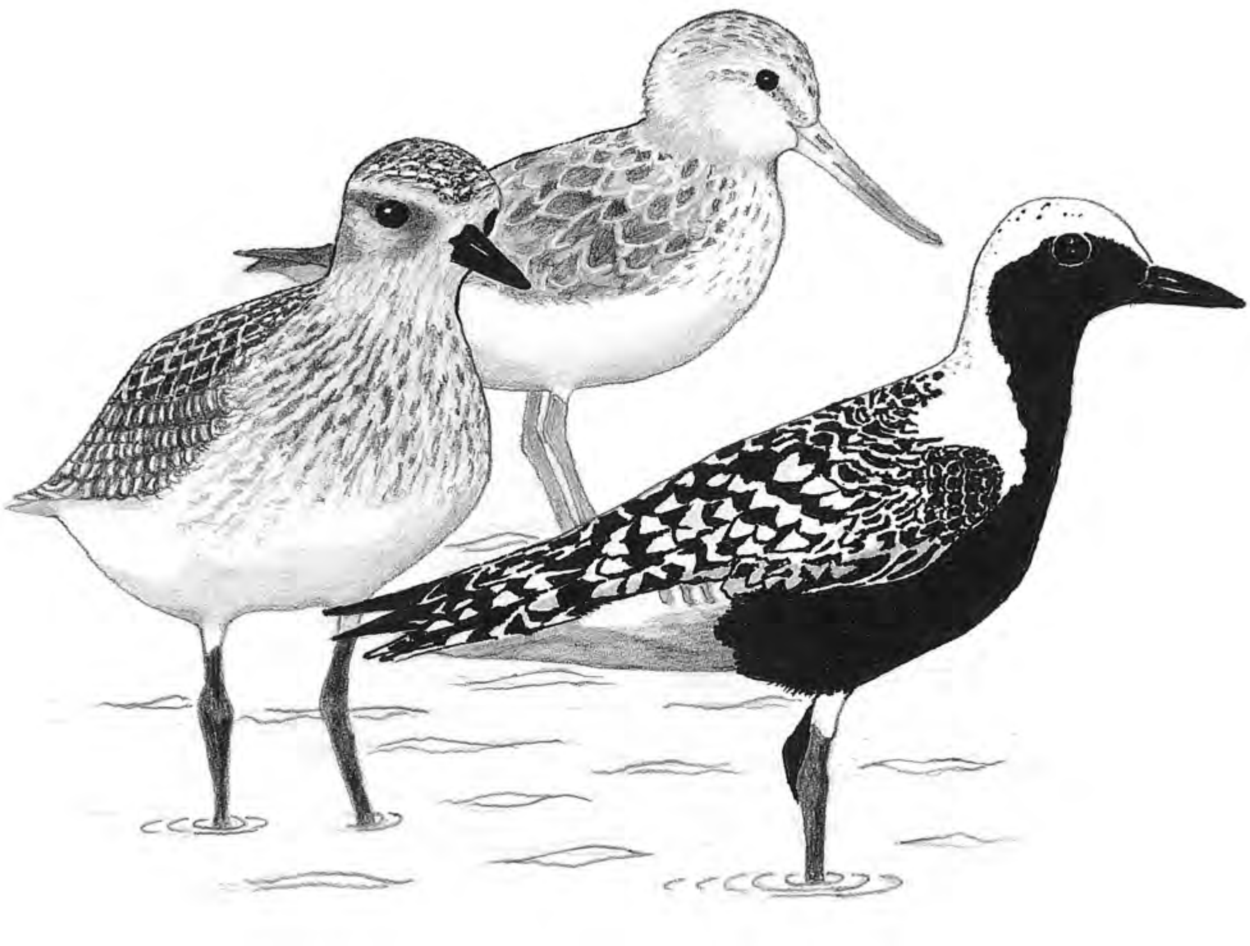
Stilt

The Journal for the East Asian-Australasian Flyway



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AWSG
Australasian Wader Studies Group

Stilt

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MISSION STATEMENT

To ensure the future of waders and their habitats in Australia through research and conservation programmes and to encourage and assist similar programmes in the rest of the East Asian–Australasian Flyway.

OBJECTIVES

- Monitor wader populations through a programme of counting and banding in order to collect data on changes on a local, national and international basis.
- Study the migrations of waders through a programme of counting, banding, colour flagging, collection of biometric data and use of appropriate scientific instruments.
- Instigate and encourage other scientific studies of waders such as feeding and breeding studies.
- Communicate the results of these studies to a wide audience through its journal *Stilt* and membership newsletter the Tattler, other journals, the internet, the media, conferences and lectures.
- Formulate and promote policies for the conservation of waders and their habitat, and to make available information to local and national governmental conservation bodies and other organisations to encourage and assist them in pursuing this objective.
- Actively participate in flyway wide and international forums to promote sound conservation policies for waders.
- Encourage and promote the involvement of a large band of amateurs, as well as professionals, to achieve these objectives.

MEMBERSHIP OF THE AUSTRALASIAN WADER STUDIES GROUP

Membership of the AWSG is open to anyone interested in the conservation and research of waders (shorebirds) in the East Asian–Australasian Flyway. Members receive the twice yearly bulletin *Stilt*, and the quarterly newsletter *Tattler*.

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EDITORIAL

Welcome to the combined issue of *Stilt* 69 and 70. Unfortunately, it was necessary to delay the production of *Stilt* 69 following submission of only two manuscripts by the February closing date. Over the following six months a diverse range of papers have been submitted, resulting in 16 informative and varied articles from regions across the flyway.

In the first of a proposed series of papers M. Newland and E. Woehler analyse a long-term Tasmanian data set to assess population trends and juvenile recruitment in Red-necked Stint. They suggest that when Red-necked Stint populations are at high levels during summer on the Australian mainland the juveniles are forced farther south to Tasmania to find foraging opportunities. P. He and five co-authors assess the key characteristics associated with shorebird use of high tide roosts on the banks of aquaculture ponds at Yalujiang Estuary Wetlands National Nature Reserve in China. As a guide to appropriate management of these sites for shorebirds, they found that they prefer to roost on long banks with little or no vegetation.

Seven papers provide survey data from poorly studied or new sites from across the flyway. This issue contains four papers by A. Crossland working with a range of co-authors. The first paper reviews the status of Great Knot in Northern Sumatra, where up to 2000 birds may be present. Also working with Great Knot, D. Melville and eight co-authors identify a new site of international importance in Liaodong Bay on the northern Bohai Sea in China. The discovery of this site came about through investigation of habitat used by satellite tagged birds, highlighting the value of ongoing satellite monitoring. Andrew also presents papers on surveys of waders on the west coast of the South Island of New Zealand, on the Solomon Islands, and a paper describing inland occurrences of Variable Oystercatchers in New Zealand. Of interest are survey findings showing the Solomon Islands host migratory shorebird species from both the West Pacific Flyway and the East Asian-Australasian Flyway, and as such should be recognised as an overlap region between the two. Documenting new information and supported by a detailed literature review, M. Schellenkens and C. Trainer assess the status of shorebirds on Flores Island in Indonesia. Continuing a series of ground-breaking surveys in the Democratic People's Republic of Korea, A. Riegen and seven co-authors, report on a trip to the North and South Pyongan Provinces in 2016. Finally, M. Jackson and ten co-authors report on the results of a collaboration with the North Australian Indigenous Land and Sea Management Alliance that is producing important insights into shorebird use of the remote and climatically challenging Greater Mapoon area in western Cape York.

P. Crighton highlights incidental mortality in fish nets as a significant threat to migratory shorebirds. Of concern is the vulnerability of the critically endangered Spoon-billed Sandpiper to this threat, the significance of which cannot be understated!

The state of flux in the taxonomy of the Black-winged Stilt complex has provided challenges in this edition. The traditional treatment is to lump all forms (except Black Stilt) as a single species Black-winged Stilt *Himantopus himantopus* (with multiple subspecies). More recently the subspecies have been moved to species level by many authors: the Asian & old world birds are treated as a full species, *H. himantopus* (usually given the English name Black-winged Stilt) and the Australasian birds are treated as a full species *H. leucocephalus*. English names that have been used include White-headed Stilt (a literal translation of the scientific name, but confusing in Australia, as they don't have white heads, while Banded Stilts do), Australasian Stilt (although they certainly occur in Indonesia and SE Asia) and variants of those two names. There are identification challenges in Asia (Bakewell 2012; Perez 2014; D. Rogers *Pers.Comm.* 09/09/2016). Both kinds occur in Indonesia (Iqbal et al. 2009; Abdillah et al. 2012) and although breeding sympatry hasn't yet been proven, the two forms nest quite close to each other, with no biogeographic barriers, co-occurring in mixed non-breeding flocks, with no evidence of hybridisation (D. Rogers *Pers.Comm.* 09/09/2016). Given that *Stilt* has published papers relevant to the taxonomy of this group, and has sometimes needed to differentiate between the forms, in this issue Black-winged Stilt *H. himantopus* has been used for Asian birds and White-headed Stilt *H. leucocephalus* for Australasian birds. Evidently more work is needed, as the split is becoming increasingly widely accepted, but so far is poorly documented.

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Greg Kerr
Editor

THE STATUS OF GREAT KNOT *CALIDRIS TENUIROSTRIS* ON THE CENTRAL EAST COAST OF NORTH SUMATRA PROVINCE, INDONESIA

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The Great Knot *Calidris tenuirostris* is uncommon in Indonesia, but recent monitoring on the central east coast of North Sumatra province confirms that it occurs in moderate numbers on both southward (August to November) and northward (late February to mid-May) passage. Smaller numbers occur during the non-breeding season (December to early February). Insufficient data are available to calculate migration turnover, but counts from multiple sites indicate that *c.* 2000 birds were present on this coastline during southward migration in September to October 2010. As yet, there are insufficient data to indicate that recent substantial increases in the abundance of Great Knot in Thailand and Peninsular Malaysia during the non-breeding season (Round & Bakewell 2015) are also occurring in northern Sumatra.

INTRODUCTION

The Great Knot *Calidris tenuirostris* is a long distant migrant within the East Asian-Australasian Flyway (EAAF) with an estimated population of 290,000 birds (Wetlands International 2016). This species is believed to typically fly non-stop between the Yellow Sea and Australia during both southward and northward migrations (Barter & Wang 1990, Minton *et al*. 2006). An estimated 95% of the population spends the non-breeding season in Australia and the species occurs in only small numbers in South-East Asia (Bamford *et al.* 2008). There are currently no sites of international importance known from the region between China and Australia (Bamford *et al*. 2008), although two sites in Vietnam have recently been reported to hold just under the 1% threshold for international importance of 2900 birds (Moores & Nguyen 2001, Robson 2014, Wetlands International 2016) and several sites in Thailand and Malaysia – where national totals have recently increased from low hundreds to low thousands – are reportedly getting close (Round & Bakewell 2015).

Count data for Great Knot in Indonesia are scarce and the species is generally considered an uncommon migrant (Mackinnon 1990; MacKinnon & Phillipps 1993, Phillipps & Phillipps 2014). National totals at sites sampled during the Asian Waterbird Census (AWC) have generally been under 1000 (Li & Mundkur 2007, Li *et al.* 2009) and the entire archipelago is thought to support just 2000 Great Knot during the non-breeding period (Bamford *et al.* 2008).

The first verified record of Great Knot in Sumatra, the western-most of Indonesia's main islands, was as recently as 1983 – *c.*70 birds observed on coastal mudflats at Berbak Game Reserve in Jambi Province (van Marle & Voous 1988). Extensive surveys of the coastlines of the south-eastern provinces of Riau, Jambi and South Sumatra found a total of 275 Great Knot among 100,892 waders in October-November 1984; three Great Knot among 53,363 waders in July-August 1985; and 88 among 41,381 waders in March-April 1986 (Silvius 1988, Danielsen & Skov 1989). Monthly monitoring of the Banyuasin Delta in South Sumatra from August 1988 to August 1989 (Verheught *et al.* 1990) found one Great Knot among 15,361 waders in September 1988; 65 among 78,561 waders in October 1988 and 21 among 7450 waders in April 1989, confirming that small numbers passed through on both southward and northward migrations, but none over-wintered. No Great Knot were observed in the 10 other months of this 13-month monitoring period, despite count monthly totals ranging from 2146 to 75,132 waders. In all cases, numbers of Great Knot observed in south-eastern Sumatra during the 1980s comprised less than 0.5% of total waders recorded on any given survey. This may still be the case as a recent wader count reported for Sembilang National Park in South Sumatra Province on 22 March 2012, recorded only two Great Knot (= 0.27%) amongst 725 waders of 17 species (Richard Fuller in ebird).

The earliest record of Great Knot in northern Sumatra appears to be 20 birds at the mouth of the Asahan River, North Sumatra Province, on 19 December 1995 (Crossland *et al*. 2009). This precedes our sighting of 300 birds at Bagan Percut on the Deli-Serdang coast on 23-30 December 1995 which was recently cited as the first record for this province (Balen *et al.* 2013). The dates of both records show that some Great Knot spend the non-breeding season in Sumatra and not all birds simply transit through while on migration passage. Putra *et al.* (2015) have recently confirmed this finding with further January and February sightings on the east coast of North Sumatra. Great Knot have subsequently been found at a number of locations along the east coast and it appears this province supports the only sizeable concentrations so far recorded in Sumatra (Crossland *et al.* 2006, Iqbal *et al.* 2013, Harahap *et al.* 2013, Putra *et al.* 2015). This paper reviews recent counts of Great Knot in North Sumatra and provides a new estimate for numbers occurring at any one time on passage along the province's central east coast.

METHODS

Between 1994 and 2012 we made many visits to coastal habitats along the eastern coastline of North Sumatra Province (Figure 1). Our study area extended along *c.*180 km of coastline within the province's four central regencies (administrative districts) – Deli-Serdang, Serdang-Bedagai, Batubara and Asahan. We made observations of wader flocks in all months of the year except June and July. Our observations for 1994 to 2006 have previously been published in Crossland *et al.* (2009) and Crossland *et al.* (2012).

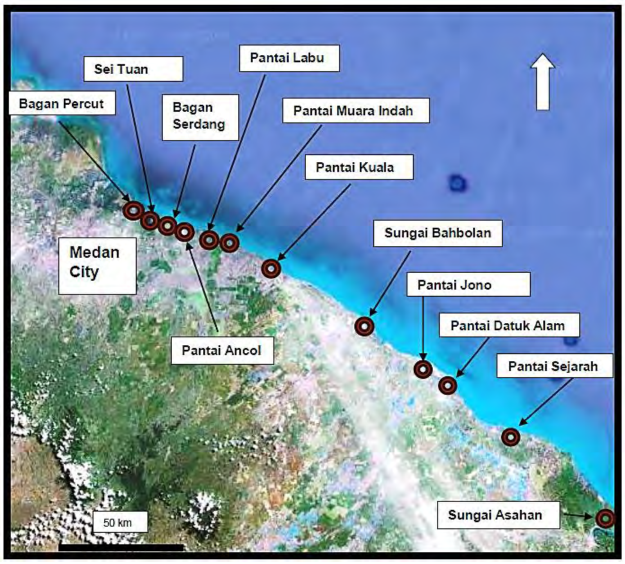

Figure 1. Sites where Great Knot have been recorded in North Sumatra Province.

In September-October 2010 we visited 40 coastal sites across the four regencies and in November 2012 we revisited six sites on the coastlines of Deli Serdang and Batubara. We made careful counts of Great Knot whenever this species was encountered and scrutinised flocks for leg-flagged birds. Counts were made by one or two observers on foot or from a small boat when birds were either congregated at high tide roosts or while foraging over open mudflats at other stages of tide. Optics used included 10x42 binoculars, 25x spotting scope and 10-90x zoom video camera. Unlike Harahap *et al.* (2013) and Putra *et al.* (2015) we undertook a complete census of all waders at each site, rather than using sampling methodologies.

RESULTS

From 1994 to 2005 we found Great Knot at just four of 15 coastal wetlands visited - Asahan River-mouth, Bagan Percut, Pantai Sejarah and Pantai Labu Baru (Table 1). Our most frequent sightings were made at Bagan Percut where our highest counts were 300 birds on 23-30 December 1995 and 400 on 28 February – 3 March 1997. In 1997 we recorded flocks of Great Knot at Bagan Percut from our first visit on 28 February continuously through to our tenth visit on 14 April. However, they were absent on our final visits on 24 April and 12 May 1997. Another notable site was Pantai Sejarah where we counted 380 on 28 March 2002. In all our observations over this period Great Knot comprised 2.07% to 4.05% of total waders recorded per count.

During September-October 2010 we counted 65,238 waders on 40 wetlands on the east coast of North Sumatra Province (Crossland & Sitorus in prep.). A total of 1806 Great Knot were found at 10 sites (Table 1), representing 2.77% of total waders counted. The majority of birds (1512 at 6 sites) were in Deli-Serdang regency, with much smaller numbers in Batubara (270 at 3 sites) and Asahan (24 at 1 site). None were seen in Serdang-Bedagai regency. We did not visit Bagan Percut (in Deli-Serdang) during this period, but the continued presence of Great Knot at this site is evidenced from counts by other observers, including 100 on 4 March 2009 (Iqbal *et al.* 2010), 117+ in February 2011 (Putra *et al.* 2015) and 150 on 19 March 2011 (J. Sterling & M. Brady (ebird). Therefore, assuming a minimum 100-200 at Bagan Percut during our survey period in September-October 2010, the central east coast of North Sumatra likely supported upwards of 2000 Great Knot at any one time during the southward migration period. What total number of individuals this equates to over a full migration season is unknown as there are insufficient data to calculate turnover.

In September-October 2010 our highest counts were at Pantai Labu Baru (554) and adjacent Pantai Labu West (639) – making a total of 1193 birds between them. We counted these adjacent sites within 15 minutes of each other and confirmed there was no interchange movement between these two roosting areas. Other notable counts were at Bagan Serdang (292) and Pantai Datuk Alam (176). Part of our study area was surveyed later in the same migration season by Putra *et al.* (2015) who undertook monthly counts from January to June 2011. Unfortunately, they made only 200 m radius point counts so direct comparison with our data is problematic. However, their counts at Sei Tuan (part of the Bagan Serdang area) of 93 in January 2011, 423 in March, 21 in April, 0 in May and 6 in June are informative when included with our count of 292 in mid-October 2010 as these combined data indicate that sizeable influxes occurred during both southward (August to November) and northward (late February to mid-May) passage, with lower numbers present through the non-breeding season (December to early February) and even a few birds present during the Northern Hemisphere summer (June to August). At variance to this pattern however were their observations in the Pantai Labu area where our full census of 1193 birds during southward passage in mid-October 2010 was far bigger than their point counts of 13 in March 2011 and 0 in April 2011. They may have missed the northward migration passage. Perhaps an explanation is that the main Great Knot feeding and roosting areas are on sand flats to the western side of Pantai Labu, out of direct sight from the main access point as they are screened by a dense belt of mangroves. Low counts by Putra *et al.* (2015) suggest their point sampling may have missed the area where Great Knot congregate as they also failed to find the flocks of Red Knot *Calidris canutus*, which associate with Great Knot, and for which this site is well known (Crossland & Sinambela 2009, Crossland & Sitorus 2011). Furthermore, two years later, Harahap *et al.* (2013) confirmed the presence of hundreds of Great Knot at Pantai Labu.

In November 2012 our survey covered a much smaller length of coastline than in 2010, but we found a total of 1348 Great Knot at three of six sites surveyed (Table 1). Great Knot comprised 8.03% of the 16,790 waders counted (A.C. Crossland & A.W. Sitorus unpublished data). Notable concentrations were 610 at Pantai Labu Baru (Figure 2) and 725 at Pantai Sejarah.

Harahap *et al.* (2013) monitored five sites in the vicinity of our study area in the months directly preceding our study (from May to November 2012). They undertook sampling but not full counts, recording Great Knot at all five sites. Their cumulative totals for the months May, June, July, September, October and November (combined) included 538 Great Knot at Bagan Percut, 210 at Tanjung Rejo, 309 at Pantai Baru, 111 at Pantai Ancol and 646 at Pantai Labu. These totals comprised from 2.76% to 11.89% (average 6.54%) of waders counted at each site.

Figure 2. Great Knot feeding in typical sand/mudflat habitat at Pantai Labu, North Sumatra, November 2012.

DISCUSSION

Our observations, together with those of Iqbal *et al.* (2010), Harahap *et al.* (2013) and Putra *et al.* (2015) indicate that much higher numbers of Great Knot occur on the east coast of North Sumatra than in other Sumatran provinces surveyed to date, i.e.:- Aceh, Riau, Jambi, South Sumatra (Silvius 1988, Danielsen & Skov 1989, Verheught *et al.* 1990, Crossland *et al*. 2006, Iqbal *et al*. 2013). High counts of 725 at Pantai Sejarah, 639 at Pantai Labu West, 610 at Pantai Labu Baru, 400 at Bagan Percut (our data) and 423 at Sei Tuan (Putra *et al.* 2015) appear to be some of the largest flocks recorded anywhere in Indonesia. The species has not been reported as being numerous anywhere else in the archipelago (Bamford *et al.* 2008), and is generally considered scarce throughout (Mackinnon 1990; Mackinnon & Phillipps 1993; Phillipps & Phillipps 2014).

The *c.*2000 birds on the central east coast of North Sumatra we estimated in September-October 2010 are comparable to the number Bamford *et al.* (2008) estimated for the total Indonesian population during the non-breeding season. Our observations at Bagan Percut over several visits and monthly monitoring by Putra *et al.* (2015) at Bagan Percut, Sei Tuan and Pantai Labu from January to June 2011, shows that Great Knot numbers are highest during both northward and southward migration periods and are much lower during the non-breeding season (the only exception being our count of 300 at Bagan Percut in late December 1995). This suggests that birds are passing through North Sumatra on their way elsewhere. Given that very few Great Knot have been recorded in the months of December, January and February in other parts of Sumatra or elsewhere in the rest of the Indonesian archipelago, we assume that their ultimate migration destination is Australia. Leg-flag and band sightings are required to confirm this, but NW and Northern Australia are well documented as the principal non-breeding areas for this species (Minton *et al.* 2006, Bamford *et al.* 2008).

From a northerly direction, we have observed one Chinese leg-flagged Great Knot in North Sumatra – at Bagan Serdang on 14 October 2010. This bird was flagged with white above black on the right tibia between April 2003 and April 2006 at Chongming Dao, 3918 km distant on a straight-line bearing of 43 degrees (AWSG Leg Flag Sightings, per C. Minton). Unfortunately, little can be ascertained from a single flagged bird other than to provide proof that at least some Sumatran Great Knot have visited the species' principal staging grounds in the Yellow Sea.

Round & Bakewell (2015) outlined clear evidence showing a recent steep increase in numbers of Great Knot in both Thailand and Peninsular Malaysia during the non-breeding season. Within the context of a decline in the global population of Great Knot (Conklin *et al.* 2014), Round & Bakewell (2015) suggest that the most plausible explanation is that habitat loss in the Yellow Sea is driving a change in the non-breeding distribution of Great Knot. They suggest that some birds no longer migrate to Australia but are now spending the non-breeding season in Thailand and Malaysia instead. If this is the case, then northern Sumatra (on the same latitudes as Peninsular Malaysia and the southern tip of Thailand) may well experience a similar increase in numbers of Great Knot in December to early February. More survey work is required to investigate this, particularly full site counts that can be directly compared with 1990s and 2000s data for previously monitored sites like Bagan Percut, Pantai Labu and Pantai Sejarah. The dataset available at present only really shows sizeable influxes during migration passage periods. Non-breeding season numbers in December, January and February still appear low. Our data does appear to indicate a slight increase in the relative abundance of Great Knot; i.e.; 2.77% in September-October 2010 compared to 8.03% in November 2012 and an average 6.54% from the 2012 counts of Harahap *et al.* (2013), but these data are mainly from migration periods, not the non-breeding season. We encourage other researchers to continue monitoring wader populations in North Sumatra and provide a measure of any genuine increase in Great Knot numbers.

Table 1: Counts of Great Knot on the central east coast of North Sumatra Province

Location	Pre. 2010													Sept 2010 to June 2011												Nov 2012	
	19-Dec-95	23-30-Dec-95	28-Feb-3-Mar-97	17-Mar-97	24-Mar-97	31-Mar-97	14-Apr-97	28-Mar-02	25-Sep-05	27-Sep-05	02-Oct-05	08-Oct-05	04-Jan-09	28-Sep-1	02-Oct-10	05-Oct-10	08-Oct-10	11-Oct-10	14-Oct-10	19-Mar-11	Jan-11	Feb-11	Mar-11	Apr-11	Jun-11	28-Nov-12	29-Nov-12
Bagan Percut				200	200	236	26			230		280	100[A]							150[B]	5[C]	117[C]					
Bagan Serdang																			292								
Pantai Ancol Indah																			12								
Pantai Ancol (west)																			14								
Pantai Datak Alam															176												
Pantai Jono																											13
Pantai Kuala														24													
Pantai Labu																					44[C]		13[C]				
Pantai Labu Baru											22								554							610	
Pantai Labu (west)																			639								
Pantai Muara Indah																		1									
Pantai Sejarah								380									63										725
Sei Tuan																					93[C]		423[C]	21[C]	6[C]		
Sungai Asaham	20	300	400						2																		
Sungai Bahbolan																31											

A Iqbal *et al.* (2010)
B J. Sterling & M. Brady - ebird
C Putra *et al.* (2015)

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RED-NECKED STINT AND CURLEW SANDPIPER IN SOUTH-EAST TASMANIA: PART 1 RED-NECKED STINT - POPULATION TRENDS AND JUVENILE RECRUITMENT

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Red-necked Stint *Calidris ruficollis* numbers in south-east Tasmania have fluctuated by an order of magnitude during the last 50 years. Current numbers (2010 - 2015) of between 500 and 1000 are at the lower end of the range, which peaked at nearly 4000 between 1981 and 1983. Superimposed on an overall long-term decrease are medium-term fluctuations in the size of summer populations. These fluctuations are similar to those reported in Victoria on the Australian mainland, but the magnitudes of the long-term changes in Tasmania are greater and slightly lagged in time relative to Victoria.

