



RED KNOT NORTHWARD MIGRATION THROUGH BOHAI BAY, CHINA, FIELD TRIP REPORT APRIL - JUNE 2016

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Red Knot feeding on a falling tide Nanpu 13 May 2016. © Adrian Boyle

Contents

2	Contents
3	Summary
5	Introduction
6	The Study Site
7	Fieldwork in 2016 Marking of Shorebirds
11	Indian Banded Shorebirds Shorebird use of the mudflats and resighting coverage
13	Internationally Important Counts
14	Red Knot <i>Calidris canutus</i>
16	Presence of <i>rogersi</i> and <i>piersmai</i> subspecies
18	Abdominal Profiles New Zealand Red Knots
19	Great Knot <i>Calidris tenuirostris</i> Black-tailed Godwit <i>Limosa limosa</i>
20	Sanderling <i>Calidris alba</i>
21	Spoon-billed Sandpiper <i>Eurynorhynchus pygmaea</i> Nordmann's Greenshank <i>Tringa guttifer</i> Chinese Egret <i>Egretta eulophotes</i> Breeding shorebirds and terns
22	Nature Reserve Status
23	Human use of the mudflats
24	Habitat Threats
26	Egg-collecting
27	Media Visit from ABC and BBC
28	Future research Non-shorebird Migration
29	Acknowledgments Collaborative partners
30	References
31	Appendix 1 New Zealand Knots
34	Appendix 2 Bird List



Summary

This year's fieldwork season commenced on 12 April 2016 and finished on 6 June 2016.

The main finding from this year's field work was that 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 (see discussion later).

We recorded 3,554 marked shorebirds from throughout the East Asian-Australasian Flyway (EAAF). 295 were individually recognisable as birds from the Global Flyway Network (GFN) colour-banding project in NWA. This was of course dominated by Red Knot *Calidris canutus* with 261 individuals identified, then Great Knot *Calidris tenuirostris* with 31 and Bar-tailed Godwit *Limosa lapponica* with 3. As in previous years, this reflects the vital importance of the area for Red Knot from NWA. This data from the Luannan Coast has added greatly to the data from NWA resulting in the important paper on declines in summer survival of three populations of migratory shorebirds that GFN published just in advance of this field season (Piersma *et al.* 2016).

The importance of the vast area of commercial ponds adjacent to the inter-tidal area has been well documented from our work in previous years. This year the use of ponds by shorebirds was high during April. They were used less as the Black-tailed Godwit and Marsh Sandpipers migrated north during May. We expected big numbers of Red Knot to use the ponds during mid to late-May, as we have seen in previous years. 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, particularly for the latter two species.

On 17 April a minimum 9,330 Black-tailed Godwits *Limosa limosa* were using the ponds. Black-tailed Godwits favour the pond habitat over the coastal mudflats. This single count represents 5.8% of the current EAAF population estimate, although still below the number recorded on 19 April 2015 (14,040). We recorded our biggest number ever of Sanderling *Calidris alba* 4,321 on 22 May. And the biggest count of Pied Avocet *Recurvirostra avocetta* of 951 on 27 April 2016. This Avocet count almost certainly reflects the increased numbers of student researchers active across the study area. The totals would still be an underestimate of the number of Pied Avocet in the area due to the fact there are still areas of ponds inaccessible to us.

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. 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. All of these figures could be much higher if turnover of migrants was taken into consideration. It appeared that in both 2015 and 2016 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.

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 press*). In the last 4 seasons thirteen 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 8% 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 four years. The building projects that are taking place in former pond habitat and mudflat areas reclaimed in recent years appeared to have also slowed. There were many fewer trucks, cranes, plant machinery and workers in the area. We assume that 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.

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 co-supervision of Professor Theunis Piersma. All work will be in close cooperation with Beijing Normal University and Fudan University.



A Eurasian Curlew feeding on the rich Nanpu mudflats 28 April 2016. © 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 discover in the EAAF. It is represented in this flyway by three subspecies *piersmai*, *rogersi* and *roselaari* (the latter is not part of this study because it only breeds on Wrangel Island and migrates to the Americas). *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 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. The attachment of geolocators to *piersmai* Red Knot in Roebuck Bay, NWA, will hopefully help us unravel this piece of the Red Knot jigsaw. Geocator 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. 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.



Bob Loos on the Nanpu Seawall 10 May 2016. © Jason Loghry

In conjunction with the work by YHY, studies by GFN have continued during the northward migration seasons of 2009 to this year, 2016. 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 seemed of utmost importance to continue the survey work. The research effort in China builds on the research conducted in NWA that from 2007 to 2013 was supported 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 and 2016 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 2016.

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.

The Study Site



Interpreted satellite image of Bohai Bay, China

The centre of the study site is situated at 39° 03' 35"N 118° 12' 33"E. It is near Nanpu Development City, situated on the edge of Bohai Bay, 190 km south east of Beijing, China. Figure 1 shows the four 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, that is 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. 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'.

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://eaflyway.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 Red Knot (4LYLB) at the Nanpu mudflats 11 May 2016. This bird has been seen 34 times at Luannan over four years, 2013 to 2016.
© Adrian Boyle

Fieldwork in 2016

The fieldwork program for 2016 started on 12 April and finished on 6 June, this is fifty six continuous days of field work with two to five observers (usually three) in the field daily. On our first field work day the dominant species were Great Knot with a minimum of 5,000 using the Zuidong and Nanpu mudflats. There were a few hundred Red Knot and Dunlin but the other species present were in low numbers. On 14 April there was an influx of birds. Red Knot with a minimum of 3,010 present and also Grey Plovers with a minimum of 765. Red Knot numbers continued to increase to 4,500 on 18 April, 14,203 on 27 April and a peak of 20,000 on 4 May. This is a very low peak count compared with all other years (see discussion and table later). The April counts were dominated by the *rogersi* subspecies, as we have come to expect from previous observations (see Figure 3). The highest count of Great Knot was an estimate of 10,000 on 19 April.

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 – 2016. 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 - 2016.

	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

Total sightings of all marked birds were down on 2015. This difference is almost entirely down to the decrease in total resightings of colourbanded Red Knots from NWA (from 1,221 to 671).

The tidal regime this season enabled us to do most of our scanning from the seawall on both outgoing and incoming tides. This means we can cover a much greater area of coast and therefore more birds than if we had to walk out on to the mudflats, even though scanning on mudflats can also be productive. If an observer can get close to a big flock of birds in good light and light-wind conditions then they can get good views. However, there are also some negatives to scanning on the mudflats. Birds often feed in shallow water making recording colour-bands on the tarsi difficult. If the birds fly away from the observer to a new feeding patch it can mean a walk of one or two kilometres to get close enough to start scanning birds again and scanning time can be severely reduced. So there is a balancing act to which option is most productive. This season scanning from the wall was the best way to get resightings. However, we did not abandon scanning on the mud completely and late in the season often had one person on the mud and two on the seawall or in the ponds to maximise our coverage.

The roosts in the closest ponds to the Nanpu mudflats were used less this season than in previous years. 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 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. So 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.



