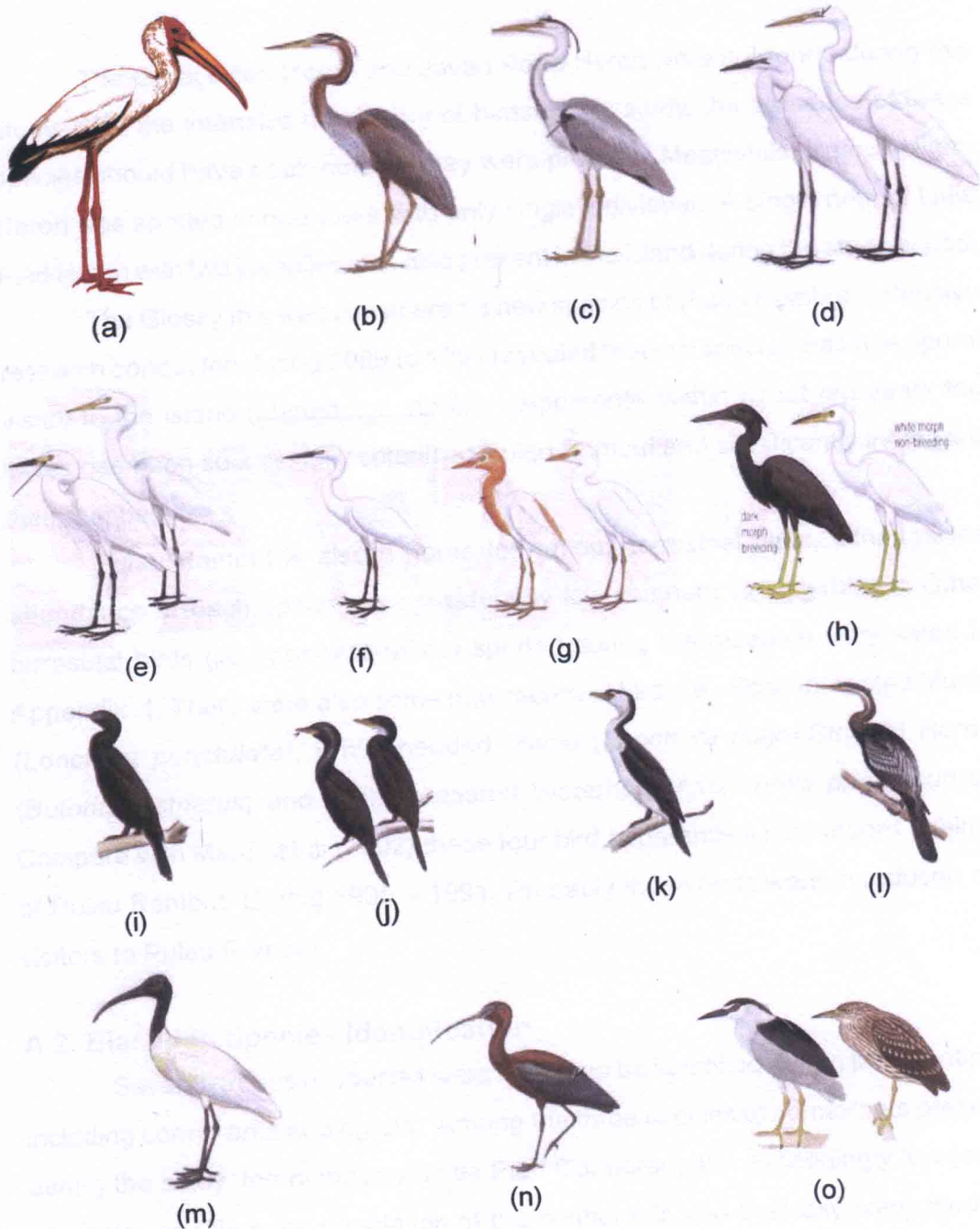


Figure 4. The waterbirds of Pulau Rambut Wildlife Sanctuary, Milky Stork (a), Grey Heron (b), Purple Heron (c), Great Egret (d), Intermediate Egret (e), Little Egret (f), Cattle Egret (g), Pacific Reef Egret (h), Little Black Cormorant (i), Little Cormorant (j), Little Pied Cormorant (k), Oriental Darter (l), Black-headed Ibis (m), Glossy Ibis (n), Black-crowned Night Heron (o).

The Great billed Heron and Javan Pond-Heron were not found during this study. With the intensive monitoring of birds in this study, the presence of these species should have been noted if they were present. Meanwhile, Rufous Night-Heron was spotted in one week with only single individual. A single nest of Little Pied Heron with two juveniles was also present in the island during the study period.

The Glossy Ibis was considered a new species of Pulau Rambut. Intensive research conducted during 1989 to 1991 revealed that this species was a temporal visitor to the island (Mardiastuti 1992). Apparently within about ten years the ibises has been successfully colonized Pulau Rambut and significantly increased their number.

Pulau Rambut is also a home for various terrestrial birds, although the abundance of each species is considerably low compare to waterbirds. Other terrestrial birds (i.e., non-waterbirds) spotted during the research were listed in Appendix. 1. There were also some new record of bird, i.e., Scaly-breasted Munia (*Lonchura punctulata*), White-headed Munia (*Lonchura maja*), Striated Heron (*Butorides striatus*) and White-breasted Waterhen (*Amauornis phoenicurus*). Compare with Mardiastuti (1992) these four bird apparently a new record of birds of Pulau Rambut. During 1990 – 1991. Probably these birds were introduced by visitors to Pulau Rambut.

A.2. Biased in Species Identification

Several groups of species were difficult to be identified during the counting, including cormorants and egrets. Among the three species of cormorants present during the study, the number of Little Pied Cormorant was exceedingly low (only one pair), and thus the population of the cormorants was basically comprised of Little Black Cormorants (body length 61 cm) and Little Cormorants (56 cm).

The Little Cormorant has a white patch on their throat during non-breeding season and this character is the only way to differentiate both species from the distance, as both of them have the same black plumage and simiiar body size. However, the white patch was too small to be spotted during the counting, resulting in a pooling of both cormorant species. The exact number of each species was

unable to obtain during the study although it was very obvious that the population of the Little Black Cormorant was far exceeded the population of Little Cormorant.

Egrets, except the dark phase of Pacific Reef-Egret, were also difficult to differentiate during their flight. All egrets have white plumage and the easiest recognized egrets was Cattle Egrets, which possess orange wash on their head, neck, and back during their breeding season. Unfortunately, during non-breeding season the orange plumage disappears, making this species very similar to the Little Egrets.

Egrets of Pulau Rambut have different sizes. The smallest egret species was Cattle Egret (50 cm), followed by Little Egret (60 cm), Intermediate Egret (69 cm) and the greatest was the Great Egret (95 cm). During the flight to and from Pulau Rambut, the egrets normally create a big flock of up to 50 individuals (refer to as the mixed egret) and, therefore, almost impossible to differentiate among each species (Fig. 5).



Figure 5. A flock of waterbirds departs from Pulau Rambut in the morning to forage in the mainland of Java

The Grey Heron and Purple Heron were very similar in size (92 cm and 80 cm, respectively) but very different in their plumage color. During daytime, both species can be identified easily. Unfortunately, when the light was limited during

dusk and down, both of them are difficult to differentiate and, therefore, the Grey and Purple Herons were lumped together for the estimation of population number.

The Pacific Reef-Egret was excluded from the mixed egret due to their peculiar form and behavior. The species has two color forms (dimorphic), namely white or charcoal, and both forms can be found in Pulau Rambut. The Reef-egrets (c. 5 individuals) were often found fishing at the shallow marine water of Pulau Rambut boundaries and seemed that seldom leave the island.

