

# Discovery of an important wintering site of the Critically Endangered Spoon-billed Sandpiper *Calidris pygmaea* in the Meghna Estuary, Bangladesh

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## Summary

The Critically Endangered Spoon-billed Sandpiper *Calidris pygmaeus* is one of the most threatened migratory shorebirds in the world, breeding in Russia and wintering in Asia. The global population is declining rapidly and is projected to be extinct within a few decades without intervention. Here, we present the results of shorebird surveys in previously unrecognised site in Bangladesh along the Meghna Estuary, identified for the first time by using species distribution models. Counts and habitat preference of Spoon-billed Sandpipers and other endangered shorebirds are described here with notes on the global importance of the newly discovered site. The sum of the peak counts for each shorebird species across the two surveys was 25,993 including a minimum of 48 Spoon-billed Sandpipers. The majority of the Spoon-billed Sandpipers were observed during low tide while foraging (66.6%) and logistic regression testing for effects on the presence of foraging Spoon-billed Sandpiper indicate that they mainly preferred to forage on shallow mud. We summarise the threats to Spoon-billed Sandpipers and other birds in the new site that is currently not recognized as a Wetland of International Importance under the Ramsar Convention, although it fulfils several Ramsar Criteria. We also propose conservation and monitoring measures for long-term protection of the Spoon-billed Sandpiper and its habitat.

## Introduction

Each year, large numbers of Arctic and sub-arctic breeding birds migrate to and from wintering grounds in the temperate and tropical zones of eastern Asia and Australia via the East Asian-Australasian Flyway (EAAF). Intertidal habitats and other coastal wetlands provide important staging and wintering areas for shorebirds undertaking migration, but a large proportion of these habitats have been lost to human use and invasive plant species in recent decades. Over the past 50 years, losses of up to half of coastal wetlands have occurred in China (Ma *et al.* 2014, Murray *et al.* 2014) and 60% in the Republic of Korea (Yee *et al.* 2010, MacKinnon *et al.* 2012). The intertidal areas of Asia are critically important for millions of migratory waterbirds of 155 species comprising 24 globally threatened or near threatened migratory intertidal species (Barter 2002, Bamford *et al.* 2008, MacKinnon *et al.* 2012). Although the EAAF faces a variety of threats, the fast pace of coastal land claim (land filling in order to create new land from the ocean) is the most pressing. For example, in Saemangeum of South Korea, a land claim project resulted in the loss of 28,000 ha of intertidal flats (Moore 2012).

Long-distance and Arctic-breeding shorebirds, such as the 'Critically Endangered' Spoon-billed Sandpiper *Calidris pygmaea*, are the fastest declining migrants of the EAAF (Amano *et al.* 2010, Zöckler *et al.* 2010b). The most recent formal population estimate (2014) is 210–228 breeding pairs, or 661–718 individuals in the post-breeding population (Clark *et al.* 2016). The species breeds in the Russian Arctic, primarily on the coast of the Chukotsk Peninsula (e.g. Flint and Kondratiev 1977, Tomkovich *et al.* 2002) and winters mainly in the intertidal habitats of Bangladesh, Myanmar, Vietnam, southern China and the inner Gulf of Thailand (Zöckler *et al.* 2010b, BirdLife International 2016, Bird *et al.* 2010, Chowdhury *et al.* 2011, Zöckler *et al.* 2016). Between 2002 and 2009 numbers at monitored breeding sites declined by about 26% per year (Zöckler *et al.* 2010a). The species was projected to be extinct within a few decades without intervention (Pain *et al.* 2011, Clark *et al.* 2014).

In order to save the Spoon-billed Sandpiper and numerous other migratory waterbirds of EAAF, actions have been undertaken throughout the flyway by a broad partnership through the Spoon-billed Sandpiper Task Force. There are encouraging signs that some conservation measures are working (e.g. hunting mitigation in Bangladesh and Myanmar), but they need to be continued and expanded (Clark *et al.* 2014). Better information is needed on the areas used by Spoon-billed Sandpipers in the non-breeding season to target advocacy, ensure long-term habitat protection and reduction of hunting pressure in all stop-over and wintering sites (Zöckler *et al.* 2016).

Recent surveys of Spoon-billed Sandpipers identified the Gulf of Mottama and Nan Thar Island in Myanmar and Sonadia Island in Bangladesh as key wintering sites, with 80% of the total winter count across all known sites (Chowdhury *et al.* 2011, Zöckler *et al.* 2016). However, the species has an extensive and poorly explored non-breeding range, so important wintering sites may still be undiscovered (Zöckler *et al.* 2016). Since 2009, the Bangladesh Spoon-billed Sandpiper Conservation Project (BSCP) has conducted regular searches in previously unsurveyed areas, such as the coastline of the Sundarbans in Bangladesh (Chowdhury *et al.* 2014).