Chris scanning from the Nanpu Seawall 10 May 2016. © Jason Loghry

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 the usual excellent haul 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 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 salt 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.



Adrian racing to scan the next flock of Red Knot, Nanpu 12 May 2016. © Jason Loghry

Occasionally we receive sightings of GFN's colourbanded birds in the EAAF that then arrive at the Luannan Coast and are sighted again by us. An example from this season is with Great Knot 3BYRR. This individual was first colourbanded on 29 August 2010 as an 'adult' 3+ (a minimum age of 3 years old). The bird was seen and photographed at Futuan River Mouth, Rizhao, Shandong Province on 5 April 2016 (430km south east of our Luannan Coast study site). We sighted this individual on our first day in the field of this season on 12 April 2016, seven days after the Futuan River sighting. This bird is now a minimum of 8 years old. This is a normal movement for Great Knots migrating from northern Australia. They usually land in southern China making one or two short stops before they head for the most heavily-used northern Yellow Sea sites, Luannan coast, Shuangtaihekou National Nature Reserve (near Panjin and Yingkou) and Yalu Jiang National Nature Reserve (near Dandong).

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.



Great Knot 3BYRR at Futuan River Mouth, Rizhao, Shandong Province on 5 April 2016. Note that on the left leg only the top of the yellow flag is visible. © Zong Feng Li

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	Total 2010-2016	Known Individuals 2016
Bohai Bay, China	122	96	129	125	108	55	162	797	34
Chongming Dongtan National Nature Reserve, China	321	447	565	552	679	510	518	3592	98
Chukotka, Russia	1	32	43	50	62	38	44	270	10
Hong Kong	5	23	19	44	39	20	20	170	8
Chilika Lake, Odisha, India	1	0	0	0	0	4	7	12	3
Point Calimere, Tamil Nadu, India	0	0	0	0	0	0	5	5	3
North Coast, Hokkaido, Japan	1	7	10	5	9	5	8	45	1
North East Coast, Japan	0	0	0	0	0	4	1	5	0
Kyushu, Japan	0	0	0	0	0	0	2	2	0
Java, Indonesia	1	0	0	0	0	0	0	1	0
Kamchatka, Russia	1	3	4	1	0	6	7	22	0
King Island, Tasmania, Australia	3	2	4	0	1	5	2	17	1
New South Wales, Australia	0	2	0	1	0	1	0	4	0
Northern Territory, Australia	3	0	0	1	0	4	57	65	16
North West Australia Colour Bands	317	412	904	613	922	1221	671	5060	295
North West Australia Flags	912	812	1166	1053	1222	1036	964	7165	215
New Zealand North Island	558	748	681	855	734	452	317	4345	29
New Zealand South Island	32	20	21	35	22	17	18	165	7
Olango Island, Central Phillipines	0	0	0	1	1	0	0	2	0
Queensland, Australia	7	7	8	27	12	4	14	79	4
Sakhalin, Russia	0	4	5	48	52	44	43	196	0
Shaungtaihekou National Nature Reserve, Liaoning, China	1	9	0	1	1	7	1	20	0
Singapore	1	0	0	1	1	0	0	3	0
South Australia, Australia	12	35	62	73	54	31	40	307	11
South Korea	0	0	0	0	8	12	5	25	0
Sumatra, Indonesia	12	4	5	8	7	6	2	44	0
South West Western Australia, Australia	6	0	0	1	4	3	0	14	0
Taiwan	4	0	2	3	2	4	1	16	0
Inner Gulf Of Thailand, Thailand	31	18	34	96	153	92	125	549	0
Ko (Island) Libong, South West Coast, Thailand	35	29	36	33	60	56	33	282	0
Victoria, Australia	746	644	798	985	858	507	487	5025	41
Yalu Jiang National Nature Reserve, China	0	0	0	1	3	3	0	7	0
Totals	3133	3354	4496	4613	5014	4147	3554	28311	776
Number of Species	14	14	13	18	17	18	17		

Indian Banded Shorebirds

During our fieldwork in 2010 AB noticed a Curlew Sandpiper with a metal band but no flag. As this is quite unusual in the EAAF, where most marking schemes use flags as well as bands, he took a number of close-up images and from the images we were able to read the band and find out that it was from Chilika Lake, Orissa, India. That site and Point Calimere, Tamil Nadu, India have now started adding flags to their captured shorebirds. This year we have further confirmation that some migratory shorebirds passing through the Luannan Coast spend the non-breeding season outside of the EAAF. We recorded Asian Dowitcher *Limnodromus semipalmatus* B08* on four separate days and also two engraved flagged Curlew Sandpipers. The white/white flag combination shows these birds to be from the Chilika Lake site. We also recorded three different Curlew Sandpipers from the Point Calimere site.



Asian Dowitcher marked B08* from Chilika Lake in India at Nanpu 27 April 2016. © Adrian Boyle
 *Asian Dowitcher B08 was seen at the same site on 29 July 2016 by Beijing-based Ornithologist Terry Townsend.

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 change and affects the suitability of different areas for the birds (particularly Red Knot our focus species and a 'specialised feeder'). We now have four major mudflat sites within the study area and also the salt ponds.

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 vast majority of our fieldwork was conducted in 2016 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. Reasonable levels of fishing activity appear not to concern the birds. 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.

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 we think they 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 2016 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 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. Last year, 2015, that changed very dramatically. There were up to 25,000 Red Knots using Beipu. This season 2016 the use of Beipu was 'average'. We did scan there and at times there were 9,000 Red Knots on the flats. It is possible the numbers may have been lower this season as there was a general decrease in Red Knots at all sites. Scanning effectively is more difficult at Beipu than it is at Nanpu, mainly due to logistics and the shorter time this mudflat 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 them whilst scanning at Nanpu.

It has taken a few years for the Beipu mudflat to be suitable for birds again but the last two seasons shows it can be a favoured feeding site when the Red Knot numbers are at their peak and a large area of mud is required to feed them all adequately so they can fatten up for the flight to their breeding grounds. It would seem mudflat habitat can cope with small amounts of change and rehabilitate itself to a degree. However, it was only due to a dispute between developers that saw the development at Beipu stop. As with all our sites, there is still no protection for this area and each year we visit we are unsure if this habitat will be being developed or in suitable condition for birds to forage at.

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' slightly with a little less thick green algal covering that we saw in 2013, 2014 and 2015 but by late May, this season, the site did have some algae on the mudflats. Because Zuidong mudflats are covered by the tide earlier than the Nanpu mudflats birds from Zuidong would regularly move between these two sites.

The North Beipu site that we worked at quite a lot in 2014 was visited a little less in 2015 and it was the same this year, 2016. We did still scan in the adjacent ponds. But we know from previous years and this year's records that individual birds that we see at North Beipu we also record at Beipu and Nanpu mudflats in the same season. As it is relatively unproductive to scan the ponds at North Beipu they are not a priority. However we do scan those ponds when tides are not suitable to scan the mudflats. However we did search the mudflats and the ponds of North Beipu thoroughly during late May when we were searching for the large numbers of Red Knots that we had expected to arrive, but had not. In general our scans of this area showed it to be used less than in previous years by all species, one obvious reason for this was that many of the pond walls had been recently repaired by plant machinery and they were very steep. Old walls are gently shelving into the water and are more suitable for birds to roost and or forage along. North Beipu also had the most disturbance from fishermen and large amounts of fishing nets were strung out along the mudflats in this survey zone.



