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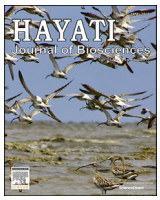

Original research article

Habitat Use of Migratory Shorebirds on the Coastline of Deli Serdang Regency, North Sumatra Province

Chairunas Adha Putra,[1] Dyah Perwitasari-Farajallah,[1*] Yeni Aryati Mulyani[2]

[1] Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, Bogor, Indonesia.
[2] Department of Forest Resources Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University, Bogor, Indonesia.

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ABSTRACT

Mangrove forests an intertidal mudflat in the eastern coastal region of Deli Serdang are important habitats for migratory shorebirds. Land-use change and forest conversion threaten this important stopover point for migrating species. The lack of data and information of shorebirds habitats in this area limits conservation efforts and further threatens the survival of these species. The objective of this study is to investigate trends in habitat use by migratory shorebirds. Field work was conducted during migration season starting from October 2014 until April 2015. The presence of migratory shorebirds was assessed using binoculars and a monocular. Scan sampling was used to describe habitat use by shorebirds. The difference in behaviour among habitat was analyzed using analysis of variance. There were 30 species of shorebirds distributed across seven different habitat types in our study area. The most widely used habitat by shorebirds was mudflats, followed by marshes and plantations. This study revealed that mudflat habitat has high potential in supporting the existence of migratory shorebirds in this area.

1. Introduction

Sumatra is an important stopover site for migratory shorebirds, but the available information is limited to population dynamics and distributional records (Crossland *et al.* 2012; Iqbal *et al.* 2010; Putra *et al.* 2015; Silvius 1988; Verheugt *et al.* 1993). Mangrove forest and intertidal mudflat along the eastern coastline of Sumatra provides habitat for migratory shorebirds is being converted to human land-use (Crossland *et al.* 2009; Putra *et al.* 2015; Silvius 1988; Verheugt *et al.* 1993). Mangrove forests in the North Sumatra province have decreased 85% since 1987 (±200.000 Ha) to 2001 (±31.885 Ha) (Susilo 2007). This trend also occurs in Deli Serdang coastal of North Sumatra Province, which is known as an important stopover region for migratory shorebirds (Crossland *et al.* 2006; Crossland *et al.* 2012; Iqbal *et al.* 2010; Putra *et al.* 2015). Loss of the protective mangrove buffer zone causes environmental changes in mudflat habitats, which threaten shorebird feeding and roosting areas (Green *et al.* 2015). The majority of habitats have been converted into oil palm plantations (Crossland *et al.* 2012; Putra *et al.* 2015), rice fields and aquaculture (Crossland *et al.* 2006). Jumilawaty (2012) identified at least eight habitat types that existed in Deli Serdang, those are mangrove forests (mudflat), marshes, agriculture, plantation, rice fields, fishponds, river banks and settlements.

Observation on shorebird behaviour can reveal how habitat use varies in response to environmental changes (Davis and Smith 1998; De Leon and Smith 1999; Goss-Custard and ditDurell 1990). In this study, we examined habitat use by migratory shorebird in Deli Serdang. The aims of this study were to (1) identify habitat and distribution of migratory shorebirds and (2) identify the use of habitat by migratory shorebirds. Identifying habitat use is an important conservation tool as it allows government and practitioners to build better informed strategies.

2. Methods

This study was conducted during the full migration season in October 2014 until April 2015 on the eastern coastline of Deli Serdang Regency of North Sumatra Province (Figure 1).

Identifying habitat, distribution and abundance of migratory shorebirds. Observations were carried out by exploring and recording the types of habitat used by migratory shorebirds along the eastern coast of Deli Serdang Regency, i.e. mudflats, marshes,