B. Population of Waterbirds

B.1. Population Size of the Waterbird Community

The number of waterbirds on the island varied greatly during the time of day, with the peak use from late evening through early morning. In the daytime most of the birds (except the nocturnal Black-crowned Night-Heron) were foraging either at sea or in wetlands in the northern coasts of the mainland (Java), leaving the island almost empty, except during incubation period. In the evening, they came back from their foraging sites and roosted on the island in large flocks. Early in the morning before sunrise, they disappeared again to their foraging grounds. For the Black-crowned Night-Heron, the daily cycles was reversed. The species stayed in the island during the day and left the island during the night.

There was also a high variation of species and numbers throughout the year, with the greatest abundance occurring during November-December with approximately 12,000 birds (all waterbird species) and the lowest abundance occurred in March-April with a total population of 7,000 waterbirds (Fig. 6). The seasonal resident species (Milky Stork and Black-headed Ibis) came to the island to breed, and soon after their young were able to fly, they left the island. During 2000-2001, they arrived on the island in February and left in August-September.

Cattle Egret was probably also a seasonal resident. During its breeding season, this species was found breeding in the island. After the breeding season, its orange-colored feathers on the head and neck disappeared, making it difficult to distinguish from the other small-sized egret, i.e., the Little Egret. However, the low abundance of small-sized egrets during the non-breeding season suggested that the Cattle Egret was not in the island at that time.



B.2. Patterns of Population Dynamics

Analyzing the trend of population of each species or group of species, it was rather obvious that there are three general patterns of waterbird population dynamics in Pulau Rambut: (a) stable high population, (b) stable low population, and (c) cyclic high population. The Black-crowned Night-Herons and cormorants (i.e., Little Black Cormorants and Little Cormorants) were always present in high numbers. Although small fluctuations occurred in certain months, overall their population was relatively stable at roughly 3,000 to 5,500 individuals. Their population was a bit low in March to April, and increased again during the following months.

Three species (or group of species) of the waterbirds had stable low population types. These species were Glossy Ibis (roughly 800 individuals), Purple and Grey Herons (roughly 300 individuals), and Oriental Darters (roughly 100 individuals). All had low but relatively stable populations.

Mixed egrets fall into the third category, the cyclic high population. During November to January, the number of mixed egrets residing in the island was very high, reaching its peak in December with roughly 5,000 individuals. Then the population decreased slowly and reached only to roughly 1,000 individuals in July. Although the cycle was not clearly shown in the graph due to the time limitation, Mardiasuti (1992) also found the same patterns for the mixed egrets during the 1990 and 1991 counting.

B.3. Bias in Population Counting

During November 2000 to July 2001 counting, the minimum and maximum number of waterbird population showed huge variations (Fig. 7) due to two main reasons: (a) the populations were indeed fluctuating because they were seasonal resident species (Milky Stork, Black-headed Ibis, Cattle Egret), which visited the island for breeding only, or (b) bias in counting. Several factors might contributed to the bias, e.g., weather condition, time of observation, and stage of breeding season.

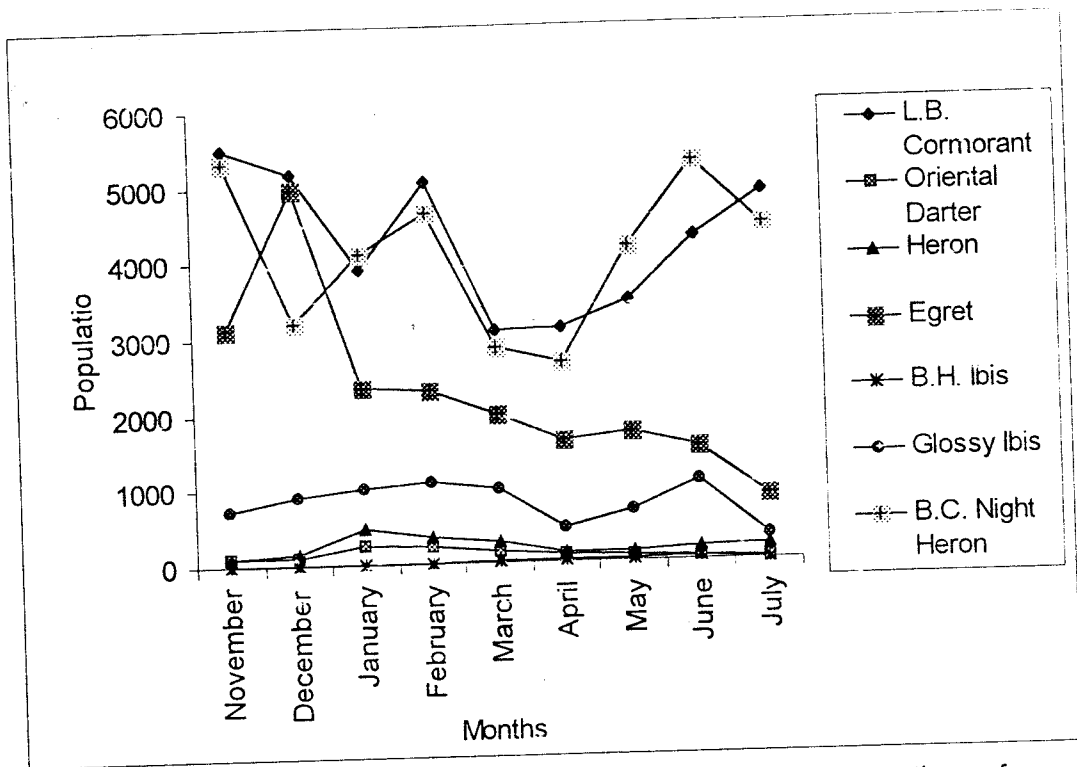


Figure 6. Monthly population size, based on the maximum counting, of some important waterbird species or group of species in Pulau Rambut Wildlife Sanctuary, November 2000 to July 2001.

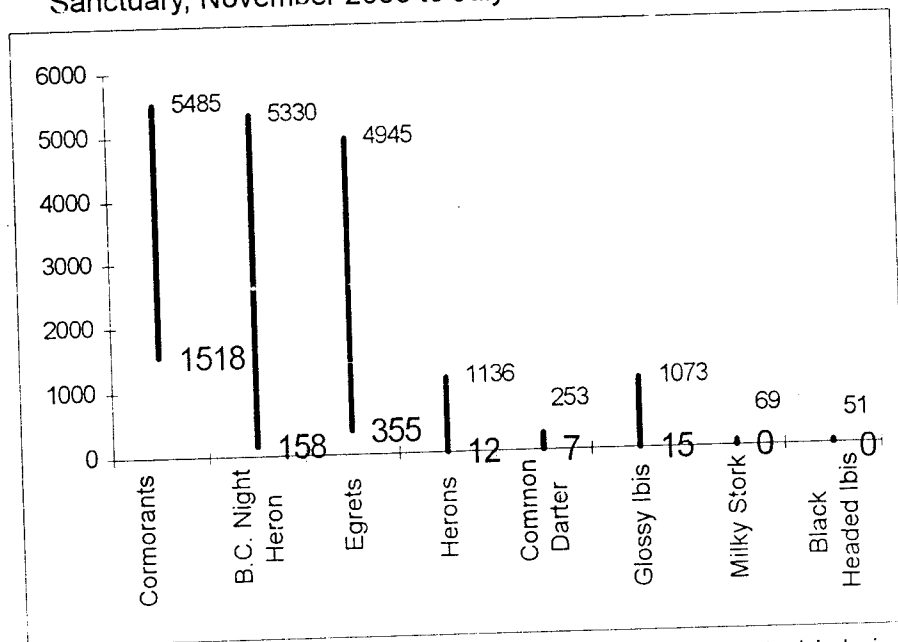


Figure 7. The range (minimum and maximum) number of waterbirds in Pulau Rambut Wildlife Sanctuary based on morning and evening counts, November 2000 to July 2001.