Adrian waiting for a flock of Red Knot to settle within scanning distance Nanpu mudflat 4 May 2015. © Bob Loos

Table 3 shows records of individually colour-banded birds from NWA recorded on the Luannan Coast for the years 2010 to 2016. The 295 of this year is 30% lower than the 423 of 2015. This is almost entirely due to the drop in individually recognisable Red Knots, 128 less this season. 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. The fact that the NWA Red Knots did not arrive in their expected numbers is the reason for this drop (see discussion later). The GFN project is getting 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 3. Totals of individually colour-banded birds from the GFN project marked in NWA resighted on the Luannan Coast 2010 to 2016

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

Internationally Important Counts

During the nine years GFN have been visiting the Luannan Coast we have been conducting regular counts. The importance of this site is not in any doubt. Table 4 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. During this 2016 season we recorded our highest count of Sanderling, Spotted Redshank and equal highest count of Great Knot. We also had internationally significant counts of various species during the field work season but none were higher than those shown in Table 4. Note that there have been higher counts of Red Knot, Curlew Sandpiper, Broad-billed

Sandpiper, Grey Plover, Asian Dowitcher, Nordmann's Greenshank and Sharp-tailed Sandpiper in previous seasons but with the renewed EAAF Population Estimates we have only used counts from the last 3 years to more accurately reflect the current situation at the Luannan Coast. Most migratory shorebird populations in the EAAF are declining and it is no surprise that many species have also shown declines in peak numbers on the Luannan Coast.

Table 4. Internationally Important Counts at Luannan Coast 2014 to 2016.

Species	Scientific Name	Date recorded	Number	% of EAAF Population present	EAAF Population from BirdLife Australia (in press)
Pied Avocet	<i>Recurvirostra avosetta</i>	27-04-2016	951	1.0	10,000*
Grey Plover	<i>Pluvialis squatarola</i>	19-04-2015	2,867	3.6	80,000
Asian Dowitcher	<i>Limnodromus semipalmatus</i>	14-05-2014	515	3.7	14,000
Black-tailed Godwit	<i>Limosa limosa</i>	19-04-2015	14,040	8.8	160,000
Eurasian Curlew	<i>Numenius arquata</i>	19-04-2015	1,686	1.7	100,000*
Spotted Redshank	<i>Tringa erythropus</i>	15-05-2016	592	2.6	25,000*
Marsh Sandpiper	<i>Tringa stagnatilis</i>	27-04-2016	8,785	6.8	130,000
Nordmann's Greenshank	<i>Tringa nebularia</i>	16-05-2016	7	1.4	400-600*
Great Knot	<i>Calidris tenuirostris</i>	04-05-2015	10,270	2.4	425,000
Red Knot	<i>Calidris canutus</i>	04-05-2015	29,965	27.2	110,000
Sanderling	<i>Calidris alba</i>	29-05-2016	4,321	12.3	35,000
Red-necked Stint	<i>Calidris ruficollis</i>	08-05-2016	4,747	1.0	475,000
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	04-05-2014	4,000	4.7	85,000
Curlew Sandpiper	<i>Calidris feruginea</i>	04-05-2014	24,500	27.2	90,000
Spoon-billed Sandpiper	<i>Eurynorhynchus pygmeus</i>	25-05-2016	1	0.3	140-480*
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	27-05-2015	2,460	8.2	30,000
White-winged Black Tern	<i>Chlidonias leucopterus</i>	May 2014	40000e	up to 40	100,000-1,000,000*

* Wetlands International (2016). "Waterbird Population Estimates 5". Nordmann's Greenshank is an underestimate. 946 individuals were seen in one survey in October 2015 at Tiaozini, Rudong, China. (Conservation Leadership Programme, unpublished).

Red Knot *Calidris canutus*

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

The most noticeable aspect of our whole field season at Luannan Coast 2016 was that many of the *piersmai* Red Knots from NWA did not arrive. 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. This 'understanding' makes us believe we did not miss the Red Knots within our study area. This can be backed up by counts (see Table 5), percentage *rogersi* V *piersmai* scans (see Table 6) and resighting totals (see Table 7) to confirm that this was the case in 2016. The brief tables below show the overall drop in total numbers between 2015 and 2016, the drop in colourband resights (despite equal marking effort in NWA over the past few years) and the unusual proportions of the two subspecies late in May. We use the numbers in late May as this is when the usual peak numbers of *piersmai* are present.

Table 5. Comparing count data from late May/early June 2015 and 2016

Counts	29/05/2015	29/05/2016	5/6/2015	5/6/2016
Red Knot	19000	5480	6230	1910

Table 6. Comparing subspecies scan data from late May/early June 2015 and 2016

rogersi V piersmai %	17-26/05/2015	17-26/05/2016	27/05 - 05/06/2015	27/05 - 05/06/2016
Red Knot	19/81	34/66	19/81	47/53

Table 7. Number of Broome colour bands compared from late May/early June 2015 and 2016

CB recorded	17-26/05/2015	17-26/05/2016	27/05 - 05/06/2015	27/05 - 05/06/2016
Red Knot	468	160	256	102

The biggest single count of Red Knot this year was an estimate of 20,000 on 4 May 2016. On the same date in 2015 we counted 30,746, the biggest count of last season. This represents a 35% drop in the biggest single count but the drop in late May when the sub-species composition is dominated by *piersmai* was 70%. We always make a concerted effort to locate Red Knots during our field work as they are our main study species. With the 'lack' of them this year we tried even harder to find them. This included repeated searches of their regularly used sites and also visiting areas on the boundary of our usual study area, to ensure we did not miss them and we are very confident that we did not do so.

The obvious question we are asking ourselves about the NWA birds is; where were they? Below we speculate about this.

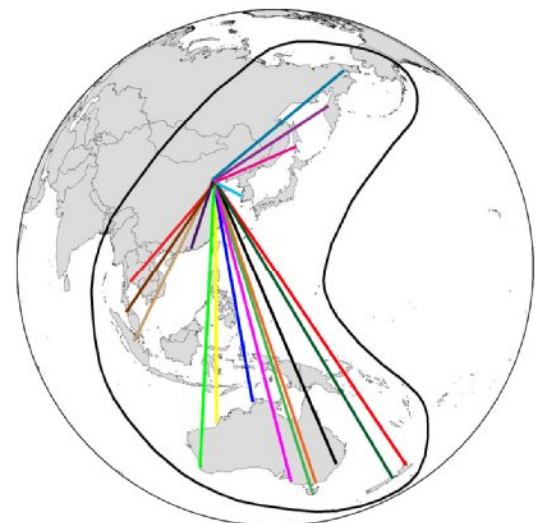
Red Knots, like most coastal specialist species in the EAAF are undergoing decreases in populations and survival (Piersma *et al.* 2016, Studds *et al.* 2016) but it is unlikely that such a collapse would happen in one hit. The declines are generally steady year on year (Clemens *et al.* 2016).