The results of banding studies in south-east Tasmania and Victoria provide valuable insights into the overwintering (non-breeding season) behaviour of Red-necked Stints in Australia. In both Tasmania and Victoria, adult birds usually return to the same location each year after breeding in the northern hemisphere. Juveniles do not migrate to breed in the northern hemisphere until at least 18 months of age, although some juveniles undertake a partial movement northward in the Austral winter. Consequently, winter count numbers in Tasmania underestimate annual juvenile recruitment.

In Victoria, juvenile proportions of Red-necked Stint in summer cannon net catches have been used to indicate recruitment rates, with annual variations attributed to changes in Arctic breeding success. Similar annual variations are apparent in the proportions of juvenile Red-necked Stint in south-east Tasmanian summer populations, based on the winter / summer count proportions. Between 1980 and 2005, the magnitudes of these metrics were similar during periods when the summer population was increasing, but the Tasmanian proportions were much lower when the populations were decreasing.

The results are consistent with a demographic model involving high levels of juvenile recruitment into the south-east Tasmanian population when Red-necked Stint populations are at high levels during summer on the Australian mainland and the juveniles are forced farther south to Tasmania to find foraging opportunities. Short term fluctuations reflect variations in Arctic breeding success, but are variably attenuated by the extent to which juveniles find foraging opportunities at more northern latitudes. Since 2010, south-east Tasmanian results are inconsistent with the previous long-term trends suggesting fundamental change(s) to one or more of the factors affecting the balance between recruitment and mortality may have occurred.

INTRODUCTION

Shorebird populations in the Hobart area of south-east Tasmania were surveyed from July 1964 to December 1968 by Thomas (1968, 1970). He highlighted that south-east Tasmania was an ideal location to study the dynamics of annual variations in trans-equatorial migrant shorebird populations. Its location at the end of the flyway removed the complication of the presence of passage birds experienced at most other sites in Australia. Monthly survey totals provided the size of peak summer populations, and the numbers of birds remaining through the Tasmanian and southern Australian winter are considered to be juveniles (Rogers and Gosbell 2006).

In 1973, the Bird Observers' Association of Tasmania (BOAT, now BirdLife Tasmania) commenced annual summer population counts (SWCs), which were supplemented by annual winter counts (WWCs) that commenced in 1980; both summer and winter counts have continued to the present, generating the longest time series data for migratory shorebirds in Australia. The counts are recorded in the Tasmanian Bird Report (most recently Woehler *et al.* 2014 and Woehler and Drake 2015). Overviews and syntheses have been published at various times (e.g. Newman and Fletcher 1981; Moverly 1995). The summer and winter counts of 2014 marked the 50-year milestone since Thomas' initial surveys. This remarkable long-term data set comprises 46 summer and 40 winter population counts, with monthly counts in eight years.

An intensive campaign of shorebird banding was conducted between 1978 and 1985 in south-east Tasmania with regular catches of the two most numerous species, Red-necked Stint *Calidris ruficollis* and Curlew Sandpiper *C. ferruginea* (summarised in Barter 1984; Harris 1983, 1984).

This paper (part 1) details the long-term fluctuations in the population of Red-necked Stints in south-east Tasmania, and focuses on the relationship between the trends in juvenile recruitment rates and summer population sizes. Subsequent papers will (a) examine how the balance between mortality and juvenile recruitment determines fluctuations in the summer population size, and (b) undertake comparisons with analyses of Curlew Sandpiper counts. Our ultimate aim is to assess whether the south-eastern Tasmanian data support the hypothesis that trends at the extremities of the flyway in locations like south-east Tasmania provide a litmus test for, and a mechanistic understanding for processes impacting elsewhere in the flyway, for example, as suggested previously in relation to the Eastern Curlew *Numenius madagascariensis* by Close and Newman (1984), and Reid and Park (2003).

METHODS

During the 51-year (1965 – 2015, inclusive) period, south-east Tasmanian shorebird monitoring has predominantly involved annual summer and winter counts. However, as discussed below there were two periods when monthly counts were conducted. Minor differences in method of counting and data evaluation over the 50-year period are presented, and are discussed in relation to the accuracy of population estimates.

Count Protocols and Effort

Thomas initiated the Hobart area studies in July 1964, conducting monthly counts until December 1968. His studies provided five summer population estimates (i.e. 1965 to 1969; summers defined by calendar years i.e. 1969 SWC refers to the Austral summer of 1968/69). He identified and surveyed most of the areas holding significant numbers of migratory shorebirds in south-east Tasmania, and demonstrated through monthly counts that there was only limited movement between and amongst the different feeding areas, which he termed resorts (subsequently referred to as sites). He did not survey areas at Marion Bay and Bruny Island that hold relatively small populations of migratory shorebirds. The consistency of shorebird numbers in Thomas' monthly counts, and his interpretations and conclusions with respect to fidelity of birds to sites and limited movement between the sites he counted were subsequently supported by the BOAT banding data (Harris 1983, 1984).

Although Thomas' work involved a single observer whose counts were not synchronised, it was possible to eliminate double counting by comparing site and total population trends over a period of months (MN is in possession of Thomas' original records and analyses). However, although banding studies indicated that most local movement was between and amongst the sites counted by Thomas, there was occasional movement between these areas and Marion Bay. From 1981 summer population counts described below included Marion Bay, but not Bruny Island, which was more remote and supported fewer birds.

SWCs were conducted in late February because Thomas' studies had indicated that some species commenced their northern migration in early March. Thomas and Dartnell (1970) showed the pre-migratory build-up of fat by Red-necked Stint occurred in March, providing further justification for the selection of February as the appropriate time to conduct SWCs. A team of experienced observers conducted synchronised counts of all migrant and resident shorebird numbers at high tide roosts on a day that was selected with high tide occurring near noon. In 1980, a corresponding set of annual WWCs was initiated, conducted in July before the first of the northern hemisphere migrants had returned. Separate teams counted each of the sites identified by Thomas and where possible led by the same person who became expert with behaviour of shorebirds at the assigned site.

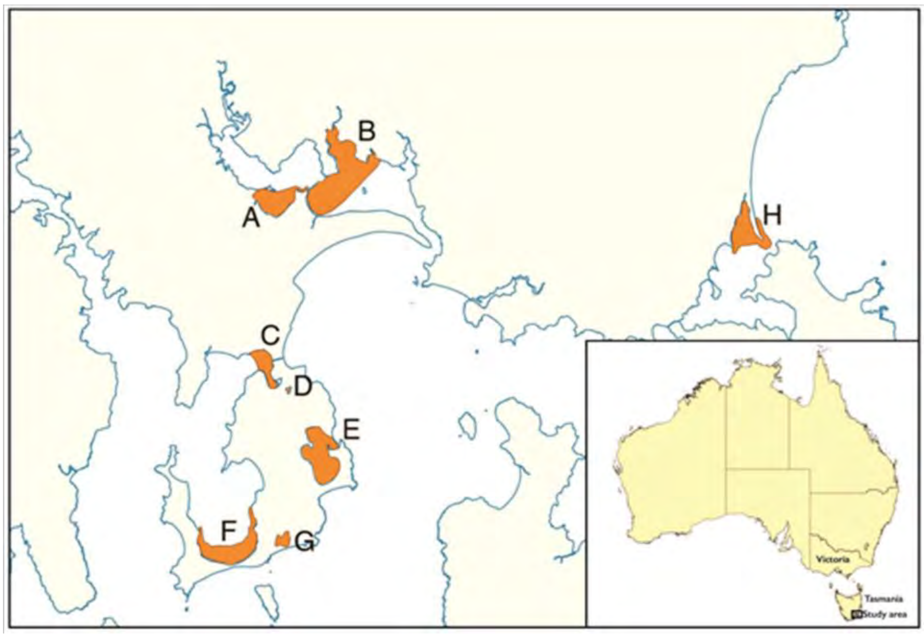

Figure 1. Map of south-east Tasmania showing shorebird roost sites monitored since 1964: Barilla Bay (A), Pitt Water/Orielton Lagoon (B), Lauderdale (C), Clear Lagoon (D), Pipeclay Lagoon (E), South Arm Neck (F), Calverts Lagoon (G) and Marion Bay (H). Inset: map of Australia showing the location of the study site in southeast Tasmania and the location of Victoria. North is to the top of the page.

Subsequently, the Australian Wader Study Group (AWSG) implemented a national Population Monitoring Program (PMP) in the early 1980s and the south-east Tasmanian counts were incorporated into that scheme with SWCs in January or February and WWCs in June or July (Gosbell and Clemens 2006).

The team involved in the initial south-east Tasmanian wader counts formed the Tasmanian Shorebird Study Group, which increased the frequency of surveys to monthly between 1980 and 1985, generating data directly comparable to that of Thomas. In periods when monthly counts were conducted, the February and June counts were used for that year's SWC and WWC totals (i.e. maximum counts were used; not average counts). In 1985, monitoring reverted to just summer (February) and winter (June) counts.

The main survey sites holding Red-necked Stint and Curlew Sandpiper in south-east Tasmania are Lauderdale, South Arm Neck and Pipeclay Lagoon, which are situated on the South Arm Peninsula, and Barilla Bay, Orielton Lagoon /Sorell, the Pitt Water Ramsar complex near Sorell, and Marion Bay (Figure 1). Two lagoons on the South Arm Peninsula are intermittently flooded and can provide important supra-tidal feeding opportunities for small shorebirds like Red-necked Stint and Curlew Sandpiper. One, Clear Lagoon, is close to Lauderdale and the other, Calvert's Lagoon, lies between Pipeclay Lagoon, which is tidal, and South Arm Neck. These lagoons were always counted when flooded, however they were often dry at the time of SWCs. Moverly's (1995) assertion that the south-east Tasmanian data set is deficient because these areas were not counted in some (dry) years is misleading; they were always counted when suitable for shorebirds.

Accuracy of Population Estimates

Rogers *et al.* (2006) concluded that it should be possible to determine changes of the order of 10 to 15% at the 80% significance level in the size of populations between one year and the next provided the roosting behaviour of birds were well known and repeat surveys were employed. It will be assumed that a similar accuracy applies to the south-east Tasmanian data set, particularly for the periods when monthly surveys were conducted by observers dedicated to one area, of which they had detailed knowledge. However, as discussed by Rogers and Gosbell (2006), there may be occasions when many birds are missed, particularly when an observer is unfamiliar with an area, and how the birds use an area, or if the weather on the scheduled day was inclement. Similar limitations apply to this study.

Data Analyses

We used a population balance approach to further our understanding of the summer (SWC) and winter (WWC) count trends.

Population Balance

In a closed system where juveniles and adults are philopatric in non-breeding habitat choice, the changes in the inter-annual summer population size will be determined by the balance between overall population mortality and the recruitment of juvenile birds, which can be calculated using equation 1.

$$N_i = C_i - C_{i-1} .S \qquad (1)$$

Where N_i is the number of juveniles in year i, C_i and C_{i-1} are the number of Red-necked Stint of all ages in the SWC in the i^{th} year and the preceding year (i-1), and S is the annual survival rate, which is assumed to be age independent.

In applying this model to the population in south-east Tasmania, we have assumed that the same annual survival rate applies to all ages of birds, and that there is no emigration to, or immigration from other populations.

Mortality

The two existing measures of Red-necked Stint annual survival / mortality both assume constant annual mortality rates and are not informative about inter-annual and age dependent variations.

Rogers and Gosbell (2006) found an annual survival rate of 85.1% (14.9% mortality) for the Victorian Red-necked Stint population for period 1980 to 2005. Their approach was to use measured values of annual juvenile recruitment based on juvenile proportions measured in cannon net samples (predominantly from Victoria) to predict annual fluctuations in the Victorian Red-necked Stint SWC population using assumed values of annual survival. The value of 85.1% annual survival provided the best fit between the estimated and counted summer population sizes.

Harris (1983) estimated the annual survival rate of Red-necked Stints in south-east Tasmania to be 80% based on the banding histories of 141 birds recaptured in October 1982, which had been banded in the previous three years.

Neither of these estimates is informative about inter-annual and age dependent variations in annual survival. Roger's and Gosbell's (2006) estimate being a mean estimate over a 25-year period is considered conservative because it includes any population losses associated with emigration from the south-east Australian population. Harris' estimate has the advantage of being measured on the south-east Tasmanian population. However, it was short term (three years compared with an estimated species half-life of 4.4 years, Harris 1983) and may not reflect the true long-term survival rate. This may explain Harris' lower higher estimate of 20% annual mortality compared with Rogers and Gosbell's 14.9%, as well as the possibility that regular cannon netting had an adverse impact on the population. As it was measured on the south-east Tasmanian population, we have used Harris' value herein unless otherwise stated.

Emigration

Both Rogers and Gosbell's (2006) and Harris' (1983) estimates include any emigration from the Victorian and south-east Tasmanian populations, respectively. Annual emigration rates are considered to be a small proportion of the annual mortality (Rogers and Gosbell 2006). Harris (1983) estimated the annual emigration rate from Pipeclay Lagoon to other sites in south-east Tasmania to be 9%, indicating a high level of site faithfulness by Red-necked Stint to individual count sites in the region.

Juvenile Recruitment

Determining juvenile proportions from cannon net catches and plumage observations (Rogers *et al*. 2005) provides direct measures of annual recruitment. In the absence of such data in south-east Tasmania three alternative measures of recruitment were investigated:

1. WWC numbers: Cannon netting has shown that the majority of Red-necked Stint present in south-east Tasmania are juveniles (see winter catch data in Barter (1984)), which do not return to the northern hemisphere to breed until they are at least 18 months old (Rogers and Gosbell 2006). However, some juveniles make a partial northward migration during the Austral winter, which prevents the use of the raw WWC numbers as a direct measure of juvenile recruitment.
2. Difference in successive SWCs: Differences between successive SWCs were used to estimate juvenile recruitment. The differences were corrected for annual mortality using equation 1 with a constant mortality rate (Harris 1983). The difficulty associated with this approach is the stochastic error associated with count data and the use of constant annual mortality, which does not consider inter-annual variations.
3. Victorian cannon juvenile proportions: The proportions of juveniles in rocket and cannon net catches between November and March provide a more reliable indication of annual variations in recruitment. Data for Victoria are available in Rogers and Gosbell (2006) and Minton *et al*. (2005, 2010 and 2015). However, these measures may not be applicable to south-east Tasmania because of its geographical isolation from mainland Australia. As a first step in determining whether these data could be used to interpret south-east Tasmanian SWC, we compared the SWC trends for the two regions. We also compared the correlations and magnitudes of the cannon net juvenile proportions to those obtained from the south-east Tasmanian data (e.g. WWC / SWC ratios).

Addressing Impact of Count Error

There are two types of error, stochastic and systematic, associated with shorebird count data. The overall and relative magnitudes of these two types of error in our data sets are unknown. The contribution of systematic error is thought to be smaller than stochastic error. However, systematic error involving under-estimation can occur when birds are not located and when observers report conservative estimates of larger flocks (Rogers *et al*. 2006).

Averaging techniques described below were used to highlight the underlying trends associated with changes in the Red-necked Stint population. While these approaches are beneficial with respect to decreasing the impact of stochastic error, they do not address systematic error.

Smoothed three year rolling means of SWCs were evaluated in order to identify longer-term population trends. This time interval was selected because the annual survival rate of Red-necked Stints is approximately 80% with an average life expectancy of 4.5 years (Harris 1983, Rogers and Gosbell 2006). Thus, provided that a population remains philopatric to an area, a conclusion supported by banding studies in south-east Tasmania (Harris 1983, Barter 1984), population changes should be gradual.

A population balance approach, involving a five-year time interval, equivalent to the average life expectancy of a Red-necked Stint, was used to test the validity of candidate juvenile recruitment estimates. This addresses not only the impact of stochastic count error, but also inter-annual variations in the survival (or inversely, mortality) rate.

The parameters and relationships described above were also evaluated over longer periods where consistent long-term SWC trends were apparent. The intent of this approach was to determine whether there were differences in apparent juvenile recruitment rate during those periods and whether the relative magnitudes of alternative measures changed (e.g. comparison of Tasmanian WWC / SWC proportions with the Victorian cannon net proportions during periods of SWC population increase and decrease). Differences could provide insights into the mechanisms and assumptions underlying the population balance approach used in this paper (e.g. that juveniles and adults continue to be philopatric in non-breeding habitat choice).

Verification of Juvenile Recruitment Estimates

The conclusions reached in this paper are primarily based on semi-quantitative measures. Equation 1 can be used iteratively to estimate the changes in the size of the south-east Tasmanian population provided that reliable values of juvenile recruitment are available and the model is valid. Comparison of the fit between the counted and modelled population estimates tests the validity of the proposed juvenile recruitment parameter set. The ultimate aspiration, which will be the subject of a subsequent paper, is the development of a model which provides a robust quantitative explanation of long-term trends in the Red-necked Stint and Curlew Sandpiper populations of south-east Tasmania.

All statistical tests were conducted with Prism 6.0h (www.graphpad.com).

RESULTS

South-east Tasmanian Population Trends

Over the five decades between 1965 and 2015, Red-necked Stint SWC numbers in south-east Tasmania ranged between 400 and 4000, an order of magnitude variation. WWC levels were much lower than SWC numbers, ranging from 2 to 762, varying over two orders of magnitude (Figure 2).

The same data are shown as three year running means in Figure 3 to accentuate the trends by decreasing the impact of stochastic error associated with individual counts. Inspection of the smoothed data in Figure 3 indicates population peaks around 1980 and 2005, approximately 25 years apart, followed by a sustained decrease to a relatively stable 50-year low level at the time of writing (2015). Between these peaks, there is trough when the population decreased to approximately one third of its peak level in 1980, before a partial recovery to about 70% of the 1980 peak level. There were also medium-term trends in the number of juveniles over-wintering in south-east Tasmania (Figure 3). Superficially, the WWC trend resembled the SWC, with an obvious peak around 2005, but with insufficient data to draw any conclusion as to whether there was a WWC peak corresponding to the sustained SWC peak between 1976 and 1984.

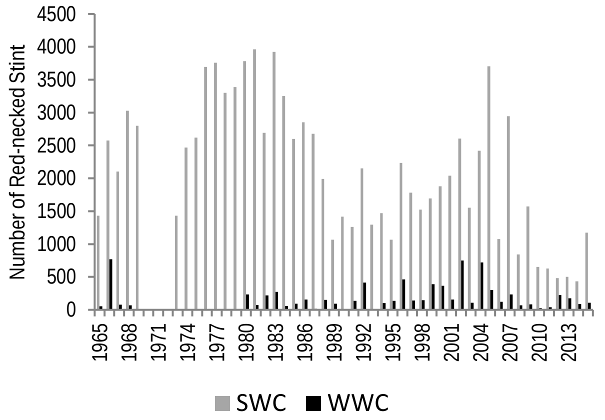

Figure 2. The numbers of Red-necked Stint in south-east Tasmania based on summer (SWC; nominally February) and winter (WWC; nominally June) counts between 1965 and 2015. Red-necked Stints were recorded in every year summer and winter count conducted (i.e. zero numbers indicate no count undertaken). The numbers are the combination of birds counted simultaneously at high tide roosts.

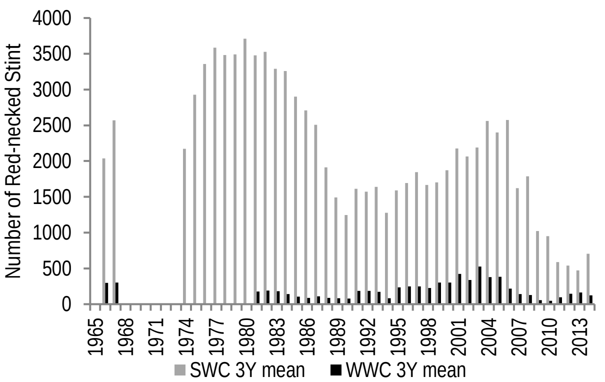

Figure 3. Summer and winter counts of Red-necked Stint in south-east Tasmania shown as three year running means to decrease the impact of stochastic variation associated with individual counts. Red-necked Stints were recorded in every SWC and WWC conducted (i.e. zero numbers indicate no count was carried out).

Juvenile Recruitment

1. WWC estimates: When the annual variations in WWC numbers as a percentage of the SWC are compared (Figure 4), it is apparent that the proportion of birds remaining in winter in south-east Tasmania (as estimated by the WWC / SWC proportion) differs widely among years (short-term variation) and different periods (long-term variation). Cannon netting studies in south-east Tasmania have demonstrated that birds present at the time of the WWC are predominantly juvenile (Barter 1984).

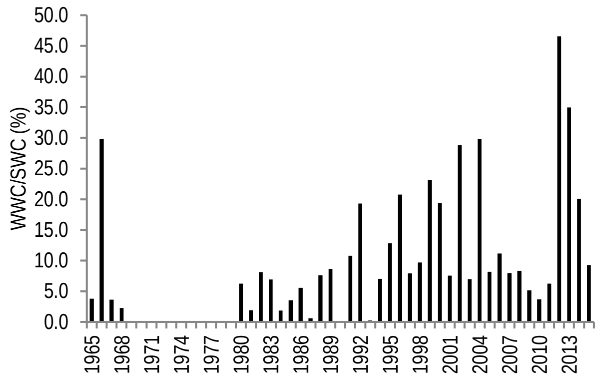

Figure 4. Comparison of the relative size of the summer and subsequent winter populations of Red-necked Stint in south-east Tasmania based on calculating the WWC as a percentage of the preceding SWC.

During the period 1979-2014 the cumulative SWC was 71,432 Red-necked Stints. Over that period 14,286 juveniles would be needed to replace deceased birds, assuming an annual survival rate of 80% (Harris 1983). The cumulative WWC for the period 1980-2015 (i.e. lagged by one year; see equation 1) was 6874, which is 48% of the number required to offset mortality. Using the higher annual survival rate of 85% (Rogers and Gosbell 2006), the cumulative WWC of 6874 equates to 64% of the 10,715 juveniles required to replace deceased birds.

2. Consecutive SWC estimates: Consecutive SWCs were compared to determine whether there had been a net increase or decrease in the size of the population, using equation 1. When there is a net gain, the additional birds are in excess to those required to offset 20% annual mortality (Harris 1983). In 24 of the 45 years there was an increase in the population (Figure 5), and in 13 of those years (29%) the gain was sufficient to offset the estimated 20% accuracy associated with between year estimates (i.e. slightly less accurate than the 10 to 15% indicated by Rogers *et al.* (2006) because single as opposed to multiple SWCs were used in most of this study). Hence, in those 13 years there is confidence that there was sufficient recruitment to increase the south-east Tasmanian population. In three years involving the summers of 1996, 2007 and 2015 the increases exceeded 100% (Figure 5).

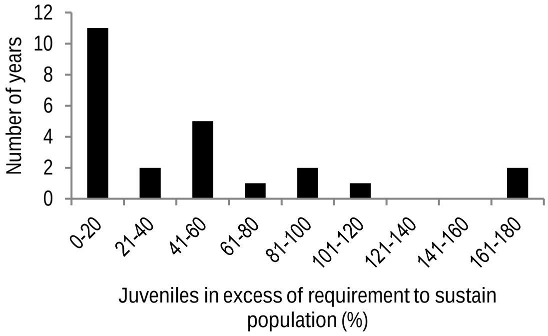

Figure 5. Number of juveniles recruited in excess of the 20% required to replace mortality in the previous summer's Red-necked Stint population, based on the difference between successive SWCs.

In 21 of 45 years, there was a decrease in the numbers of Red-necked Stints counted in summer compared with the previous year. The size of the year-to-year decrease was greater than 40% on five occasions. A 40% annual decrease is the upper limit which can be explained based on an annual survival rate of 80%, no juvenile recruitment, and an expectation that the error on the measurement of the difference in the size of the populations is unlikely to exceed 20%. Indeed, this upper limit is conservative, because as indicated (Figures 2 and 3) there appears to be continuous annual recruitment of juveniles, albeit in variable numbers. These larger population decreases occurred in 1989 (-47%), 2003 (-41%), 2006 (-71%), 2008 (-71%) and 2010 (-58%). It was concluded that differences in successive SWCs do not give accurate or reliable estimates of juvenile numbers for individual years.

Three year running means of SWC data were used to minimise the impact of the error associated with SWC estimates, potentially inflating the estimated level of juvenile recruitment. Even after this adjustment, there were six years when there was an apparent negative recruitment of juveniles, suggesting that some impact of anomalous counts remained. For the 33 years in which recruitment estimates were positive, approximately 17,000 Red-necked Stints were gained, which is equivalent to 516 juveniles each year. This level is higher than an estimate of 191 juveniles / year based on WWC numbers, in part reflecting differences in the periods evaluated (i.e. this estimate included years when SWCs were high and there were no WWCs).

Because Red-necked Stint SWC numbers varied by an order of magnitude during the 50-year period (Figures 2 and 3), comparisons of population changes expressed as percentages do not reflect the variability in the numbers of birds recruited annually as shown in Figure 6, which is based on the differences between successive SWCs, after adjustment for 20% annual mortality (Harris 1983). This analysis used differences between successive three year mean values to minimise the impact of anomalous data associated with individual years.