Lack of resources has prevented a comprehensive shorebird survey of the entire coastline of Bangladesh, so survey effort has been focused on areas with remotely-sensed attributes characteristic of sites known to have winter concentrations of Spoon-billed Sandpipers throughout the species' winter range. A species distribution model reported elsewhere (Zöckler *et al.* 2016) allows potentially suitable habitat for wintering Spoon-billed Sandpipers to be identified prior to expensive and time-consuming ground surveys. We simply used this model focusing on Bangladesh and satellite images from the Landsat Programme and Google Earth to identify previously unsurveyed areas of Bangladesh (especially the Meghna Estuary) likely to hold wintering Spoon-billed Sandpipers.

In this paper, we present the results of shorebird surveys in one of these areas, the Meghna Estuary. We present counts of Spoon-billed Sandpipers and other threatened and near threatened shorebirds and demonstrate the global importance of the newly discovered site by comparing our counts with those made at other sites. We also describe the threats to Spoon-billed Sandpipers and other birds and propose conservation measures for their long-term protection.

## Methods

### *Study area*

We used the maximum entropy species distribution model developed by Zöckler *et al.* (2016) to map potential habitat suitability for wintering Spoon-billed Sandpipers for the entire coastline of Bangladesh. However, in this paper we mainly focused on the previously unsurveyed areas of Meghna Estuary (Figure 1) as other suitable sites are either regularly or periodically surveyed. The model uses mapped data on climatic, land cover, ocean chlorophyll, tide height and distance from the coast from November to February to predict Spoon-billed Sandpiper habitat suitability at 1-km resolution (Figure 1).

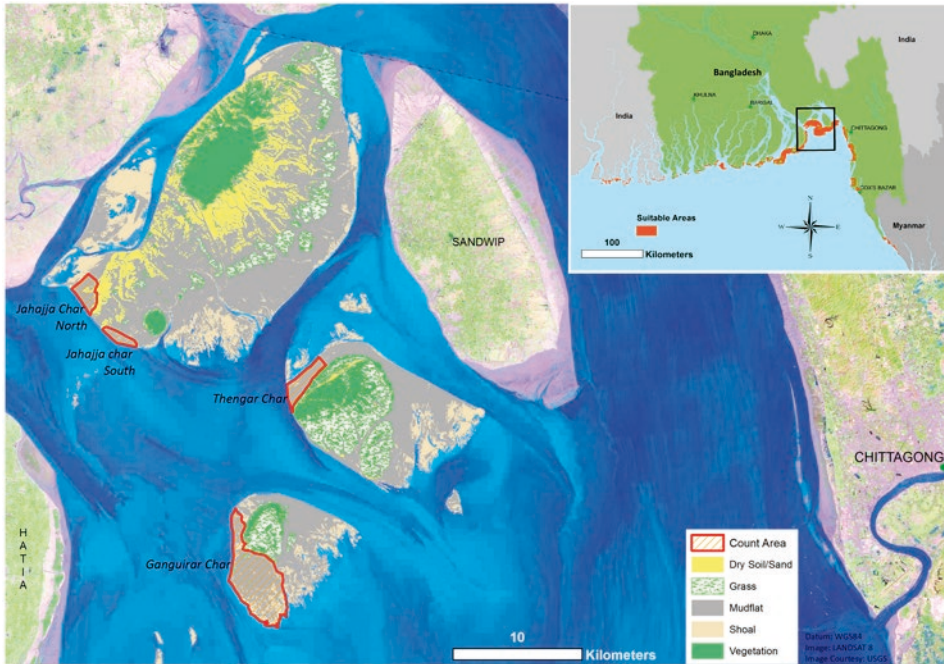


Figure 1. Count sites and habitat features of the study area in Meghna Estuary, Bangladesh. Inset: The most suitable parts of Bangladesh and neighbouring areas of India and Myanmar for wintering Spoon-billed Sandpipers, according to the species distribution model of Zöckler *et al.* (2016).

The Meghna Estuary, on the east coast of Bangladesh was included within the top 5% of modelled suitability values within the country described in Zöckler *et al.* (2016) for all Spoon-billed Sandpiper wintering countries, largely because of high offshore concentrations of chlorophyll. We further refined our search area within Meghna Estuary using recently obtained satellite imagery of unvegetated estuarine mud from the Landsat Programme (<http://landsat.gsfc.nasa.gov/>), ASTER (<http://glovis.usgs.gov/>) and Flash Earth ([www.flashearth.com/](http://www.flashearth.com/)). We used local names (collected during the surveys from local fishermen) of the survey sites as the names vary in different documents by different government agencies and separate sites have the same name (Table 2).

### Field methods

We conducted a reconnaissance survey of the Meghna Estuary between 3 and 11 February 2015. Suitable sites were searched carefully and shorebird counts conducted on 5–13 December 2015 and 2–9 February 2016, following methods for counting non-breeding shorebirds outlined in Bibby *et al.* (2000). A large wooden fishing trawler was used to travel between sites. Four observers carried out the surveys at each site to minimise errors in counting and identification. Time spent surveying at each site varied depending on the number of birds present, and typically ranged between three and eight hours covering high tide and low tide. Counts were usually repeated for each species twice in close succession, the higher of the two counts was used. Counts were undertaken during high tide and low tide, depending on the habitat type (mudflat or high tide roost). Birds were identified using Grimmett *et al.* (2001) and Chowdhury (2011). Observations were made using 10x42 binoculars and 25-50x spotting scopes. In addition, photographs were taken (using a DSLR camera with 300 mm lens) during the survey for difficult species and images examined later to identify the species.