Weather condition, especially rain and wind, greatly affected the counting results. Heavy rain and strong wind might prohibit some waterbirds to leave the island in the morning or forced them not to return (i.e., stayed in the mainland of Java) to Pulau Rambut at dusk, resulting in a lower number in counting. Other species, such as Milky Stork, relied on the thermal column to perform soaring flight. The thermal column occurred only after the air received enough heat from the sun. Counting in the morning might not appropriate for such species.

Bias due to time selection during counting also happened for at least two waterbirds, the Black-crowned Night-Heron and the cormorants. Being nocturnal, the Black-crowned Night-Heron left the island at late dusk and came back to the island at early dawn. Both period of time hampered the sighting to count them accurately. In addition, some of the night-herons have already gone back to the island as early as 3 am, particularly during full moon, making counting underestimate. The cormorants were considered as seabirds, as they often forage for marine fishes near Pulau Rambut. For cormorants, there was no hurry to leave their roosting/nesting sites in Pulau Rambut, resulting in some underestimating in morning count.

The stage of breeding season also might forbid the waterbirds to leave the island in the morning. During the period of incubation and protecting young chicks, it is very crucial for the parents to stay on their nest. Morning counts surely would underestimate the real population number.

C. Assessment of the Diversity and Population Trend: Ten Years Apart

Waterbirds diversity of Pulau Rambut has been the same as ten years ago. There was some new sightings of two species, Striated Heron and Rufous Night-Heron. However, their number is extremely low and negligible.

As mentioned previously, the total population of waterbird community might reach 18,023. Overall, the population of the waterbirds community in Pulau Rambut has been decreasing compare to the 1990-1991 counting by Mardiasuti (1992). Ten years ago the maximum number of the waterbird community reached almost

24,000 individuals. However Morishita Index shows the similarities data between 1990 and 2000 data (Morishita Index = 0,98).

Comparing with the population data of 1990-1991 (Mardiastuti 1992), we have change pattern of waterbirds population in Pulau Rambut. In 1990 the highest population number was Black-crowned Night Heron. However in 2000 the highest abundance was Cormorant. This trend was happen due to decreasing of wetlands as the main feeding ground of Black-crowned Night Heron. Meanwhile the cormorant that actually seabird species was not disturbed, they were still able to find the food in the marine environment.

However if we separated Cormorant being two different species it would be the highest number of waterbirds population was still Black-crowned. Night Heron. Therefore, we summarize there no significant change of waterbirds population in Pulau Rambut during 1990 until 2000

Nonetheless, if we compare the total number of waterbirds between 1990 and 2001, there was significant decreasing of number of waterbirds in Pulau Rambut. We consider the decreasing of wetland areas in North Coast of Java has impact to the number of waterbirds in Pulau Rambut. Almost entire life of waterbirds in Pulau Rambut depends on availability of wetland areas in Mainland of Java.

Glossy Ibis was also found during 2000-2001. They were not migrant waterbirds anymore. This tend happen due to food were available near Pulau Rambut during the year. They feed on paddy field along north coast of Java nearby Pulau Rambut. Comparing with 1990 data the population of Glossy Ibis was also increase during the research 2000-2001.

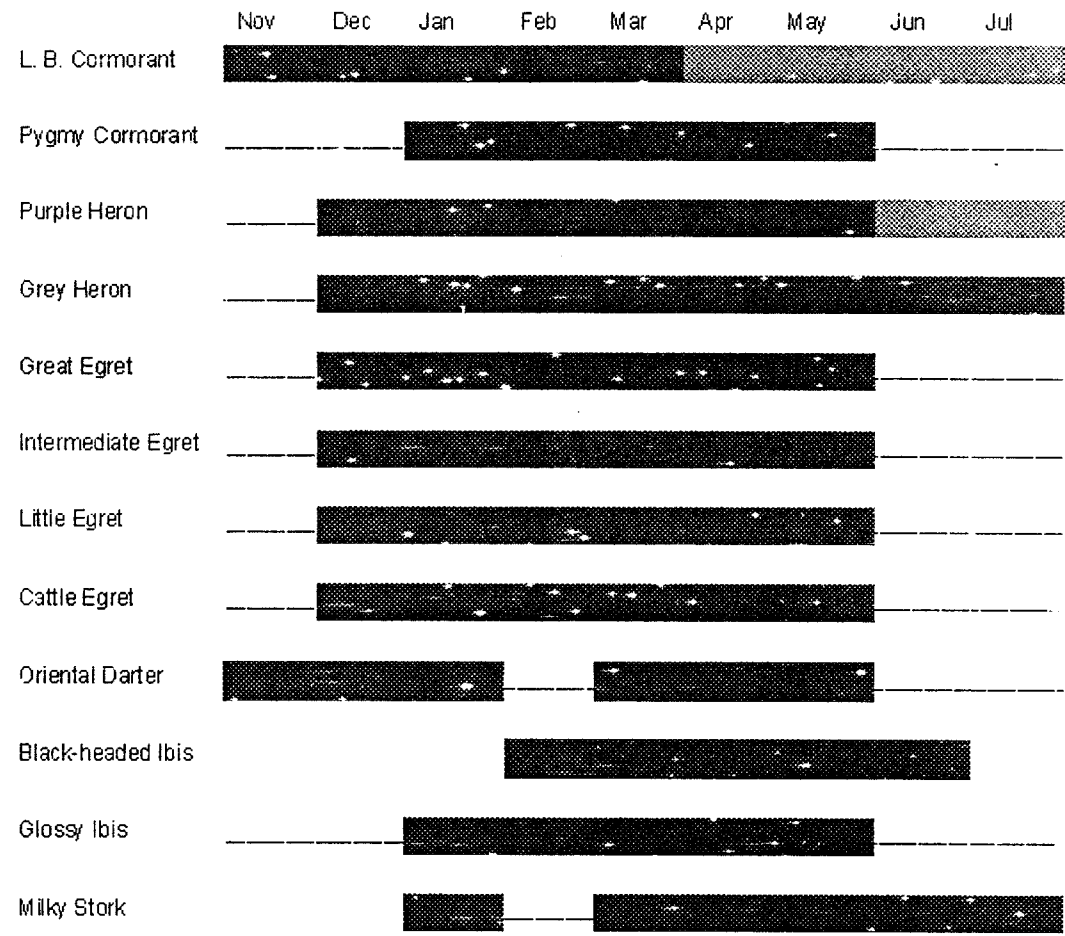
Population number of waterbirds in Pulau Rambut tends to diverge in wide range (see Fig. 7). However it was difficult for counting waterbirds population when they flew away to foraging area, they move on the whole direction and made the counting was not easy to conduct and make the counting overestimate. Bias also happened during the strong wind, most of waterbirds in Pulau Rambut stay longer in the island. They waiting until the wind was stop or became lower, these made the counting underestimate.



D. Breeding Seasons

Birds in the tropics usually have breeding seasons coinciding with the onset of the rain. The relationship between the breeding season and rainfall in Pulau Rambut is shown in Fig. 6, in which the monthly rainfall and breeding season are plotted together. Among these waterbirds, the breeding seasons were considerably spread out. Although there were peaks of breeding activity in the rains, some species (i.e., Little Egret, Great Egret) started to nest just as the majority had almost finished rearing their young.

For some species peak of breeding season were not clearly seen, this species such Black-crown Night-heron and Little Black Cormorant. They tend to breed during the year. Nevertheless another waterbirds such Milky Stork, Black-headed Ibis, Glossy Ibis and Egret have peak of breeding season.



