



SHOREBIRD NORTHWARD MIGRATION THROUGH BOHAI BAY, CHINA, THE REPORT ON THE *TENTH* FIELD SEASON APRIL – JUNE 2019

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Red Knots foraging, Nanpu 30 April 2019 © Rob Buiter

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Summary

This year's fieldwork season commenced on 11 April 2019 and finished on 6 June 2019. The Luannan Coast referred to throughout this report encompasses our study sites shown in Figure 1 and the adjacent salt and aquaculture ponds.

The main findings from this year's fieldwork showed that Red Knot *Calidris canutus* were once again using the Luannan Coast in large numbers. During a count on 22 May 2019, we counted 47,537 Red Knot, similar to the totals for this species in 2018, 2014 and 2015. This is in contrast to the low numbers recorded during 2016 and 2017. During a count on 8 May 12,971 Great Knots *Calidris tenuirostris* were recorded. This is the highest number we have recorded in the ten years of complete survey periods for this species.

We recorded 3,450 marked shorebirds (and 2 Relict Gulls *Ichthyaetus relictus*), 3,444 from throughout the East Asian-Australasian Flyway (EAAF) and six from two sites on the east coast of India which is in the Central Asian Flyway. During the previous 2018 study period we recorded 4,125 (13 of those from India) (Table 1). This year, 387 birds were individually recognisable from the Global Flyway Network (GFN) colour-banding project in Northwest Australia (NWA). This is 26 more than the 361 in 2018. A 7% increase that can probably be explained by good weather and viewing conditions for the vast majority of this season. The totals were dominated by Red Knot with 336 (313 in 2018) individuals identified, Great Knot with 48 (44 in 2018) and Bar-tailed Godwit *Limosa lapponica* with 3 (4 in 2018) (Table 3). These results come from 'scanning'; this is systematically searching through feeding or roosting birds using telescopes and looking specifically for flags and colour-bands on bird legs. Each marked bird is recorded and the records sent to each banding project at the end of the fieldwork season. This season, due to the water levels in the pond habitat being deeper than in all previous years, Red Knots did not feed there and subsequently spent more time on the mudflats. Resighting observations and counts are easier and more productive in terms of recording marked birds on the mudflats and this along with good weather and viewing conditions, contributed to the increased number of sightings. As in previous years, these records reflect the vital importance of the area for Red Knots from NWA and throughout the EAAF and increasingly so for Great Knots.

The ponds within the salt works/aquaculture areas host all the migrant shorebirds at high tide when the mudflats are inundated by the sea, making the area a critical component of the Luannan Coast. For their roosting opportunities alone the ponds should be included in any conservation initiatives. The ponds are also an important contributing factor to the local economy and jobs (see Study Site). The importance of the vast area of commercial ponds adjacent to the inter-tidal area for shorebirds has been well documented from our work and that of Beijing Normal University (BNU) students in previous years. This year the use of ponds by shorebirds was very similar to 2018, which had much reduced use than in any previous year. Many species usually utilise the ponds, but all except one of the ponds that we explored had deep water in them consistently throughout the season, as has been the situation for a few years. This deep water provides few foraging opportunities for the smaller shorebirds.

During systematic counts of the area, conducted in conjunction with BNU, we recorded five species in their largest numbers since 2014 (see table 4). These were Black-tailed Godwit *Limosa limosa* (1,937, 4.9% increase), Eurasian Curlew *Numenius arquata* (2,722, 55.2%), Great Knot (12,971, 26.3%), Grey Plover *Pluvialis squatarola* (3,220, 12.3%) and Pied Avocet *Recurvirostra avosetta* (1,149, 13.9%). Counting large numbers of birds over a wide area is an inaccurate science so the Black-tailed Godwit count could be construed as 'the same' as the previous highest count. The increase in Pied Avocet is probably due to the increased study effort on this particular species. However; the other 3 species do appear to have increased

in numbers at Luannan this season. Whether these are ‘one-off’ counts or a genuine increase of these species at Luannan is unknown, but hopefully our counts in the future years will inform us more on this. It is not unreasonable to speculate that as the habitat destruction has all but ceased at Luannan since 2011, but continues in other areas, that birds displaced from those areas are now turning up at Luannan. This seems like good news, but all habitats have a carrying capacity, and survival of individuals can be impacted if there are too many birds for the available resources (Burton *et al* 2006, Kraan *et al.* 2009, Piersma *et al.* 2017).



Chris heading out to scan at Nanpu, 2 May 2019 © Rob Buiters

A table of species recorded in internationally important numbers has been compiled from GFN and BNU studies over the previous ten northward migration seasons (2010–2019). It is an effective way to give an indication of the immense importance of the Luannan Coast Shorebird Site. In the last six seasons seventeen species of migratory shorebirds and one migratory tern have been recorded in internationally significant numbers (1% Ramsar criteria). Five species have an absolute minimum of 10% of their entire EAAF population passing through the Luannan Coast site during northward migration (Table 4). Note that these are single peak counts and do not account for turnover rate, 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).

On the Luannan Coast the direct destruction of the intertidal habitat has slowed in the last seven years. The pressures on the intertidal areas appear to be less in terms of direct destruction, but are still present with the

development of industrial and housing areas adjacent to and on previously reclaimed mudflats. There are building projects that are taking place in former pond habitat and mudflat areas reclaimed in recent years including a large steel works that will have a port developed on existing intertidal flats. Currently, multi-billion yuan projects are in the planning stages for development within the Luannan Coast area and the future of these critically important intertidal areas remain under threat despite the commencement of management actions at the Luannan coast by the Luannan County government.



Red Knot foot prints, Nanpu 3 June 2019
 © Chris Hassell

Global Flyway Network aims to continue conducting research activities and follow-up analysis 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.

A critical question is the interpretation of the increased use of the Luannan Coast by Red and Great Knots. Does this increase reflect a recovery of overall population size, or the increased reliance on this area because of changes to habitat elsewhere? Knowing this distinction is critical, but requires local and flyway-wide research efforts, including the continuation of satellite tracking of individual knots.

Introduction

Most of the Yellow Sea 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 a number of sites on their way north. The Luannan Coast is one such critical area and it is particularly important to Red Knot (Piersma *et al.* 2016, Rogers *et al.* 2010). The ecology of the enigmatic long-distance migratory shorebird Red Knot, despite a lot of study, still leaves much to be discovered in the EAAF. It is represented in this flyway by three subspecies *piersmai*, *rogersi* and *roselaari* (the latter is not part of this study because it only breeds on Wrangel Island 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).

Despite Red Knots having been one of the best researched shorebirds in the world for quite some time (see, e.g., summary in Piersma *et al.* 1997), we certainly do not fully understand the northward and southward migration strategies of the two subspecies, and changes therein, as a consequence of habitat change and loss within the EAAF. Surveys of the Yellow Sea by Mark Barter and Chinese colleagues failed to find significant numbers of the species despite extensive searching in May 2000. During northward migration in 2002 they did record 14,277 in the NW Bohai Bay region, now called the Luannan Coast (Barter *et al.* 2003). During a brief six-day visit in late-April 2007 Chris Hassell (CH) from GFN counted a single flock of 10,650 Red Knot in the same region. In September 2007 Yang Hong-Yan (YHY, then a PhD student at Beijing Normal University) 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 birds in the study area had increased over the years, presumably due to habitat destruction elsewhere and consequently birds moving into the study site (Yang *et al.* 2011).

It is well documented that migratory shorebirds can move from one area to another if one area becomes unsuitable. However, this is of course unsustainable if habitat destruction continues; eventually there is not enough habitat to support populations. It is equally well documented that there are negative survival consequences for birds moving to new sites (Burton *et al.* 2006). Until Local and International Governments accept that birds cannot continue to 'just move somewhere else' indefinitely (see arguments in Piersma *et al.* 2017), the populations of migratory shorebirds passing through the Yellow Sea and therefore returning to their various non-breeding locations in the southern areas of the EAAF are in grave danger of diminishing to unsustainable levels (Piersma *et al.* 2016, Studds *et al.* 2017).

It is clear from our current knowledge that the Luannan Coast is the single most important site for Red Knot on northward migration in the EAAF. The southward migration route and staging areas of Red Knot are still a relative mystery to us. Geolocator and satellite transmitter studies are just beginning to answer some of the questions pertaining to the southward migration (Piersma *et al.* MS in preparation).

In conjunction with the work by YHY, studies by GFN have continued during the northward migration seasons of 2009 to this year, 2019. These fieldwork studies have concentrated on searching for individually-marked Red Knots and have been remarkably successful. In view of the many human-related threats to this area, it is the single most important staging area for two subspecies of Red Knot in the EAAF encompassing all Red Knots wintering in Australia and New Zealand, it seems of utmost importance to continue the survey work. The research effort in China builds on the research conducted in NWA funded from 2007 to 2013 by BirdLife-Netherlands. BirdLife-Netherlands and WWF-Netherlands have continued to financially support Theunis Piersma as the Chair in Global Flyway Ecology at the University of Groningen through which the analytic and data-processing work by Dr Tamar Lok (2014-2016) was made possible. Beijing Normal University funded the daily on-ground costs notably accommodation and transport through Professor Zhang Zhengwang. From this year, 2019, the new Centre for East Asian-Australian Flyway Studies at Beijing Forestry University, headed by Prof. Guangchun Lei, has taken on the responsibility of covering the salaries of the international GFN team. Here we report on what we have achieved in April – June 2019.

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 for the future of migratory birds.



Red Knots feeding, Nanpu 22 May 2019 © Nigel Jackett

The Study Site



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

The centre of the study site is situated at 39° 03' 35"N 118° 12' 33"E. It is near Nan Pu Development City, situated on the edge of Bohai Bay, 190 km south east of Beijing, China. Figure 1 shows the five main coastal study sites and the Caofeidian New Area Industrial Park. This enormous area will have destroyed 142 km² of intertidal mudflat at its completion in 2020 (Yang *et al.* 2011), of which >75% has already been developed. The mudflats of our five study sites cover 30 km in length and are 1-4 km wide (on the lowest tides).

