global flyway network
Team Piersma

SHOREBIRD NORTHWARD MIGRATION THROUGH THE LUANNAN COAST, BOHAI BAY, CHINA, APRIL – JUNE 2024

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Red Knots and other shorebirds on Nanpu mudflats, 2 May 2024 © Katherine Leung

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Shorebirds flying above Nanpu mudflats, 17 May 2024. © Katherine Leung

Summary

This is the fifteenth year in a row for Global Flyway Network (GFN)'s fieldwork at the Luannan Coast, Bohai Bay, China. Chris Hassell, Katherine Leung and Yang Liu carried out the fieldwork for 5 weeks, from 29 April to 2 June 2024, 35 days in total.

The main findings from this year's fieldwork showed that in 2024, Red Knot *Calidris canutus* number recovered from the low number in 2023. The biggest day count was 13,000 on 23 and 27 May at Nanpu. The number of Red Knot using the Luannan Coast varies a lot from year to year. The 2018 (48,630) and 2019 (47,537) counts were our highest since 2015, and the lowest was 3,660 in 2023 since the start of our studies in 2010. As none of the non-breeding areas of the East Asian – Australasian Flyway (EAAF) have had dramatic changes in the numbers of Red Knots utilising them in the 2023/24 season, so, despite the dramatic changes in numbers over the past 10 years at the Luannan Coast, we do not think there is a flyway-wide crash in Red Knot numbers. We believe that the northward migration pattern of Red Knot has changed in recent years and the fluctuating numbers of Red Knot at Nanpu are also impacted by the local food abundance. The biggest day counts of Red Knot this year is equivalent to 11.8% of the EAAF Red Knot population, highlighting the importance of the Luannan Coast to EAAF's Red Knot.

This year, we recorded 1,288 marked shorebirds of 12 species from 21 marking locations throughout the EAAF, as well as from India on the Central Asian Flyway (CAF). One hundred and thirty-four birds were individually recognisable from the GFN colour-banding project in Northwest Australia (NWA), which is similar to 2023 but lower than most other years. The GFN colour band totals were dominated, as always, by Red Knot with 131 individuals identified, Great Knot *Calidris tenuirostris* with one and Bar-tailed Godwit *Limosa lapponica* with two. Despite the low number of records this year, these records still once again reflect the vital importance of the Luannan Coast for Red Knots from NWA and throughout the EAAF.

This 2024 season's work was made possible with financial support from Beijing Normal University (BNU) and GFN. Katherine Leung and Chris Hassell volunteered their time and expertise.

Red Knots and other shorebirds on Nanpu mudflats, 16 May 2024 © Katherine Leung

The Wetland Park Exhibition Center, 20 May 2024. © Chris Hassell

A list of species recorded in internationally important numbers has been compiled from GFN and BNU studies from 2010–2024. It is an effective way to give an indication of the immense importance of the Luannan Coast shorebird site. In the period 2015-2019, fourteen species of migratory shorebirds have been recorded in internationally significant numbers, including four species with an absolute minimum of 10% of their entire EAAF population passing through the Luannan Coast during northward migration. In addition to the migratory shorebirds and terns passing through the Luannan Coast, there are nine species we have recorded breeding within the study site from 2010 to 2024.

Both the mudflats and the adjacent ponds of the Luannan Coast are vital components of the area for shorebird conservation, and an important contributing factor to the local economy and jobs. Since October 2020, 5,791.6 ha of the Luannan Coast at Nanpu was protected as Hebei Luannan Nanpu Zuidong Provincial Wetland Park. Yet, we feel there has not been much positive progress in respect to the site as to be important for shorebirds. Proper strategic conservation management with careful planning and engagement with scientists from China is vital to enhance the status of this critical site. It is hoped that better communication can be set up between decision makers and scientists so that subsequent conservation management of the Wetland Park will ultimately enable the Red Knots and many other waterbird species of the EAAF to maintain sustainable population levels, as well as serving the local communities for sustainable economy and conservation awareness raising. GFN will endeavour to continue conservation efforts at the Luannan Coast in conjunction with BNU in the future.

Red Knot feeding in the salt pond, 1 Jun 2024. © Katherine Leung

Introduction

Most of the Yellow Sea intertidal mudflats are critical feeding areas for migratory shorebirds on their journeys to and from their breeding and non-breeding grounds. The areas used by migratory shorebirds are referred to as 'stop-over sites' (sites used mainly for a 'pit-stop', a rest) or 'staging sites' (sites used for more than a few days for serious refuelling). Birds spend from a few days to about six weeks at any one or several sites on their way north. The Luannan Coast is one such critical area and is particularly important to Red Knot (Piersma *et al.* 2016, Rogers *et al.* 2010). Red Knot are represented in the EAAF by three subspecies: *piersmai, rogersi* and *roselaari* (the latter is not part of this study because it only breeds on Wrangel Island in the Russian Far East and migrates to the Americas). The subspecies *piersmai* and *rogersi* breed in different locations in the Siberian Arctic and share non-breeding locations in Australasia (Tomkovich 2001, Rogers *et al.* 2010), as well as South-east Asia.

Red Knots roosting at Nanpu salt pond, 27 May 2024. © Katherine Leung

Despite Red Knots having been one of the best researched shorebirds in the world for quite a long time (see, for example, summary in Piersma *et al*. 1997), we only started to understand the northward and southward migration strategies of the two subspecies that use the Luannan Coast, and changes to these strategies, as a consequence of habitat loss and change within the EAAF (Piersma *et al.* 2021). Surveys of the Yellow Sea by Mark Barter and Chinese colleagues did not find significant numbers of the species despite extensive searching in May 2000. During northward migration in 2002, they did record 14,277 in the north-west Bohai Bay region, now called the Luannan Coast (Barter *et al.* 2003). During a brief six-day visit in late April 2007, Chris Hassell from GFN counted a single flock of 10,650 Red Knot in the same region. In September 2007, Hongyan Yang, a Master postgraduate and then a PhD graduate at BNU commenced a project on the food, foraging and staging ecology of Red Knots in the area. She had been conducting regular counts since 2003 during northward migration and her work showed that numbers of Red Knot at the Luannan Coast had increased over the years, presumably due to habitat destruction elsewhere and consequently birds moving into her study site (Yang *et al*. 2011).

Building on the research conducted in NWA, in conjunction with the work by researchers from BNU, Fudan University and the CEAAF Center for East Asian-Australasian Flyway Studies at Beijing Forestry University (CEAAF), studies by GFN have continued during the northward migration seasons of 2010 to this year, 2024. These fieldwork studies have concentrated on searching for individually marked Red Knots and have been remarkably successful. Several PhD students have graduated at the University of Groningen under the tutelage of Theunis Piersma, and a number of them have used data from the Luannan Coast studies. These academic studies are made possible under the Rudi Drent Chair in Global Flyway Ecology at the University of Groningen, with past support from WWF Netherlands, WWF-China, SEE Foundation of China and BirdLife-Netherlands, with the in-kind support of the Royal Netherlands Institute for Sea Research (NIOZ), and in close cooperation with BNU.

GFN and BNU team at Hangu, 6 May 2024. © GFN

It is clear from our current knowledge that the Luannan Coast has been the single most important site known for Red Knot on northward migration in the EAAF, encompassing the vast majority of the populations wintering in Australia, New Zealand and South-east Asia. In recent years there have been changes to the peak single day counts of Red Knot at the Luannan Coast and possibly there are now other sites which support more Red Knots during the northward migration season. But this is not certain, and the Luannan Coast remains a site of significant international importance to the EAAF's Red Knot.

This 2024 season's work was made possible with financial support from BNU and GFN. Katherine Leung and Chris Hassell volunteered their time and expertise.

All the migratory birds mentioned in this report are covered by the China-Australia Migratory Bird Agreement (CAMBA). The data in this report confirm the importance of the Luannan Coast for migratory birds and the priority for both Australia and China to advance and build on their actions to protect this site and the wider Yellow Sea mudflats for the future of migratory birds.

Study site

Figure 1. Interpreted satellite image of northern Bohai Bay, China with the coastal study sites marked in yellow.

The Luannan Coast referred to throughout this report encompasses our study sites shown in Figure 1 and the adjacent salt and aquaculture ponds.

The centre of our study site is situated at 39° 03' 35" N, 118° 12' 33" E. It is near Nanpu Development Zone of Tangshan City, situated 190 km south-east of Beijing, China. Figure 1 shows the six coastal study sub-sites. The mudflats of our six sub-sites cover 40 km in length and are 1-4 km wide (on the lowest tides). The total coastline of Bohai Bay is 1,294 km of which more than 95% is considered to be 'built environment'. This is mostly the huge port and industrial developments of Caofeidian, Tianjin and Huanghua (Sun *et al.* 2017).

The Nanpu mudflat is the largest of the sub-sites that we study at 8 km long and 4 km wide, at the lowest tide. It is probably the most important of the remaining mudflats in the area, where most of the Red Knots often congregate. This is presumably because, at present, this site has the most

abundant and/or accessible prey. Due to the topography of the artificial seawall, it is also the last area of mudflat to be covered on an in-coming tide and the first to become exposed on an out-going tide. Consequently, this is where we obtain the best views of birds and is where most of our fieldwork is conducted.

