



RED KNOT NORTHWARD MIGRATION THROUGH BOHAI BAY, CHINA, FIELD TRIP REPORT APRIL - JUNE 2017

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Red Knot flying in to forage on a falling tide at Nanpu 30 April 2017 © Adrian Boyle

Contents

2	Contents
3	Summary
5	Introduction
6	The Study Site
8	Marking of Shorebirds Fieldwork in 2017
14	Shorebird use of the mudflats and resighting coverage
17	Internationally Important Counts
18	Red Knot <i>Calidris canutus</i> and the presence of <i>rogersi</i> and <i>piersmai</i> subspecies
19	Patterns of subspecies' composition through the season
21	Resightings support a change in schedules of <i>piersmai</i>
22	Red Knots numbers
23	Abdominal Profiles
24	Great Knot <i>Calidris tenuirostris</i>
25	Black-tailed Godwit <i>Limosa limosa</i> Sanderling <i>Calidris alba</i> Spoon-billed Sandpiper <i>Eurynorhynchus pygmaea</i> Nordmann's Greenshank <i>Tringa guttifer</i> <i>Black-faced Spoonbill Platalea minor</i> Chinese Egret <i>Egretta eulophotes</i> Breeding shorebirds and terns
26	
27	White-winged Black Tern <i>Chlidonais leucopterus</i> Nature Reserve Status
28	Human use of the mudflats
29	Habitat Threats
31	Egg-collecting Future research
32	Non-shorebird Migration Acknowledgments
33	Collaborative partners
34	References
35	Appendix 1 Building Nanpu Wetland Nature Reserve for a Healthier Ecosystem
37	Appendix 2 Bird List



Summary

This year's fieldwork season commenced on 13 April 2017 and finished on 6 June 2017.

The main findings from this year's field work were similar to those of 2016. The Red Knot that spend the non-breeding season in north west Australia (NWA) arrived at the Luannan Coast in much lower numbers than in previous years and earlier in the season (see discussion later).

We recorded 2,765 marked shorebirds from throughout the East Asian-Australasian Flyway (EAAF) compared to 3,554 during the 2016 field work season. This year 295 birds were individually recognisable from the Global Flyway Network (GFN) colour-banding project in NWA. This is exactly the same number as in 2016. This was of course dominated by Red Knot *Calidris canutus* with 269 individuals identified, then Great Knot *Calidris tenuirostris* with 22 and Bar-tailed Godwit *Limosa lapponica* with 4. As in previous years, this reflects the vital importance of the area for Red Knots from NWA.

The importance of the vast area of commercial ponds adjacent to the inter-tidal area 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 less than in previous years. The number of birds utilising the ponds was reasonably high during April but much lower during May than in previous years. We expected big numbers of Red Knot to use the ponds during mid to late May, as we have seen in previous years, excluding 2016. This, however, did not eventuate. Red-necked Stints and Curlew Sandpipers were not present in big numbers either. This was probably due to the generally high water levels in the ponds giving fewer foraging opportunities.

On 2 April a minimum 17,100 Black-tailed Godwits *Limosa limosa* were using the Hangu site (see figure 1.). This single count is higher than any we have recorded in previous years and represents 11% of the current EAAF population estimate. We recorded our highest count of Asian Dowitcher *Limnodromus semipalmatus* 1,754 on 8 May also at Hangu. On May 7 a count of 40,000 Dunlin *Calidris alpina* was the biggest count of this species over all our study years.



Asian Dowitchers, Red Knot and a Broad-billed Sandpiper, Nanpu 30 April 2017 © Adrian Boyle

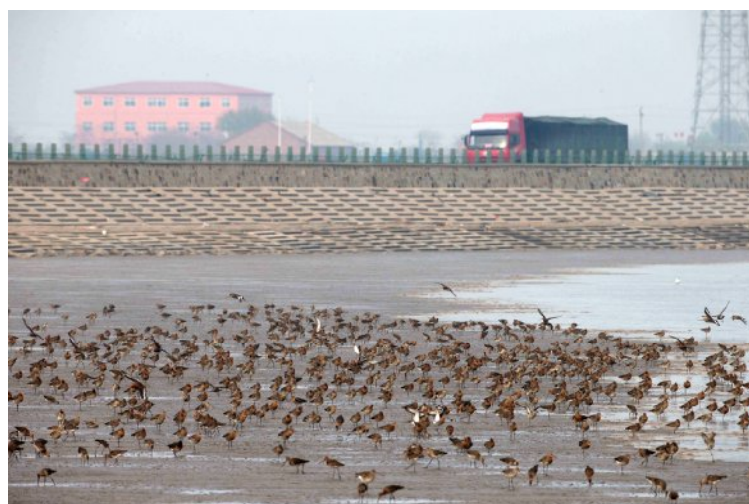
During our field season in 2012, 2013 and 2014, we estimated that a minimum of 40,000 White-winged Black Terns *Chlidonias leucopterus* were using the area at a single point in time. Numbers never approached that many this year. The biggest single count we made was of 2,000 at North Beipu on 25 May. But overall there were probably only several thousand in the area on any given day during their peak staging times from mid to late May.

The ponds in the salt works area host all the migrant birds at high tide when the mudflats are inundated by the sea, making the area a critical component of the Luannan Coast Shorebird Site. These ponds should be included in any conservation initiatives. They are also contributors to the local economy and jobs (see Study Site).

A table of species recorded in internationally important numbers has been compiled from GFN studies over the previous nine northward migration seasons. It is an effective way to give an indication of the immense importance of the Luannan Coast Shorebird Site. This year's table is updated from previous reports to use the latest EAAF Population Estimates (BirdLife Australia 2016). In the last 4 seasons fourteen 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 (see Table 4).

The continuing pressures on the intertidal area are obvious with the development of industrial and housing areas adjacent to and on reclaimed mudflats. In our study area the direct destruction of the intertidal habitat has slowed in the last five years. The building projects that are taking place in former pond habitat and mudflat areas reclaimed in recent years appear to have slowed. There were many fewer trucks, cranes, plant machinery and workers in the area. We assume this slowdown is due to the general downturn of the wider Chinese economy. However, a six-lane highway has been constructed part way along our study site, bridges are in place and a new road through the ponds is under construction. It would only take an upturn in the world, Chinese or local economies to see renewed expansion and loss of mudflats in this critically important area. Currently multi-billion yuan projects are in the planning stages for development within the Luannan Coast area.

The Global Flyway Network aims to continue to conduct research activities and follow up analysis to document the fates of four shorebird species (Bar and Black-tailed Godwit and Red and Great Knot) at their non-breeding sites in NWA and throughout the flyway, with an emphasis on the Luannan Coast, Bohai Bay. This will depend on continued financial support. From this work we will be able to assess the effects of human induced habitat change through statistical analysis. GFN will continue to support conservation efforts with in-depth analyses of the data collected at Bohai Bay in conjunction with Department of Conservation-New Zealand, World Wide Fund for Nature (WWF)-China, and Wetlands International-China. Dr Tamar Lok, a postdoctoral researcher from the University of Groningen, Post-doc Dr Hong-Yan Yang at Beijing Forestry University and PhD student Ying-Chi Chan, will continue to analyse GFN data under the co-supervision of Professor Theunis Piersma. All work will be in close cooperation with Beijing Normal University and Fudan University.



Black-tailed Godwits forage next to the highway at Hangu
 15 April 2017 © Adrian Boyle

Introduction

The ecology of the enigmatic long-distance migratory shorebird Red Knot *Calidris canutus*, despite a lot of study, still leaves much to be discovered in the East Asian-Australasian Flyway (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). *Piersmai* and *rogersi* breed in different locations in the Siberian Arctic and share non-breeding locations in Australasia (Rogers *et al.* 2010).

Despite a lot of research involving Red Knot, we certainly do not fully understand the northward and southward migration strategies of the two subspecies, and changes therein as a consequences 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. They did record 14,277 in the NW Bohai Bay region (now called the Luannan Coast) during northward migration in 2002 (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 stopover ecology of Red Knots in the area. She has been conducting regular counts since 2003 during northward migration and her work shows 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). This increase now appears to have stopped and declines at the site are beginning to be noticed.

It is well documented that migratory shorebirds can move from one area to another however this is of course non-sustainable if the current rate of habitat destruction continues. 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 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.

It is clear from our current knowledge that this site is the single most important 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 studies of male, *rogersi* Red Knot from the breeding grounds in Chukotka show that they use the northern Yellow Sea on northward migration as is already well documented but also that some *rogersi* pass through northern Bohai Bay on southward migration (Tomkovich *et al.* 2013). They don't appear to do so in large numbers though as ornithologists at the Luannan Coast during the southward migration period have only recorded very small numbers.

In conjunction with the work by YHY, studies by GFN have continued during the northward migration seasons of 2009 to this year, 2017. These field 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 between 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 was made possible. In 2015, 2016 and 2017 most costs were paid from the 2014 Spinoza Premium to Theunis Piersma from the Netherlands Organization for

Scientific Research (NWO) and WWF-Netherlands, with additional support from Beijing Normal University. Here we report on what we have achieved in April - June 2017.

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 site for migratory birds and the priority for both Australia and China to advance their actions to protect this site for the future of migratory birds.



Bob Loos returning from a rained-off scanning session at Nanpu ponds 20 May 2017 © Adrian Boyle

The Study Site

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 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). It has already covered >75% of its planned area. The mudflats of the four study sites previously exposed a 25 km long and 1-3 km wide (on the lowest tides) foraging area for shorebirds. This is no longer the case as most of the Zuidong mudflats have been claimed for industry. The mudflats are separated by a man-made seawall from the Nanpu Salt 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, roost and for some species to nest but some of these areas are also being lost to industrial development. The area of ponds adjacent to the Luannan Coast is vast, stretching 10km inland and across the entire 20km, from south east to north west, of our study sites and therefore roosting opportunities are many and varied for migratory shorebirds and terns.



Figure 1. Interpreted satellite image of Bohai Bay, China with new site Hangu.

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. The majority of shorebirds and terns use the evaporation ponds for roosting and feeding and subsequently the majority of Beijing Normal University students' studies are conducted in these ponds. However shorebirds and terns use all the ponds and so for the purposes of this report all and any pond, regardless of its use, is referred to as a 'pond'. Our 'new site' of Hangu is 24km NNE from the middle of our main study site of Nanpu. The habitat is identical, open mudflats adjacent to ponds, roads and industry (a huge power station dominates the area). The site is also used in the same way by the birds. They roost in the ponds and use them for foraging if the opportunity exists but feed predominately on the mudflats. There is almost zero fishing activity on the mud at Hangu as it is incredibly soft and high-on impossible to walk on. All our work there was done from sea walls and in the ponds.



