Global Flyway Network

The shorebird ecological demographics & conservation initiative

# SHOREBIRD NORTHWARD MIGRATION THROUGH BOHAI BAY, CHINA, MAY – JUNE 2020

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Red Knots foraging on Nanpu mudflat 29 May 2020 © Katherine Leung

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Mixed shorebird flock heading to Hangu mudflat, 19 May 2020 © Katherine Leung

## Summary

Due to the COVID-19 pandemic, Global Flyway Network (GFN) researchers from Australia, The Netherlands and the United Kingdom were unable to travel to China. Luckily, our colleague Katherine Leung was able to lead the fieldwork. She had to endure 28 days of quarantine to achieve this. Fourteen days on arriving in Shanghai from Hong Kong and 14 days when moving from Shanghai to Nanpu Development City. GFN thanks her for her fortitude.

Katherine was ably assisted in the fieldwork by six additional scanners, Mr. Guan Xiangyu, a Beijing bird guide, Miss Gao Chang, a freelance investigator from Beijing and graduate from Beijing Normal University (BNU) under our long-time collaborator Prof. Zhang Zhengwang, Miss Wu Entao, Miss Guo Jia and Miss He Ying, research assistants at Beijing Forestry University, and our close colleague Hebo Peng. We thank them all for their efforts in difficult times. The costs this year were covered by the Center for East Asian-Australasian Flyway Studies (CEAAF) at Beijing Forestry University (BFU) under the leadership of Prof. Lei Guangchun

The team was in the field from 4 May to 7 June, 34 days (less than a usual spring field season of 56 days).

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 on the Luannan Coast in 2020, Red Knot *Calidris canutus* were never present in such large numbers as in 2019. The biggest single count in 2020 was of 20,000 on 24 May. This is in stark contrast to the 47,537 counted on 22 May 2019. The numbers of Red Knot using the Luannan Coast varies a lot from year to year. Relatively large numbers were present in 2014, 2015 and 2018. However, relatively low numbers recorded during 2016 and 2017. Given that food resources usually determine distributions, the benthic food at Luannan and other sites determine the numbers of Red Knot that come to Luannan.

Due to limited time spent at Zuidong, the most used site in our study area for Great Knots *Calidris tenuirostris*, the highest count there was on 6 May of 7,350. This is considerably lower than the count in 2019 on 8 May of 12,971. The count in 2019 was the highest number we have recorded in the eleven years of complete survey periods for this species. So, it is possible that both Red and Great Knots were at Luannan in smaller numbers this year.

We recorded 1,169 marked shorebirds from throughout the East Asian-Australasian Flyway (EAAF). Due to the shorter time and relatively inexperienced team this is, as expected, a much lower total than that of previous years (see Table 2). This year, 193 birds were individually recognisable from the Global Flyway Network (GFN) colour-banding project in Northwest Australia (NWA). While this is also lower than in years with greater effort, it is a particularly good sample and testament to the hard work of the 2020 team. The totals were dominated, as always, by Red Knot with 189 individuals identified, Great Knot with 3 and Bar-tailed Godwit *Limosa lapponica* with 1 (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 little feeding 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. Despite the shorter study period and subsequently lower numbers, as in previous years, these records reflect the vital importance of the area for Red Knots from NWA and throughout the EAAF.

At high tide, when the mudflats are inundated by the sea, the ponds within the salt works/aquaculture areas host all the migrant shorebirds, 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) in previous years. This year the use of ponds by shorebirds was similar to 2019, which had much reduced use than in any previous year. Many species usually utilise the ponds, but all except two of the ponds that were explored had deep water in them consistently throughout the season. The main pond we used for scanning in 2017 to 2019 now has high water levels. This was not a surprise as we had talked in 2019, via our driver Mr. Liu, to a pond manager who had told us this pond would be filled with water for aquaculture. We do not know if the loss of all these ponds as foraging habitat is detrimental to the shorebirds fattening up at the Luannan coast to the extent that it deprives them of resources required to put on enough weight for successful migration and breeding. Nevertheless, our observations show that the loss of shallow ponds is depriving birds of foraging opportunities. 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 pond on 16 May. On 29 May that year, we had a count of 34,200 Red Knot foraging in a shallow pond. The deep water provides few foraging opportunities particularly for the small and medium-sized shorebirds.

A table of species recorded in internationally important numbers has been compiled from GFN and BNU studies over the previous 11 northward migration seasons (2010–2020). 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 during the last nine years. The pressures on the intertidal areas appear to be less severe in terms of direct destruction but are still present with the development of industry 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. This includes a large steel works that will have a port developed on still 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.

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

Team scanning at Nanpu, 26 May 2020 © Katherine Leung

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 variable use of the Luannan Coast by Red and Great Knots. What does this variability mean? Is it due to changes to, or loss of, habitat elsewhere? Or that the favoured food of Red Knots, *Potamocorbula laevis* is not in regular or consistent abundance at all sites and Red Knots 'choose' the best sites year on year? Knowing this distinction is critical, but requires local and flyway-wide research efforts, including the continuation of satellite tracking of individual knots.

Roosting Red Knots in Nanpu salt pond, 5 June 2020 © Katherine Leung

## 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 several 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 that use Luannan, and changes to these strategies, 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 from GFN counted a single flock of 10,650 Red Knot in the same area. In September 2007, Yang Hong-Yan, 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 will not be enough habitat to support the 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 dangerously low 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*. manuscript in preparation).