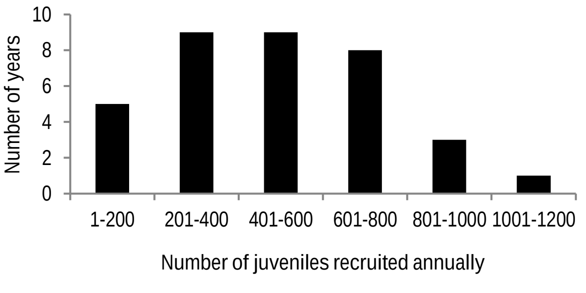

Figure 6. The number years (n=35) in which the number of juvenile Red-necked Stint recruited annually to south-east Tasmania fell into six categories (1-200, 201-400, 401-600, 601-800, 801-1000, 1001-1200). Juvenile recruitment estimates based on differences in consecutive three year mean SWCs adjusted by 20% for mortality of the previous season's SWC numbers.

In Figure 7, the number of juvenile Red-necked Stints estimated from differences in successive SWCs is compared with the number of juveniles present in winter based on WWC data. Mean numbers were compared for five year periods to overcome the issues associated with stochastic error outlined above. The sizes of the mean annual SWC populations are also shown for comparison. Both estimates of juvenile recruitment decreased to low levels in the period 1985 to 1995, followed by a marked increase during the period 1995-2005. During the first 40 years of the study, the juvenile numbers estimated from differences in successive SWCs always exceeded the WWC estimates. However, between 2005 and 2014 the trends were unusual compared with the previous 40 years. In the period 2005-2010, there were erratic fluctuations in the SWCs (Figure 2), which may have contributed to overestimation of juvenile recruitment based on successive SWCs. In the period 2010-2014, the estimated number of juveniles present, indicated by the WWCs, exceeded the number estimated from differences in SWCs, contrary to experience during the previous 45 years. The results in Figure 7 suggest differences in successive SWCs are meaningful indicators of juvenile recruitment in south-east Tasmania over five year intervals, even though results for individual years may be anomalous.

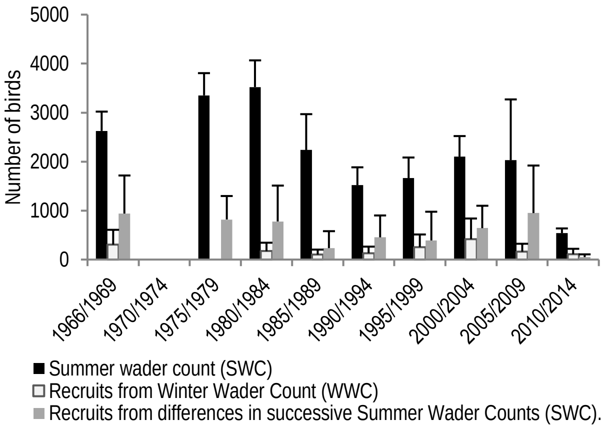

Figure 7. Comparison of the south-east Tasmanian Red-necked Stint SWC with two estimates of the mean number juveniles recruited annually for nine, 5-year periods spanning 50 years. Juvenile numbers estimates were based on differences in successive SWCs adjusted for 20% annual mortality in one instance and on WWC numbers in the other. There were no winter counts for the years 1975 to 1979 and there were insufficient counts for the period 1970-74 for analyses.

Comparison with Victorian Summer Population

The SWC data from south-eastern Tasmania for the period 1982-2005 were compared as three year rolling means with Victorian SWCs in Figure 8 using data from the AWSG PMP (Rogers and Gosbell 2006). Both data sets indicated periods of rapid population decrease, commencing about 1985. The decrease in south-east Tasmania was more pronounced (>60%) and extended longer (six years) than in Victoria (>25% over four years). After a period of stability, both populations increased, and by 2001 the Victorian population had increased by 50% to a level almost 25% above the 1983 base level. The recovery in south-east Tasmania lagged that in Victoria by two years, and by 2004 remained 22%

below the 1983 baseline level. The net impact of these differences was that between 1983 and 2004, the Victorian PMP SWC increased from 12 to 20 times the size of south-east Tasmanian SWC.

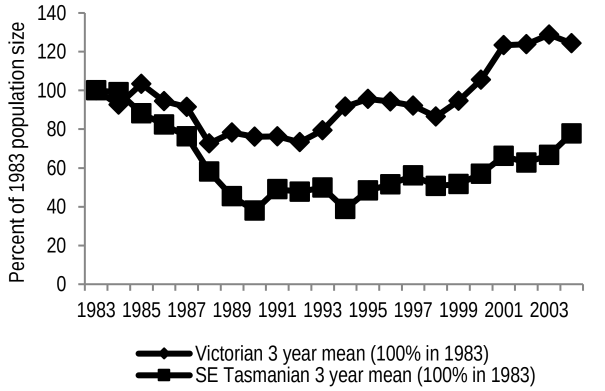

Figure 8. Comparison of fluctuations in the relative size of the south-east Tasmanian and Victorian PMP SWCs of Red-necked Stint between 1983 and 2004 based on 3 year rolling mean values. Both populations have been indexed to 100% in 1983 when the Victorian population was 39,623 (Rogers and Gosbell 2006) compared with a south-east Tasmanian population of 3290.

There were two statistically different (based on comparison of elevations) correlations between the Victorian and south-east Tasmanian SWCs (Figure 9). Both correlations, one during the period of Victorian population decrease (1983-87), and the other during the subsequent periods of population stability and increase (1998-2004), were significant (population decrease: $r^2 = 0.96$, 3 d.f., $p = 0.0034$; population stability / increase: $r^2 = 0.55$, 15 d.f., $p = 0.0006$).

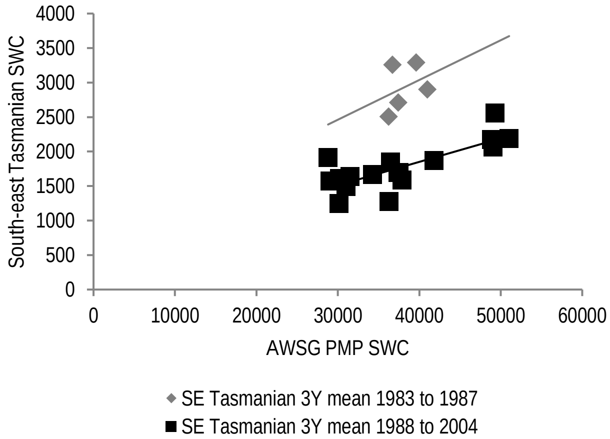

Figure 9. Correlation between Red-necked Stint SWCs in south-east Tasmania and Victoria based on the AWSG PMP data for the period 1983 to 2004. Comparison involves rolling 3-year means of SWCs). The slopes of both correlations are significantly different from zero: 1983-1987 equation;
$Y = -211.3*X + 422364$, $r^2 = 0.96$, 3 d.f., $p = 0.0034$
And 1988-2004 equation;
$Y = 49.62*X -97265$, $r^2 = 0.55$, 15 d.f., $p = 0.0006$.
The slopes were significantly different at the 10% level ($F_{2,38} = 2.842$, $p = 0.0707$) and the difference between the elevations was highly significant ($F_{2,8} = 391.2$, $p < 0.0001$).

Comparison with Juvenile Recruitment in Victoria

In Victoria, juvenile proportions in cannon net catches have been used as an indication of juvenile recruitment (e.g. Rogers and Gosbell 2006). In the absence of similar long-term cannon net data in south-east Tasmania, the possibility of using WWC / SWC proportions as a surrogate indicator was examined. The south-east Tasmanian WWC / SWC proportions usually underestimated the level indicated by the Victorian cannon net catches, particularly during the period 1983-1987 (Figure 10). However, there was a general correspondence between years in which the ratios increased and decreased between 1980 and 2005, but not after 2006. Support for the existence of three distinct periods involving differences between the estimates of juvenile proportions provided by cannon net samples in Victoria and WWC / SWC proportions in south-east Tasmania is provided by the correlations shown in Figure 11. Although the individual correlations are not statistically different, the elevations of the trend lines are.

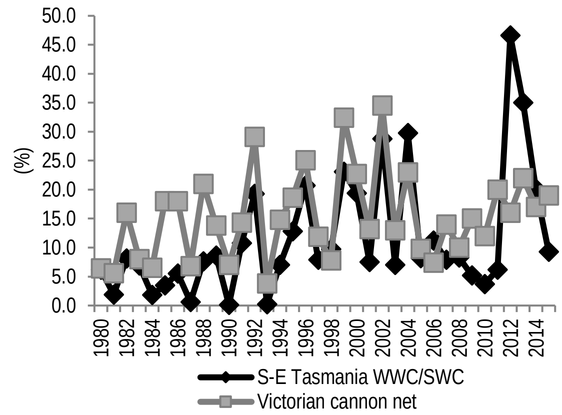

Figure 10. Annual juvenile proportions in Victoria and in south-east Tasmania summer populations of Red-necked Stint. The Victorian data are based on the proportions of juveniles in cannon net catches (Rogers and Gosbell 2006, Minton *et al.* 2010 and 2015). The south-east Tasmanian data are based on SWC / WWC proportions.

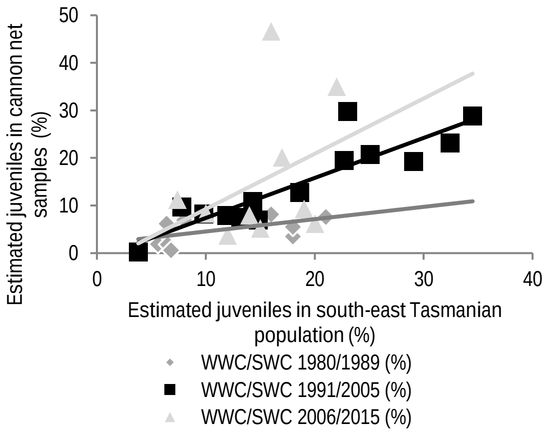

Figure 11. Comparison of estimated juvenile proportions of Red-necked Stint in the south-east Tasmanian and Victorian summer populations for three time periods. The elevations of the trends are significantly different ($F_{4,101} = 6.89$, $p < 0.0001$), but not the slopes ($F_{4,97} = 1.927$, $p = 0.112$). The individual correlations were not significant.

All the available measures of juvenile recruitment in south-east Tasmania and Victoria between 1980 and 2015 are summarised in Table 1. The data are presented for four periods which reflect differences in the south-east Tasmanian SWC trends. This approach provides more definition of the period 2006 / 2010 when the trends in south-east Tasmanian were more erratic than the Victorian (Figure 11).

Table 1. Comparison of juvenile / summer wader count proportions for Red-necked Stint during periods of population increase and decrease in south-east Tasmania and Victoria.

	1980-1990	1991-2005	2006-2010	2011-2015
SE Tasmanian SWC trend	Decrease	Increase	Decrease	Decrease
Victorian SWC trend	Decrease	Increase		
SE Tasmanian WWC/SWC	0.05 ± 0.04	0.14± 0.09	0.07 ± 0.03	0.23 ± 0.17
SE Australian cannon net J/A [1]	0.11 ± 0.06	0.19 ± 0.09	0.12 ± 3.1	0.19 ± 0.24
Ratio Vic.(J/A)/Tas.(WWC/SWC)	2.2	1.4	1.7	0.83
Cumulative WWC	1372	4338	529	635
Juveniles required [2]	6438	4988	2028	540
Tas. WWC/juveniles required	0.21	0.87	0.26	1.18

[1] Rogers and Gosbell 2006: Minton *et al.* 2010 and 2015.
[2] Calculated using equation 1.

DISCUSSION

Red-necked Stints and Curlew Sandpipers were the most numerous migratory shorebirds visiting the Hobart area during Thomas' pioneering studies, which comprised sites in the Derwent Estuary and adjacent Pitt Water. Bamford *et al.* (2008) estimated the East Asian – Australasian Flyway (EAAF) population of Red-necked Stints to be 325,000 with 260,000 non-breeding birds in the Australian region during the Austral summer. The Derwent Estuary and Pittwater were listed by Bamford *et al.* (2008) as a site of international significance supporting over 1% of the flyway population. A recent assessment of EAAF species by Conklin *et al.* (2014) did not include the EAAF population of Red-necked Stints, as the species does not have an elevated global IUCN conservation status, which was the criterion for inclusion.

Since Thomas' studies in the 1960s, the Red-necked Stint population, as estimated by the SWCs, has fluctuated in size by an order of magnitude (i.e. between 400 and 4000), with peaks apparent around 1980 and 2005 (Figures 2 and 3).

The interval of 25 years between the two apparent population peaks is approximately five times the estimated half-life of the Red-necked Stint (Harris 1983, Rogers and Gosbell 2006). In addition, the magnitudes of the decreases in population level were large, that is, by approximately 60% and 85% respectively, comparing the minimum levels in 1990 and 2005 with the 50-year peak level in 1980. Falls of this magnitude and persistence relative to the generation time of the species suggests that the south-east Tasmanian population experiences periods of sustained decrease greater than would be expected in a stable population in which juvenile recruitment and mortality are in balance. Consequently, explanations of the observed trends may need to consider possibilities such as an indirect link between juvenile recruitment in south-east Tasmania and Arctic breeding success. Murray *et al.* (submitted) have undertaken a preliminary investigation of the roles of global environmental changes in the decrease of another EAAF species, the Bar-tailed Godwit *Limosa lapponica*. Examining the numerous environmental factors that influence population sizes, and incorporating these alternative and additional factors could be expected to improve our understanding of observed trends.

The period 2001 to 2005 provides insight into factors driving the dynamics of the south-east Tasmanian Red-necked Stint population. During that period WWC numbers, which underestimate juvenile numbers, were persistently around 500 birds (Figure 3), which is greater than at any other time in the last 50 years in south-east Tasmania. To put this result in perspective, between 2001 and 2005 on average at least 500 juvenile Red-necked Stints were being recruited into the south-east Tasmanian population each with a mean life expectancy of 4.4 years. At that time, the SWC data indicated the Red-necked Stint population was at a peak level of around 2500, but a decade later had decreased by >75%. Periods of high juvenile recruitment are central to understanding the demography of the south-east Tasmanian Red-necked Stint population. We discuss below alternative indicators of juvenile recruitment in south-east Tasmania.

Juvenile Recruitment

In this section, we compare alternative estimates that might be used to understand recruitment of juvenile Red-necked Stints to south-east Tasmania. Two measures were considered: juvenile numbers and juvenile proportions. Consideration of juvenile proportions allows comparison with recruitment to the Victorian Red-necked Stint population based on cannon net data.

Juvenile Numbers

WWCs (Figure 2) indicated that juvenile numbers were highly variable, with very high numbers being present in some years. Numbers exceeded 700 juveniles in three years (1966, 2002 and 2004) and over 400 in a further two (1992 and 1996). In those years, the WWC / SWC proportions (Figure 4) were of the order or higher than 0.2, the proportion necessary to sustain the population at an annual survival rate of 80%. In addition, some juveniles make a partial northward migration in the Austral winter; WWCs underestimate the number of juveniles recruited each year. Indeed, between 1980 and 2015, WWC numbers only accounted for between 48% and 64% of the predicted losses associated with mortality.

Estimates based on successive SWCs indicated that in 13 years the number of birds recruited in south-east Tasmania exceeded the numbers required to sustain the Red-necked Stint population (Figure 5), and in 12 years the numbers of juveniles exceeded 600 (Figure 6). These results are consistent with the qualitative assessment of the WWCs that there were large fluctuations in the annual numbers of juveniles over-wintering in south-east Tasmania, and that the replenishment of the south-east

Tasmanian population is intermittent. However, there were discrepancies among years in which maximum juvenile recruitment occurred using the two methods, highlighting limitations of this approach.

In addition, in five years the decrease in the SWC population size exceeded 40%, the maximum decrease predicted by equation 1. When mean count numbers for successive five-year periods (Figure 7) were compared with the anomalies of individual years removed, some interesting and potentially insightful differences emerged, which are discussed later. For instance, with the exception of the period 2010-2014, the number of juveniles estimated from successive SWCs exceeded the WWC numbers as expected on the basis that some juveniles had moved north at the time of the count. There was no obvious reason for the anomalous result for 2010-2014. During the period when the south-east Tasmanian population was decreasing (1985-1994), juvenile estimates based on successive SWCs were between two and five times higher than the WWCs, but only 1.5 times higher when the SWC population was increasing (1995-2004).

Juvenile Proportions

A comparison of south-east Tasmanian and AWSG Victorian PMP summer counts (Figure 8) indicates a general similarity between the timing of periods of population decrease and increase. However, as shown in Figure 9, the correlations between the two populations were significantly different during periods of population decrease and increase. This suggests that there has been a change in the fundamental factors determining the size of the south-east Tasmanian population relative to the Victorian population. Of recruitment and mortality, the two possibilities proposed previously, differences in recruitment were considered a more probable explanation, a position supported by Rogers and Gosbell (2006).

When the relationship between Victorian cannon net proportions and WWC / SWC ratios, the most reliable indicator of juvenile recruitment in south-east Tasmania in individual years, was examined we found a complex relationship (Figure 10). Short term, inter-annual variations were superficially similar in both data sets. These variations were attributed to differences in Arctic breeding success (Rogers and Gosbell 2006; Minton *et al.* 2005, 2010 and 2015). However, there were three periods in which there were differences in the relative magnitudes of the Victorian cannon net and south-east Tasmanian WWC / SWC juvenile proportions (Figure 11). These periods corresponded to times when the SWCs were decreasing and increasing (Figure 9 and Table 1). It is suggested that each of these periods involved different mechanisms determining the population dynamics of the south-east Tasmanian Red-necked Stint population as proposed below.

(a) 1980 to 1989: SWC decreasing – this period involved substantial decreases in Red-necked Stint SWCs in both south-east Tasmania and Victoria (Figure 8). Fluctuations in south-east Tasmanian WWC / SWC ratios corresponded well with Victorian cannon net proportions. This suggested that changes in both annual populations were influenced by Arctic breeding success and were responding coherently. However, Victorian cannon net estimates were 2.2 times greater than the south-east Tasmanian WWC / SWC ratios (Table 1).

(b) 1991 to 2005: SWC increasing – Both the Victorian and south-east Tasmanian Red-necked Stint populations were stable or increasing throughout this period (Figure 8). The good correspondence in between year fluctuations in the two estimates of juvenile recruitment continued, again suggesting that recruitment was influenced by Arctic breeding success. However, in this period the mainland cannon net estimates were only 1.7 times the WWC / SWC ratios (Table 1).

(c) 2006 to 2015: SWC decreasing in Tasmania – In this period the trends and correspondence between the south-east Tasmanian and Victorian populations were less consistent (Figures 10 and 11). In Table 1 the results have been divided into two five year periods to reflect temporal differences in the south-east Tasmanian data. SWC numbers were decreasing in south-east Tasmania throughout, but with some spikes (Figure 2). Unfortunately, there was no corresponding published AWSG PMP data for Victoria. In contrast to the previous periods, there was no correspondence between the annual fluctuations in Victorian cannon net and south-east Tasmanian WWC / SWC juvenile proportions. Between 2006 - 2010 the ratio of the Victorian cannon net / south-east Tasmanian WWC / SWC estimates increased to 1.7 (Table 1), consistent with the higher level of this ratio for the period 1980 - 1989, when both populations were decreasing. Between 2011 and 2015 the ratio fell to 0.83 (Table 1) indicating that juvenile recruitment was higher in south-east Tasmania than in Victoria. However, with the exception of 2015, the south-east Tasmania population continued to decline.

To investigate this surprising result, we compared the number of juveniles recruited based on cumulative WWCs with the number required to sustain the south-east Tasmania population (Table 1). In the periods 1980 - 1989 and 2006 - 2010, the WWC estimates were only 21 and 26% of the numbers of juveniles required to sustain the population at a constant annual mortality rate of 20%. This proportion increased to 87% for the period 1990 - 2005 when the population was increasing. In marked contrast, for 2011 - 2015 the WWC estimates indicated recruitment of 117% of the juvenile required to sustain the SWC population at a time when, with the exception of 2015, the SWC numbers continued to decrease. This suggests that a fundamental change had occurred in the behaviour of Red-necked Stints (e.g. decreased survival, juveniles recruited to south-east Tasmania no longer philopatric to the area in winter as adults, or a combination of these mechanisms).

Mortality

Within this study, the 80% annual survival (20% mortality) determined by Harris (1983) for birds captured in Pipeclay Lagoon was used for all analyses (see methods). Rogers and Gosbell (2006) modelled the Victorian population trend as a function of Red-necked

Stint annual survival using cannon net juvenile capture rates to estimate annual recruitment. The best fit for the correlation between their model and the AWSG PMP Victorian summer count data indicated 85% annual survival (15% mortality) over the period 1980 - 2005. There is no obvious reason why the survival of Red-necked Stints in south-east Tasmania should be appreciably different from those spending the Austral summer in mainland Australia. It is possible that Rogers and Gosbell's higher annual survival rate (lower mortality) is a superior estimate to Harris' value, because it was determined over a longer period, however we preferred to use the value measured in south-east Tasmania. When a population is stable the overall annual survival rate (which may fluctuate annually) determines the mean level of recruitment necessary to sustain the population balance. Migrating stints may intermittently experience abnormally high annual mortality rates, for instances as a consequence of unfavourable weather conditions during migration and such variations should be taken into account by the 25-year determination made by Rogers and Gosbell (2006). Of more serious concern is the impact of the loss of foraging grounds used during migration, which has been highlighted as a conservation issue for a number of migratory shorebirds (e.g. Clemens *et al.* in press, Studds *et al.* submitted, Murray *et al.* submitted), which could compromise the use of historical measures of mortality we have used in this study.

Emigration

The uncertainty about the numbers or proportions of juveniles moving north each year after spending the Austral summer in south-east Tasmania, and whether they return the following summer as second year birds has been raised previously. Analysis of inter-annual recaptures at Pipeclay Lagoon in south-east Tasmania by Harris (1983) suggested that Red-necked Stints showed little indication of emigration from the region, including the movement to the other local sites identified by Thomas in south-east Tasmania. This conclusion is supported by the analysis in this study showing that with the exception of 2011 – 2015 juvenile recruitment, as indicated by WWC numbers, was insufficient to sustain the SWC population sizes. However, there have been significant habitat changes since that time which may have adversely affected the suitability of the south-east Tasmanian shorebird resorts. For instance, commercial cultivation of Pacific Oysters *Crassostrea gigas* has increased substantially, particularly at Pipeclay Lagoon and Barilla Bay. These commercial developments have potential impacts to shorebirds in terms of disturbance, particularly at roosts and decreasing food availability. Leases have decreased the tidal area available for shorebird feeding, and the use of vehicles in inter-tidal and supra-tidal areas compacts the substrate. In addition, rising sea levels and increased prevalence of storm driven high tides has eroded many of the spits and shell grit banks previously used as high tide roosts, particularly at Lauderdale (Newman 2015). Recently, dry conditions have increasingly removed the super-tidal feeding opportunities provided by Calvert's and Clear Lagoons, which are important options for small shorebirds when they need to put on body fat before their migration north. Collectively, these factors may have decreased the suitability of the south-east Tasmanian area and induced juveniles to seek other options during winter. If they move north, they are more likely to find superior conditions elsewhere when the mainland shorebird sites are below their holding capacity. This raises the possibility that emigration of juveniles increases when Victorian - and by inference the Australian population - of Red-necked Stint is at low levels.

Implications for south-east Tasmanian Population

Rogers and Gosbell (2006) successfully explained many features of the Victorian PMP SWC data for Red-necked Stint for the period 1980 – 2005 using a demographic model in which population fluctuations were driven by variations in annual recruitment of juveniles, and mortality of all age groups was assumed to be constant. South-east Australian, primarily Victorian (and referred to as Victorian in this paper), cannon net juvenile proportions were used to predict annual recruitment rates. The validity of using cannon net juvenile proportions as an indicator of Arctic breeding success has been questioned because the levels of mortality between fledging and subsequent capture in Australia are unknown (McCaffery 2006). However, the ratios are a valid index or proxy of annual breeding success, provided that they are related to the adult fraction of a population (Weston 1992), an approach adopted by Rogers and Gosbell (2006) in their demographic model.

Based on Rogers and Gosbell (2006) the differences in the long-term trends in the south-east Tasmanian and Victorian PMP Red-necked Stint population sizes (Figures 8 and 9) imply that there are differences in the juvenile recruitment rates of the two populations. In the absence of comparable long-term cannon net juvenile proportions in the south-east Tasmania, the use of the WWC / SWC ratio was examined as a surrogate indicator of juvenile recruitment (Figure 10) and three significantly distinct relationships were found (Figure 11). In making these comparisons unadjusted juvenile ratios, which give relative estimates of annual juvenile recruitment in the two areas were used. The differences in the three relationships provide insights into the mechanism of juvenile recruitment in south-east Tasmania, and the consequent fluctuations in the Red-necked Stint SWC:

(a) 1980 to 1989 - During this period, the cumulative sum estimates of the adjusted juvenile ratios in south-east Australia indicated a period of below average recruitment (Gosbell and Rogers 2006), which coincided with a period of sustained decrease in the Victorian PMP SWC population. For the corresponding period there was an even more pronounced and extended decrease in the south-east Tasmanian population, suggesting that the short-fall in the level of recruitment necessary to sustain the local population of Red-necked Stints was greater than that experienced in Victoria. The 2.2 times difference in the WWC / SWC estimate of the juvenile proportion in south-east Tasmania compared with the

Victorian cannon net estimates is consistent with this interpretation (Table 1). However, the WWC / SWC measure underestimates the juvenile recruitment rate, if juveniles return to south-east Tasmania the following summer as 2nd year, non-breeding birds, after moving north at the time of the WWC as indicated to occur by the analysis presented in a previous section of this paper.

(b) 1991 to 2005 – The cumulative sum estimates indicated that Victorian juvenile proportions were at or above long-term average levels throughout this period (Rogers and Gosbell 2006) and the Victorian PMP SWC of Red-necked Stints recovered and increased above the 1980 levels (Figure 8). A similar increase was observed in the south-east Tasmanian SWC (Figure 8) consistent with the much higher juvenile recruitment levels (Figure 10 and Table 1). During this period, the Victorian cannon net proportions were only 1.4 times greater than the south-east Tasmanian WWC / SWC proportions. This suggests that comparable juvenile recruitment rates were occurring in the two areas and that majority of the south-east Tasmanian birds were remaining in the area rather than moving north in winter.