Did some of the birds arrive and then move on as there was not enough food? We don't think this is the case, we would have noticed the increase and decrease in Red Knot numbers as we conducted our field work and drove to and from the coast. The birds that were using the area looked healthy, late in the season AP scores of 4 and 5 were common, as in previous years (see Fig 4). Also we saw individually colourbanded birds on multiple occasions over days and indeed up to 2 weeks showing some birds were certainly foraging effectively.

Disturbance of Red Knot flocks is not the reason for the low numbers. There is the same amount of shellfishing activity as last year and less people and general activity than in years prior to 2015. Bird of prey occurrence was very similar to previous years.

The birds were not still in NWA, the July population census there did not record unusual numbers and resighting work in early April recorded the 'usual' numbers of Red Knot. It seems that, for reasons as yet unknown, the *piersmai* Red Knot stopped short of the Luannan Coast unless they found another suitable foraging area. This is not typical behaviour of migratory shorebirds, they tend to return to the same sites year after year if they are still available, as the Luannan Coast is. The next non-breeding season counts in NWA, our field work in spring 2017 and possibly the retrieval of geolocators will shed more light on this.

During this northward migration season there were many other shorebird researchers at important staging areas throughout the EAAF and to our knowledge none of these researchers recorded any Red Knot flocks that were larger than previous years.

**Figure 2.** Between 2009 and 2016 we have recorded Red Knot from 17 different banding locations throughout the EAAF. The map above is a representation of some of these sites.



Sitting left to right, Chris Hassell, Kerry Hadley, Adrian Boyle and Jason Loghry and Mr Lui (standing) on the Nanpu Sewall 25 May 2016. © Bob Loos

Presence of *rogersi* and *piersmai* subspecies

Red Knot were assigned to the *rogersi* or *piersmai* sub-species on the basis of plumage characteristics in 221 separate scans during our study season. The results show that the *rogersi* birds arrive earlier than *piersmai* birds and leave for the breeding grounds earlier despite the anomaly in the 2016 data. 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. This is particularly noticeable when the two subspecies are side by side as is usually the case in our study site. The 221 scans were random assessments of the proportions of the two subspecies of Red Knots and conducted regularly throughout the study period totalling 38,364 individuals. This number is similar to 2014 (39,864) and 2015 (39,925).

The *rogersi* birds, predominately from SE Australia and New Zealand, arrived first and left for their eastern Siberian breeding grounds earlier than the *piersmai* birds, predominately from NW Australia, which breed in more northerly latitudes on the New Siberian Islands. This is consistent with the patterns observed in previous seasons (figure 3). This year's data though was effected by the *piersmai* Red Knot not arriving on the Luannan Coast in the expected numbers. The proportion of *piersmai* in the last period of the migration season is actually lower than that of *rogersi* and lower than in any previous year. This indicated the absence of an influx of *piersmai* during late May.

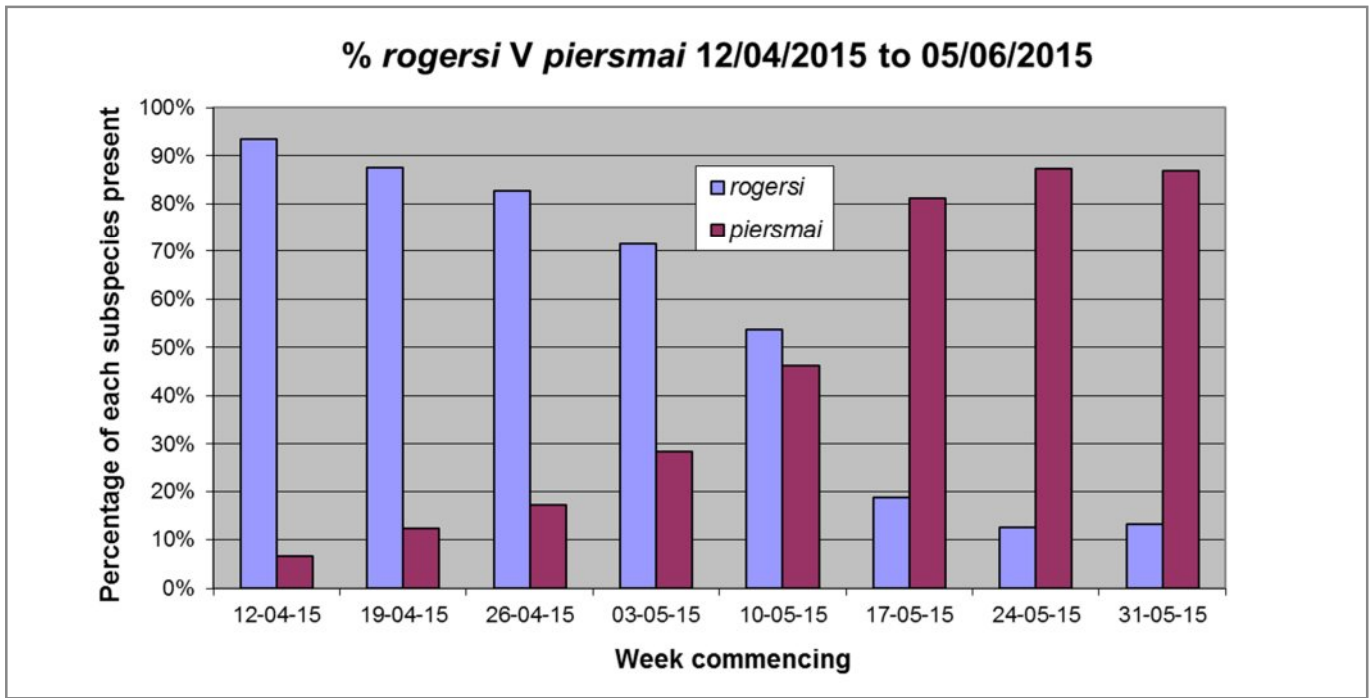
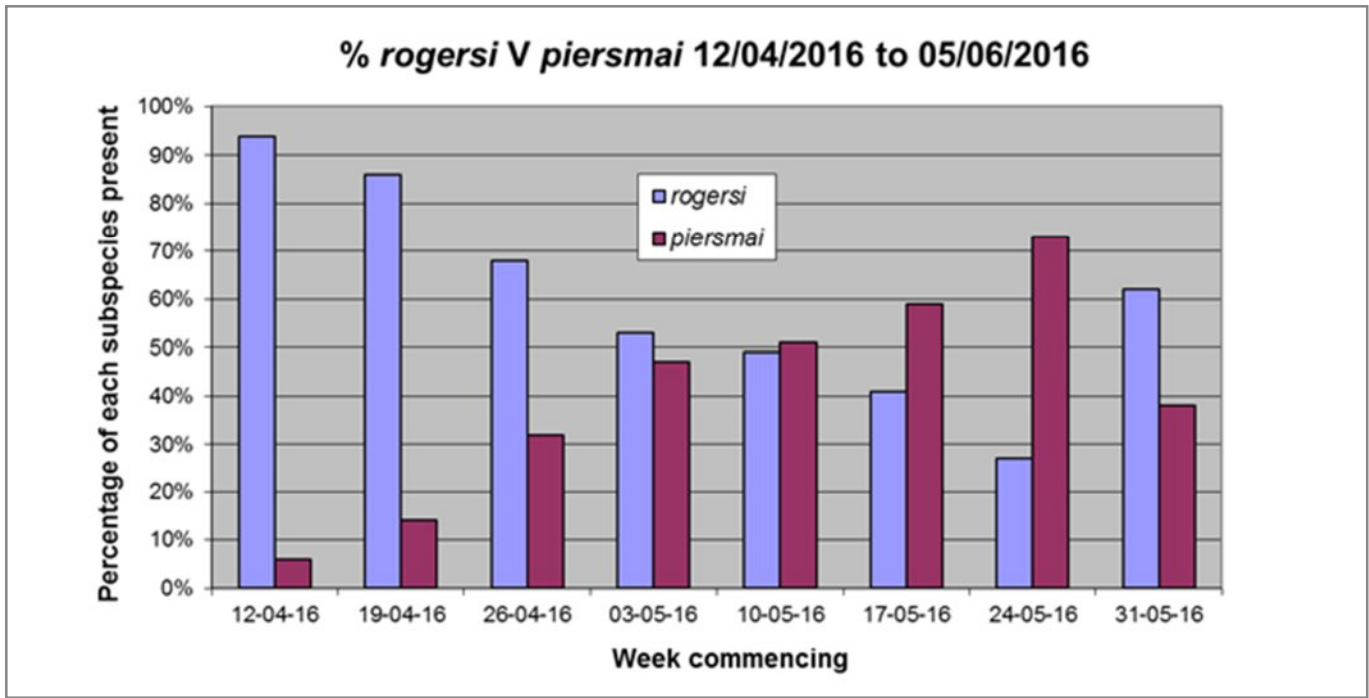