* Corresponding author.
E-mail addresses: witafar@yahoo.com, witafar@ipb.ac.id (D. Perwitasari-Farajallah).
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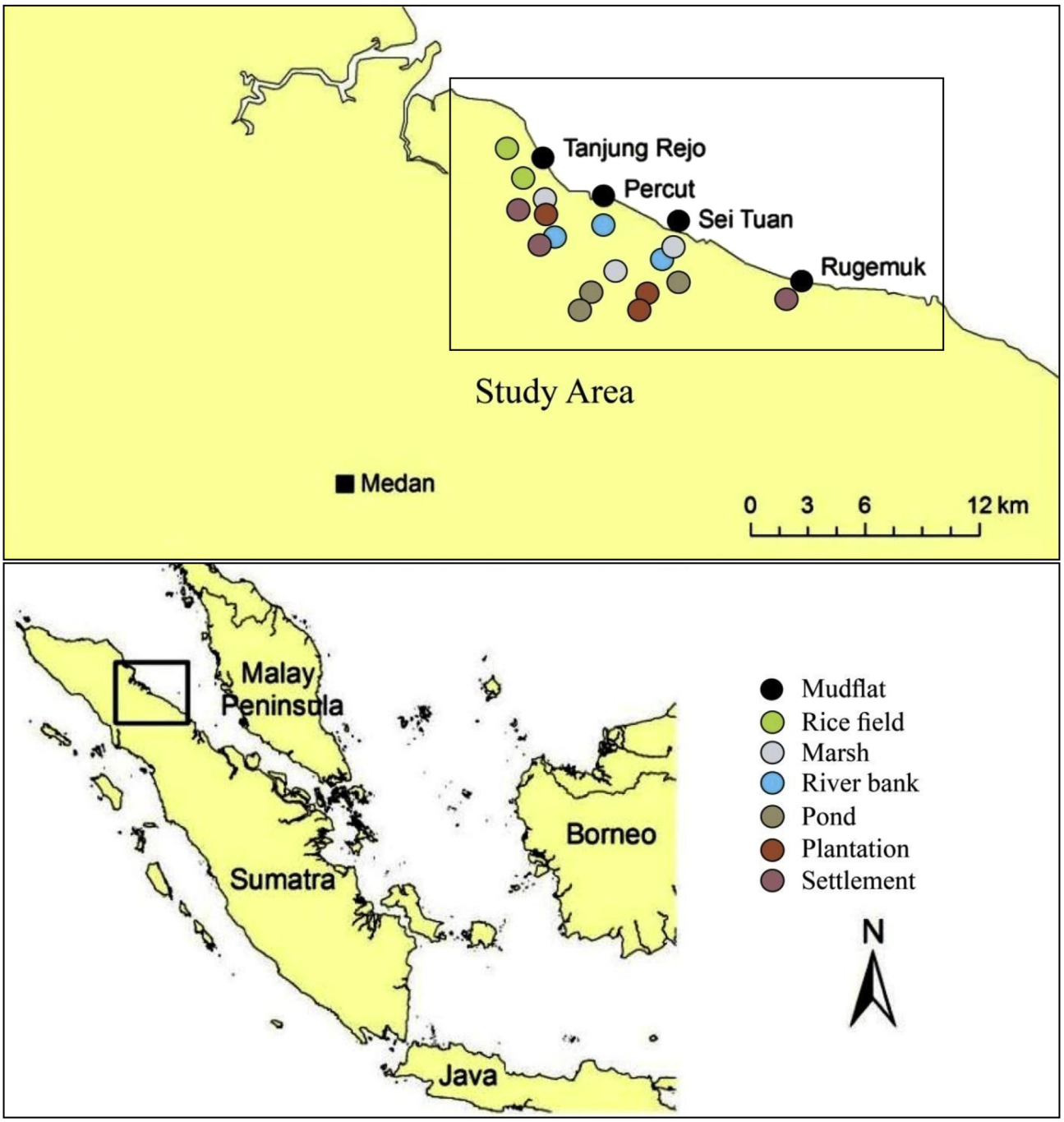

Figure 1. Study area in eastern coast of Deli Serdang, North Sumatera.

plantations, ponds, rice fields, human settlements and river banks (Table 1). Monthly observation was conducted in each habitat for 7 months. Data collected include geographic coordinates, species and number of individuals. The number of individuals was estimated by using "block method" (Howes *et al.* 2003). Scientific name of shorebirds followed Sukmantoro *et al.* (2007).