(c) 2006 to 2015 - While the Victorian cannon net data indicated a steadily increasing trend in juvenile recruitment, the south-east Tasmanian WWC / SWC proportions indicated a period of decrease between 2006 and 2010, followed by increased and variable levels through to 2015 (Figure 10). The low WWC / SWC ratios between 2006 and 2011 (Figure 10) coincided with a decrease in the south-east Tasmanian Red-necked Stint population (Figures 2 and 3), which reached a 50-year low. The WWC / SWC ratios increased between 2012 and 2014, but there was no corresponding increase in the south-east Tasmanian SWC until 2015. The period 2011-2015 was the only occasion in which the south-east Tasmanian WWC / SWC juvenile proportions exceeded the corresponding Victorian cannon net estimates and the cumulative WWC exceeded the number of juveniles required to sustain the south-east Tasmanian population (Table 1). The results for 2011-2015 are not consistent with the qualitative explanation we have provided for the variations in the south-east Tasmanian data, namely that the size of summer population is driven by juvenile recruitment and juveniles subsequently return annually to the area in the Austral summer throughout their adult lives. Decreased fidelity by juveniles, and even adults, to south-east Tasmania as a consequence of a deterioration in the suitability of south-east Tasmania as habitat for Red-necked Stint is one possible explanation.

Collectively the experience over these three periods is qualitatively consistent with a model in which short-term (i.e. inter-annual) recruitment of juveniles is related to Arctic breeding conditions, but the number of juveniles reaching south-east Tasmania is attenuated by conditions on the Australian mainland, which determine the longer-term (i.e. decadal or longer) trends. Thus, during periods of sustained below average Arctic breeding success, the population of Red-necked Stints decreases in Victoria and other areas of mainland Australia. We suggest this may decrease the density of stints in areas where they spend the Austral summer and the competition for food in these areas decreases (i.e. the sites are below their carrying capacity).

It is suggested that juvenile Red-necked Stints, which migrate separately and later than adults, find suitable areas to spend the Austral summer at more northern latitudes within Australia more easily when the mainland population is at low levels. For instance, in 1988 when the Victorian population was at a minimum as indicated by the AWSG PMP count (Figure 8), a lower proportion of the juveniles reaching Australia would have moved to southern latitudes, especially to south-east Tasmania, than when the population was at higher levels. This situation would have been exacerbated during periods when increased rainfall in inland areas of the mainland increased the amount of available habitat. Support for the proposed model is provided by the hysteresis in the south-east Tasmanian trends relative to those experienced in Victoria (Figure 8). It is suggested that the continued fall and later recovery of the south-east Tasmanian population is a consequence of the delay associated with gradual build-up in the density of Red-necked Stints in the wetlands of mainland Australia and Victoria, eventually forcing more juveniles seeking foraging opportunities to move even farther south.

The proposed model also explains the duality of the short-term fluctuations in population size driven by Arctic breeding success superimposed on the long-term trends driven by the extent to which wetlands supporting stints approach their carrying capacity. It is also consistent with the concept of leapfrog migration in which a group of birds breeding at more northerly latitudes migrates beyond another group to become the more southerly group during winter (in the present case the Austral summer). This phenomenon is widespread among shorebirds *Charadrii* and has been attributed to both intra- and inter-specific competition (Boland 1990). North American shorebirds provide examples of both intra-specific (e.g. Rock Sandpiper *Calidris ptilocnemi*) and inter-specific competition, forcing leapfrog migrants father south in their non-breeding range. The predominance of small species at the southern extremities of the North American flyway was attributed to inter-specific contribution. The occurrence of the Red-necked Stint as the smallest and most numerous shorebird species in Tasmania at the southern extremity East Asian – Australasian Flyway is consistent with this mechanism. However, Pienkowski *et al.* (1985) have questioned the inter-specific mechanism on the basis that species should have evolved foraging modes which are sufficiently different to prevent competition.

This qualitative explanation reinforces the value of monitoring the south-east Tasmanian population by providing a sensitive litmus test, and an improved understanding of what is happening to Red-necked Stint populations elsewhere in Australia and in the EAAF. It is intended to develop and test these explanations in a more quantitative manner in a subsequent paper.

CONCLUSIONS

The size of the Red-necked Stint population of south-east Tasmania has fluctuated between 400 and 4000 during the last 50 years, and is currently (2015) at the lower end of that range. The observed trends in summer numbers were similar to those indicated by the AWSG PMP counts for Victoria, which have been conducted since 1980. However, the south-east Tasmanian decreases were larger, more prolonged, and subsequent recovery was less complete.

Cannon netting has shown that Red-necked Stints overwintering are predominantly juvenile and variations in WWCs were used to provide an indication of the number of juveniles recruited annually to south-east Tasmania. Annual fluctuations in the proportion of Red-necked Stints overwintering (WWC / SWC) correlate with juvenile proportions in cannon net catches in Victoria, which provides credence to the use of WWC / SWC ratios for understanding juvenile recruitment to south-east Tasmania. Conversely, Victorian cannon net proportions might be used as indicators of annual variations in juvenile recruitment of Red-necked Stints and other species. For instance, juvenile Curlew Sandpipers seldom over-winter in south-east Tasmania and WWC / SWC data are not available.

When the Victorian population of Red-necked Stints, as indicated by AWSG PMP count is decreasing, the estimates of juvenile proportions in south-east Tasmania are much lower than in Victoria.

These results can be qualitatively explained by a model in which juveniles move to Tasmania in greater numbers during periods when the density of Red-necked Stints in wintering areas on the mainland approaches carrying capacity. It is suggested that under these conditions, competition for feeding resources with established adults, which migrate earlier, forces juveniles to move farther south in search of superior (Austral) wintering opportunities. Once a suitable location is found, based on the south-east Tasmanian studies, they will usually return to the same area for the rest of their lives.

In summary, the dynamics of fluctuations in the south-east Tasmanian population of the Red-necked Stint are primarily driven by the numbers of Red-necked Stints juveniles migrating to the area annually. Large numbers of juveniles only reach Tasmania when conditions on the Australian mainland make it difficult to find foraging opportunities. The resulting long-term periods of population decrease and increase typically extend several half-lives and are primarily related to conditions on mainland Australia as opposed to Arctic breeding success. Nevertheless, smaller annual fluctuations in juvenile numbers do appear to reflect annual breeding success. The key to understanding this paradox is to appreciate that the juveniles recruited to the south-east Tasmanian area are unlikely to be related to the established adult population.

The above conclusions endorse the wisdom of the late Davis Thomas who initiated the shorebird monitoring in south-east Tasmania and predicted the results would provide a litmus test for trends occurring in mainland Australia and in the EAAF. Conditions elsewhere in the EAAF will determine whether the south-east Tasmanian Red-necked Stint population will ever return to the peak levels experienced during this study. There are also concerns whether the carrying capacity of south-east Tasmania may have been decreased by commercial coastal developments and coastal erosion.

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STATUS OF SHOREBIRDS ON FLORES ISLAND, WALLACEA, INDONESIA, AND IDENTIFICATION OF KEY SITES

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The shorebirds of most Wallacean islands, including Flores (13,540 km^2), are poorly-known. We document new information on the status of shorebirds on Flores from more than 611 visits to 37 sites during 2000-2013, and review records from a total of 55 sites. Forty-two shorebird species have been recorded on Flores: five resident breeding species (e.g. Comb-crested Jacana *Irediparra gallinacea* and Javan Plover *Charadrius javanicus*), one probable breeding-visitor (Greater Painted-snipe *Rostratula benghalensis*), 33 Palearctic non-breeding visitor, one Nearctic vagrant, and two Austral non-breeding visitors (Australian Pratincole *Stiltia isabella* and Masked Lapwing *Vanellus miles*). The Greater Painted-snipe is the only species that has not been recorded during the past 40 years. Coastal wetland sites are relatively small (<1,000 ha) and lack extensive intertidal mudflats. Maximum total counts of migratory shorebirds were low (<500-1,000 birds) with only four migrant shorebirds counts of >100 individuals. Most Palearctic migrants were rare, with 19 of 33 species recorded on fewer than 10 occasions / days. The Labuan Bajo area (22 migratory shorebirds) and Maumere Bay (28 migratory shorebirds) are at least nationally significant sites for shorebirds. Other interesting results were the: (1) presence of Javan Plover at Labuan Bajo which may regularly hold more than 1% of the global population; (2) the rarity of Red-necked Stint *Calidris ruficollis*, Curlew Sandpiper *C. ferruginea*, Sharp-tailed Sandpiper *C. acuminata* and Australian Pratincole, which occur frequently, and in substantially larger numbers, on nearby Timor Island; and (3) the absence of several migrant shorebirds which apparently overfly Flores (e.g. Black-tailed Godwit *Limosa limosa* and Red Knot *Calidris canutus*). We also make suggestions for further field surveys.

INTRODUCTION

Flores is a large, high, elongated (13,500 km^2; 2,376 m; 360 km long) and volcanically active island in the Wallacean global biodiversity hotspot. It is the most biologically significant island in the North Nusa Tenggara Endemic Bird Area with at least five endemic bird species and 21 other globally restricted-range bird species among the *c.*180 resident birds known from the island (Stattersfield *et al.* 1998, Verhoeye & Holmes 1999, Trainor & Lesmana 2000). The shorebirds of Flores have been poorly documented. This probably results from the limited extent of shorebird habitat such as intertidal mudflats and lakes, combined with the focus of colonial collectors and recent ornithological visitors on the highly endemic forest bird fauna. The unusual island shape, essentially a crude 'scorpion' ('body' in west, 'tail' in east), has extensive coast and shoreline (*c.* 1800 km), beach, fringing coral reefs and numerous bays. There are few large bays, apart from Maumere, Terang and around Riung, which have been suitable for development of stands of mangrove and intertidal mudflats. Most mangrove is on the north coast, particularly in the west. Some of the most extensive wetland habitat is ricefields (>650 km^2) and short grass, suitable for 'grasshopper-eating' shorebirds.

Knowledge of the composition and distribution of birds on Flores has improved slowly since the intensive 19th century collecting efforts. The history of ornithological exploration and generation of knowledge of the birds of Flores has been well documented by White & Bruce (1986) and in greater detail by Mees (2006). The first collectors arrived in 1862: J. Semmelink was based at Larantuka in far-east and during 1862-1863 collected about 45 bird species. Independently, C. Allen, who worked as A.R Wallace's assistant also appears to have been based at Larantuka (Mees 2006). The first shorebirds were collected by C. Allen in 1862 including Pacific Golden Plover *Pluvialis fulva*, Whimbrel *Numenius phaeopus*, Greater Sand Plover *Charadrius leschenaultii* and White-headed Stilt *Himantopus leucocephalus*. M.W.C. Weber (1888-1889) collected Comb-crested Jacana *Irediparra gallinacea* and Red-necked Stint *Calidris ruficollis* during visits to west and east Flores in 1888-1889. Two naturalist priests made major advances in knowledge of birds over several decades of specimen collection and field observation, especially in west Flores. Father Jilis A.J. Verheijen arrived on Flores in 1935 but began collecting birds from 1952 until about 1980, mainly in Manggarai District. This included the first Flores records of Greater Painted-snipe *Rostratula benghalensis* by J. Verheijen (Paynter 1963), and observations of Red-necked Phalarope *Phalaropus lobatus* (Verheijen 1971). Erwin Schmutz arrived on Flores in 1963 and mainly from 1968-1983 collected specimens of approximately 80 bird species, primarily in the southwest corner of Manggarai District (Trainor & Lesmana 2000, Mees 2006). This included collection of Sanderling *Calidris alba* in 1971 (Mees 2006).

The Wallacean region comprises thousands of oceanic islands on the East Asian-Australasian Flyway (EAAF), between important wetlands for shorebirds on Java and Sumatra and those in northern Australia including Roebuck Bay. According to Coates and Bishop (1997) the Gulf of Bone in Sulawesi and Kupang Bay in West Timor are the only large sites which seem to attract 'significant numbers' of shorebirds in Wallacea. No sites of international significance for shorebirds have previously been identified on Flores (Conklin *et al.* 2014). Most migrants probably overfly Wallacea but for some it provides important refuelling opportunities (Coates & Bishop 1997). Recent satellite tracking from studies in north-west Australia show that Little Curlew *Numenius minutus* and Bar-tailed Godwit *Limosa lapponica* fly-over and sometimes land on, or near, Flores during return migration (MacKinnon *et al*. 2012, Veltheim & Milton 2015). Overall, the status on shorebirds on most islands is poorly known, with studies of migratory shorebirds in the EAAF focussing on the Yellow Sea or wintering grounds in Australia or New Zealand (Choi *et al*. 2016, Szabo *et al*. 2016). Recent surveys at more than 100 wetland sites on Timor Island - 150 km to the southeast of Flores - have improved knowledge of the status of shorebirds on the island (Trainor 2005a, 2011, Trainor & Hidayat 2014). A wide variety of migrant and resident shorebird species were recorded, all in relatively small counts of less than about 400 individual birds, except for the Oriental Pratincole *Glareola maldivarum* (to *c.*3,000 birds). Information on shorebird status on Timor provides a useful baseline to compare the composition, abundance and status of shorebirds on Flores.

This article provides a summary of the status of shorebirds on Flores based on observations by Mark Schellekens (hereafter, MS) during 2000-2013 and review of published and unpublished records to: 1) describe the composition, abundance and seasonal status of resident and non-breeding visiting shorebird species; and 2) identify sites of national or international significance. Particular attention is given to shorebird count data including maximum counts and habitat use.

METHODS

Conventions

Global threat status for shorebird species follows the International Union for Conservation of Nature and Natural Resources [IUCN] (2016).

To identify sites of international significance we use standard criteria such as 'site holds at least 1% of EAAF population' or 'more than 20,000 migrant shorebirds', and to identify sites of national significance we use sites which hold at least 0.1% of the EAAF population, 2,000 migratory shorebirds or presence of at least 15 migratory shorebird species at a site (Commonwealth of Australia 2015). Information on shorebird EAAF population size was taken from MacKinnon *et al*. (2012) or Conklin *et al*. (2014) and information on the population size of Javan Plover *Charadrius javanicus* was from Iqbal *et al*. (2013).

The seasonal occurrence of shorebirds on Flores is classified as: 1) *resident* for shorebirds which breed on Flores and are sedentary; 2) *non-breeding visitor* for Palearctic, Nearctic or Austral species which migrate during specific seasons but do not breed on Flores; 3) *staging* for non-breeding visitors which occur for short periods of days or weeks on Flores; and 3) *breeding-visitor* for shorebird species that breed but are only present on the island for part of the year. The seasonality of several shorebird species is incompletely understood.

Field Survey

During 2000-2013 surveys of shorebirds were made during annual visits to Flores of 4-6 months (total of *c.* 6 yrs). A summary of sites visited by MS, and visits by others (see below) is included as Table 1. MS viewed shorebirds with binoculars and visited the Moni ricefields approximately 500 times (*c.*100-200 ha; Figures 1-2);

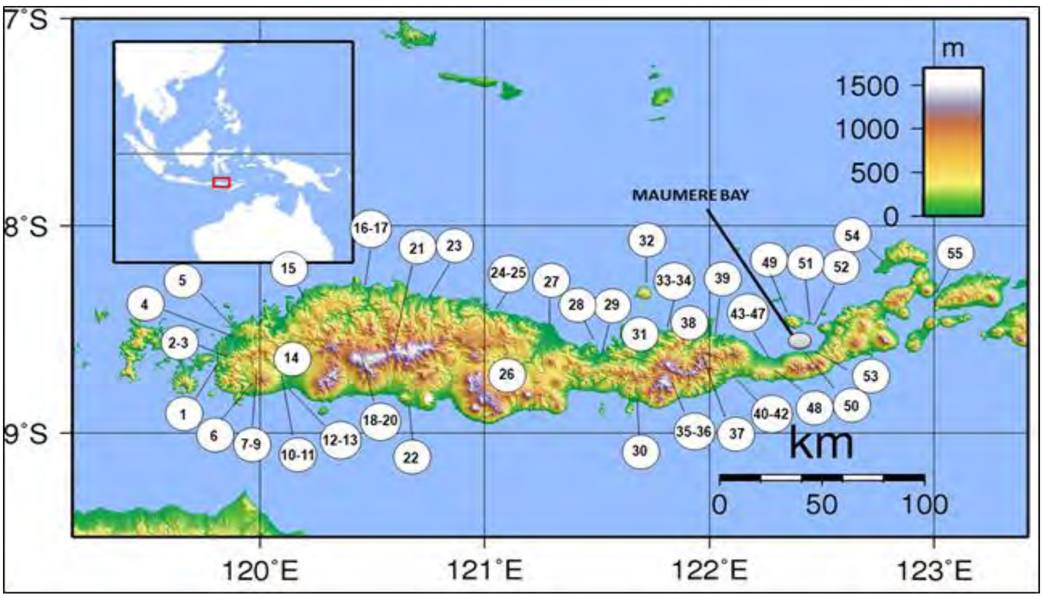

Figure 1. Map of Flores Island and the 55 sites considered in this article. Refer to Table 1 for site names and other details. Source: https://commons.wikimedia.org/wiki/File:Flores_Topography.png and modified by CRT.

with regular visits to Tambak Koliaduk (43 visits; a 20 ha area of aquaculture ponds, mangrove and intertidal mudflats at Maumere in Maumere Bay); Tiwu Bowu (21 visits; a 13 ha permanent freshwater lake with surrounding short grass habitat); Ende-Mbu'u estuary (15+ visits, 30 ha estuary); Pulau Pangabatang (five visits; a 30 ha sandspit islet in Maumere Bay; hereafter referred to as Pangabatang; (Figure 1-2) as well as opportunistic records throughout the island (see Figure 1, Table 1). We provide a summary of shorebird observations by MS, including the total number of field days each species were seen, dated records and counts. Site area was measured in ha using the polygon tool in GoogleEarth Pro, which was probably accurate for some discrete wetlands like lakes, but indicative only for some large and less discrete coastal wetland complexes.

Shorebird Site Documentation

We summarise published and unpublished records of shorebirds on Flores, particularly dated shorebird records from a total of 55 sites including the 37 sites visited by MS (Table 1). Systematic data are not available for all sites. Some sites are included on the basis of single historical shorebird species, while other sites have been surveyed regularly by MS and others, and where survey effort has probably been enough to record most species. Sites mentioned in literature and not visited by MS or CRT were located on maps in Mees (2006), or by searches using internet map programs (Googleearth Pro, http://mapcarta.com, http://wikimapia.org) or with the assistance of colleagues (see Acknowledgements). Site names used in literature have been retained including some dryland sites (e.g. where records of grassland shorebirds such as pratincoles were recorded) and a summary of sites is given as Appendix 1 and Figure 1. Ten sites occur in the large Maumere Bay area on the northern coast (Figure 1).

Survey Effort and Shorebird Knowledge

To illustrate relative survey effort on shorebirds of Flores, we describe temporal patterns in the addition (date of first record) of shorebird species on Flores from 1862 to 2016 based on information collected during the literature review. In addition to documenting shorebird records in this article, all dated species by site records will be submitted to Ebird (2016) and the Indonesian Bird Atlas (http://atlasburung.web.id).

Literature Review

A major review of the Wallacean avifauna by White & Bruce (1986) describes collection and survey efforts on Flores. Modern day visitors to Flores have included: J. Verhoeye (July 1986 to December 1989) who resided at villages in Ende and Sikka Districts and added significantly to knowledge of shorebirds on Flores (Verhoeye & King 1990, Verhoeye & Holmes 1999); T. Andrews visited in 1988 (Andrews 1989); D. Gibbs visited Flores in December 1989 to January 1990 (Gibbs 1996); V. Mason visited Pangabatang in 1989 and 1990 (Mason 1991,1993); the Cambridge University/ Sumbawa-Flores Conservation Project 1993 spent about 1 month surveying birds mostly in tropical forest habitats in West Flores and Pulau Besar in north-central Flores (Butchart *et al*. 1994, 1996); D. A. Holmes made opportunistic bird observations during seven visits to Flores in 1993-1994 (Verhoeye & Holmes 1999); and, the 'Flores '97 Expedition' of the University of East Anglia focused on four sites in Manggarai and Ngada districts in West Flores (Pilgrim *et al*. 2000). Over 7 months in 1997 BirdLife International-Indonesia Programme, WWF and Balai Konservasi dan Sumberdaya Alam (BKSDA) assessed birds and other wildlife at 17 forest blocks with brief visits to several coastal locations including beach, aquaculture ponds and freshwater lakes (Drijvers 1998, Trainor & Lesmana 2000, Trainor *et al*. 2006). Since about 2004 there have been regular annual visits by bird tour parties and independent ornithologists. We include a summary of unpublished data collected by Craig Robson (BirdQuest) mostly in the Labuan Bajo area during annual visits from September 2006 to September 2014.

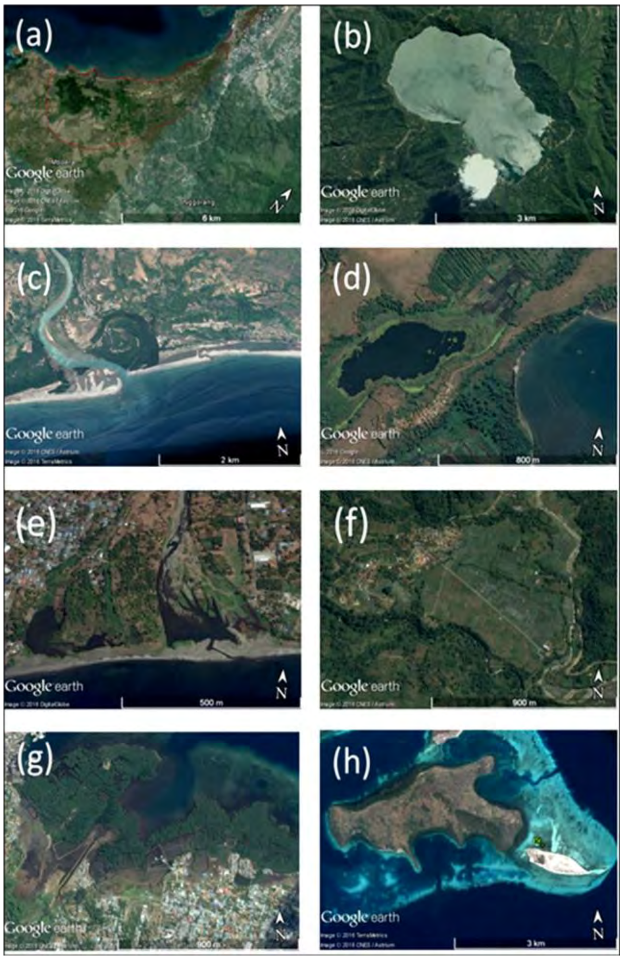

Figure 2. Examples of wetland areas on Flores: (a) Labuan Bajo mudflats and coastal complex (image date 2014); (b) Sano Nggoang crater lake (2014); (c) Nangalili estuary (2014); (d) Lake Tiwu Bowu (2013); (e) Ende-Mbu'u estuary (2014); (f) Moni ricefields (2013); (g) Tambak Koliaduk fishponds and mangroves (2013). (h) Pulau Damhila [left] and Pangabatang [right and green arrow] (2013). Copyright Google Earth 7.1.5, DigitalGlobe, CNES/Astrium and Terrametrics and modified by CRT.

Table 1. Summary of wetland and dryland sites mentioned in the text: location, area, elevation and habitat type. Site names with an asterisk were visited by MS. Refer also to Figure 1.