Remarks

- = present
- = peak breeding season
- ▨ = low breeding season

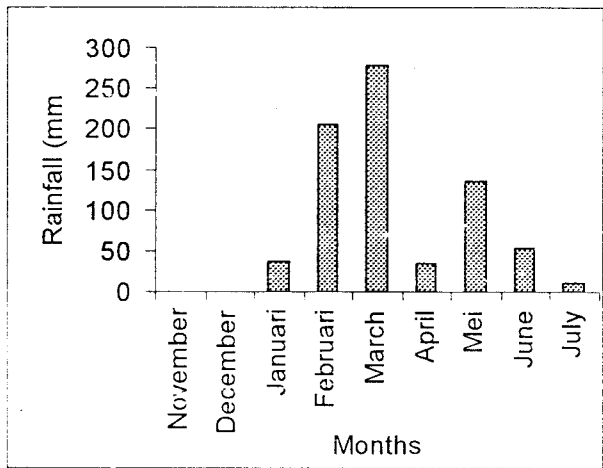


Figure 8. Breeding season of 12 waterbirds and rainfall in Pulau Rambut Wildlife Sanctuary 2000-2001.



Figure 9. Milky Stork nesting in Sterculia trees in Pulau Rambut Wildlife Sanctuary.

During the research, peak breeding season start between December 2000 and January 2000 almost whole species was breed except Grey Heron, Milky Stork (Fig 9) and Glossy Ibis start in February 2001. There are three main breeding season type, first is continuous breeding season type. This type was defined by no boundary between one breeding season to another breeding season. It seemed they always breeding during the year i.e. Cormorants and Black-crowned Night Heron. The second type is dual breeding season. This type define by two breeding season was intervening by few months of non-breeding season in the year i.e. Oriental Darter. They breed twice a year and breeding season lasted in three months and intervening by one month non breeding season. The third type is fixed breeding season defined by clear boundary of breeding season and the breeding season only occur once a year. Mostly of the waterbirds breeding in Pulau Rambut are these types.

E. Nest Site Distribution

Distribution of nest sites was not fixed. Rather, they were constantly changing. During East season when the wind drive from east part of island almost

whole waterbirds use west side of the island to place nest and roosting area in the night. Meanwhile during west season when the wind drive from west part of island they tend to use west part of island. In Pulau Rambut nest site distribution influenced by wind direction, during west monsoon waterbirds tend to lie down their nest in east side of island. Meanwhile in east monsoon they tend to lie down in west side of island.

In the center of island which rather save from strong wind dominated by big size waterbirds such as Grey Heron, Milky Stork and Common Darter, The distribution of this three waterbirds seem never change. Most of large size waterbirds species use the center of island as nesting areas due to the safest areas from strong wind. In the center of island *Sterculia* trees dominated the vegetation type. Small size waterbirds (except Little Black Cormorant) shows a remarkable ability to use wide variety of vegetation type. As matter of fact they can use both center and edge of island as nesting area. The edge of island dominated by mangrove forest

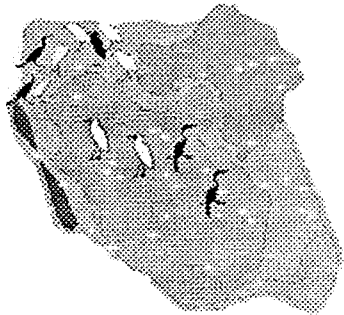
In the part of mangrove forest in western area, dominated by Little Black Cormorant, Little Egret and also Glossy Ibis. This area used during the East monsoon. They use *Rhizophora mucronata* trees that distributed in the area. In the Northern part usually used by Great Egret, Intermediate Egret, Purple Heron and some time Cattle Egret, which used *Ceriop tagal* as nesting trees. In this area distribution more fixed and use during the year. Fig. 10 showed the distribution of waterbirds during east monsoon.

There were some places which never used as nesting sites, i.e., the beach forest in the south and west side of the island. Birds using this vegetation type were restricted to the smaller birds such as Brown throated Sunbird, Magpie Robin, and Black--napped Oriole. Waterbirds also never used the mangrove forest in the southeastern part of island (near base camp) as nesting area, although this mangrove forest was still good.

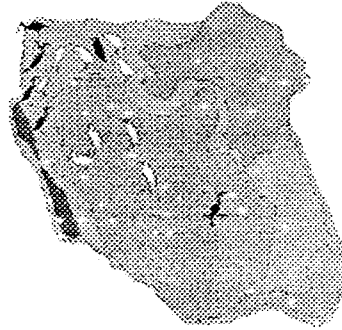
Most of waterbirds in Pulau Rambut using life trees as nesting trees and tend to laid their nest at 75%-90% of tree height, Some time they use the same trees together and lied the nest close each other. In the mangrove forest they laid

the nest at 7-9 m from ground, meanwhile in secondary mixed forest they laid the nest at 20-25 m from ground.

(November-December)



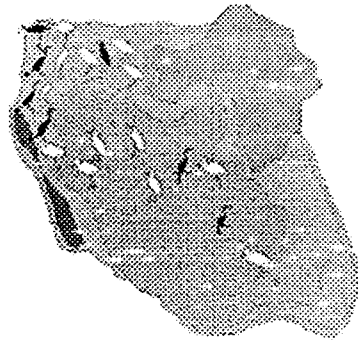
(January)



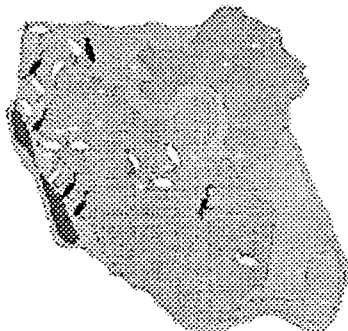
(February - March)



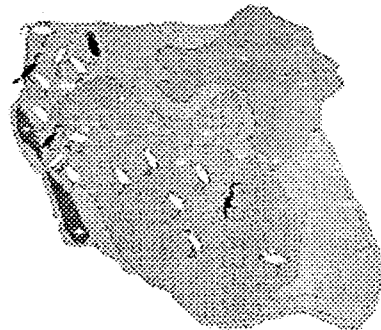
(April - May)



(June)



(July)












- | | | | | | |
|---|-------------------|---|--------------------------|--|----------------|
|  | = Milky Stork |  | = Purple Heron |  | = Great Egret |
|  | = Grey Heron |  | = B. crowned Night Heron |  | = Little Egret |
|  | = Oriental Darter |  | = Black-headed Ibis |  | = Glossy Ibis |

Figure 10. Distribution of waterbirds in Pulau Rambut during 2000-2001.



Most of the mangrove forest was preferred as nesting area except the Eastern area. Although in this area have good mangrove forest waterbirds never use as nesting area. Probably this happen due high disturbances caused by visitors of the island. Meanwhile in Eastern of the island never use due to destruction of mangrove forest. This area in 1991 ever use as nesting areas but now they never use anymore without unknown reason. Beach forest was never used by waterbirds as nesting area due to high human disturbances. This area used only by terrestrial bird for nesting area.

F.Nesting Association

Some waterbirds able to nest together and some apparently are not. When two species occur together in the same vegetation, they might coincidentally or there are may be a kind of association. Positive association indicate by the presence of one species in any small place will make it more likely that the other will also found. The species tend to make association if they have beneficiary from the association. On the other hand they might to avoid each other if they did not have any beneficiary. However association did not mean their live dependent each other. Association mean they use the same resources without harmful another (Fig 11).