The power station at Hangu dominates the view 11 May 2017 © Chris Hassell

Marking of Shorebirds

Shorebirds captured throughout the EAAF are marked with plain coloured flags, engraved leg flags (ELF), or combinations of four colour-bands and one 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 colourbanded birds from 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 to various species and regions from throughout the flyway.



NWA colour-banded Great Knot (5RYYL) at Meynypilgyno, Chukotka 27 May 2017 © Egor Loktionov

Fieldwork in 2017

The fieldwork program for 2017 started on 13 April and finished on 6 June, this is fifty five continuous days of field work with two to three (occasionally four) observers in the field daily. On our first field work day the dominant species were Great Knot with a minimum of 6,000 using the Zuidong and Nanpu mudflats. There were a few hundred Red Knot, 1,000's of Dunlin, over 1,000 Eurasian Curlew (*Numenius arquata*) and 700 Grey Plover (*Pluvialis squatarola*) were all using the mudflats while other species were present in low numbers. Great Knot numbers stayed fairly constant until 12 May when mass migrations of this species took place. Red Knot numbers increased quickly from 13 April when there were 100's to 4,000 on 16 April and to 6,000 on 20 April. These are presumed to be birds arriving at the site and not redistributing within the site. Our biggest single count of Red Knots was on 15 May of 15,000 at Hangu Wind Farm. There was probably another 2,000 Red Knots at Nanpu but this is a very low overall total for the Luannan Coast compared to previous years except 2016 (20,000).

We recorded our biggest number ever of Asian Dowitcher *Limnodromus semipalmatus* 1,754 on 8 May at Hangu. And the biggest count of Dunlin *Calidris alpina* 40,000 on 7 May. This Dunlin count is some 4 times higher than we have recorded before. We don't think this was a massive influx of Dunlin from another site but rather the conditions being just right on the mudflats and our team being 'in the right place at the right time' to record them. We think these birds are usually within the Luannan complex of mudflats and ponds but rarely gather in one large congregation. All the totals of each species would still be underestimates 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 our first day we recorded 1,000's of Kentish Plover (*Charadrius alexandrinus*) but in the following days the most was only ever a couple of hundred. This is usual as birds move north and spread out throughout the ponds to breed.

Table 1 documents the 'evolution' of our studies at Bohai Bay as our understanding of the importance of the site became clear to us. We started with a preliminary visit in 2007 leading to the complete and continuous coverage of northward migration from 2010 – 2017. No observations were made during northward migration season 2008 as CH and Adrian Boyle (AB) were conducting shorebird studies in South Korea.

Table 1. Days of observation and resightings at the Luannan study site 2010 - 2017.

	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	3,143	106
2011	52	3,336	170
2012	53	4,503	279
2013	59	4,616	269
2014	57	5,018	345
2015	57	4,151	387
2016	56	3,582	261
2017	55	2,771	265

Total sightings of all marked birds were down on 2016. The total number of resightings from NWA for all marked birds was very similar 1,663 (2016) to 1,596 (2017). As was the total number of Red Knot colourband resightings 671 (2016) 680 (2017) and shown in the table above the individually identifiable Red Knot was only 4 birds different.

After a few visits to find the best tides and times for resighting work the Hangu site produced a good data set. From our observations and checking individual birds resighting history we were able to establish that the birds using the Hangu site were mainly the same birds that were using the Nanpu and Beipu sites. They would move between the two sites within a day in some instances. Why, is not known. There was more shell-fishing activity at Nanpu this year with up to 100 people on the mud collecting shell-fish. This would constrain the birds foraging opportunities when there is only a small amount of mud exposed as the tide approaches or recedes from the seawall but at mid and low tides there is plenty of mudflat available for birds with no shell-fishers on it. There is almost zero fishing activity on the mud at Hangu as it is incredibly soft and nigh-on impossible to walk on. All our work there was done from sea walls and in the ponds.

As last year, the roosts in the closest ponds to the Nanpu mudflats are being used less than in 2010 to 2015. We have not worked out why this was the case. The ponds had suitable depth of water with many suitable spits and banks exposed for birds to roost on and there was little disturbance. This meant we spent less time in the roosts than in previous years (excluding 2016) and this may have contributed to the lower overall resightings collected this year. However, the birds are still using the ponds but not in areas that are conducive for colourband scanning. The final week of field work was particularly frustrating in that the bulk of the Red Knot that remained in that final week (12,800 on 30 May dropping to 880 on 5 June) spent the majority of their time foraging in the middle of a huge pond where we cannot access them for resightings. Very small numbers would come and forage on the edge of the ponds but resightings were almost zero for the last week. As is usually the case the birds were using the mudflats much less at the end of the season than at the start. It remains the case that both the salt works area and the adjacent intertidal mudflats of the Luannan Coast are vital components of the area for shorebird conservation.

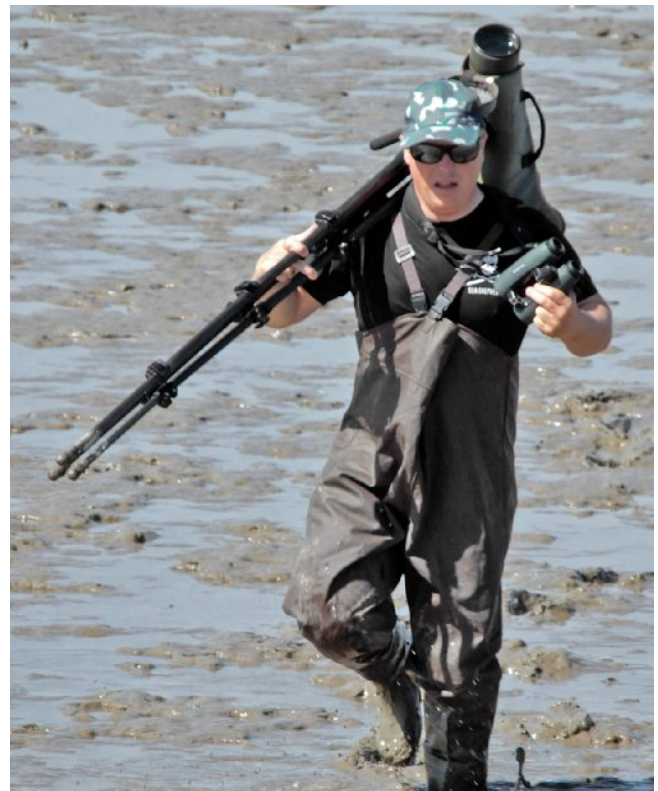
The scanning of foraging birds from the seawall, on the intertidal mudflats and exploration of the salt ponds occupied the majority of our time. We recorded a good set of sightings (see Table 1, 3 and 4). All shorebirds that forage on the mudflats leave the mud at high tide, as the sea reaches the seawall and fly to roost in the ponds. Some roost in close proximity to the mudflats (especially early in the season), but as with previous years, by early May most birds flew many



Chris and Adrian scanning from the Nanpu Seawall © Bob Loos

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 still not obvious to us. The roosts we did access for the entire field work season continued to be relatively undisturbed, and although migrating raptors and pond workers do cause some disturbance, it is not significant and no different between roosts sites close to or distant from the intertidal mudflats. The myriad roosting opportunities are a positive for the shorebirds, but the foraging opportunities for them do not appear to be constant in the ponds. Thus the retention of the remaining intertidal mudflats at Zuidong, Nanpu and Beipu remains of greatest conservation importance enabling the huge numbers of migrant shorebirds and terns using the area to fatten up, continue their migrations to their breeding grounds and to breed successfully.

Occasionally we receive sightings of GFN's colourbanded birds in the EAAF from south of our study site that then arrive at the Luannan Coast and are sighted again by us giving further insights in to staging times and migration routes. This season, for the first time, we had the opposite. A Red Knot sighted by the GFN team at Luannan and then seen further north in the flyway. In this case just outside the village of Meinypilgyno, Chukotka in far north east Russia on the Spoon-billed Sandpiper and Red Knot study area. One bird was from the GFN study, caught and individually colour-banded as 5RLLY on 20 February 2016 as an adult (2+). This year it was seen in Roebuck Bay on 26 March then the next sightings were at Luannan 25 April and 5 May before Pavel Tomkovich's team saw the bird in Chukotka 27 May. That is 4,670km NE from Luannan meaning a minimum distance of migratory flight from the bird's non-breeding site to its breeding area of 11,070km.



Adrian returning from scanning on the mud flats of Nanpu © Bob Loos

This was very exciting for the GFN team and then things got better as a Red Knot (individually marked - YVA) banded for the AWSG project in NWA was also seen and photographed at the same site. YVA was initially caught and banded in Roebuck Bay 20 February 2014 aged 1 (in its first year of life). It was seen regularly in Roebuck Bay during 2014. The last sighting for 2014 in Roebuck Bay was 8 August. The next sighting of the bird was near Auckland in New Zealand 26 December the same year. This is a well-known strategy for first year Red Knot of the *rogersi* subspecies; from the Chukotka breeding grounds to NWA and then to move to their 'permanent' non-breeding area. The bird was seen a number of times in New Zealand during January and February 2015 with the last sighting being on 22 February. The next place the bird was resighted was back in Roebuck Bay on its northward migration. This is not a well-documented route. Despite the thousands of Red Knots marked with individual colourbands and engraved leg flags in both NWA and New Zealand only a few have been recorded passing though NWA to and from New Zealand, once they have become adults and enter the migrating and breeding population. There were two sightings of YVA in Roebuck Bay in March and April 2015 the last one being 17 April. YVA was then seen back in Roebuck Bay three times between 12 September and 13 October. There were no resightings in New Zealand or NWA during the first months of 2016. The next sighting came from the Luannan Coast study site on 10 May 2016. YVA was not seen in NWA on southward migration 2016 with the next record being 1 January 2017 back near Auckland, New Zealand. Two sightings were recorded there and then YVA was back on the Luannan Coast 17 April 2017. The final record in this well-documented bird was from Meynypilgyno, Chukotka 28 May 2017. It is very interesting to note the difference in migration timing between 2015, even though it was not seen on migration after the Roebuck Bay sightings no sightings between 16 April and 12 September strongly suggest it did migrate. But this year 2017 the bird was already on the Luannan Coast by 17 April. It is unknown if the bird has changed its migration route to take the more well-known route from New Zealand to the Gulf of Carpentaria, north east Australia and then on to the Yellow Sea and YVA does not come via Roebuck Bay anymore, which the lack of resightings suggests. Both 5RLLY and YVA were assessed to be the *rogersi* subspecies on breeding plumage characteristics both in Roebuck Bay and on the Luannan Coast. This, of course, matches well with the breeding location.