No.	Site name	Coordinates	Area (ha)	Elevation (m)	Habitat
1	Nggoer	8˚42`18``S, 119˚47`48``E	n/a	sea-level	dryland
2	Look	8˚41`30``S, 119˚49`45``E	n/a	200	dryland
3	Kenari	8˚36`56``S, 119˚51`02``E	n/a	200	dryland
4	Dolat marsh*	8˚34`06``S, 119˚51`07``E	13	18	freshwater marsh / lake
5	Labuan Bajo*	8˚29`54``S, 119˚52`43``E	1200	sea-level	mudflats and coastal complex
6	Nisar	8˚47`47``S, 119˚57`30``E	n/a	140	dryland
7	Lake Sano Nggoang (Nunang-Meer)*	8˚42`10``S, 119˚58`37``E	510	660	crater lake
8	Sesok (or Sisok)	8˚45`24``S, 119˚59`36``E	n/a	400	dryland
9	Nunang (Sano Nggoang)	8˚43`10``S, 120˚00`07``E	n/a	660	dryland
10	Waewako (Wae Wako)	8˚41`35``S, 120˚05`10``E	n/a	80	dryland
11	Lita	8˚43`16``S, 120˚06`26``E	n/a	80	dryland
12	Joneng (Nangalili)	8˚46`57``S, 120˚06`52``E	100	sea-level	beach
13	Nangalili*	8˚47`16``S, 120˚07`49``E	400	sea-level	estuary, sandflats
14	Lembor*	8˚42`26``S, 120˚10`13``E	3800	140	ricefields
15	Bari	8˚21`05``S, 120˚10`54``E	100	sea-level	coastal complex
16	Kedindi (Reo harbor)	8˚17`08``S, 120˚27`09``E	100	sea-level	coastal complex
17	Reo	8˚18`42``S, 120˚29`33``E	340	sea-level	coastal complex
18	Rahong, Wangkung (Ruteng)	8˚36`23``S, 120˚24`25``E	200	1200	ricefields, drainage channels
19	Golo Lusang*	8˚39`48``S, 120˚27`27``E	200	1600	dryland/montane forest
20	Ruteng*	8˚36`56``S, 120˚27`44``E	10,000	1200	ricefields, drainage channels
21	Lake Rana Mese*	8˚38`19``S, 120˚33`40``E	12	1200	crater lake (forest edged)
22	Nangarawa*	8˚49`13``S, 120˚36`21``E	50	sea-level	estuary, sandflats
23	Pota	8˚20`32``S, 120˚45`31``E	100	sea-level	coastal complex
24	Riung (Bugis Pools)*	8˚24` 42``S, 121˚01`18``E	100	sea-level	mudflats and coastal complex
25	Riung*	8˚24`49``S, 121˚01`28``E	100	sea-level	mudflats and coastal complex
26	Soa*	8˚42`20``S, 121˚04`08``E	5000	441	ricefields
27	Mbai (Mbay)*	8˚30`46``S, 121˚19`19``E	5000	sea-level	mangroves and coastal complex
28	Pulau Kinde*	8˚34`00``S, 121˚30`01``E	2	sea-level	mangrove
29	Koborea near Riung*	8˚37`33``S, 121˚29`51``E	400	sea-level	mangrove, estuary
30	Ende-Mbu'u estuary*	8˚50`45``S, 121˚40`39``E	40	sea-level	estuary, sandspits
31	Danau Rana Mbata*	8˚33`06``S, 121˚41`00``E	18	14	freshwater lake
32	Pulau Pulue	8˚20`25``S, 121˚42`23``E	4000	sea-level	beach, dryland
33	Mausambi*	8˚30`05``S, 121˚46`38``E	200	sea-level	beach
34	Maurole*	8˚30`35``S, 121˚48`09``E	100	sea-level	beach
35	Kelimutu National Park*	8˚46`05``S, 121˚49`19``E	1000	800-1700	dryland/montane forest
36	Moni village*	8˚44`55``S, 121˚51`06``E	200	625	ricefields
37	Danau Tiwu Sora*	8˚39`17``S, 121˚57`00``E	3	1120	freshwater lake/forest edged
38	Ndondo (W of Tiwu Bowu)*	8˚29`10``S, 122˚00`30``E	150	sea-level	mangrove, estuary
39	Danau Tiwu Bowu*	8˚30`34``S, 122˚00`02``E	100	20	freshwater lake, ricefields
40	Mauloo (E of Paga)*	8˚46`48``S, 122˚02`38``E	100	sea-level	coralline beach
41	Paga*	8˚46`48``S, 122˚02`38``E	300	sea-level	sandy beach
42	Kali Wajo estuary (Paga)*	8˚45`45``S, 122˚03`26``E	14	sea-level	estuary
43	Magepanda*	8˚32`13``S, 122˚02`41``E	Sea	sea-level	beach, mangrove
44	Tambak Koliaduk*	8˚36`29``S, 122˚12`32``E	80	sea-level	mangrove, fishponds
45	Maumere*	8˚37`05``S, 122˚13`08``E	200	sea-level	beach, dryland
46	Maumere airport (Waioti)*	8˚38`26``S, 122˚14`19``E	100	36	air-field, short grass
47	Waiara*	8˚38`02``S, 122˚18`34``E	20	sea-level	beach
48	Watublapi*	8˚41`55``S, 122˚18`45``E	50	450	dryland/village
49	Pulau Besar	8˚28`01``S, 122˚23`48``E	5700	0-800	beach, reef, mangroves, dryland, beach, mangrove
50	Magaramut	8˚36`35``S, 122˚23`00``E	100	sea-level	beach
51	Pulau Damhila	8˚28`21``S, 122˚26`01``E	470	sea-level	beach, mangrove
52	Pulau Pangabatang*	8˚28`44``S, 122˚27`42``E	30	sea-level	beach, fishpond
53	Waigete*	8˚36`17``S, 122˚28`40``E	100	sea-level	sandy and coral beach
54	Danau Walbelen (Asmara)*	8˚10`45``S, 122˚47`12``E	50	30	crater lake, forest edged
55	Larantuka*	8˚18`34``S, 123˚01`12``E	100	sea-level	beach

RESULTS

Status of Shorebirds on Flores

A total of 42 shorebird species have been recorded on Flores including five resident breeding species, one visiting breeding species of unknown origin, 33 Palearctic non-breeding visitors, one Nearctic non-breeding visitor and two Austral non-breeding visitors. MS recorded 40 shorebird species and had no records of Greater Painted-snipe and Curlew Sandpiper *Calidris ferruginea*. The most regularly recorded shorebirds by MS were Common Sandpiper *Actitis hypoleucos*, Whimbrel, Common Greenshank *Tringa nebularia* and Wood Sandpiper *Tringa glareola* (Table 2). Four migrant shorebirds have been recorded on Flores in groups of more than 100 individuals, with the largest counts by MS of Oriental Pratincole (750+ birds), Red-necked Phalarope *Phalaropus lobatus* (75 birds) and Whimbrel (68 birds). Excluding Oriental Pratincole and Red-necked Phalarope, the mean maximum count of the remaining Palearctic migrant shorebirds on Flores (Table 2) was 25.0 (s.e. 5.50).

Most Palearctic migrants were rare with 19 of 33 species recorded by MS on fewer than 10 occasions/ days (Table 2). Six migratory shorebirds may occur on Flores in total numbers of >1,000 individuals (Table 2). Shorebird counts at all sites were low, with highest counts of non-breeding visiting shorebirds at Pangabatang (390+ birds) and Labuan Bajo (180 birds) (Table 3). Ten of the 42 shorebirds recorded are considered as globally threatened: two are categorised as Endangered and eight as Near-threatened. There has been a major increase in knowledge of shorebirds on Flores with only nine shorebird species known from Flores before 1958 and most (60%) shorebird species have been first recorded since 1986 (Figure 3).

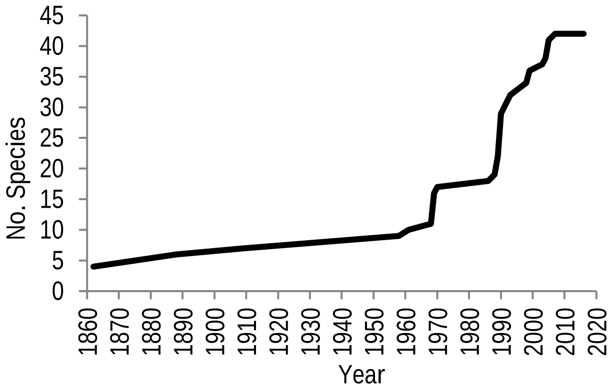

Figure 3. Accumulation of shorebird species (*n* = 42) on Flores Island from 1862-2016.

Table 2. Status of shorebird species on Flores: residence, number of individual day records by MS, maximum count and an approximate estimate of the Flores island population. IUCN conservation status: NT= Near threatened and EN= Endangered. Seasonal status: Av= Austral non-breeding visitor; Nv= Nearctic non-breeding visitor; Pv= Palearctic non-breeding visitor; Vb= Visiting breeder (unknown origin), R= Resident breeding bird.

Common and Scientific name	Status	No. individual day records	Max. count by MS (max. by others)	Estimated island population	EAAF 0.1% of flyway population
Comb-crested Jacana *Irediparra gallinacea*	R	23	30(50)	<100 pairs	n/a
Greater Painted-snipe *Rostratula benghalensis*	Vb	0	0(?)	<200 pairs	100-250
White-headed Stilt *Himantopus leucocephalus*	R?	12	39(9)	<200	100-250
Masked Lapwing *Vanellus miles*	Av	3	7(0)	<20	n/a
Grey Plover *Pluvialis squatarola*	Pv	11	49(100+)	<400	125
Pacific Golden Plover *Pluvialis fulva*	Pv	62	81(40)	<500	100
Little Ringed Plover *Charadrius dubius*	Pv	1	1(8)	<20	25
Kentish Plover *Charadrius alexandrinus*	Pv	1	1(3)	<10	100
Javan Plover *Charadrius javanicus*[NT]	R	2	15(35)	<50 pairs	20-60
Malaysian Plover *Charadrius peronii*[NT]	R	l	6(7)	<100 pairs?	10
Lesser Sand Plover *Charadrius mongolus*	Pv	23	31(2)	<500	140
Greater Sand Plover *Charadrius leschenaultii*	Pv	22	38(20)	<500	110
Oriental Plover *Charadrius veredus*	Pv	6	7(20)	<500	70
Little Curlew *Numenius minutus*	Pv	2	3(2)	<20	180
Whimbrel *Numenius phaeopus*	Pv	85	68(100+)	1,000-2,000	100
Eurasian Curlew *Numenius arquata*[NT]	Pv	2	1(1)	<5	c.300
Eastern Curlew *Numenius madagascariensis*[EN]	Pv	12	3(5)	<100	38
Bar-tailed Godwit *Limosa lapponica*[NT]	Pv	14	15(40)	<50	325
Common Redshank *Tringa totanus*	Pv	47	17(30)	<200	75
Marsh Sandpiper *Tringa stagnatilis*	Pv	6	6(15)	<200	100-1,000
Lesser Yellowlegs *Tringa flavipes*	Nv	1	1(0)	<5	100-1,000
Common Greenshank *Tringa nebularia*	Pv	64	19(50)	<200	60
Wood Sandpiper *Tringa glareola*	Pv	62	25(10)	500-1,500	100-1,000
Terek Sandpiper *Xenus cinereus*	Pv	4	5(10)	<50	60
Common Sandpiper *Actitis hypoleucos*	Pv	157	25(20)	1,000-2,000	25
Grey-tailed Tattler *Tringa brevipes*[NT]	Pv	32	33(32)	<200	50
Ruddy Turnstone *Arenaria interpres*	Pv	6	9(?)	<100	35
Asian Dowitcher *Limnodromus semipalmatus*[NT]	Pv	2	4(0)	<5	24
Swinhoe's Snipe *Gallinago megala*	Pv	43	<6(?)	3,000-5000	25-100
Pin-tailed Snipe *Gallinago stenura*	Pv	19	<6(?)	1,000-3,000	25-1,000
Great Knot *Calidris tenuirostris*[EN]	Pv	3	3(2)	<10	375
Sanderling *Calidris alba*	Pv	2	3(1)	<100	22
Red-necked Stint *Calidris ruficollis*[NT]	Pv	8	21(100)	<200	325
Long-toed Stint *Calidris subminuta*	Pv	4	16(1)	<500	25
Sharp-tailed Sandpiper *Calidris acuminata*	Pv	4	4(2)	<100	160
Curlew Sandpiper *Calidris ferruginea*[NT]	Pv	0	0(1)	<20	180
Broad-billed Sandpiper *Limicola falcinellus*	Pv	1	2(1)	<20	25
Ruff *Philomachus pugnax*	Pv/Nv	1	2(0)	<5	
Red-necked Phalarope *Phalaropus lobatus*	Pv	6	75(10,000s)	?5,000-20,000	100-1,000
Beach Stone-curlew *Esacus magnirostris*[NT]	R	2	2(?)	<20 pairs?	
Australian Pratincole *Stiltia isabella*	Av	13	7(4)	<200	
Oriental Pratincole *Glareola maldivarum*	Pv	7	750(85)	?<5,000	2,880

Table 3. Status of shorebird species at selected sites on Flores. +, denotes recorded by Mark Schellekens (MS), and 0 denotes recorded by Craig Robson (CR, at Labuan Bajo) or other visitors.

Common and Scientific name	Labuan Bajo		Maumere Bay								
	MS	CR	Pangabatang	Tambak Koliaduk	Waira	Moni	Ende-**Mbu'u estuary**	Riung	Tiwu Bowu	Mausambi	Nangarawa
White-headed Stilt *Himantopus leucocephalus*	+0		+	+	+		+		+	+	
Grey Plover *Pluvialis squatarola*			+0	+							
Pacific Golden Plover *Pluvialis fulva*	+0		+	+0	+	+	+		+		0
Little Ringed Plover *Charadrius dubius*	0		+0								
Kentish Plover *Charadrius alexandrinus*	0		+								
Javan Plover *Charadrius javanicus*	+0	0									
Malaysian Plover *Charadrius peronii*	+		+0	+				0		0	0
Lesser Sand Plover *Charadrius mongolus*	+	0	+	+	+0					+	0
Greater Sand Plover *Charadrius leschenaultii*	+0	0	+	+0			+	0		+	
Oriental Plover *Charadrius veredus*			+	+0					0	+	
Little Curlew *Numenius minutus*				+					+0		
Whimbrel *Numenius phaeopus*	+0	0	+0	+0	+			+0		+	
Eurasian Curlew *Numenius arquata*	0			+							+
Eastern Curlew *Numenius madagascariensis*	+0	0	+0	+0				+		+	+
Bar-tailed Godwit *Limosa lapponica*	0	0	+0	+0							
Common Redshank *Tringa totanus*	+0	0	+0	+0				0	+		
Marsh Sandpiper *Tringa stagnatilis*	+0		+	+0							
Lesser Yellowlegs *Tringa flavipes*				+							
Common Greenshank *Tringa nebularia*	+0	0	+0	+0	+						
Wood Sandpiper *Tringa glareola*	+0			+0		+		+	+0	+	
Terek Sandpiper *Xenus cinereus*	0	0	+	+0				0			0
Common Sandpiper *Actitis hypoleucos*	+0	0	+0	+0		+		0	+0	+	0
Grey-tailed Tattler *Tringa brevipes*	+0	0	+0	+0	+			0			
Ruddy Turnstone *Arenaria interpres*			+	+							
Asian Dowitcher *Limnodromus semipalmatus*			+								
Swinhoe's Snipe *Gallinago megala*				?		+				?	
Pin-tailed Snipe *Gallinago stenura*						+					
Great Knot *Calidris tenuirostris*	0	0		+0			+		+		
Sanderling *Calidris alba*			+0	+							
Red-necked Stint *Calidris ruficollis*	+0	0	+0	+0							
Long-toed Stint *Calidris subminuta*			+	+0			+				
Sharp-tailed Sandpiper *Calidris acuminata*				+0					+	+	
Curlew Sandpiper *Calidris ferruginea*	0	0									0
Broad-billed Sandpiper *Limicola falcinellus*	0						+				
Ruff *Philomachus pugnax*			+	+							
Red-necked Phalarope *Phalaropus lobatus*	0	0					+				0
Beach Stone-curlew *Esacus magnirostris*	0		+0								0
Australian Pratincole *Stiltia isabella*				+					+		
Oriental Pratincole *Glareola maldivarum*				+							
Total Palearctic non-breeding visitors	21	14	22	26	5	5	6	8	8	9	7
Total shorebird species	25	15	25	30	6	5	7	9	11	11	9
Max. count Palearctic non-breeding visitors	180	149	390+	131+	31	21	35	<100	37	<100	<100

Annotated List

Where relevant the following annotated list begins with IUCN threatened species status, then with a broad statement on the abundance and seasonal status of the species on Flores, followed by a summary of observations by MS including counts (and frequency of records for sites regularly visited), and finally a paragraph summarizing previous published and unpublished records from Flores, and comparison of shorebird status on Timor and Wallacea / Indonesian archipelago.

Comb-crested Jacana *Irediparra gallinacean*

Locally common resident. Common at Tiwu Bowu where 15-30 birds were recorded during every visit; on 16 Oct 2006 an adult with two chicks were observed. One new site record at Lake Rana Mbata where more than 10 were present on 4 Nov 2007 and three were present on 11 Dec 2007.

Collected by M.W.C. Weber at Bari on 26-28 Nov 1888 (Mees 2006); observed by E. Schmutz at Pota (swamp) on 10 Jun 1974. Considered as a common year-round resident at Tiwu Bowu with several 'tens of pairs' (Verhoeye & Holmes 1999) or 'a very common breeder at Tiwu Bowu' (Verhoeye in Coates & Bishop 1997). Approximately 50 were noted at Tiwu Bowu in Aug-Sep 1998 (Drijvers 1998). On Timor, Trainor (2011) noted four breeding records from Dec to May at Lake Iralalaro. A regionally rare resident shorebird with very few wetlands occupied in Wallacea; Lesser Sundas records are restricted to Timor, Roti, Sumba, Flores and Sumbawa (Coates & Bishop 1997).

Greater Painted-snipe *Rostratula benghalensis*

No records by MS. The only Flores records are those by J.A.J. Verheijen who collected three (two held in MCZ and one collected on 14 Sep 1971 in RMNH). A specimen collected in Jul was breeding (Paynter 1963). Four sets of eggs were collected at Soa (Bajawa district) from nests housed at RMNH – these are dated as 23 May 1961 (four eggs), 29 Jun 1961 (sets of two and four eggs) and 31 May 1961 (two eggs) (Mees 2006). The eggs were probably collected by Verheijen's assistant A. Mommersteeg (Mees 2006). Verheijen (1961) lists nest records as Apr (two nests), May (2) and Jun (1). The status of Greater Painted-snipe is unclear on Flores and throughout the Indonesian archipelago. Breeding in late Jun and Jul and presence in Sep suggests that could be resident on Flores, rather than a wet season breeding-visitor.

White-headed Stilt *Himantopus leucocephalus*

Status unclear, either local breeding bird, or a visitor in small numbers. MS had a total of only 14 records during Sep to Dec with the maximum count of 39 at Ende-Mbu'u estuary on 3 Dec 2005. Other records: Pangabatang (18 including one immature on 7 Dec 2004), Labuan Bajo mudflats (1-3), Mausambi beach (two), Tambak Koliaduk (1-17), Waiara beach (27 and 9) and Tiwu Bowu (two).

A specimen was collected at Kenari in 11 Jul 1969 and at Nunang (Lake Sano Nggoang) and on 10 Jan 1977 (Schmutz 1977, Mees 2006). Noted as present in 'small numbers' in wet ricefields, swamps and marshy lakes throughout the year but especially during Apr to Jun (Verhoeye & Holmes 1999). Nine observed in the Dolat marsh area south of Labuan Bajo in Nov 1999 (Allwood 1999) and one present at the same site on 1 Sep 2005 (Bauer 2005). On Timor the White-headed Stilt breeds locally, for example at Kupang Bay (Trainor 2011) with a build-up of numbers in Mar-Apr and maximum count of 338 in May in Timor-Leste (Trainor 2005a). In Wallacea considered as a likely visitor from Australia based on specimens dated Apr-Nov (White & Bruce 1986), but on Flores it is present in all months. The Nusa Tenggara population has been mapped as a 'winter visitor' (Pierce *et al*. 2016) presumably referring to visiting Australian birds. In Australia White-headed Stilt is considered to be dispersive and with 'probably no regular northward movement from Aust. to PNG' and no specific mention of the likelihood of movement into Wallacea (Marchant & Higgins 1993). White-headed Stilt is known to breed as far west as Sumatra (Iqbal 2009).

Masked Lapwing *Vanellus miles*

A rare non-breeding visitor from Australia. Three records near Maumere in 2007, probably referring to the same birds: seven birds on 24 Sep at Maumere-Frans Seda airport in dry grassland; five on 20 Nov feeding on exposed coral reef at Waigete (12 km east of Maumere on the Larantuka road); and four at Maumere-Frans Seda airport on 21 Dec (Trainor *et al*. 2009).

In 2005, 2-4 birds were observed in Timor-Leste, and 3-13 at Kupang Bay, West Timor (Trainor *et al*. 2009). There are further unpublished records from Timor-Leste and it may be a regular near-annual visitor in small numbers.

Grey Plover *Pluvialis squatarola*

An uncommon migrant. Common only at Pangabatang were relatively large flocks were observed including a maximum count of 49 on 11 Nov 2004. At Tambak Koliaduk recorded during eight of 43 visits with a maximum of six noted on 14 Sep 2004.

Relatively few records but with large counts of *c*.40 birds on Pangabatang on 6 Oct 1990 and more than 100 at this site on 29 May 1993 (Mason 1991, 1993). Otherwise observed as ones and twos along the coast at Mauloo and Mbai (Verhoeye & Holmes 1999).

Pacific Golden Plover *Pluvialis fulva*

A regular and common non-breeding visitor. Recorded at many locations during Augto Mar from sea-level to 700 m: Waiara (51 birds on 24 Nov 2002), Ende-Mbu'u estuary (15 on 17 Dec 2005); common at Pangabatang (47 on 8 Oct 2004, 81 on 7 Dec 2004, 13 on 11 Nov 2005 and seven on 17 Oct 2006). Common also at Tambak Koliaduk with a mean count of 26 birds with high counts of 76 on 3 Nov 2004; 73 on 19 Dec 2002 and 71 on 23 Nov 2002. At Tiwu Bowu 35 observed in fallow ricefields on 28 Sep 2005. An inland record of a single bird was seen feeding in a freshly planted rice field in Moni at *c.*700 m amongst a flock of 17 Wood Sandpipers on 10 Sep 2004. At Labuhan Bajo seven present on 23 Oct 2004 and 45 on 21 Oct 2005.

A specimen was obtained by Schmutz near Nisar (11 May 1969, Leiden 178: R. Dekker *in litt.* 1993 to E. Schmutz), with an observation between Sesok and Nangalili in Dec 1969. Considered as a 'very common migrant to the coast' from early Aug to at least mid-Apr, with one inland record at Soa (600 m) (Verhoeye & Holmes 1999). Noted at Nangarawa on 1 Jan 1990 (Gibbs 1996) and present at this site on 1 Oct 2001 (Benstead & Benstead 2001). About 30 birds were present at Tambak Koliaduk in Sep 1998 (Drijvers 1998). Two were noted south of Labuan Bajo in Nov 1999 (Allwood 1999), with a maximum count at this site of 40 on 21 Sep 2011 (C. Robson *in litt*. 2011). Regarded as a common to common staging and non-breeding visitor (Coates & Bishop 1997) and one of the most regularly recorded migratory shorebirds on Timor (Trainor 2005a).

Little Ringed Plover *Charadrius dubius*

Rare non-breeding visitor. Just a single record by MS of one bird at Pangabatang on 11 Nov 2005.

The first island record of eight birds was reported on 29 May 1993 at Pangabatang (Mason 1993). Noted also by De Win and Ericsson (2015) as present at Labuan Bajo in Jul-Aug 2015. A regular visitor to the region with seven records of 1-3 during Sep to Apr noted in Timor-Leste (Trainor 2005a) and considered as an uncommon visitor to Wallacea (Coates & Bishop 1997).

Javan Plover *Charadrius javanicus*

NEAR THREATENED. Local resident in west of island. Only known from the vicinity of the Labuan Bajo mudflats with 15 recorded by MS on 21 Oct 2005 and nine on 23 Oct 2004.

The first island record was of nine birds in Dolat marsh south of Labuan Bajo in Nov 1999 (Allwood 1999), six in same area on 31 Jul 2001 by Adcock (2001), and one on 1 Sep 2005 (Bauer 2005). Recorded annually near Labuan Bajo with a maximum count of 35 on 21 Sep 2011 (C. Robson *in litt*. 2015). On sandflats at Labuan Bajo in Sep 2009 (Myers 2009) and 'plenty' were present in Aug 2012 (Eaton 2012) and four also observed in Oct 2014 (Hoddinott 2014). The distribution of Javan Plover has only recently been clarified, with Lesser Sunda records including Lombok, Sumbawa, Semau and Timor-Leste (Trainor 2011, Iqbal *et al*. 2013, Johnstone *et al*. 2014). The first Lesser Sundas record was from Sape, Sumbawa Island (where given as Kentish Plover *C. alexandrinus*), about 94 km to the west of Labuan Bajo (Coates & Bishop 1997). The global population has been estimated at 2,000-6,000 birds (Iqbal *et al*. 2013) and therefore the Labuan Bajo and Dolat marsh population might hold more than 1% criteria.

Kentish Plover *Charadrius alexandrines*

Rare non-breeding visitor. The first record of one bird seen on Pangabatang on 8 Oct 2004 (Schellekens 2009). Three observed near Labuan Bajo on *c.* 18 Oct 2014 (Hoddinott 2014). There are few published regional records (see Trainor 2005a, 2011) and this plover is probably regularly overlooked, or mis-identified as Javan Plover. Records of resident birds at nearby Sape, Sumbawa Island (Coates & Bishop 1997) refer to Javan Plover (see also Ilalang 2016a).

Malaysian Plover *Charadrius peronei*

NEAR THREATENED. Local resident. Nine dated records at Labuan Bajo (one pair), Pangabatang (to three pairs) and Tambak Koliaduk (pairs or singles).

Up to seven birds at Nangarawa in mid-Sep 1993 (Butchart *et al*. 1994, Verhoeye & Holmes 1999); a male and a female noted at Nangarawa by Chartier (1997) and noted as present at the same site on 1 Oct 2001 (Benstead & Benstead 2001). Listed for Pangabatang by Mason (1991,1993). Up to four at Riung during 3-29 Aug 1997 (Pilgrim *et al.* 2000); and one male and three females at Mausambi from 30 Aug to 3 Sep 1998 (Drijvers 1998). In Wallacea considered as an 'uncommon, sparsely distributed resident' (Coates & Bishop 1997).

Lesser Sand Plover *Charadrius mongolus*

A common Palearctic migrant visitor to coastal habitats from Aug to Mar. Recorded in small numbers, except at Pangabatang, with larger counts of 25+, 22, 27, 31 and 21 birds on 8 Oct, 7 Dec 2004, 11 Nov 2005, 17 Oct 2006 and 13 Sep 2007, respectively. At Labuan Bajo five present on 23 Oct 2004 and two on 21 Oct 2004; two at the Mausambi beach on 5 Oct 2003 and three on 5 Nov 2006. At Tambak Koliaduk 2-7 recorded on 14 out of 43 visits. A single bird observed at Waiara on 27 Sep 2005.

Two birds at Waiara on 6 Oct 1989 (Verhoeye & Holmes 1999), and present at Nangarawa on 1 Oct 2001 (Benstead & Benstead 2001). A single bird was seen near Labuan Bajo on 21 Sep 2011 (C. Robson *in litt*. 2015). Considered as a locally moderately common to common visitor to Wallacea (Coates & Bishop 1997). In Wallacea the Greater Sand Plover *Charadrius leschenaultii* is represented by about four-times more specimen records than Lesser Sand Plover (White 1975).