Habitat use of migratory shorebirds. Monthly observations were carried out on mudflats, marshes and plantations. Data were collected in three periods, early morning (6:00–10:00 h), midday (13:00–15:00 h) and late afternoon (16:00–18:00 h) using scan sampling (Altmann 1974). Recording of behaviour was performed in 1-h interval for 20 min (Burger *et al.* 1997). Behaviour recorded were classified into six categories: 1) feeding (actively feeding by pecking and probing), 2) resting (motionless with bill tucked under wing, head and neck held stationary or eyes closed), 3) alert (standstill with bird visually scanning surroundings), 4) body maintenance (bathing, preening or wing and neck stretching), 5) aggression (chasing, pecking or threatening another individual) and 6) locomotion (wading, walking, running, swimming or flying to another place) (Figure 2). The behaviour categories were based on works by Baker (1971), Davis and Smith (1998), De Leon and Smith (1999).

Table 1. Type of habitats used by migratory shorebirds in East Coast of Deli Serdang

Habitat	Description
Mudflat	Wetlands in the mangrove forest area which affected by tide
Marsh	An area of lowland that is flooded in wet seasons or at high tide, and typically remains waterlogged at all times
Plantations	Young oil palm plantations
Pond	Fishpond (active or non-active) were flooded by fresh water periodically
Rice field	Rice fields where the water comes from rain (rainfed)
Settlement	Human settlements
River bank	Small and large stream in coastal areas

2.1. Data analysis

Identifying habitat, distribution and abundance of migratory shorebirds. Habitat data were presented in table form and described descriptively. Identification of birds species used shorebirds: An Identification Guide to the Waders of the World (Hayman *et al.* 1986), Photographic Guide to the Shorebirds of the World (Rosair and Cottridge 1995), A Field Guide to the Waterbirds of Asia (Bhusnan *et al.* 1993) and Birds of Sumatra, Java, Bali and Kalimantan (MacKinnon *et al.* 2010). Scientific name followed Sukmantoro *et al.* (2007).

Habitat use of migratory shorebirds. Data on habitat use was analyzed descriptively by using *Microsoft Excel Professional Plus 2013* (Microsoft) program to determine the frequency of each behaviour in form chart. Analysis of variance test (SPSS version 18 (IBM)) was used to see the differences between the frequency of the behaviour in each habitat.

3. Results

Habitat, distribution and abundance of migratory shorebirds. Seven different habitats were used by 30 species of shorebirds (Table 1). Mudflats held the highest abundance of shorebirds with a total of 10.687 individuals (Table 2). Human settlements and river banks were the habitat types with the lowest number of individuals, and together with ponds and rice fields used by groups of <100 birds.

The dominant species in the mudflat habitat was Lesser Sand Plover *Charadrius mongolus* (1840 individuals), followed by Whimbrel *Numenius phaeopus* (1482 individuals) and Eurasian Curlew *Numenius arquata* (1452 individuals). The dominant species in marsh habitat was Common Redshank *Tringa totanus* (212 individuals), Pacific Golden Plover *Pluvialis fulva* (112 individuals) and White-headed Stilt *Himantopus leucocephalus* (76 individuals). In plantation habitat, the dominant species were Lesser Sand Plover (382 individuals), Pacific Golden Plover (314 individuals) and Whimbrel (274 individuals). Three habitats that potentially support the highest number of species and individuals were mudflats (total species = 23; total individuals = 10.687), marshes (total species = 14; total individuals = 513) and plantations (total species =13; total individuals = 1394).

Habitat use of migratory shorebirds. Observations in the three habitat types indicated that mudflat habitat was used as feeding area. The highest percentage of individuals exhibiting feeding behaviour was found in mudflats (41.6%; Figure 3). Feeding behaviour was significantly higher ($p < 0.05$) when compared with other behaviours. Besides feeding, mudflats were also used for body maintenance (18.8%) and resting (20.9%). The highest percentage of the resting behaviour in three habitats was found in plantations and marsh with the values of 74.3% and 55.6%, respectively.

Extensive mudflats in coastal areas of Deli Serdang varied in every region. Shorebirds were found foraging in the estuary with sandy mud substrate. The depth of mudflats in every estuary also varies. Plantations that was used by shorebirds was young oil palm plantation area (about 50 cm tall tree—1.5 m), which has uneven soil surface. In addition, there are grass of approximately 50–80 cm tall (Figure 4). This area is close (approximately 75–100 m) to the shoreline and human settlements. Marsh habitat is an area of open land near the beach with a bit of standing water (water level ranges from 5 to 15 cm). The water level is fluctuated depending on rain and tide. In this area, there is also shrubs with a maximum height of about 1–1.5 m.