The mudflats are separated by a man-made seawall from the Nanpu ponds complex. These are reputedly 'the largest salt works in Asia'. This area, adjacent to the mudflats, is also critical habitat for birds to forage and roost (Lei *et al.* 2018), and for some species to nest but some of these areas are 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 study sites and therefore roosting opportunities are many and varied for migratory shorebirds and terns. The ponds 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 shrimp to fatten them for harvest and sale for human consumption. Brine shrimp cysts (dormant eggs) are also collected and 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. Different salinities are more, or less, suited to the different uses.

In previous years the majority of shorebirds and terns have used the evaporation ponds for roosting and feeding. The years of 2016 to 2019 were markedly different with very few shorebirds making use of the ponds as they were all, bar one, in 2018 and 2019 too deep. For the purposes of this report all and any pond, regardless of its use, is referred to as a 'pond'.



Kentish Plover nest, Nanpu ponds 20 April 2019
© Matt Slaymaker

Marking of Shorebirds

Shorebirds captured throughout the EAAF are marked with plain coloured leg flags, engraved leg flags (ELF), or combinations of four colour-bands and one 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 coloured flag and/or position of the flag on the birds' leg: http://eaaflyway.net/documents/Protocol_birds%20marking.pdf

The focus of our study is the individually colour-banded birds marked at Roebuck Bay and 80 Mile Beach, NWA, but we record every single marked bird we see during our fieldwork thereby documenting the importance of this area for various species from regions throughout the flyway.

In addition to the data collected during our studies at Luannan the GFN project is also getting 10's of 1,000's of resightings at Roebuck Bay and 80 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 (6YYYYY) marked at Roebuck Bay 15 July 2017. This was the first resighting of this bird since marking. This image is from 5 June 2019 © Nigel Jackett

Fieldwork in 2018

The fieldwork program for 2019 started on 11 April and finished on 6 June, equating to fifty-seven consecutive days of fieldwork with two to three (occasionally five) observers in the field daily. On our first fieldwork day the usual suite of species that we expect to see were present Eurasian Curlew, Grey plover, Kentish Plovers *Charadrius alexandrinus*, Dunlin *Calidris alpina* and Great Knot being the most common. On the third day of field work, 13 April we recorded a minimum of 7,663 Great Knot using the Nanpu and Zuidong mudflats. Our highest count of Great Knot was 12,971 on 8 May. Numbers stayed fairly constant until 12–17 May when most of this species left to continue their northward migration.

Red Knot were apparently later arriving than in 2016 and 2019, but were eventually recorded in greater numbers than in those years. Numbers increased from hundreds on 12 April to 4,500 on 27 April and then to 9,534 on 1 May. The count of all areas in conjunction with Beijing Normal University on 16 May showed there to be 46,830 Red Knot, our highest count since 2013. These birds were at the 'main sites' that we have come to expect big numbers of Red Knot to use. 25,250 at Nanpu, 8,110 at Beipu and 12,226 at Hangu

Wind Farm. This a big increase on the biggest count from 2016 (20,000) and 2019 (17,000). It is still not clear if we were unable to locate some birds during 2016 and 2019 or they didn't arrive at Luannan and were using other sites in the Yellow Sea region. Our 'sense' was that the birds were not here (see reports from 2016 and 2019).

All the totals of each species should be considered underestimates, or absolute minimum totals, for the area due to the fact there are still areas of ponds inaccessible to us and we cannot count all sites used by shorebirds simultaneously.

Red Knot numbers increased from just 792 on 13 April to 10,030 on 26 April and then to 44,241 on 8 May. The peak count was of 47,537 on 22 May. This count was 1,093 birds less than the count of 16 May 2018 (46,830). This is a 2% difference which, given the margin for error associated when counting large flocks of birds, is effectively the same. These two counts are our highest since 2013. This is a big increase on the biggest count from 2016 (20,000) and 2017 (17,000). It is still not clear if we were unable to locate some birds during 2016 and 2017 or they didn't arrive at Luannan and were using other sites in the Yellow Sea region. Our 'sense' was that the birds were not here (see reports from 2016 and 2017).



Matt looking for knots to scan at a foggy Nanpu, 14 April 2019 © Adrian Boyle

All the totals of each species should be considered absolute minimum totals for the area due to the fact there are still areas of ponds inaccessible to us and we cannot count all sites used by shorebirds simultaneously.

On 26 April 2019, 5,133 Kentish Plover were counted, but in the days following most of this species moved further north and spread out throughout the ponds to breed.

Note: all counts throughout this document are minimum numbers

Table 1 documents the duration of our study periods at Bohai Bay. As our understanding of the importance of the site became clear to us we started to cover the entire migration season of Red Knots. We started with a preliminary visit in 2007 leading to the complete and continuous coverage of northward migration from 2010 – 2019. No observations were made during northward migration season 2008.

Total sightings of all marked birds for 2019 were lower than in 2018 by 16% (Table 1). This is possibly due to fewer birds being marked at the many banding locations throughout the EAAF. The total number of Red Knot colour-band resightings for 2019 was 880; almost 250 less than the 1,122 in 2018, but the number of known individuals recorded increased to 336 for 2019 from 313 in 2018. This equates to a decrease of 21% in total observations but an increase of 7% in identifiable individuals. This is difficult to interpret, but we do put most of our efforts in to identifying colour-banded individuals and this method of marking makes them easier to see at a distance in good conditions, which we experienced for most of the season. It is a pleasing result and suggests that we are seeing the majority of the colour-banded individuals from NWA that pass through Luannan.

Table 1. Days of observation, total sightings of marked birds and resightings of individually recognisable colour-banded Red Knot from NWA at the Luannan study site 2010 - 2019.

	Days of Observation	Total Flag Sightings	Colour-banded Red Knot from NWA
2007	7	49	0
2008	0	0	0
2009	19	859	76
2010	57	3,133	106
2011	52	3,354	170
2012	53	4,496	279
2013	59	4,613	269
2014	57	5,014	345
2015	57	4,147	387
2016	56	3,554	261
2017	55	2,765	265
2018	57	4,116	313
2019	57	3,452	336
Total	586	39,552	2,807

This was our third year with good coverage of the Hangu Wind Farm site. However, only a few Red Knots were using this site in 2019 for reasons that are not obvious. Perhaps the abundance of *Potamocorbula laevis*, the knots preferred food, at Nanpu meant that Red Knots had no need to explore Hangu for foraging opportunities. Hebo Peng of the University of Groningen/NIOZ had this encouraging news '*The main food of shorebirds in general and Red Knots in particular is very abundant in Nanpu this year (2019), Potamocorbula bivalves were found in the highest (average) density over the last five years. Other shellfish species also show a high density in this area, which means that Nanpu wetland is still healthy and can support large numbers of shorebirds.*' (Hebo Peng, pers. comm.) We didn't record any colour-banded Red Knots at Hangu this season. From our previous work we know, from checking individual birds resighting history, that the birds using the Hangu Wind Farm site, are the same birds that use the Nanpu and Beipu sites.

The shell-fishing activity at Nanpu stopped this year as of 1 May. The Hebei Provincial Oceanic Administration banned all summer fishing activity including shell-fishing from 1 May to 1 September in line with national guidelines. This is a very welcome move and very sensible in that the fisherman will be permitted to return from 1 September when there will be less birds utilising the site. Note: it has been argued that the very intense fishing practices, for *Potamocorbula bivalves*, in the late-summer may even benefit shorebirds staging in the spring because it would allow an increase in the settlement of new recruits the subsequent spring (Yang et al. 2016). There is almost zero fishing activity on the mudflats at Hangu as it is incredibly soft and is very difficult to walk on.

Despite the mud also being soft at Beipu, there are some fishing nets there. And this year some areas had been seeded with shellfish to grow and be harvested for human consumption. The birds found this area and the owners of the shellfish started to scare the birds by firing loud fireworks at them. This was reported to the authorities and the practice stopped. Our scanning at both Hangu and Beipu was conducted from sea walls and in the adjacent ponds. At both Nanpu and Zuidong we work from the seawall and by walking out on the mudflats. Zuidong does have some shell-fishing activity but it is not mechanical, only people searching for

shell-fish by hand. At the eastern area of Zuidong there is a popular site where people access the mudflat and collect shellfish. There can be over 200 people on the mudflat, but they stay in a relatively small area and their current use likely has little effect on the overall population of benthos available to shorebirds.



Ady scanning from the busy Nanpu Seawall, 11 May 2019 © Chris Hassell

Between 2016 and 2018 the ponds have gradually become deeper and deeper and subsequently there were fewer foraging opportunities for shorebirds. This was the same during the 2019 season. In the years up to 2016 we spent about 25% of our scanning efforts in ponds, but for 2018 and 2019 that was reduced to under 5%. The birds still use the pond walls for roosting, but observing tightly packed roosts is relatively unproductive (results in fewer colour-band observations) and access to the ponds where the birds roost can be difficult. Due to the deep ponds, the birds were still using the mudflats to forage, even late in the season. In the years before 2018, late in the season the birds used to utilise the mudflats less frequently and forage in the shallow ponds. During 2018 and this year 2019, we only found one accessible pond with foraging Red Knot. This is a pond that has been a suitable foraging site for birds including Red Knot in all previous years.

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. The importance of the ponds can easily be augmented with proper management. Any opportunities to engage with the owners and managers of the ponds should therefore be taken to explain the importance of the ponds to migratory shorebirds. As the water flows through the ponds system there may be opportunities to retain some shallow ponds without impacting on the commercial effectiveness of the ponds.