Figure 11. Association among waterbirds

There were positive and negative associations between pairs of species. Table 2 shows the results of a Chi square test on the presence and absence of species in each of the occupied trees. There was a highly positive significant association between (a) Purple Heron and Great Egret, (b) Grey Heron and Oriental Darter, (c) Grey Heron and Milky Stork, (d) Little Black Cormorant and Little Egret, and (e) Cormorant and Glossy Ibis.

Table 2. Nesting association among pairs of waterbirds in Pulau Rambut Wildlife Sanctuary 2000-2001.

	Grey Heron	Great Egret	Little Egret	L. B. Cormorant	B.C. Night Heron	Oriental Darter	Milky Stork	Glossy Ibis
Purple Heron	0	**	*	0	ns	0	0	0
Grey Heron		ns	0	0	*	**	**	0
Great Egret			ns	0	ns	ns	0	0
Little Egret				**	ns	0	0	ns
Little Black Cormorant					*	0	0	**
Black-crowned Night Heron						ns	ns	ns
Oriental Darter							ns	0
Milky Stork								0
Glossy Ibis								

ns : non significant

0 : Negative association

** : highly significant association (p<0.01)

* : significant association (p<0.05)

Negative association was found between some congeneric species (i.e., Purple Heron-Grey Heron, Great Egret-Little Egret). A previous study revealed that closely related species, especially those in the same genus (congeneric species), are often quite similar morphologically, physiologically, behaviorally, and ecologically (Pianka 1983). These species of the same genus presumably require very similar habitat components (nesting/roosting site, nest material, etc). Therefore, in order to decrease competition, they would rather avoid each other.

The Table 3 shows that in Pulau Rambut all of waterbird made association among them and there is no evident of waterbird that could life solitary. Black-crown Night Heron shows a remarkably ability to nest together with various of waterbirds. This species is nocturnal, they flew away to foraging area in the late afternoon and would be back in the morning. Their small body make them easy to use all stratification of trees therefore they could make association among waterbirds in Pulau Rambut and this species distribute whole over the island.

G. Foraging Area

Mainland of Java has been long known as the foraging area of the waterbirds from Pulau Rambut. Some important wetland types use as foraging areas are rice fields, shrimp ponds, fish ponds, swampy areas, rivers, mudflats, grassland located near waterbodies and lakes.

Feeding grounds of waterbirds from Pulau Rambut analyzed by satellite image TM 5 to identify wetlands area and followed by ground check. Today, human settlement, domestic waste, pesticides, fishponds and industrial development degraded wetland areas along North Coast of Java. The type of remnant wetland areas founded along north coastal of Java within radius 30 km from Pulau Rambut was paddy fields (Muara Gembong, Teluk Naga, Tanjung Pasir, Mauk), fishponds (Muara Gembong, Teluk Naga, Tanjung Pasir, Mauk), marsh (Muara Sampan, Muara Angke), lakes (Kemayoran, Pantai Indah Kapuk, Kelapa Gading, Cipondoh) and rivers (Cisadane, Citarum) another rivers in Jakarta (Ciliwung, Sunter, Angke, etc).

Satellite imagery (Fig. 12) showed the remaining wetlands in mainland of Java within range 30 Km from Pulau Rambut. The light green areas were wetlands

that still can be used as foraging areas. Other areas were fishponds, showed in blue in the mainland areas.

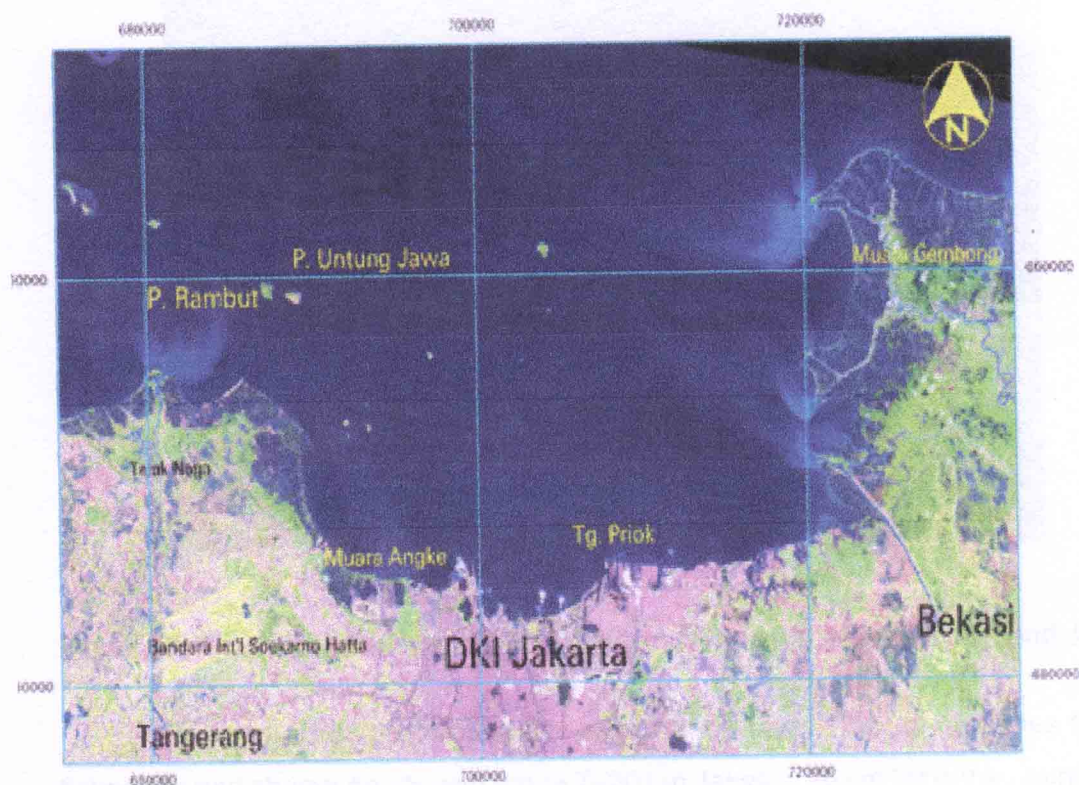


Figure 12. Satellite Imagery of Wetlands in Mainland of Java.

Each waterbird in Pulau Rambut has a preference on a certain type of feeding ground, which related to its behavior and morphological characteristics. Little Black Cormorant as a diving species use deep wetland areas as feeding ground. The wetland types that usually use by Little Black Cormorant are fishponds, lakes and shrimp ponds. Another type which related to this species is Oriental Darter, which only able to dive in freshwater. For wading species that have no ability to dive, they use the area with shallow water, including various species of egrets (not including Reef Egret and Cattle Egret), and Milky Stork. They use wetland areas with low water level (not higher then tarsal). Meanwhile Herons species use marshy area. Another species, Cattle Egret and Glossy Ibis usually feed on paddy field during dry season and grassland areas (Fig 13).



Figure 13. Glossy Ibis forage on paddy field in the coastal areas of mainland Java

Foraging areas distributed along coastal of Java. The range varies from fishponds and shrimp ponds with range 7–30 km, lakes c. 25 km far in the mainland and marsh c.17 km. Within range 30 km, we only identified only 2 lakes. The farthest lake is Danau Sunter with a distance of 25 km and the nearest is Situ Cipondoh. These 2 lakes were not suitable for waterbirds anymore due to the high human disturbances. These two lakes used to be feeding grounds for Little Black Cormorant but now the landscape nearby has been changed to be human settlement.

The nearest fishpond area is Tanjung Pasir and the farthest is Muara Gembong (30 km away from Pulau Rambut). The fishpond and shrimp pond stretched out from Mauk until Muara Gembong. This area was a major feeding ground for Cormorant and Darter. Inbetween these areas, there was a small marshy area, Muara Angke Wildlife Sanctuary (Fig 14).