Daily behaviour of migratory shorebirds varied according to the time of the day. Feeding in mudflats habitat was dominant in the early morning (Figure 5). The dominant behaviour during the late afternoon in mudflat habitats were body maintenance and resting. Resting behaviour at the marsh and plantation habitats was the highest for all periods when compared with other behaviours. Resting was mostly conducted in early morning, and increasing during the midday and late afternoon.

Feeding behaviour, body maintenance and resting on the mudflats are also varied according to tidal conditions (Table 3). Shorebirds performed foraging behaviour in all tidal conditions in mudflat habitats, even during high tide, as long as there were some areas of the mudflats that were not flooded.

Figure 2. Six categories of shorebird behaviours: (A) feeding, (B) resting, (C), alert, (D) body maintenance, (E) aggression and (F) locomotion.

Table 2. List and mean (maximum count) shorebirds in each habitat during 7 months

Scientific names	Common names	Habitat						
		Md ($n = 7$)	Mr ($n = 7$)	P ($n = 7$)	Pn ($n = 7$)	Rf ($n = 3$)	S ($n = 3$)	Rb ($n = 3$)
Rostratula benghalensis	Greater Painted Snipe	0.0	0.6 (4)	0.0	0.0	0.7 (2)	0.0	0.0
Vanellus cinereus	Grey-headed Lapwing	9.6 (67)	0.0	0.0	0.0	0.0	0.0	0.0
Pluvialis squatarola	Grey Plover	319.0 (520)	0.0	4.9 (34)	0.0	0.0	0.0	0.0
P. fulva	Pacific Golden Plover	346.7 (712)	37.3 (112)	176.4 (314)	0.0	0.0	0.0	0.0
Charadrius mongolus	Lesser Sand Plover	1115.0 (1840)*	0.0	194.6 (382)*	0.0	0.0	0.0	0.0
C. alexandrinus	Kentish Plover	2.7 (12)	0.0	0.0	0.0	0.0	0.0	0.0
C. leschenaultii	Greater Sand Plover	240.6 (542)	0.0	10.6 (74)	0.0	0.0	0.0	0.0
Numenius phaeopus	Whimbrel	893.0 (1482)	5.4 (27)	162.4 (274)	2.4 (17)	0.0	0.0	0.0
N. arquata	Eurasian Curlew	933.0 (1452)	0.0	3.9 (27)	0.0	0.0	0.0	0.0
N. madagascariensis	Eastern Curlew	3.4 (15)	0.0	0.0	0.0	0.0	0.0	0.0
Limosa limosa	Black-tailed Godwit	121.4 (274)	0.0	1.7 (12)	0.0	0.0	0.0	0.0
L. lapponica	Bar-tailed Godwit	329.4 (465)	0.0	64.3 (112)	0.0	0.0	0.0	0.0
Tringa totanus	Common Redshank	90.0 (277)	60.1 (212)*	21.9 (78)	0.7 (3)	0.0	0.0	0.7 (1)
T. stagnatilis	Marsh Sandpiper	0.0	3.7 (12)	0.0	2.4 (9)	0.0	0.0	0.0
T. nebularia	Common Greenshank	4.9 (12)	0.7 (5)	0.0	0.0	0.0	0.0	0.0
T. glareola	Wood Sandpiper	0.0	2.0 (5)	0.0	2.3 (11)	1.7 (5)*	0.0	0.0
Xenus cinereus	Terek Sandpiper	177.7 (341)	0.4 (3)	7.0 (31)	0.0	0.0	0.0	0.0
Actitis hypoleucos	Common Sandpiper	4.0 (7)	3.0 (6)	2.4 (5)	0.9 (2)	0.7 (2)	0.7 (1)*	1.0 (1)*
Arenaria interpres	Ruddy Turnstone	68.3 (126)	0.0	2.7 (14)	0.0	0.0	0.0	0.0
Limnodromus semipalmatus	Asian Dowitcher	114.6 (321)	0.0	0.0	0.0	0.0	0.0	0.0
Gallinago gallinago	Common Snipe	0.0	9.6 (37)	0.0	0.0	0.3 (1)	0.0	0.0
Calidris tenuirostris	Great Knot	492.3 (1255)	0.0	0.0	0.0	0.0	0.0	0.0
C. canutus	Red Knot	31.3 (219)	0.0	0.0	0.0	0.0	0.0	0.0
C. alba	Sanderling	35.0 (89)	0.0	0.0	0.0	0.0	0.0	0.0
C. ruficollis	Rufous-necked Stint	12.4 (34)	0.0	0.0	0.0	0.0	0.0	0.0
C. ferruginea	Curlew Sandpiper	309.6 (568)	0.0	2.3 (16)	0.0	0.0	0.0	0.0
Limicola falcinellus	Broad-billed Sandpiper	22.6 (57)	0.0	0.0	0.0	0.0	0.0	0.0
Philomachus pugnax	Ruff	0.0	0.4 (2)	0.0	0.0	0.0	0.0	0.0
Himantopus himantopus	Black-winged Stilt	0.0	1.7 (12)	0.0	1.6 (5)	0.0	0.0	0.0
H. leucocephalus	White-headed Stilt	0.0	30.4 (76)	3.0 (21)	5.6 (19)*	0.0	0.0	0.0
Total species		23	14	13	7	4	1	2
Total individuals		10.687	513	1394	66	10	1	2