*Threat assessment*

We identified various factors that may have a direct or indirect effect on the Spoon-billed Sandpiper and its habitat. A list of potential threats (Table 1) was developed based upon previous studies (TNC 2007, Zöckler *et al.* 2008, Li *et al.* 2009) and discussions amongst the authors about threats that are likely to occur in the future. A similar method was used previously by Aziz *et al.* (2013) to prioritise threats to the Sundarbans, a Ramsar wetland in Bangladesh.

We noted the ecological attributes of each site and conducted semi-structured interviews targeting local natural resource harvesters, using a basic interview guide in order to cover pre-defined topics, following Newing (2010). We encountered a total of 30 fishermen and five cattle ranchers, and conducted semi-structured interviews on hunting, poaching, shooting of birds, grazing and fishing. We then ranked the threats based on three attributes (scope, severity and irreversibility) and scored each as Very High, High, Medium and Low for the current state of each threat (Aziz *et al.* 2011) using the definitions presented in Table 1. The ratings

Table 1. Definitions of components and associated ratings used to prioritise each threat (adapted from TNC 2007 and Aziz *et al.* 2013).

Component & Rating	Definition
<b>Scope</b>	The geographical scope of impact on the target aimed for conservation that can be reasonably expected in 10 years under existing circumstances
Very high	The threat is possibly extensive in its scope, and affect the target aimed for conservation throughout or majority (71–100%) of its occurrence or population
High	The threat is possibly extensive in its scope, and affect the target aimed for conservation throughout much (31–70%) of its occurrence or population
Medium	The threat is possibly limited or confined in its scope, and affect the target aimed for conservation across (11–30%) of its occurrence or population
Low	The threat is possibly very small in its scope, and affect the target aimed for conservation across (1–10%) of its occurrence or population
<b>Severity</b>	The level of damage to the target aimed for conservation that can reasonably be expected within 10 years if existing conditions prevail
Very high	The threat is expected to destroy or terminate the target aimed for conservation or decrease its population by 71–100% in 10 years or 3 generations within the scope
High	The threat is expected to severely deteriorate/degrade the target aimed for conservation or its population by 31–70% in 10 years or 3 generations within the scope
Medium	The threat is expected to somewhat deteriorate/degrade the target aimed for conservation or its population by 11–30% in 10 years or 3 generations within the scope
Low	The threat is expected to only slightly deteriorate/degrade the target aimed for conservation or its population by 1–10% in 10 years or 3 generations within the scope
<b>Irreversibility</b>	The degree to which the effects of a source of stress can be brought back
Very high	The effects of the threat is irreversible and it is almost impossible that the target can be brought back, and/or it would take 100 years to accomplish this (e.g. wetlands converted to an industry)
High	The effects of the threat can theoretically be reversed and the target can be brought back, but is not economical and/or would take 21–100 years to accomplish this (e.g. wetlands converted to agricultural fields)
Medium	The effects of the threat can be reversed and the target can be brought back, but with considerable or adequate use of resources and/or within 6–20 years (e.g. ditching and draining of wetland)
Low	The effects of the threat are easily reversible and the target can be easily restored at a relatively low cost and/or within 0–5 years (e.g. off-road vehicles trespassing in wetland)

for scope, severity and irreversibility of each threat component were assigned by the authors based on the results field surveys undertaken 3–11 February 2015, 5–13 December 2015 and 2–9 February 2016, and existing knowledge gathered through literature review, following TNC (2007).

### *Habitat surveys*

We recorded substrate depth (cm) by measuring the depth to which a single observer (SUC) could sink a leg in the mud, using a measuring tape. We assumed the body weight of the observer to be a constant exerting the same pressure on the mud at all sites. We visually assessed substrate type (sand, mud, sand-mud mixed) and numbers of Spoon-billed Sandpipers and all other shorebird species at 15 locations of shorebird flocks that included Spoon-billed Sandpipers and 14 randomly selected locations of shorebird flocks without Spoon-billed Sandpipers, which showed similar habitat characteristics in general, such as open mudflats, away from saltmarsh, dense vegetation and human disturbance (Also see Bird *et al.* 2010). All observations were recorded during receding tide in order to assess effects of variable mentioned above on the occurrence of Spoon-billed Sandpiper in the study area at Meghna Estuary.

### *Statistical analysis*

We wished to assess whether the presence/absence of Spoon-billed Sandpipers at our habitat survey sites was associated with substrate attributes. We therefore fitted logistic regression models in which the presence/absence of Spoon-billed Sandpipers in a location was the binary dependent variable with binomial error distribution and logit link. The independent variables were mud depth (continuous), substrate type (factor with three levels), the number of all shorebirds in the flock (continuous) and the number of species other than Spoon-billed Sandpiper in the flock. All independent variables were fitted as fixed effects. All analyses were conducted in R (R Core Team 2012).

