

# The importance of the Myeik mangroves and mudflats, Tanintharyi, Myanmar for migratory waders and other waterbirds

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From December 2013 to November 2017, eight bird surveys were conducted in the mangroves and mudflats of the Myeik Archipelago, Tanintharyi, Myanmar. The archipelago stretches over ca. 620,000 ha, and its mudflats and mangroves host more than 32,000 migratory waders, gulls and terns. We detected six globally threatened and nine Near-threatened species, including two stork and one heron species. The globally Critically Endangered Spoon-billed Sandpiper *Calidris pygmaea* was found at two sites, and at least 60 Endangered Nordmann's Greenshanks *Tringa guttifer* were confirmed at three different sites. Globally Endangered Great Knots *Calidris tenuirostris* were observed at several locations, including a flock of over 2,000 individuals. New wader species recorded for the Tanintharyi Province were the Far-Eastern Curlew *Numenius madagascariensis*, Grey-tailed Tattler *Tringa brevipes* (both also new for Myanmar) and Crab Plover *Dromas ardeola*. The more than 2,000 Eurasian Curlews *Numenius arquata*, representing >1% of the flyway population of this globally Near-threatened species, were among the ten waterbird species (including six wader species) that occurred in internationally important concentrations. The area therefore qualifies as a Wetland of International Importance under the Ramsar Convention. A cluster of coastal wetland sites is proposed for Ramsar designation within the wider setting of an UNESCO Biosphere Reserve, to protect the area from numerous threats, such as coastal development, mangrove degradation and hunting.

## Keywords

shorebirds  
conservation  
Ramsar

## INTRODUCTION

In 2014, the importance of the coastal wetlands of Myanmar for migratory waterbirds was first documented (Zöckler *et al.* 2014). This report identified parts of the Myeik Archipelago as an important site, based on preliminary surveys of ca. 25% of the area. The archipelago, however, has never been comprehensively surveyed. Older bird surveys reporting sporadic observations, mostly referring to non-waterbirds, were mentioned in overviews by Hume & Davidson (1878) and Smythies (1953). Scott (1989) lists 30 species of waders for the Northern Myeik Archipelago in his Directory of Asian Wetlands but does not provide further details, and refers largely to the list of species in Smythies (1953). Inskipp & Inskipp (2003) provided an annotated checklist of birds seen during a field trip in the archipelago, but they visited primarily the outer islands and not the mangroves and mudflats of

Auckland Bay and Whale Bay. Finally, Nature Conservation and National Parks Project, Burma (1982, 1983) noted a few birds seen during brief surveys of several islands and mainland areas in Tanintharyi Province.

Here, we summarise observations from eight separate in-depth surveys over the past five years in the Myeik Archipelago. From December 2013 to November 2017, the archipelago was surveyed eight times for birds and other biodiversity, during November–March and once in May (2015). The surveys were focused mainly on coastal habitats, especially intertidal mudflats and mangroves. We confirm its status as one of the most important coastal wetland regions for migratory waterbirds in Myanmar.

In this paper, special emphasis is given to migratory waders. However, to meet the criteria for the nomination of the area, by the Myanmar Government, as a Wetland of International Importance under the Ramsar Convention,

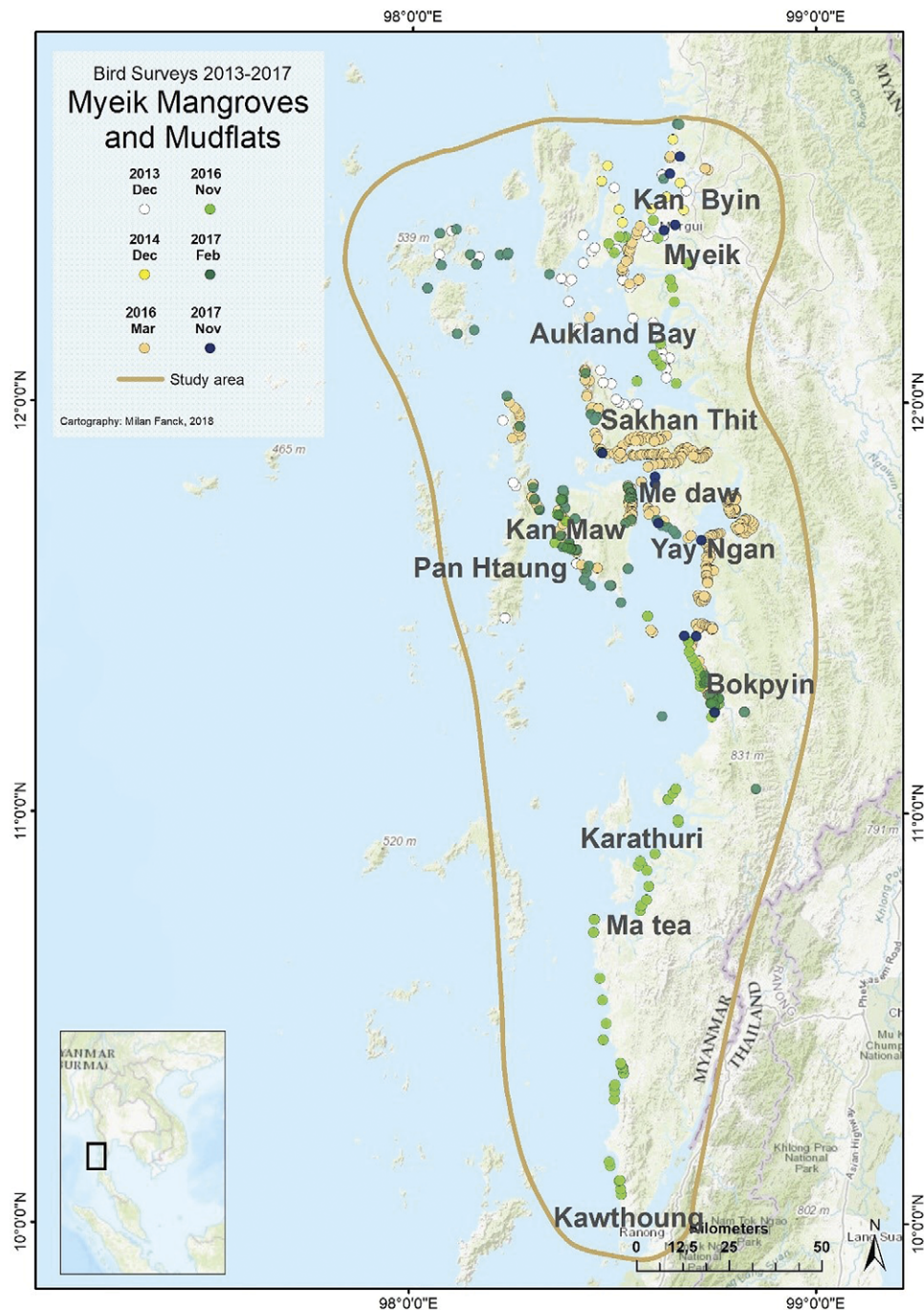


Fig. 1. Survey area in the Myeik Archipelago, Myanmar, December 2013–November 2017.

we also include information about gulls, terns and other waterbirds of conservation importance that utilise intertidal mudflats and mangroves.