Md = mudflat; Mr = marsh; n = number of observations; P = plantation; Pn = pond; Rb = river bank; Rf = rice field; S = settlement.
*Species with the highest count in each habitat.

4. Discussions

Our data showed that mudflat habitats, marshes and plantations could potentially support the presence of several shorebird species in terms of both number of species and number of individuals. The highest number of both individuals and species was found in mudflat habitats. We attribute this finding to the high abundance of foraging opportunities found in mudflats. Mudflats comprise major habitat for foraging and resting for migratory shorebirds (Howes *et al.* 2003). A large number of species and number of individuals of shorebirds can indicate the availability of food resources in those locations (Goss-Custard *et al.* 1991; Jumilawaty 2012). The coastal mudflat of Percut Sei Tuan has the potential food (macrozoobenthos) for shorebirds (Jumilawaty 2012).

In recent years, as mangrove forest has been cleared shorebirds roosting on expansive areas of bare substrate that was being ready for development of one kind or another (usually palm oil plantation or fish ponds). These areas have now been planted in young oil palms. For a while, the shorebirds will still use this habitat as they represent attractive roosting habitat (the substrate is still bare, there is no dense ground-smothering weed vegetation, the oil palms are small and not dominating the habitat, the area is open to the sky). However, as soon as the palms grow bigger, this habitat will become completely unusable for shorebirds.

Young oil plantations and marsh habitat are used as a resting place because they still suitable and provide protection for

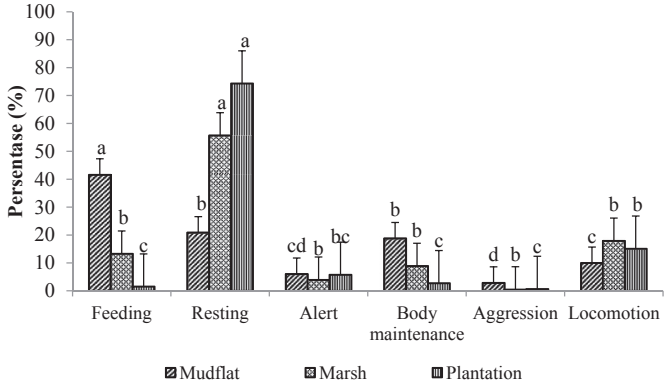

Figure 3. Percentage of shorebirds behaviour at mudflat, marsh and plantation. Means within a behaviour with different letters are different ($p < 0.05$). Number of observation at mudflat ($n = 51$ h), marsh ($n = 48$ h) and plantation ($n = 48$ h).

Figure 4. A flock of Lesser Sand Plover used young oil palm plantations area for resting if mudflat area was not available during high tide. (Photo taken 24 January 2016.)