## **Results**

### *Shorebird sites and counts*

We found shorebird concentrations, which we defined as groups of more than 500 birds, at four sites along the Meghna Estuary (Table 2). Totals of 27,791 shorebirds of 26 species and 2,865 other waterbirds of 16 species were recorded between 5 and 13 December 2015. In a repeat survey of the same sites conducted between 2 and 9 February 2016 (see Table S1 in the online supplementary material for detailed count data) we counted 19,717 shorebirds of 25 species and 1,807 other waterbirds of 15 species. In both count periods combined, a total of 29 shorebird species were recorded. The sum of the peak counts for each shorebird species across the two surveys was 25,993, which we take to be the minimum number of shorebirds that used the sites surveyed during 2015–2016.

The most abundant species was Lesser Sand Plover *Charadrius mongolus* (10,335.5 ± 5111.7), followed by Greater Sand Plover *Charadrius leschenaultii* (2,566 ± 981.5). Other than Spoon-billed Sandpiper, nine globally near threatened and threatened shorebirds were recorded during the surveys and the peak counts include two 'Endangered' Spotted Greenshank *Tringa guttifer* and 40 Great Knot *Calidris tenuirostris*, 279 'Near Threatened' Eurasian Curlew *Numenius arquata*, 690 Black-tailed Godwit *Limosa limosa*, 15 Bar-tailed Godwit *Limosa lapponica*, 12 Red Knot *Calidris canutus*, 1,202 Curlew Sandpiper *Calidris ferruginea*, 1,273 Little/Red-necked Stint *Calidris minuta* / *Calidris ruficollis* and 71 Asian Dowitcher *Limnodromus semipalmatus* (Total counts across all four sites in the Meghna Estuary for each species are presented in Table S1).

Table 2. Number of shorebirds and other waterbirds recorded at four sites along the eastern part of Meghna Estuary or around Sandwip Island of Bangladesh.

Site Name	Site description	Area in hectares	No. of shorebirds recorded in Dec 2015	No. of other waterbirds recorded in Dec 2015	No. of shorebirds recorded in Feb 2016	No. of other waterbirds recorded in Feb 2016
1 Jahajja Char North	Mudflat & high tide roost	347	13,765	1,849	3,162	171
2 Jahajja Char South	Mudflat & high tide roost	170	10,681	342	9,729	352
3 Thengar Char (also known as Jaliar Char, Char Piya)	Mudflat & high tide roost	276	504	149	540	91
4 Gangair Char (Also known as Thengar Char)	Mudflat & high tide roost; Sand-mud mixed;	2,004	2,841	525	6,308	1,193

### Spoon-billed Sandpiper

During the December 2015 survey a minimum of 39 Spoon-billed Sandpipers were counted comprising 29 at Gangair Char, 6 at Jahajja Char South and 4 at Jahajja Char North. In February 2016, 48 (7.2–6.6% of the global population described in Clark *et al.* 2016) Spoon-billed Sandpipers were observed at the three sites with highest count of 45 from Gangair Char, indicating that this is the most important site for the species. Among the 48 birds, we recorded seven (14.5%) with engraved leg flags.

The majority of individuals were observed during low tide while they were foraging (66.6%) rather than at high tide roosts (33.3%). Similarly, 85.7% of leg flag sightings were at low tide. This is probably because Spoon-billed Sandpipers are easier to distinguish from other small shorebirds such as Red-necked Stint, Little Stint and Sanderling by their distinctive foraging behaviour.

Logistic regression testing for effects on the presence of foraging Spoon-billed Sandpiper indicate a significant effect of mud depth (Table 3), where Spoon-billed Sandpipers mainly preferred to forage on shallow mud (mean at locations with the species;  $8.43 \pm \text{SE } 1.93$  cm) with sand-mud mixed substrate type ( $n = 16$ ; 80%), compared to deep mud at locations without the species (mean  $21.14 \pm 5.81$  cm). The locations of the foraging sites of the Spoon-billed Sandpiper remained constant between two survey periods where major concentration of birds including individually marked birds were observed at the same patch of foraging area within a mudflat, compared to high tide roost locations that varied based on the height of the tide.

Table 3. Results of logistic regression models testing for effects of mud depth, substrate type, flock size and flock diversity (no of shorebird species other than Spoon-billed Sandpiper present within a flock) on the presence of foraging Spoon-billed Sandpiper across all sites of the study area. Significant effects are indicated in bold.

Model term	Parameter Estimate	SE	z value	Pr (> z )
<b>Mud Depth</b>	<b>-0.5924</b>	<b>0.2952</b>	<b>-2.007</b>	<b>0.0448 *</b>
Flock Size	-0.0064	0.0260	-0.250	0.8029
Flock Diversity	0.0443	0.8080	0.055	0.9562
Substrate Type: Sand-Mud	0.1823	3.1975	0.057	0.9545
Substrate Type: Sand	0.3479	3.3112	0.105	0.9163

### Threats

We identified a total of 16 potential threats, comprising four that are likely to impact shorebirds directly and 12 threats to shorebird habitats (Table 4). Land reclamation, causeway construction, oil spill, mangrove plantation and sea level rise were ranked as the most serious threats to habitats. In this area, hunting and trapping of migratory shorebirds appear to be low, compared to other Spoon-billed Sandpiper sites in Bangladesh and other areas across the flyway.