Figure 14. Muara Angke Wildlife Sanctuary, a marshy area nearby Jakarta

The assessment of the wetland areas near Pulau Rambut by using criteria of Davies and Giessen (Fig. 15) shows that among the 16 sites tested, Muara Angke is the only wetland that still have a good quality as foraging areas (laid on 4th quadrant). This area is the remaining marshy area within range 30 km from Pulau Rambut that potentiall as feeding ground of waterbirds from Pulau Rambut. Figure 15 also showed that only few areas of wetland were still has good condition.

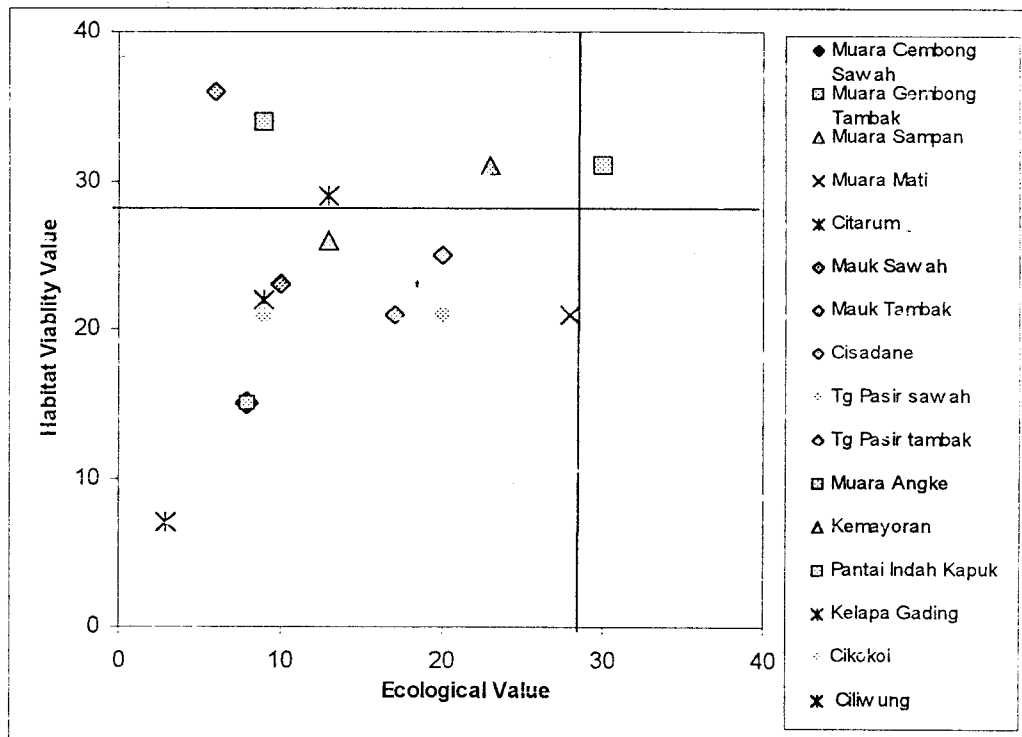


Figure 15. Assessment of wetland areas within range 30 km from Pulau Rambut based on criteria of Davies and Giessen 1994.

Several species of waterbirds that forage in along coastal of Java have a preference area. The species which quite sturdy from human disturbances used paddy field as feeding area and they likely have ability to live nearby human settlement, i.e. Great Egret, Little Egret and Cattle Egret. In the other hand some species was not sturdy from human disturbances or shyer they used marshy areas or mangrove areas as feeding ground. They tend to feed far away from human activity or human settlement i.e. Grey heron and Purple Heron.

As mentioned above that Common Darter and Little Black Cormorant from Pulau Rambut forage in the fishponds at the north coastal of Java and they were like pest for several fishpond owners. For this reason the farmer always chase the species away and some time they killed by the rifle or net. For some species such Egrets were still able to live nearby human activities however they also facing problem such illegal poaching and illegal hunting. Some factors influenced birds presence in some areas were food abundance, space for roosting and resting

areas, water quality (Kushlan 1976), structure of vegetation, size of area, water level, behavior and morphological structure of birds.

According to Peterson (1976) bird distribution have correlation with food availability. Ismanto (1989) found that Great Egret, Little Egret and Cattle Egret found in Rawa Jambor only when fish and frogs were breed which the main food of that bird. The food preference also has correlation to feeding ground type. Great Egret mostly found in mudflat, fishponds and paddy field, they main food was fish (68,42%), meanwhile Cattle Egret which feed in dry paddy field feed insect (91,08%) as main food (Elfidasari 2001).

Perrins and Birkhead (1983) reveal three main types of bird distribution in the world. The first type is random, usually happens if habitat condition was homogen. Including this type were Purple heron, Grey Heron, Black Crown Night Heron and Cattle Egret. The second type is regular which happens as result of competition among bird individual and they tend to form space between competitors. The third type is clumped, this type happen when source of food was limited. Including to this type was Cormorant, Egret and Milky Stork (Figure 16).



Figure 16. Milky Stork feed on mudflat areas in Muara Sampan (Bekasi).

Wetlands from Mauk until Muara Angke probably the important site for feeding ground this area including Teluk Naga and Tanjung Pasir the nearest foraging site from Pulau Rambut. Widodo and Hadi (1990) show the important of this area as feeding ground. They spotted many waterbirds using this wetlands area including endangered stork species Milky Stork.

Almost all of wetland areas along North Coast of Java facing some threat which impact to the quality of wetlands itself. increasing of human population number and industrial development has increased requiring of land and made the wetland areas tend to be decline. Another problem is mangrove deforestation that has been happening since 20 year ago as result of developing of fishpond and shrimp pond.

Another threat in feeding ground is pesticide usage by farmer or by fishpond owner. Some farmer use pesticide to eliminating pest during cultivating, but the residue still possible harmfully for waterbirds that feed in the paddy field. Pesticide can cause the eggshell thinner than usual.

V. Management of Pulau Rambut

A. Threats and Problem from Outside the Island

1. Deteriorating Condition of Jakarta Bay.

Pulau Rambut is one of 108 island scattered in Jakarta bay. Situated facing the Java Sea, Jakarta bay is the most recognized bay in Indonesia because Jakarta (the capital of the country) is also the main focus of almost all activities in the region. At present, the condition of Jakarta Bay is deteriorating rapidly. It is estimated that in the long run, unless necessary measures are taken, the quality of the environment may be reduced so much that it will pose a threat to the lives of the people and wildlife living in the surrounding area.

The deteriorating condition of the Jakarta Bay waters is mainly caused by (i) polluted bay (ii) polluted sediment (iii) polluted marine biota (iv) Excessive exploitation of natural resources (v) unorganised management of Jakarta Bay by various government offices.

2. Decreasing Size of Feeding Ground.

A major threat to the waterbirds of Pulau Rambut is in the feeding grounds, outside the reserve boundaries. Feeding ground is decreasing with the increase in the number of people. In addition, poisoning from pesticides and killing of waterbirds occurs.

Land use of the northern coast of western Java has been changing very rapidly during the last decade. Wetlands and mangrove forests have been converted into purposes less favourable for waterbirds, such as Soekarno – Hatta International Airport, extension of Tanjung Priok harbour, housing, fish ponds, shrimp hatcheries and recreation areas.

3. Disturbances from Local People.

People are prohibited from living on the island but do some fishing near Pulau Rambut. However, the neighbouring island, Pulau Untung Jawa, is crowded with people. People from Pulau Untung Jawa often visit Pulau Rambut.