The Nanpu mudflats are an important shorebird foraging ground as well as contributing to the local fishing communities. Shell-fishing operations are carried out by people from the nearby village of Beipu. Reasonable levels of fishing activity do not appear to concern the birds, we often watch flocks of birds feeding close to the people collecting shellfish. Thanks to the continuous effort and discussions between provincial and county governments, BNU and NGOs, the Nanpu mudflats and some of the adjacent ponds are protected within the Hebei Luannan Nanpu Zuidong Provincial Wetland Park since October 2020 (see later section).

Retention of Nanpu and the remaining mudflats at the Luannan Coast remains of great conservation importance to enable the internationally significant number of migratory shorebirds and terns to continue using the area as a staging site. For details of the other sub-sites, please refer to the previous Reports (see Report 2021).

Red Knots feeding on the Nanpu mudflats, 18 May 2024. © Katherine Leung

The intertidal mudflats are separated by a man-made seawall from the Nanpu ponds complex. These were reputedly 'the largest salt works in Asia'. This ponds complex, adjacent to the mudflats, is also critical habitat for birds to forage and roost (Lei *et al.* 2018, Lei *et al.* 2021a), and for some species to nest (Lei *et al.* 2021b), but some of these areas have also been lost to industrial development. The area of ponds adjacent to the Luannan Coast is vast, stretching 10 km inland and across the entire 20 km, from south-east to north-west, of our four southerly study sites and therefore roosting opportunities are many and varied for migratory shorebirds and terns. There are also suitable ponds for roosting shorebirds and terns adjacent to the Hangu mudflats but almost zero roosting opportunities behind the seawall at Heiyanzi as this area is now highly industrialized.

Scanning at the Hangu Wind Farm site, 6 May 2024. © Theunis Piersma

Salt, fish, *Litopenaeus* shrimp, *Artemia* brine shrimp (adult and cysts) are the major products from the ponds adjacent to the Luannan Coast. Different water levels and salinities of the ponds are, more or less, suited to the different uses. For the purposes of this report, all and any pond, regardless of its use, is referred to as a 'pond'.

Prior to 2018, the majority of shorebirds and terns have used the ponds for roosting as well as feeding. In 2013 when there were many and varied ponds available to birds, we had the amazing sight of 95,833 mixed shorebird species foraging in a single, shallow, large pond (2.6 km^2) on 16 May. On 29 May that year, we had a count of 34,200 Red Knot foraging in another shallow, large pond (3.4 km^2). Between 2016 and 2018, the water levels in most ponds have gradually become deeper due to increased management for

aquaculture while still maintaining salt production. Some birds still use these pond walls for roosting but there were very few foraging opportunities particularly for the small and medium-sized shorebirds.

In recent years salt productions have ceased in these ponds and water levels maintain high throughout the season. Our drive to the seawall has enabled us to see the same ponds over the entire 15 years of study, despite that journey now occurring along a stretch of newly built highway. This year even long-legged waders such as Black-tailed Godwits *Limosa limosa* and Pied Avocets *Recurvirostra avosetta* were rarely seen in the ponds. The foraging opportunities within the ponds we accessed have diminished almost completely.

A 10-ha area of small salt ponds behind the seawall adjacent to Nanpu mudflats were the main roosting sites in the past few years. This is different from before 2018 when birds used to roost and do some foraging in these close ponds early in the season but then move further inland to the pond complex around mid-May. The 10-ha roost area continues to be relatively undisturbed although pond workers do cause some occasional disturbance.

Despite this change, it remains the case that both the ponds and the adjacent mudflats of the Luannan Coast are vital components of the area for shorebird conservation, even though the ponds are now predominately only suitable for their safe and relatively undisturbed roosting opportunities.

Red Knot roosting on bunds in Nanpu salt pond, 27 May 2024 © Katherine Leung

Marking of shorebirds

Shorebirds captured throughout the EAAF are mostly marked with plain coloured leg flags, engraved leg flags (ELF), or combinations of four colour-bands and one plain leg flag. Each bird also has a metal band placed on it supplied by the country's relevant banding scheme. Each capture location has its own colour flag combination and/or position of the flag on the birds' leg: Shorebird Colour Flagging Protocol on the East Asian-Australasian Flyway.

'Scanning' is systematically searching through feeding or roosting birds using telescopes to look specifically for flags and colour-bands on bird legs. Each marked bird is recorded, and the records are sent to each banding project at the end of our fieldwork season.

The focus of our study is the individually colour-banded birds marked at Roebuck Bay and Eighty Mile Beach, NWA, but we record every single marked bird we see during our fieldwork thereby documenting the importance of the Luannan Coast for various shorebird species from regions throughout the EAAF and CAF.

In addition to the data collected during our studies at the Luannan Coast, the GFN project is also getting tens of thousands of resightings at Roebuck Bay and Eighty Mile Beach. This huge dataset, with such a high number of records of individually marked birds, is very valuable for learning about survival and movements of these shorebirds (Piersma *et al.* 2016).

NWA colour-banded Red Knot (3LRYL) was marked at Eighty Mile Beach, NWA on 16 February 2011. This bird has been recorded at the Luannan Coast every spring since (except 2019) and is a minimum of 15 years old. This image is from 18 May 2024. © Katherine Leung

Fieldwork in 2024

The fieldwork program for 2024 started on 29 April and finished on 2 June, equating to 35 consecutive days of fieldwork with two or three observers in the field daily. This year fieldwork was again almost solely focused on Red Knots at Nanpu with much reduced visits to other sites. The first fieldwork day was some three weeks later than the standard years (2010-2019 and 2021).

Table 1 documents the duration of our study periods at the Luannan Coast, Bohai Bay. We started with a preliminary visit in 2007, as our understanding of the importance of the site became clear to us, we started to cover the entire northward migration season of Red Knots, leading to the complete and continuous coverage of northward migration from 2010-2019 and 2021. The fieldwork in 2020 and 2022 were hampered by COVID-19 restrictions. In 2023 and 2024, the fieldwork period was reduced due to funding availability.

The birds' use of the study site (Fig. 1) has changed since our first visit in 2007 and continues to vary each year as local conditions fluctuate and affect the suitability of different areas for the birds (particularly Red Knot, our focal species as it is a 'specialised feeder'). We have previously had three major mudflat study sites for Red Knot (Nanpu, Beipu and Hangu). We have two other areas that we have only visit occasionally (North Beipu and Heiyanzi). Nanpu was where most of our fieldwork is conducted, and was the same this year. We have been unable to access Beipu, North

Table 1. Days of observation, total sightings of marked birds and resightings of individually recognisable colour-banded Red Knot from NWA at the Luannan Coast study site 2007-2024.

YEAR	DAYS OF OBSERVATION	TOTAL SIGHTINGS OF ALL MARKED BIRDS	COLOUR-BANDED RED KNOT FROM NWA
2007	7	49	0
2008	-	-	-
2009	19	859	76
2010	57	3133	106
2011	52	3354	170
2012	53	4496	279
2013	59	4613	269
2014	57	5014	345
2015	57	4147	387
2016	56	3554	261
2017	55	2765	265
2018	57	4116	313
2019	57	3452	336
2020	34	1169	189
2021	59	2087	208
2022	40	486	106
2023	42	1211	124
2024	**35**	**1288**	**131**
TOTAL	**796**	**45793**	**3565**

Beipu and Heiyanzi as the seawall was blocked by locked gates. We only made a few visits to Hangu this year as the highest single count of Red Knot at Hangu this year was only 1,133. From our previous work we know that a high proportion of the Red Knots using the Hangu Wind Farm site, are the same birds that use Nanpu, so we do not think we miss any marked Red Knots during the season.

We have previously had one major mudflat study site, Zuidong, for Great Knot. We didn't do any resighting work at Zuidong this year due to the small team size, shorter field work season, and that we were seeing the Great Knots, that move to Zuidong, on the Nanpu mudflats as they came off the pond roosts.

Table 2 below shows the totals of all marked migratory shorebirds recorded during all our fieldwork seasons and the locations they were originally marked. The birds with plain flags just indicate the original marking location and cannot be identified to an individual bird. The colour-banded birds, the engraved leg-flagged birds and some birds with unique positioning of flags on their legs can be attributed to individual birds when close views are obtained. As the team were seeing individually marked birds that were 'new' to the area late into the fieldwork period, it is not unreasonable to assume that plain-flagged birds were also still arriving while others will have moved through the site. So, while some will undoubtedly be multiple sightings, the numbers in the table are a good reflection of the numbers of flagged birds present during the study period. These records from 36 marking locations within the EAAF highlight the importance of the Luannan Coast, not only to birds from NWA, but from the entire EAAF. In recent years, we have also started to record birds marked from 2 areas in India which is part of the CAF.