Table 2. A tabular breakdown of the resightings of Red Knot YVA

Species	Red Knot	ELF	YVA
Location	Country	Date Seen	
Roebuck Bay, Broome	Australia	11-05-14	
Roebuck Bay, Broome	Australia	18-05-14	
Roebuck Bay, Broome	Australia	20-05-14	
Roebuck Bay, Broome	Australia	22-05-14	
Roebuck Bay, Broome	Australia	27-05-14	
Roebuck Bay, Broome	Australia	28-05-14	
Roebuck Bay, Broome	Australia	02-07-14	
Roebuck Bay, Broome	Australia	03-07-14	
Roebuck Bay, Broome	Australia	04-08-14	
Roebuck Bay, Broome	Australia	13-10-14	
Karaka, Auckland	New Zealand	26-12-14	
Karaka, Auckland	New Zealand	18-01-15	
Karaka, Auckland	New Zealand	26-01-15	
Karaka, Auckland	New Zealand	07-02-15	
Karaka, Auckland	New Zealand	22-02-15	
Roebuck Bay, Broome	Australia	05-03-15	
Roebuck Bay, Broome	Australia	16-04-15	
Roebuck Bay, Broome	Australia	12-09-15	
Roebuck Bay, Broome	Australia	12-09-15	
Roebuck Bay, Broome	Australia	13-10-15	
Roebuck Bay, Broome	Australia	19-10-15	
Luannan Coast, Hebei	People's Republic of China	10-05-16	
Karaka, Auckland	New Zealand	01-01-17	
Karaka, Auckland	New Zealand	02-01-17	
Karaka, Auckland	New Zealand	22-02-17	
Luannan Coast, Hebei	People's Republic of China	17-04-17	
Meynypilgyno, Kamchatka	Russian Federation	28-05-17	

In addition to these birds marked in NWA we have records of birds marked in Chukotka seen by GFN in Luannan and then seen again at their banding location.

This news came from Pavel Tomkovich on 28 June 2017: "Many thanks for your information -- GFN efforts help a lot to learn about movements of our Chukotka birds. Several days ago chicks of Red Knots started to hatch, and we started our surveys for broods every third day. The male CUY successfully hatched chicks this year, the male CUS has not been seen this year, however it is a very secretive bird (we still hope to find him with a brood)."

We had seen CUY on 16 and 21 April 2017 and CUS 19 April and 1 May 2017. CUS is a regular Luannan Coast bird also seen during the northward staging period 2011, 2012, 2013, 2015 and 2016. All the resightings of these birds have been recorded as *rogersi* giving strength to the data set we compile on subspecies using plumage characteristics.

These fantastic life histories from a simple marking method and dedicated resightings show the connectivity of the Luannan Coast from the southern areas of the EAAF (New Zealand) to the far north east (Chukotka).



Red Knot YVA, Meynypilgyno, Kamchatka, Russian Federation Province on 28 May 2017 © Egor Loktionov

Table 2 below shows the totals of all marked migratory shorebirds recorded during our fieldwork seasons and the location they were originally marked. The birds with plain flags just indicate the original banding location 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 marked shorebirds, of all species, by capture area recorded during fieldwork 2010 to 2016. These records (2010-2016) represent 31 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	2017	Total 2010-2017	Known Individuals 2017
Australia, King Island, Tasmania	3	2	4	0	1	5	2	4	21	2
Australia, New South Wales	0	2	0	1	0	1	0	0	4	0
Australia, Northern Territory	3	0	0	1	0	4	57	24	89	8
Australia, North West Australia (Colour Bands)	317	412	904	613	922	1221	671	680	5740	295
Australia, North West Australia (Flags)	912	812	1166	1053	1222	1036	964	916	8081	200
Australia, Queensland	7	7	8	27	12	4	14	3	82	1
Australia, South Australia	12	35	62	73	54	31	40	20	327	7
Australia, South West Western Australia	6	0	0	1	4	3	0	0	14	0
Australia, Victoria	746	644	798	985	858	507	487	290	5315	28
China, Bohai Bay	122	96	129	125	108	55	162	78	875	11
China, Chongming Dongtan National Nature Reserve	321	447	565	552	679	510	518	342	3934	53
China, Jiangsu	0	0	0	0	0	0	0	1	1	0
China, Liaoning Liaohkou National Nature Reserve, Liaoning	1	9	0	1	1	7	1	5	25	4
China, Yalu Jiang National Nature Reserve	0	0	0	1	3	3	0	0	7	0
Hong Kong	5	23	19	44	39	20	20	6	176	1
India, Point Calimere, Tamil Nadu	0	0	0	0	0	0	5	5	10	0
India, Chilika Lake, Odisha	1	0	0	0	0	4	7	5	17	2
Indonesia, Java	1	0	0	0	0	0	0	0	1	0
Indonesia, Sumatra	12	4	5	8	7	6	2	2	46	0
Japan, Kyushu	0	0	0	0	0	0	2	0	2	0
Japan, North Coast, Hokkaido	1	7	10	5	9	5	8	2	47	0
Japan, North East Coast	0	0	0	0	0	4	1	0	5	0
New Zealand, North Island	558	748	681	855	734	452	317	198	4543	48
New Zealand, South Island	32	20	21	35	22	17	18	5	170	1
Phillipines, Olango Island	0	0	0	1	1	0	0	0	2	0
Russia, Chukotka	1	32	43	50	62	38	44	22	292	4
Russia, Kamchatka	1	3	4	1	0	6	7	20	42	3
Russia, Sakhalin	0	4	5	48	52	44	43	33	229	0
Singapore	1	0	0	1	1	0	0	0	3	0
South Korea	0	0	0	0	8	12	5	0	25	0
Taiwan	4	0	2	3	2	4	1	0	16	1
Taiwan, Kinman Island	0	0	0	0	0	0	0	2	2	0
Thailand, Inner Gulf Of Thailand	31	18	34	96	153	92	125	75	624	0
Thailand, Ko (Island) Libong, South West Coast	35	29	36	33	60	56	33	27	309	0
Totals	3133	3354	4496	4613	5014	4147	3554	2765	31076	669
Number of Species	14	14	13	18	17	18	17	15		

Shorebird use of the mudflats and resighting coverage

The use of the study site (see Fig. 1, Study Site image) has changed from our first visit in 2007 and changes each year as local conditions fluctuate and affect the suitability of different areas for the birds (particularly Red Knot our focus species and a 'specialised feeder'). We have four major mudflat sites within the study area and also the ponds. This year we started working at a 'new' site, Hangu, but we did almost no resighting work at North Beipu.

The Nanpu mudflat is 8km long and 4km wide and it is usually where most of the birds congregate. This is presumably because at present this site has the most abundant 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 the majority of our fieldwork was conducted in 2017 as in all other years. The mechanical shellfishing operation is still working the Nanpu mudflats. It is unclear if this operation has any effect on the birds or their food (see discussion in Yang *et al.* 2016). Plumes of sediment can be seen in the water when the pumps are working but we cannot quantify any effects of large areas of sediment disturbance. This season we regularly saw up to 100 people on the mud at the Nanpu site collecting shellfish. They were collecting Chinese Razor Clams *Sinonovacula constricta* we have not seen them target this species in previous years and we have never seen such numbers of people on the mud flats. The fisher-people seem very skilled at collecting them. They appear to push a wooden stick somewhat randomly in to the mud but when they stop and insert the thin hooked wire they almost have 100% success in getting a clam. It is interesting that we have never seen this mollusc targeted before as it seems common. Tong Mu, a PhD student from Princeton University, asked the shellfishers if the clams are 'seeded' but they replied they were not. It is potentially a disturbance issue for the birds with people out on the mudflats but if it is at all, it is very minor at this stage with this amount of people. However, conflicts between birds and fisherman have been documented in other areas of the Yellow Sea. Reasonable levels of fishing activity appear not to concern the birds and the Nanpu mudflats are still relatively undisturbed and 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 off-shore for oil extraction, but the mudflats abutting the seawall are still excellent shorebird foraging grounds. The Nanpu mudflats is the area that must be protected and given nature reserve status to enable the Red Knot and many other migratory shorebird species of the EAAF to maintain sustainable population levels. It is hoped the MOU (see later) will bring this about.

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 field work 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 field work season finished in 2010 development work started and was still going on during our 2011 season. This involved many large industrial dredging ships pumping mud out of the mudflats and over the seawall in to the adjacent salt ponds. So it damaged two shorebird habitats in the one process. In the areas that were dredged the mud was extracted up to a depth of 15m. 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 2017 season with no dredging or development work being done on the Beipu mud flats for five years. However, the ponds immediately inland from the mudflats at the northern end that had mud pumped into them in 2011 are now dry mud and offer no feeding or roosting opportunities for birds. Due to this



Basic transport 15 May 2017 © Chris Hassell

reclamation work the Beipu mudflats held almost no birds during both 2012 and 2013, but in 2014 small numbers of birds had started to forage there again. In 2015 that changed very dramatically. There were up to 25,000 Red Knots using Beipu. Last season 2016 the use of Beipu was 'average'. We did scan there and at times there were 9,000 Red Knots on the flats. This year 2017, Beipu had very low numbers of shorebirds once again and in particular Red Knot. In the first month of our study period we didn't count more than 500 Red Knot at Beipu and the highest count we had there was 2,230 on 15 May 2017. Red Knots do move on to the Beipu mud flats as the tide recedes and the birds can then be a long way from the sea wall. However we only ever saw Red Knots close to the creek and seawall where the Nanpu and Beipu sites abut one another. We didn't see distant feeding flocks. It seems that Red Knots moved from Nanpu all the way to Hangu and hardly used Beipu this season. Scanning effectively is more difficult at Beipu than it is at Nanpu, mainly due to logistics and the shorter time this mud flat is available due to tide conditions. We know from previous years' 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 8 years of our full study years. Detailed studies on the benthos of the site are not undertaken by students as the very soft mudflats are difficult and indeed dangerous to access.



One of the 'resort' buildings toppling on to the mud flats © Adrian Boyle

Another issue at Beipu that highlights the lack of regulation on the coast is that in 2106 a 'resort' was built on the sea wall. By this year it had mostly fallen over the edge of the sea wall and been abandoned. This is not a major conservation issue in comparison to the huge losses of mud flats along the Yellow Sea coast, but illustrates the unregulated nature of the human use of this very important site.