Greater Sand Plover *Charadrius leschenaultia*

A common non-breeding visitor to the coast. Recorded from most coastal locations in small numbers. Relatively common only at Pangabatang with 30+, 38, 35+, 3 and 28 birds present on 8 Oct, 7 Dec 2004, 11 Nov 2005, 17 Oct 2006 and 13 Sep 2007, respectively. Regular visitor to Tambak Koliaduk where 1-11 recorded during 14 of 43 visits. On mudflats at Labuan Bajo 5-11 during Sep and Oct visits; single birds were noted at Mausambi and Ende-Mbu'u estuary and 2-3 noted during Nov and Jan visits to Waiara.

Probably collected by C. Allen in 1862 (Mees 2006). Frequent along the beach at Riung from late Aug 1997 (Pilgrim *et al.* 2000); 10 noted at Tambak Koliaduk in Sep 1998 (Drijvers 1998). Two noted at a wetland south of Labuan Bajo in Nov 1999 (Allwood 1999). Recorded most years near Labuan Bajo with a maximum of 20 on 11 Sep 2011 (C. Robson *in litt*. 2015). A moderately common to common visitor to Wallacea (Coates & Bishop 1997).

Oriental Plover *Charadrius veredus*

An uncommon staging bird in low numbers during southward migration. Seven records by MS of 1-8 birds: near Mausambi 5 Oct 2003 (8 birds); at salt field on Pangabatang 8 Oct 2004 (5), 11 Nov 2005 (7), 17 Oct 2006 (4) and 13 Sep 2007 (3); at Tambak Koliaduk 14 Sep 2004 (2) and 29 Oct 2005 (1).

Reported from Magepanda on 7 Dec 1989 (2), near Tiwu Bowu in a fallow ricefield on 21 Oct 1990 (20) and six on 26 Oct 1990; and, one at Tambak Koliaduk on 23 Dec 1990 (Verhoeye & Holmes 1999). Probably under-reported, as preferred short grass and fallow ricefield habitat is rarely visited by ornithologists on Flores. Probably occurs on Flores as a staging bird for a few days or weeks. Much more commonly reported on Timor with 34 records of up to 100 birds mostly during southward migration (Trainor 2005a) and a maximum count of 130 at Oesau near Kupang on 10 Sep 2010 (C. Robson *in litt*. 2015) and 100 at Kupang Bay (Andrew 1985). In Wallacea considered as an 'uncommon passage migrant to and from Australia' (Coates & Bishop 1997), though almost all records are during southward migration (White 1975, Trainor 2005a).

Little Curlew *Numenius minutus*

A rare visitor during southward migration. A single bird was observed on dry fishponds at Tambak Koliaduk on 9 Nov 2001, and three present in fallow ricefields north of the Tiwu Bowu on 4 Nov 2004.

Two birds also at Tiwu Bowu on 21 Oct 1990 (van Balen 1996, Verhoeye & Holmes 1999). Probably under-recorded to some extent because preferred short grass habitat is rarely surveyed on Flores by ornithologists. The highest count in the region is the 160+ recorded on Kai Island on 1 Oct 2008 (Johnstone & van Balen 2013) with only low numbers (<30) known from the Lesser Sundas (Trainor 2005a, Trainor & Hidayat 2014). In Apr-May 2015, three of the four Little Curlews satellite tracked from the Roebuck Bay area, Western Australia, flew over, or near Flores during return migration (Veltheim & Minton 2015). It is likely that larger numbers use Flores and neighbouring islands for staging during southward and return migration.

Whimbrel *Numenius phaeopus*

A common non-breeding visitor and passage migrant. Usually observed by MS singly or in small groups of 5-15. Although counts are small, the c.1,800 km long coastline on Flores could potentially host a population of 1,000-2,000 individuals. Common on Pangabatang with counts of 27, 68, 37, 28 and 37 on 8 Oct and 7 Dec 2004, 11 Nov 2005, 17 Oct 2006 and 13 Sep 2007, respectively. An average of seven birds were counted at Tambak Koliaduk, with maximum counts of 27 on 23 Nov 2002, 21 on 14 Sep and 29 Sep 2004. At Labuhan Bajo mudflats four present on 23 Sep 2001, with at least 25 on 23 Oct 2004 and 14 on 21 Oct 2005. There were few other site records: two on Riung beach (14 Nov 2002), five and two on Mausambi beach (28 Dec 2003 and 5 Nov 2006, respectively); 2-9 at Paga beach and Waiara beach from Sep-Jan and four on Sikka beach on 13 Dec 2001.

Several collected by J. Semmelink at Larantuka in 1862 (Mees 2006). Recorded by Schmutz along the coast at Nisar (26 Oct 1969 & 20 Nov 1975), and near Joneng in Dec 1969 (Mees 2006). Noted as very common along the coast from early Aug until at least mid-Apr (Verhoeye & Holmes 1999); more than 100 present on Pangabatang on 6 Oct 1990 (Mason 1991); noted as frequent at Riung and Maurole by Pilgrim *et al*. (2000). At Tambak Koliaduk *c*.20 birds were noted in Sep 1998; and also present at Mausambi during 31 Aug to 3 September 1998 (Drijvers 1998). A maximum of 80 counted near Labuan Bajo on 21 Sep 2011 (C. Robson *in litt*. 2015) and few at the same site in Jul-Aug 2015 (De Win & Ericsson 2015). Regarded as a common to very common visitor to Wallacea (Coates & Bishop 1997). The subspecies occurring on Flores is *variegatus* (Mees 2006).

Eurasian Curlew *Numenius arquata*

NEAR THREATENED. Rare non-breeding visitor. The first island record was one bird present at Tambak Koliaduk on 19 Dec 2005 (Schellekens 2009). A single bird at Labuan Bajo in Jul-Aug 2015 (De Win & Ericsson 2015).

A rare visitor to Wallacea (Coates & Bishop 1997) in small numbers, with eight listed by Schellekens (2009), and two on Gili islands, Lombok (Boon 1996). The only other recent Timor record was of a single bird at Tibar mudflats on 5 Apr 2008 in Timor-Leste (Trainor 2011). It is common on Bali with up to 200 birds at Serangan Island (Durand 2012).

Eastern Curlew *Numenius madagascariensis*

ENDANGERED. A regular visitor mostly in ones, twos or threes during southward migration (August-December). A total of 12 observed in ones or twos at Tambak Koliaduk between 17 Aug and 23 Nov. Recorded during each visit to Pangabatang: one bird on 6 Oct 2004, one on 7 Dec 2004, two on 11 Nov 2005, one on 17 Oct 2006 and three on 13 Sep 2007. Three observed at Koborea near Riung on 20 Aug 2005; two at Labuhan Bajo on 23 Oct 2004 and one on 21 Oct 2005; one at Riung on 14 Nov 2002; one at Mausambi on 5 Nov 2006; and, one at Nangarawa on 19 Dec 2005.

Small numbers including five near Darat Pantai on 14 Jan 1988; seven on Pangabatang on 21 Mar 1989 (Verhoeye & Holmes 1999); at Labuan Bajo on 1-2 Oct 1993 (Verhoeye & Holmes 1999); two at Labuan Bajo on 5 Sep 2013 (C. Robson *in litt*. 2015) and two at Tambak Koliaduk on 5 Sep 1998 (Drijvers 1998). In Timor-Leste, where more regular, there was a total of 52 records of up to 26 during 2003-2004 (Trainor 2005a) and more than 250 have been seen in West Timor (Andrew 1985). A regular but generally uncommon visitor to Wallacea (Coates & Bishop 1997).

Bar-tailed Godwit *Limosa lapponica*

NEAR THREATENED. A regular visitor in small numbers during southward migration (14 Sep to 13 Dec), with 14 records at four sites of 1-15 birds. Regularly recorded at Tambak Koliaduk (2-5) and Pangabatang (2-15).

Noted at Sesok (5 Dec 1969) and Nisar (20 Nov 1975) in West Flores (Schmutz 1977). Approximately 40 at Pangabatang on 6 Oct 1990 (Mason 1991, Verhoeye & Holmes 1999). A single bird at Tambak Koliaduk in Sep 1998 (Drijvers 1998) and 1-2 at Labuan Bajo during Sep visits (C. Robson *in litt*. 2015). Quite uncommon in Timor-Leste with only 18 records of 1-6 during 2002-2006 (C. Trainor unpubl. data). In Wallacea considered as a 'regular winter visitor and passage migrant' (Coates Bishop 1997).

Common Redshank *Tringa tetanus*

A regular visitor in small numbers. Regular at Tambak Koliaduk with records of 1-10 during 31 of 43 visits, with a maximum count of 17 on 19 Dec 2002. Fifteen at Pangabatang on 6 Oct 2004 with single birds on 7 Dec 2004 and 13 Sep 2007. Single birds at Tiwu Bowu on 8 Nov 2001, 15 Sep 2004 and 21 Oct 2007. A total of eight during three visits to the Labuhan Bajo (23 Sep 2001, 23 Oct 2004 and 21 Oct 2005).

The highest count was 30 birds at Pangabatang on 6 Oct 1990 (Mason 1991). Three at Bugis Pools, Riung on 5 Aug 1997 (Pilgrim *et al.* 2000); 10 at Tambak Koliaduk in Sep 1998 and two at Tiwu Bowu in Aug-Sep 1998 (Drijvers 1998). A few at Dolat marsh near Labuan Bajo in Nov 1999 (Allwood 1999) and two near Labuan Bajo on 10 Sep 2009 (C. Robson *in litt*. 2015). Considered by Verhoeye & Holmes (1999) to be a common visitor to the coast of Flores from mid-Aug until at least mid-Apr. On Timor, during 2002-2015, it was more regular with 95 records of up to 27 birds (C. Trainor unpubl. data). A regular visitor to Wallacea in small numbers (Coates & Bishop 1997).

Marsh Sandpiper *Tringa stagnatilis*

An uncommon visitor during southward migration. Single birds at Tambak Koliaduk during four of 43 visits (4 Aug, 19 Dec and 29 Dec 2002 and 29 Sept 2004). Six at an estuary near Labuan Bajo on 23 Sep 2001, and single birds at Pangabatang on 11 Nov 2005 and 17 Oct 2006.

First noted by J. Verhoeye along the Magepanda River on 24 Dec 1989 (Verhoeye & Holmes 1999); a first year bird observed at Tambak Koliaduk on 20 Sep 1998 (Drijvers 1998). Up to 15 at Dolat marsh near Labuan Bajo in Nov 1999 (Allwood 1999). On Timor, Marsh Sandpiper has been recorded in larger counts (maximum 64) during staging for return migration in Feb to Mar (Trainor 2005a). Considered as a regular visitor to Wallacea where generally uncommon or scarce (Coates & Bishop 1997).

Lesser Yellowlegs *Tringa flavipes*

Vagrant Nearctic non-breeding visitor. The only record, and second for Indonesia, relates to an individual observed at Tambak Koliaduk on 17 Sep 2003 (Schellekens 2006). This bird was observed for about 25 minutes from a distance of 50 m and identified based on direct field comparisons with Common Greenshank, Wood Sandpiper and Pacific Golden Plover with its 'bright yellow legs, …moderately long, straight, stout bill,.. white belly which stood out sharply against dark-grey upperparts' (Schellekens 2006).

Common Greenshank *Tringa nebularia*

A common visitor to Flores mostly in small numbers. At Tambak Koliaduk greenshanks were recorded during 32 of 43 visits; usually 2-10, maximum 19 on 19 Dec 2005; a single bird at Waiara on 24 Nov 2002. Common at Pangabatang with 19 on 7 Dec 2004 and nine, three, three and eight during four other visits. A total of 13 at Labuan Bajo mudflats (23 Sep 2001, 23 Oct and 7 Nov 2004).

Two specimens were collected by Schmutz presumably at edge of Lake Sano Nggoang (Nunang-Meer site) on 25 Sep 1969 and 6 Dec 1982 (Mees 2006), with other records from Nunang (27 Jul 1969) and Nangalili (1 Feb 1973) (Schmutz 1977). Considered as a common visitor to the coast of Flores by Verhoeye & Holmes (1999). A maximum count of *c.*50 birds at Pangabatang on 6 Oct 1990 (Mason 1991). Two at Tambak Koliaduk in Sep (Drijvers 1998). A few birds south of Labuan Bajo in Nov 1999 (Allwood 1999) and one at Dolat marsh area on 31 Jul 2001 (Adcock 2001). Up to four near Labuan Bajo on 10 Sep 2009) (C. Robson *in litt*. 2015). In Wallacea 'generally sparsely distributed but locally common' (Coates & Bishop 1997).

Wood Sandpiper *Tringa glareola*

A regular non-breeding visitor and passage migrant in small numbers during Jul to Nov, but surprisingly with no records after Nov. At Moni rice fields Wood Sandpipers were usually observed in small flocks of 10-25 between 25 Jul and 9 Sep. Regular at Tambak Koliaduk where recorded in small groups of 2-7 during 22 of 43 visits, with a maximum 10+ on 18 Aug 2003. Regular also at Lake Tiwu Bowu with observations during 15 of 21 visits, with maximum of 11 on 17 Aug 2003 and also on 15 Sep 2004. Four at a river estuary near Ndondo (west of Tiwu Bowu) on 4 Nov 2004; present at Labuan Bajo mudflats on 25 Sep 2001 and four at Dolat marsh on 25 Sep 2001; two at Riung on 14 Nov 2002; two at Mausambi beach on 5 Oct 2003 and two at Lake Rana Mese (1,200 m) on 24 Oct 2004.

Site records from Nunang (14 Sep 1969), and Look (end of Sep 1969) (Schmutz 1977). Considered common in west Flores but less common in central and east Flores (Verhoeye & Holmes 1999), associated with the extent of ricefields and mangrove habitat in the west. Ten present at Tiwu Bowu and six and three at Tambak Koliaduk in Sep 1998 (Drijvers 1998). 'Several birds' were at Dolat marsh on 31 Jul 2001 (Adcock 2001); two at wetland (presumably Dolat marsh) south of Labuan Bajo on 1 Sep 2005 (Bauer 2005) and noted at Labuan Bajo on 6-7

Oct 2001 (Benstead & Benstead 2001). A common to abundant visitor to Wallacea (Coates & Bishop 1997).

Terek Sandpiper *Xenus cinereus*

An uncommon visitor to Flores in small numbers. Maximum count of five at Pangabatang on 13 Sep 2007. Three at Tambak Koliaduk: four on 1 Oct 2003, three on 14 Sep 2004 and two on 3 Nov 2004.

Five records by Verhoeye & Holmes (1999) of one, two or 'several' birds from 9 Aug to 28 Oct all in 1990. Four at Nangarawa on 14 Aug 1997 (Chartier 1997). At Tambak Koliaduk one on 5 Sep 1998, four on 11 Sep and two on 20 Sep 1998 (Drijvers 1998). Two on the beach at Riung (Pilgrim *et al*. 2000). At Labuan Bajo in Oct 2009 (Myers 2009) and 10 near Labuan Bajo on 21 Sep 2011 (C. Robson *in litt*. 2015). Lack of coastal surveys may have under-reported Terek Sandpiper on Flores.

Common Sandpiper *Actitis hypoleucos*

Common to abundant non-breeding visitor and passage migrant during Aug to at least Feb. Abundant at Tambak Koliaduk with 15-25 present each visit in Sep to Feb. Earliest date at Tambak Koliaduk was 4 Aug 2002. Common in small numbers at Lake Tiwu Bowu between Sep and Feb, and along rocky shores on the north and south coast. Present at Pangabatang and Pulau Kinde; up to 25 at Labuhan Bajo estuary on 21 Oct 2005; two at Lake Rana Mese on 24 Oct 2004. Common near mountain streams in the Moni / Mount Kelimutu area from Aug to Feb in twos and threes.

Collected at Larantuka by J. Semmelink in 1862, and by J. Verheijen near Ruteng at 1,150m on 22 Sep 1971 (Mees 2006). Two observed on Pulau Pulu'e off central-north Flores (Verheijen 1961). Two at Nunang (27 Jul 1971), and seen at Waewako (Schmutz 1977). Considered to be a very common visitor to the coast and large rivers of Flores from mid-Aug to mid-Apr (Verhoeye & Holmes 1999). Noted at Nangarawa in Aug 1993 by Butchart *et al.* (1994) and also on 1 Oct 2001 (Benstead & Benstead 2001). Noted as common on beaches at Riung and Maurole (Pilgrim *et al.* 2000) with two at Lake Rana Mese. A total of 15 at Tambak Koliaduk, 10 at Tiwu Bowu and 10 along the beach at Mausambi in Sep (Drijvers 1998). Present at Dolat marsh on 31 Jul 2001 (Adcock 2001) and about five at the same site on 1 Sep 2005 (Bauer 2005). A maximum 20 near Labuan Bajo on 5 Sep 2013 and a high elevation record at Golo Lusang (1,600 m) on 29 Aug 2007 (C. Robson *in litt*. 2015). Noted as present at Labuan Bajo in Jul-Aug 2015 (De Win & Ericsson 2015).

Grey-tailed Tattler *Tringa brevipes*

NEAR THREATENED. A common migrant to coast and mudflats from 14 Sep to Mar. The highest counts were at Pangabatang: 33 present on 8 Oct and 29 on 7 Dec 2004, 11 on 11 Nov 2005, six on 17 Oct 2006 and 15 on 13 Sep 2007. Grey-tailed Tattler were present during 15 of 43 visits at Tambak Koliaduk with maximum four birds on 13 Oct 2001 and 19 Dec 2002. Other records: six at Sikka beach on 13 Dec 2001; two on Mausambi beach on 28 Oct 2003; present at Paga and Waiara beaches; five at Labuan Bajo beach on 23 Oct 2004 and four on 21 Oct 2005.

Regarded as a common visitor to the coast of Flores from mid-Aug to mid-Apr (Verhoeye & Holmes 1999). A high count of 32 at Pangabatang on 6 Oct 1990 (Mason 1991); 'several' birds near Larantuka (Verhoeye & Holmes 1999); up to five at Riung in mid-Augt 1997 (Pilgrim *et al.* 2000); at least 15 at Tambak Koliaduk on 11 Sep 1998, with 2-7 on other dates in Aug-Sep 1998 (Drijvers 1998). Usually present each year at Labuan Bajo with maximum of four on 5 Sep 2013 (C. Robson *in litt*. 2015). A locally moderately common to common visitor to Wallacea (Coates & Bishop 1997).

Ruddy Turnstone *Arenaria interpres*

An uncommon to rare visitor to Flores, with one bird at Tambak Koliaduk on 8 Oct 2004, four at Pangabatang on 8 Oct and seven on 7 Dec 2004, six on 11 Nov 2005, five on 17 Oct 2006 and nine on 13 Sep 2007.

Considered as an uncommon visitor to the coast, with just a single observation in March (Verhoeye & Holmes 1999). Collected on Adonara Island (1 km off Larantuka) in Aug 1880 by P.F.A. Colfs (Mees 2006). Probably under-recorded because of limited specific survey of beaches and exposed reefs at low tide. In Wallacea considered as a locally common bird mainly during southward migration (Coates & Bishop 1997).

Asian Dowitcher *Limnodromus semipalmatus*

NEAR THREATENED. The first island records were four birds observed at Pangabatang on 8 Oct 2004 and two at the same location on 7 Dec 2004 (Schellekens 2009).

An uncommon non-breeding visitor to Flores, and regionally, with only about 10 Wallacean records of up to four birds (Andrews 1986, Coates & Bishop 1997, Schellekens 2009, Robson 2011, Trainor 2011).

Snipe spp. (Swinhoe's Snipe *Gallinago megala* and Pin-tailed Snipe *G. stenura*)

Locally common non-breeding visitors of ricefields and wet grass habitat. A total of 116 individual *Gallinago* snipe spp. were recorded on 59 separate dates (mean 2.0 birds survey day^{-1}) including 111 at the Moni ricefields. The dates of first and last records on Flores were 4 Nov and 5 Feb (*c.* 94-day span) and maximum day count of six birds on 3 Jan 2006. The only birds that could be definitively identified were of three Pin-tailed Snipe observed at close range while on sale at Moni village market on 18 Nov 2002. These birds had been leg-snared in the Moni ricefields earlier that day. Of the 116 snipe observed on Flores, including the three captive birds, 62 (53%) were identified as a 'Swinhoe's type', 21 (18%) as 'Pin-tailed type' and the remaining 33 (29%) were not identified to species. Altitudinal use was from sea-level (one bird at Tambak Koliaduk in aquaculture pond habitat, four birds at Mausambi in a river estuary) to 825 m in ricefields at Moni.

A long series of Swinhoe's Snipe were collected on Flores by J. Verheijen and E. Schmutz and three Pin-tailed Snipe were collected (Paynter 1963, Mees 2006).

Both species were first collected in 1958. The Swinhoe's Snipe were collected in Nov (n= 13 specimens), Dec (5), Feb (4), Mar (1), two specimens are listed as collected in 'Oct / Nov' and one was undated (Mees 2006). All specimens except RMNH97173 (collected at Lembor by E. Schmutz) were collected at the site 'Rahong, Wangkung' an area of irrigated ricefields and vegetable gardens associated with a parish church of the Roman Catholic diocese of Ruteng, West Flores. *Gallinago* snipe are regular non-breeding visitors to Flores, in relatively large numbers (*c.* 4,000-8,000 individuals estimated: Table 1) in ricefields and wet grass habitat, especially in the west.

Great Knot *Calidris tenuirostris*

ENDANGERED. A rare visitor. Five birds seen at three sites: a single flagged bird (possibly flagged in Australia, though the photo was not clear enough to confirm: C. Minton & C. Hassell *in litt*. 2005) at Ende-Mbu'u estuary on 23 Oct 2005; one at Tambak Koliaduk on 26 Sep 2006 and three at Lake Tiwu Bowu in a fallow ricefield on 4 Nov 2004.

The first island record was of one first year bird at Tambak Koliaduk on 20 Sep 1998 (Drijvers 1998, Trainor *et al*. 2006). Noted at Labuan Bajo mudflats on *c.*3 Oct 2009 (Myers 2009) and two near Labuan Bajo on 5 Sep 2013 (C. Robson *in litt*. 2015). An uncommon passage migrant in Wallacea (Coates & Bishop 1997, Trainor 2005a).

Sanderling *Calidris alba*

Uncommon to rare migrant visitor: three birds at Pangabatang on 7 Dec 2004, and one at Tambak Koliaduk on 1 Oct 2003.

The first island record was of one bird near Mauloo on 23 Dec 1986, and one on Pangabatang on 21 Mar 1989 (Verhoeye & Holmes 1999). Possibly overlooked through lack of specific survey along high-energy coasts. Rare according to low number (3) of specimens (White 1975) but considered a regular passage migrant to Wallacea (Coates & Bishop 1997).

Red-necked Stint *Calidris ruficollis*

NEAR THREATENED. A surprisingly uncommon to rare visitor in low numbers during southward migration. The highest count was 21 at Labuan Bajo mudflats on 21 Oct 2005. Uncommon at Tambak Koliaduk with just four records of 2-4 in Oct and Dec. Other records include nine at Mausambi beach on 9 Oct 2003 and two on 5 Nov 2006; six at Pangabatang on 6 Oct 2004. Unidentified stints - either Red-necked- or Long-toed - were noted at Labuhan Bajo mudflats on 21 Oct 2005 (*c.* 15), at Pangabatang on 7 Dec 2004 (*c.* 15) and Maumere harbor on 15 Aug 2003. Most were probably Red-necked Stint.

Two specimens were collected at Reo on 23-25 Nov 1888 by M.W.C. Weber (Mees 2006). Considered as a common visitor to coastal areas (Verhoeye & Holmes 1999). A high count of approximately 100 at Pangabatang on 6 Oct 1990 (Verhoeye & Holmes 1999). Five at Tambak Koliaduk on 4-5 Sep and eight on 20 Sep 1998 (Drijvers 1998). In the Labuan Bajo area two were seen in Nov 1999 (Allwood 1999); also present on 6-7 Oct 2001 (Benstead & Benstead 2001) and a maximum two birds near Labuan Bajo on 30 Aug 2007 and 12 Sep 2009 (C. Robson *in litt*. 2015). Red-necked Stint is one of the most regularly recorded Palearctic migrants on Timor (Trainor 2005a) with maximum of *c.*600 (Andrew 1985) and 457 (Trainor & Hidayat 2014). Considered as a moderately common visitor to Wallacea (Coates & Bishop 1997).

Long-toed Stint *Calidris subminuta*

An uncommon visitor. Just five dated records of 2-16 birds at Pangabatang, Ende-Mbu'u estuary and Tambak Koliudak during Sep to Nov.

The first island record was of a first-year bird at Tambak Koliaduk on 4 Sep 1998 (Drijvers 1998, Trainor *et al*. 2006). More common on Timor where it is regular in ricefields and montane marshes up to 1,100 m (Trainor 2005a). Considered as mostly scarce but probably overlooked in Wallacea (Coates & Bishop 1997).

Sharp-tailed Sandpiper *Calidris acuminate*

A surprisingly uncommon to rare visitor. Four records of 1-4 birds in Aug and Oct at Tambak Koliaduk and Mausambi beach.

The first island record was of two birds at Tiwu Bowu on 17 Nov 1990, with subsequent records of two at Tambak Koliaduk and one at Tiwu Bowu, both on 25 Nov 1990 (Verhoeye & Holmes 1999). One adult and a first-year bird observed at Tambak Koliaduk on 20 Sep 1998 (Drijvers 1998). One of the most regularly recorded Palearctic migrants occurring in Timor-Leste (Trainor 2005a), with larger counts of up to 550 at Kupang Bay, West Timor (Andrew 1985) and 131 on Roti Island (Trainor 2005b). Regarded as an 'uncommon migrant' to Wallacea (Coates & Bishop 1997).