Figure 3. These 2 graphs show the difference in the proportions of *rogersi* and *piersmai* Red Knots over time and the difference between the end of the season reflecting the small numbers of *piersmai* Red Knots that had arrived at the site.



A 'typical' *piersmai* AP 4 (left) and *rogersi* AP 3 (right) © Adrian Boyle

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 (see images above). 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.

It would seem that both subspecies and most individuals are arriving at our Luannan Coast study site in good condition whilst almost no birds are arriving in very poor condition (AP 1). This might mean that they are staging between their Australian and New Zealand non-breeding sites and the Luannan Coast. We do know that some birds stop in Hong Kong and southern China from resighting records. This is however one piece of the Red Knot migration question that we are still attempting to answer with various methods; GFN and the Australian Wader Studies Group (AWSG) currently have geolocators deployed with the hope that we will recover some of these birds in future capture events to try and gain further insight into the migration strategy of Red Knot from NWA.

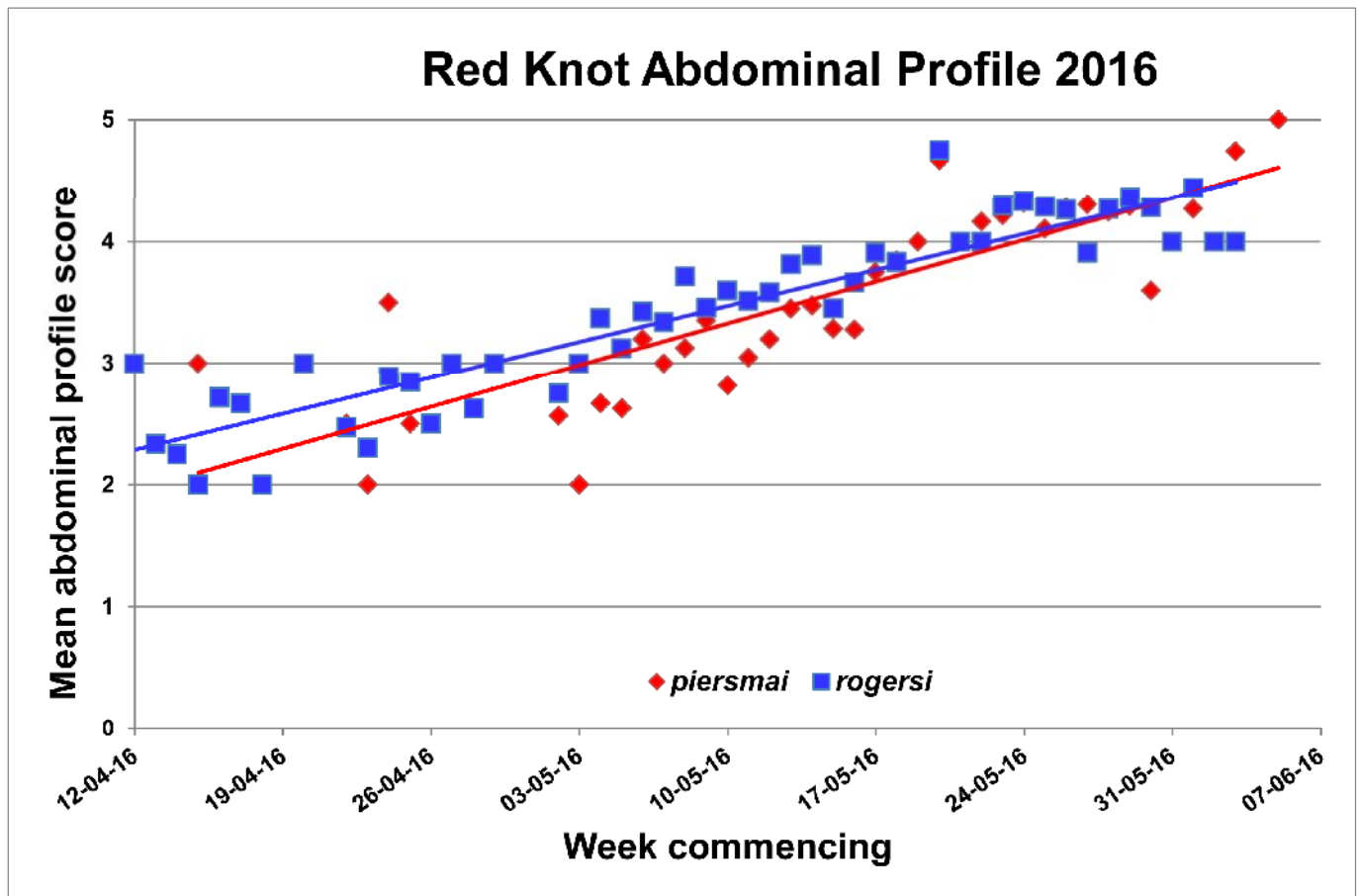


Figure 4. The graph shows the increase in AP, over time, for the two subspecies of Red Knot in 2016 using 1,201 records. This pattern is very similar to previous years. This is what we expected despite the non-arrival of *piersmai* Red Knots. The birds utilising the Luannan Coast were able to find adequate food to put on fat stores for the next leg of their migration.

New Zealand Red Knots

During our work at the Luannan Shorebird Site we record large numbers of individually marked Red Knots from New Zealand. Presented in Appendix 1 is a report from Adrian Riegen of the New Zealand Wader Studies Group, summarising our sightings over the years.