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 sea wall 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 mud flats and not from the seawall.

The North Beipu site has been worked progressively less and less over the years and this season we explored it a few times but did very little formal scanning there. 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. The only birds using North Beipu this season in reasonable numbers were White-winged Black Terns. 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.

We first found out about the Hangu site from Mr Wong, a friend of Zhu Bingrun's, as he had seen 1,000's of Black-tailed Godwits there. As this is Zhu's main study species for his PhD, he went there immediately and reported to us about the site. On our first visit we didn't find a single Red Knot but we did scan, very thoroughly, the 1,000's of Black-tailed Godwits. Not a single marked bird from NWA was seen. 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. Zhu's PhD will hopefully discover more about this.



Part of the flock of Black-tailed Godwits at Hangu 13 April 2017 © Adrian Boyle

During April as we explored the area we found very suitable habitat for Red Knots, but not actually any Red Knots. However the site became a regular place for us to work at from 8 May until 24 May. The Red Knots did their usual ‘disappearing act’ from the Nanpu site as they seem to do each year and we ‘found them’ at Hangu. Numbers peaked at the site with 15,000 on 16 May. This had dropped to just 435 on 27 May.

Table 4 shows records of individually colour-banded birds marked in NWA recorded on the Luannan Coast for the years 2010 to 2017. The 295 individuals recorded this year is exactly the same as 2016. The composition of the species is very similar also. This was a pleasing result as there were less Red Knots in total at the site. This year we didn’t have any ‘brilliant’ days scanning as we have sometimes achieved in previous years. The main change was a drop of individually recognisable Great Knot from 31 to 22. Great Knot numbers were lower overall than in 2016 so this is not a surprising result. Resighting conditions on the Luannan Coast were very similar to last year and marking effort on the non-breeding grounds of NWA have also been very similar so this seems a true reflection that Great Knots were not at Luannan in the same numbers as 2016 as indicated by counts. The Luannan Coast is not a major staging site for Bar-tailed Godwits. The GFN project is getting 10’s of 1,000’s of resightings in Roebuck Bay and 80 Mile Beach in NWA in addition to this set of data that is compiled from resighting work 6,400km distant from the marking location. 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.

Table 4. Totals of individually colour-banded birds from the GFN project marked in NWA resighted on the Luannan Coast 2010 to 2017

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

Internationally Important Counts

During the ten years GFN have been visiting the Luannan Coast we have been conducting regular counts particularly from 2010 to 2017. The importance of this site is not in any doubt. Table 5 below shows clearly the immense importance of these mudflats and salt ponds to shorebirds from throughout the EAAF. All counts are minimum counts as the vast area can never be completely covered with our current resources and no turnover analysis is done. During this 2017 season we recorded our highest count of Asian Dowitcher. We also had internationally significant counts of various species during the field work season but none were higher than those shown in Table 5. Note that there have been higher counts of Red Knot, Curlew Sandpiper, Broad-billed Sandpiper, Grey Plover, Nordmann’s Greenshank and Sharp-tailed Sandpiper in previous seasons but with the renewed EAAF Population Estimates (BirdLife Australia 2016) we have only used counts from the last 4 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 5. Internationally Important Counts at Luannan Coast 2014 to 2017.

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>	02-04-17	17,100	10.7	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>	19-04-15	1,686	1.7	100,000"	1,000
Great Knot	<i>Calidris tenuirostris</i>	04-05-15	10,270	2.4	425,000	4,250
Grey Plover	<i>Pluvialis squatarola</i>	19-04-15	2,867	3.6	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>	27-04-16	951	0.95	100,000*	100
Red Knot	<i>Calidris canutus</i>	04-05-15	29,965	27.2	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 5n

uncertainty of distribution of all subspecies in EAAF.

Red Knot *Calidris canutus* and the presence of *rogersi* and *piersmai* subspecies

The main focus of our studies on the Luannan Coast are Red Knots. 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, predominately from NW Australia non-breeding areas, which 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* then 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 previous experience it appeared that birds, who arrive at Luannan early in the season, predominately *rogersi*, before 1 May, stay for up to a month but birds that arrive late in the season, mid-May onwards, predominately *piersmai* are only here for a short time, a week or less. However, the general trend of subspecies arrival periods has been changing, most noticeably over the last two years.



Red Knots roosting at Hangu ponds 10 May 2017 © Adrian Boyle

Patterns of subspecies' composition through the season

To evaluate the proportions of the two subspecies we conduct random scans of flocks and assigning 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 on the basis of the colour and pattern of that breeding plumage (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 BoyleA 'typical' *rogersi* AP 3 © Adrian Boyle

To obtain the data for the graphs below we conduct regular, random scans of Red Knots. The number of flocks and birds scanned is very similar over the years.

During 2010-2015, in the first weeks of the season *rogersi* dominated then as the *piersmai* arrived in greater numbers it evened out to around 50/50 but only for about a week then as *rogersi* left for the breeding grounds and *piersmai* continued to arrive *piersmai* dominated the scans. (Figure 2 (a)).

Table 6.

Year	Number of Scans	Number of Red Knots assessed
2015	225	39,925
2016	221	38,364
2017	218	38,866

In 2016 and 2017 the composition of the two subspecies has changed (Figure 2 (b & c)). *Rogersi* dominate for the first two weeks as usual but then *piersmai* 'catch up' and instead of it being an even split for one week the proportions of the subspecies are even for three weeks with *piersmai* never reaching the high proportions of the last 3 weeks of 2015.

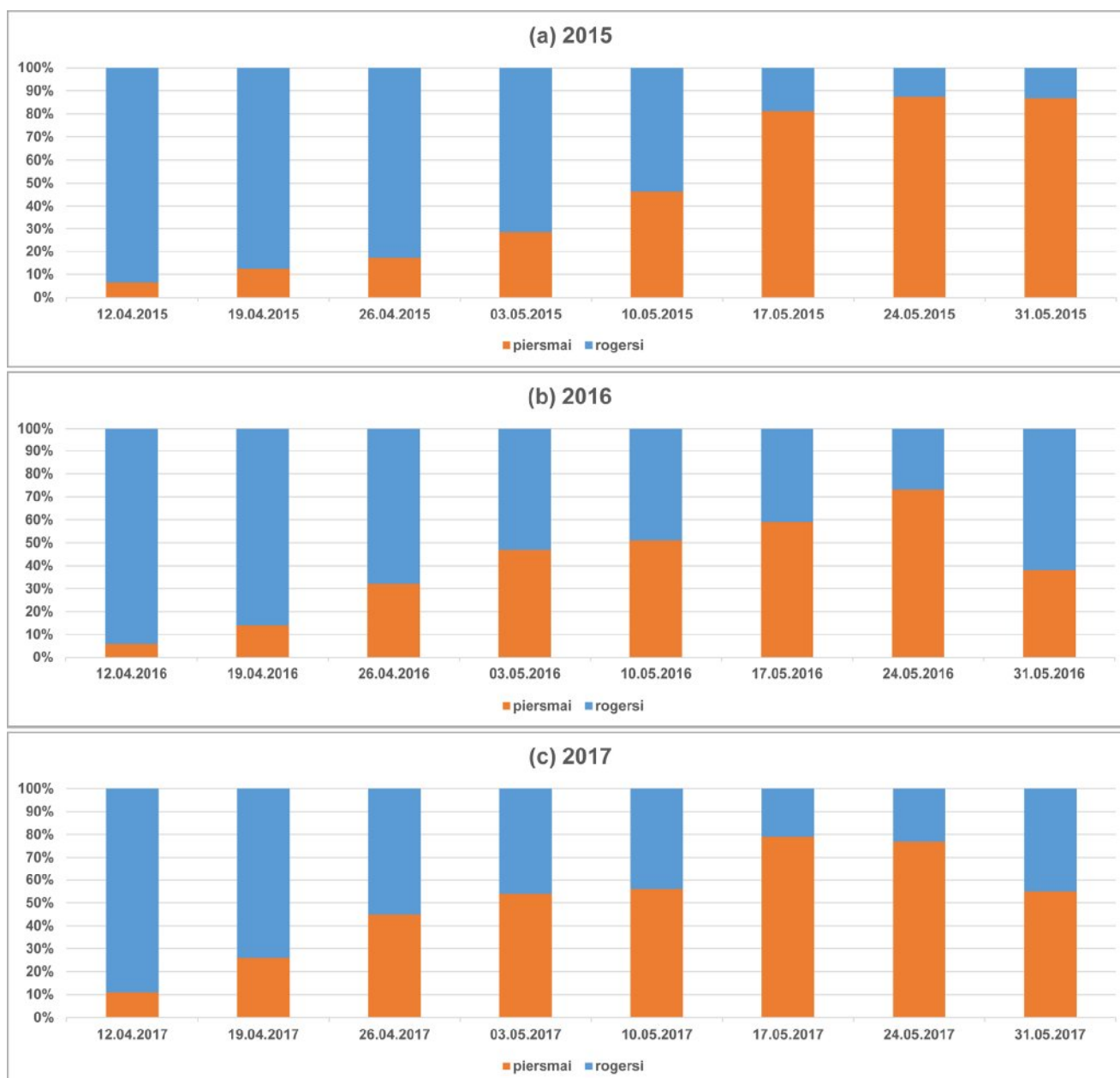
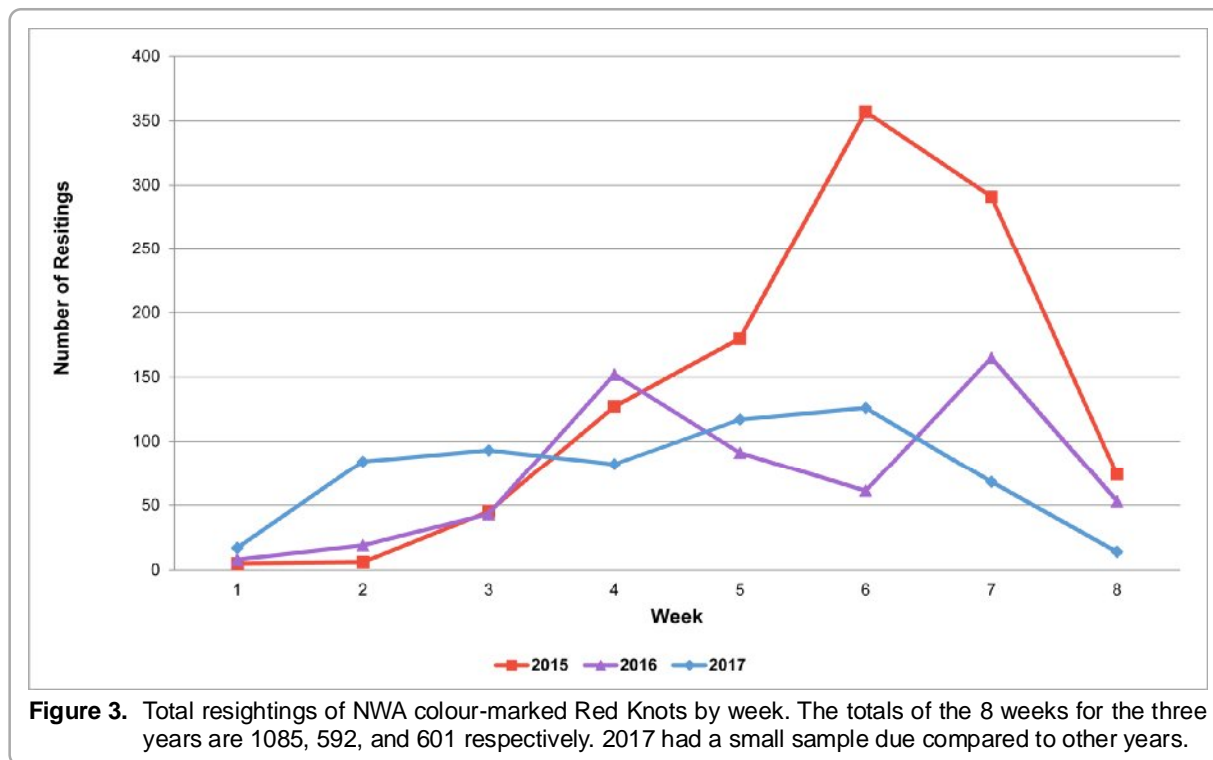