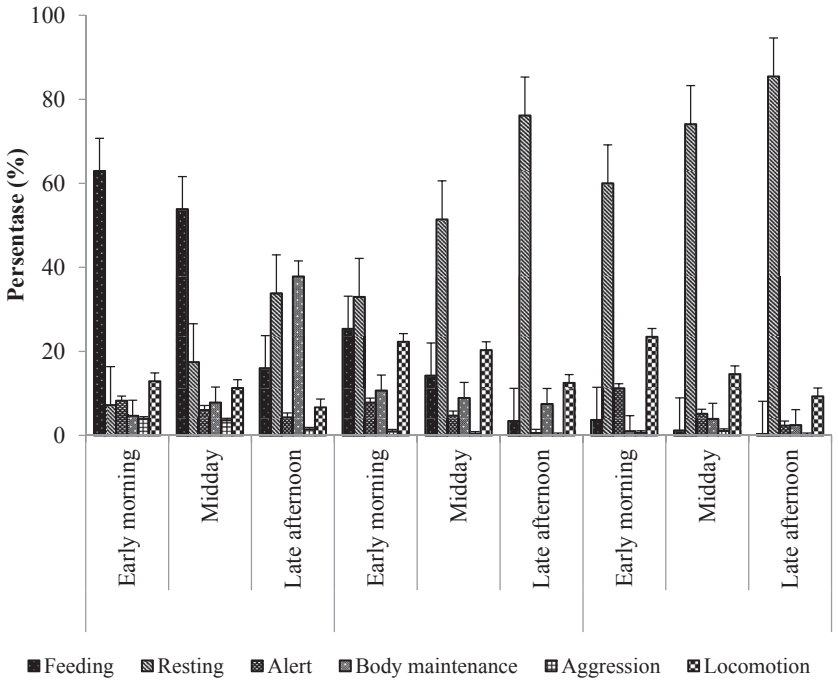

Figure 5. Shorebirds behaviour based on time period at mudflat, marsh and plantation. Number of observation at mudflat (early, $n = 23$ h; midday, $n = 14$ h; late, $n = 14$ h). Marsh (early, $n = 20$ h; midday, $n = 14$ h; late, $n = 14$ h). Plantation (early, $n = 20$ h; midday, $n = 14$ h; late, $n = 14$ h). The selection of tree species for nesting in the primary forest and restoration area.

Table 3. Mean (±SD) number of birds based on tidal stage at mudflats, marshes and plantations

Tide		Shorebird behaviours					
		Feeding	Resting	Alert	Body maintenance	Aggression	Locomotion
Mudflat	Low tide ($n = 23$)	88.9 ± 41.2	60.2 ± 51.7	17.3 ± 21.2	66.5 ± 67.4	4.8 ± 6.0	22.4 ± 25.6
	Rising tide ($n = 12$)	162.1 ± 36.7	19.5 ± 12.2	15.0 ± 37.1	12.6 ± 13.2	8.7 ± 8.7	18.1 ± 9.0
	High tide ($n = 2$)	42.5 ± 21.9	92.5 ± 36.1	14.5 ± 17.7	71.0 ± 11.3	5.5 ± 4.9	26.5 ± 6.4
	Falling tide ($n = 14$)	160.7 ± 51.0	30.5 ± 40.1	11.3 ± 17.5	15.0 ± 13.4	10.0 ± 12.6	38.9 ± 25.4
Marsh	Low tide ($n = 19$)	5.1 ± 5.1	26.8 ± 49.9	2.2 ± 4.2	2.5 ± 3.5	0.2 ± 0.6	11.3 ± 12.8
	Rising tide ($n = 12$)	7.0 ± 8.4	57.6 ± 50.3	1.1 ± 2.6	12.1 ± 23.9	0.4 ± 0.8	13.0 ± 15.2
	High tide ($n = 5$)	20.1 ± 40.8	37.0 ± 15.7	6.8 ± 12.0	5.5 ± 2.9	0.4 ± 0.5	12.4 ± 7.4
	Falling tide ($n = 12$)	6.6 ± 10.8	32.2 ± 31.3	6.7 ± 9.1	4.1 ± 7.5	0.7 ± 1.0	17.3 ± 18.4
Plantation	Low tide ($n = 16$)	2.5 ± 5.4	132.8 ± 59.6	13.6 ± 25.3	5.0 ± 8.1	0.5 ± 1.2	35.1 ± 27.7
	Rising tide ($n = 9$)	7.1 ± 6.0	119.6 ± 43.7	23.5 ± 46.5	2.4 ± 3.5	1.6 ± 1.2	61.8 ± 60.8
	High tide ($n = 8$)	2.3 ± 1.5	152.9 ± 92.8	10.5 ± 15.2	14.4 ± 14.2	2.6 ± 3.6	59.5 ± 50.5
	Falling tide ($n = 15$)	2.3 ± 3.5	180.8 ± 98.0	7.2 ± 23.1	4.1 ± 5.1	1.4 ± 3.7	8.6 ± 13.6

n = number of observation; SD = standard deviation.