Above: Chris scanning on the Nanpu seawall, 10 May 2024. © Katherine Leung

Below: Kath counting Great Knot at Zuidong mudflat, 7 May 2024. © Theunis Piersma

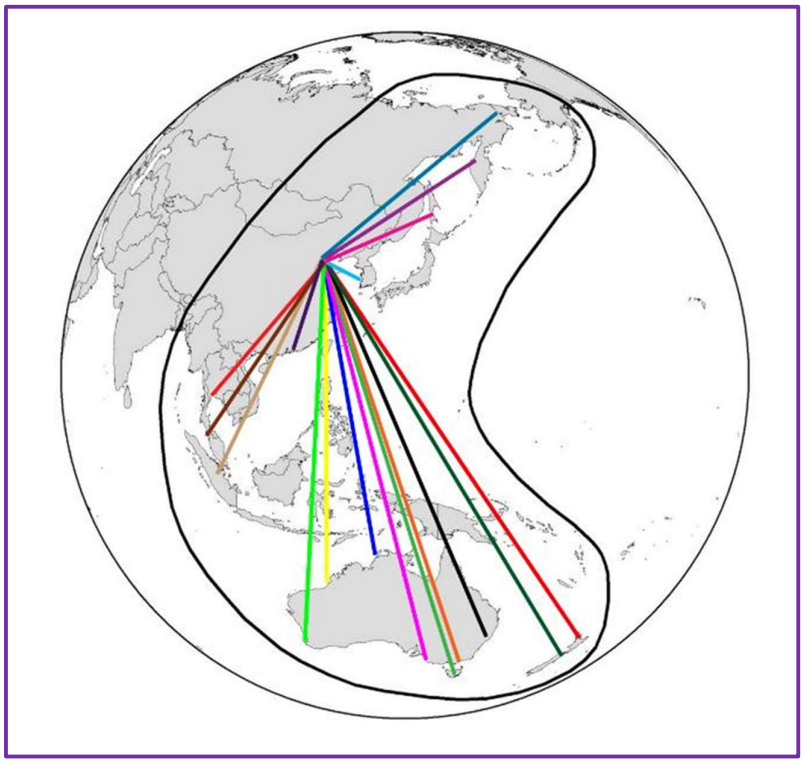


Figure 2. Between 2010 and 2024 we have recorded Red Knot from 23 different banding locations throughout the EAAF, and from India on the CAF. The map is a representation of some of these sites.

Table 2. Totals of resightings of marked shorebirds, of all species, by banding area, recorded during fieldwork 2010-2024.

	MARKING LOCATION	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total 2010-24	KNOWN INDIVIDUALS 2024
1.	CHUKOTKA, RUSSIA	1	32	43	50	62	38	44	22	22	50	6	16	4	14	**17**	**421**	**4**
2.	KAMCHATKA, RUSSIA	1	3	4	1	0	6	7	20	37	65	11	25	23	17	**23**	**243**	**4**
3.	SAKHALIN, RUSSIA	0	4	5	48	52	44	43	33	36	21	3	1	1	4	**2**	**297**	**0**
4.	MONGOLIA	0	0	0	0	0	0	0	0	0	0	0	5	0	1	**1**	**7**	**0**
5.	HOKKAIDO, JAPAN	1	7	10	5	9	5	8	2	0	2	0	0	0	0	**0**	**49**	**0**
6.	NORTH-EAST COAST, JAPAN	0	0	0	0	0	4	1	0	0	0	0	0	0	0	**0**	**5**	**0**
7.	TOKYO BAY, JAPAN	0	0	0	0	0	0	0	0	1	7	0	1	0	1	**0**	**10**	**0**
8.	KYUSHU, JAPAN	0	0	0	0	0	0	2	0	0	0	0	0	0	0	**0**	**2**	**0**
9.	SOUTH KOREA	0	0	0	0	8	12	5	0	5	0	0	0	0	0	**0**	**30**	**0**
10.	LIAONING YALUJIANGKOU WETLAND NATIONAL NATURE RESERVE	0	0	0	1	3	3	0	0	0	0	0	5	0	1	**0**	**13**	**0**
11.	LIAONING LIAOHEKOU NATIONAL NATURE RESERVE (SAUNDERS'S GULL)	1	9	0	1	1	7	1	5	0	0	0	0	0	0	**0**	**25**	**0**
12.	HEBEI ZHANGJIAKOU (RELICT GULL)	0	0	0	0	0	0	0	0	0	2	0	0	1	0	**0**	**3**	**0**
13.	BOHAI BAY, LUANNAN & HANGU	122	96	129	125	108	55	162	78	126	77	16	43	2	75	**101**	**1330**	**13**
14.	BOHAI BAY, SOUTH										4	0	4	0	5	**2**		**1**
15.	JIANGSU, DONGTAI AND RUDONG	0	0	0	0	0	0	0	1	2	8	0	7	0	3	**3**	**24**	**0**
16.	SHANGHAI CHONGMING DONGTAN NATIONAL NATURE RESERVE	321	447	565	552	679	510	518	342	437	356	98	231	25	86	**156**	**5323**	**28**
17.	ZHEJIANG, HANGZHOU BAY	0	0	0	0	0	0	0	0	0	0	4	2	0	6	**8**	**20**	**0**
18.	GUANGDONG, LEIZHOU	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**0**	**2**	**0**
19.	HONG KONG	5	23	19	44	39	20	20	6	18	9	4	24	10	19	**16**	**276**	**8**
20.	TAIWAN	4	0	2	3	2	4	1	0	1	7	0	6	0	1	**0**	**31**	**0**
21.	KINMEN ISLAND	0	0	0	0	0	0	0	2	0	0	0	0	0	0	**0**	**2**	**0**
22.	SINGAPORE	1	0	0	1	1	0	0	0	0	0	0	0	0	0	**0**	**3**	**0**
23.	INNER GULF OF THAILAND	31	18	34	96	153	92	125	75	113	118	47	82	1	63	**58**	**1106**	**2**
24.	PENINSULA, THAILAND	35	29	36	33	60	56	33	27	49	33	12	32	3	11	**8**	**457**	**0**
25.	PHILIPPINES	0	0	0	1	1	0	0	0	0	0	0	0	0	0	**6**	**8**	**3**
26.	JAVA, INDONESIA	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**1**	**0**
27.	SUMATRA, INDONESIA	12	4	5	8	7	6	2	2	0	2	0	0	0	0	**0**	**48**	**0**
28.	NORTH-WEST AUSTRALIA (COLOUR-BANDS)	317	412	904	613	922	1221	671	680	1122	1095	446	535	177	329	**317**	**9761**	**134**
	NORTH-WEST AUSTRALIA (FLAGS)	912	812	1166	1053	1222	1036	964	916	1315	963	332	791	191	405	**371**	**12449**	**87**
29.	NORTHERN TERRITORY, AUSTRALIA	3	0	0	1	0	4	57	24	55	53	6	11	0	9	**6**	**229**	**3**
30.	QUEENSLAND, AUSTRALIA	7	7	8	27	12	4	14	3	1	13	1	8	0	3	**2**	**110**	**0**
31.	NEW SOUTH WALES	0	2	0	1	0	1	0	0	0	0	0	0	0	0	**0**	**4**	**0**
32.	SOUTH-WEST WESTERN AUSTRALIA	6	0	0	1	4	3	0	0	0	0	0	0	0	0	**0**	**14**	**0**
33.	SOUTH AUSTRALIA	12	35	62	73	54	31	40	20	20	26	15	12	1	9	**12**	**422**	**3**
34.	VICTORIA, AUSTRALIA	746	644	798	985	858	507	487	290	433	309	97	139	25	76	**86**	**6480**	**17**
35.	KING ISLAND, AUSTRALIA	3	2	4	0	1	5	2	4	1	0	0	1	0	0	**0**	**23**	**0**
36.	NORTH & SOUTH ISLAND, NEW ZEALAND	590	768	702	890	756	469	335	203	309	226	71	95	22	61	**83**	**5580**	**14**
37.	NORTH INDIA	0	0	0	0	0	0	5	5	5	4	0	7	0	4	**5**	**35**	**2**
38.	SOUTH INDIA	1	0	0	0	0	4	7	5	8	2	0	2	0	8	**5**	**42**	**1**
	TOTALS	**3133**	**3354**	**4496**	**4613**	**5014**	**4147**	**3554**	**2765**	**4116**	**3452**	**1169**	**2087**	**486**	**1211**	**1288**	**44885**	**324**
	NUMBER OF SPECIES	**14**	**14**	**13**	**18**	**17**	**18**	**17**	**15**	**14**	**15**	**11**	**16**	**6**	**11**	**12**		

During the 35 days of fieldwork, we made a total 1,288 sightings of marked birds of which 324 were 'known individuals', those able to be identified from unique engraved leg flags or colour-band combinations to an individual bird (Tables 1, 2 and 3). Total sightings of all marked birds for 2024 were low due to the shorter fieldwork period and the reduced usage of the section of mudflat close to the Nanpu seawall by the Red Knots. Also, this is possibly due to fewer birds being marked overall at some banding locations throughout the EAAF as some banding activities have been disrupted due to COVID-19 in the past few years. The total number of NWA Red Knot colour-band resightings for 2024 was 311, and the number of known individuals recorded was 131.