Figure 2. % *rogersi* V *piersmai* over time. (a) 2015, represents all years 2010-2015. (b) 2016. (c) 2017.

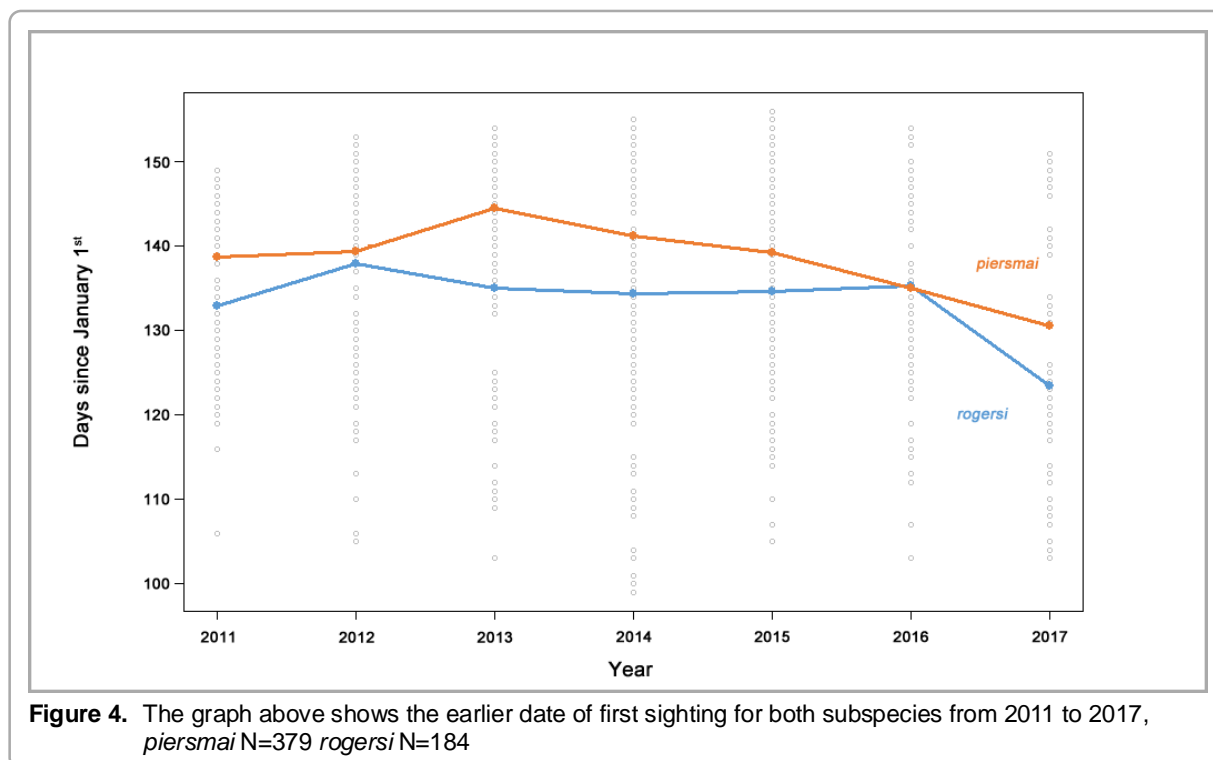
This pattern suggests that *piersmai* are arriving at the Luannan Coast earlier in the last 2 years. This is also supported by the total resightings of colour-marked birds from NWA recorded at the study site.

Resightings support a change in schedules of *piersmai*

Table 7 below shows the very obvious increase in resightings in the first three weeks of 2017 and also between 2016 and 2015. From week 3 to 8 the resightings for 2017 are well under 2015 with some fluctuation in relation to 2016. However note that all 2016 and 2017 numbers are well below 2015. This is further information implying that birds from NWA (predominately *piersmai*) are arriving at the Luannan Coast earlier.



In addition to the total resightings we looked at data from 563 'known' individually Red Knot marked in NWA from 2011 to 2017. All 563 had been assessed to sub-specific level. This small sample supports the notion that indeed *piersmai* are arriving earlier but it also shows that so are *rogersi*. Note we may miss some of the effect of *rogersi*'s earlier arrival due to our field season timing.



Our data show that Red Knots are arriving earlier at the Luannan Coast, but it will take more analysis to tease out the mechanisms behind this. This is not within the scope of this report, but some questions seem obvious for us to explore. And we have some knowledge about aspects of them:

1. Have the sites that Red Knots use between Australia, New Zealand and Luannan been degraded and offer less foraging opportunities so they need to pass through them more quickly?
2. Have the conditions on the Australian and New Zealand non-breeding sites changed? Our recent knowledge of this is there has not been any obvious change in the past few years.
3. Is there some subtle climate change effect that means the breeding grounds are becoming snow-free and available to birds earlier?
4. Or are some coastal sites becoming available to birds in the Sea of Okhotsk and they are stopping there to refuel before the final leg of their journey to the breeding grounds? This would only effect the migration timing of the *rogersi* subspecies. The Chukotka breeding areas of *rogersi* are snow-free and available for birds in advance of the New Siberian Islands nesting areas of *piersmai* and their migration route takes them over the Sea of Okhotsk.

Red Knots numbers

The peak count of Red knot in 2017 (14,577 on 15 May) was down some 5,000 on 2016 (20,000 on 4 May) and that was our lowest count since full surveys started in 2010. The drop in the highest single count of Red Knot between 2015 and 2017 is 51%. The highest count in 2015 was 30,746 (29 May), around that date in 2017, there were only 12,800 Red Knots (30 May) in the ponds and on the mudflats although it was more than we counted in 2016 (5,480 on 29 May).

There is a second wave of mass migration of Red Knots towards the breeding grounds that commences in very late May and numbers drop off quickly and on our last day of field work, in all years, there are just hundreds to a few thousand Red Knots remaining.

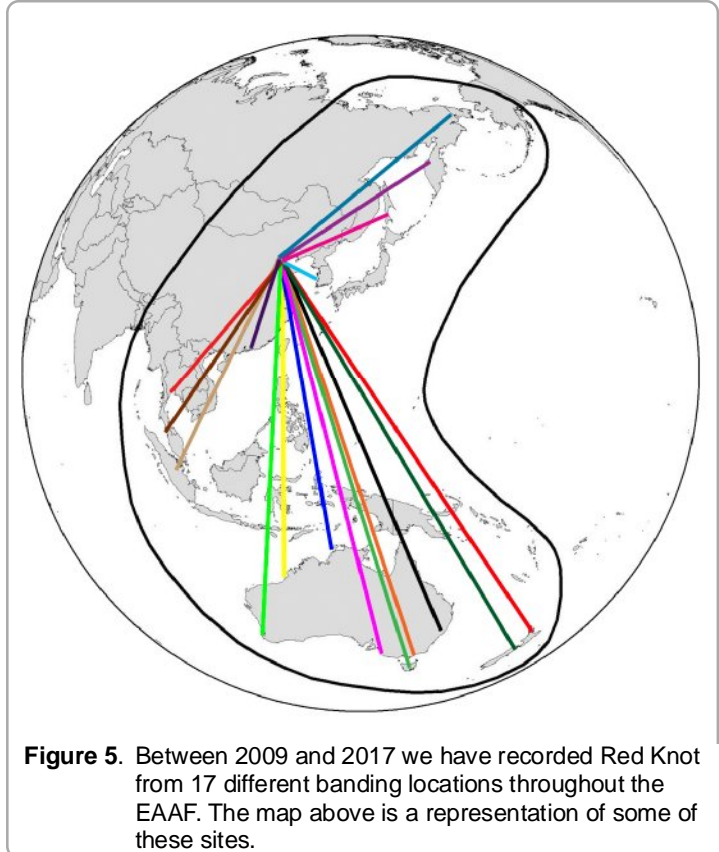
The count data for the site is not as strong as the colour-band resighting data or the subspecies ratio data due to the logistical difficulty of conducting complete counts of the site. However we believe the drop in the counts was not caused by us missing large numbers of Red Knots within our study area. We have a good understanding of how Red Knots use the Luannan Coast and adjacent ponds (but not perfect) so we get a 'feel' for what is happening in the area as we travel through it twice a day and spend every day in the field observing Red Knot.

Table 7.