Their activities fall into two categories: (1) gathering firewood, usable waste, molluscs, and seaweeds stranded along the coast (2) fishing within the boundaries of the reserve. In addition, fisherman from far away places often land on Pulau Rambut during bad weather.

It is rather difficult to ask them to stay away from the reserve, since the distance between these two island is only 0,5 km. Every day there are fisherman set their nest nearby, although according to PHPA's rule, they must be at least 0,5 km off shore from the reserve.

A guard, stationed at Pulau Rambut, has chosen to let fishing and collecting of molluscs occur, because these people are poor and only use the fish and molluscs for their own consumption. Besides, the local people sometime help him in guarding the island.

4. Disturbance from visitors.

The density of nesting waterbirds is low in the areas where peak human activity is encountered. This is particularly evident within a 50 m radius of the guard post and near the observation tower at the center of the island. However, waterbirds still nest along the walking trail because they select high nest trees (more than 20 m), which are numerous along the trail, reducing the disturbance by visitors.

The mangrove forest receives fewer visits due to its wet and unpleasant mud. Unfortunately, the island is sometime used for student from local universities for practicing vegetation/mangrove inventory by establishing transect or plots all over the area. During such activity, many nestling and eggs were ejected from the nest during the parents panic flight.

5. Possible Disturbance from Airport Activities

The development of Soekarno-Hatta International Airport has also influenced the life of waterbirds in Pulau Rambut. The airport itself has taken up large amount of waterbirds feeding ground. Since the beginning of the airport development (1984/1985), there has been no study on its impact to waterbirds in Pulau Rambut.

Sound louder than 95 dBA created by highway traffic near the airport has been found to change the behavior of some species of Egrets and Day-herons. The impact of sound created by airplane on waterbirds in Pulau Rambut is still unknown.

B. Threats and Problem from inside the island.

1. Reduction of Mangrove Forest.

The greatest threat to waterbirds in Pulau Rambut was the reduction of mangrove forest. It was evident that the mangrove forest is very important for the survival of the waterbirds. Unfortunately, ground measurement revealed that almost half (39,78%, 7.575 ha) of the mangroves (19.04 ha) were dying back and in very poor condition.

2. Poor Natural Regeneration.

Vegetation analysis also revealed that the overall natural regeneration of mangrove forest was poor. The Importance Values of seedling of most species was zero, indicating that none of them were included in the plot samples. A few species had few seedlings, but the number is still lower than needed for sustainable forest regeneration.

3. Possible Competition with the Flying Foxes.

Milton and Marhadi (1984) concluded that Flying Foxes on the island did not constitute an important threat to birds on the island, through competition for nesting or roosting sites. Wiriosoepartho *et al.* (1986) suspected that these bats were responsible for their observed reduction in bird numbers between two surveys, five months apart. However no evidence to support this hypothesis was provided. Darmawan (1987) studied the competition between waterbirds and Flying Foxes and concluded that there was indeed an intense competition for roosting and nesting trees between them.

In January 1988, Lambert and Erftemeijer (1988) noted that the flying Fox population was estimated to be less than 300 individuals, and these all roosted in an area which did not appear to be particularly important for nesting and roosting waterbirds.

The only cause for concern arising from the occurrence of the Flying Fox population is that their accumulating feces could alter the soil pH to a degree that trees are killed. Flying Foxes may be rare in the Jakarta area, and it would seem that the protection of the bat colony on Pulau Rambut is also an important function of the reserve.

C. Management Implication

1. Predator monitoring

Placement of waterbirds' nest has suggested that predation by Monitor Lizard was the biggest threat for survival of eggs and young. Predation by others (mangrove Snakes, White-bellied Sea Eagle and Brahminy Kite), and kleptoparasitism by Christmas Frigate birds, *Fregata andrewsi*, were not considered to be important.

The Monitor Lizard is the top predator in the Pulau Rambut ecosystem. This species has no natural enemy, although sometime they are illegally hunted for their skin. Their population in Pulau Rambut is still unknown and it is difficult to obtain an accurate estimate.

An adult Monitor Lizard presumably requires a lot of eggs and/or young for their daily meal. Unfortunately, mortality due to predation by this reptile is still unknown.

Activities in predator monitoring should include:

- a. population number of Monitor Lizard, including age class, sex ratio, birth rate, and death rate.
- b. Distribution of the Monitor Lizard on the entire island in relation to the distribution of the five colonies of waterbirds
- c. Feeding behaviour and degree of predation.

2. Monitoring of Waterbird Species and Population

Regular monitoring of species of waterbirds present in Pulau Rambut should be conducted. The heronry used to support more species. Local extinction of waterbirds (or other wildlife species) should be treated seriously and its cause should be determined.

The increase of species number could be an indicator of habitat condition outside the island. Considering its status, Pulau rambut is the safest breeding and roosting site in Jakarta Bay area. If other locations are gone or decrease in size, it is possible that more waterbirds might move to reside in Pulau Rambut.

Population size is also an indicator of habitat condition, especially feeding ground availability. If the feeding ground is decreasing, the waterbirds number might decrease, or they might search for other further feeding grounds (which means more energy required to seek food).

3. Man-made Regeneration for Mangrove Forest

Of the 15 waterbird species found in Pulau Rambut, 14 of them dependent on the mangrove forest for their roosting and breeding sites. If the condition of the mangrove is left alone like this, it is possible that in the future the mangrove will be extirpated.

Vegetation analysis revealed that the natural regeneration is not in good condition. In addition the die back of mangrove has created a worse situation. Unfortunately, experiments on man-made regeneration are not promising. The germination time (time between planting and germination) of *Ceriops* and *Rhizophora* were very long, averaging 43 days and 47 days, respectively. For the first three month, the average percent of germination is only about 5-9% for *Rhizophora* and 70% for *Ceriops* (Hermana 1991).

In addition to the high level of oil in the soil (11,267 ppm), germination failure was also due to herbivory by mollusc *Terebralia palustris*, and destruction by solid wastes (e.g. plastics, lumber, bamboo, etc) entering the site during high tides.

Considering the low percentage of germination using a direct planting method, it is worthwhile to try another planting method; it is worthwhile to try another planting method, for example sapling planting. To do this, seedling are germinated *ex-situ* in poly bags, then planted in the field when they are strong enough to withstand factors mentioned previously.

4. Control of Visitors

The overall distribution of nesting sites also showed that sites close to visitor's activities were not used. During the study, it was also known that all waterbird species (with exception of Milky Stork) were very susceptible to human approach. Therefore, it is important to:

- (a) Prohibit visitors from entering the heronry during the peak breeding season
- (b) Limit the visitors number to fewer than 25
- (c) Recommend only daily visits, not overnight. Overnight visitors can use the camping ground on Pulau Untung Jawa. Researcher could still spend the night on the island without turning on the noisy electric generator.

5. Improvement of Facilities and Budget

Lack of Facilities and low salaries for the guardians can jeopardize the safety of the reserve. As an illustration, the Wildlife Sanctuary is often left unguarded during the night, which makes it easily accessible and disturbed. The absence of sea transportation also prohibits regular visits by the guardians or by other researchers.

A considerable amount of budget should also be allowed, especially for man-made regeneration activities. If the activities are not started promptly, the cost of mangrove restoration could be increased due to the increasing damaged areas.

Considering the low percentage of germination using a direct planting method, it is worthwhile to try another planting method; it is worthwhile to try another planting method, for example sapling planting. To do this, seedling are germinated *ex-situ* in poly bags, then planted in the field when they are strong enough to withstand factors mentioned previously.