## METHODS

### Site description

The 620,000 ha survey area extends from the coast *ca.* 50 km north of the city of Myeik, *ca.* 300 km south to the southern tip of Myanmar at Kawthoung (Fig. 1). The 5–10 km broad mangrove belt is interspersed with several

rocky islands and surrounded by intertidal mudflats. The islands are part of a large archipelago that continues seaward of the survey area. With increasing distance from the mainland these seaward islands have a decreasing area of mudflats and an increase in rocky coasts and reefs. The predominant coastal habitat in the region is mangrove forest (Fig. 2), which in most parts is mature and largely unharmed by human interference, although degradation from recent human impact is becoming apparent (Zöckler & Aung 2019). The mangroves are interspersed with numerous channels extending to intertidal mudflats varying in size and sediment characteristics. Shallow bays between

large islands are suitable for large numbers of waders, gulls and egrets. In shallow areas protected by the sea, most intertidal flats consist of deep mud that is impossible to walk through. Local people use wooden sledges to move across mudflats, when collecting crabs or shellfish or controlling fishing nets at low tide. Only a few areas near the mainland consist of sandier sediments and can be easily accessed. These sandier sites exist mostly in the very north of the study area and in the south near Bokpyin. The mangroves are very important for waterbirds as high-tide roosting sites. Even though some of the area is covered by permanent water or dense mangroves and not suitable for waterbirds, it was still impossible to survey the entire remaining area of suitable habitat in one survey period, and the surveys were spread out over several years.

### Timing of survey

During 2013–2017, eight surveys were designed specifically to provide complete coverage, allowing for repeated surveys of sites with higher concentration of key waterbird species (Table 1, Fig. 1).

### Team

Surveys of the mudflats and mangroves were organised by the FFI Tanintharyi Programme, jointly conducted with the Manfred-Hermsen Foundation by the authors (CZ, SM, STL) with support of Zaw Lunn and Ren Naung Soe (FFI), Peter Südbeck (Germany), Lay Win, U Soe Naing (University of Myeik), Zaw Aung and Pyae Phy Aung (BANCA) and Stefan Pfützke (*Greenlens.de*); see also Table 1.

### Equipment

Several different survey boats were used in the first years

from 2013 to 2016, but most were not suitable for accessing the survey sites. The preferred means of transport for the survey was a small boat of about 9 m in length that could cross larger areas of water and some degree of rough sea. This typical 9-m fishing boat was able to access shallow waters, at least at high tide, and could be grounded at low tide to access mudflats and approach high-tide roost sites. The boat, sleeping 4–6 people, was operated by the same boatman, Myo Lwin, for the southern surveys since spring 2016. Smaller, 3-m fishing boats, each seating a maximum of two observers plus boatman, were hired on-site when available to explore shallower areas. Some areas north of Myeik and near Bokpyin were accessed from the land by motorcycles.

For observations we used binoculars (8–10 x 40) and three zoom telescopes (30–70 x 85). Digital cameras were often used to identify bird species in magnified images. Bird observations included all waterbirds but here only waders, gulls and terns will be considered (see species and scientific names in Table 2), because these taxa were recorded on a daily basis, in significant numbers. Most bird records were also tagged with GPS coordinates, using a mobile phone application specifically designed for entering data on bird numbers and health status of mangrove habitats.

## RESULTS & DISCUSSION

### Waterbird abundance & distribution

From December 2013 to November 2017, more than 270 bird species were recorded, including 74 waterbird species. Most of the waterbirds were waders (32 species) or gulls and terns (*Laridae*; 12 species). The remainder were storks, egrets, ibises, rails and one duck species.

**Table 1.** Timing and means of the waterbird surveys in the Myeik mangroves and mudflats, Myanmar, during 2013–2017.

Survey number	Period	Map legend (see Fig. 2)	Sites visited	Transport means	Team
1	3–22 Dec 2013	2013 Dec	Myeik, Auckland Bay, Kan Maw, Pan Htaung	Initial exploration trip by boat	CZ, SM, Zaw Lunn, Peter Südbeck, Nyen Chan
2	28 Nov–2 Dec 2014	2014 Dec	N of Myeik	By boat and on foot	CZ, SM
3, 4	28 Jan–1 Feb 2015 5–6 May 2015		N of Myeik	Short day trips by motorbike	SM, CZ, SM, Lay Win
5	3–17 Mar 2016	2016 Mar	Sakhan Thit – Kan Maw – Medaw – Yay Ngan Gyi – Bokpyin – Kan Maw	By boat and on foot	CZ, STL, Ren Noe Soe
6	17–25 Nov 2016	2016 Nov	Kawthoung – Bokpyin – Kan Maw – Sakhan Tit	By boat and on foot	CZ, STL, Soe Naing, Stefan Pfützke
7	23 Feb–4 Mar 9–12 Mar 2017	2017 Feb	Sakhan Thit – Kan Maw – Bokpyin – Pan Htaung – Daung – Thayawthadangyi Islands	By boat and motorbike	CZ, STL
8	25–30 Nov 2017	2017 Nov	Sakhan Thit – Medaw – Yay Ngan Gyi – Bokpyin	By boat and motorbike	CZ, STL, SM, Pyae Phy Aung, Soe Naing, Aung Thaw





Fig. 2. A mixed flock of waders among mangroves on a rising tide in the Myeik Archipelago, Myanmar.

The total number of waterbirds for the entire area exceeded 35,000, including 3,000–5,000 herons and egrets. Large congregations of waterbirds were found especially in the central and southern areas of the archipelago (regions III and IV; see Fig. 3, Table 2). The distribution of the four IUCN Red-Listed wader species shows that additional important areas for waders were found in the northern part (region I). Further important sites for other vulnerable waterbird species were found throughout the archipelago.

Waders are particularly important for the archipelago; of the 32 wader species and 12 gull and tern species, a total of *ca.* 32,100 individuals was observed on the Myeik coastal mudflats (Table 2, Fig. 3). These included four globally threatened (CR, EN, VU) and eight Near-threatened wader species (NT; details below), but also other East Asian and Arctic migrant waders that winter regularly in the Myeik Archipelago in large numbers. Several observations were first for the country. Note that some figures in Table 2 may not represent the wintering population in the area, since the numbers are based on counts in the first half of Mar 2016 (see Table 1), which overlaps with the migration period for many species.

Since not all sites in the survey area were visited, the total number of waders, gulls and terns may be even higher. For selected species and for some that are globally Near-threatened, the mudflats south of Sakhan Thit seemed very important (areas II and III in Fig. 3). This area between Sakhan Thit in the north and Karathuri in the south alone hosted over 25,000 waterbirds (Table 2). Of these important waterbird areas, Kan Maw, Pan Htaung and Medaw (III) and Bokpyin and Yay Ngan (IV) seemed most important, each hosting over 10,000 waterbirds.

Bokpyin had the highest concentration of globally Red-Listed species, with all six globally threatened waterbird species occurring here, some in significant numbers; e.g. a maximum of 50 Nordmann's Greenshanks in Jan 2019.