The scanning of foraging birds from the seawall and on the mudflats occupied most of our time. Exploration of the ponds also took a little time, as we were hoping to find good scanning opportunities, despite our experience of 2018. Only one pond of the area we explored was suitable for small shorebirds to forage in. During the 57 days of field work we made a total 3,454 sightings of marked birds of which 776 were 'known individuals', those able to be identified from unique engraved flags or colour-band combinations to an

individual bird (Tables 1, 2 and 3). All shorebirds that forage on the mudflats leave there at high tide, as the sea reaches the seawall and fly to roost in the ponds.

Some birds roost in close proximity to the mudflats (especially early in the season), but as with previous years, by early-May most birds flew many kilometres from the mudflats to their pond roost sites, some of which are difficult to scan successfully. This change in roost preference seems to happen every year. The reasons are a mystery. The roost areas we did access continued to be relatively undisturbed although migrating raptors and pond workers do cause some disturbance. The levels of disturbance do not appear to differ between roosts sites close to or distant from the mudflats. The myriad of roosting opportunities available are a positive for the shorebirds, but the foraging opportunities within the ponds have diminished almost completely.



Nigel scanning from the van on a windy day, 12 May 2019 © Adrian Boyle

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 migrant shorebirds and terns to continue using the area as a staging site. This need has been recognised and discussions between provincial and county governments and NGOs are progressing with the aim of establishing either a nature reserve or a wetland park (see later section)

Table 2 below shows the totals of all marked migratory shorebirds recorded during all our fieldwork seasons and the location they were originally marked. The birds with plain flags just indicate the original banding area and cannot be identified to an individual bird. The colour-banded birds, the engraved leg-flagged birds (ELF) 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.

Table 2. Totals of resightings of marked shorebirds, of all species, by banding area, recorded during fieldwork 2010 to 2019. These records (2010–2019) represent 35 different marking areas in 13 countries and territories within the EAAF highlighting the importance of these mudflats, not only to birds from NWA, but from throughout the entire EAAF.

Marked at	2010	2011	2012	2013	2014	2015	2016	2019	2018	2019	Total 2010-2019	Known Individuals 2019
Australia, King Island, Tasmania	3	2	4	0	1	5	2	4	1	0	22	0
Australia, New South Wales	0	2	0	1	0	1	0	0	0	0	22	0
Australia, Northern Territory	3	0	0	1	0	4	57	24	55	53	197	12
Australia, North West Australia (Colour Bands)	317	412	904	613	922	1221	671	680	1122	1095	7957	387
Australia, North West Australia (Flags)	912	812	1166	1053	1222	1036	964	916	1315	963	10359	187
Australia, Queensland	7	7	8	27	12	4	14	3	1	13	96	2
Australia, South Australia	12	35	62	73	54	31	40	20	20	26	373	5
Australia, South West Western Australia	6	0	0	1	4	3	0	0	0	0	14	0
Australia, Victoria	746	644	798	985	858	507	487	290	433	309	6057	33
China, Bohai Bay	122	96	129	125	108	55	162	78	126	81	1082	11
China, Chongming Dongtan National Nature Reserve	321	447	565	552	679	510	518	342	437	356	4727	54
China, Hebei Province (inland)	0	0	0	0	0	0	0	0	0	2	2	2
China, Jiangsu	0	0	0	0	0	0	0	1	2	8	11	0
China, Liaoning Liaohekou National Nature Reserve, Liaoning	1	9	0	1	1	7	1	5	0	0	25	0
China, Yalu Jiang National Nature Reserve	0	0	0	1	3	3	0	0	0	0	7	0
Hong Kong	5	23	19	44	39	20	20	6	18	9	203	1
India, Point Calimere, Tamil Nadu	0	0	0	0	0	0	5	5	5	4	19	0
India, Chilika Lake, Odisha	1	0	0	0	0	4	7	5	8	2	27	0
Indonesia, Java	1	0	0	0	0	0	0	0	0	0	1	0
Indonesia, Sumatra	12	4	5	8	7	6	2	2	0	2	48	0
Japan, Kyushu	0	0	0	0	0	0	2	0	0	0	2	0
Japan, North Coast, Hokkaido	1	7	10	5	9	5	8	2	0	2	49	0
Japan, North East Coast	0	0	0	0	0	4	1	0	0	0	5	0
Japan, Tokyo Bay	0	0	0	0	0	0	0	0	1	7	8	1
New Zealand, North Island	558	748	681	855	734	452	317	198	307	219	5069	57
New Zealand, South Island	32	20	21	35	22	17	18	5	2	7	179	1
Philippines, Olango Island	0	0	0	1	1	0	0	0	0	0	2	0
Russia, Chukotka	1	32	43	50	62	38	44	22	22	50	364	9
Russia, Kamchatka	1	3	4	1	0	6	7	20	37	65	144	12
Russia, Sakhalin	0	4	5	48	52	44	43	33	36	21	286	0
Singapore	1	0	0	1	1	0	0	0	0	0	3	0
South Korea	0	0	0	0	8	12	5	0	5	0	30	0
Taiwan	4	0	2	3	2	4	1	0	1	7	24	0
Taiwan, Kinman Island	0	0	0	0	0	0	0	2	0	0	2	0
Thailand, Inner Gulf Of Thailand	31	18	34	96	153	92	125	75	113	118	855	2
Thailand, Ko (Island) Libong, South West Coast	35	29	36	33	60	56	33	27	49	33	391	0
Totals	3133	3354	4496	4613	5014	4147	3554	2765	4116	3452	38644	912
Number of Species	14	14	13	18	17	18	17	15	14	15		

Shorebird use of the mudflats and resighting coverage

The birds' use of the Study Site (see Fig. 1, Study Site image) has changed from our first visit in 2007 and continues to vary each year as local conditions fluctuate and effect the suitability of different areas for the birds (particularly Red Knot, our focal species and a 'specialised feeder'). We have four major mudflat study sites within the entire study area and also the ponds.

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, and it is often where most of the birds congregate. This is presumably because, at present, this site has the most abundant 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 the majority of our fieldwork was conducted in 2019 as in all other years. The mechanical shellfishing operation has been stopped from 1 May to 1 September. During 2017 we regularly saw up to 100 people on the mudflats at the Nanpu site collecting shellfish by hand, but last year, 2018 and this year 2019, there were substantially less (usually less than 10). Reasonable levels of fishing activity in past years did not appear to concern the birds, we would watch flocks of birds feeding close to shell-fishermen. However, we cannot be sure that the increased presence of Red Knot on the Nanpu mudflats in the last two years isn't somehow connected to the lower levels of fishing activity. Although high densities of suitable prey species is probably the over-riding factor for this being the favoured Red Knot feeding site. The Nanpu mudflats are undoubtedly the most important of the remaining mudflats in the area. There had been some dredging in 2006 for small-scale reclamation and artificial islands have been built close offshore for oil extraction, but the mudflats abutting the seawall are still excellent shorebird foraging grounds. It is imperative that this site gains some form of protection to enable the Red Knot and many other migratory shorebird species of the EAAF to maintain sustainable population levels. It is hoped the ongoing work towards establishing a nature reserve/wetland park will continue and ultimately be successful.

The mudflats at Beipu are 4.5 km long and approximately 4 km wide at the lowest tide. The flats here have undergone many changes since our first visit in 2009. During our fieldwork in 2009 and 2010 we were regularly scanning at Beipu with thousands or tens of thousands of Red Knots frequenting the site. However, soon after our fieldwork season finished in 2010, development work started and was still going on during the 2011 field season. This involved many large industrial dredging ships pumping mud out of the mudflats and over the seawall into the adjacent salt ponds, damaging two shorebird habitats in the one process. In the areas that were dredged the mud was extracted up to a depth of 15 m. This brings up anaerobic sediment and is pumped into the pond that is going to be filled. The heavy sediments settle and remain in the pond while the finer sediment and water run back out through sluice gates placed in the seawall for this purpose. As the fine black water and sediments run out back over the mudflats, they may smother it and cause the benthos to 'suffocate'. Just after this process there is a dramatic drop in shorebirds foraging at the affected site, we also saw this happen at our southern-most study site of Zuidong.

The destruction of the mudflats at Beipu ceased prior to our 2012 season due to a dispute between the development companies and the pumping companies. This situation has remained the same up to this 2019 season, with no dredging or development work being done on the Beipu mudflats for seven years. Due to these activities, the Beipu mudflats have had wildly fluctuating numbers of foraging Red Knots over the years. In 2012, 2013 and 2014 very small numbers were recorded there. In 2015 that changed very dramatically with up to 25,000 Red Knots using Beipu. The usage in 2016 was reasonably high with up to 9,000 Red Knots on the flats. 2017 reflected the low numbers of Red Knot in the area with very low numbers

of Red Knot, the biggest count being 2,230. This year on 22 May there were 10,582 Red Knot counted compared to the highest 2018 count of 8,110. Scanning effectively is more difficult at Beipu than it is at Nanpu, mainly due to logistics and the shorter time the birds are close enough to read flags and colour-bands. We know from our work and resighting histories that birds use all sites and so we were likely to encounter any birds that were using Beipu at either Nanpu or Hangu. The suitability of the Beipu mudflat as a foraging site for migratory shorebirds has certainly not been consistent over the 10-year period of our full study years. Detailed studies on the benthos of the site have not been undertaken by the PhD students, as the very soft mudflats are difficult and indeed dangerous to access.



Chris scanning as trucks rumble past, 11 May 2019 © Nigel Jackett

Another issue at Beipu that highlights the lack of regulation on the coast is that in 2016 a 'resort' was built on the seawall. By 2017 it had already been abandoned, having never been used. Some of the buildings had toppled over the edge of the seawall. The decrepit development does not seem to be a major conservation issue in comparison to the huge losses of mudflats along the Yellow Sea coast, but it illustrates the unregulated nature of the human use of this very important site. It has been reported to us that in late-June 2019 the site was being cleaned up and buildings removed.