Table 3 shows records of individually colour-banded birds marked in NWA recorded on the Luannan Coast for the years 2010 to 2024. The 134 individuals recorded this year is significantly lower than most standard years but similar to 2023. This reflects the fact that very little marking of Red Knots with colour bands has been done in NWA since 2019. The totals were dominated by Red Knot, as always with 131 individuals identified, then Bar-tailed Godwit with two and Great Knot with one. Numerous Red Knots have been seen over many consecutive years with some in all fifteen years. One of the Bar-tailed Godwit has been seen in all years since 2010 (except 2022), and the bird is a minimum of 19 years old. Despite this individual being very faithful to the Luannan Coast, this area is not a major staging site for Bar-tailed Godwits.

Table 3. Totals of individually colour-banded birds from the GFN project marked in NWA resighted on the Luannan Coast 2010-2024. No marked Black-tailed Godwit from NWA have been recorded within the study site.

NWA COLOUR-BANDED INDIVIDUALS	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
BAR-TAILED GODWIT	3	2	4	3	5	6	3	4	4	3	1	5	0	3	**2**
GREAT KNOT	6	20	17	12	11	30	31	22	44	48	3	23	1	1	**1**
RED KNOT	106	170	287	272	329	387	261	269	313	336	189	208	106	124	**131**
TOTAL	**115**	**192**	**308**	**287**	**345**	**423**	**295**	**295**	**361**	**387**	**193**	**236**	**107**	**128**	**134**

Yang and Chris scanning on the Nanpu seawall at dawn, 11 May 2024. © Katherine Leung

Internationally important counts

During the fifteen years GFN have been visiting the Luannan Coast from 2010 to 2024, we have been conducting regular counts in conjunction with BNU. The importance of this site is not in any doubt. Table 4 below shows clearly the immense importance of these mudflats and ponds to shorebirds from throughout the EAAF. All the counts should be considered absolute minimum totals for the area because there are areas of mudflats and ponds inaccessible to us and we cannot count all sites used by shorebirds simultaneously with our current resources and no turnover analysis is done: if that statistic was applied, the total number of birds assessed using the Luannan Coast during the northward migration season would be much greater (Lok *et al.* 2019). Note that there have been higher counts of some species in Table 4 prior to 2015 but with the renewed EAAF Waterbird Populations Portal (Wetlands International 2023), we have only used counts from the last ten years to more accurately reflect the current situation at the Luannan Coast. Most migratory shorebird populations in the EAAF are declining and it is no surprise that many species have also shown declines in peak numbers on the Luannan Coast.

Grey Plover, Asian Dowitcher and Red Knot on Nanpu mudflats, 15 May 2024. © Katherine Leung

Table 4. Internationally important counts at Luannan Coast 2015-2024.

Species	Scientific name	Date recorded	Count	% of EAAF population present	Waterbird Populations Portal*	Total for 1% Ramsar criteria^
Pied Avocet	*Recurvirostra avosetta*	26 04 2019	1,149	1.1	100,000	1,000
Grey Plover	*Pluvialis squatarola*	26 04 2019	3,220	4	80,000	800
Eurasian Curlew (NT)	*Numenius arquata*	26 04 2019	2,722	2.7	100,000	1,000
Black-tailed Godwit (NT)	*Limosa limosa*	13 04 2019	17,937	11.2	160,000	1,600
Great Knot (EN)	*Calidris tenuirostris*	08 05 2019	12,971	3.1	425,000	4,250
Red Knot (NT)	*Calidris canutus*	16 05 2018	48,630	43.8	110,000	1,100
Broad-billed Sandpiper	*Calidris falcinellus*	27 05 2015	2,460	8.2	30,000	300
Curlew Sandpiper (NT)	*Calidris ferruginea*	08 05 2016	16,568	18.4	30,000	300
Spoon-billed Sandpiper (CR)	*Calidris pygmaea*	02 06 2019	1	0.1	800	8
Red-necked Stint (NT)	*Calidris ruficollis*	08 05 2016	4,747	0.99	475,000	4,800
Sanderling	*Calidris alba*	29 05 2016	4,321	14.4	30,000	300
Dunlin	*Calidris alpina*	07 05 2017	40,000	1.6	2,460,900#	24,609
Asian Dowitcher (NT)	*Limnodromus semipalmatus*	08 05 2017	1,754	6.26	28,400	280
Spotted Redshank	*Tringa erythropus*	15 05 2016	592	2.6	25,000	250
Nordmann's Greenshank (EN)	*Tringa guttifer*	08 05 2016	7	0.7	1,200	10
Marsh Sandpiper	*Tringa stagnatilis*	27 04 2016	8,785	6.8	130,000	1,300

* - Wetlands International (2023). # - Uncertainty of distribution of all subspecies in EAAF.
e - Estimate

^ - The 1% Ramsar criteria refers to Criterion 6 of the Ramsar Convention: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

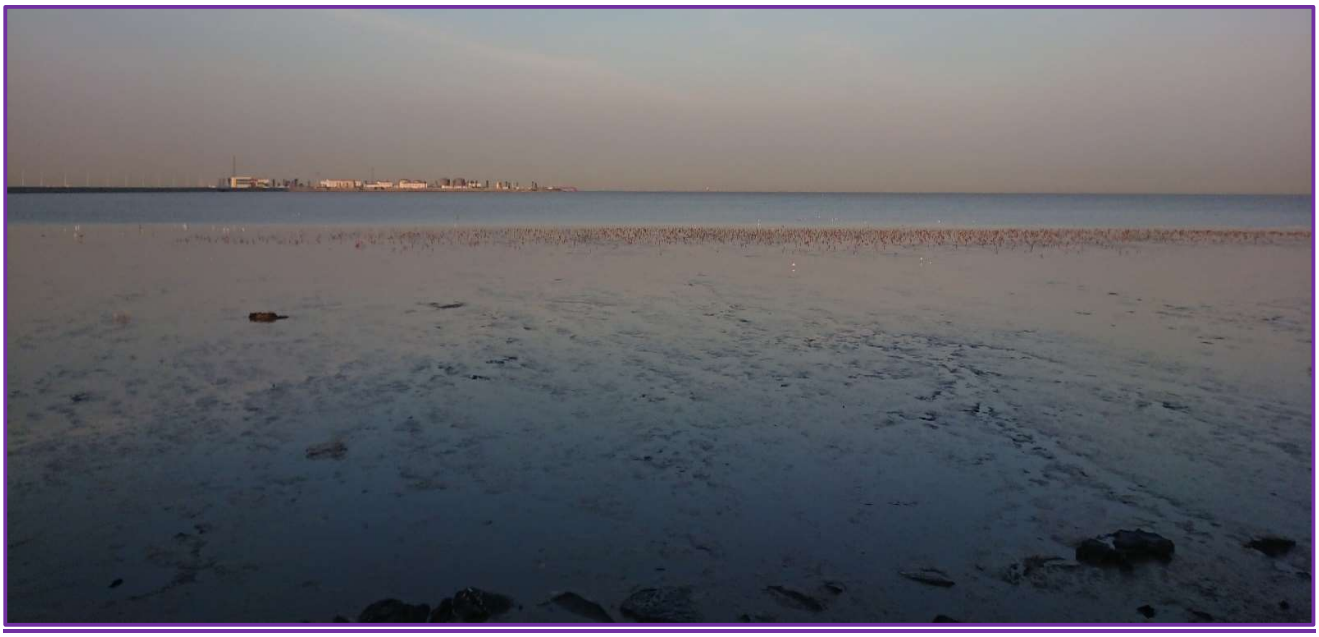
Red Knot numbers

The focus of our studies on the Luannan Coast is the Red Knot. This year the highest peak daily counts at Nanpu increased from the low numbers of 2023, which were the lowest of our 15-year study period. The biggest day count for 2024 was 13,000 on 23 and 27 May. There was an influx between 12 and 14 May then numbers were very settled at between 10,000 to 13,000 for 14 days until a considerable drop in numbers to 6,000. And then a gradual decline to 1,500 on 2 June, our last day of field work. It should be noted that these two counts are from Nanpu only as described earlier, other sites are inaccessible. We had a count of 1,133 Red Knot at Hangu on 21 May. From our knowledge of the study sites over the years, we know that Nanpu is where the largest numbers of Red Knots are seen. So, while we cannot completely rule it out, we are confident that there were not thousands of Red Knots at any of the other sub-sites.

The number of Red Knot using the Luannan Coast varies a lot from year to year. The 2018 (48,630) and 2019 (47,537) counts were our highest since 2015 (Table 5). None of the non-breeding areas of the EAAF have had dramatic changes in the numbers of Red Knots utilising them in the 2023/24 season. So, despite the dramatic changes in numbers over the past 10 years at the Luannan Coast, we do not think there is a flyway-wide crash in Red Knot numbers. For example, The Monitoring Yellow Sea Migrants in Australia (MYSMA) count programme that has been running for 20 years shows 'no significant change' in the north west Australia Red Knot population. We believe that the migration pattern of Red Knot during northward migration has changed in recent years. GFN, in a cooperative study with BNU, Princeton University and Australasian Wader Studies Group (AWSG) have attached trackers to 29 Red Knots at Roebuck Bay, NWA and hoped this will increase our understanding on the current migration patterns and can be compared to tracking work from previous years (see Tagging Report 2023). We also think the fluctuating numbers of Red Knot at Nanpu are also impacted by the local food abundance (see later section).