In conjunction with the work by Dr. Yang Hong-Yan, studies by GFN have continued during the northward migration seasons of 2009 to this year, 2020. 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 Rudi Drent 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 Prof. Zhang Zhengwang. From 2019, the new Center for East Asian-Australasian Flyway Studies at Beijing Forestry University, headed by Prof. Lei Guangchun, has taken on the responsibility of covering the costs of this project. Here we report on what we have achieved in May – June 2020.

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, 15 May 2020 © Katherine Leung

## 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 Nanpu Development City, situated on the edge of Bohai Bay, 190 km south-east of Beijing, China. Figure 1 shows the six coastal study sites and the Caofeidian New Area Industrial Park. This enormous area will have destroyed 142 $km^2$ of intertidal mudflat at its completion in 2020 (Yang *et al.* 2011), of which >75% has already been developed. The mudflats of our six study 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 'built environment'. This is mostly the huge port and industrial developments of Caofeidian, Tianjin and Huanghua (Sun *et al.* 2017).

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 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 almost zero foraging and roosting opportunities behind the seawall at Heiyanzi as this area is now highly industrialized. There are suitable ponds for foraging and roosting adjacent to the Hangu mudflats and these are used by shorebirds. 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 *Litopenaeus* 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 ponds for roosting and feeding. The years of 2016 to 2020 have been markedly different with very few shorebirds making use of the ponds as they were all, bar one in 2018 and 2019 and two in 2020 too deep. For the purposes of this report, all and any pond, regardless of its use, is referred to as a 'pond'.

Brine shrimps, Hangu salt ponds, 19 May 2020 © Katherine Leung

## 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 combination 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 tens of thousands 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 (5RLRL) marked at Roebuck Bay 20 February 2016. This image is from 19 May 2020. © Katherine Leung

## Fieldwork in 2020

The fieldwork program for 2020 started on 4 May and finished on 7 June. One day, 8 May was missed due to very heavy rain. This amounts to thirty-four days of fieldwork with two to three (occasionally five) observers in the field daily. The first fieldwork day was some twenty-three days later than usual. Due to the limited experience of the team, the fieldwork was focused on Nanpu even more so than usual and the possibilities to explore other sites was reduced compared to other years.

Red Knot numbers were never at the levels of 2019. They fluctuated at Nanpu between 2,000 and 6,000 from 11 May until there was a noticeable increase to 20,000 on 24 May. This count remained the highest of the season. These 2020 counts are similar to the counts of 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 did not arrive at Luannan and were using other sites in the Yellow Sea region. Our 'sense' was that the birds were not there (see reports from 2016 and 2017). This year, when it appeared that numbers were 'low', the team looked for Red Knots at Beipu and Hangu but found no significant numbers at either site. So, we are confident that there were not thousands of Red Knots at any of our regular study sites that we missed.

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.

***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 2010–2020. No observations were made during northward migration season 2008.

Scanning on the Nanpu mudflat, 29 May 2020 © Katherine Leung

**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 - 2020.

| Year | Days of Observation | Total Sightings of all marked birds | 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 |
| 2020 | 34 | 1,169 | 189 |
| **Total** | **620** | **40,721** | **2,996** |

Total sightings of all marked birds for 2020 were lower due to the shorter study period and relative inexperience of the team. The total number of Red Knot colour-band resightings for 2020 was 446, but the number of known individuals recorded was a very pleasing 189.

The Hangu Wind Farm site was only visited once this season, restrictions of local movements due to COVID-19 made it difficult to fit in to the fieldwork schedule. On that visit on 19 May a minimum of 800 Red Knots were using the site. However, six individually colour-banded Red Knots were recorded. 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. This season three of the six were recorded at both Nanpu and Hangu.

The mechanical shellfishing activity at Nanpu stopped this year as of 1 May. The Hebei Provincial Oceanic Administration banned all summer fishing activity including mechanical shellfishing from 1 May to 30 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 October 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 in 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 difficult to walk on. Despite the mud also being soft at Beipu, there are some fishing nets there. Our scanning at both Hangu and Beipu was conducted from seawalls 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 shellfishing activity but it is not mechanical, only people searching for shellfish by hand. At the eastern area of Zuidong there is a popular site where people access the mudflat and collect shellfish recreationally. 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. Zuidong was only visited on two days this year.


Salt production at Nanpu ponds, 4 Jun 2020 © Katherine Leung

Between 2016 and 2018, the water level in most ponds had gradually become deeper due to increased management for aquaculture while still maintaining salt production. Subsequently there are fewer foraging opportunities for shorebirds. This was the same during the 2020 season. In the years up to 2016 we spent about 25% of our scanning efforts in ponds, but for 2018, 2019 and 2020 that has reduced to under 5%.

The birds still use the pond bunds 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 utilised the mudflats less frequently and foraged in the shallow

ponds. During 2018 and 2019 we only found one accessible pond with foraging Red Knot. This season there were two ponds, neither of them the same as the 2018 and 2019 pond, being used late in the season. Scanning here was still relatively productive for the short time it was available to birds. Ten colour-banded individuals were recorded in just one of the two ponds. Five of these birds were also seen on the Nanpu mudflat.

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 for their safe and relatively undisturbed roosting opportunities. The importance of the ponds for foraging could be augmented with different 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 occupied most of our time. Only three days were spent out on the mudflats near the end of the season. Exploration of the ponds also took some time, as we were hoping to find other scanning opportunities. Two large ponds 10 km from the Nanpu mudflats had suitable water levels for shorebirds, for just three days, towards the end of the season. The 10 ha salt ponds behind the seawall adjacent to Nanpu mudflats were the main scanning site on the last week of our fieldwork. This is different to most years. Usually birds roost and do some foraging in these close ponds early in the season but then move further into the pond complex around mid-May.