shorebirds. Protection is in the form of shrubbery as hiding places or a substrate suited to the camouflaged plumage of shorebirds. However, the potential threat of predators and the high human activities across the region is likely to occur (Putra *et al.* 2015). Shorebirds always roosted inland if the tides were really high. They were using cleared areas inland of the mangrove zone, low marshes, or some species like Whimbrel and Common Sandpiper were actually roosting in the mangroves (A. Crossland pers. obs.). The marsh habitat is also used by groups of shorebirds for feeding and body maintenance as shown by Burger *et al.* (1997).

The presence of shorebirds varied greatly between tidal stages. We attributed the difference in species presence between high and low tides to morphology with short-legged species often moving towards mainland habitats during high tide. There are a quite number of birds foraging in the marsh habitat during the high tide, it indicates that marsh habitats are also potential for foraging locations if mudflats are not available. Burger *et al.* (1997) mentioned that shorebirds used the marsh habitat as feeding area if mudflats habitat were no longer available. Feeding on mudflats habitat is dominant behaviour during early morning and midday. The resting behaviour on marsh habitat and plantation was dominant during early morning, midday and late afternoon. Feeding and resting behaviours are predominant amongst shorebirds at a stopover location at every time (Davis and Smith, 1998).

The species which are only found in mudflat habitats were Grey-headed Lapwing *Vanellus cinereus*, Kentish Plover *Charadrius alexandrinus*, Eastern Curlew *Nepenthes madagascariensis*, Asian Dowitcher *Limnodromus semipalmatus*, Great Knot *Calidris tenuirostris*, Red Knot *Calidris canutus*, Sanderling *Calidris alba*, Rufous-necked Stint *Calidris ruficollis* and Broad-billed Sandpiper *Limicola falcinellus*. These species are thought to use the mudflats only for foraging. Grey-headed Lapwing is a species not commonly found in Indonesia. Sixty-seven were found in November 2014 on a mudflat at Sei Tuan, the largest number ever recorded for the island of

Sumatra and Indonesia (Iqbal *et al.* 2013). In 2008, there were 20 birds in Aceh on paddy field habitat (Iqbal *et al.* 2009). Our results and those of Crossland and Sitorus (2011) suggest that Grey-headed Lapwing is a winter visitor for Sumatra.

Species only found in the marsh habitat were Ruff *Philomachus pugnax* and Black-winged Stilt. Both species often observed resting and preening in shallow marsh water with shrubs with a height of about 50 cm or more. In the same general area, breeding records of Black-winged Stilt were recorded in 2010 (Abdillah *et al.* 2012). In 2011, Putra *et al.* (2015) found 25 individuals Ruff on mudflat near the village of Tanjung Rejo. In March 2015, four (1 adult and 3 chicks) Greater Painted Snipe *Rostratula benghalensis* were recorded in marsh habitat of Sei Tuan village. This study confirmed that this species is successfully breed in Sumatra. Previously, Marle and Voous (1988) only found the eggs in Deli Serdang district. The species that was found widely distributed in all habitats is Common Sandpiper *Actitis hypoleucos*, but the number in every habitat is small; 1–2 individuals. According to Hayman *et al.* (1986) and MacKinnon *et al.* (2010), Common Sandpiper is rarely found in groups and generally occurs in various habitats to an altitude of 1500 m asl.

Our results indicated that mudflats support shorebirds for foraging, body maintenance and resting. Aggression and alertness were observed in considerably higher percentages in mudflats compared with other habitats. Aggression behaviour might be occurred because of competition for food resources. Alertness behaviour can be influenced by human activities (crab snares) and raptor presence in mudflat habitat. Burger *et al.* (1979) revealed that high density of shorebirds in a limited area with a high level of aggression could indicate the competition occurrence within the area. This has conservation implications for shorebirds as habitat availability decreases from land-use change, inter and intra-species competition will likely increase in mudflats. This could have impacts on species fitness as our results show that this habitat is important for foraging, body maintenance and resting.

Conflict of interest

The authors declare that there is no conflict of interest.

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