This year we once again worked regularly at Zuidong, particularly early in the season when large numbers of Great Knot were using the mudflats there. The mudflats there have 'improved' since the major pumping and seawall construction in 2009–2011. Because Zuidong mudflats are covered by the tide earlier than the Nanpu mudflats, birds from Zuidong would regularly move between these two sites. Most of our scanning here is done out on the mudflats and not from the seawall. A lot of industrial development continues on the reclaimed land adjacent to the remaining Zuidong mudflats.

The North Beipu site has been worked less and less over the years and this season we explored it only once. The mudflats here are very soft and access is prohibited due to the Chlor-alkali liquid waste facility located there. The ponds at North Beipu that used to be good roosting and foraging habitat have had all the pond walls built up by dredging mud from within each pond. This has made the sides steep and the water deep at the base of the walls and therefore unsuitable for foraging shorebirds. The top of the walls are very rough and as the dredged mud dries out they become very cracked and unsuitable for roosting birds. As with the Beipu mudflats we know from previous years that individual birds that we see at North Beipu we also record at Beipu and Nanpu mudflats in the same season.

Hangu Wind Farm site is now regarded as one of our study sites within the Luannan Coast study area. We first visited Hangu regularly in 2017 but it is evident that it is an important component of the Luannan Coast for shorebirds and we included it in our fieldwork schedules this year and will continue to do so. Red Knots have used the area in large numbers, but not this year. The biggest count this year was just 1,786 Red Knot but 12,266 in 2018. Perhaps the abundance of *Potamocorbula laevis* at Nanpu (Hebo Peng, *pers. comm.*) meant that Red Knots had no need to use Hangu for foraging opportunities this year. We didn't record any colour-banded Red Knots at Hangu this season. From our previous work we know, from checking individual

birds resighting history, that the birds using the Hangu Wind Farm site, are the same birds that use the Nanpu and Beipu sites. Hangu remains an important site for Black-tailed Godwits, a species that likes to forage in very soft sediments. 17,920 Black-tailed Godwit were counted by BNU on 13 April. Not a single Black-tailed Godwit marked in NWA has been seen amongst these large flocks over all the years of GFN studies. This is not surprising as these birds are not the subspecies that spend the non-breeding season in NWA. They are the subspecies that spend the non-breeding season in South China and Hong Kong and probably some of South East Asia (B. Zhu *et al.* in prep.).

The maximum count of Asian Dowitcher this season was 354, this is in stark contrast to the 1,703 on 13 May 2018 and the 1,754 on 8 May 2017. The mudflats of Lianyungang, Jiangsu Province are just 470 km south of Luannan and are known for large numbers of Asian Dowitchers (Chan *et al.* 2019). This year, during late-April to mid-May, Jimmy Choi of the Southern University of Science and Technology in Shenzhen was surveying Lianyungang with volunteers from "the Spoon-billed Sandpiper in China project". The team recorded 'an absolute minimum of 13,000 Asian Dowitchers with potentially as many as 20,000' (J. Choi *pers.comm.*). It is possible that the Asian Dowitcher that usually use Luannan on northward migration were at Lianyungang due to a very high abundance or easy to access food source during the 2019 northward migration season. Asian Dowitcher is a relatively easy species to count on the mudflats. They have a very distinctive feeding method and usually feed in a single species flock, therefore, we are confident that this species was not at Luannan in the high numbers of the previous years.



Asian Dowitchers head to a roost at Hangu, 21 May 2019 © Adrian Boyle

Table 3 shows records of individually colour-banded birds marked in NWA recorded on the Luannan Coast for the years 2010 to 2019. The 387 individuals recorded this year is our second highest total. This is 92 more than the 295 in 2016 and 2017 and likely reflects the increased numbers of Red and Great Knots using Luannan. The totals were dominated by Red Knot with 336 (313 in 2018) individuals identified, then Great Knot with a slight increase to 48 (44 in 2018) and Bar-tailed Godwit with 3 (4 in 2018). Two of the Bar-tailed Godwit have been seen over multiple years, one for the sixth consecutive year, one the tenth. Resighting conditions on the Luannan Coast were 'better' this year and marking effort on the non-breeding grounds of NWA has been consistent over the years. The Luannan Coast 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 to 2018. No Black-tailed Godwits have been recorded within the Study Site.

NWA colour-banded individuals	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bar-tailed Godwit	3	2	4	3	5	6	3	4	4	3
Great Knot	6	20	17	12	11	30	31	22	44	48
Red Knot	106	170	287	272	329	387	261	269	313	336
	115	192	308	287	345	423	295	295	361	387

Internationally Important Counts

During the ten years GFN have been visiting the Luannan Coast we have been conducting regular counts in conjunction with Beijing Normal University, 2010 to 2019. 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 counts are absolute minimum counts as the vast area can never be completely covered with our current resources and no turnover analysis is done. During this 2019 season we recorded our highest count of Black-tailed Godwit, Eurasian Curlew, Great Knot, Grey Plover and Pied Avocet. We also had internationally significant counts of various species during the fieldwork season but none were higher than those shown in Table 4. Note that there have been higher counts of some species prior to 2014 but with the renewed EAAF Population Estimates (BirdLife Australia 2016) we have only used counts from the last 5 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.

Table 4. Internationally Important Counts at Luannan Coast 2014 to 2019.

Species	Scientific Name	Date recorded	Number	% of EAAF Population present	EAAF Population from BirdLife Australia 2016	1% Criteria
Asian Dowitcher	<i>Limnodromus semipalmatus</i>	08-05-17	1,754	12.5	14,000	140
Black-tailed Godwit	<i>Limosa limosa</i>	13-04-19	17,937	11.2	160,000	1,600
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	27-05-15	2,460	8.2	30,000	300
Curlew Sandpiper	<i>Calidris feruginea</i>	04-05-14	24,500	27.2	90,000	900
Dunlin	<i>Calidris alpina</i>	07-05-17	40,000	1.6	2,500,000*#	25,000
Eurasian Curlew	<i>Numenius arquata</i>	26-04-19	2,722	2.7	100,000"	1,000
Great Knot	<i>Calidris tenuirostris</i>	08-05-19	12,971	3.1	425,000	4,250
Grey Plover	<i>Pluvialis squatarola</i>	26-04-19	3,220	4	80,000	800
Marsh Sandpiper	<i>Tringa stagnatilis</i>	27-04-16	8,785	6.8	130,000	1,300
Nordmann's Greenshank	<i>Tringa nebularia</i>	16-05-16	7	1.4	400-600"	5
Pied Avocet	<i>Recurvirostra avosetta</i>	26-04-19	1,149	1.1	100,000*	100
Red Knot	<i>Calidris canutus</i>	16-05-18	48,630	43.8	110,000	1,100
Red-necked Stint	<i>Calidris ruficollis</i>	08-05-16	4,747	1	475,000	4,750
Sanderling	<i>Calidris alba</i>	29-05-16	4,321	12.3	35,000	350
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	04-05-14	4,000	4.7	85,000	850
Spoon-billed Sandpiper	<i>Eurynorhynchus pygmeus</i>	25-05-16	1	0.3	140-480*	3
Spotted Redshank	<i>Tringa erythropus</i>	15-05-16	592	2.6	25,000*	250
White-winged Black Tern	<i>Chlidonias leucopterus</i>	14-05-14	40000e	4 to 40	100,000-1,000,000*	1,000

e Estimate * Wetlands International (2016). "Waterbird Population Estimates 5" # Uncertainty of distribution of all subspecies in EAAF.

The column 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 *Calidris canutus* and the presence of *rogersi* and *piersmai* subspecies

The main focus of our studies on the Luannan Coast are the Red Knot. We get fabulous data each year on the individually marked birds from the GFN project.

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



Adrian and Nigel return from scanning, Nanpu 31 May 2019 © Chris Hassell

In relation to Red Knot marked in Roebuck Bay and 80 Mile Beach (NWA), for both the total number of resightings and the individuals that those sightings represent, it needs to be taken in to 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 Bohai under different schedules than *rogersi* that have 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 Luannan 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* are only here for a short time, in some cases, a week or less. This was confirmed by a sophisticated scientific paper showing the *piersmai* subspecies to stay for 5-9 days at Luannan (Lok *et al.* 2019).

To evaluate the proportions of the two subspecies we conduct random scans of flocks and assign a subspecies to each bird. Red Knot were assigned to the *rogersi* or *piersmai* sub-species on the basis of plumage characteristics. 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.