### Discussion

Results of our surveys reveal the presence of significant numbers of Spoon-billed Sandpipers in the eastern part of Meghna Estuary of Bangladesh in two winter count periods separated by about two months. The minimum numbers counted comprise about 20% of the currently known global winter population (Zöckler *et al.* 2016).

The overall shorebird and Spoon-billed Sandpiper populations counted in the study area were both higher than those at Sonadia Island in the 2015–2016 winter (Chowdhury and Foysal 2016). Sonadia Island was previously the only known regular wintering site for the Spoon-billed Sandpiper in Bangladesh and up to 23 birds were recorded in March 2010 during migration from Domar Char, c.40 km south-west from this new site (Bird *et al.* 2010, Chowdhury *et al.* 2011, Chowdhury 2012). Co-ordinated winter counts at both sites (Sonadia Island and Meghna Estuary) between January and February 2016 organized by the Spoon-billed Sandpiper Task Force indicate that Bangladesh supports the second largest wintering populations of the Spoon-billed Sandpiper in the world after the Gulf of Mottama, Myanmar. A total of 79 Spoon-billed Sandpipers were counted from several sites of Bangladesh between January and February 2016 (Chowdhury *in litt.* 2016), providing further evidence that Bangladesh is equally important to Myanmar for the conservation of wintering Spoon-billed Sandpipers.

### Conservation implications

The Meghna Estuary is not only important for the Spoon-billed Sandpipers but also critical for numerous globally threatened migratory shorebirds of the EAAF. This previously unexplored

Table 4. Ranking score for threats to shorebirds including the Spoon-billed Sandpiper and shorebird habitat along the eastern coast at Meghna Estuary (around Sandwip island) of Bangladesh.

Target	Threat	Ranking		
		Scope	Severity	Irreversibility
Shorebirds	Hunting	Low	Low	Medium
	Trapping	Low	Low	Medium
	Poisoning	Low	Low	Medium
	Predation by raptors	Low	Low	High
Habitat	Fishing & harvesting of other natural resources	Low	Low	High
	Livestock grazing	Medium	Medium	Medium
	Agriculture & aquaculture	Low	Low	High
	Mangrove plantation	High	Medium	High
	Mineral & gas extraction	Medium	Medium	Medium
	Oil spill	High	High	Medium
	Land reclamation	High	High	High
	Cross dam construction	High	High	High
	Deep sea port construction	Low	Low	High
	Commercial navigation	High	Medium	Medium
	Commercial infrastructure	Low	Low	Medium
	Sea level rise	High	High	High

area (except for Thengar Char, also known as Jaliar Char, where four Spoon-billed Sandpipers were recorded in March 2011; Thompson *et al.* 2014) is not currently recognised as a Wetland of International Importance under the Ramsar Convention, although it fulfils several Ramsar Criteria. It qualifies as a Ramsar site under Criterion 2 (supporting Vulnerable, Endangered, or Critically Endangered species), Criterion 5 (regularly supporting 20,000 or more waterbirds), Criterion 6 (supporting 1% of the flyway population) (Wetlands International 2016) of one species or subspecies of waterbird; these species include Kentish Plover *Charadrius alexandrinus*, Lesser Sand Plover, Greater Sand Plover, Broad-billed Sandpiper *Calidris falcinellus*, Spoon-billed Sandpiper and Terek Sandpiper *Xenus cinereus* (Ramsar Convention Secretariat 2007). Moreover, the channels, offshore and near-shore areas around the island also hold Irrawaddy Dolphin *Orcaella brevirostris* and Indo-Pacific Humpback Dolphin *Sousa chinensis*. For example, on 5 February 2016 we attempted to rescue two Irrawaddy Dolphins that were trapped inside a long-shore net by local fishermen at Ganguirar Char. The Ganges-Brahmaputra-Meghna delta (75,000 ha) as a whole is an Important Bird Area but most of it remains unprotected (BirdLife International 2016).

Unlike other important wintering sites of Spoon-billed Sandpiper (e.g. Gulf of Mottama and Sonadia Island), hunting, trapping and poisoning of shorebirds (see Chowdhury 2010, Zöckler *et al.* 2010b, 2016) were not recorded at our study area. The long-shore nets that are used to trap fish are made from brightly coloured, thick material and are of small mesh, so shorebirds are likely to see these nets and even if they strike the taut nets, it is likely that the birds would bounce out (Schemnitz *et al.* 2009). Therefore, the scope and severity of direct threat to shorebirds have been ranked as 'Low' (Table 4). However, these long-shore nets pose a huge threat to the threatened cetaceans of Bangladesh (Smith *et al.* 1998).