Table 5. Peak counts of Red Knots at Luannan Coast from 2015-2024.

2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
29,956	20,000	17,000	48,630	47,537	20,000	9,000	9,938 (BNU's data)	3,660	**13,000**



Red Knots arriving on Nanpu mudflats as it started to expose at dawn, 27 May 2024. © Katherine Leung

The presence of rogersi and piersmai Red Knot subspecies

A 'typical' *piersmai* (left) and 'typical *rogersi* (right). © Adrian Boyle

The subspecies *piersmai* and *rogersi* Red Knot both use the Luannan Coast as a staging site. We get fabulous data each year on the individually marked birds from the project. The majority of the two subspecies of Red Knot using the EAAF can be distinguished, when in fresh, full or near-full breeding plumage by the colour and pattern of that breeding plumage (Tomkovich 2001, Hassell *et al.* 2011). This is particularly noticeable when the two subspecies are side by side as is usually the case in our study site.

The *rogersi* birds, predominately from south-east Australia and New Zealand non-breeding grounds, generally arrive first and leave for their eastern Siberian breeding grounds earlier than the *piersmai* birds. The *piersmai* birds, predominately from NW Australia non-breeding grounds, breed in more northerly latitudes on the New Siberian Islands.

In relation to Red Knot marked in Roebuck Bay and Eighty Mile Beach, NWA, for both the total number of resightings and the individuals that those sightings represent, it needs to be taken into account that approximately 20% of Red Knots marked in NWA may be the *rogersi* subspecies. These *rogersi* birds may or may not move to New Zealand after marking in NWA and then use New Zealand as their permanent non-breeding area. From New Zealand they may migrate to the Luannan Coast under different schedules than *rogersi* that use NWA as their non-breeding location. Interestingly both *rogersi* and *piersmai* depart NWA at the same time (late April) despite the difference in breeding locations (Verhoeven *et al*. 2016).

In our experience it appeared that birds which arrive at the Luannan Coast early in the season, before 1 May, are predominately *rogersi* and stay for up to a month. Birds that arrive late in the season, mid-May onwards, are predominately *piersmai* that only stay for a short time, in some cases, a week or less. This was confirmed by a sophisticated scientific paper showing the *piersmai* subspecies stay for 5-9 days at the Luannan Coast (Lok *et al.* 2019).

To evaluate the proportions of the two subspecies we conduct regular, random scans of flocks and assign a subspecies to each individual bird based on plumage characteristics. The number of flocks and birds scanned have been similar over the years. Because the outbreak of CORVID-19, no scans were carried out in 2020 and 2022 (Table 6).

Table 6. Number of Red Knot flocks and birds scanned for subspecies at Luannan Coast 2015-2024.

YEAR	Number of scans	Number of Red Knots assessed
2015	225	39,925
2016	221	38,364
2017	218	38,866
2018	231	39,164
2019	257	52,186
2020	0	0
2021	212	34,184
2022	0	0
2023	176	39,830
2024	**140**	**31,423**

The subspecies scans are often carried out while we are waiting for the tide to recede, 2 May 2024.

Figure 3 shows the 'flow' of the *rogersi* and *piersmai* subspecies through the Luannan Coast over the northward migration period. In the past years, *rogersi* arrived and left earlier, *piersmai* later (here 2019 is used as a 'typical' year, Figure 3a). The breeding grounds of *rogersi* in Chukotka become snow free from about mid-May while the New Siberian breeding grounds of *piersmai* are not snow free until early-June. This year's flow (Figure 3b) was very different from the 'typical' years. The percentage of *piersmai* birds gradually built up from 20% at the end of April until reaching 60% in mid-May, but then dropped back to 40-50% in the 2nd half of May. This year's flow indicates that the migration pattern through the Luannan Coast has changed, with *rogersi* staying longer and/or the *piersmai* subspecies did not use the area as they have in previous years. A similar situation was recorded in 2023 (see Report 2023).

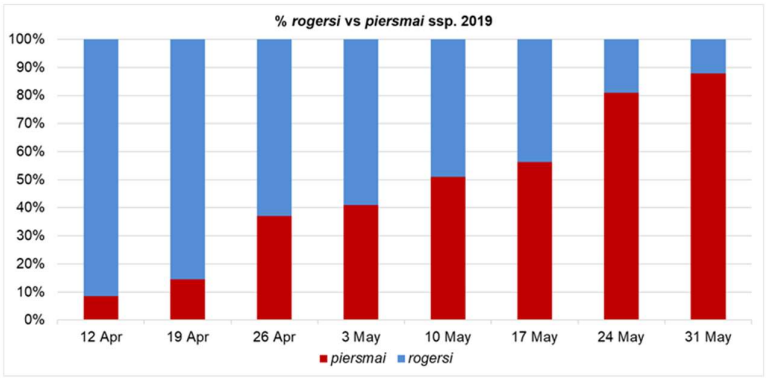


Figure 3a. Percentage *rogersi* vs *piersmai* subspecies over time 2019.

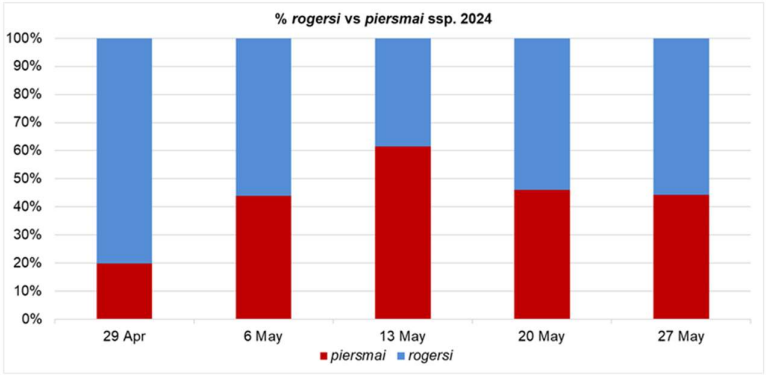


Figure 3b. Percentage *rogersi* vs *piersmai* subspecies over time 2024.

Red Knot abdominal profiles and *Potamocorbula laevis* density

As we are not catching Red Knots at the Luannan Coast, there is an absence of year-to-year body mass data (but see Hua *et al*. 2013 for data on the first study years), however it is possible to score the abdominal profile (AP) of birds visually in the field from telescope observations (Wiersma & Piersma 1995). This is a suitable alternative way to assess the fat stores and weight gain of birds**.** We record abdominal profile on all flagged and colour-banded Red Knot when we get a suitable view. A side-on view of the bird is needed for an accurate assessment. The scores range from AP 1- very thin to AP 5 - obese. A bird scored as 1 looks unhealthy and a bird scored at 5 is very fat.

Both subspecies and most individuals are arriving at our Luannan Coast study site in good body condition, whilst no birds are arriving in very poor condition (AP 1). This likely means that they are staging somewhere between their Australian, New Zealand and SE Asian non-breeding sites and the Luannan Coast. Colour-band and flag resightings show this and it is further supported from geolocator and satellite tracking data confirming birds stop at many sites south of the Luannan Coast including north east Borneo, southern and eastern China coast (GFN, AWSG unpublished data, Piersma *et al*. 2021).

The results in 2010-2019 have been very similar with both subspecies' abdominal profile score increasing gradually throughout the season. Since 2020, there are some changes to the results such as early appearance of AP 5 birds in 2020 and 2021, and in 2023 both subspecies have only reached AP 4 rather than AP 5 at the end of the season. These changes coincide with the four-year period with low density of *Potamocorbula laevis* in the Nanpu mudflats.