Great Knot *Calidris tenuirostris*

This season our field work recorded an almost identical number of Great Knots, 10,000, for the Luannan Coast as in 2015 (10,270), which was our highest count during the nine years of study. These counts are 47% higher than the count of 7,000 from 14/04/2010. Also the sightings of 31 colour-banded birds from this 2016 (30 in 2015) season is 50% higher than the 20 individuals from 2011. There is clearly an increased number of Great Knots using the Luannan Coast these last two seasons.

It is possible that these birds have 'prior knowledge' of the Luannan Coast having relocated from Yalu Jiang National Nature Reserve during the northward migration season of 2015. Studies being conducted at Yalu Jiang NNR by Fudan University showed that the bivalves favoured by Great Knots had dramatically decreased from the mudflats and this might have led to Great Knots moving away from that site and seeking alternative feeding areas. Also much bigger than usual aggregations of Great Knots have been recorded at Gaizhou, near Panjin, Liaoning Province in the last three years. Yalu Jiang NNR is 180 km from the Gaizhou mudflats and 520 km from the Luannan Coast. These distances are easily covered by a Great Knot, when fit and healthy. But to remain fit they need large areas of mudflat with suitable food and such areas are becoming very scarce in the Yellow Sea region due to industrialisation.

Migratory shorebirds can move from one area to another but this is of course non-sustainable if the current rate of habitat destruction continues. There may be 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.



Great Knot on Roebuck Bay mudflats, Broome NWA 5 March 2016. © Nigel Jackett

Black-tailed Godwit *Limosa limosa*

Black-tailed Godwits use the Luannan coast in internationally significant numbers. On 17 April a minimum 9,330 Black-tailed Godwits *Limosa limosa* were using the ponds. This single count represents 5.8% of the current EAAF population estimate, although still below the number recorded on 19 April 2015 (14,040, 8.8%). Black-tailed Godwits favour the pond habitat over the coastal mudflats. 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 nine years at Luannan GFN have never recorded a marked bird from NWA. There are records 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 (GFN unpublished data). So it is possible there is a new subspecies of Black-tailed Godwit 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 including this species in his PhD that he is undertaking at Luannan.



Black-tailed Godwit flock over the ponds 17 April 2016. © Zhu Bingrun

Sanderling *Calidris alba*

This season during our field work we recorded the biggest ever count of Sanderling that GFN have had for the Luannan Coast. The total of 4,320 individuals on 21 May 2016 is a huge 78% higher than the count of 2,430 from 29 May 2013. The latest population estimate for the EAAF is 35,000 (BirdLife Australia *in press*). This count represents 12% of the total flyway population. Sanderling are not a species that GFN particularly focus on and it is difficult to assess numbers as they come to the mudflats late from the roosts and spread over a wide area. This year AB was far out on the Nanpu mudflats and there were many Sanderlings present but they were spread out over a large area that wasn't suitable for counting. Later, when an Amur Falcon (*Falco amurensis*) frightened the birds, they formed two large flocks of nearly pure Sanderlings, very close to him where they were now easily counted. As we have often said if we see an opportunity to count a species we do so, we don't just do counts on specified days. This was a case of where that mindset came in to its own. We are unsure if this is a genuine increase in Sanderlings on the Luannan Coast or was a result of AB being far out on the mudflats and the falcon disturbance provided an opportunity to get a count. Counts in future years should help clarify the picture. It is of course possible these birds have moved from another site away from the Luannan Coast that has a diminished food source or has been lost entirely to development.



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 25 May. This is GFN's 4th 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.



Record' shot of the Spoon-billed Sandpiper
25 May 2016. © Adrian Boyle

Nordmann's Greenshank *Tringa guttifer*

Nordmann's Greenshank is an endangered shorebird (IUCN 2001) with a continuing decline in its population. During our fieldwork we saw up to at least 7 on any one day. Nordmann's Greenshanks were recorded on twenty seven days between 15 April and 24 May. The sightings, were of them feeding on the mudflats at Nanpu and roosting in the adjacent ponds.

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 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 confirmed as a breeding species for the first time in our study area last year and was recorded again this year with the sighting of 2 chicks. Little Ringed Plover *Charadrius dubius*, also breed. We have witnessed territorial behaviour in previous years and assumed this species was breeding. It was confirmed this year with some of the eggs confiscated from egg-collectors from this species. Egg collecting for food by people and destruction of nests by stray dogs appears to be the main threats to breeding success of all species (see Egg-collecting). 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. A PhD student from Beijing Normal University, Leiming, has the Pied Avocet as one of his main study species including breeding studies.

Whiskered Terns *Chlidonias hybridus* breed in reed beds inland from the ponds, but are included here as they forage over the salt ponds and inter-tidal mudflats.



Common and Gull-billed Terns nesting in the Ponds 2 June 2016. © Adrian Boyle

Nature Reserve Status

The data presented here and in previous surveys on the Luannan Coast show that this part of the Yellow Sea supports internationally significant numbers of 16 populations (1% Ramsar criteria) of migratory shorebirds and one migratory tern on northward migration. Five species have an absolute minimum of 8% of their entire EAAF population passing through the Luannan Coast site during northward migration (see Table 4).

The continuing pressures on the inter-tidal area are detailed elsewhere in this and previous reports with the development of industry and housing areas adjacent to and on reclaimed mudflats and the associated loss of foraging habitat the major factor. 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 expansion and loss of mudflats in this critically important area.

“In June 2015 the Committee of the People’s Government of Hebei Province published a list of the 12 most important wetlands in Hebei province. The Luannan Coast (Caofeidian south Wetland) is one of these 12 sites.

The basis on which the wetland were included in the list are:

- ❖ Representativeness and uniqueness
- ❖ Wildlife offspring areas, winter hiding or migration staying over habitats
- ❖ Ecological, hydrological importance for scientific research
- ❖ Ecological function importance or historical culture significance.

The ongoing development work noted above is a direct threat to these values and to the stated objective of the Peoples Government of Hebei Province to protect key important wetlands of Hebei."

The data presented in this report further supports the establishment of a Nature Reserve along the Luannan Coast.

The migratory birds that were the subject of this report are covered by the bilateral migratory bird agreement between China and Australia. The data reported here reaffirms the international importance of the Luannan Coast site and the priority for both Australia and China to advance actions to protect these shared migratory birds. The securing of this area would make a substantial contribution to the undertakings of the bilateral agreement that China has with other flyway countries and the objectives of East Asian-Australasian Flyway Partnership.



A Tourist Development is being built on the edge of the seawall at Beipu. The raw sewage will run on to the mudflats and the houses already look like they are falling in to the sea even though the 'resort' is not finished. 23 April 2016. © Chris Hassell

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 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 is 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 unloaded onto a large truck and taken to Beijing and other large cities to be sold in restaurants. It's amazing just how productive the mudflat can be for both the local economy and the migrant birds. We hope that the local shellfishers will want to see 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.



Artemia harvest 3 June 2016. © Chris Hassell

Habitat Threats

This was the third 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.

The race to conserve the area is still on. 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.