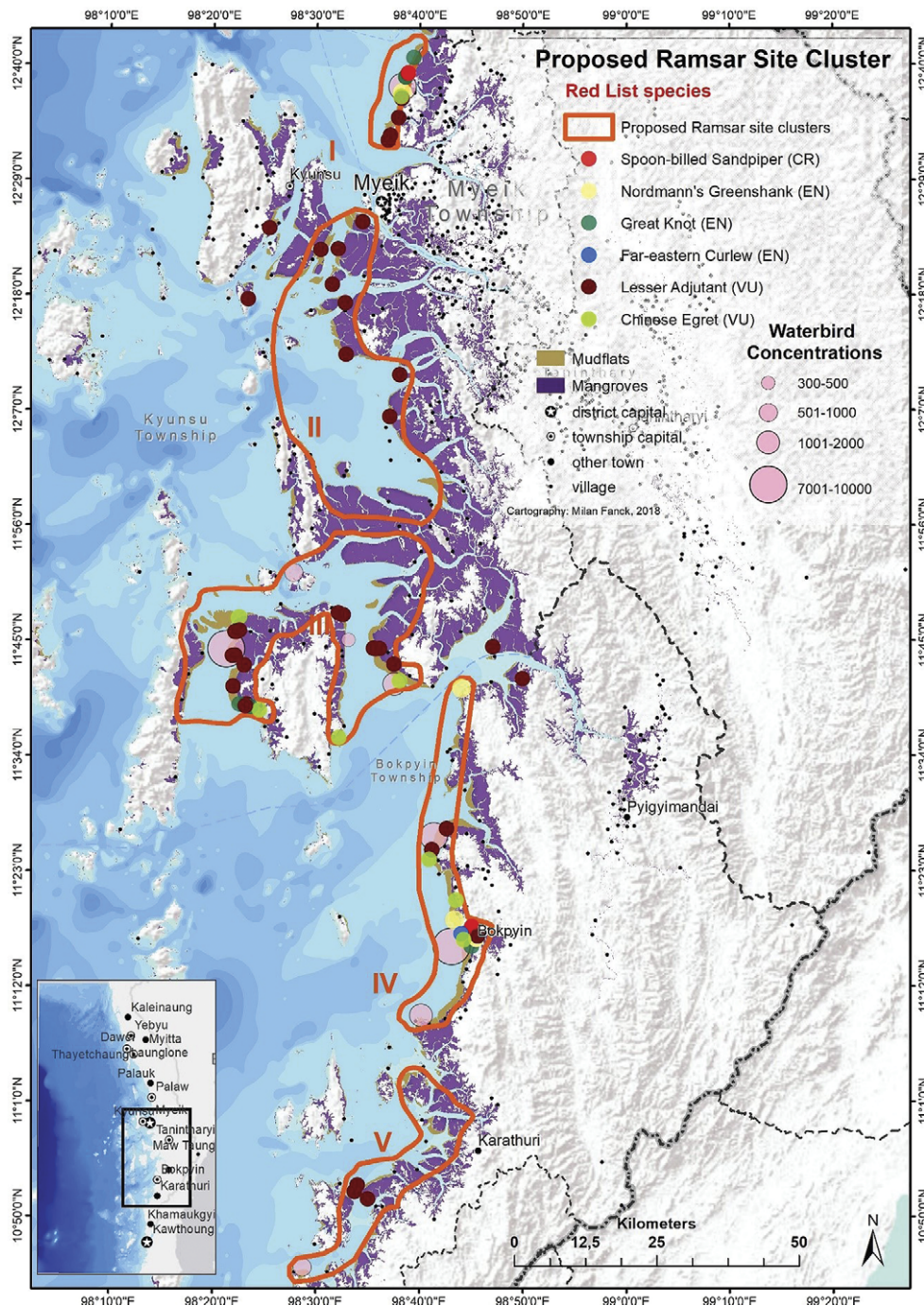
#### **Occurrence of globally threatened bird species**

A total of six globally threatened waterbird species and nine Near-threatened waterbird species were recorded along the Myeik coast (Table 3), highlighting the significance of the area for birds. The distribution of the observations of the globally threatened wader species is given in Fig. 3. Of the 12 threatened or Near-threatened species, nine species are strongly associated with intertidal mudflats and mangroves; the distributions of three examples (Bartailed Godwit, Eurasian Curlew and Asian Dowitcher) are shown in Fig. S2. Three additional non-waterbird species which depend on or favour mangrove habitats (Red-breasted Parakeet *Psittacula alexandri*, Brown-winged Kingfisher *Pelargopsis amauroptera*, and Mangrove Pitta *Pitta megarhyncha*) were observed but are not included in Table 3.

#### **Species accounts**

The following text provides details on the occurrence of 12 selected species in the Myeik Archipelago. This includes the four globally Red-Listed waders occurring in the area, and seven species that are noteworthy because they are globally Near-threatened or particularly important for this area because they are present in numbers exceeding 2% of their flyway populations (Wetlands International 2015); details on two species fulfilling these criteria (Lesser Sand-plover and Whimbrel) are not provided





**Fig. 3.** Significant waterbird concentrations of 300–10,000 waders, gulls and terns (pink circles; size scaled to four categories) and presence of six globally threatened waterbird species (CR = 1, EN = 3, VU = 2), including one stork and one egret species, highlighting the importance of the Myeik coastal wetlands. See Fig. S1 for details on numbers of globally threatened wader species.

because they show no clear clusters of distribution. Additionally, a first record of the Near-threatened Grey-tailed Tattler was previously published (Zöckler & Moses 2015). The extremely rare occurrence of Crab Plover is also highlighted.

In addition, Lesser Adjutant (Zöckler *et al.* 2014) and Chinese Egret (Zöckler & Lwin 2018b) were observed in large numbers. These two species are depicted in Fig. 3 and also listed in Tables 4 and 5, as the occurrence con-

tributes to the justification for the Ramsar nomination of the area, but are not discussed further in this paper.

**Spoon-billed Sandpiper (CR)** – On 30 November 2014, one Spoon-billed Sandpiper was observed at Kan Byin Beach north of Myeik in a flock of about 800 waders (see Figs. 3, S1). A revisit on 29 January 2015 confirmed one and possibly two birds. Subsequent surveys in the following years failed to relocate the birds. Approximately 120 km further south, near the coastal town of

**Table 2.** Distribution and abundance of selected waterbirds (waders, gulls and terns; Charadriiformes) in the Myeik mudflats during the survey periods between Dec 2013 and Nov 2017. For site locations see Fig. 2; Roman numerals refer to sections shown in Fig. 3. Presented are total maxima for each site from different survey periods. IUCN Red List status: CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near-threatened, blank = Least Concern or unknown status. Ramsar 1% = > 1% of the flyway population in at least one season; only given for species that approach or exceed this Ramsar criterion.