Red Knots in AP 5, 15 May 2024. © Katherine Leung

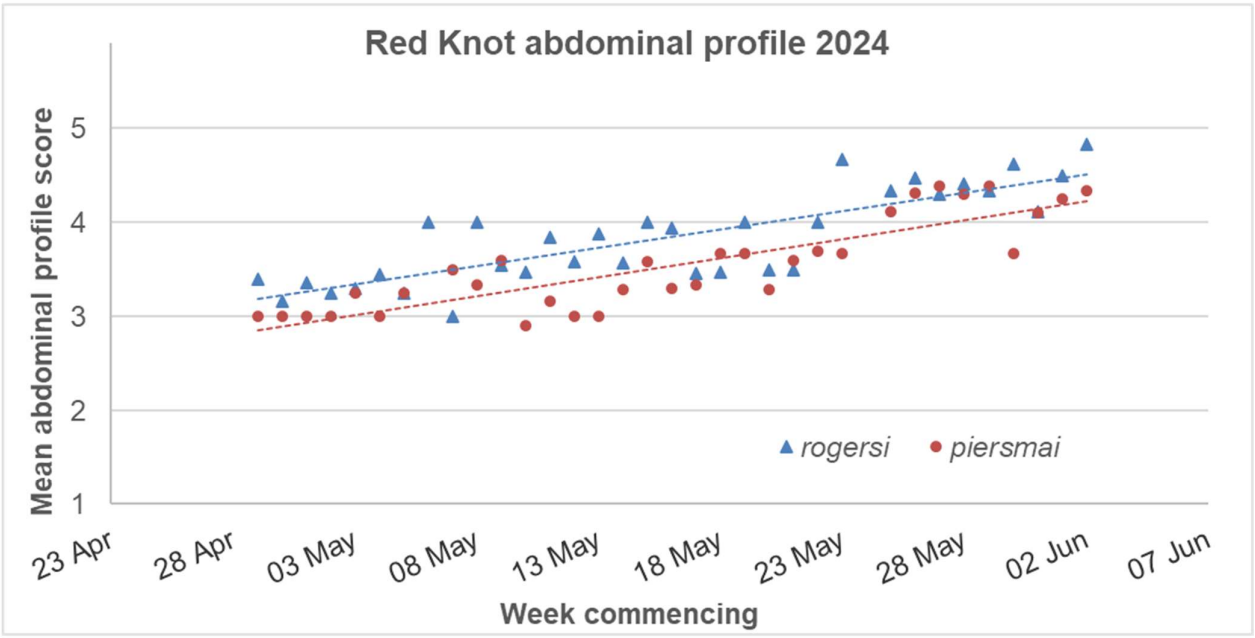


Figure 4. The graph shows the change in abdominal profile, over time, for the two subspecies of Red Knot in 2024 using 914 records.

P. laevis is the key food for Red Knot at the Luannan Coast (Yang *et al.* 2013). Understanding the availability of food for Red Knots would help to interpret variations in the changes in AP scores of Red Knot using the Luannan Coast from year to year. Our colleague Dr Hebo Peng conducted benthic sampling on mudflats along the China coast to monitor the variation of shorebirds' food (Peng *et al.* 2021, also "The 2024 shorebird survey in China: a myriad of threats"). His team visited the Luannan Coast twice to survey the macrobenthos in both early and late May. From 2010-2019, *P. laevis* showed stable levels at a high density, which provided abundant, high-quality food for Red Knots and other shorebirds. Results show that *P. laevis* densities declined at the Luannan Coast in 2020-2023, that not only coincide with the changes in AP scores results, but also with the low Red Knot numbers in those years.

P. laevis next to a Chinse one yuan coin.
© Jan van de Kam

This year the *P. laevis* density has considerably recovered from the previous 4 years (Dr Hebo Peng pers. comm.). Abdominal profile score assessed on 914 Red Knot individuals shows that both subspecies gradually fatten up throughout the fieldwork season, particularly for *rogersi* appeared to be able to feed effectively enough to gain suitable condition for the next leg of their migration to the breeding grounds at the end of the season.

The northward migration strategy is one piece of the Red Knot life-cycle question that we are still attempting to answer more fully. We are not clear yet how the numbers, density and availability of food at a particular site is affecting Red Knot distribution along the Chinese coast, particularly the Yellow Sea coast, during northward migration. The intriguing question to us is, how do the Red Knots know and 'decide' if there is enough food for the numbers of birds present to allow them, as an individual, to gain enough weight for successful migration? And then logically they would need to decide to either stay at a particular site or to move on to ensure the necessary weight gain? Birds are not on 'auto-pilot' driven by instinct alone. They must make decisions throughout the year and some of these are critical to get correct. Continuation of the benthic sampling fieldwork along the Chinese coast and our fieldwork at the Luannan Coast, together with analysis of migration tracking data should eventually give us more insights.

GFN's joint force of fieldwork and tracking

Red Knot 4BYLR is one of the 29 Red Knots tagged with Bluetooth-GPS trackers in a cooperative study with BNU, Princeton University and AWSG in October 2023 (see Tagging Report 2023).

It was first banded on 20 Feb 2014 as an adult at Roebuck Bay, NWA and is a minimum of 12 years old. It has been resighted at the Luannan Coast every spring since (except for 2016).

4BYLR was resighted on 20 May at Nanpu this year. Tracking data shows it departed Roebuck Bay on 28 Apr and reached the Luannan Coast on 18 May.

4BYLR was last seen on 7 Apr 2024 at Roebuck Bay.
© Adrian Boyle

Breeding shorebirds and terns

In addition to the migratory shorebirds and terns passing through the Luannan Coast, there are nine species we have recorded breeding within the study site from 2010 to 2024: Black-winged Stilt *Himantopus himantopus*, Pied Avocet, Eurasian Oystercatcher *Haematopus ostralegus*, Grey-headed Lapwing *Vanellus cinereus*, Kentish Plover *Anarhynchus dealbatus*, Little Tern *Sternula albifrons*, Gull-billed Tern *Gelochelidon nilotica*, Whiskered Tern *Chlidonias niger* and Common Tern *Sterna hirundo*.

Pied Avocet is the most common species we recorded and is the focus of continued study by Professor Zhengwang Zhang at College of Life Sciences at BNU (see Lei *et al*. 2018, Lei *et al*. 2021b). Pied Avocets nest on the bare banks of ponds, on open areas of dry mud in unused or recently reclaimed ponds and on small islands within the ponds. Many of these banks are impossible to access so an accurate estimation of the total nesting population is difficult but there are between 1,000 and 2,000 pairs in the Luannan pond complex (Weipan Lei *pers. comm*.). In recent years they have had less breeding habitat available and lower breeding success due to deep or unstable water levels in the ponds. Sudden rises in water level by severe weather or for the purpose of pond management often lead to direct loss of eggs or chicks. Feral animals also pose threats to the breeding shorebirds and terns. We have observed feral dogs chasing and eventually catching an adult Pied Avocet in the past. Feral cats were found by camera trap to consume eggs in nests (Yang Wu *pers. comm.*).

Black-winged Stilt, Kentish Plover, Common Tern and Little Tern breed in the same locations as Pied Avocet, all were recorded breeding in 2024 and presumably face similar threats to those of the Pied Avocet.

Common Tern nesting on dry area of pond, 13 May 2024. © Katherine Leung

Wetland Park

The Hebei Luannan Nanpu Zuidong Provincial Wetland Park (the Wetland Park) established on 26 October 2020 covers an area of 5,791.6 ha, including nearly 3,000 ha of shallow sea habitat and 2,177 ha of intertidal mudflat along the whole 8 km shore of Nanpu, plus 690 ha of salt and aquaculture ponds behind the Nanpu seawall at the north-west corner near Beipu. The decision to protect the area as a wetland park allows both the biodiversity and, importantly, the income of the local communities to be safeguarded.

In June 2021, a workshop was held in Luannan with all the major stakeholders to share their view of the future management for the Wetland Park. Back then we saw lots of potential for the Wetland Park management to be a success and a model example of a win-win situation for both biodiversity conservation and sustainable income for the local communities. However, we feel there has not been much positive progress.

Map showing different kind of habitats in the Wetland Park, 29 Apr 2024. © Katherine Leung

A hundreds-million yuan ‘wetland restoration’ project has been carried out at the Wetland Park since October 2022. During our 2023 fieldwork season we saw shorebirds feeding on the intertidal mudflats frequently disturbed by large trucks

running along the seawall to transport earth into a few ponds for building high and steep-sided artificial islands which were not designed with any forethought for their use by shorebirds. This year we saw hundreds of tree seedlings were planted on these islands. Although we recorded Black-winged Stilt, Pied Avocet, Eurasian Oystercatcher, Kentish Plover, Little Tern and Common Tern breeding in the 'restored' ponds, all these species breed in ponds around Nanpu and birds breeding in the 'restored' ponds could be despite of, not because of, the changes. We observed these birds only nested on the limited bare and flat parts of the islands or bunds in these restored ponds indicating that the rest of the vegetated area are not suitable for them.

'Restored' island in the Wetland Park with limited bare and flat parts for shorebirds, 20 May 2024.
© Katherine Leung

A 'typical' island with roosting shorebirds in the pond at Luannan Coast, 11 May 2021. © Katherine Leung

The ponds previously had shallow water with low, sloping perimeter and internal bunds which do not require massive modification to provide roosting, feeding and breeding habitat for birds. It is with regret that we feel an opportunity has been missed to enhance the site, particularly in respect to its suitability for roosting shorebirds and breeding shorebirds and terns. Low islands with sparse vegetation surrounded by shallow water for the migration and breeding seasons would be preferable. Then the water level can be raised in the ponds in preparation for winter. This will be good for gulls and waterfowl and 'drown' the vegetation on the islands making it suitable once again the following spring for breeding and roosting birds with a corresponding lowering of the water level. This is standard management practice in managed wetlands around the world and would work at the Nanpu ponds.