Count Date	29.05.2015	29.05.2016	30.05.2017
Red Knot	19000	5480	12800
Count Date	05.06.2015	05.06.2016	05.06.2017
Red Knot	6230	1910	880

Is this sudden drop in peak count in 2016 and 2017 caused by a steep decrease in Red Knot population along the flyway? Like most coastal-specialist species in the EAAF, Red Knots are undergoing decreases in populations and survival (Piersma *et al.* 2016, Studds *et al.* 2016), but it is unlikely that such a collapse would happen in one hit. The declines are generally steady year on year (Clemens *et al.* 2016). Adrian Riegen of Pukorokoro Miranda Shorebird Centre tells us that the last 4 years, Red Knot numbers in New Zealand have been stable, and this is also the case in NWA and south east Australia (AWSG unpublished data).

Does the lower numbers mean that some of the birds arrive and then move on quickly as there was not enough food? This is a possibility Hebo Peng reports to us “From my recent results, the shellfish *Potamo-corbula laevis* ‘pots’ declined a lot this year (2017). I did not find any sampling point with abundant ‘pots’, even the sampling points which are close to the seawall, where in 2015 there was a density of more than 2000 ind./m. The number of ‘pots’ has declined from 2015 and 2016 with 2017 having the lowest numbers in the sample plots over these three years.” This is interesting as the birds that were using the area looked healthy, late in the season AP scores of 4 and 5 being common, as in previous years (see Fig 6). If there is indeed less food available on the Luannan Coast then the AP score data suggests that the lower overall numbers of Red Knots means that they can still acquire enough food to put on sufficient weight to migrate. But as stated before in this report, that while it is well documented that migratory shorebirds can move from one area to another, but it is equally well documented that there is negative survival consequences for birds moving to new sites (Burton *et al.* 2006). During our season’s work we did see individually colour-banded birds on multiple occasions over several days, and indeed over a period of 2 weeks showing some birds were certainly staying in the area and that there wasn’t constant turnover.



Abdominal Profiles

In the absence of body mass data from captured birds, it is possible to score the abdominal profile (AP) of birds in the field from telescope observations (Wiersma & Piersma 1995). We record abdominal profile on all flagged and colour banded birds 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 1-skinny to 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 condition whilst no birds are arriving in very poor condition (AP 1). This likely means that they are staging 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. This northward migration strategy is however one piece of the Red Knot life-cycle question that we are still attempting to answer more fully.

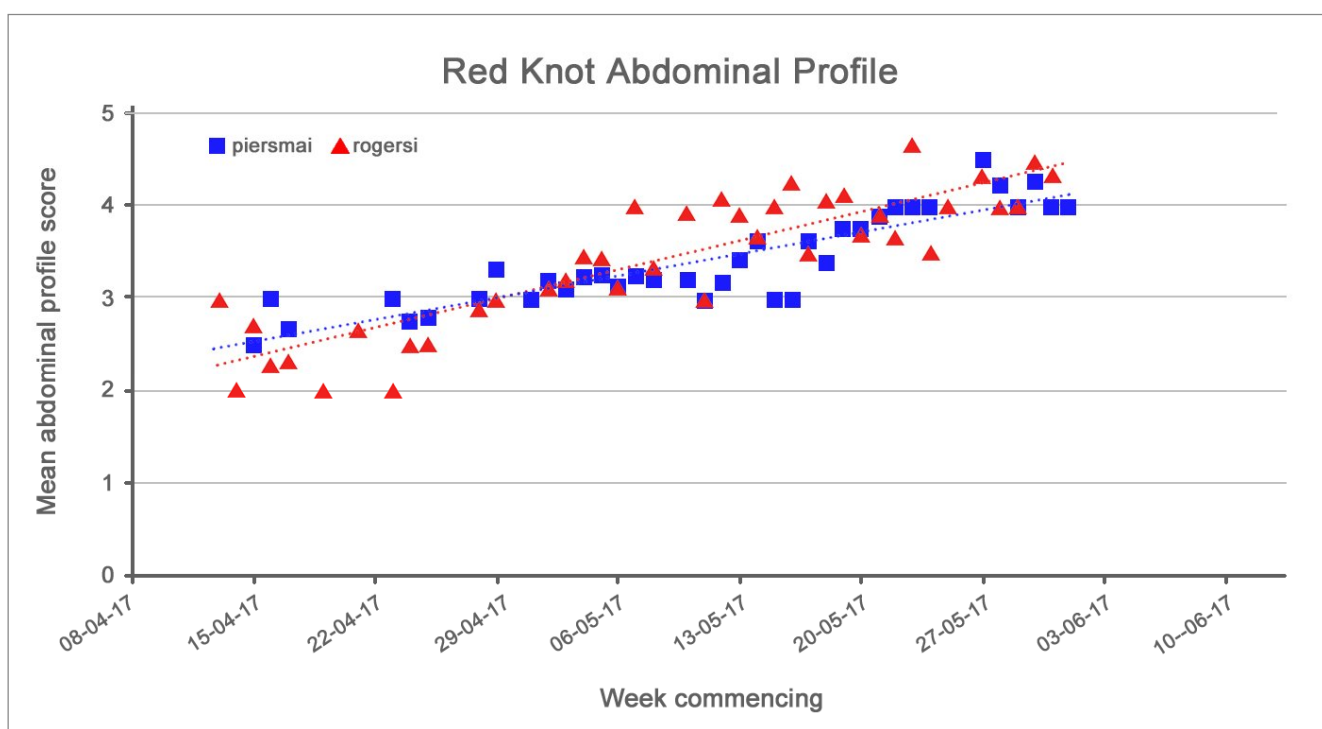


Figure 6. The graph shows the increase in AP, over time, for the two subspecies of Red Knot in 2017 using 614 records. This pattern is very similar to all previous years. Despite the change in arrival times of birds and the lower numbers it seems all the birds that are using the Luannan Coast are able to forage effectively and get enough food to put on the expected weight to fuel them on the next leg of their journey north.

Great Knot *Calidris tenuirostris*

This season our field work recorded a reduced number of Great Knots, 6,000 for the Luannan Coast compared to 2015 (10,270) and 2016 (10,000). Those two years were our highest counts during the eight years of complete survey periods. The 2017 count is more in line with previous counts from 2010 - 2014. This could also explain why the resightings of individually marked Great Knot from the GFN catching in NWA was down from 31 individuals to 22. The Great Knots we saw at their favoured site of Zuidong seemed to be obtaining food, we saw them finding and ingesting suitable sized bivalves and they were gaining weight, as assessed from our abdominal profile records. But it is quite possible that the mudflats there are not able to support the 10,000 individuals of 2015 and 2016 and that those birds have had to move on. GFN have received information from PhD student Hebo Peng of Groningen University about the peak counts at the other main northern Yellow Sea sites that we know about, Yalu Jiang National Nature Reserve (YJNNR) and Gaizhou, near Panjin, Liaoning Province. Numbers have been relatively stable at YJNNR in 2015 – 2017 but much lower at Gaizhou in 2017 than in 2015 and 2016, down some 60%. Food resources are declining at some sites and Great Knots may be ‘roaming’ around the northern Yellow Sea looking for good foraging opportunities. Whether they will find them is unknown. Further analysis of satellite tracked Great Knots and an analysis of the movement of marked birds within the Yellow Sea by GFN's Ying Chi Chan may shed some light on this.



Great Knot colour-marked 5RRYB on Roebuck Bay mudflats, Broome NWA © Nigel Jakkett

Black-tailed Godwit *Limosa limosa*

Black-tailed Godwits use the Luannan coast in internationally significant numbers. On 2 April a minimum 17,100 Black-tailed Godwits were using the Hangu site. This single count is higher than any we have recorded in previous years and represents 10.7% of the current EAAF population estimate. This count was before our arrival at Luannan but these birds were seen by BNU PhD student Zhu Bingrun whom we work closely with. Black-tailed Godwits have always favoured the pond habitat over the coastal mudflats and this was the same at the Hangu site. 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 and the ones they see in NWA. The NWA birds are smaller and have brighter breeding plumage, on average. During field work over ten years at Luannan GFN have never recorded a marked bird from NWA. There are a few records of NWA marked Black-tailed Godwit from further south in China and in South Korea. Also there are now many sightings of NWA-marked Black-tailed Godwits from the west coast of Kamchatka on southward migration (GFN unpublished data). So it is possible there is a new subspecies of Black-tailed Godwit to be described in the EAAF or that the subspecies from Europe have a more easterly distribution than is currently realised. This intrigue has led to Zhu Bingrun focusing on this species in his PhD. He is conducting the field work at the Luannan Coast.



Black-tailed Godwits, the typical large and pale birds that we see on the Luannan Coast and ponds
20 April 2017 © Zhu Bingrun

Sanderling *Calidris alba*

This season during our field work we recorded another big count of Sanderling for the Luannan Coast. The total of 4,000 individuals on 20 April was very similar to the 4,320 of 2016 but it was a whole month earlier. 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 land a kilometre or more from the seawall and spread out over a wide area. Our big counts of Sanderling usually occur when we are ourselves well out on the mudflats, but as our focus is the resighting for colour-marked birds we don't always spend much time well out on the mudflats as that is rarely the best place for resighting work. The latest population estimate for the EAAF is 35,000 (BirdLife Australia 2016). This count from 2017 represents 11.4% of the total flyway population. We didn't get any more counts near 4,000 during the rest of the season. This could be due to the reasons mentioned above or as this count was early in the season it is possible some of these birds were genuinely moving through Luannan en-route to more northerly staging sites.



Sanderling Nanpu Salt Ponds 14 May 2015
© Adrian Boyle

Spoon-billed Sandpiper *Eurynorhynchus pygmaea*

The Spoon-billed Sandpiper is a critically endangered species with vigorous conservation programs under way to try and save this species from extinction. With possibly fewer than 200 pairs left in the wild it was exciting to find a single bird on the Nanpu mud flats on the 27 May and to relocate it the next two days. This is GFN's 5th record over the nine years we have been surveying this site. 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 2001) with a continuing decline in its population. Nordmann's Greenshanks were recorded on twenty one days between 16 April and 14 May 2017. The sightings were of them feeding on the mudflats at Nanpu and roosting in the adjacent ponds. We counted a minimum of 5 on any one day but this is 2 down on 2016 and 4 down on 2015. It is half the number we recorded in 2012 of a minimum of 10. This is an easy species to locate at Luannan and these counts are probably accurate.



Record shot of Nordmann's Greenshank Nanpu Ponds
 April 2014 © Adrian Boyle

Black-faced Spoonbill *Platalea minor*

Black-faced Spoonbill is a rare wading bird endemic to the EAAF and classified as endangered (IUCN 2015). We recorded 1 bird with the big flock of Black-tailed Godwits foraging at the tide edge at Hangu 15 April. This is only our second record since 2010. The first record was a 2nd calendar year bird seen on 19 May 2013.