A 'typical' *piersmai* AP 4 © Adrian Boyle



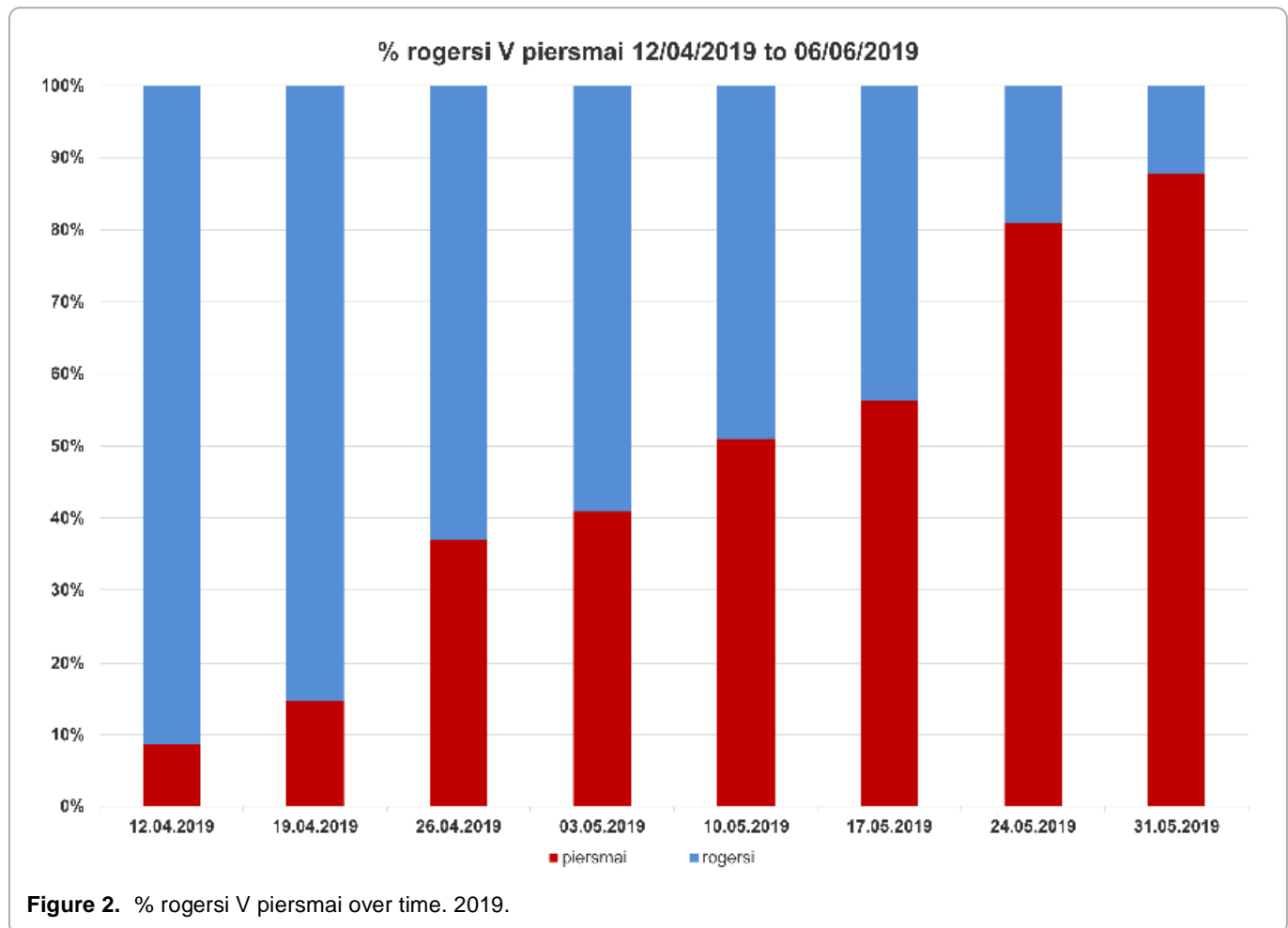
A 'typical' *rogersi* AP 3 © Adrian Boyle

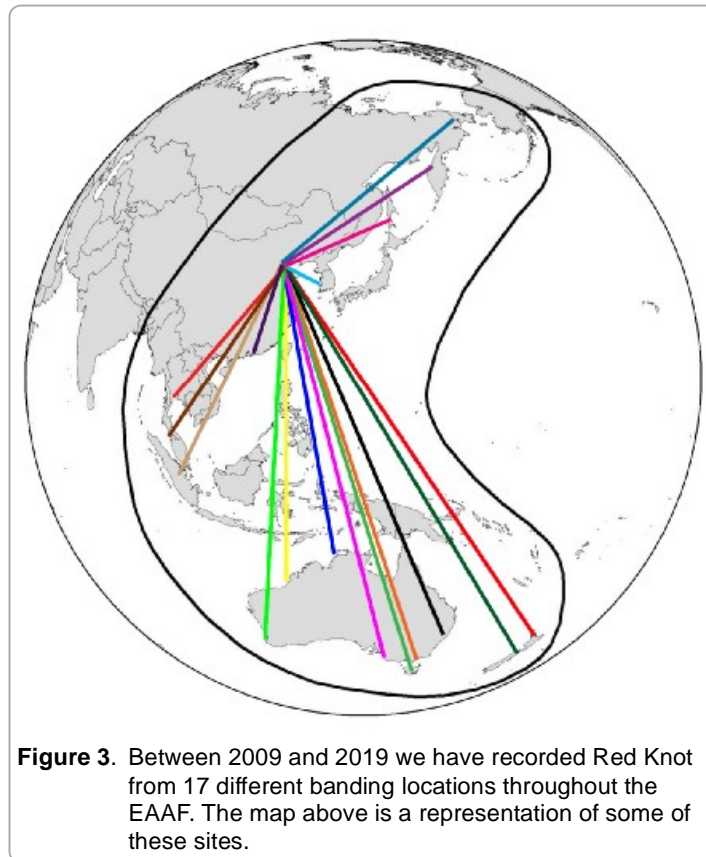
To obtain the data for the graphs below we conduct regular, random scans of Red Knots flocks, assigning each individual bird to a subspecies. The number of flocks and birds scanned had been very similar over the years. There was a big increase in the number of Red Knots assessed in 2019 (Table 5.) This is because this season large flocks of Red Knots foraged together and when three observers are on one flock it enables one of them to spend more time conducting subspecies scans than when the team is spread out on separate flocks.

Table 5.

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

Figure 2 below shows the 'flow' of the *rogersi* and *piersmai* subspecies through the Luannan coast over the northward migration period. *Rogersi* arriving and leaving earlier, *piersmai* later. 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.





Abdominal Profiles

As we are not catching Red Knots at Luannan, 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. A factor the observer has to take into account is if the bird is 'fluffed-up' due to cold weather. This can mislead the observer into thinking the bird is 'fatter' than it really is. This can certainly be a problem, but the experienced observers of GFN are aware of this and so all observers are scoring under the same criteria. The scores range from AP 1-thin to AP 5-obese. A bird scored as 1 looks unhealthy and a bird scored at 5 is very fat.

It would seem that 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 and New Zealand non-breeding sites and the Luannan Coast. Colour-band and flag resightings show this and it is further supported from geolocator tracks and satellite data confirming birds stop at many sites south of Luannan including Hong Kong, Taiwan, southern China and north east Borneo (GFN, AWSG unpublished data, Piersma *et al.* unpubl. manuscript). This northward migration strategy is, however, one piece of the Red Knot life-cycle question that we are still attempting to answer more fully.

During the 2019 fieldwork season, 621 Red Knot of both subspecies were assessed and given an abdominal profile score during a single sighting. The results for all years from 2010 have been very similar to those of 2019 (Figure 4).

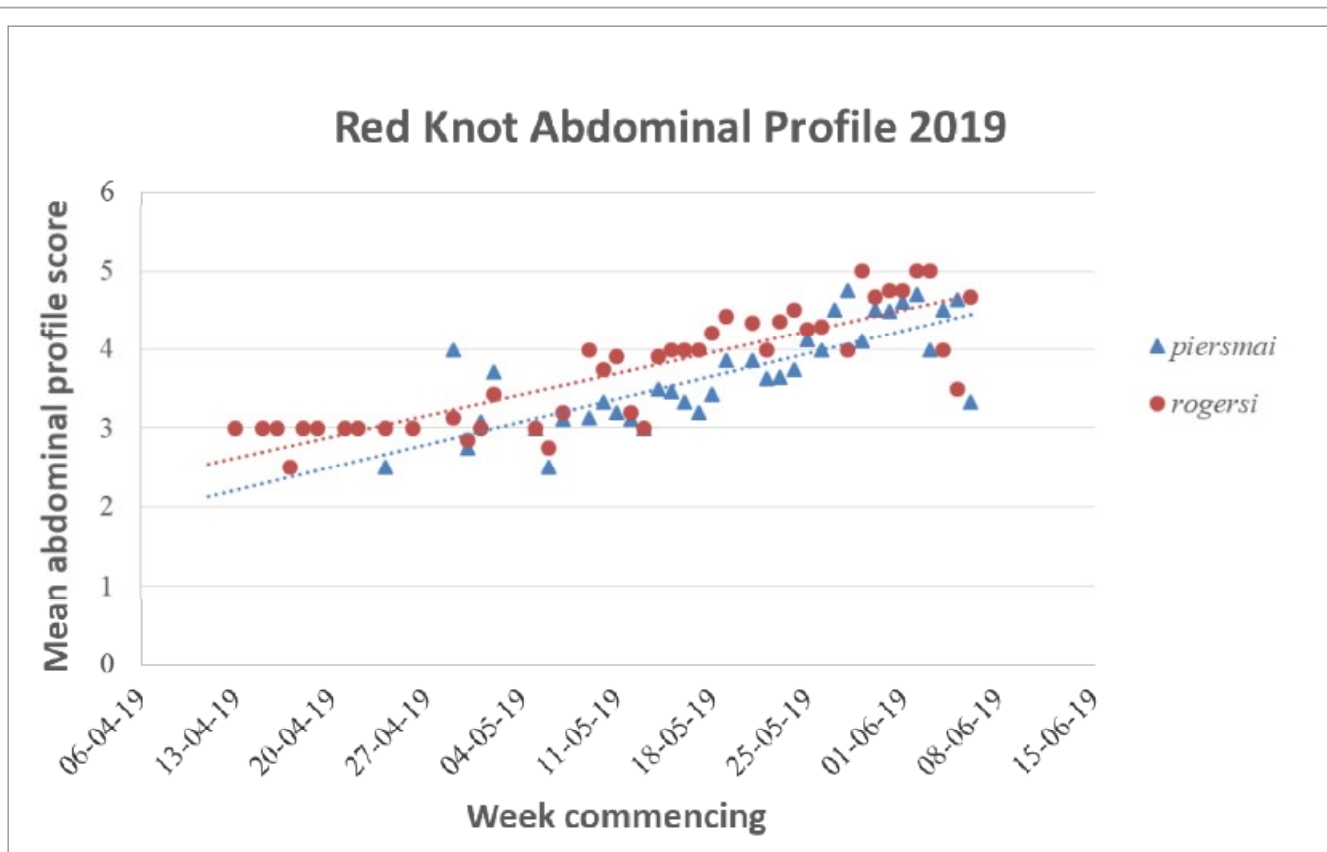


Figure 4. The graph shows the increase in AP, over time, for the two subspecies of Red Knot in 2019 using 621 records. This pattern is very similar to all previous years. Despite the changes in the numbers of Red Knot over the years it seems that all the birds using the Luannan Coast are able to forage effectively and get enough food to put on the expected weight to fuel them on the next leg of their journey north.