Yang scanning in between the *Tamarix* trees on the Nanpu seawall, 16 May 2024. © Katherine Leung

Before the start of our field season in 2021, a line of *Tamarix* sp. tree seedlings was planted on the first 1.8 km section of the south-east end of the Nanpu seawall. During this fieldwork season as part of the 'wetland restoration' project, the Wetland Park continued to plant trees on both sides of the seawall for the remaining 5.3 km. It is obvious that the tree planting is to enhance the 'beauty' of the site not to improve the site for shorebird use. It is broadly accepted that shorebirds do not like tall trees close to them when they are feeding or roosting as it restricts their view of approaching danger, mainly birds of prey (Rogers *et al*. 2006). So, it remains to be seen if this tree planting will be detrimental to the bird's ability to forage close to the seawall, a very valuable portion of the mudflat to them as the importance of the upper tidal area is very likely a joint effect of longer exposure and higher food density (Mu *et al* 2022). However, there is nuance in this. Currently the first section of trees that were planted are now at a height that shields trucks and people from the birds without being so tall that

birds are nervous close to the trees therefore seemingly alleviating disturbance. If the trees grow tall then this may change.

Over the past years we have also seen some other improper management of the area including a completely unnecessary viewing platform built. Great views of the birds can be obtained from the path and the platform does not get people any closer to the birds. The only outcome from people climbing on to the platform will be disturbing the birds. When the birds first return from the salt pond roosts, they land close to the wall, start to feed, sometimes bathe, and sleep, people high on a platform will only disturb birds. We suggest to change the platform to birdwatching hide in a suitable place in the future.

A series of educational signages and a visitor centre have been constructed over the past couple of years. We visited the centre on 8 May and found the exhibitions very informative. These facilities have great potential to educate local communities, school kids and the general public about the importance of Luannan Coast for biodiversity. We hope the Wetland Park open for public visitors as soon as possible.

It goes without saying that GFN is supportive of the protection of the Luannan Coast as a Wetland Park. However, there are clear planning failures in respect to the site as to be important for shorebirds. Proper strategic conservation management with careful planning and engagement with shorebird experts from BNU is vital to enhance the status of this critical site. It is hoped that better communication can be set up between decision makers and scientists so that subsequent conservation management of the Wetland Park will ultimately enable the Red Knot and many other waterbird species of the EAAF to maintain sustainable population levels, as well as serving the local communities for sustainable economy and conservation awareness raising.

A short documentary about the Luannan Coast exhibits in the visitor centre. © Katherine Leung

Human use of the mudflats and ponds

Mollusc aquaculture is carried out at both Zuidong and Nanpu mudflats by the local fishing communities of Nanpu and Beipu villages. Locals mentioned that summer harvesting (July to August) of *P. laevis* could be beneficial to their harvest in the following year. This theory has been argued by Yang *et al.* (2016) that the very intense fishing practices for *P. laevis* in the late-summer may even benefit shorebirds staging in the spring because it would allow an increase in the settlement of new recruits in the subsequent spring. Our colleague Dr Hebo Peng's work demonstrate that careful management of the mollusc aquaculture is needed to secure the food for the staging Red Knots (Peng *et al*. in press.). With the establishment of the Wetland Park, there is potential to explore regulated aquaculture and harvesting of *P. laevis* on the Nanpu mudflats, which might maximise the benefit to both shorebirds, especially Red Knot, and local communities.

At the Zuidong mudflats, the main mollusc harvested is *Mactra veneriformis*. Zuidong mudflats is the main foraging area of Great Knot on the Luannan Coast and is currently not protected within the Wetland Park.

Shellfish collectors returning to the seawall with their harvest, 7 May 2024. © Katherine Leung

Mudflats of the Luannan Coast is vital for both shorebirds and the local economy, 20 May 2024. © Katherine Leung

The ponds adjacent to the Luannan Coast are used for the production of salt (evaporation, storage and crystallization ponds), fish and shrimp for human consumption, brine shrimp *(Artemia)* that are fed to larger species of *Litopenaeus* shrimp to fatten them for harvest and sale for human consumption. Harvesting of brine shrimp are either carried out manually or with mechanical boats dragging a fine net in the water column. Brine shrimp cysts (dormant eggs) are also collected at the edge of the pond with hand net. They can be stored for long periods and hatched, on demand, to provide a convenient form of live feed for larval fish and are the most sought after of the *Artemia* products. The brine shrimp cysts in the shallow waters of the ponds are important food source for Red Knots and many other shorebirds. In recent years, most ponds in Nanpu had become deeper due to increased management for aquaculture and the availability of brine shrimp cysts for shorebirds, had diminished almost completely.

Manual harvesting of brine shrimp, 1 May 2024.
© Katherine Leung

Red Knots having a feast on brine shrimp cysts in shallow waters of the ponds, 1 Jun 2024.
© Katherine Leung

While GFN are conducting our work on the Luannan Coast, we always try to engage the local shellfish collectors, pond and oil rig workers, we share our binoculars with them and show them the birds through our telescopes. Over the years our drivers Junfeng Liu and Yang Liu have developed great interest in the migratory birds and in our studies. They chat to various people who we encounter during our work and ask local fishermen or shellfish collectors about the situation relating to the birds and shellfishing on the mudflats. Since 2020, the GFN team has been comprised of Chinese language speakers and not predominately English speakers, this has given even more scope for engagement.

Habitat threats and management actions

The Luannan Coast is very important for oil production and China National Petroleum Corporation (CNPC) operate there and have done so for many years. Generally, this industry does not cause too much of a conservation threat to the migratory bird populations. There is the loss of some habitat for drill rigs and infrastructure, but much of the exploration and infrastructure is offshore and away from the mudflats.

A MOU has been signed between CNPC and the Luannan County in 2020 to maintain CNPC's right to oil production without compromising protection of the site for migratory waterbirds. Surrounded by the Wetland Park area, there is a small pond adjacent to the seawall which is owned by CNPC. This year a new drill rig was being constructed in this area during our fieldwork period. The construction created high levels of disturbance to feeding shorebirds on the Nanpu mudflats as well as to our scanning fieldwork when the trucks are transporting earth for the foundation and carrying equipment to the site. We often observed feeding bird flocks flushed as the trucks passed by. However, once the building and initial drilling phase is completed the drill rigs are benign in their operation and cause little or no disturbance to feeding birds.

Some serious risks are associated with large scale oil production. An oil spill would be serious for the Luannan Coast mudflats, the associated benthos and birds. If that oil spill were to coincide with the spring migration season, the effects on migratory populations could be catastrophic. If an accident were to occur outside of peak bird use of the area it would still be a very serious as the benthos would be affected and diminish the areas biodiversity, suitability for shorebirds and shellfish harvest for the local people.

Due to the presence of oil production in the area, the World Heritage listing China – Migratory Bird Sanctuaries along the Coast of Yellow Sea-Bohai Gulf of China (Phase II) has not been supported by the IUCN. The committee have stated that the nomination requires '*Significant boundary modification recommended for approval'* as '*at the present time in line with the established position of the World Heritage Committee that mineral exploration or exploitation is incompatible with World Heritage status'.*

Newly constructed oil rig and newly planted tree seedlings on Nanpu seawall, 20 May 2024. © Katherine Leung

Smooth Cordgrass *Spartina alterniflora* is a highly invasive, non-native species and has caused huge problems in important shorebird sites in the Yellow Sea. In the past years, this invasive plant has established on the mudflats adjacent to the seawall at Zuidong and Nanpu. In June 2018, it was very pleasing to see that the issue was addressed at Nanpu in a project led by WWF-China with a spraying program to control the spread of the Spartina, following the success at Shanghai Chongming Dongtan National Nature Reserve. The Spartina at Nanpu was sprayed three times from July to September in 2018 with about 85% success rate. In June and July 2019, WWF once again organised for two sprays of the Spartina with drones. This follow up procedure was highly effective and has all but eliminated Spartina from the south-east corner of the Nanpu mudflats abutting the oil island causeway. The spraying programme was very successful with only small green spouts of new growth observed during the 2020 field season. A similar spraying project was also initiated by the Paulson Institute at Zuidong mudflats in 2019.

During the winter in late 2020/early 2021, an ecological restoration project was carried out by the Luannan County Government, which involves the removal of Spartina by cutting and digging the plants up to a depth of 40 cm over a total area of 18.3 ha at the Nanpu and Zuidong mudflats. We are uncertain whether such mechanical digging would cause any impact on the mudflat habitat, but a digger would bring greater and longer disturbance to birds when comparing to using drones to spray and treat the Spartina. Nevertheless, it is good to see the Luannan County Government's good intention in addressing the issue.

Persistent efforts over the past few years have been a great success in eradicating Spartina. Almost zero regrowth was observed at both sites. In early 2023, the Chinese Central Government has set a target to eliminate at least 90% of the invasive Spartina along China coast by 2025. Monitoring and control of this invasive species ought to be continued in future years.

Similar effort on control of Spartina has also been carried out on the Hangu mudflats over the past couple of years successfully in conjunction with a 'wetland restoration project' along the Hangu coast. However, some of the works are not centred around the biological importance of the area. They consist of a running and cycling track along the seawall and some of the ponds adjacent to the mudflat which used to be high tide roost for shorebirds were being planted with trees this year.