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 did not record Chinese Egret in 2017 or 2016 despite 4 records in 2015.

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 in the study site. Pied Avocet *Recurvirostra avosetta* is the most common species we record. They 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. Black-winged Stilt *Himantopus himantopus* and Kentish Plover *Charadrius alexandrinus* breed in the same locations as Pied Avocet in good numbers. Common Redshank *Tringa totanus* was recorded again as a breeding species for the third year running with 2 nests with eggs seen. 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*". Another tern species breeding on small islands within the ponds is Gull-billed Tern *Gelochelidon nilotica affinis* they are much less numerous than Common Terns but still probably number up to 100 pairs in the pond complex. Little Terns *Sterna albifrons* breed in small numbers in the same habitat as the Pied Avocet. 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.

This year a PhD student from Beijing Normal University, Wu Fuxing, has commenced studies on the breeding terns using the ponds complex.



Pied Avocet Chick 23 May 2017 © Chris Hassell

White-winged Black Tern *Chlidonais leucopterus*

The White-winged Black tern does not breed at Luannan but does pass through in large numbers. We have never made an accurate count of this species. They are mostly seen flying and are spread out over the majority of the ponds area. Our best estimate was from mid-May 2014 when we estimated some 40,000 to be present. 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. It appeared that in 2015, 2016 and 2017 there were fewer White-winged Black Terns in the study area, but it should be noted that it is impossible to cover all the ponds at any one time. However, as there has been an apparent decline noted for two years in a row it may mean that migrant terns are under similar pressures as migrant shorebirds.



Record shot of White-winged Black Tern
May 2014 © Adrian Boyle

Nature Reserve Status

The data presented here and in previous GFN reports and the growing list of scientific papers from institutions, most notably GFN and BNU, documenting the shorebirds and benthos of the Luannan Coast has now led to a 5 year Memorandum of Understanding being signed between the Paulson Institute, World Wide Fund for Nature (WWF), Hebei Provincial Forestry Department and Hebei Luannan County Government on 15 June 2017 (see appendix 2).

Despite this undoubtedly positive news, the continuing pressures on the inter-tidal area are still current and are detailed elsewhere in this and previous reports. The development of industry and housing areas adjacent to and on reclaimed mudflats and the associated loss of foraging habitat remains the major threat. While the direct reclamation of the intertidal area has slowed since 2012, now huge building

projects are taking place in former pond habitat and areas reclaimed in recent years. A six lane highway is part way along our study site, bridges are in place and a new road through the ponds is under construction. It would only take an upturn in the world, Chinese economy or local economy to see renewed pressure for expansion on the intertidal mudflats in this critically important area. So we fervently hope that some practical action occurs from the signing of the MOU.

To assist in highlighting the importance of the coast, Adrian Riegen from Pukorokoro Miranda Naturalists Trust approached the New Zealand Embassy in Beijing suggesting they arrange a visit to the area. Subsequently, the Embassy approached State Forestry Administration and they agreed to host a visit by New Zealand's Ambassador to China (Mr John McKinnon) and an accompanying entourage of Officials from National, Hebei Provincial and Local Government. We were also privileged to be able to show the site and some Red Knots to the group that included Mr John McKinnon and Mr Chen Fengxue (President of China Wildlife Conservation Association and former Vice Administrator of State Forestry Administration). We thank Mr Chen Kelin (Director, Wetlands International - China) for his assistance supporting the visit.



Theunis Piersma presents one of his books to Mr John McKinnon and Mr Chen Fengxue 5 May 2017 © Adrian Boyle

Human use of the mudflats

The birds share the mudflats and food resources with the human population. The professional shellfishers are able to harvest huge amounts of bivalves *Macra quadrangularis* from the highly productive mudflats that comprise our study site. This method for harvest ranges from searching by hand with small rakes to pumping equipment powered by generators mounted on large floating tyre tubes. The economic benefit to the local communities has been in the region of 10 million RMB per annum (A\$1.7 million) (Yang, pers.comm. 2009) and as the mudflats are gradually destroyed their livelihood is threatened.

The tidal flats are worked for about 6 months each year (Yang *et al* 2016). It is a very profitable industry for the local operators and will be into the future if it is being managed sustainably (this we do not know). The harvest is loaded on to boats that are anchored close to the working parties and brought in to the seawall. Here the shellfish are loaded onto trucks and taken to Beijing and other large cities to be sold in restaurants. Shellfishing is potentially a disturbance issue for the birds. However it seems unlikely that currently it impacts on the populations of birds using Luannan. There is a short time when the tide is close to the seawall and clam fishing is being conducted where birds may be displaced but most of the time on the wide open mudflats it seems birds can still forage in areas without people.



Razor Clam harvester Nanpu left: 22 May 2017 © Bob Loos right: 17 May 2017 © Adrian Boyle

It's amazing just how productive the Luannan mudflats can be for both the local economy and the migrant birds. We hope that the local shellfishers will support efforts for the establishment of a reserve and be consulted during the MOU process, so as to attain a reserve that allows them access, because good healthy shorebird habitat, without industrial complexes built on it, is good for the local economy and shorebirds.

Habitat Threats

This was the fifth year the destruction of the inter-tidal flats themselves had slowed. However, the development adjacent to the mudflats was still in full-swing with a six-lane highway having been completed to and along half of the Zuidong seawall, this can only herald plans for further destruction of the inter-tidal areas to the north west, further into the critically important areas of the Luannan Coast Shorebird Site. Factories and apartment blocks have been and are being built on recently claimed land at Zuidong. This will be a major challenge for the MOU partners.

Enormous areas of inter-tidal mud flats have been converted to industrial land at the Luannan Coast and if the area is to remain an important area for migratory shorebirds the remaining mudflats need to be given high level reserve status. Between 1994 and 2009, approximately 453 km² of sea area in Bohai Bay was lost to development. This included 156 km² of intertidal mudflats being destroyed, a 36% loss of the total area of 428 km² mudflats (Yang *et al.* 2010). This is the last published data from the Luannan Coast, but more shorebird habitat has been lost since that publication and is continuing to be lost. This scenario is playing out all along the Yellow Sea coast of China not just in Bohai Bay. It is a real challenge for Governments and other organisations to find a balance between development and conservation reserves before shorebird populations reach critically low levels from which they will not be able to recover.

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 and 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.

One off massive pollution events like oil spills such as the ConocoPhillips accident of June 2011 are a problem along with chronic pollution issues. The China Marine Environment Monitoring Centre states that “the Bohai Sea is the most polluted sea in the world and absorbs nearly 5.7 billion tonnes of sewage and 2 million tonnes of solid waste each year. 43 of the 52 rivers that flow into it are heavily polluted” (the China Marine Environment Monitoring Centre website). The latest study by the IUCN states that “at least 24 species of shorebirds from the EAAF are heading towards extinction, with many others facing exceptionally rapid losses of 5–9 % per year” (MacKinnon *et al.* 2012).

Another potential threat to the mudflat foraging area is the establishment of areas of Smooth Cordgrass *Spartina alterniflora* on the mudflats at the seawall at Zuidong and Nanpu. The patches are small, but 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. We urge the local Wildlife Authorities to begin to address this problem immediately regardless of the Reserve status of the mudflats. If this *Spartina* is left unchecked it could have serious impacts on shorebird feeding opportunities and also impact the commercially important shellfishing industry and associated employment. It is well documented how *Spartina* can spread to cover huge areas (Zuo *et al.* 2012).



Spartina establishing at the south of Nanpu 2 June 2015 © Adrian Boyle



Spartina increase at the south of Nanpu 4 June 2017 © Adrian Boyle

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 both seem interested in what we do 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 explaining GFN's presence at Luannan 17 May 2017
© Adrian Boyle

Egg-collecting

Every year of our study we have seen egg-collecting. Last year we witnessed it on the most serious scale in our 8 years. This year the 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 in a move organised by Mr Tian Zhiwei and a CCTV News story was produced and shown on television.

Future research

GFN strives to continue to document the fates of four shorebird species at 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.

GFN will continue conservation efforts at Bohai Bay in conjunction with WWF- China, Wetlands International - China and Department of Conservation - New Zealand. Miss Ying-Chi Chan, a PhD student of Theunis Piersma, is currently researching migration of Bar-tailed Godwits, Great Knots and Red Knots along the EAAF, using mark-resighting data presented in this report, and other methods such as satellite telemetry and benthic sampling. He-Bo Peng is in the 2nd year of his PhD at University of Groningen with Theunis Piersma as a 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.



Theunis Piersma scanning a flock of *piersmai* Red Knots
4 May 2017 © Adrian Boyle

There is a proposal for GFN and BNU to collaborate on a satellite tracking study of the population of Black-tailed Godwits that spend the non-breeding season in NWA. This will be a component of Zhu Bingrun's PhD. Dr Tamar Lok is still engaged postdoctoral work on sophisticated demographic analyses on the GFN data. 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.

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 2 has a complete list of all the 225 species of birds seen during the fieldwork period.



Fujian Niltava *Niltava davidi* in the 'Magic Wood'
 23 April 2017 © Adrian Boyle

Acknowledgments

Financial support for this season's work came from the 2014 Spinoza Premium (the Dutch Nobel prize) awarded to Theunis Piersma by the Netherlands Organization for Scientific Research (NWO) and by funding from WWF-Netherlands, Beijing Normal University. .

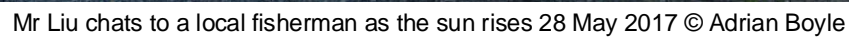
A huge thank you to Zhu Bingrun and Tong Mu for their friendship and constant help during our fieldwork. We thank Mr Lui (senior) and Mr Lui (junior) they are the perfect drivers for the project, constantly thoughtful and helpful. We only speak a tiny bit of each other's language but we genuinely enjoy their company. Thanks to Mr Wong for information on the Hangu site.

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Thank you to all the shorebird enthusiasts throughout the EAAF who send in sightings of marked birds. Thank you to the NWA expedition teams and the Australasian Wader Studies Group. Thank you to the fabulous group of volunteers from the Broome community who assist with the marking of the birds. GFN acknowledges the Yawuru People via the offices of Nyamba Buru Yawuru Limited for permission to catch birds to be marked for this project on the shores of Roebuck Bay, traditional lands of the Yawuru people. GFN acknowledges the Karajarri and Nyangumarta people for permission to catch birds to be marked for this project on the shores of 80 Mile Beach, traditional lands of the Karajarri and Nyangumarta people.