Large cargo ships and oil-tankers were observed navigating c.5 km west of Ganguirar Char during our visits and this regular ship navigation route raises concern over possible oil spill and thus commercial navigation is listed a potential threat with high risk of habitat deterioration (Table 4). In December 2014, an oil spill took place in the Sundarbans that spread over 350 km<sup>2</sup> and is believed to be threatening local ecosystems and wildlife (Raha 2015).

In 1957 and 1964, Bangladesh reclaimed 1,000 km<sup>2</sup> of new land in the Meghna Estuary by building two dams (CCC 2009). We ranked land reclamation (including small scale but gradual reclamation for agricultural land) and cross dam construction along the Meghna Estuary as a critically important and irreversible threat. The government has now approved an ambitious project to build a series of dams in the Meghna Estuary to connect islands and help deposit hundreds of millions of tonnes of sediment, reclaiming 600 km<sup>2</sup> of land from the sea over the next five years (MacKinnon *et al.* 2012). Although the proposed cross dams are outside our study area they are likely to affect other parts of the estuary (MacKinnon *et al.* 2012). A study by the Dutch-funded Institute of Water Modelling (IWM) claims that the damming process would not affect other parts of the coastline (CCC 2009). Sea level rise could be a major issue for shorebirds along the Meghna Estuary in the future as UN's Intergovernmental Panel on Climate Change (IPCC) predicts that 17% of Bangladesh's land could disappear under rising sea levels by 2050 (MacKinnon *et al.* 2012).

In Bangladesh, newly accreted land is managed by Bangladesh Forest Department for a period of 20 years for afforestation in order to ensure land stabilisation and coast protection (Papry 2014). Moreover, mangrove reforestation is a common strategy for coastal rehabilitation (Iftekhar and Islam 2004), Bangladesh Forest Department and other NGOs tend to plant mangrove as soon as new mudflats form (Chowdhury *et al.* 2011). However, evidence suggests that mangrove plantation unintentionally reduces the available feeding grounds of shorebirds (Custodio 1996, Erfteimeijer and Lewis 2000).

These proposed major developments and management goals of Ganges-Brahmaputra-Meghna Delta will certainly impact the wintering grounds of many globally threatened shorebirds of EAAF, including the 'Critically Endangered' Spoon-billed Sandpiper, which is largely dependent on the Ganges-Brahmaputra-Meghna Delta in the non-breeding season (Zöckler and Bunting 2006).



Evidence on intertidal habitat destruction from more developed parts of Asia indicates that development projects get approval from the government without proper costing of environmental damages and losses. Hence, national and international parties engaged in nature conservation in Bangladesh may focus on coastal biodiversity conservation, where the habitat is still less damaged compared to other countries in Asia (MacKinnon *et al.* 2012, Moores 2012, Ma *et al.* 2014).

Currently these sites are not recognised under any conservation management scheme (International Resources Group 2012). Ganguirar Char may coincide with the boundary of one of the six Hilsa shad *Tenulosa ilisha* sanctuaries of the country (Islam *et al.* 2014), Jahajja Char and Thengar Char were mentioned as possible marine protected areas (MPA) in a framework report prepared by IUCN Bangladesh Country Office under the project Bay of Bengal Large Marine Ecosystem (BOBLME 2013). Comprehensive conservation policies are needed for newly accreted land and estuary management in order to ensure that there is no net loss of intertidal mudflats or their availability to biodiversity as a result of mangrove plantation or development. Immediate protection of these globally important sites within the Ganges–Brahmaputra–Meghna Delta is necessary to ensure long-term conservation of several globally threatened avifauna species, cetaceans, marine turtles, fisheries (Islam *et al.* 2014) and livelihoods of the local community. We therefore recommend establishing Bangladesh's second MPA in the lower Meghna Estuary, covering the important intertidal mudflats (mentioned here) and coastal waters. We also recommend regular monitoring of the waterbird community, cetaceans, and fisheries of this area in order to understand the population trend of globally and nationally threatened species.

## Supplementary Material

To view supplementary material for this article, please visit <https://doi.org/10.1017/S0959270917000247>

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## References

- Amano, T., Székely, T., Koyama, K., Amano, H. and Sutherland, W. J. (2010) A framework for monitoring the status of populations: an example from wader populations in the East Asian–Australasian flyway. *Biol. Conserv.* 143: 2238–2247.
- Aziz, A., Barlow, A. C., Greenwood, C. C. and Islam, A. (2013) Prioritizing threats to improve conservation strategy for the tiger *Panthera tigris* in the Sundarbans Reserve Forest of Bangladesh. *Oryx* 47: 510–518.
- Bamford, M., Watkins, D., Bancroft, W., Tischler, G. and Wahl, J. (2008) *Migratory shorebirds of the East Asian–Australasian flyway: Population estimates and internationally important sites*. Canberra, Australia: Wetlands International–Oceania.
- Barter, M. (2002) *Shorebirds of the Yellow Sea: importance, threats and conservation status*. Canberra, Australia: Wetlands International–Oceania. (Wetlands International Global Series 9, International Wader Studies 12).