Common name	Scientific name	IUCN status	Ramsar 1%	Total 2013–2017	Kan Byin & T hit Yar War	Auckland Bay	Kan Maw, Sakhan Thit & Medaw	Yay Ngan – Bokpyin	Kawthoung – Karathuri
					I	II	III	IV	V
Beach Thick-knee	<i>Esacus neglectus</i>	NT		5	2		3		
Crab Plover	<i>Dromas ardeola</i>			1				1	
Pacific Golden Plover	<i>Pluvialis fulva</i>			468	39		150	255	24
Grey Plover	<i>Pluvialis squatarola</i>			233	133		32	61	7
Red-wattled Lapwing	<i>Vanellus indicus</i>			10	8			2	
Little Ringed Plover	<i>Charadrius dubius</i>			5				5	
Kentish Plover	<i>Charadrius alexandrinus</i>		1.4	1,374	66		1,010	250	48
Lesser Sand-plover	<i>Charadrius mongolus</i>		5.7	5,725	2,750	50	402	1,600	923
Greater Sand-plover	<i>Charadrius leschenaultii</i>			452	212		80	150	10
Bar-tailed Godwit	<i>Limosa lapponica</i>	NT		617	212	17	248 <sup>a</sup>	140	
Black-tailed Godwit	<i>Limosa limosa</i>	NT		203	3		200		
Whimbrel	<i>Numenius phaeopus</i>		3.1	1,871	233	200	996	370	72
Eurasian Curlew	<i>Numenius arquata</i>	NT	2.6	2,674	202	20	406	2,020	26
Far-Eastern Curlew	<i>Numenius madagascariensis</i>	EN		1				1	
Asian Dowitcher	<i>Limnodromus semipalmatus</i>	NT		24			4	20 <sup>a</sup>	
Terek Sandpiper	<i>Xenus cinereus</i>		2.0	1,003	105	90	421 <sup>a</sup>	320	67
Grey-tailed Tattler	<i>Tringa brevipes</i>	NT		1	1				
Common Sandpiper	<i>Actitis hypoleucos</i>			140	14	50		36	14
Common Greenshank	<i>Tringa nebularia</i>			203	39	3	50	80	31
Nordmann's Greenshank	<i>Tringa guttifer</i>	EN	6.6	66	16			50 <sup>b</sup>	
Marsh Sandpiper	<i>Tringa stagnatilis</i>			1					1
Common Redshank	<i>Tringa totanus</i>		3.6	3,568	300	320	2,037	500	411



Table 2 continued...

Common name	Scientific name	IUCN status	Ramsar 1%	Total 2013–2017	Kan Byin & T hit Yar War	Auckland Bay	Kan Maw, Sakhan Thit & Medaw	Yay Ngan – Bokpyin	Kawthoung – Karathuri
Spotted Redshank	<i>Tringa erythropus</i>			3	3				V
Wood Sandpiper	<i>Tringa glareola</i>			3				2	1
Great Knot	<i>Calidris tenuirostris</i>	EN		2,667	267		2,150 <sup>a</sup>	250	
Sanderling	<i>Calidris alba</i>			4	2			2	
Little/Red-necked Stint	<i>Calidris minuta/ruficollis</i>	NT		703	349	1	1	352	
Curllew Sandpiper	<i>Calidris ferruginea</i>	NT		178	62		50	66	
Spoon-billed Sandpiper	<i>Calidris pygmaea</i>	CR		3	1			2	
Broad-billed Sandpiper	<i>Limicola falcinellus</i>			25	5			20	
Ruddy Turnstone	<i>Arenaria interpres</i>			25			1	24	
Small Pratincole	<i>Glareola lactea</i>			1	1				
Pallas' Gull	<i>Larus ichthyaetus</i>			1	1				
Brown-headed Gull	<i>Chroicocephalus brunneicephalus</i>		4.3	6,144	700		2,566	2,790	88
Black-headed Gull	<i>Chroicocephalus ridibundus</i>			2	1		1		
Mew Gull	<i>Larus canus</i>			1				1	
Caspian Tern	<i>Hydroprogne caspia</i>			1	1				
Gull-billed Tern	<i>Gelochelidon nilotica</i>		0.8	314			50	243	21
Lesser Crested Tern	<i>Sterna bengalensis</i>			389	175		10	180	24
Greater Crested Tern	<i>Sterna bergii</i>			845	80		53	290	422
Common Tern	<i>Sterna hirundo</i>			974			920	54	
Little Tern	<i>Sternula albifrons</i>			1,165	120		105	720	220
White-winged Tern	<i>Chlidonias leucopterus</i>			1			1		
Whiskered Tern	<i>Chlidonias hybrida</i>			8			2	5	1
<b>Total</b>				<b>32,058</b>	<b>6,103</b>	<b>751</b>	<b>11,975</b>	<b>10,862</b>	<b>2,411</b>

<sup>a</sup> Figure based on Mar 2016 count; <sup>b</sup> Recent figure from Feb 2019 (Nordmann's Greenshank only)

Bokpyin, two Spoon-billed Sandpipers were discovered on 22 November 2016 and again one bird on 25 November 2017, at the same location feeding among a flock of small waders of about 500 birds near the mouth of the Bokpyin channel (see Figs. 3, S1). A visit on 23 January 2018, at the high-tide roost near the same location by two authors (SM and STL), confirmed that one bird was present in the area.

The area around Bokpyin appears to be suitable for this species as this area includes more sandy mudflats and more wintering birds might roost here. The area is difficult to survey as access was only possible with small boats. Together with the 1–2 birds in Kan Byin Beach north of Myeik, the Myeik archipelago hosts an estimated 4–5 wintering birds.

**Nordmann's Greenshank (EN)** – On 29 and 30 November 2014, four Nordmann's Greenshanks were recorded at a high-tide roost at Kan Byin Beach, north of Myeik. In the following year these were confirmed and three juvenile or second calendar year birds stayed until early May 2015. On 22–23 November 2016, a maximum of 23 birds were found in the mudflats north of Bokpyin (Fig. S1). At the same site at least 17 birds were found in late November 2017. A recent survey by SM in Feb 2019 paid special attention to this species and revealed at least 50 Nordmann's Greenshanks in the area north of Bokpyin. On 25 November 2017, a new site was found with at least nine birds in Yay Ngan mudflats ca. 50 km north of Bokpyin (Fig. 3). At

the same time in late November 2017, a record total of 14 Nordmann's Greenshanks was observed after an intensive search at the wider Kan Byin Beach area (Fig. S1). The total of over 60 individuals confirms the importance of these sites for this globally Endangered wader species. The Myeik mangroves and mudflats constitute the largest flock of Nordmann's Greenshanks in Myanmar, more than the previously recorded 46–48 birds that wintered in the Ayeyarwaddy Delta in 2015 and 2016 (Zöckler *et al.* 2018a).