Red Knot numbers

Red Knot numbers increased from 792 on 13 April to 10,030 on 26 April and then to 44,241 on 8 May. The peak count was of 47,537 on 22 May. This count was 1,093 birds less than the count of 16 May 2018 (46,830). This a 2% difference which is, given the margin for error associated when counting large flocks of birds, effectively the same. These two counts are our highest since 2013. This is a big increase on the biggest count from 2016 (20,000) and 2017 (17,000). It is still not clear if we were unable to locate some birds during 2016 and 2017 or they didn't arrive at Luannan and were using other sites in the Yellow Sea region. Our 'sense' was that the birds were not here (see reports from 2016 and 2017).

It seems unlikely that this increase reflects a recovery of overall population size; it is much more likely that habitat changes elsewhere on the Yellow Sea coast have led to the increased numbers of Red Knot we have recorded at Luannan in the past two seasons. That we cannot establish the source of the variations is annoying. A programme of repeated satellite tracking would easily give us the answers but requires deep and long term funding.

Table 6.

2015	2016	2017	2018	2019
29,956	20,000	19,000	46,830	47,537

Additional species of interest

The following section reports on some additional species at Luannan of particular interest, these include vulnerable, endangered and critically endangered species that GFN take the opportunity to record and report on. Black-tailed Godwit does not fall in to one of those categories but is the subject of much interest due to the likelihood of a new subspecies being described soon and GFN's close cooperation with BNU student Zhu Bingrun. Sanderling appear to have a stable but not large population in the EAAF, but the occasional very large counts of this species lead us to record and report on it in our annual reports.

Great Knot *Calidris tenuirostris*

The Great Knot is classified as endangered by International Union for Conservation of Nature (IUCN 2016) <http://www.iucnredlist.org/details/22693359/0> and as critically endangered by the Australian Government <http://www.environment.gov.au/biodiversity/threatened/species/pubs/862-conservation-advice-05052016.pdf>.

During the 2019 fieldwork a high count of 12,971 Great Knots was recorded. This is the highest number we have recorded in the 10 years of complete survey periods (Table 7).

Table 7.

2015	2016	2017	2018	2019
10,270	10,000	6,000	8,230	12,971

It is possible that the increasing numbers of Great Knot at Luannan reflects the worsening conditions of other habitats and declines in food resources at other sites in the northern Yellow Sea. Many sites still experience mudflat destruction, changes of tidal flows from large scale developments and pollution which effect Great Knot prey. It is of course good news that the mudflats of Luannan are apparently able to support these 'extra' birds but all habitats have a carrying capacity and survival of individuals can be impacted if there are too many birds for the available resources at any one site. The numbers of individually marked Great Knot (Table 3) has fluctuated over the years, in-line with the numbers of Great Knot using the site. This year we got an excellent set of colour-banded birds that we could identify to an individual (48) our second highest after 2018.

The Great Knots come from the roost ponds on to the mudflats in front of the seawall at Nanpu where we usually start our scanning activities. They don't forage much in this area but move off to Zuidong as the tide recedes there. Zuidong seemed to be good for foraging and we saw Great Knot finding and ingesting suitably sized bivalves and they were gaining weight, as assessed from our abdominal profile records.



Great and Red Knots swirl over the Nanpu ponds, 30 April 2019 © Rob Buiter

Black-tailed Godwit *Limosa limosa*

Black-tailed Godwit use the Luannan coast in internationally significant numbers (Table 4). They are not a focus of the GFN studies at Luannan despite them being one of the four study species in Roebuck Bay. This is because the subspecies that visits Luannan is not from the Australian non-breeding population. However, the Black-tailed Godwits using the Study Site are studied as they are the focus of a PhD being carried out by Zhu Bingrun from BNU/University of Groningen.

The taxonomy of Black-tailed godwits in the EAAF is not clearly understood. GFN researchers noted a difference in morphology of the Black-tailed Godwits they see at the Luannan Coast compared to the ones they see regularly in NWA. The NWA birds are smaller and have brighter breeding plumage, on average. During fieldwork over ten years at Luannan, GFN have never recorded a marked bird from NWA. It is almost certain that there is a new subspecies of Black-tailed Godwit to be described in the EAAF. Zhu's PhD study and associated genetic work with his colleagues at the University of Groningen in the Netherlands will hopefully unravel this mystery. It is hoped that, in the next couple of years, BNU and GFN will be able to attach satellite transmitters to the birds in NWA to further add information to this study. We know from the work of Dmitry Dorofeev of the All-Russian Research Institute for Environmental Protection and a PhD student at Moscow State University, that many Black-tailed Godwits from the NWA population pass through the west coast of Kamchatka during July and August on their southward migration and some may breed in that area. Where the majority of the NWA population breed is currently not well understood and if funding can be secured for a proposed tracking project, using modern satellite technology, it would be another step towards understanding the Black-tailed Godwits of the EAAF.

Black-tailed Godwits have always favoured the pond habitat over the coastal mudflats at Luannan. This year Zhu had a BNU colleague at Luannan, Mr. Wu Yang. On 13 April Mr. Wu Yang counted 17,937 Black-tailed Godwit. This count is greater than any we have recorded in previous years (Table 4) and represents 11.2% of the entire estimated EAAF population. This will obviously be a much higher percentage of this subspecies' population. As with other counts within the Study Site, these totals represent a single peak count and do not account for turnover as birds pass through the area. Luannan is evidently a critically important staging site for Black-tailed Godwits.

Sanderling *Calidris alba*

This season the biggest count of Sanderling was 1,560. This is much lower than the 4,000 individuals of 2016 and 2017. Sanderling are not an easy species to monitor at Luannan, as they can come over from the roosting ponds well after the tide has receded and can land a kilometre or more from the seawall and spread out over a wide area. Our largest counts of Sanderling are usually made when we are ourselves well out on the mudflats; however, our time spent in this area varies annually depending on the location of our key target species. Due to the depth of the water, it is unlikely that thousands of Sanderling were feeding in any of the ponds, so maybe, like we assume with the Red Knots in previous years, they have used alternative sites in the Yellow Sea and, like the Red Knots, will return to use Luannan in the coming years as conditions and feeding opportunities change at different sites.

Spoon-billed Sandpiper *Calidris pygmaea*

The Spoon-billed Sandpiper is critically endangered (IUCN 2016) <http://www.iucnredlist.org/details/22693452/0>.

The species has vigorous conservation programs under way to try and save it from extinction. With possibly fewer than 200 breeding pairs left in the wild it was exciting to record two separate individuals on two different days this season. The first bird was on a single bird on the Nanpu mudflats on 22 May and the second sighting at the same site on 2 June. These are GFN's seventh and eighth records. All have been in late May or early June. None of the individuals we have recorded have been banded or flagged from the well-studied population in Meinypil'gyno, Chukotka, Russia.

Nordmann's Greenshank *Tringa guttifer*

Nordmann's Greenshank is an endangered shorebird (IUCN 2016) <http://www.iucnredlist.org/details/summary/22693225/0> with a continuing decline in its population. Nordmann's Greenshanks were recorded on 26 days between 19 April and 14 May 2019. The sightings were of them feeding on the mudflats at Nanpu and roosting in the adjacent ponds. We counted a minimum of 6 on any one day, 4 less than the 10 we recorded in 2012. Although occurring in low numbers, this is an easy species to locate at Luannan due to its predictable habits and distinctive behaviour, so this change likely reflects a real decrease in the number of birds present using the site over the years.

Black-faced Spoonbill *Platalea minor*

Black-faced Spoonbill is a rare wading bird endemic to the EAAF and classified as endangered (IUCN 2015). We did not record this species during our 2019 survey work and we have only 2 records of this species since 2010.

Chinese Egret *Egretta eulophotes*

Chinese Egret is a vulnerable species with a small, decreasing population with a maximum of 4,100 adults (Wetlands International 2016). We recorded Chinese Egret on three days in 2019, 27 and 30 April (presumed the same individual) and another on 22 May.



Chinese Egret at Zuidong, 30 April 2019 © Adrian Boyle

Breeding shorebirds and terns

In addition to the migratory shorebirds and terns passing through the Luannan Coast there are 9 species we have recorded breeding within the study site. Pied Avocet is the most common species we record and are the focus of Dr Weipan Lei's postdoctoral study. Lei is one of three students studying shorebirds and terns from Professor Zhang Zhengwang's department, College of Life Sciences at Beijing Normal University (see Lei *et al.* 2018). The avocets breed 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.*). Black-winged Stilt *Himantopus himantopus* and Kentish Plover breed in the same locations as Pied Avocet. Little-ringed Plover *Charadrius dubius* and Common Redshank *Tringa totanus* were seen doing display fights but no nesting was recorded this year.



A Kentish Plover settles on eggs, Nanpu ponds 20 April © Matt Slaymaker

Common Tern *Sterna hirundo* breed in scattered colonies numbering from a few pairs to a few hundred pairs. The subspecies *longipennis* is the most common subspecies to breed in our study area but we have recorded and photographed birds with black-tipped red bills of the subspecies *minussensis*. Paul Holt (a Beijing-based ornithologist) informs us that "*minussensis* is regular on the Hebei coast (and in Beijing) and often outnumbers *longipennis*. They breed in both areas too, occasionally even pairing with *longipennis*".