- Bibby, C. J., Burgess, N. D., Hill, D. A. and Mustoe, S. H. (2000) *Bird census techniques*. Second edition. London, UK: Academic Press.
- Bird, J. P., Lees, A. C., Chowdhury, S. U., Martin, R. and Haque, E. U. (2010) A survey of the Critically Endangered Spoon-billed Sandpiper *Eurynorhynchus pygmeus* in Bangladesh and key future research and conservation recommendations. *Forktail* 26: 1–8.
- BirdLife International (2016) Important Bird and Biodiversity Area factsheet: Ganges-Brahmaputra-Meghna delta. Downloaded from <http://www.birdlife.org> on 08/05/2016
- BOBLME. (2013) *Marine Protected Areas in Bangladesh - a framework for establishment and management*. Dhaka, Bangladesh: IUCN.
- CCC (2009) *Impact assessment of climate change and sea level rise on monsoon flooding*. Dhaka, Bangladesh: Climate Change Cell, DoE, MoEF.
- Chowdhury, S. U. (2010) Preliminary survey of shorebird hunting in five villages around Sonadia Island, Cox's Bazar, Bangladesh. *Birding Asia* 16: 101–102.
- Chowdhury, S. U. (2011) *A pictorial field guide to the shorebirds of Bangladesh*. Dhaka, Bangladesh. Bangladesh Spoon-billed Sandpiper Conservation Project (BSCP).
- Chowdhury, S. U. (2012) Survey and conservation of the critically endangered Spoon-billed Sandpiper in Bangladesh. *Ibis* 154: 210–211.
- Chowdhury, S. U., Foysal, M., Das, D. K., Mohsanin, S., Diyan, M. A. A. and Alam, A. B. M. S. (2011) Seasonal occurrence and site use by shorebirds at Sonadia Island, Cox's Bazar, Bangladesh. *Wader Study Group Bull.* 118: 77–81.
- Chowdhury, S. U., Diyan, M. A. A., Zöckler, C., Foysal, M., and Lemke, H. W. (2014) Shorebird survey sites along the coast of the Sundarbans, south-west Bangladesh. *Stilt* 66: 10–13.
- Chowdhury, S. U. and Foysal, M. (2016) *Bangladesh Spoon-billed Sandpiper Conservation Project Annual Report*. Dhaka, Bangladesh: Bangladesh Spoon-billed Sandpiper Conservation Project (BSCP).
- Clark, N., Pain, D., and Green, R. (2014) Saving the Spoon-billed Sandpiper: an update on the conservation programme. *British Birds* 107: 467–475.
- Clark, N. A., Anderson, G. Q., Li, J., Syroechkovskiy, E. E., Tomkovich, P. S., Zöckler, C., ... and Green, R. E. (2016). First formal estimate of the world population of the Critically Endangered spoon-billed sandpiper *Calidris pygmaea*. *Oryx* 1–10. DOI: <https://doi.org/10.1017/S0030605316000806>.
- Custodio, C. C. (1996) Conservation of migratory waterbirds and their wetland habitats in the Philippines. In D. R. Well and T. Mundkur, eds. *Conservation of migratory waterbirds and their wetland habitats in the East-Asian-Australasian Flyway. Proceedings of an International Workshop*. Kushiro, Japan.
- Erfteimeijer, P. L. A. and Lewis, R. R. (2000) *Planting mangroves on intertidal mudflats: habitat restoration or habitat conversion? Proceedings of the Ecotone VIII—enhancing coastal ecosystems restoration for the 21st century*. Bangkok, Thailand: Royal Forest Department of Thailand.
- Flint, V. E. and Kondratiev, A. Ya. (1977) An experience of evaluating of the total number of a rare stenotypic species (Spoon-billed Sandpiper *Eurynorhynchus pygmeus* as an example). P. 250 in M. A. Voinstvenski, ed. *7th All-Union Ornithol. Conf. Abstracts of talks. Part 2*. Kiev, Naukova Dumka. (In Russian).
- Grimmett, R., Inskipp, C., Inskipp, T. and Allen, R. (2011). *Birds of the Indian sub-continent*. London, UK: Christopher Helm.
- Iftekhar, M. S. and Islam, M. R. (2004) Managing mangroves in Bangladesh: a strategy analysis. *J. Coastal Conserv.* 10: 139–146.
- International Resources Group (2012) *State of Bangladesh's Forest Protected Areas 2010*. Dhaka, Bangladesh: Integrated Protected Area Co-Management (IPAC).
- Islam, M., Mohammed, E. Y. and Ali, L. (2014) *Economic incentives for sustainable hilsa fish management in Bangladesh: An analysis of the legal and institutional framework*. IIED Working Paper. London, UK: IIED. <http://pubs.iied.org/15523IIED>
- Li, Z. W. D., Bloem, A., Delany, S., Martakis, G. and Quintero, J. O. (2009) *Status of waterbirds in Asia - results of the Asian waterbird census: 1987-2007*. Kuala Lumpur, Malaysia: Wetlands International.
- Ma, Z., Melville, D. S., Liu, J., Chen, Y., Yang, H., Ren, W., Zhang, Z., Piersma, T. and Li, B.