**Great Knot (EN)** – The Great Knot has undergone serious declines due to habitat loss in its prime stopover and moulting sites in the Yellow Sea (e.g. Moores *et al.* 2008) and was uplisted to globally Endangered (EN) in 2015 (BirdLife International 2017). Compared to other Endangered wader species, however, it is still relatively common, with a global population currently estimated at 290,000–295,000 individuals (Wetlands International 2015). With flocks of 2,000 and 150 in the mudflats west of Kan Maw and 250 near Bokpyin in Feb 2017 and 190 north of Myeik in Nov 2017, the Myeik Archipelago is the most important wintering site for the species in Myanmar (Figs. 3, S1). The Myeik intertidal mudflats might all together host over 2,600 birds and are one of the most important wintering grounds outside Australia, along with the Inner Gulf in Thailand, the Selangor coast in Malaysia and the Mekong Delta (Round & Bakewell 2015).

**Table 3.** Abundance of Red-Listed waterbird species within the Myeik Archipelago survey area during Dec 2013–Nov 2017. Estimated totals (right column) are projections of total abundance based on expert opinion, reflecting survey data, expected occurrence in unsurveyed or poorly surveyed areas, and additional observations subsequent to the survey period.

Common name	Scientific name	IUCN status	Max. 2013–2015	Mar 2016	Nov 2016	Feb/Mar 2017	Nov 2017	Estimated total
Spoon-billed Sandpiper	<i>Calidris pygmaea</i>	CR	1		2	2	1	4–5
Nordmann's Greenshank	<i>Tringa guttifer</i>	EN	5	3	23	20+	40–48	60–70
Great Knot	<i>Calidris tenuirostris</i>	EN	150	840	350	2,250	380	2,700
Far-Eastern Curlew	<i>Numenius madagascariensis</i>	EN				1		
Lesser Adjutant Stork	<i>Leptoptilos javanicus</i>	VU	19	22	7	8	9	50–75
Chinese Egret	<i>Egretta eulophotes</i>	VU				28	37	100
Black-headed Ibis	<i>Threskiornis melanocephalus</i>	NT	10	18	–	–	21	20–25
Beach Thick-knee	<i>Esacus neglectus</i>	NT	2	2		3	2	40–50
Eurasian Curlew	<i>Numenius arquata</i>	NT		1,650	1,300	2,500	1,400	3,000
Bar-tailed Godwit	<i>Limosa lapponica</i>	NT	20	230	350	300	263	800
Black-tailed Godwit	<i>Limosa limosa</i>	NT			200	–	–	300
Asian Dowitcher	<i>Limnodromus semipalmatus</i>	NT	–	25	–	4	–	50
Grey-tailed Tattler	<i>Tringa brevipes</i>	NT	1					
Curlew Sandpiper	<i>Calidris ferruginea</i>	NT		20	100	–	–	200
Red-necked Stint	<i>Calidris ruficollis</i>	NT		30	350	110	340	700



**Far-Eastern Curlew (EN)** – One bird was observed among a flock of almost 2,000 Eurasian Curlews on 10 March 2017 in the Bokpyin area (Fig. S1). This is the first record of this species for Myanmar. Subsequent surveys have not recorded further sightings.

**Eurasian Curlew (NT)** – Almost 2,700 Eurasian Curlews have been recorded in the survey area, most of them in the Kan Maw and Bokpyin mudflats, representing 2.7% of the global flyway population. The total number might be even higher, when all areas have been surveyed. The Bokpyin mudflats alone supported a flock of 1,900 Eurasian Curlews, making the area around Bokpyin the most important site for the species in Myanmar (Fig. S2), and a site of national and flyway importance for this globally near-threatened species. The former combined total for the entire Gulf of Mottama of 2,146 individuals in 2010 (Zöckler et al. 2014) has not been reached in recent years (Pyae Phyo Aung et al. 2018) or anywhere else in SE Asia (Li & Mundkur 2007). The high-tide roost just north of Bokpyin might attract curlews from a large area and birds were observed flying into the roost from mudflat areas north and south of Bokpyin.

**Bar-tailed Godwit (NT)** – In total, over 600 individuals were observed, of which at least 388 were recorded in the Kan Maw and Bokpyin mudflats only (Table 2, Fig. S2). Although less than 1% of the flyway population, it represents (together with the Gulf of Mottama) the largest number wintering in Myanmar (Zöckler et al. 2014) and outside its main wintering areas in Australia and New Zealand. The birds observed in the Myeik Archipelago belong most likely to the Siberian population breeding in North Yakutia and Chukotka (*L. l. menzbieri*). The Alaska breeding population (*L. l. baueri*) has not been observed but could have easily been overlooked.

**Asian Dowitcher (NT)** – A total of 25 individuals were observed roosting in mangroves and on fishing racks in Yay Ngan Gyi and West Kan Maw in March 2016 (Fig. S2), but none were recorded in Nov 2016 and Nov 2017. In February 2017 at least four birds were observed in the mudflats in West Kan Maw. This globally near-threatened bird has been rarely observed in Myanmar (Zöckler et al. 2014). Actual numbers could be higher as only a part of the mudflats was surveyed and a huge flock was only partly scanned before it flew to the high-tide roost. The Asian Dowitcher breeds in the steppe region of Mongolia, China and southern Siberia and has suffered strong declines in recent years (Wetlands International 2015). The presence of Asian Dowitcher in the surveyed mudflats and in Myanmar is not surprising, considering the presence of up to 600 birds in the neighbouring Inner Gulf of Thailand (Round 2006), but confirms the importance of the mudflats for migratory waterbirds.

**Terek Sandpiper** – A total of over 1,000 birds in the Myeik mudflats (Table 2, Fig. S3) represents 2% of the flyway population and hence exceeds the Ramsar 1% threshold. The species is largely solitary and, similar to Common Sandpiper, widely dispersed across the entire survey area. But there are two distinct places with high

concentrations of flocks totalling 150 birds in Auckland Bay and exceeding 200 birds in Kan Maw West, which appeared unusual, reflecting a special type of mudflat habitat suitable for the species. This number is by far the highest recorded in Myanmar, surpassing the maxima of 317 and 150 respectively, observed in the Gulf of Mottama and Ayeyarwady Delta (Zöckler et al. 2014). Among the flock of over 200 Terek Sandpiper, one bird was noticed on 25 November 2016 near Kan Maw island with an orange flag indicating it had been marked in North-west Australia. This suggests that, in addition to being a wintering area for Terek Sandpiper, it may also be a staging site for birds wintering in more southern areas of the East Asian–Australasian Flyway.

**Common Redshank** – This species is one of the most common and widespread waders in the region. Over 3,500 Common Redshanks were observed in the survey area (Table 2), but the number could be much higher, as the species is widespread and often difficult to spot, hiding deep within the mangroves at high tide. The mudflats west of Kan Maw (see Fig. S3) host more than 1,200 birds and appear to be very important for this species. Many birds are roosting dispersed in smaller flocks across the mangroves and it is quite likely that a large number of Redshanks had been overlooked. The total number is already above the Ramsar 1% threshold of the flyway population.

**Beach Thick-knee (NT)** – Close to the mangrove and mudflat belt are small islands, some of which host breeding Beach Thick-knees, which prefer uninhabited or little-disturbed small islands. On 3 March a nest with one egg was found on Johnny Island east of Thayawdayangyi. This is the first breeding record for the species in Myanmar, which is widely but sparsely distributed across the Myeik Archipelago. The total population is estimated to be 40–50 pairs (Zöckler & Lwin 2018a).