The roost areas in the ponds that 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.

During the 34 days of fieldwork we made a total 1,169 sightings of marked birds of which 391 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.

Team heading to scan at Nanpu ponds, 2 Jun 2020 © Katherine Leung

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. This need has been recognised and discussions between provincial and county governments and NGOs had started with the aim of establishing a wetland park, however these talks have stalled (see later section).

Table 2 below shows the totals of all marked migratory shorebirds recorded during all of 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 2020. These records (2010–2020) represent 36 different marking areas in 13 countries and territories within the EAAF, highlighting the importance of the Luannan coast, not only to birds from NWA, but from throughout the entire EAAF.

| Marking location | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2019 | 2018 | 2019 | 2020 | Total 2010-2020 | Known Individuals 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Australia, King Island, Tasmania | 3 | 2 | 4 | 0 | 1 | 5 | 2 | 4 | 1 | 0 | **0** | 22 | **0** |
| Australia, New South Wales | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | **0** | 4 | **0** |
| Australia, Northern Territory | 3 | 0 | 0 | 1 | 0 | 4 | 57 | 24 | 55 | 53 | **6** | 203 | **1** |
| Australia, North West Australia (Colour Bands) | 317 | 412 | 904 | 613 | 922 | 1221 | 671 | 680 | 1122 | 1095 | **446** | 8403 | **193** |
| Australia, North West Australia (Flags) | 912 | 812 | 1166 | 1053 | 1222 | 1036 | 964 | 916 | 1315 | 963 | **332** | 10691 | **115** |
| Australia, Queensland | 7 | 7 | 8 | 27 | 12 | 4 | 14 | 3 | 1 | 13 | **1** | 97 | **1** |
| Australia, South Australia | 12 | 35 | 62 | 73 | 54 | 31 | 40 | 20 | 20 | 26 | **15** | 388 | **4** |
| Australia, South West Western Australia | 6 | 0 | 0 | 1 | 4 | 3 | 0 | 0 | 0 | 0 | **0** | 14 | **0** |
| Australia, Victoria | 746 | 644 | 798 | 985 | 858 | 507 | 487 | 290 | 433 | 309 | **97** | 6154 | **14** |
| China, Bohai Bay | 122 | 96 | 129 | 125 | 108 | 55 | 162 | 78 | 126 | 81 | **16** | 1098 | **4** |
| China, Chomgming Dongtan National Nature Reserve | 321 | 447 | 565 | 552 | 679 | 510 | 518 | 342 | 437 | 356 | **98** | 4825 | **27** |
| China, Hangzhou Bay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **4** | 4 | **0** |
| China, Hebei Province (Inland) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | **0** | 2 | **0** |
| China, Jiangsu | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 8 | **0** | 11 | **0** |
| China, Liaoning Liaohekou National Nature Reserve | 1 | 9 | 0 | 1 | 1 | 7 | 1 | 5 | 0 | 0 | **0** | 25 | **0** |
| China, Yalujiang National Nature Reserve | 0 | 0 | 0 | 1 | 3 | 3 | 0 | 0 | 0 | 0 | **0** | 7 | **0** |
| Hong Kong | 5 | 23 | 19 | 44 | 39 | 20 | 20 | 6 | 18 | 9 | **4** | 207 | **1** |
| India, Point Calimere, Tamil Nadu | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 5 | 4 | **0** | 19 | **0** |
| India, Chilika Lake, Odisha | 1 | 0 | 0 | 0 | 0 | 4 | 7 | 5 | 8 | 2 | **0** | 27 | **0** |
| Indonesia, Java | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | 1 | **0** |
| Indonesia, Sumatra | 12 | 4 | 5 | 8 | 7 | 6 | 2 | 2 | 0 | 2 | **0** | 48 | **0** |
| Japan, Kyushu | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | **0** | 2 | **0** |
| Japan, North Coast, Hokkaido | 1 | 7 | 10 | 5 | 9 | 5 | 8 | 2 | 0 | 2 | **0** | 49 | **0** |
| Japan, North East Coast | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | **0** | 5 | **0** |
| Japan, Tokyo Bay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | **0** | 8 | **0** |
| New Zealand, North Island | 558 | 748 | 681 | 855 | 734 | 452 | 317 | 198 | 307 | 219 | **70** | 5139 | **24** |
| New Zealand, South Island | 32 | 20 | 21 | 35 | 22 | 17 | 18 | 5 | 2 | 7 | **1** | 180 | **0** |
| Phillipines, Olango Island | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | **0** | 2 | **0** |
| Russia, Chukotka | 1 | 32 | 43 | 50 | 62 | 38 | 44 | 22 | 22 | 50 | **6** | 370 | **1** |
| Russia, Kamchatka | 1 | 3 | 4 | 1 | 0 | 6 | 7 | 20 | 37 | 65 | **11** | 155 | **2** |
| Russia, Sakhalin | 0 | 4 | 5 | 48 | 52 | 44 | 43 | 33 | 36 | 21 | **3** | 289 | **0** |
| Singapore | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | **0** | 3 | **0** |
| South Korea | 0 | 0 | 0 | 0 | 8 | 12 | 5 | 0 | 5 | 0 | **0** | 30 | **0** |
| Taiwan | 4 | 0 | 2 | 3 | 2 | 4 | 1 | 0 | 1 | 7 | **0** | 24 | **0** |
| Taiwan, Kinman Island | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | **0** | 2 | **0** |
| Thailand, Inner Gulf of Thailand | 31 | 18 | 34 | 96 | 153 | 92 | 125 | 75 | 113 | 118 | **47** | 902 | **4** |
| Thailand, Ko Libong, South West Coast | 35 | 29 | 36 | 33 | 60 | 56 | 33 | 27 | 49 | 33 | **12** | 403 | **0** |
| **Totals** | **3133** | **3354** | **4496** | **4613** | **5014** | **4147** | **3554** | **2765** | **4116** | **3452** | **1169** | **39813** | **391** |
| **Number of Species** | **14** | **14** | **13** | **18** | **17** | **18** | **17** | **15** | **14** | **15** | **11** | | |