Gull-billed Tern *Gelochelidon nilotica* (of the subspecies *affinis*) is another tern species breeding on small islands within the ponds. They are much less numerous than Common Terns but still probably number up to 100's of pairs in the pond complex. This season there was a Little Tern *Sterna albifrons* colony in a pond directly behind the Nanpu seawall with over 100 pairs nesting. Unfortunately the pond was being filled with seawater by a shrimp farmer late in the season and it seemed that all the nests of the Little Terns, Kentish Plovers, Pied Avocets and Black-winged Stilts would be lost if they still had eggs or chicks that weren't old

enough to swim to high ground. There was no malice by the shrimp farmer it is just another example of the conflict over habitat for birds and economic benefit to local people. Very interestingly this pond also had a pair of Saunder's Gulls *Saundersilarus saundersi* prospecting for a nest site. We saw a pair making a nest scrape but we did not confirm breeding. Whiskered Terns *Chlidonias hybridus* breed in reed beds inland from the ponds, but are included in this report as they forage over the salt ponds and inter-tidal mudflats Wu Fuxing is continuing with his PhD studies on the breeding terns using the ponds complex.



A Little Tern incubates eggs, 15 May 2019 © Adrian Boyle

This season we recorded, for the first time, Grey-headed Lapwing *Vanellus cinereus* breeding at 3 sites. None of the sites are in our designated study area but they are at sites we go for recreational birding on regular occasions, so they are included here as a note. One pair was found with 3 eggs and later seen to have successfully hatched 3 chicks. 2 other pairs were seen doing distraction displays although no nests were seen we are confident both of these pairs were also breeding.



Grey-headed Lapwing adult and chick, 29 April 2019 © Adrian Boyle

White-winged Black Tern *Chlidonais leucopterus*

The White-winged Black tern does not breed at Luannan, but the species does pass through in large numbers. We have never made an accurate count of this species due to the logistical difficulties of counting within the extensive pond complex where they feed. Our best estimates were from mid-May 2012, 2013 and 2014 when it was estimated some 40,000 to be present. Numbers have never approached that many for the last four years. Overall, there were probably only several thousand in the area on any given day during their peak staging times from mid- to late-May 2019. As there has been not been a high count for five years in a row it may mean that migrant terns are under similar pressures as migrant shorebirds. Despite the difficulty of counting flying terns over the vast area of ponds there is undoubtedly many fewer of this species using the study area. The population estimate for this species in the flyway is vague, but 40,000 would constitute anything from 4 to 40% of the EAAF population.

Nature Reserve/Wetland Park

At the end of the GFN Bohai Report 2018 we reported that a MoU had been signed between the Paulson Institute, World Wide Fund for Nature (WWF), Hebei Provincial Forestry Department and Hebei Luannan County Government on 15 June 2017. The intent was to establish a nature reserve at the Nanpu site. It was supposed to be designated on 18 December 2018. This process is being delayed, maybe due to the strict rules governing nature reserves.

It goes without saying that GFN is supportive of a nature reserve or a wetland park being established. However, we would like to take the opportunity to comment. One rule, set by the central government, for nature reserves is the complete, year-round banning of commercial fishing and shell fishing. This was not welcomed by the local government as it has the potential to reduce local employment and income generation. GFN have no desire to see the local fishermen banned from the area. From our observations over the years the current level of fishing activity isn't detrimental to the diversity or populations of birds. Also, there is a temporary national ban on fishing from 1 May to 1 September each year and this is good timing for the birds as it obviously coincides with the main time of the year when most migratory birds are passing through the region and reduces disturbance and competition for resources.

Some management of the area is happening, presumably as some form of reserve or park will be declared. A new path has been built at the south east end of the Nanpu seawall and information signs erected. This is a good addition to the site. However, a viewing platform has also been built. To GFN this really seems a completely unnecessary addition. Great views of the birds can be obtained from the path and the platform doesn't 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. GFN assume that the nature reserve/wetland park will have some promotion to the public and attract people there. The close proximity of the people to the birds could lead to increased disturbance. Of course, we don't know how many people the new structures will bring to the area. But some careful management of people will be required if large numbers are drawn in.

Despite this positive news, there are still continuing pressures on the inter-tidal area and are detailed elsewhere in this and previous reports (see Habitat Threats and Management Actions).



The new path and one of the interpretive signs at Nanpu, 7 May 2019 © Chris Hassell

Human use of the mudflats

The most striking change in the past two years has been the ban on mechanical shell-fishing between 1 May and 1 September, as mentioned previously. The fisherman will be welcomed back from 1 September when there will be less birds utilising the site. The very intense fishing practices in the late-summer may even benefit shorebirds staging in the spring (Yang *et al.* 2016). We hope that the local communities will still be able to make good incomes from their fishing activity outside the dates of the ban. Very few shell-fishers searching by hand were on the mudflats this season, a few tens was all. However, at the eastern area of Zuidong there is a popular tourist site where people access the mudflat and collect shellfish. There can be over 200 people on the mudflat at any one time but they stay in a relatively small area and their current impact is likely to have little effect on the overall population of benthos available to shorebirds.

Habitat Threats and Management Actions

Despite the positive news related above, many huge projects are already underway and there is no explanation of what 'national policies' are. As is the case in all and any nation in the world, the economy will usually take precedence over the environment. One such massive industrial project is happening right now in one of our less frequented study sites between Beipu and Hangu Wind Farm. This is an area we have seldom visited due to the difficulty of access to the mudflats and limited opportunities for scanning. Over the years, we have done some exploration of the ponds (now reclaimed) in that area but we know little about shorebird use of the adjacent mudflats. A classic case of losing something before it is even documented what ecological value it has.

The area is now called the "Hebei Fengnan By-port Economic Zone". The new zone has an enormous steel works. It has amalgamated 5 steel companies, each moved from their former locations within or near urban areas. This will undoubtedly bring an economic upturn to the area with additional jobs and investment.

The project started in August 2017 and is scheduled to be complete by July 2021. The steel works portion is finished and is a working mill. The total investment will be around the equivalent of A\$4 billion. The land on which the steel works has been built was reclaimed many years ago and used as aquaculture ponds, before being filled in for this project. In addition to the steelworks, a port will be developed. This will, from our understanding of the 'information boards' at the site, cover some 54 square km of mudflats and shallow sea and become an imposing feature of the coast. Another large chunk of mudflat set to disappear!



Recreational shell-fishing, 3 May 2019 © Rob Buiter

The Luannan Coast is very important for oil production and China National Offshore Oil Corporation (CNOOC) 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.

However, some serious risks are associated with large scale oil production. An oil spill would be very 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 local fisher-people. It would be ideal if one of our Chinese collaborative partners could have a meeting with CNOOC to start a dialogue regarding the shared use of the area for on-going profitable oil production and keeping the area safe for foraging migratory shorebirds. These two objectives can be met with good will from both sides.

Another threat to the mudflat foraging area is the establishment of areas of Smooth Cordgrass *Spartina alterniflora* on the mudflats adjacent to the seawall at Zuidong and Nanpu. The patches had increased markedly since they first established. This is a highly invasive, non-native species and has caused huge problems in other important shorebird sites in the Yellow Sea, most notably at Chongming Dongtan National Nature Reserve where a multi-million dollar project is underway to mitigate the problem. In June 2018 it was very pleasing to see that the issue was starting to be addressed in a project led by WWF-China. The dead *Spartina* being cleared, removing the tall dead vegetation makes spraying for control to be more efficient.

The *Spartina* was sprayed three times from July to September 2018 and the results were clear to see during our 2019 season. There had been about 85% success rate in killing off the *Spartina*.

In June and July 2019 WWF once again organized for two sprays of the *Spartina* with drones and it is hoped that this will further inhibit its spread. Eradication is the goal of the project but may take a few years to achieve. And then regular checks for any re-colonization will be required. This has been a great project with very positive results and GFN congratulate WWF-china for their foresight in tackling the problem.



Spartina alterniflora in late May 2018 (left) before the spraying programme commenced and in late May 2019 after spraying

While GFN are conducting our work on the Luannan coast, we always try to engage the local fisher-people and pond workers. Despite the language barrier, we lend them our binoculars to look through and show them the birds in our telescopes. BNU have had some information brochures printed in Chinese developed by their students and we hand those out to many people who approach us to ask what we are doing. A big bonus is that our driver Mr Liu and his son Xiao Liu are both genuinely interested in the migratory birds and in our studies and they chat to various people who we encounter during our work and from what we can tell give a very enthusiastic story!



Xiao Liu birding, Nanpu 1 May 2019 © Adrian Boyle

Egg-collecting

This could well be down to the efforts of the local conservation group Tangshan Wildlife Protection Society, Caofeidian Youth Volunteer Organization, who in 2016 came to the Salt Ponds to erect signs saying egg-collecting was illegal. This was organised by Mr Tian Zhiwei and a CCTV News story was produced and shown on television in 2016.



Egg collecting is illegal, Nanpu ponds 25 May 2019 © Weipan Lei

New Zealand Ambassador visit

On 6 May we were pleased to host the New Zealand Ambassador to China, Clare Fearnley. This was the second year running that the nation of New Zealand have shown, very clearly, their commitment to the conservation of the Luannan Coast and the Red Knots that flood through here in the northward migration season, with an ambassadorial visit. Remember that nearly the entire Red Knot population of the EAAF pass through for a portion of their staging time in China. This includes both the *rogersi* and *piersmai* subspecies, tens of thousands of which spend the non-breeding season in New Zealand. The ambassador was with us for some hours and also met a number of students. This gave us time to give information on the site, the birds and the issues pertinent to their conservation. Michael and Wen Powles accompanied the Ambassador. Michael is a previous Ambassador to China and Wen works as the Political Counsellor at the New Zealand Embassy in Beijing. Wen was formally Consul-General in Shanghai. GFN extends a heartfelt thank you to the NZ delegation for their time and interest and political efforts.



Chris presenting a book co-authored by Theunis to Clare Fearnley, 5 May 2019 © Adrian Boyle

Future Research

GFN continues to document the fate of four shorebird species from their non-breeding sites in NWA by applying individual colour-band combinations and conducting intensive resighting scans for the marked birds. A comprehensive database of sightings from the marking sites in NWA and throughout the flyway is being maintained. With the work in Bohai Bay and sightings from other shorebird colleagues throughout the flyway we will be able to assess the effects of human-induced habitat change on survival rates of the populations and a variety of demographic parameters.