**Crab Plover** – One second-year Crab Plover was observed among a flock of over 100 Gull-billed Terns north of Bokpyin on 10 March 2017. This is the first record for Tanintharyi and only the second record for Myanmar (Thet Zaw Naing pers. comm.).

**Brown-headed Gull** – Among gulls and terns, the Brown-headed Gull was the most numerous species and the only one of this group fulfilling the 1% Ramsar criterion, represented by over 6,000 birds or 4.3% of the flyway population (see Table 2, Fig. S3). This is the highest number recorded for this species in Myanmar. Similar numbers of 2,800 were recorded in the Eastern Ayeyarwaddy Delta (Zöckler et al. 2014) but hardly anywhere else in SE Asia (BirdLife International 2001), apart from the Inner Gulf of Thailand where over 8,000 birds were present (Round 2006).

## CONCLUSIONS

### Future monitoring

The area is very large, partly difficult to access, and it is impossible to repeat surveys annually in the entire area

with currently available funding and manpower. However, it is recommended that key areas are surveyed regularly to provide regular and valuable insights into the trends and responses of waterbird species to management changes and various threats and pressures. The applied methodology demonstrated that it is possible to obtain at least an overview of important areas for waders and waterbirds. Over such a large area there will likely be errors in the numbers, and the iterative approach of adding data from different years and different seasons across the large area might reveal errors and weaknesses. The survey would benefit from a wider and more simultaneous coverage, but most important is observer consistency and future training of local people in waterbird identification.

### **Threats to waterbirds**

**Development** – The biggest potential threat to the area is coastal development. The Myeik Archipelago is close to the booming regional city and commercial hub of Myeik. The city is expanding and increasingly encroaching into the mangroves and mudflats. Many pristine mangrove areas have been converted or degraded. Mangrove degradation might additionally alter sediment flow and content, and hence also impact wader habitat. The southern town of Bokpyin is likely to expand too, threatening potentially valuable intertidal mud and sandflats as well as mangroves north and south of the town. Although no immediate plans are known, it is important to secure long-term protection for these valuable sites. Other forms of coastal development include aquaculture, partly supported by European aid agencies, which is potentially detrimental to the conservation goals of securing the existing mangroves and mudflat areas (Wudan 2019).

**Hunting** – Little is known about the hunting pressure in the region but the few interviews undertaken by the authors to determine the scale of bird hunting, revealed a similar picture that is well known along the entire coast of Myanmar. Whenever there are larger flocks of waterbirds (>1,000 individuals), bird hunters are setting up their traps, as revealed by interviews with the villagers of Kan Byin in the northern part of the area; the same is true for Nipa village near Bokpyin. Attracted mainly by regular roosts of almost 2,000 Eurasian Curlews, local hunters target primarily larger shorebirds, such as curlews, Whimbrel and godwits. In the Bokpyin area, bird hunting has been reported but the scale and impact is not known, although according to preliminary surveys little hunting is taking place (Pyae Phyo Aung 2018). Further exploration is required to establish the level of hunting across the survey area. Close collaboration with the communities is essential when undertaking socio-economic surveys. Applying the experiences gained in the Gulf of Mottama and other places along the coast of Myanmar hunting mitigation measures can be negotiated with the local communities (Pyae Phyo Aung 2016).

### **Conservation recommendations**

The mangroves and mudflats of the Myeik Archipelago are one of the most important sites for migratory waterbirds

in Myanmar. The numbers and diversity of waterbirds attest to the high ecological integrity of the area. However, the mangroves in particular are subjected to unsustainable harvest and degradation which could impact the area (Graham 2017). Urgent action is required to save the remaining intact mangroves of Myanmar and the adjacent mudflat areas. While the Ramsar site designation would protect the key areas important for waterbirds in the region, the mangroves and adjacent coastal habitats might not be covered. The creation of a large overarching Biosphere Reserve would be ideal, which then could incorporate the proposed Ramsar sites as core areas. A mix of immediate law enforcement, community involvement and income incentives is recommended. The creation of Ramsar sites as proposed (Fig. 3), embedded in a Biosphere Reserve, is crucial to provide the framework for the sustainable future of this region and its people.

**Ramsar site and criteria** – The international Ramsar Convention on the protection of wetlands has been signed by almost all nations in the world, including Myanmar. By the end of 2018, Myanmar had designated five sites ([www.ramsar.org](http://www.ramsar.org)). Many more coastal sites, including the survey area, would qualify. Four out of nine criteria are met within the Myeik mangrove and mudflat cluster and justify the nomination of the area as a Ramsar site. These are:

**Criterion 2: Rare species** – In total six globally threatened waterbirds and nine Near-threatened waterbirds fulfil criterion 2 (Table 5).

**Criterion 4: Critical life-cycle stage** – Lesser Adjutant Stork (VU) nests in all five sections of the survey area.

**Criterion 5: 20,000 waterbird threshold** – In Table 2 the counts from all five sections represent more than 32,000 waders, gulls and terns. This criterion is achieved even without the additional 3,000–5,000 egrets and herons.

**Criterion 6: 1% of waterbird flyway population** – Table 5 summarises sites for those species that fulfil this criterion for each section in the survey area. In total, eleven species qualify for this criterion (Table 4).

The mudflats and mangroves of this area clearly meet these Ramsar criteria, and it seems to be one of the most important sites in Myanmar yet to be listed under the Wetland Convention. The unique type and status of largely unaffected mangroves and mudflats would further add to the value, potentially meeting criterion 1 for ‘representative, rare, or unique wetland types’.

Although counts were accumulated from different sites and different survey periods, repeated surveys of key areas holding large numbers confirmed similar figures present in different years (see also Table 5). Considering the congregation of waterbirds and globally threatened species at some sites, the proposed cluster of the several distinct sites can be summarised into one Ramsar site designation. Only in this combined form will all sites together meet criteria 5 and 6 for a total of eleven waterbird species. In Table 5, each section of the Myeik Ramsar cluster is listed separately. Each of the clusters



**Table 4.** Eleven waterbird species (8 waders, 1 gull, and 2 additional waterbirds) with populations of ‘significant importance’ (present in numbers equal to or exceeding 1% of their flyway populations) in the Myeik mangroves and mudflats during survey periods between Dec 2013–Nov 2017.

Common name	Scientific name	IUCN status	% of population	Total Myeik mangrove & mudflat cluster
Lesser Adjutant Stork	<i>Leptoptilos javanicus</i>	VU	1	50+
Chinese Egret	<i>Egreta eulophota</i>	VU	1.3	65
Kentish Plover	<i>Charadrius alexandrinus</i>		1.4	1,374
Lesser Sand-plover	<i>Charadrius mongolus</i>		5.7	5,725
Greater Sand-plover	<i>Charadrius leschenaultii</i>		1.5	1,500 <sup>a</sup>
Whimbrel	<i>Numenius phaeopus</i>		3.1	1,871
Eurasian Curlew	<i>Numenius arquata</i>	NT	2.6	2,674
Terek Sandpiper	<i>Xenus cinereus</i>		2	1,003
Nordmann’s Greenshank	<i>Tringa guttifer</i>	EN	6.6	66
Common Redshank	<i>Tringa totanus</i>		3.6	3,568
Brown-headed Gull	<i>Larus brunneicephalus</i>		4.3	6,144

<sup>a</sup> Includes 900 individuals outside the identified potential Ramsar sites.