## 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 affect the suitability of different areas for the birds (particularly Red Knot, our focal species as a 'specialised feeder'). We have four major mudflat study sites (Nanpu, Zuidong, Beipu and Hangu) within the entire study area and the ponds. We have two areas that we only visit occasionally (North Beipu and Heiyanzi).

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 most of our fieldwork is conducted. The mechanical shellfishing operation has been stopped from 1 May to 30 September. Some shellfishing is still conducted but this is by hand. Reasonable levels of fishing activity in past years did not appear to concern the birds, we would watch flocks of birds feeding close to people collecting shellfish. 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 wetland park will continue and ultimately be successful (see later section).

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

Red Knots feeding in front of a fallen 'resort' building at Beipu, 17 May 2020 © Katherine Leung

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 was a dramatic drop in shorebirds foraging at the affected site. We also saw this happening 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 not changed up to this 2020 season, with no dredging or development work being done on the Beipu mudflats for eight years. Due to these activities, the Beipu mudflats have had wildly fluctuating numbers of foraging Red Knots over the years, ranging from only a few hundred to 25,000. This year on 17 May there were 5,000 Red Knot counted, half the biggest count of 2019, reflecting the generally low numbers. 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. During this season, of six individually colour-banded Red Knot seen at Beipu five were also record at Nanpu. The suitability of the Beipu mudflat as a foraging site for migratory shorebirds has certainly not been consistent over the 11-year period of our full study years. Detailed studies on the benthos of the site have not been undertaken, as the soft mudflats are difficult and indeed dangerous to access.

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 important site. When we arrived in May 2020 the site had been partially cleaned up and some buildings removed.

This year Zuidong was only visited twice by the scanning team and that was for counting as the primary reason. However, Hebo Peng was there from 4-6 May conducting benthos sampling and foraging studies. He counted 7,350 Great Knot on 6 May. The mudflats there have 'improved' since the major pumping and seawall construction in 2009–2011. 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 it was only visited once and no flags or bands were recorded from the low numbers of shorebirds at the site. The mudflats here are incredibly soft and access is prohibited due to the Chlor-alkali liquid waste facility located there. The ponds at North Beipu had, in the early years of our study been good roosting and foraging habitat. The pond walls are now built up by dredged mud from within the ponds. This has made the side walls steep and the water deep at the base of the walls and therefore unsuitable for foraging shorebirds. The top of the walls are rough and as the dredged mud dries out, they become very cracked and unsuitable for roosting birds. As with colour-banded Red Knots seen on the Beipu mudflats we know from previous years that individual birds seen at North Beipu are also recorded 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 on the one visit this year. Restrictions of local movements due to COVID-19 made it difficult to fit in to the fieldwork schedule. On that visit on 19 May, a minimum of 800 Red Knots were using the site. This single count does however match with the low numbers of Red Knots in general this year. The biggest count in 2019 was 1,786 about double that of 2020 as was the case at Nanpu.

Despite the small numbers and a single visit, six individually colour-banded Red Knots were recorded. Three of these were also seen at Nanpu.

Shorebirds feeding in a shallow pond at Hangu, 19 May 2020 © Katherine Leung

Table 3 shows records of individually colour-banded birds marked in NWA recorded on the Luannan Coast for the years 2010 to 2020. The 193 is lower than most years for reasons discussed earlier. However, it is a particularly good return for the short season we could conduct resighting work in due to COVID-19 and the associated difficulties. The totals were dominated by Red Knot with 189 individuals identified, then Great Knot with 3 and Bar-tailed Godwit with 1. The Bar-tailed Godwit has been seen annually for eleven consecutive years, 2010 to 2020, and the bird is a minimum of 15 years old. Despite this individual being very faithful to Luannan, this area is not a major staging site for Bar-tailed Godwits. Numerous Red Knots have been seen over many consecutive years with some in all 11 years.

**Table 3**. Totals of individually colour-banded birds from the GFN project marked in NWA resighted on the Luannan Coast 2010 to 2020. 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 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bar-tailed Godwit | 3 | 2 | 4 | 3 | 5 | 6 | 3 | 4 | 4 | 3 | 1 |
| Great Knot | 6 | 20 | 17 | 12 | 11 | 30 | 31 | 22 | 44 | 48 | 3 |
| Red Knot | 106 | 170 | 287 | 272 | 329 | 387 | 261 | 269 | 313 | 336 | 189 |
| | **115** | **192** | **308** | **287** | **345** | **423** | **295** | **295** | **361** | **387** | **193** |

## Internationally important counts

During the eleven years GFN have been visiting the Luannan Coast from 2010 to 2020, we have been conducting regular counts in conjunction with Beijing Normal University. The importance of this site is not in any doubt. Table 4 below clearly shows 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 2020 season with much reduced time spent at the study area, no counts of any species compared to other years were recorded (see Table 4.) Note that there have been higher counts of some species in Table 4 prior to 2014 but with the renewed EAAF Population Estimates (BirdLife Australia 2016) we have only used counts from the last 6 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.