Curlew Sandpiper *Calidris ferruginea*

NEAR THREATENED. A very uncommon to rare visitor with no observations by MS. Recorded at Nangarawa on 14-15 Sep 1993 (Butchart *et al*. 1994, Verhoeye & Holmes 1999) and a single bird at Labuan Bajo on 12 Sep 2009 (C. Robson *in litt*. 2015). An uncommon to rare visitor of up to four birds in Timor-Leste (Trainor 2005a), but up to 180 have been counted and 450 estimated at Kupang Bay, West Timor (Andrew 1986).

Broad-billed Sandpiper *Limicola falcinellus*

A very uncommon visitor with only two Flores records: one bird at Dolat marsh area in Nov 1999 (Allwood 1999), and two adults seen at Ende-Mbu'u estuary on 17 Oct 2006 which was claimed as a first island record (Schellekens 2009).

Uncommon regionally, with, for example, more records of rare non-breeding visitors such as Ruff *Philomachus pugnax*. The only large count in the region has been of 360 birds at Kupang Bay, West Timor (Andrew 1985). Generally scarce in Wallacea (Coates & Bishop 1997).

Ruff ***Philomachus pugnax***

Rare non-breeding visitor. The first and only Flores record was of two adult birds at Tambak Koliaduk on 5 Dec 2005 (Schellekens 2009). A single female was observed on Komodo Island on 4 Apr 1999 (Mauro 1999).

Rare in the Wallacean region with fewer than *c.*15 records (Coates & Bishop 1997, Trainor 2005a, 2011).

Red-necked Phalarope ***Phalaropus lobatus***

A common wintering species on seas surrounding Flores. On 18 Jan 2005, five flocks of 12-50 observed from 100 m off the Ende-Mbu'u estuary, and approximately 75 between Flores and Rinca on 22 Oct 2004; more than 30 between Flores and Pangabatang on 6 Oct 2004; 17 at same location on 7 Dec 2004; single bird on beach on Pangabatang on 17 Oct 2006 and 59 near Pangabatang on 13 Sep 2007. A flock of about 50 observed from the KM.Awu Pelni-ship off the north-eastern tip of Flores on 9 Feb 2001.

One bird in a saline stream 200 m from the beach at Reo (Kedindi) on 1 Nov 1970 (Verheijen 1971). Considered as a very common visitor to Flores from mid-Aug to Jan, but especially Aug to Oct (Verhoeye & Holmes 1999). On 29 Aug 1990 a continuous stream of birds probably totalling tens of thousands was observed off Paga (Verhoeye & Holmes 1999). During a storm, tens of birds were apparently grounded on missionary grounds at Watublapi in the mountains south of Maumere (Verhoeye & Holmes 1999); six birds were seen off Ende on 9 Mar 1999 (Mauro 1999); and present off Nangarawa on 1 Oct 2001 (Benstead & Benstead 2001). During visits to and from Komodo Island from Labuan Bajo small numbers are seen annually in waters with a maximum count of 40 birds on 5 Apr 1999 (Mauro 1999) and 21 Sep 2011 (C. Robson *in litt*. 2015). Flocks of 5,000-10,000 birds have been seen between Alor and Pantar suggesting that large numbers may winter in the region (Johnstone 1994).

Beach Stone-curlew ***Esacus magnirostris***

NEAR THREATENED. An uncommon beach-dwelling resident. A single bird at Pangabatang on 13 Sep 2007 and two birds on exposed reef / rocks at Paga beach on 8 Nov 2005 were the only observations by MS.

At least three specimens were collected by Van der Sande in 1909, Rensch in 1927 and by E. Schmutz or J. Verheijen (Mees 2006). Schmutz mentions Father Geeraeds observed them between Look and Nggoer (undated) along the west coast. One nest was found in Nov (Verheijen 1964). Noted as 'sparsely distributed' by Verhoeye and Holmes (1999) with records from Darat Pantai, Pangabatang, Palau Damhila and Pulau Kondo in Maumere Bay, as well as Paga and Nangarawa. Also present at Nangarawa on 1 Oct 2001 (Benstead & Benstead 2001). Noted at Labuan Bajo during 20-22 Dec 1989 (Gibbs 1996), and one bird seen in Jul-Aug 2015 (De Win & Ericsson 2015).

Australian Pratincole ***Stiltia Isabella***

An uncommon to rare visitor from Australian. Most observations were at Maumere-Frans Seda airport with three birds on 29 Nov and one on 27 Dec 2001 and three on 25 Oct 2002. There were only three other records: seven at Tambak Koliaduk on 29 Oct 2005, three on fallow ricefields at Magepanda and one at Tiwu Bowu both on 28 Sep 2005.

Collected at Larantuka by J. Semmelink in 1862. Around Ruteng an immature female was collected by J. Verheijen on 23 Jun 1969; two males were collected on 25 Jun 1969 and a male and three females on 18 Jul 1969 (Mees 2006). Considered by Verhoeye and Holmes (1999) as a 'rare austral migrant' with four birds at Waioti during 8-23 Sep 1987 and one at Lembor on 30 Jul 1993. The late observations by Schmutz near Nisar on 23 Nov 1969, and between Joneng and Lita in early Dec 1969 were questioned by Mees (2006), who suggested that these observations were more likely to have referred to Oriental Pratincoles. In Wallacea noted as 'uncommon to rare, though less so on Timor' (Coates & Bishop 1997).

Oriental Pratincole ***Glareola maldivarum***

A regular visitor during staging for southward migration, though probably under-recorded through lack of observation on short grass habitat. A maximum count of *c.*750 birds near the village of Magaramut on 2 Dec 2006. Birds circled and disappeared to the west; 36 circled over Tambak Koliaduk on 22 Nov 2002 and 24 at Waiara on 27 Dec 2005. Recorded on several occasions at Maumere-Frans Seda Airport: 15 Dec 2003 (15), 12 Nov 2005 (127) and 13 Nov 2005 (*c.* 85).

Five records noted by Verhoeye & Holmes (1999): at Kali Wajo on 10-14 Nov 1987 (four) and four records in 1990 from Tambak Koliaduk on 17 Nov (10), 3 Dec (85), 8-9 Dec (six), and 23 Dec (one). In Wallacea considered as a rare but regular visitor (Coates & Bishop 1997) but records of 3,000 birds on Timor (Trainor 2005a) and 1,400 on Sumba (C. Robson *in litt*. 2015) show that it does stage in the region.

DISCUSSION

We show that Flores Island has a diverse range of resident and migratory shorebirds; that the seasonal status and origin of visiting shorebird species is generally clear except for the White-headed Stilt (possibly mainly a visitor, though known to breed in region), Greater Painted-snipe, Swinhoe's Snipe, Pin-tailed Snipe and Red-necked Phalarope. Counts of all shorebird species were small with only four migrants recorded in groups of more than 100 birds (Grey Plover, Red-necked Stint, Red-necked Phalarope and Oriental Pratincole). The highest day count was of *c.*750 birds for the 'short grass' preferring Oriental Pratincole, and among migrant shorebird species that may depend on wetland habitat, the highest count by MS was of 83 Pacific Golden Plover at Pangabatang.

Although specific shorebird survey has not yet covered all wetlands on Flores, with particularly inadequate survey of pelagic habitats, ricefields and beaches and coastlines, we feel that there are now sufficient data collected recently and historically to clarify the status of most shorebird species on Flores, and on the relative importance of wetland sites. Some migrant shorebirds visit Flores in numbers probably totalling low 1000s of birds (e.g. Whimbrel, Common Sandpiper and snipe: Table 2), but for most species it is also used for staging by larger numbers of birds. While there is little specific information on the magnitude of birds using Flores to stage, recent data from satellite-tracked birds confirms that Flores and surrounding islands are used by birds staging during southward and return migration (e.g. Veltheim & Minton 2015).

Labuan Bajo and Maumere Bay may qualify as nationally and international significant sites for shorebirds. Labuan Bajo may hold 1% (35 birds) of the global population of *c.*2,000-6,000 Javan Plover (Iqbal *et al.* 2013). It also reaches national criteria of providing habitat for more than 15 migratory shorebird species. Pulau Pangabatang in Maumere Bay is still little-visited but has the highest counts (<400 birds) of any Flores site for Palearctic non-breeding visitors, and is clearly '…an important staging post-post for migratory waders' (Mason 1993). It is also used by migratory shorebirds for feeding and roosting (MS). The presence of more than 15 migratory shorebirds at Pangabatang and counts of approximately 0.1% of the Grey Plover EAAF population confirm that it should be considered as a nationally significant site. Tambak Koliaduk is another site of national significance in Maumere Bay that provides habitat for at least 26 migratory shorebird species, though total counts were low at this site.

The small counts of the majority of migrant shorebirds on Flores was a consistent trend with substantially higher (by 1-2 orders of magnitude) counts for most species on Timor Island (e.g. Eastern Curlew, Common Greenshank, Wood Sandpiper, Sanderling, Sharp-tailed Sandpiper, Curlew Sandpiper and Australian Pratincole), even in the similarly small-scale wetlands of Timor-Leste (Trainor 2005a, 2011). The very low counts of Red-necked Stint (except at Pangabatang), Sharp-tailed Sandpiper and Australian Pratincole are notable and clearly these birds are choosing to overfly Flores presumably because of lack of suitable habitat. The pattern with Australian Pratincole may be different, with a general trend of decreasing numbers of birds, or records of birds, through the Indonesian archipelago with increasing distance from Timor (Coates & Bishop 1997, C. Trainor unpubl. data). The rarity of Australian Pratincole on Flores was in sharp contrast to Timor where *c.*5,000-10,000 have been observed at Kupang Bay, West Timor (Silvius 1987).

Most of the globally threatened and near threatened migratory shorebird species have been recorded infrequently and in very low numbers on Flores (e.g. Great Knot maximum count of two birds, Eastern Curlew maximum count of three birds) and presumably the majority of birds overfly the island for lack of extensive suitable habitat. The absence of Flores records of Black-tailed Godwit *Limosa limosa* and Red Knot is surprising and these birds obviously overfly Flores. The Black-tailed Godwit is regular in small numbers on Timor with a maximum of 188 at Kupang Bay, West Timor, while the Red Knot is rare on Timor with a maximum of 18 at Kupang Bay (Andrew 1986). These two migrants are probably the most likely additions to the Flores shorebird fauna in the future. Near threatened residents such as Beach Stone-curlew and Malaysian Plover typically occur in low densities, but significant populations may occur on Flores given the irregular shape of the island and very extensive shoreline (>1,800 km long), presence of numerous small islands and islets. Coastal and beach habitat may not yet have been adequately surveyed on Flores, so these two resident shorebirds, as well as other beach and 'fringing reef' preferring species such as Sanderling, Ruddy Turnstone and Greater Sand Plover may yet be recorded in higher numbers.

One surprising result refers to the resident population of Javan Plover at Labuan Bajo and Dolat Marsh. Until relatively recently the range of Javan Plover (when considered as either a species or as a subspecies of Kentish Plover) was given as 'endemic to Java' including Kangean Island and possibly Bali (MacKinnon & Philipps 1993). A recent review noted that Javan Plover occurs on many large islands through the Indonesian archipelago including Lombok, Sumba, Semau and Timor in the Lesser Sundas (Iqbal *et al*. 2013). Records from nearby Sumbawa were omitted (Iqbal *et al*. 2013) but it was first recorded there in the 1980-1990s (Coates & Bishop 1997, D. Milton *in litt*. 2005) and recent records by local photographer / naturalists show that there is a good population on the extensive mudflats (*c.*1,500 ha) at Bima Bay and also the *c.*200 ha of habitat at Sape Bay (Illalang 2016ab). There have been records further east at Tibar, Timor-Leste (Trainor 2011) and recently a Javan Plover was photographed at Lake Laga, Timor-Leste, which is 750 km east of the Labuan Bajo area (C. Trainor unpubl. data). The spate of recent records reflects greater survey effort and improved ease of identification. However, the presence of relatively small (<50 individuals, except Sumbawa) and isolated populations seems to be an unusual strategy for this bird and which deserves further attention. There has been no specific survey for Javan Plover in the Labuan Bajo area and the population may be larger than currently known because approximately 1,000 ha of habitat is available, though not all habitat may be occupied.

The only species not recorded during recent (post-1980s) surveys was the Greater Painted-snipe which was last recorded in 1971, and whose seasonal status and geographic origin remains unclear. All Flores specimens of Greater Painted-snipe, including eggs, were from the west of the island around Ruteng, or Soa near Bajawa in the centre-west. Greater Painted-snipe are frequently overlooked because of their cryptic behaviour and this is probably the main reason that they have not been recorded recently. Specific searches around Ruteng are likely to be successful. The Greater Painted-snipe has been noted in literature as breeding on Flores (White &

Bruce 1986, Coates & Bishop 1997) and has been assumed to be resident on the island. It has been mapped as a 'year-round resident' throughout the Indonesian archipelago (Kirwan 2016). Breeding has been confirmed on Borneo, where it is considered as 'mainly a visitor' (Kirwan 2016), and this appears to be the status of birds on Flores and presumably most of the Indonesian archipelago. The best regional data on breeding and seasonal occurrence is from Bali. There is one published breeding record from Bali of chicks in March (Hermawan *et al*. 2013) and two additional breeding records with egg-laying in May (S. Jones *in litt.* 2016). On Bali it appears to be a breeding visitor during November to July, with birds absent from August to October (Steve Jones *in litt*. 2015). In Timor-Leste the seven records were from August to May (Trainor 2011) and there has been a recent October record from West Timor (Robson 2015). Records from Flores cover a wider range of months than Bali or Timor with breeding confirmed during April to July and with a September specimen. The source of birds visiting the Indonesian archipelago, including Flores, is unknown but populations that experience cold winters include those occurring in NE China, S Japan and SE Russia (Kirwan 2016). The absence of records by MS around Moni is surprising, but ricefield habitat is less extensive than in the west of the island (e.g. >650 km^2 in the three Manggarai districts). Rainfall around Moni is also substantially lower than Ruteng, but may be similar to the Soa area (RePPProT 1989). Judging by patterns of specimen collection (and perhaps field observations) we speculate that it is likely that all snipe species occur in greater numbers around Ruteng because of the wetter and more extensive habitat.

Many conservation reserves have been declared on Flores, including several coastal reserves covering important shorebird habitat such as the 62,450 ha Gugus Pulau Telek Maumere Nature Recreation Reserve and 9,900 ha Tujuh Belas Pulau Riung Nature Recreation Reserve (Direktorat Jenderal Perlindungan Hutan dan Konservasi Alam 2007). However, conservation management is likely to be focused more on fish, reef and marine resources in these reserves. Leg-snaring of migrant snipe was observed by MS at Moni, but overall there is limited information to speculate on the scale of hunting for shorebirds on Flores, other than to say that use of leg-snares and air-guns is common.

Suggestions for Further Shorebird Survey

Apart from observations by MS, and bird tour parties around Labuan Bajo, there has been little targeted survey of shorebirds on Flores. Each year in Indonesia approximately 500 university theses, broadly in the fields of forest conservation and biology, focus on field studies of birds. This has included several single-species studies on Flores and nearby Komodo National Park by students of the Institute Pertanian Bogor (e.g. Aziz 2014, Kuspriyangga 2013, Panggur 2008). We suggest the following as potentially interesting and straight-forward studies on the shorebirds of Flores:

- An assessment of the Javan Plover population size about Labuan Bajo, with survey of other nearby Flores sites with potential habitat (e.g. Nangalili and Terang Bay [8˚26`S, 120˚05`E]) and including the extensive habitat at Bima (8˚32`S, 118˚39`E) and Sape (8˚34`S, 119˚01`E), on nearby Sumbawa Island.
- Assessment of the status of resident beach-dwelling shorebirds the Beach Stone-curlew and Malaysian Plover along, for example, a series of well-distributed 5-10 km long beach transects on Flores, and perhaps also Komodo and Rinca islands and numerous other small islands.

Additional survey of Pangabatang should also be a high priority as it hosts a wide range of migratory shorebird species (including globally threatened) and has the highest counts on Flores for several shorebird species. A specific survey of Greater Painted-snipe, Swinhoe's and Pin-tailed Snipe in the Ruteng region (and other extensive ricefield areas such as Lembor) would be fascinating, but requires relatively high-level skills in snipe identification and which may not suit university students. An assessment of the population size of the migrant snipe without specific species identification would also be interesting. We identified the estuary at Nangalili as one additional potentially significant site for shorebirds on Flores which should be a priority site for future visiting ornithologists (Figure 3c). The estuary includes more than 400 ha of coastal complex habitat including sand spits and beach, mangroves and lagoons mudflats, and could be an important roost site for migratory shorebirds.

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COASTAL SHOREBIRD SURVEY IN THE PROVINCES OF NORTH AND SOUTH PYONGAN, THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA, APRIL 2016

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INTRODUCTION

The Yellow Sea and Bohai Bay are vital staging areas for shorebirds during migrations between southern non-breeding grounds and breeding grounds in north Asia and Alaska. Since the 1990s, the distribution and abundance of shorebirds along the coasts of China and South Korea have become relatively well known, especially on northward migration (Barter 2002, Hua *et al.* 2015) but much less is known about shorebirds on the Yellow Sea coast of the Democratic People's Republic of Korea (DPRK). The first coordinated counts of shorebirds using tidal areas of the West Sea (as the Yellow Sea is known in the DPRK) were undertaken in 2009 (Riegen *et al.* 2009).

In 2015 the Nature Conservation Union of Korea (NCUK) and Pūkorokoro Miranda Naturalists' Trust (PMNT) initiated a programme to survey shorebirds along the West Sea coast. The first of these surveys was undertaken along the coast of Onchon County in April 2015, where we surveyed three areas and counted 20,635 shorebirds of 31 species. We found the area was internationally important for Great Knot, Bar-tailed Godwit and Dunlin (Riegen *et al.* 2016). Here we report on the second survey conducted in April 2016.

METHODS

Survey Sites

The 2016 survey was undertaken at the Chong Chon River estuary (approximately 39° N 125° E) in the provinces of North and South Pyongan (Figure 1).

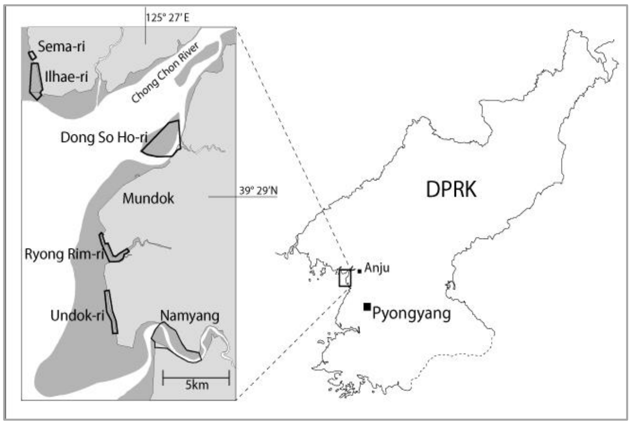

Figure 1. Map of DPRK and Pyongan coast. Polygons show areas counted.

The Mundok area on the south side of the estuary is a Nature Reserve, but the north shore has no formal protection. The coast was comprised of firm sediment, which appeared to extend several kilometres offshore at low tide, and was backed predominantly by rice paddies and some salt extraction ponds. Six locations, some 23 km apart north to south, had been identified by NCUK as suitable for the surveys (Figure 1).

Sites from North to South

Sema-ri (39° 32.5' N - 125° 15.6' E) and Ilhae-ri (39° 31.4' N - 125° 16.3' E)

These two sites are close together lying either side of a land locked island. To the north is another small landlocked island, the two being joined by a substantial seawall, approximately 1 km long. The tide reached the seawall at Sema-ri earlier that at Ilhae-ri and was already fully in when we arrived on 22 April. This had forced birds to roost in a shallow lagoon just behind the seawall, beyond which were salt extraction ponds. Ilhae-ri has a larger area of tidal flats between two landlocked islands. The tidal flat here is higher than at Sema-ri and the upper parts remained exposed on 21 April, enabling all the birds to roost on the mud outside the seawall. The higher banks had a good covering of *Suaeda*, with seeds just germinating. Many crabs (species unidentified) inhabited these banks and Whimbrel *Numenius phaeopus* were actively feeding on them. Far Eastern Curlew *Numenius madagascariensis* and Eurasian Curlew *N. arquata* were the most abundant species, followed by Bar-tailed Godwit *Limosa lapponica* and Dunlin *Calidris alpina*. On 22 April, once the tide reached the seawall at Ilhae-ri, many of the birds flew around the coast to roost at Sema-ri. However, not all birds seen on 21 April could be accounted for at Sema-ri, and there was no sign of them roosting in paddies or salt ponds at Ilhae-ri, so we are unsure where they roosted that day. The counts for 21-22 April have been adjusted to allow for this and avoid double counting. The tidal flats on the seaward side of the seawall were firm at Ilhae-ri, with people seen walking out to fish nets at least 500 m offshore in little more than ankle deep mud.

Dong So Ho-ri, Mundok (39° 30.2' N - 125° 23.2' E)

This area is the central part of the Mundok Reserve. It consists of an offshore mudbank, separated from the mainland by a 500 m wide channel. There is a large area of *Phragmites* reeds and other lower vegetation, probably *Suaeda*, growing on the bank, which has increased in area since our visit in 2009, when no vegetation was visible. On the highest tide most of the bank goes under water. In 2009, while we had permission to cross to the bank, we decided it was better to count birds from the hill on the mainland. Although the birds were at least 1 km distant the elevated position gave us a clear view of the whole mud bank. In 2016 we counted from the hill again and on this occasion the tide covered the entire bank but only short-legged waders were forced to leave; larger species such as curlews were able to stay there over high tide.

Ryong Rim-ri, Mundok (39°26.0' N - 125° 21.6'E)

This small estuary has embankments on both sides of the river and is surrounded by paddies. A long, narrow lagoon edged by *Phragmites* runs just behind the seawall and provided good habitat for ducks and grebes and one Korean Water Deer *Hydropotes inermis argyropus*. In 2009 there was a small area of salt ponds where birds roosted, these are now paddies and not suitable for shorebirds to roost. On 23 April when we counted this site, the tide, at 6.7 m, barely covered the mudbanks, which enabled birds to stay within the estuary over high tide. Like most of these small estuaries there are higher banks of mud usually covered with *Suaeda* and the birds roost in these places. Small fishing boats were working in the river but did not unduly disturb the birds.

Undok-ri (39° 23.4' N - 125° 21.7' E)

A seawall running roughly north-south along this part of the coast allowed good views over the mudflats and inland across paddies, patches of saltmarsh and small water bodies. We did not see how expansive the mudflats were at this site as we arrived within 15 minutes of the tide reaching the seawall. Some birds moved inland to paddies and saltmarsh while others flew south and into the estuary at Namyang. There were few people working in the paddies, which allowed birds to settle and roost.

Namyang (39° 22.9' N - 125° 24.5' E)

Namyang is an extensive area of active salt ponds covering approximately 20 km^2 set between two river estuaries. We visited the larger estuary at the northern edge of the salt ponds and a small portion of the ponds. As with other estuaries this one had a rock-lined seawall on both sides and areas of higher mudflats with some patches of *Suaeda* within the estuary. The tide was predicted to be 6.9 m on 26 April. Although the entire surface of the estuary was covered by the tide there were several places where long-legged shorebirds could stand and most chose to do that, rather than move to salt ponds. Short-legged birds moved to ponds close to our observation point.

Survey Methods

The survey was undertaken during high spring tides between 21–26 April 2016; predicted tides for Unmu Do (39° 25' N - 125° 07' E*)*, an island 20 km due west of Ryong Rim-ri, ranged from 6.0 m on 20 April to 7.0 m on 25 April. The spring tides were chosen as we hoped that no mud would remain exposed outside the seawall and all birds would have to move inland thus facilitating counting, but this did not always happen. At Namyang the small waders were forced to move to ponds while the larger godwits and curlews preferred to stay in the estuary, even though for a time they were almost swimming. Why they were reluctant to move to the salt ponds, where it appeared that there would have been very little disturbance, is unclear.

The weather on the first two days was damp with rain and drizzle, and poor visibility. The next four days were clear and dry, with better viewing conditions, although the air was quite hazy.

The NCUK team had identified areas where shorebirds were known to occur and each day we travelled from our hotel in Anju to one of these sites. We tried to arrive at least two hours before high tide in the hope of seeing birds leaving the mudflats and observing where they went to roost, as once landed they can be difficult to locate. However, this was not possible on three days as rough roads and unforseen detours from road closures delayed our arrival. As some count sites overlapped, care was taken to avoid double counting birds; thus count data for Sema-ri and Ilhae-ri are combined, as are those for Undok-ri and Namyang.

RESULTS

A total of 16,590 individuals of 26 shorebird species were counted (Table 1). Two species, Bar-tailed Godwit and Far Eastern Curlew, occurred in numbers that met the 1% population criterion used by the Ramsar Convention to identify internationally important wetlands (Table 2). In addition, 4,513 Dunlins were counted. Together, these three species accounted for 85% of the total shorebirds recorded. The counts at Mundok in 2009 and 2016 are shown for comparison in Table 3.

The visit to Mundok allowed a comparison with the results of the initial survey seven years earlier. In 2009 shorebirds roosted in a small network of salt ponds but in 2016 these had been converted to cropland. The offshore mudbank at Dong So Ho-ri was devoid of vegetation in 2009, but in 2016 had patches of *Phragmites* scattered across it, especially at the northeast (upstream) end. It is thought that this is a natural change; it is likely that an island will develop in future. Numbers of the key shorebird species at Mundok were very similar in 2016 to those counted in 2009 (Table 3) and the count dates were similar. The significant difference was the small number of Eurasian Curlews in 2016 compared to 2009. Eurasian Curlews are early migrants and may have already left in 2016. The two species with notably different numbers were Great Knot *Calidris tenuirostris* down from 172 in 2009 to just two in 2016 and Terek Sandpiper *Xenus cinereus* down from 133 to 22.