One off massive pollution events like oil spills (e.g. ConocoPhillips 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).



Tian Jin Power Station from the Nanpu Seawall 7 May 2016. © Bob Loos

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 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.

Spartina increasing at the south of Nanpu 3 June 2016.

© Adrian Boyle



Google Earth image showing main concentrations of *Spartina* within our study site (yellow pins).

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 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. 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.

Egg-collecting

Every year of our study we have seen egg-collecting. This has usually been on a small scale by people working in the ponds taking a few eggs from easily accessible nests. This year was different, in addition to the small scale collecting one woman was seen with a large sack containing two hundred eggs. The woman said the eggs were for her own use but that seems highly unlikely with that number of eggs and they probably would have been sold. The eggs were mostly from the nests of Pied Avocet, Black-winged Stilt with smaller numbers of Kentish and Little-ringed Plover. PhD student Leiming was able to retrieve the eggs and talk to the woman involved about the effects of egg-collecting. The eggs were taken to a Laoting Rescue Centre. Nearly eighty eggs hatched successfully, others failed because they were damaged during transportation (twenty) or did not hatch out (one hundred). Unfortunately in the first group of chicks to hatch forty were killed by a rat, or rats in the Rescue Centre. After the re-cementing of the floor the second batch of chicks were growing well, and they will be returned to the wild soon.

In the most serious case we witnessed two men waded out to islands in one of the biggest ponds and proceed to collect all the eggs from two tern colonies (Common and Gull-billed) this would have amounted to many hundreds of eggs. In this instance the Police were called and Leiming filmed the egg-collectors and tried to talk to the men but they were aggressive and uncooperative and had left the site before the police arrived. But the policeman who attended the scene said the area was not their responsibility.

Leiming made more than twenty calls to various agencies, the Police, Forest Administration from the local Salt Production Officials and both Caofeidian and Tangshan Government but no one would take responsibility for the matter. Egg-collecting is illegal in China but application of the law is lax and the punishments not clearly stated in any legislation. This is a threat to the migrant, breeding shorebirds and terns that we had not seen to such an extent before. And undoubtedly we only see 'the tip of the iceberg'.

After these episodes the local conservation group Tangshan Wildlife Protection Society, Caofeidian Youth Volunteer Organization came to the 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.

For Chinese speakers the link is below;

<http://m.news.cctv.com/2016/06/18/ARTIEAWDOjpRxUIYrba1R3gM160618.shtml>



Eggs being transported to the incubators. © Leiming. Pied Avocet Chicks in Laoting Rescue Centre. © Tian Zhiwei

Media Visit from ABC and BBC

During this northward migration season the Australian and British Broadcasting Corporations (ABC and BBC) produced a four-part series on shorebird migration in the EAAF. The ABC's Anne Jones from the show 'Off Track' interviewed Chris Hassell and Adrian Boyle on the shores of Roebuck Bay in early April and on the Nanpu Seawall in late May. On the Nanpu seawall interviews were also conducted with Professors Zhang Zhengwang and Theunis Piersma. The show also visited many other areas of the EAAF and interviewed many and varied shorebird volunteers and professionals. This excellent series can be found at the link below in audio and with a written account of Anne's and Andrew Luck-Bakers making of the story.



Professor Zhang Zhengwang being interviewed by Anne Jones of ABC radio
7 May 2016. © Theunis Piersma

<http://www.abc.net.au/radionational/programs/offtrack/features/flying-for-your-life/>

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. Dr Tamar Lok has started postdoctoral work on sophisticated demographic analyses on the GFN data. All this work is made possible under the Chair in Global Flyway at the University of Groningen, with support from WWF-Netherlands, WWF-China and BirdLife-Netherlands, with in-kind support of the NIOZ Royal Netherlands Institute for Sea Research and in close cooperation with Beijing Normal University.

Theunis Piersma contemplating the future of the Luannan Coast.
 © Ann Jones

Non-shorebird Migration



Amur Falcon *Falco amurensis* resting during some rain near the Nanpu sea wall 15 May 2016. © Adrian Boyle

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 birds seen during the fieldwork period.

Acknowledgments

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

Contact Chris on turnstone@wn.com.au

Collaborative partners

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

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Appendix 1

NZ knots

New Zealand Red Knot in Bohai Bay, China

A brief review to the 2016 sightings

The New Zealand Wader Study Group (NZWSG) started banding Red Knot in the mid 1980's in an effort to understand among other things, the Red Knot's migration routes. Up to 1991 only a metal band was used to mark birds, which relied on someone finding the bird and returning the band, to learn anything of its movements. In the first few years about one overseas recovery for every 350 birds banded was received. There were few birdwatchers in Asia in the 1980's and even fewer looking for marked waders. Staging sites in China were generally out of bounds to foreigners and to a greater extent not even known.

In the early 1990's Mark Barter started searching the Chinese coast for wader staging sites, and in 2000 with Yang Hongyan, who was studying Red Knot in Bohai Bay, found some 25,000 along the northern shores of Bohai Bay (the Luannan Coast). At the time the estimated Red Knot population was at least 220,000, so this find amounted to around 10% of the population. Where were the rest? In 2005 the NZWSG started using white flags engraved with three black letters. It was hoped that with more birdwatchers in Asia and foreign wader people visiting East Asia, these flagged birds would be seen and thus help identify more staging sites.

Counts of Red Knot and sightings of New Zealand engraved flags show that few sites outside Bohai Bay appear to hold significant numbers of Red Knot, (see table 1). More effort does go into looking for flags in Bohai Bay than any other part of the flyway but nevertheless some other sites are covered quite well. Yalu Jiang in particular is well surveyed but has very few Red Knots.

In 2009 the Global Flyway Network (GFN) team, led by Chris Hassell started fieldwork that focused on the northwest Bohai Bay region primarily, looking for Red Knot during northward migration that they had colourbanded in NW Australia. The spin off was that they not only found many of their birds but an ever increasing number of New Zealand colour-banded and engraved flagged Red Knot as well.

The GFN team's impressive efforts over the past eight years have generated a huge amount of data and have clearly shown that the small area of the northwest Bohai Bay is by far the most significant staging site for Red Knot so far known on the East Asian-Australasian Flyway during northward migration. With most of the Yellow Sea coast of China and South Korea now surveyed, and several sections of the North Korea coast, it seems unlikely there is another major staging site. The flyway population of Red Knot was revised down in 2010 to around 110,000, (Rogers *et al*, 2010), and it now appears that the majority of the flyway's Red Knots stage in Bohai Bay during northward migration.

The volume of data generated from the GFN fieldwork is impressive and the GFN Bohai Teams put a huge effort into identifying the marked birds from all over the flyway. The following data summarises engraved flag sightings of New Zealand Red Knot along with Red Knot flagged in Victoria, Northwest Australia, which have been seen at least once in New Zealand.

The numbers

1,001 Red Knot have been fitted with engraved flags in New Zealand and of those 921 have been resighted in New Zealand or overseas (91.5%). A total of 6,622 sightings have been recorded with 1,481 of those being from overseas (22.3%). 527 individuals have been seen overseas, 58% of the total seen. Of the 527 individuals seen overseas 445 have been recorded in the Bohai, all but one of them on the Luannan coast. This represents 83% of all overseas sighting.