Asian Dowitchers in flight, Nanpu 18 May 2020 © Katherine Leung

**Table 4**. Internationally Important Counts at Luannan Coast 2014 to 2020.

| Species | Scientific Name | Date recorded | Count | % of EAAF Population present | EAAF Population from BirdLife Australia 2016 | Total for 1% Ramsar Criteria |
|---|---|---|---|---|---|---|
| Asian Dowitcher | *Limnodromus semipalmatus* | 08.05.2017 | 1,754 | **12.5** | 14,000 | 140 |
| Black-tailed Godwit | *Limosa limosa* | 13.04.2019 | 17,937 | **11.2** | 160,000 | 1,600 |
| Broad-billed Sandpiper | *Calidris falcinellus* | 27.05.2015 | 2,460 | **8.2** | 30,000 | 300 |
| Curlew Sandpiper | *Calidris ferruginea* | 04.05.2014 | 24,500 | **27.2** | 90,000 | 900 |
| Dunlin | *Calidris alpina* | 07.05.2017 | 40,000 | **1.6** | 2,500,000*# | 25,000 |
| Eurasian Curlew | *Numenius arquata* | 26.04.2019 | 2,722 | **2.7** | 100,000* | 1,000 |
| Great Knot | *Calidris tenuirostris* | 08.05.2019 | 12,971 | **3.1** | 425,000 | 4,250 |
| Grey Plover | *Pluvialis squatarola* | 26.04.2019 | 3,220 | **4** | 80,000 | 800 |
| Marsh Sandpiper | *Tringa stagnatilis* | 27.04.2016 | 8,785 | **6.8** | 130,000 | 1,300 |
| Nordmann's Greenshank | *Tringa guttifer* | 16.05.2016 | 7 | **1.4** | 400-600* | 5 |
| Pied Avocet | *Recurvirostra avosetta* | 26.04.2019 | 1,149 | **1.1** | 100,000* | 100 |
| Red Knot | *Calidris canutus* | 16.05.2018 | 48,630 | **43.8** | 110,000 | 1,100 |
| Red-necked Stint | *Calidris ruficollis* | 08.05.2016 | 4,747 | **1** | 475,000 | 4,750 |
| Sanderling | *Calidris alba* | 29.05.2016 | 4,321 | **12.3** | 35,000 | 350 |
| Sharp-tailed Sandpiper | *Calidris acuminata* | 04.05.2014 | 4,000 | **4.7** | 85,000 | 850 |
| Spoon-billed Sandpiper | *Calidris pygmaea* | 25.05.2016 | 1 | **0.3** | 140-480* | 3 |
| Spotted Redshank | *Tringa erythropus* | 15.05.2016 | 592 | **2.6** | 25,000* | 250 |
| White-winged Tern | *Chlidonias leucopterus* | 14.05.2014 | 40,000e | **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 1% Ramsar criteria in Table 4 above 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 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.

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* 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 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 based on 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.

To obtain the data for graphs in the years 2015 to 2019 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 similar over the years. This season due to the relative inexperience of the team this data was not collected.

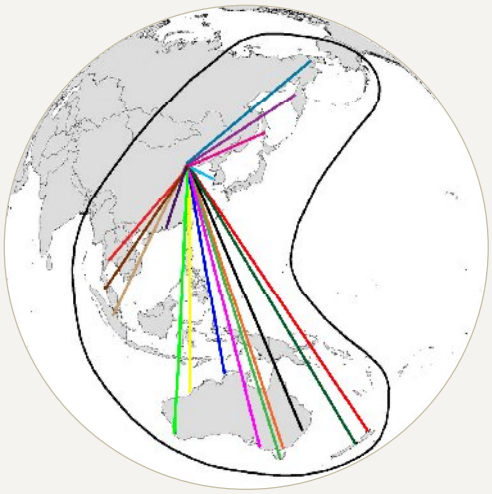

**Figure 2**. Between 2010 and 2020 we have recorded Red Knot from 17 different banding locations throughout the EAAF. The map above is a representation of some of these sites.

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

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

## 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 must consider 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.

Both subspecies and most individuals are arriving at our Luannan Coast study site in good body condition, whilst no birds are arriving in 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 tracking 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 2020 fieldwork season, 382 (621 in 2019) Red Knot of both subspecies were assessed and given an abdominal profile score during a single sighting. The results for all years from 2010 to 2019 have been similar and the records spanned from early-April to early-June. This year, 2020, with data collection not starting until 11 May, much lower numbers of birds assessed and different observers there may be some bias. There are more AP 5 scores earlier in the season than in other years. However, as in all previous years all birds appeared to be able to feed effectively enough to gain suitable condition for the leg of their migration to the breeding grounds (Figure 3). Initial thoughts from Hebo Peng regarding the abundance of *P. laevis* are 'I can feel the density of pots is lower than last year, just a sense, we still have to check by processing the samples'. But the overall numbers of Red Knots at the site were lower than in 2019. Do Red Knots have the ability to assess this abundance in relation to how many of their congeners are at the site and move to other sites? Or if they find a good site further south do they stay there and by-pass Luannan?