Our major funders over the years have been BirdLife Netherlands (2007-2012) WWF Netherlands (2010-2014, 2016) and Spinoza Premium of Netherlands Organisation for Scientific Research to Theunis Piersma (2014-2016). We also receive financial and much logistical support during field work from Beijing Normal University principally from Professor Zhang Zhengwang, and his PhD students.

More information on the GFN colour-banding project can be found at: www.globalflywaynetwork.com.au/



Collaborative partners

- ❖ Australasian Wader Studies Group (AWSG)
- ❖ Beijing Normal University, China
- ❖ Groningen University, Netherlands
- ❖ Netherlands Institute for Sea Research
- ❖ Broome Bird Observatory
- ❖ Broome Community Volunteers
- ❖ WWF-China
- ❖ WWF-Netherlands

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Appendix 1

Building Nanpu Wetland Nature Reserve for a Healthier Ecosystem

2017-06-15 保尔森基金会

Nanpu Wetland by Jianmin Wang

Today, the Paulson Institute, World Wide Fund for Nature (WWF), Hebei Provincial Forestry Department and Hebei Luannan County Government signed a five-year Memorandum of Understanding (MoU) today for cooperation among the four parties, aiming to protect Nanpu coastal wetland, one of the most important habitats for migratory waterbirds along Bohai Bay in China. The four parties will work closely to conserve and manage the site and establish a provincial nature reserve (PNR) at Nanpu wetland within the next year. According to the MoU, the Paulson Institute and WWF will support the planning and application of the proposed provincial nature reserve; and continue to work with other partners to support follow-up conservation and management, development, and environmental education efforts. The objective is to enhance biodiversity conservation at Nanpu wetland and promote a harmonious relationship between local people and nature.

Located in Luannan County of Hebei Province and north of Bohai Bay, Nanpu wetland consists of natural intertidal mudflats, aquaculture ponds, and salt pans. Its unique geographic location and wetland resources make Nanpu wetland one of the most important stopover sites for migratory water birds along the East Asian-Australasian Flyway (EAAF), serving as a key stopover site for rare and endangered species such as Red Knot, Curlew Sandpiper, Black-tailed Godwit, and Spotted Greenshank. Each year, as many as 350,000 water birds stage and refuel here. Among the water birds at the Nanpu wetland, the population of 22 species exceeds 1 percent of their global population sizes or their population sizes along the EAAF, making it a wetland of international importance according to criteria determined by the Ramsar Convention, an intergovernmental treaty that provides the framework for the conservation of wetlands and their resources.

"Over the past three years, with financial support from the Lao Niu Foundation, the Paulson Institute, the State Forestry Administration of the People's Republic of China and the Chinese Academy of Sciences, among others, have jointly completed the Blueprint of Coastal Wetland Conservation and Management in China (Blueprint project), which has conducted a systematic assessment of the current status and threats of coastal wetlands and their biodiversity in China. As one of the key deliverables, the Blueprint project defined 11 key habitats that are urgently needed to be protected for migratory water birds, including the Luannan Nanpu coastal wetland in Hebei," said Jerry Yu, chief representative of the Paulson Institute Beijing Office.

Overall, coastal wetlands in China are facing great pressure from economic development. Over the past 50 years, China has lost more than 60 percent of its natural coastal wetlands. Although Nanpu wetland is arguably a site that is being kept largely intact in China's Bohai Bay area, it is facing many threats, such as reclamation, over-fishing and invasion of *Spartina alterniflora*, an rapidly spreading grass that kills off ecosystems, just like many other coastal wetlands across the country. This may have a serious negative impact on the survival of many water birds staging and living at the Nanpu wetland, and adversely affect local sustainable socio-economic development. Studies show that there has been a steady decrease in population of some migratory water birds that depend highly on Nanpu wetland for refueling. For instance, over the past decade, the population of Red Knots that overwinter in New Zealand and Australia along the EAAF has been declining at an annual rate of 9 percent. IUCN claims that if no further conservation measures are taken, few Red Knots might remain ten years from now.

At present, governments at various levels in Hebei Province and relevant organizations are working closely to protect Nanpu wetland. At the International Symposium on Coastal Wetland and Waterbird Conservation and Management in the Yellow Sea and Bohai Sea held in Beidaihe in October 2016, the former governor of Hebei Province stated that efforts should be made to enhance protection of key coastal wetland sites in Hebei, including Luannan wetland. The Luannan County government decided to establish a nature reserve at Nanpu wetland and take stricter protection measures. As conservation organizations that have been paying attention to and advocating for the protection of the Nanpu wetland, the Paulson Institute and WWF appreciate this action, and will provide best domestic and international nature reserve construction and management practices in the process of planning, approving, building, and managing Nanpu Wetland Nature Reserve, so as to build, protect and manage it in an effective and efficient manner.

The Paulson Institute would like to thank Heren Charity Foundation for its generous financial support in terms of Luannan wetland protection.



Red Knot roost 22 May 2017 © Chris Hassell

Appendix 2

Bird List

The full list of the 225 species recorded April 13 to June 6 2017

Common Shelduck	Oriental Pratincole	Eurasian Oystercatcher
Ruddy Shelduck	Grey-headed Lapwing	Black-winged Stilt
Bar-headed Goose	Woodcock	Pied Avocet
Mallard	Common Snipe	Pacific Golden Plover
Spot-billed Duck	Ruff	Grey Plover
Northern Shoveler	Black-tailed Godwit	Little Ringed Plover
Northern Pintail	Bar-tailed Godwit	Kentish Plover
Mandarin Duck	Eastern Curlew	Greater Sand-plover
Garganey	Eurasian Curlew	Lesser Sand-plover
Common Teal	Whimbrel	Black-tailed Gull
Falcated Duck	Little Curlew	Mew (Common) Gull
Common Goldeneye	Grey-tailed Tattler	Glaucous Gull
Red-breasted Merganser	Asian Dowitcher	Vega Gull
Eurasian Wryneck	Marsh Sandpiper	Heuglin's Gull
Great-spotted Woodpecker	Common Greenshank	Pallas's Gull
Rufous-bellied Woodpecker	Nordmann's Greenshank	Black-headed Gull
Common Kingfisher	Spotted Redshank	Saunders's Gull
Dollarbird	Common Redshank	Relict Gull
Eurasian Hoopoe	Wood Sandpiper	Common Tern
Common Cuckoo	Green Sandpiper	Little Tern
Indian Cuckoo	Common Sandpiper	Caspian Tern
Common Swift	Terek Sandpiper	Gull-billed Tern
Fork-tailed Swift	Ruddy Turnstone	Whiskered Tern
Short-eared Owl	Great Knot	White-winged Tern
Brown Hawk Owl	Red Knot	Eastern Marsh Harrier
Grey Nightjar	Sanderling	Northern Harrier
Pallas's Sandgrouse	Sharp-tailed Sandpiper	Hen Harrier
Feral Pigeon	Pectoral Sandpiper	Pied Harrier
Oriental Turtle Dove	Broad-billed Sandpiper	Chinese Sparrowhawk
Spotted Dove	Curlew Sandpiper	Japanese Sparrowhawk
Eurasian Collared Dove	Dunlin	Eurasian Sparrowhawk
Japanese Quail	Little Stint	Northern Goshawk
Common Pheasant	Red-necked Stint	Osprey
Moorhen	Spoon-billed Sandpiper	Eastern Buzzard
Common Coot	Temminck's Stint	Grey-faced Buzzard
Watercock	Long-toed Stint	Common Kestrel



Alpine Accentor © Adrian Boyle



Osprey © Adrian Boyle

Amur Falcon	Dusky Thrush	Radde's Warbler
Eurasian Hobby	Chinese Thrush	Eastern Crowned Warbler
Peregrine Falcon	Siberian Thrush	Arctic Warbler
Little Grebe	Red-flanked Blue-tail	Yellow-browed Warbler
Great Crested Grebe	Bluethroat	Pallas's Leaf Warbler
Black-necked Grebe	Siberian Rubythroat	Yellow-streaked Warbler
Slavonian Grebe	Siberian Blue Robin	Bianchi's TYPE Warbler
Great Cormorant	Rufous-tailed Robin	Two-barred Warbler
Oriental Stork	Black Redstart	Pale-legged Leaf Warbler
Great Egret	Daurian Redstart	Reed Parrotbill
Little Egret	Stejneger's Stonechat	Vinous-throated Parrotbill
Cattle Egret	Blue-and-white Flycatcher	Asian Short-toed Lark
Grey Heron	Taiga Flycatcher	Chestnut-flanked White-eye
Purple Heron	Yellow-rumped Flycatcher	Tree Sparrow
Chinese Pond Heron	Chinese Flycatcher	Alpine Accentor
Black-crowned Night Heron	Mugimaki Flycatcher	Eastern Yellow Wagtail
Eurasian Bittern	Asian Brown Flycatcher	Citrine Wagtail
Yellow Bittern	Grey-streaked Flycatcher	Grey Wagtail
Schrenk's Bittern	Dark-sided Flycatcher	White Wagtail
Black Bittern	Fujian Niltava	Forest Wagtail
Eurasian Spoonbill	White-cheeked Starling	Richard's Pipit
Black-faced Spoonbill	Red-billed Starling	Blyth's Pipit
Brown Shrike	Daurian Starling	Olive-backed Pipit
Tiger Shrike	Crested Myna	Pechora Pipit
Black-billed Magpie	Yellow-bellied Tit	Red-throated Pipit
Rook	Chinese Penduline Tit	Buff-bellied Pipit
Carrion Crow	Sand Martin	Chinese Grosbeak
Black-naped Oriole	Barn Swallow	Oriental Greenfinch
Ashy Minivet	Red-rumped Swallow	Brambling
Black Drongo	Light-vented Bulbul	Common Rosefinch
Hair-crested Drongo	Brown-eared Bulbul	Yellow-throated Bunting
Blue Rock Thrush	Zitting Cisticola	Yellow-browed Bunting
White-throated Rock Thrush	Lanceolated Warbler	Black-faced Bunting
White's Thrush	Pallas's Grasshopper Warbler	Chestnut-eared Bunting
Grey-backed Thrush	Siberian Bush Warbler	Tristram's Bunting
Grey-sided Thrush	Oriental Reed Warbler	Little Bunting
Pale Thrush	Thick-billed Warbler	Yellow-breasted Bunting
Eyebrowed Thrush	Black-browed Reed Warbler	Chestnut Bunting
Naumann's Thrush	Dusky Warbler	Pallas's Bunting



Yellow Bittern © Adrian Boyle



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