Table 1. All overseas sightings of individually identifiable, total numbers of engraved flags and plain or unread engraved flags of New Zealand Red Knot on northward and southward migration to June 2016.

Loaction	Individuals	Total sightings of engraved flags	Plain flag and unread engraved flags sightings
Bohai Bay, China	445	1279	1734
Newcastle, New South Wales, Australia	37	128	55
South East Queensland, Australia	18	26	61
Gulf of Carpentaria, Australia	5	6	20
Chongming Dongtang National Nature Reserve, China	4	5	1
New South Wales (other than Newcastle), Australia	3	7	16
Japan	3	7	5
Yalu Jiang National Nature Reserve, China	2	2	1
Taiwan	4	5	13
North West Australia	2	2	6
Chukotka, Russia	1	1	4
South Korea	1	1	10
Rest of China	0	0	1
Norfolk Island, Australia	0	0	1
Northern Territory, Australia	0	0	2
Victoria, Australia	2	2	2

Putting the Bohai sightings into context

The number of individual engraved flags seen on the Luannan coast in 2016 is the lowest since 2010, which is of concern, but could be partly due to the fact that since January 2010 only 145 new engraved flags have been deployed and only 27 since January 2013. The reduced number of Red Knot in New Zealand and their habit of regularly moving between roosting sites has made catching them much more difficult.

Victoria

31 Orange engraved flagged Red Knot have been seen in New Zealand and Bohai. It is likely that most of these orange flagged birds are now regulars in New Zealand during the non-breeding season. Two of these were seen at Farewell Spit in the South Island and the rest were seen in the Auckland area.

Table 2. Number of engraved flagged New Zealand Red Knot seen in Bohai Bay

Year	Sightings	Number of individual Birds
2007	1	1
2008	5	5
2009	21	21
2010	90	79
2011	190	136
2012	154	117
2013	344	184
2014	249	115
2015	100	84
2016	115	71



A Red Knot CEE in North Island, New Zealand 23 March 2016. © Phil Battley

Northwest Australia

Eight yellow engraved flags have been seen in New Zealand prior to sighting in Bohai Bay. Of particular interest was ZPW, seen in New Zealand from December 2011 to 10 March 2013. 19 days later on 30 March 2013 it was seen in Bohai Bay. During southward migration the same year it was seen at Newcastle, New South Wales, Australia between 24 October and 06 November 2013. It was not seen that summer in New Zealand but was probably there, before heading north to be seen at Bohai Bay again on 16 May 2014. It was last seen in New Zealand on 12 December 2015.

These sightings show that Bohai Bay and particularly the Luannan Coast are vitally important staging sites for birds from a variety of original sites outside New Zealand as well as birds banded in New Zealand.

No other site in East Asia comes remotely close to being as important a staging site for Red Knot from New Zealand than the Luannan coast, as can be clearly seen in Table 1. The continued efforts of the GFN Bohai Team is an impressive contribution to the knowledge of New Zealand Red Knots during northward migration, and the NZWSG is extremely grateful to all those involved with the GFN project and their principal funders. We hope they are able to continue this work and that the focus they have put on the area will help to save it from complete destruction. Already 50% of the Red Knot population in New Zealand has been lost over the past 15 or so years. It will be a tragedy if this trend continues. The importance of Bohai Bay and the Luannan Coast in particular for Red Knot cannot be overstated and without these feeding and staging grounds the outlook for their future is very bleak.

There are encouraging signs that the Luannan coast may be spared from further development. Chinese authorities and international agencies are now very well aware of the importance of this small fragment, (one fifth of one percent) of the Chinese coast.

Adrian Riegen
Convener, NZWSG
July 2016

Appendix 2

Bird List

The full list of the 225 species recorded April 12 to June 5 2016

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



Golden-spectacled 'Type' Warbler, Greater Flamingo. April 2016. © Adrian Boyle

Grey faced Buzzard	Bluethroat	Claudia's Leaf warbler
Common Kestrel	Siberian Rubythroat	Yellow-browed Warbler
Amur Falcon	Siberian Blue Robin	Pallas's Leaf Warbler
Eurasian Hobby	Rufous-tailed Robin	Sulphur breasted Warbler
Peregrine Falcon	Black Redstart	Rufous-crowned Warbler
Little Grebe	Daurian Redstart	Golden-spectacled 'Type' Warbler
Great-crested Grebe	Stejneger's Stonechat	Two-barred Warbler
Great Cormorant	Isabelline Wheatear	Pale-legged Leaf Warbler
Oriental Stork	Blue-and-white Flycatcher	Reed Parrotbill
Great Egret	Taiga Flycatcher	Vinous-throated Parrotbill
Little Egret	Yellow-rumped Flycatcher	Asian Short-toed Lark
Cattle Egret	Mugimaki Flycatcher	Greater short toed Lark
Grey Heron	Asian Brown Flycatcher	Mongolian Lark
Purple Heron	Grey-streaked Flycatcher	Chestnut-flanked White-eye
Chinese Pond Heron	Dark-sided Flycatcher	Russet Sparrow
Striated Heron	White-cheeked Starling	Tree Sparrow
Black-crowned Night Heron	Red-billed Starling	Eastern Yellow Wagtail
Yellow Bittern	Daurian Starling	Citrine Wagtail
Greater Flamingo	Crested Myna	Grey Wagtail
Eurasian Spoonbill	Yellow-bellied Tit	White Wagtail
Brown Shrike	Coal Tit	Forest Wagtail
Tiger Shrike	Chinese Penduline Tit	Richard's Pipit
Black-billed Magpie	Sand Martin	Blyth's Pipit
Carrion Crow	Barn Swallow	Olive-backed Pipit
Azure winged Magpie	Red-rumped Swallow	Red-throated Pipit
Black-naped Oriole	Northern House Martin	Buff-bellied Pipit
Ashy Minivet	Light-vented Bulbul	Chinese Grosbeak
Black Drongo	Zitting Cisticola	Siskin
Hair-crested Drongo	Asian Stubtail	Brambling
Blue Rock-thrush	Lanceolated Warbler	Common Rosefinch
White-throated Rock Thrush	Gray's Grasshopper Warbler	Yellow-throated Bunting
White's Thrush	Pallas's Grasshopper Warbler	Yellow-browed Bunting
Grey-backed Thrush	Oriental Reed Warbler	Black-faced Bunting
Eyebrowed Thrush	Thick-billed Warbler	Chestnut-eared Bunting
Naumann's Thrush	Black-browed Reed Warbler	Tristram's Bunting
Dusky Thrush	Dusky Warbler	Little Bunting
Chinese Thrush	Radde's Warbler	Yellow-breasted Bunting
Siberian Thrush	Eastern Crowned Warbler	Chestnut Bunting
Red-flanked Blue-tail	Arctic Warbler	Pallas's Bunting



Mongolian Lark, Sulphur-breasted Warbler. April 2016. © Adrian Boyle



Shorebird ecological
demographics and conservation

<http://globalflywaynetwork.com.au/>