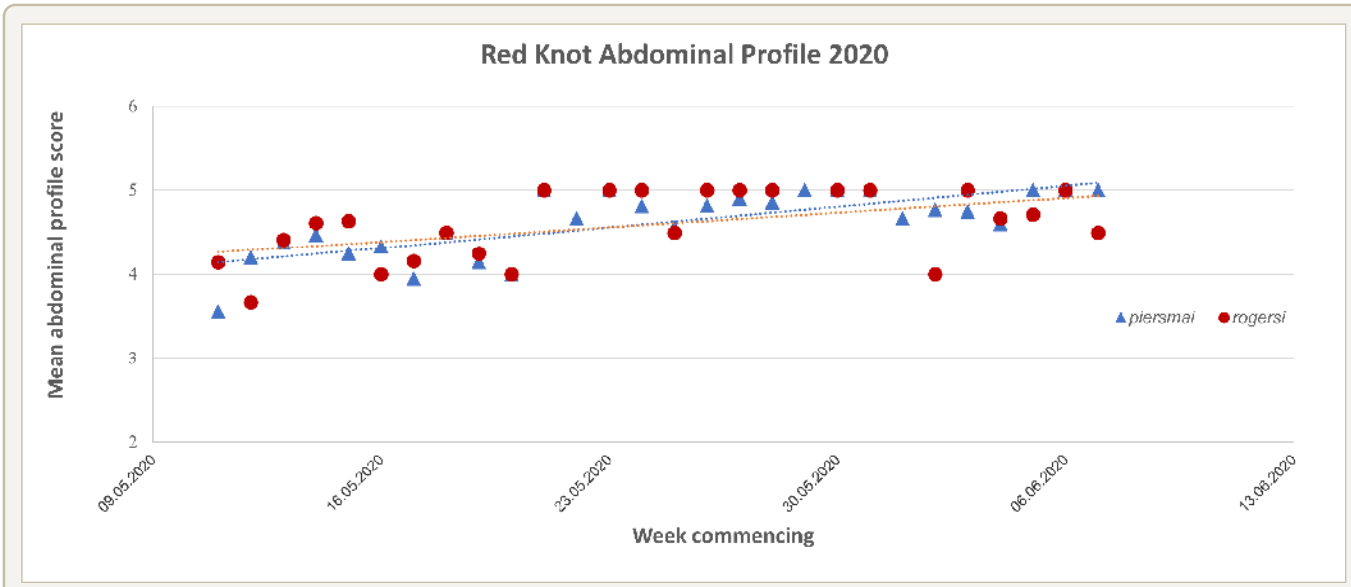


**Figure 3.** The graph shows the increase in AP, over time, for the two subspecies of Red Knot in 2020 using 382 records. This pattern is similar to all previous years. Despite the changes in the numbers of Red Knot over the years it seems that all the birds using the Luannan Coast are able to forage effectively and get enough food to put on the expected weight to fuel them for the next leg of their journey north.

## Red Knot numbers

This year the biggest single count of Red Knot was of 20,000 on 24 May. Numbers never got anywhere near to the high counts of 47,537 on 22 May 2019. The 2019 count was 1,093 birds less than the count of 16 May 2018 (48,630). This a 2% difference, which is, given the margin for error associated when counting large flocks of birds, effectively the same. The 2018 and 2019 counts were our highest since 2013. However, this year's biggest single count of 20,000 is the same as 2016 (20,000) and similar to 2017 (17,000). It is still not clear if we were unable to locate some birds during 2016 and 2017 or they did not 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). Despite the logistics and relative inexperience of the 2020 team, we are confident that we did not miss 20,000 Red Knots in the study area. This is almost impossible to do now we know the area so well. The field team were in daily contact with Chris Hassell who advised on when and where to look for Red Knot flocks when it became clear it was a 'low numbers' year. Hangu, the most distant of our sites from Nanpu, was visited on 19 May and only 800 Red Knots were at that site. It seems clear that Red Knots do not use the Luannan coast in the same numbers each year. 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 5**. Peak counts of Red Knots at Luannan from 2015 to 2020

| 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| 29,956 | 20,000 | 17,000 | 48,630 | 47,537 | 20,000 |

Roosting Red Knots in Nanpu pond, 1 June 2020 © Katherine Leung

## 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 2020. Pied Avocet is the most common species we record and are the focus of Dr. Weipan Lei's postdoctoral study. Lei along with Wu Yang and Dr. Wu Fuxing are three students studying shorebirds and terns from Prof. 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*.). It is likely they will have had low breeding success this year due to frequent heavy rain and a severe hailstorm on 21 May. These weather events are dangerous to young chicks and flood nests. Black-winged Stilt *Himantopus himantopus* and Kentish Plover *Charadrius alexandrinus* breed in the same locations as Pied Avocet, both were recorded breeding in 2020. Little-ringed Plover *Charadrius dubius* and Grey-headed Lapwing *Vanellus cinereus* were seen doing distraction displays and were presumed to be breeding. This site is not one in our designated study area but a site we go to for recreational birding on regular occasions, so they are included here as a note.

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"*.

Grey-headed Lapwing on barren land near 'Eco Lodge', 26 May 2020. © Katherine Leung

Dr. Wu Fuxing is continuing with his PhD studies on the breeding terns using the ponds complex including this year fitting GSM-GPS trackers on Common Terns to understand more about their movement during and after breeding. Little Terns *Sternula albifrons*, Gull-billed Terns *Gelochelidon nilotica* and Whiskered Terns *Childonias hybrida* were all recorded carrying food from the mudflats to the salt ponds, so we believed they were also nesting in the area.