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Appendix 1. Annotated Checklist of Important Birds of Pulau Rambut Wildlife Sanctuary

Family Fregatidae

1. *Fregata andrewsi* (Christmas Frigatebird)

Vernacular name: Burung angin

Found mostly when soaring high in the sky. Pirating another waterbirds for taken some food from them. Some time perching in *bagan* (fish trap made from bamboo and net in the sea), especially there is no available wind to perform dynamic soaring flight. This bird were not breed in Pulau Rambut, but were easy to find during the year.

Family Phalacrocoracidae

1. *Phalacrocorax sulcirostris* (Little Black Cormorant)

Vernacular name: Pecuk padi, Pecuk besar.

The most abundant cormorant species in Pulau Rambut, breed almost the whole year and use all forest type and stratification. The species sometimes consider as seabirds, as they are able to feed in the marine environment. In Pulau Rambut easily can be spotted in the surrounding the island, diving and pursuit the prey. Since they do not have oil glands to protect their feather against water, they have to spread out their wing to get rid off the excess water, performing a position which call delta wing.

2. *Phalacrocorax melanoleucos* (Little Pied Cormorant)

Vernacular name: Pecuk belang

Only single sight during the research. Found breed on *Rhizophora mucronata* trees in the periphery of island, with two juvenil. This species was recorded in 1992 (Mardiastuti 1992), not common in Pulau Rambut, mostly distributed in the eastern part of Indonesia.

3. *Phalacrocorax niger* (Little Cormorant)

Vernacular name: Pecuk kecil

Found only in mangrove forest, breed from January – May. Similar with *Phalacrocorax sulcirostris* but is smaller with a white patch in the chin and upper throat. Usually the species seen fly together with Black Cormorant, making them difficult to distinguish each other. Their nest, however, neatly arranged

and small, easily differentiated with Black Cormorant which have larger and messy arrangement.

Family Anhingidae

1. *Anhinga melanogaster* (Oriental Darter)

Vernacular name: Pecuk ular.

Common waterbird in Pulau Rambut, breed in secondary mixed forest use *Sterculia foetida* and *Dysoxylum caulostachyum* trees. They place the nests on top of the tree canopy make them extremely difficult to reach and being studied. Always fly solitary, using combination of soaring and flapping flight.

Family Ardeidae

1. *Ardea cinerea* (Grey Heron)

Vernacular name: Cangak abu.

Common large waterbird, were breed only in secondary mixed forest. There were some observation that this bird partly nocturnal, leaving the island at dusk and went home in the morning. Ten years ago the bird sometimes still be able to nest in the mangrove forest. Recently they can be found in secondary mixed forest perhaps due to the tight competition with other waterbird species inhabited the mangrove forest.

2. *Ardea purpurea* (Purple Heron)

Vernacular name: Cangak merah

The body size similar to *Ardea cinerea*, with reddish brown plumage. Breed in the mixed colony in the mangrove forest especially in the north-west side, together with Great Egret. Their number far exceed the Grey Heron.

3. *Butorides striatus* (Striated heron)

Vernacular name: Kokokan laut

Rare waterbird in Pulau Rambut, but were easy to find in mangrove forest banks. Only single pair was reported to breed in the east side of the island.

4. *Bubulcus ibis* (Cattle Egret), sin: *Ardeola ibis*

Vernacular name: Kuntul kerbau

Common waterbird, in the non-breeding season have similar coloration with *Egretta garzetta*. Among waterbirds species this birds were mainly feed on insect. Probably were seasonal resident. Usually creates mix flocks with other Egret species during flight to and from the mainland.

5. *Egretta sacra* (Pacific Reef Egret)
Vernacular: Kuntul karang

Rare bird in Pulau Rambut, found mainly when foraging in the sandy beach and reef around the island. Both dark and white phases of the species can be found in Pulau Rambut. There is no record on breeding aspect of this species in Pulau Rambut.

6. *Egretta alba* (Great Egret), sin: *Casmerodius albus*
Vernacular name: Kuntul besar

Large Egret found only in mangrove forest. They breed in the north west of the island together with Purple Heron and some time use the secondary mixed forest as alternative breeding site. In breeding season they can be distinguished by green coloration around the eyes.

7. *Egretta intermedia* (Intermediate Egret)
Vernacular name: Kuntul sedang

Common waterbird, were similar with Great Egret, but rather smaller. Found breed only in mangrove forest in mixed colony with Great Egret. When they perch, they can be identified through their yellow bill, differ then Great Egret which have black bill.

8. *Egretta garzetta* (Little Egret)
Vernacular name: Kuntul kecil

Common waterbird, were found breed in mangrove forest and secondary forest. Use short trees for nesting. At breeding season they can be distinguished by long head plume on the crown.

9. *Nycticorax nycticorax* (Black-crown Nignt-Heron)
Vernacular name: Kowak maling

The most abundant waterbird in Pulau Rambut, distributed in all type and stratification of forest excluded beach forest. This bird is a nocturnal species, the main diet were fish, frogs, rat, etc. In the day they stay in Pulau Rambut

and hidden between tree canopy.

10. *Nycticorax caledonicus* (Rufous Night-Heron)

Vernacular name: Kowak merah

Single sighting in mangrove forest on March 2000. Found feed on floor of mangrove forest. Rare species.

Family Ciconiidae

1. *Mycteria cinerea* (Milky Stork)

Vernacular name: Bluwok

The only stork species in Pulau Rambut, were seasonal species. In Pulau Jawa Milky Stork breed only in Pulau Rambut. They breed from January until August. Listed in Red Data Book (King 1979), including vulnerable category (Collar *et al.* 1994). In year 2000 found 25 active nests. They rely on thermal column to perform soaring flight.

Family Threskiornithidae

1. *Plegadis falcinellus*

Vernacular name: Roko-roko

The most abundant species from family Threskiornitidae, use to be migrant species but now probably became resident and found during the year, breed in January - July. They have maroon plumage with glossy green in the wing. However during the flight their plumage look black, very similar to cormorant in the distance. They can be distinguish by curved bill and fast flight and able to glide in a short period.

2. *Threskiornis melanocephalus*

Vernacular name: Pelatuk besi

Rare waterbird, seasonal resident, were breed in small colony in mangrove forest. In year 2000 breed from February until August. Easily identified through their white plumage, black neck and head, and curved bill. Fly in small groups.

Family Rallidae

1. *Amurornis phoenicurus* (White-breasted Waterhen)

Vernacular name: Kareo

Probably accidental introduced bird, not common in mangrove forest, can be identified from the sound call. Found only in very small population, a pair was seen behind the base camp.

Family Sternidae

1. *Sterna sumatrana* (Black-naped Tern)
Vernacular name: Camar laut

Rare bird, were mostly found in the sea around the island perching on bagan.

Family Anatidae

1. *Anas giberifrons*
Vernacular name: Itik benjut

Seasonal waterbirds, were not breed in Pulau Rambut. Uses mangrove pool for foraging area. Very rare.

Family Pandionidae

1. *Haliaeetus leucogaster* (White-bellied Sea Eagle)
Vernacular name: Elang laut.

Rare bird but easily to find bird of prey, only a pair were nesting in Pulau Rambut on Sterculia trees. Preyed upon fishes and chicks of various waterbird species. Some time find soaring above the island.

2. *Haliastur indus* (Brahminy Kite)
Vernacular name: Elang bondol

Rare bird, has been selected as a mascot of DKI Jakarta province, seen occasionally in single individual. Easily recognized through their brown and white plumage and smaller than the White-bellied Sea Eagle.

Family Scolopacidae

1. *Tringa hypoleucos*
Vernacular name: Trinil pantai

Common waterbird found during the year in the beach area, were *not breed* in Pulau Rambut

2. *Numenius phaepus*
Vernacular name: Gajahan

Uncommon waterbird in Puiiau Rambut, found in the reef around the island that dry when the tide level was low easily distinguish by wistle sound.