**Table 5.** Internationally important wetland sites within the wider Myeik mangrove and mudflat belt meeting Ramsar criteria. Ramsar criteria 2, 4 and 6 applied for waders and some selected important waterbirds for the survey period 2013–2017. The criteria are further supported by other forms of biodiversity (e.g. mammals such as dolphins and otter) which are not part of this publication (see Zöckler et al. 2018b).

Coastal section (see Fig. 3)	Name	Criterion 2: Threatened Species	Criterion 4: Critical life-cycle stage	Criterion 5: 20,000 waterbirds	Criterion 6: 1% of flyway population	Survey regularity
I	Kan Byin Beach & surrounding areas	Spoon-billed Sandpiper (CR), Nordmann’s Greenshank (EN), Great Knot (EN), Lesser Adjutant Stork (VU), Chinese Egret (VU)	Lesser Adjutant Stork nesting	—	Lesser Sand-plover (2–2.7%), Nordmann’s Greenshank (1.6%)	Visited five times during 2013–2018. Numbers confirmed but Spoon-billed Sandpiper not recorded since 2015.
II	Auckland Bay	Lesser Adjutant Stork (VU), Chinese Egret (VU)	Lesser Adjutant Stork nesting	—	—	Visited only in 2013 and 2016. Repeated surveys necessary.
III	Kan Maw, Sakhant Thit & Medaw	Great Knot (EN), Lesser Adjutant Stork (VU), Chinese Egret (VU)	Lesser Adjutant Stork nesting	—	Kentish Plover (~1%), Whimbrel (1.9%), Redshank (2%), Brown-headed Gull (1.8%)	Thoroughly surveyed twice in 2016 and once in 2017 and figures varied due to difficult access of most sites. Repeated surveys necessary to confirm numbers.
IV	Bokpyin & Yay Ngan	Spoon-billed Sandpiper (CR), Nordmann’s Greenshank (EN), Great Knot (EN), Far-Eastern Curlew (EN) Lesser Adjutant Stork (VU), Chinese Egret (VU)	Lesser Adjutant Stork nesting	—	Lesser Sand-plover (1.6%), Eurasian Curlew (2%), Nordmann’s Greenshank (5%), Brown-headed Gull (2%)	Core areas near Bokpyin have been regularly surveyed more than three times since 2016, confirming their importance for waterbirds.
V	Kawthoung-Kharaturi	Lesser Adjutant Stork (VU)	Lesser Adjutant Stork nesting	—	Lesser Sand-plover (0.9%)	Surveyed only once. Area is relatively large and could reveal higher numbers of waterbirds.

meets at least one of criteria 2, 4 and 6, but sections II (Auckland Bay) and V (Kawthoung–Kharaturi) are the weakest with only one criterion met each. However, both sites have been infrequently visited and repeated surveys might reveal higher numbers.

Even though sites II and V meet only one out of four criteria, a cluster of five Ramsar sites is proposed (see Fig. 3, Table 5), considering also the unique and mature mangrove and mudflat habitats in the context of the entire coastal region (criterion 1). The core areas, such as I, III and IV could provide the core areas for a future Biosphere Reserve (Zöckler *et al.* 2018b).

**Biosphere Reserve** – Together with a cluster of proposed Ramsar sites as core areas and the adjacent communal forest and fishing zones the total area would benefit from different forms of protection, secured and managed for the future as a UNESCO Biosphere Reserve. Especially in combination with community conservation areas (CCA) and Ramsar sites, the coastal mangrove and mudflat belt could provide the level of protection and zonation necessary in a Biosphere Reserve. It could provide a unique framework for the co-management of the area that could secure the long-term needs of the local communities to develop sustainably and avoid the vicious cycle of ecological and social destruction. This can be achieved if all communities and stakeholders involved work together and collaborate for a common goal and are fully supported by the national and international agencies and organisations.

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## ONLINE SUPPLEMENTARY MATERIAL

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**Fig. S1.** Distribution in the Myeik Archipelago of four

globally Endangered or Critically Endangered waders: Spoon-billed Sandpiper, Nordmann's Greenshank, Far-Eastern Curlew and Great Knot.

**Fig. S2.** Distribution in the Myeik Archipelago of three selected Near-threatened wader species that are strongly associated with tidal mudflats: Eurasian Curlew, Bar-tailed Godwit and Asian Dowitcher.

**Fig. S3.** Distribution in the Myeik Archipelago of three selected species of 'significant importance' that are strongly associated with tidal mudflats: Redshank, Terek Sandpiper and Brown-headed Gull.

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*Supplementary material for*

## **The importance of the Myeik mangroves and mudflats, Tanintharyi, Myanmar for migratory waders and other waterbirds**

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This PDF contains:

**Fig. S1.** Distribution in the Myeik Archipelago of four globally Endangered or Critically Endangered waders: Spoon-billed Sandpiper, Nordmann's Greenshank, Far-Eastern Curlew and Great Knot.

**Fig. S2.** Distribution in the Myeik Archipelago of three selected Near-threatened wader species that are strongly associated with tidal mudflats: Eurasian Curlew, Bar-tailed Godwit and Asian Dowitcher.

**Fig. S3.** Distribution in the Myeik Archipelago of three selected species of 'significant importance' that are strongly associated with tidal mudflats: Redshank, Terek Sandpiper and Brown-headed Gull.

**Fig. S1.** Distribution in the Myeik Archipelago of four globally Endangered or Critically Endangered waders (see Table 3): Spoon-billed Sandpiper, Nordmann's Greenshank, Far-Eastern Curlew and Great Knot.