Common Tern parent feeding one of its chicks, another two were under its body, 1 June 2020 © Katherine Leung

## White-winged Tern *Chlidonais leucopterus*

The White-winged 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 again. Overall, there were probably only a few thousand in the area on any given day during their peak staging times from mid to late-May 2020. As there has 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.

## Wetland park

At the end of the GFN Bohai Report 2018 we reported that a memorandum of understanding 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. That nature reserve status will not happen and a new proposal for a lower grade protected area of a wetland park is now proposed. This process continues to be delayed. Discussion between China National Petroleum Corporation (CNPC), who operate the Jidong Nanpu oil field and have mining rights over areas of the proposed wetland park, and the Luannan County Government are on-going. Therefore, in December 2019, the Luannan County Government held another meeting with the Tangshan Forestry Bureau, Paulson Institute, Beijing Normal University, and Zhonglin International, and both CNPC and Luannan County have sent reports to the Ministry of Natural Resources and are waiting for the next steps to be established. So, while this is disappointing news, at least all the major stakeholders are talking to one another.

It goes without saying that GFN is supportive of a wetland park being established. Some management of the area started in April 2019. 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 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. GFN assumes that the wetland park will have some promotion to the public and attract visitors there. The proximity of the visitors to the birds could lead to increased disturbance. Of course, we do not know how many people the new facilities will bring to the area. But some careful management of visitors will be required if large numbers are drawn in.

## Human use of the mudflats

The most striking change in the past two years has been the ban on mechanical shellfishing between 1 May and 30 September, as mentioned previously. The fisherman will be welcomed back from 1 October when there will be less birds utilising the site. The very intense fishing practices in the autumn may even benefit shorebirds staging in the following 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. At both Nanpu and Zuidong there was some low-level shellfishing by hand on the mudflats this season. Non-mechanical harvesting is not restricted during the 1 May to 30 September period. This year the shellfishers seeded one area of

the Zuidong mudflats that we give the name 'Double Bridges' with the edible mollusc *Ruditapes philippinarum,* a commercially valuable resource. 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

Many huge industrial projects are underway around the Yellow Sea coast and our study area is no exception. A massive steel works has been built on reclaimed land at Heiyanzi, 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 habitat before the biological importance of the area has been documented.

The area is now called the "Hebei Fengnan By-port Economic Zone". The new zone has an enormous steel works. It has amalgamated five 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 industrial zone has been completed. The total investment will be around the equivalent of $4 billion (Australian). 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 $km^2$ of mudflats and shallow sea and become an imposing feature of the coast. Another large chunk of mudflat set to disappear!

Shellfisher and landing Red Knots on Nanpu mudflat, 29 May 2020 © Katherine Leung

The Luannan Coast is 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 (but see Wetland Park section above). 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 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 very serious as the benthos would be affected and diminish the areas biodiversity, suitability for shorebirds and shellfish harvest for local fisher-people. It is at least a positive sign that CNPC and Luannan County have sent reports to the Ministry of Natural Resources following meetings between Luannan County, Paulson Institute and BNU. The shared use of the area for on-going profitable oil production and keeping the area safe for foraging migratory shorebirds is quite possible 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 (CMDT) where a multi-million-dollar project has been carried out 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 with a spraying program to control the spread of the Spartina, following the success at CMDT.

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 organized 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 mudflat abutting the oil island causeway. Katherine has been in contact with WWF to inform them of the success and to suggest one more follow up as there are a few small green sprouts of new growth emerging. Spartina is a notoriously difficult plant to control. This has been a great project with positive results and GFN congratulate WWF-China for their foresight in tackling the problem.

Successful control of *S. alterniflora* on Nanpu mudflat, 18 May 2020 © Katherine Leung

Unfortunately, while this success has happened at Nanpu just 4 km east at Zuidong there is a large well-established patch of Spartina encroaching on the mudflat. This area is a key foraging site for Great Knot. GFN will ask WWF if they have the funds to tackle this area after the great success at Nanpu.

*S. alterniflora* on Zuidong mudflat, 25 May 2020 © Katherine Leung

While GFN are conducting our work on the Luannan coast, we always try to engage the local fisher-people and pond workers, we share our binoculars with them and show them the birds through our telescopes. BNU has some information brochures, developed by their students, and printed in Chinese, which we hand out to people who approach us to ask what we are doing. A big bonus is that our drivers Mr. Liu and 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 scanning with team, Nanpu 12 May 2020 © Katherine Leung

## Egg-collecting

Every year of our study we have seen egg-collecting. In 2016 we witnessed it on the most serious scale in our ten years. Thankfully, from 2017 to 2019 egg-collecting pressure had returned to more 'normal' levels and we only saw local pond workers taking a few eggs from easily accessible nests, mostly Pied Avocet. 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.

This year no illegal egg-collecting was seen. Some signs were put up in the area to discourage the consumption of wildlife following the national policy announced by the Chinese Central Government in February to ban all illegal wildlife trading and may have had an effect.