Nanpu mudflats once invaded by *Spartina*, late May 2018. © Adrian Boyle

Nanpu mudflats without *Spartina*, 29 Apr 2023. © Katherine Leung

Recommendations

- Support Universities and Global Flyway Network to continue conducting research activities and follow-up analysis utilising the huge set of resightings data already recorded and collated in the GFN database. This will help to document the futures of four shorebird species (Bar- and Black-tailed Godwit and Red and Great Knot) at their non-breeding sites in NWA and throughout the EAAF, with an emphasis on the Luannan Coast, Bohai Bay. We hope that our data set will be able to assess the effects of human-induced habitat change on survival rates of the populations and a variety of demographic parameters.
- The retention of the remaining mudflats at Zuidong, Nanpu, Beipu and Hangu remains of great conservation importance. Retaining these mudflats in good ecological condition will enable the huge numbers of migratory shorebirds and terns to continue using the area as a staging site.
- Following the establishment of the Hebei Luannan Nanpu Zuidong Provincial Wetland Park, explore the possibilities for the sustainable harvesting of shellfish on the mudflat, which could maximise the benefit to both local communities and shorebirds for foraging and breeding.
- Establish strategic conservation management and consistent communications between decision makers and scientists for the Wetland Park.

Shorebirds landing on Nanpu mudflats, 16 May 2024.
© Katherine Leung

Key points from 2024

- It is clear from our current knowledge that the Luannan Coast is an important staging site of international significance for two subspecies of Red Knot in the EAAF encompassing the vast majority of Red Knots wintering in Australia, New Zealand and South-east Asia. Between 2010 and 2024, we have recorded Red Knot from 23 different banding locations throughout the EAAF.
- We recorded 1,288 marked shorebirds of 12 species from throughout the EAAF, as well as from India (usually regarded as a part of the CAF), highlighting the importance of the Luannan Coast for these 2 flyways.
- This year, 134 birds were individually recognisable from the GFN colour-banding project in Northwest Australia (NWA), dominated by Red Knot with 131 individuals identified.
- In the period 2015-2019, fourteen species of migratory shorebirds have been recorded in internationally significant numbers, including four species with an absolute minimum of 10% of their entire EAAF population passing through the Luannan Coast during northward migration.
- In addition, there are nine species of shorebirds and terns we have recorded breeding within the study site from 2010 to 2024.
- On the Luannan Coast in 2024, the highest peak daily counts of Red Knot were 13,000 on 23 and 27 May at Nanpu. The number increased from the lowest count of only 3,660 in 2023 on the Luannan Coast since the start of our studies in 2010. The count this year is equivalent to 11.8% of the EAAF Red Knot population. Densities of the Red Knot's preferred bivalve prey *Potamocorbula laevis* also show a recovery from the decline in the past few years.
- Both the mudflats and the adjacent ponds of the Luannan Coast are vital components of the area for shorebird conservation, and an important contributing factor to the local economy and jobs.

Non-shorebird migration

Although the migratory shorebirds were the focus of our work, whenever there was an opportunity, we were looking for anything with wings. The passerine migration through the area is marked by high species diversity despite the paucity of any substantial wooded habitat.

Chris birdwatching at the Hangu trees, 6 May 2024. © Katherine Leung

Appendix 1 has a complete list of all the 172 birds seen during the fieldwork period.

Reed Parrotbill *Paradoxornis heudei* on Nanpu seawall, 12 May 2024. © Katherine Leung

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Collaborative partners

- Australasian Wader Studies Group (AWSG), Australia
- BirdEyes, Centre for Global Ecological Change at the University of Groningen, Groningen, The Netherlands
- Broome Bird Observatory, Broome, Australia
- Broome Community Volunteers, Broome, Australia
- CEAAF Center for East Asian-Australasian Flyway Studies, Beijing Forestry University, Beijing, China
- Conservation Ecology Group, Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, The Netherlands
- Ministry of Education Key Laboratory for Biodiversity Sciences and Ecological Engineering, College of Life Sciences, Beijing Normal University, Beijing, China
- Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, National Observation and Research Station for Wetland Ecosystems of the Yangtze Estuary, Fudan University, Shanghai, China
- NIOZ Royal Netherlands Institute for Sea Research, Department of Coastal Systems, Texel, The Netherlands
- Princeton School of Public and International Affairs, Princeton University, New Jersey, USA
- WWF China, Shanghai/Beijing, China
- WWF Netherlands, Zeist, The Netherlands

More information of GFN, see https://www.globalflywaynetwork.org/.

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Shorebirds flying over Nanpu, 30 April 2024. © Katherine Leung

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Appendix 1. Bird list

The full list of the 172 species recorded 28 April to 2 June 2024.

Greylag Goose
Common Shelduck
Ruddy Shelduck
Northern Shoveler
Falcated Duck
Eastern Spot-billed Duck
Mallard
Eurasian Teal
Red-breasted Merganser
Common Pheasant
Little Grebe
Great Crested Grebe
Rock Dove
Oriental Turtle Dove
Eurasian Collared Dove
Spotted Dove
Indian Cuckoo
Common Cuckoo
Common Swift
Pacific Swift
Common Moorhen
Eurasian Coot
White-breasted Waterhen
Black-winged Stilt
Pied Avocet
Eurasian Oystercatcher
Grey Plover
Pacific Golden Plover
Little Ringed Plover
Grey-headed Lapwing
Siberian Sand Plover
Greater Sand Plover
Kentish Plover
Eurasian Whimbrel
Far Eastern Curlew
Eurasian Curlew
Bar-tailed Godwit
Black-tailed Godwit
Asian Dowitcher
Red-necked Phalarope
Terek Sandpiper
Common Sandpiper
Green Sandpiper
Grey-tailed Tattler
Marsh Sandpiper
Wood Sandpiper
Common Redshank
Nordmann's Greenshank
Spotted Redshank
Common Greenshank
Ruddy Turnstone
Great Knot
Red Knot
Ruff
Broad-billed Sandpiper
Sharp-tailed Sandpiper
Curlew Sandpiper
Red-necked Stint
Sanderling
Dunlin
Little Stint
Oriental Pratincole
Saunders's Gull
Black-headed Gull
Relict Gull
Black-tailed Gull
Common Gull
Vega Gull
Lesser Black-backed Gull
Little Tern
Gull-billed Tern
Caspian Tern
Whiskered Tern
White-winged Tern
Common Tern
Oriental Stork
Great Cormorant
Eurasian Bittern
Yellow Bittern
Black-crowned Night Heron
Chinese Egret
Little Egret
Striated Heron
Chinese Pond Heron
Eastern Cattle Egret
Great Egret
Grey Heron
Purple Heron

Eurasian Oystercatcher *Haematopus ostralegus* on Nanpu mudflats, 28 May 2024. © Katherine Leung

Saunders's Gull *Saundersilarus saundersi* on Nanpu mudflats, 28 May 2024. © Katherine Leung

Crested Honey Buzzard
Eastern Marsh Harrier
Pied Harrier
Japanese Sparrowhawk
Little Owl
Eurasian Hoopoe
Common Kingfisher
Black-caped Kingfisher
Eurasian Wryneck
Rufous-bellied Woodpecker
Great Spotted Woodpecker
Common Kestrel
Amur Falcon
Eurasian Hobby
Peregrine Falcon
Ashy Minivet
Black-winged Cuckooshrike
Black-naped Oriole
Black Drongo
Brown Shrike
Azure-winged Magpie
Grey Treepie
Oriental Magpie
Daurian Jackdaw
Carrion Crow
Large-billed Crow
Chinese Penduline Tit
Asian Short-toed Lark
Eurasian Skylark
Zitting Cisticola
Thick-billed Warbler
Black-browed Reed Warbler
Oriental Reed Warbler
Lanceolated Warbler
Sand Martin
Barn Swallow
Red-rumped Swallow
Light-vented Bulbul
Yellow-browed Warbler
Pallas's Leaf Warbler
Radde's Warbler
Dusky Warbler
Eastern Crowned Warbler
Arctic Warbler
Reed Parrotbill
Vinous-throated Parrotbill
Chestnut-flanked White-eye
Swinhoe's White-eye
White-cheeked Starling
Crested Myna
White's Thrush
Siberian Thrush
Grey-backed Thrush
Eyebrowed Thrush
Dusky Thrush
Grey-streaked Flycatcher
Dark-sided Flycatcher
Asian Brown Flycatcher
Rufous-tailed Robin
Siberian Blue Robin
Siberian Rubythroat
Yellow-rumped Flycatcher
Taiga Flycatcher
Daurian Redstart
Blue Rock Thrush
Amur Stonechat
Eurasian Tree Sparrow
Grey Wagtail
Eastern Yellow Wagtail
White Wagtail
Richard’s Pipit
Olive-backed Pipit
Brambling
Chinese Grosbeak
Eurasian Siskin
Chestnut-eared Bunting
Yellow-throated Bunting
Pallas's Reed Bunting
Yellow-breasted Bunting
Little Bunting
Black-faced Bunting
Chestnut Bunting
Yellow-browed Bunting
Tristram's Bunting

Brown Shrike *Lanius cristatus* on Nanpu seawall, 9 May 2024. © Katherine Leung

Sand Martin *Riparia riparia* at Caofeidian, 21 May 2024. © Katherine Leung