GFN will continue conservation efforts at Bohai Bay in conjunction with Beijing Normal University, Beijing Forestry University, WWF-China, Wetlands International–China, the Paulson Institute, Department of Conservation–New Zealand and any provincial and local government agencies that we can engage with. Ying-Chi Chan, a PhD student with Theunis Piersma, is currently writing up her research on the migration of Bar-tailed Godwits, Great Knots and Red Knots along the EAAF. Her study has used mark-resighting data presented in this report, as well as other methods such as satellite telemetry and benthic sampling. He-Bo Peng is in the 4th year of his PhD at NIOZ/University of Groningen with Theunis Piersma as supervisor. He is studying the benthic resources for migrant shorebirds along the entire Yellow Sea coast of China and does field work on the Luannan Coast. All this work is made possible under the Chair in Global Flyway Ecology at the University of Groningen, with support from WWF-Netherlands, WWF-China and BirdLife-Netherlands, with the in-kind support of the NIOZ Royal Netherlands Institute for Sea Research and in close cooperation with Beijing Normal University.



Professors Theunis Piersma and Zhang Zhengwang, Nanpu 3 May 2019 © Rob Buiter

Non-shorebird Migration

Although the migratory shorebirds were the focus of our work, we had a number of keen ornithologists present and, 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 wooded habitat. Appendix 1 has a complete list of all the 236 birds seen during the fieldwork period.



Red-flanked Bluetail *Tarsiger cyanurus*, 23 April 2019 © Adrian Boyle

Acknowledgements

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Thank you to Dr Weipan Lei and Mr Wu Yang (BNU) for their friendship and constant help during our fieldwork. We thank Mr Liu (senior) and Mr Liu (junior) they are the perfect drivers for the project, constantly thoughtful and helpful. We only speak a tiny bit of each other's language, but we genuinely enjoy their company.

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Mr Liu, 17 May 2019 © Adrian Boyle

More information on the GFN colour-banding project can be found at www.globalflywaynetwork.com.au/
For a view of the global reach of GFN, see www.teampiersma.org.

Contact Chris: turnstone@wn.com.au

Collaborative partners

- ❖ Australasian Wader Studies Group (AWSG), Australia
- ❖ Beijing Forestry University, Center for East Asian-Australasian Flyway Studies, Beijing, China
- ❖ Beijing Normal University, Beijing, China
- ❖ Fudan University, Shanghai, China
- ❖ Rudi Drent Chair in Global Flyway Ecology, University of Groningen, The Netherlands
- ❖ NIOZ Netherlands Institute for Sea Research, Texel, The Netherlands
- ❖ Broome Bird Observatory, Broome, Australia
- ❖ Broome Community Volunteers, Broome, Australia
- ❖ WWF-China, Shanghai/Beijing, China
- ❖ WWF-Netherlands, Zeist, The Netherlands

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Appendix 1

Bird List

The full list of the 236 species recorded April 11 to June 6 2019

Tundra Swan (Bewick's)	Eurasian Moorhen	Green Sandpiper
Ruddy Shelduck	Eurasian Coot	Grey-tailed Tattler
Common Shelduck	White-breasted Waterhen	Spotted Redshank
Mandarin Duck	Eurasian Black-winged Stilt	Common Greenshank
Garganey	Pied Avocet	Nordmann's Greenshank
Northern Shoveler	Eurasian Oystercatcher	Marsh Sandpiper
Gadwall	Grey Plover	Wood Sandpiper
Falcated Duck	Pacific Golden-Plover	Common Redshank
Eurasian Wigeon	Grey-headed Lapwing	Oriental Pratincole
Eastern Spot-billed Duck	Lesser Sand-Plover	Saunders's Gull
Mallard	Greater Sand-Plover	Black-headed Gull
Northern Pintail	Kentish Plover	Relict Gull
Green-winged Teal	Little Ringed Plover	Black-tailed Gull
Common Pochard	Whimbrel	Mew Gull
Ferruginous Duck	Little Curlew	Herring Gull (Mongolian)
Tufted Duck	Eastern Curlew	Lesser Black-backed Gull (Heuglin's)
Common Goldeneye	Eurasian Curlew	Glaucous Gull
Smew	Bar-tailed Godwit	Little Tern
Common Merganser (Eurasian)	Black-tailed Godwit	Gull-billed Tern
Red-breasted Merganser	Ruddy Turnstone	Caspian Tern
Japanese Quail	Great Knot	White-winged Black Tern
Ring-necked Pheasant	Red Knot	Whiskered Tern
Little Grebe	Ruff	Common Tern
Great Crested Grebe	Broad-billed Sandpiper	Oriental Stork
Eared Grebe	Sharp-tailed Sandpiper	Great Cormorant
Rock Dove (Feral Pigeon)	Curlew Sandpiper	Great Bittern
Oriental Turtle-Dove	Temminck's Stint	Yellow Bittern
Eurasian Collared-Dove	Long-toed Stint	Grey Heron
Spotted Dove	Spoon-billed Sandpiper	Purple Heron
Asian Koel	Red-necked Stint	Great Egret
Large Hawk-Cuckoo	Sanderling	Chinese Egret
Northern Hawk-Cuckoo	Dunlin	Little Egret
Indian Cuckoo	Little Stint	Cattle Egret
Common Cuckoo	Asian Dowitcher	Chinese Pond-Heron
Oriental Cuckoo	Common Snipe	Black-crowned Night-Heron
Grey Nightjar	Terek Sandpiper	Eurasian Spoonbill
Common Swift	Red-necked Phalarope	Black-winged Kite
Pacific Swift	Common Sandpiper	Oriental Honey-buzzard (Northern)



Grey Bushchat © Adrian Boyle

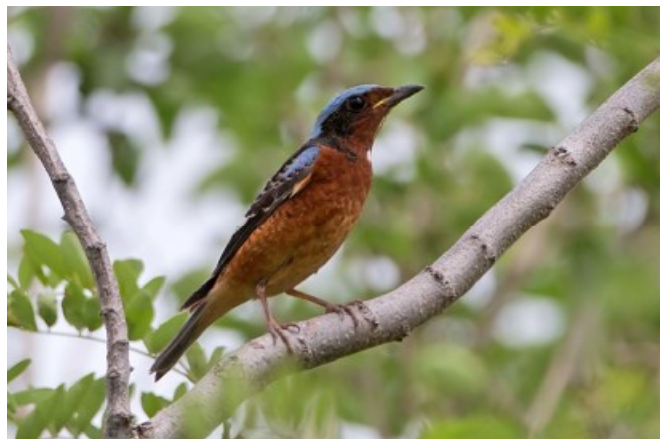


Yellow-browed Bunting © Adrian Boyle

Grey-faced Buzzard	Light-vented Bulbul	Blue Rock-Thrush
Eastern Marsh-Harrier	Asian Stubtail	Siberian Stonechat
Pied Harrier	Rufous-faced Warbler	Grey Bushchat
Crested Goshawk	Manchurian Bush Warbler	Isabelline Wheatear
Japanese Sparrowhawk	Yellow-browed Warbler	White's Thrush
Eastern Buzzard	Chinese Leaf Warbler	Siberian Thrush
Oriental Scops-Owl	Pallas's Leaf Warbler	Chinese Thrush
Little Owl	Radde's Warbler	Grey-backed Thrush
Long-eared Owl	Dusky Warbler	Grey-sided Thrush
Northern Boobook	Eastern Crowned Warbler	Eyebrowed Thrush
Eurasian Hoopoe	Two-barred Warbler	Dusky Thrush
Common Kingfisher	Pale-legged Leaf Warbler	Naumann's Thrush
Black-capped Kingfisher	Arctic Warbler	Purple-backed Starling
Dollarbird	Claudia's Leaf Warbler	Red-billed Starling
Eurasian Wryneck	Thick-billed Warbler	White-cheeked Starling
Rufous-bellied Woodpecker	Black-browed Reed Warbler	Crested Myna
Great Spotted Woodpecker	Oriental Reed Warbler	Forest Wagtail
Eurasian Kestrel	Pallas's Grasshopper-Warbler	Grey Wagtail
Amur Falcon	Lanceolated Warbler	Eastern Yellow Wagtail
Eurasian Hobby	Baikal Bush Warbler	Citrine Wagtail
Peregrine Falcon	Zitting Cisticola	White Wagtail
Long-tailed Minivet	Reed Parrotbill	Richard's Pipit
Ashy Minivet	Vinous-throated Parrotbill	Blyth's Pipit
Black-winged Cuckooshrike	Chestnut-flanked White-eye	Olive-backed Pipit
Tiger Shrike	Japanese White-eye	Red-throated Pipit
Bull-headed Shrike	Grey-streaked Flycatcher	American Pipit (japonicus)
Brown Shrike	Dark-sided Flycatcher	Brambling
Long-tailed Shrike	Asian Brown Flycatcher	Yellow-billed Grosbeak
Black-naped Oriole	Blue-and-white Flycatcher	Common Rosefinch
Black Drongo	Rufous-tailed Robin	Chestnut-eared Bunting
Hair-crested Drongo	Siberian Blue Robin	Yellow-throated Bunting
Oriental Magpie	Bluethroat	Pallas's Bunting
Carrion Crow	Siberian Rubythroat	Yellow-breasted Bunting
Asian Short-toed Lark	Red-flanked Bluetail	Little Bunting
Eurasian Skylark (Asian)	Yellow-rumped Flycatcher	Black-faced Bunting
Bank Swallow	Green-backed Flycatcher	Chestnut Bunting
Barn Swallow	Mugimaki Flycatcher	Yellow-browed Bunting
Red-rumped Swallow	Slaty-backed Flycatcher	Tristram's Bunting
Common House-Martin	Taiga Flycatcher	Russet Sparrow
Yellow-bellied Tit	Daurian Redstart	Eurasian Tree Sparrow
Chinese Penduline-Tit	White-throated Rock-Thrush	



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White-throated Rock-Thrush © Adrian Boyle



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