Posters saying no to wildlife consumption, 11 May 2020
© Katherine Leung

## 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 Forestry University, Beijing Normal University, WWF China, Wetlands International, 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 at the University of Groningen and the Royal Netherlands Institute for Sea Research (NIOZ) 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. Hebo Peng, also a PhD student of Theunis Piersma, is studying the benthic resources for migrant shorebirds along the entire Yellow Sea coastline of China, including fieldwork on the Luannan Coast. All this work is made possible under the Rudi Drent 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 NIOZ in close cooperation with Beijing Forestry University and Beijing Normal University.

Red Knots taking off at roost, Nanpu ponds 2 June 2020
© Katherine Leung

## Non-shorebird migration

Although the migratory shorebirds were the focus of our work, we had several 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 substantial wooded habitat. Appendix 1 has a complete list of all the 168 birds seen during the 2020 fieldwork period.

Amur Falcon *Falco amurensis*, 18 May 2020 © Katherine Leung

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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 https://www.globalflywaynetwork.org/.

Contact Chris Hassell: turnstone@wn.com.au

## Collaborative partners

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

Red Knots feeding on Nanpu mudflat, 26 May 2020 © Katherine Leung

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## Appendix 1 Bird list

The full list of the 168 species recorded 11 May to 7 June 2020

Tundra Bean Goose
Common Shelduck
Gadwall
Eastern Spot-billed Duck
Mallard
Japanese Quail
Common Pheasant
Little Grebe
Great Crested Grebe
Feral Pigeon
Rufous Turtle Dove
Collared Dove
Spotted Dove
Indian Cuckoo
Common Cuckoo
Grey Nightjar
Common Swift
Pacific Swift
Common Moorhen
Eurasian Coot
Ruddy-breasted Crake
Black-winged Stilt
Pied Avocet
Eurasian Oystercatcher
Grey Plover
Pacific Golden Plover
Grey-headed Lapwing
Lesser Sand Plover
Greater Sand Plover
Kentish Plover
Little Ringed Plover
Whimbrel
Eurasian Curlew
Far Eastern Curlew
Bar-tailed Godwit
Black-tailed Godwit
Ruddy Turnstone
Great Knot
Red Knot
Ruff
Broad-billed Sandpiper
Sharp-tailed Sandpiper
Curlew Sandpiper
Long-toed Stint
Red-necked Stint
Sanderling
Dunlin
Little Stint
Asian Dowitcher
Common Snipe
Terek Sandpiper
Red-necked Phalarope
Common Sandpiper
Green Sandpiper
Grey-tailed Tattler
Spotted Redshank
Common Greenshank
Nordmann's Greenshank
Marsh Sandpiper
Wood Sandpiper
Common Redshank
Oriental Pratincole
Saunders's Gull
Black-headed Gull
Relict Gull
Black-tailed Gull
Little Tern
Gull-billed Tern
Caspian Tern
White-winged Black Tern
Whiskered Tern
Common Tern
Oriental Stork
Great Bittern
Yellow Bittern
Grey Heron
Purple Heron
Great White Egret
Chinese Egret
Little Egret
Chinese Pond Heron
Black-crowned Night-Heron
Eurasian Spoonbill
Osprey
Eastern Marsh Harrier
Pied Harrier
Chinese Sparrowhawk
Japanese Sparrowhawk
Eurasian Hoopoe
Common Kingfisher
Black-capped Kingfisher
Dollarbird
Eurasian Wryneck
Rufous-bellied Woodpecker
Great Spotted Woodpecker
Common Kestrel
Amur Falcon
Eurasian Hobby
Peregrine Falcon
Black-naped Oriole
Black Drongo
Hair-crested Drongo
Brown Shrike
Oriental Magpie
Yellow-bellied Tit
Chinese Penduline Tit
Asian Short-toed Lark
Eurasian Skylark
Zitting Cisticola
Thick-billed Warbler
Black-browed Reed Warbler
Oriental Reed Warbler
Pallas's Grasshopper Warbler
Lanceolated Warbler
Sand Martin
Barn Swallow
Red-rumped Swallow
Light-vented Bulbul
Yellow-browed Warbler
Pallas's Warbler
Radde's Warbler
Dusky Warbler
Eastern Crowned Warbler
Two-barred Warbler
Arctic Warbler
Claudia's Leaf Warbler
Reed Parrotbill
Vinous-throated Parrotbill
Chestnut-flanked White-eye
Swinhoe's White-eye
White-cheeked Starling
Crested Myna
White's Thrush
Siberian Thrush
Orange-headed Thrush
Chinese Thrush
Grey-backed Thrush
Grey-streaked Flycatcher
Dark-sided Flycatcher
Asian Brown Flycatcher
Fujian Niltava
Blue-and-white Flycatcher
Rufous-tailed Robin
Siberian Blue Robin
Bluethroat
Siberian Rubythroat
Red-flanked Bluetail
Yellow-rumped Flycatcher
Green-backed Flycatcher
Mugimaki Flycatcher
Taiga Flycatcher
White-throated Rock-Thrush
Siberian Stonechat
Eurasian Tree Sparrow
Forest Wagtail
Eastern Yellow Wagtail
White Wagtail
Richard's Pipit
Olive-backed Pipit
Red-throated Pipit
Brambling
Japanese Grosbeak
Yellow-breasted Bunting
Little Bunting
Black-faced Bunting
Chestnut Bunting
Yellow-browed Bunting
Tristram's Bunting

Fujian Niltava *Niltava davidi* © Mr. Liu

Lanceolated Warbler *Locustella lanceolata* © Wu Entao

Chinese Egret *Egretta eulophotes* © Katherine Leung

Grey Nightjar *Caprimulgus Jotaka* © Katherine Leung


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