- (2014) Rethinking China's new great wall. *Science* 346 (6212): 912.
- MacKinnon, J., Verkuil, Y. I. and Murray, N. (2012) *IUCN situation analysis on East and Southeast Asian intertidal habitats, with particular reference to the Yellow Sea (including the Bohai Sea)*. Gland, Switzerland: IUCN. (Occasional paper of the IUCN Species Survival Commission, 47).
- Moores, N. (2012) *The distribution, abundance and conservation of avian biodiversity in Yellow Sea habitats in the Republic of Korea*. Unpublished PhD thesis. University of Newcastle, UK.
- Murray, N. J., Clemens, R. S., Phinn, S. R., Possingham, H. P. and Fuller, R. A. (2014) Tracking the rapid loss of tidal wetlands in the Yellow Sea. *Frontiers Ecol. Environ.* 12: 267–272.
- Newing, H. (2010) *Conducting research in conservation: social science methods and practice*. Routledge.
- Pain, D., Green, R. and Clark, N. (2011) On the edge: can the Spoon-billed Sandpiper be saved? *British Birds* 104: 350.
- Papry, R. I. (2014) Status of coastal plantation in Chittagong Coastal Forest Division. *IOSR J. Environ. Sci. Toxicol. Food Technol.* 8: 79–83.
- R Core Team (2012) *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing.
- Raha, S. (2015) Fate of oil pollution in Bangladesh - a review. *Asian J. Multi-disciplinary Stud.* 3(5).
- Ramsar Convention Secretariat (2007) Designating Ramsar sites: The strategic framework and guidelines for the future development of the List of Wetlands of International Importance. *Ramsar handbooks for the wise use of wetlands, 3rd edition, vol. 14*. Gland, Switzerland: Ramsar Convention Secretariat.
- Schemnitz, S. D., Batcheller, G. R., Lovallo, M. J., White, H. B. and Fall, M. W. (2009) *Capturing and handling wild animals*. Baltimore, Maryland: USDA National Wildlife Research Center - Staff Publications.
- Smith, B. D., Haque, A. A., Hossain, M. S. and Khan, A. (1998). River dolphins in Bangladesh: conservation and the effects of water development. *Environ. Manage.* 22: 323–335.
- Thompson, P. M., Chowdhury, S. U., Haque, E. U., Khan, M. M. H. and Halder, R. (2014). Notable bird records from Bangladesh from July 2002 to July 2013. *Forktail* 30: 50–65.
- TNC (2007) *Conservation Action Planning handbook: Developing strategies, taking actions and measuring success at any scale*. Arlington, USA: The Nature Conservancy.
- Tomkovich, P. S., Syroechkovski, E. E., Jr, Lappo, E. G. and Zöckler, C. (2002) First indications of a sharp population decline in the globally threatened Spoon-billed Sandpiper *Eurynorhynchus pygmeus*. *Bird Conserv. Internatn.* 12: 1–18.
- Wetlands International (2016) *Waterbird population estimates*. Retrieved from wpe.wetlands.org on Saturday 31 December 2016.
- Yee, A. T. K., Ang, W. F., Teo, S., Liew, S. C. and Tan, H. T. W. (2010) The present extent of mangrove forests in Singapore. *Nature in Singapore* 3: 139–145.
- Zöckler, C. and Bunting, G. C. (2006) Bangladesh 2006 Expedition Report. Unpublished report to the Deutsche Ornithologen Gesellschaft.
- Zöckler, C., Syroechkovskiy, E. E., and Bunting, G. (2008) *International Single Species Action Plan for the conservation of the Spoon-billed Sandpiper *Calidris pygmeus**. On behalf of BirdLife International for the CMS.
- Zöckler, C. Syroechkovskiy, E. E. and Atkinson, P. W. (2010a) Rapid and continued decline in the Spoon-billed Sandpiper *Eurynorhynchus pygmeus* indicates imminent extinction unless conservation action is taken. *Bird Conserv. Internatn.* 20: 95–111.
- Zöckler, C., Htin Hla, T., Clark, N., Syroechkovskiy, E., Yakushev, N., Daengphayon, S. and Robinson, R. (2010b) Hunting in Myanmar: a major cause of the decline of the Spoon-billed Sandpiper. *Wader Study Group Bull.* 117: 1–8.
- Zöckler, C., Beresford, A. E., Bunting, G., Chowdhury, S. U., Clark, N. A., Fu, V. W. K. Hla, T. H., Morozov, V. V., Syroechkovskiy, E. E., Kashiwagi, M., Lappo, E. G., Tong, M., Long, T. L., Yu, Y., Huettmann, F., Akasofu, H. K., Tomida, H. and Buchanan, G. M. (2016) The winter distribution of the Spoon-billed Sandpiper *Calidris pygmaeus*. *Bird Conserv. Internatn.* 1–14.

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