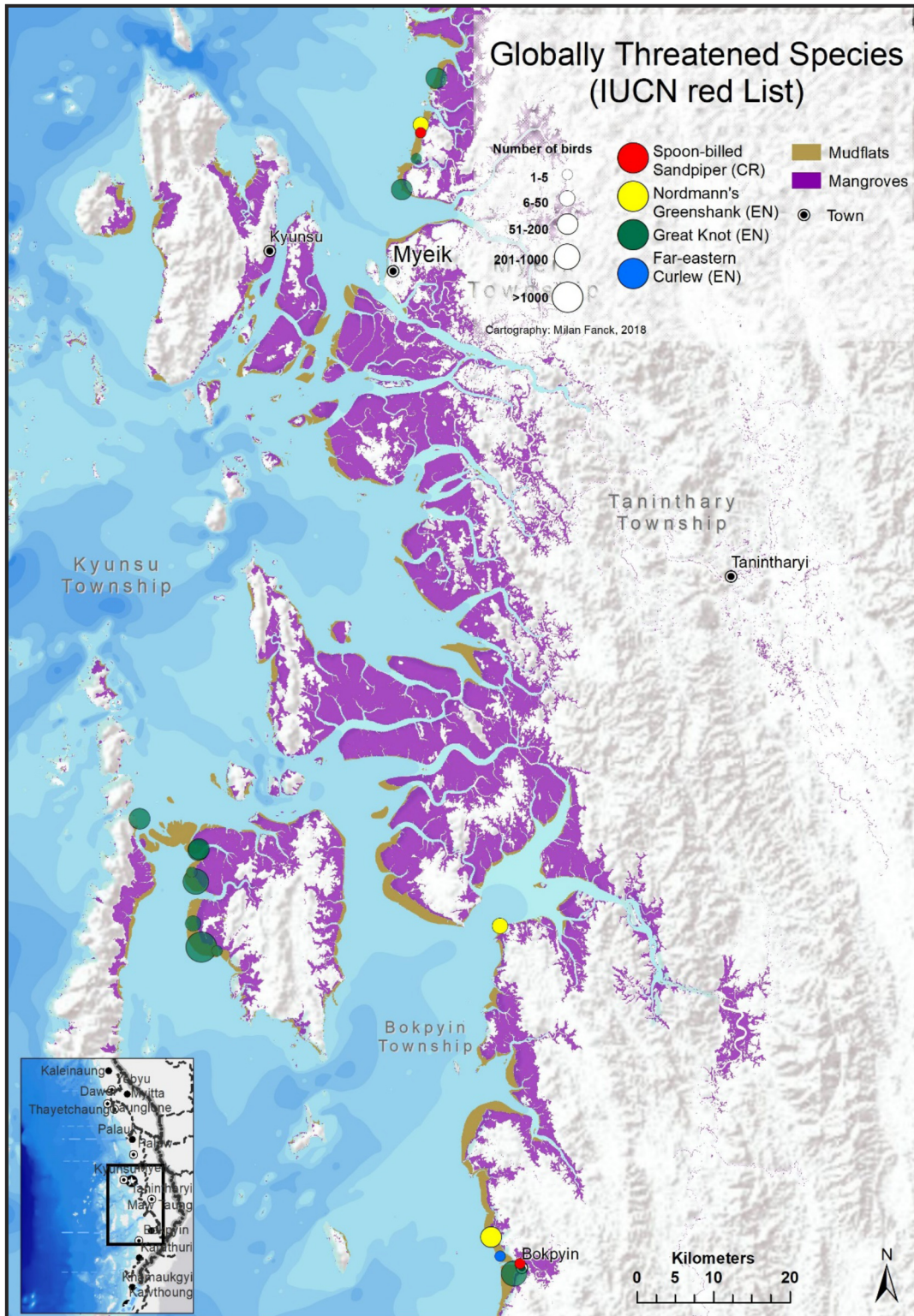
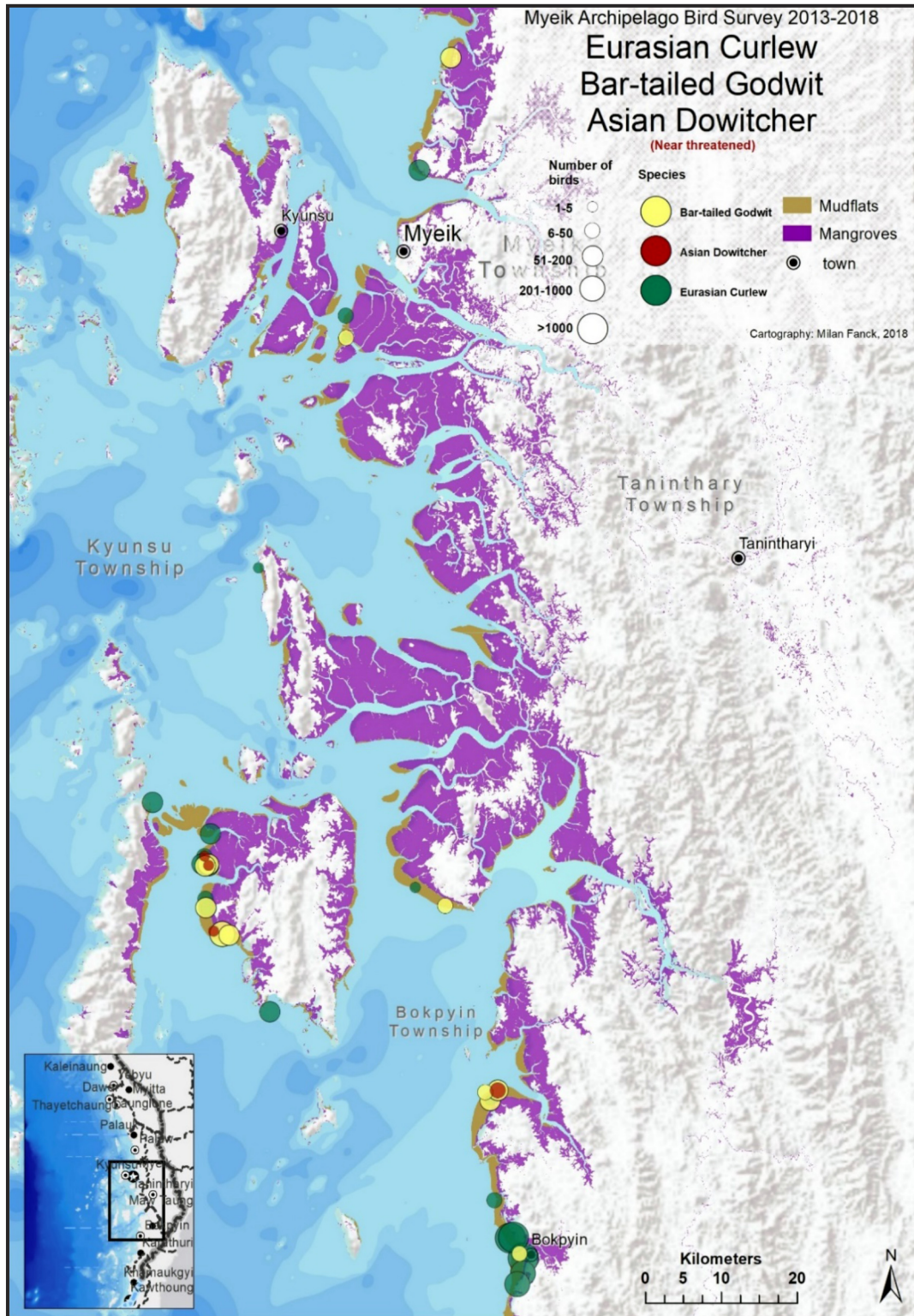




Fig. S2. Distribution in the Myeik Archipelago of three selected Near-threatened wader species (see Table 3) that are strongly associated with tidal mudflats: Eurasian Curlew, Bar-tailed Godwit and Asian Dowitcher.





**Fig. S3.** Distribution in the Myeik Archipelago of three selected species of 'significant importance' (present in numbers equal to or exceeding 1% of their flyway populations as listed in Table 4) that are strongly associated with tidal mudflats: Redshank, Terek Sandpiper and Brown-headed Gull.