There were limited opportunities to look for flags and colour bands due to our inability to approach birds closely, and on most occasions when they were close, they were standing in water. Details of marked birds are given in Tables 4 and 5.

Table 1. Total shorebird counts for 21-26 April 2016

Species	Total	21-22 April Ilhae-ri Sema-ri	23-24 April Mundok	25 April Undok-ri	26 April Namyang Salt ponds
Eurasian Pied Oystercatcher *Haematopus [ostralegus] osculans*	4	2	2		
Black-winged Stilt *Himantopus himantopus*	5		5		
Grey-headed Lapwing *Vanellus cinereus*	1			1	
Pacific Golden Plover *Pluvialis fulva*	7			7	
Grey Plover *Pluvialis squatarola*	599	134	136	25	304
Little Ringed Plover *Charadrius dubius*	1			1	
Kentish Plover *Charadrius alexandrinus*	14	11	2		1
Lesser Sand Plover *Charadrius mongolus*	224	15	3		206
Black-tailed Godwit *Limosa limosa*	11			5	6
Bar-tailed Godwit *Limosa lapponica*	6928	359	2069		4500
Whimbrel *Numenius phaeopus*	430	37	40	140	213
Eurasian Curlew* *Numenius arquata*	504	250	20	94	140
Far Eastern Curlew* *Numenius madagascariensis*	2716	1316	670	30	700
Spotted Redshank *Tringa erythropus*	143	2	6	118	17
Common Redshank *Tringa totanus*	11	6	2	1	2
Common Greenshank *Tringa nebularia*	70	2	7	44	17
Nordmann's Greenshank *Tringa guttifer*	1				1
Wood Sandpiper *Tringa glareola*	11	2	1	3	5
Terek Sandpiper *Xenus cinereus*	68	21	25	10	12
Common Sandpiper *Actitis hypoleucos*	2	1	1		
Ruddy Turnstone *Arenaria interpres*	10	2	2		6
Great Knot *Calidris tenuirostris*	222	91	2		129
Red Knot *Calidris canutus*	2		1		1
Red-necked Stint *Calidris ruficolls*	84	2			82
Sharp-tailed Sandpiper *Calidris accuminata*	9			9	
Dunlin *Calidris alpina*	4513	1000	878	45	2590
TOTALS	16,590	3253	3872	533	8932

Note: *Combined total numbers of both curlews are correct but number of each species is estimated and based on observations of samples of birds in flight.

Table 2. Population estimates for some shorebirds in the East Asian-Australasian Flyway

Species	Wetlands International 2016	Murray *et al.* *in prep*	Hansen *et al.* 2016	Conklin *et al.* 2014	1% used in this study
Bar-tailed Godwit *baueri*	133,000	129,000			
Bar-tailed Godwit *menzbieri*	146,000	101,000			
Bar-tailed Godwit combined ssp.	279,000	230,000			2300
Far Eastern Curlew	32,000		31,000		310
Eurasian Curlew	100,000				
Dunlin	>200,000			553,900	5539

Table 3. Shorebird counts for Mundok in 2009 and 2016 for comparison.

Species	2016 23 April Mundok Ryong Rim-ri	2009 27-29 April Mundok Ryong Rim-ri	2016 24 April Mundok So Ho-ri	2009 26 April Mundok So Ho-ri
Eurasian Pied Oystercatcher			2	
Black-winged Stilt	5	3		11
Pacific Golden Plover		40		
Grey Plover	67	140	65	55
Kentish Plover		10	1	1
Lesser Sand Plover		22		
Black-tailed Godwit		3		
Bar-tailed Godwit	2020	2200	48	200
Whimbrel	25	30	15	6
Eurasian Curlew	10		10	580
Far Eastern Curlew	230	750	440	200
Spotted Redshank	6	25		
Common Redshank	2	11		8
Common Greenshank	6	5	1	3
Wood Sandpiper	1	21		
Terek Sandpiper		133	22	
Common Sandpiper	1	3		
Ruddy Turnstone	2			
Great Knot	2	172		
Red Knot	1			
Sanderling		2		
Red-necked Stint		12		
Temminck's Stint		6		
Sharp-tailed Sandpiper		9		
Dunlin	400	290	428	1290
TOTALS	2778	3887	1032	2354

Table 4. Leg flag and colour band sightings 20-26 April 2016.

Species	Colours *	Code	Location	Notes
Great Knot	Black/White		Ilhae-ri	
Great Knot	Yellow		Ilhae-ri	
Dunlin	Black/White		Ilhae-ri	
Dunlin	Pale Blue/White		Ilhae-ri	
Bar-tailed Godwit	Green		Sema-ri	Plain flag
Bar-tailed Godwit	Yellow		Mundok - Ryong Rim-ri	ELF Unread
Bar-tailed Godwit	Green		Mundok - Ryong Rim-ri	ELF Unread female
Bar-tailed Godwit	Yellow		Mundok - Ryong Rim-ri	Male BP 5
Bar-tailed Godwit	Orange		Mundok - Ryong Rim-ri	Male BP 5.5
Bar-tailed Godwit	Orange		Mundok - Ryong Rim-ri	ELF Unread faded male
Bar-tailed Godwit	Orange		Mundok - Ryong Rim-ri	ELF Unread female
Bar-tailed Godwit	Yellow		Mundok - Ryong Rim-ri	ELF Unread female
Bar-tailed Godwit	Yellow		Mundok - Ryong Rim-ri	ELF Unread female
Bar-tailed Godwit	Yellow		Mundok - Ryong Rim-ri	ELF Unread male BP6
Bar-tailed Godwit	White	BPL	Mundok - Ryong Rim-ri	
Bar-tailed Godwit	Yellow	Y3LBLL	Mundok - Ryong Rim-ri	Faded flag
Bar-tailed Godwit	Red	R3BR- -	Mundok - Ryong Rim-ri	Female
Bar-tailed Godwit	White		Mundok - Ryong Rim-ri	Plain flag
Far Eastern Curlew	Flag		Undok-ri	Large flag colour unseen
Bar-tailed Godwit	Orange		Undok-ri	ELF Unread female
Far Eastern Curlew	Black/White		Namyang Saltworks	
Bar-tailed Godwit	Orange		Namyang Saltworks	ELF Unread female
Bar-tailed Godwit	Orange		Namyang Saltworks	Faded
Bar-tailed Godwit	Yellow	Y5YRWR	Namyang Saltworks	Female
Bar-tailed Godwit	Yellow		Namyang Saltworks	ELF Unread female
Bar-tailed Godwit	White		Namyang Saltworks	ELF Unread female
Bar-tailed Godwit	Yellow	Y3-4 - - YY -	Namyang Saltworks	Only one leg seen
Bar-tailed Godwit	Flag unseen	Partial - - RY -	Namyang Saltworks	
Bar-tailed Godwit	Yellow		Namyang Saltworks	ELF Unread
Bar-tailed Godwit	Orange	K8	Namyang Saltworks	Looked Yellow but probably Orange

* Black/White - Chongming Dongtan National Nature Reserve, Shanghai, Green - Southeast Queensland, Orange – Victoria, Pale Blue/White - Wrangel Island, Russia, White & Red - New Zealand, Yellow - Northwest Australia

Table 5. Banding details of individually marked birds.

Species	Code/Colour band combination	Band No	Banding and resighting details
Bar-tailed Godwit	White BPL	Y6699	Miranda, Firth of Thames, NZ, 14 March 2009 aged 3+ Resighted 17 times at Miranda until 15 March 2016 and twice at Yalu Jiang in April 2010 and 2011
Bar-tailed Godwit	Y3LBLL	073-64667	Roebuck Bay, Northwest Australia 6 August 2011 aged 3 Resighted 6 times in Roebuck Bay until 25 November 2013
Bar-tailed Godwit	Orange K8	073-59312	Banded Corner Inlet, Victoria 23 June 2009 aged 1 Resighted once only, in Japan on 15 May 2011
Bar-tailed Godwit	R3BR--		One of two banded at Catlins Lake, South Island, NZ on 2 February 2014 and fitted with geolocator (still attached).

Table 6. Incidental waterbird counts at shorebird count sites 21-26 April 2016.

Species	Total	21-22 April Ilhae-ri Sema-ri	23-24 April Mundok	25-26 April Undok-ri Namyang
Swan Goose *Anser cygnoides*	*2*		2	
Greater White-fronted Goose *Anser albifrons*	*4*		4	
Common Shelduck *Tadorna tadorna*	*273*	7	142	124
Gadwall *Anas strepera*	*4*		4	
Eurasian Wigeon *Anas penelope*	*2*		2	
Mallard *Anas platyrhychos*	*15*	1	11	3
Eastern Spot-billed Duck *Anas zonorhyncha*	*323*	156	165	2
Northern Pintail *Anas acuta*	*1*	1		
Garganey *Anas querquedul*a	*12*		12	
Common Teal *Anas crecca*	*75*		75	
Little Grebe *Tachybaptus ruficollis*	*4*		4	
Eurasian Spoonbill *Platalea leucorodia*	*2*	2		
Black-faced Spoonbill *Platalea minor*	*1*		1	
Grey Heron *Ardea cinerea*	*22*	8	13	1
Purple Heron *Ardea purpurea*	*1*		1	
Great White Egret *Ardea alba*	*16*	3	13	
Little Egret *Egretta gazetta*	*7*	5		2
Chinese Egret *Egretta eulophotes*	*1*	1		
Common Coot *Fulica atra*	*2*		2	
Black-tailed Gull *Larus crassirostris*	*271*	16	80	175
Herring' type - Gull *Larus [agentatus]*	*5*	2	1	2
Black-headed Gull *Larus ridibundus*	*131*	1	101	29
Saunders's Gull *Saundersilarus saundersi*	*81*		1	80
Little Tern *Sterna albifrons*	*2*	2		
TOTALS	1257	205	634	418

One Bar-tailed Godwit was recorded that has previously been recorded at the Yalu Jiang National Nature Reserve, Liaoning, China, in 2010 and 2011. This bird has not been seen there subsequently, despite observers being present. Bar-tailed Godwits usually show a high degree of site faithfulness to both non-breeding (Battley *et al*. 2011) and staging areas (A. Riegen & P.F. Battley unpublished), thus the possible move of this bird to a different staging site is noteworthy.

While counting shorebirds, the opportunity arose to count other waterbirds but this was not a priority and so the list is not exhaustive. The totals are shown in Table 6.

DISCUSSION

Criterion 6 for the designation of Wetlands of International Importance under the Ramsar Convention states: 'A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird'. The East Asian-Australasian Flyway Partnership has determined that a staging site used by waterbirds may be identified as being of international importance if it supports 0.25% of the flyway population at any one time. Continuing loss of habitat in East Asia (Murray *et al*. 2014) and declining annual survival rates (Piersma *et al.* 2016, Conklin *et al.* 2016), mean that population estimates need to be regularly revised. Recent population estimates for the three dominant shorebird species in the survey are shown in Table 2.

Both subspecies of Bar-tailed Godwit were seen, but we were unable to determine their relative proportions. As *baueri* are known to migrate earlier to Alaska than *menzbieri* do to Siberia, predominantly in late April and early May, it is possible there were more *menzbieri* present during our counts (McCaffery & Gill 2001, Battley *et al*. 2012, Riegen *et al*. 2014, Choi *et al*. 2015). For the purposes of determining the 1% population threshold we adopted a conservative approach and combined both subspecies (Table 2).

Two sites met the Ramsar 1% criterion for Bar-tailed Godwit, and three sites for Far Eastern Curlew. Dunlin and Eurasian Curlew met the EAAF Partnership 0.25% staging site threshold at one site each.

The Chong Chon River estuary (including Mundok Nature Reserve) is currently recognised as an Important Bird Area by BirdLife International (Chan *et al*. 2004) with both Nordmann's Greenshank *Tringa guttifer* and Far Eastern Curlew being recorded as present. It is also designated as Crane Network Site under the East Asian-Australasian Flyway Partnership (Chan 2006), being of importance for Red-crowned *Grus japonensis*, Hooded *G. monacha* and White-naped *G. vipio* Cranes (EAAF 2016).

The lack of Great Knots was unexpected, as we had recorded 7600 in Onchon County, further south, in 2015 (Riegen *et al.* 2016). It was notable that this year we did not record any people digging for shellfish, whereas we had recorded extensive shellfish harvesting in Onchon County in 2015, where Great Knots were present. Great and Red Knots *Calidris canutus*, are specialised bivalve feeders and if the absence of fishers is indicative of a lack of bivalves this might account for the low numbers of knots. However old shell remains at the Namyang Salt Works included *Potamcorbula laevis,* which is an important prey for both species of knots in China (Choi *et al.* 2014, Yang *et al*. 2016). There were large number of crabs on the tidal flats in the estuaries, which attracted both curlew species and Whimbrel.

At a time when there is rapid loss and degradation of intertidal habitats around the Chinese and South Korean coasts (Murray *et al.* 2014, Melville *et al*. 2016), the coast of the DPRK is of increasing importance as a potential 'safety valve' for shorebirds in the EAAF. The areas we have seen do not appear to be under imminent threat from development or over exploitation of natural resources and the Mundok area had changed little since our first visit in 2009. As yet we have not been able to determine whether there are plans for coastal development at the sites surveyed but it is hoped that the results of the surveys will enable wise decisions to be made in the future, should coastal development be proposed. The DPRK is interested in becoming a Party to the Ramsar Convention and joining the East Asian-Australasian Flyway Partnership and these surveys will help identify potential sites for designation as Ramsar and / or Flyway Network sites. This survey, and those planned for the coming three years, will assist in the identification of those parts of the DPRK coast that are nationally and internationally important for shorebirds, and identify ways in which they can be conserved and their habitats protected and potentially enhanced

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Appendix 1. List of shorebirds and waterbirds recorded during the coastal survey 21-26 April 2016.

English common name	Scientific name	Korean common name	Korean English common name
Far Eastern Oystercatcher	*Haematopus [ostralegus] osculans*	까치도요	Kkachidoyo
Black-winged Stilt	*Himantopus himantopus*	장다리물떼새	Jangdarimulttsae
Grey Plover	*Pluvialis squatarola*	검은배도요	Komunbaedoyo
Little Ringed Plover	*Charadrius dubius*	알도요	Aldoyo
Kentish Plover	*Charadrius alexandrinus*	흰가슴알도요	Huingasumaldoyo
Lesser Sand Plover	*Charadrius mongolus*	왕눈도요	Wangnundoyo
Black-tailed Godwit	*Limosa limosa*	검은꼬리도요	Komunkkoridoyo
Bar-tailed Godwit	*Limosa lapponica*	큰뒷부리도요	Kundaetburidoyo
Whimbrel	*Numenius phaeopus*	발도요	Batdoyo
Eurasian Curlew	*Numenius arquata*	마도요	Madoyo
Eastern Curlew	*Numenius madagascariensis*	알락꼬리마도요	Allakkkoridoyo
Spotted Redshank	*Tringa erythropus*	학도요	Hakdoyo
Common Redshank	*Tringa totanus*	붉은발도요	Bulunbatdoyo
Common Greenshank	*Tringa nebularia*	청다리도요	Chengdaridoyo
Wood Sandpiper	*Tringa glareola*	알락도요	Allakdoyo
Terek Sandpiper	*Xenus cinereus*	뒷부리도요	Daetburidoyo
Common Sandpiper	*Actitis hypoleucos*	민물도요	Minmuldoyo
Ruddy Turnstone	*Arenaria interpres*	꼬까도요	Kkoggadoyo
Great Knot	*Calidris tenuirostris*	붉은어깨도요	Buluneggaedoyo
Red Knot	*Calidris canutus*	붉은배도요	Bulunbaedoyo
Red-necked Stint	*Calidris ruficollis*	좀도요	Jomdoyo
Sharp-tailed Sandpiper	*Calidris accuminata*	메추리도요	Mechuridoyo
Dunlin	*Calidris alpina*	갯도요	Gaetdoyo
WATERBIRDS			
Common Shelduck	*Tadorna tadorna*	꽃진경이	Kotjingyongi
Eastern Spot billed Duck	*Anas zonorhyncha*	검독오리	Kemdokori
Gadwall	*Anas strepera*	알락오리	Allagori
Eurasian Wigeon	*Anas penelope*	알숭오리	Allsungor
Mallard	*Anas platyrhychos*	청둥오리	Cheongdung oli
Northern Pintail	*Anas acuta*	가창오리	Gachangori
Garganey	*Anas querquedula*	알락발구지	Allagbalguji
Eurasian Teal	*Anas crecca*	반달오리	Bandalori
Little Grebe	*Tachybaptus ruficollis*	농병아리	Nongbyongari
Eurasian Spoonbill	*Platalea leucorodia*	누른뺨저어새	Nurunpyamjeoeosae
Black-faced Spoonbill	*Platalea minor*	검은머리저어새	Jeo-eosae
Grey Heron	*Ardea cinerea*	왜가리	Whaegari
Purple Heron	*Ardea purpurea*	자지왜가리	Zajiwhaegari
White Heron	*Ardea alba*	대백로	Huin baeglo
Little Egret	*Egretta gazetta*	쇠백로	Soebaengno
Chinese Egret	*Egretta eulophotes*	누른물까마귀	Nurunmulgamagi
Common Coot	*Fulica atra*	큰물닭	Kunmuldak
Black-tailed Gull	*Larus crassirostris*	검은꼬리갈매기	Kemunkkorigalmaegi
Black-headed Gull	*Larus ridibundus*	붉은부리갈매기	Bulunburigalmaegi
Saunders's Gull	*Saundersilarus saundersi*	검은머리갈매기	Geomeunmeorigalmaegi
Little Tern	*Sterna albifrons*	쇠갈매기	Saegalmaegi

A SURVEY OF WADERS IN THE WEST COAST REGION, SOUTH ISLAND, NEW ZEALAND

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A survey of waders was conducted in coastal habitats in the West Coast Region of the South Island, New Zealand in Feb 2006. This month is assumed to be the peak period for wader abundance as indigenous species congregate into post-breeding flocks and share coastal habitats with migratory species from the Northern Hemisphere. A total of 2721 waders were counted, comprising six indigenous species and three migratory species. Wader abundance and species richness on the West Coast was found to be relatively low compared to other parts of New Zealand.

INTRODUCTION

The West Coast Region of New Zealand's South Island covers an area of approximately 23,000 km^2 and has a human population of 32,700 (Statistics New Zealand 2013, West Coast Regional Council 2014). The region is one of the least developed parts of New Zealand and retains approximately 58% indigenous forest land cover, as well as extensive areas of native shrubland, wetland and montane habitats (O'Donnell & Dilks 1986). The region's coastline spans approximately 600 km and comprises mainly sand / shingle beaches, rocky shore and sea cliffs, with limited estuarine and coastal lagoon habitat.

Due to long travel distances, a sparse human population and a lack of ornithologists in the region, the West Coast seldom receives full coverage during the Ornithological Society of New Zealand's national wader counts, and has occasionally been completely omitted (Sagar *et al.* 1999). Therefore, any systematic data on wader abundance and distribution outside of the traditional national wader count periods (November-December and June-July), is scarce and worthy of publication. This paper reports on a survey of waders conducted on the West Coast in February 2006. This is the time of year when local wader populations can be expected to reach maximum numbers as sites support both indigenous waders at peak post-breeding abundance, as well as migratory wader flocks just prior to their departure on northward migration (Crossland 2009, 2010, 2013).

METHODS

Between 21 and 23 February 2006 we travelled the length of the West Coast Region from Jackson's Bay (latitude 43°59' S) in the south to Oparara Estuary (latitude 41°11' S), near Karamea in the north (Figure 1), searching for concentrations of waders. A total of 15 sites with potential wader habitat had previously been identified from satellite images and topographical maps. Each of these was visited during the three days of field work to investigate whether waders were present and to count them. Two other sites (Three Mile Lagoon and Saltwater Lagoon) are known to occasionally support waders (Imboden & Crocker 1978; Cromarty & Scott 1996), but were not visited as they were flooded during the survey period. These lagoons are intermittently open and closed to the sea and periodically have large expanses of mudflats available to waders when tidal. However, when their outlets are closed these lagoons fill up with freshwater and the mudflats are flooded for prolonged periods.

Survey techniques followed those outlined by Howes & Bakewell (1989). Birds were identified and counted individually, with surveys made at either high tide roosts or at quarter tide when birds were dispersed, either loafing or foraging, over a limited extent of inter-tidal habitat.

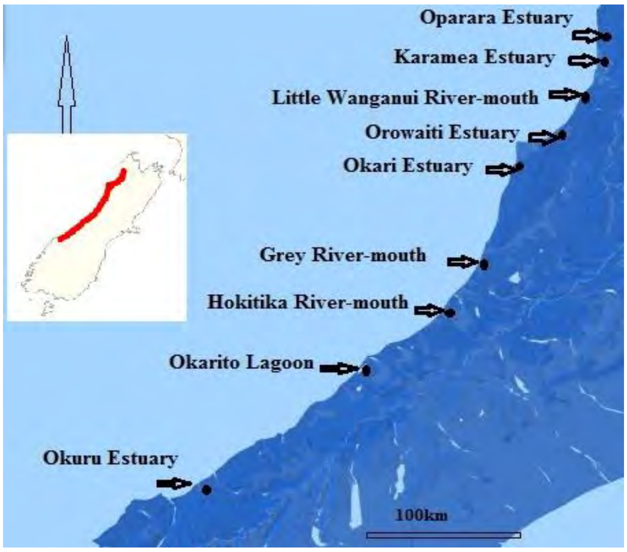

Figure 1. West Coast Region showing sites where wader concentrations were found.

RESULTS

Concentrations of waders were found at nine of the 15 sites surveyed, comprising five estuaries (Okuru, Okari, Orowaiti, Karamea and Oparara); three river-mouths (Hokitika, Grey, Little Wanganui); and one tidal lagoon (Okarito). Nil counts were made at six other sites (Waiatoto River-mouth, Haast River-mouth, Wanganui River-mouth, Taramakau River-mouth, Bradshaw's Lagoon and Mokihinui River-mouth).

Table 1. Waders counted in the West Coast Region, February 2006.

Common Name	Scientific Name	Okuru Estuary	Okarito Lagoon	Hokitika Rivermouth	Grey Rivermouth	Okari Estuary	Orowaiti Estuary	Little Wanganui Rivermouth	Karamea Estuary	Oparara Estuary	Total
Variable Oystercatcher	*Haematopus unicolor*	2	8	2	1	26	23	6	35	18	121
South Is. Pied Oystercatcher	*Haematopus finschi*	2	124		1	625	372		410	206	1740
White-headed Stilt	*Himantopus leucocephalus*		2		6	56	75	2	49	20	210
Masked Lapwing	*Vanellus miles novaehollandiae*	4			2		46				52
Double-banded Plover	*Charadrius bicinctus*	8		6	10		32		90	13	159
Wrybill	*Anarhynchus frontalis*								2		2
Whimbrel	*Numenius phaeopus*					1					1
Bar-tailed Godwit	*Limosa lapponica baueri*		39			69	93		205	20	426
Red Knot	*Calidris canutus*								10		10
TOTAL		16	173	8	20	777	641	8	801	277	2721

A total of 2721 waders were counted, comprising 2284 indigenous waders (six species) and 437 Arctic migrants (three species) (Table 1). The most abundant species were South Island Pied Oystercatcher *Haematopus finschi* (1740 birds), Eastern Bar-tailed Godwit *Limosa lapponica baueri* (426), White-headed Stilt *Himantopus leucocephalus* (210) and Double-banded Plover *Charadrius bicinctus* (159). Wader distribution was uneven with 2504 waders counted at sites in the northern third of the region (Okari Estuary to Oparara Estuary), 28 waders counted in the central third (Hokitika and Grey river-mouths), and 189 counted in the southern third (Okuru Estuary and Okarito Lagoon).

DISCUSSION

Species Accounts

Variable Oystercatcher *Haematopus unicolor*

This endemic coastal-breeding wader was found at all nine sites where wader concentrations occurred. It was found mainly in pairs and family groups. The total of 121 represents 2.6% of the New Zealand and global population, estimated at 4500 in 2006 (Dowding & Moore 2006). Sites supporting more than 20 birds were Karamea Estuary (35 birds), Okari Estuary (26) and Orowaiti Estuary (23).

South Island Pied Oystercatcher *Haematopus finschi*

By far the most numerous wader species recorded. A total of 1740 South Island Pied Oystercatcher were counted, representing 1.3 - 2.2% of the New Zealand population (Wetlands International 2016). They were present at seven sites except Hokitika and Little Wanganui river-mouths, with sizeable flocks at Okari Estuary (625 birds), Karamea Estuary (410), Orowaiti Estuary (372), Oparara Estuary (206) and Okarito Lagoon (124). Within the West Coast, South Island Pied Oystercatchers breed inland on shingle braided riverbeds and short grasslands, but local breeding populations are considered to be fairly small (Robertson 1985; Heather & Robertson 2015; AC unpubl. data). The number counted probably represents the bulk of the West Coast breeding population and may include birds that have crossed over from the eastern regions of the South Island.

White-headed Stilt *Himantopus leucocephalus*

This species was recorded at seven sites, totalling 210 with the largest flocks at Orowaiti Estuary (75 birds), Okari Estuary (56) and Karamea Estuary (49). White-headed Stilts breed at coastal sites, as well as on inland wetlands, stony riverbeds and flooded fields (Marchant & Higgins 1990). They move mainly to estuaries and coastal lagoons after breeding (Dowding & Moore 2006). This species is thinly distributed as a breeding species on the West Coast (Robertson *et al.* 2007) and it is likely that numbers found on estuaries during the survey comprised a significant proportion of the total regional population.

Masked Lapwing *Vanellus miles novaehollandiae*

Masked Lapwing are not reliant on estuarine habitats (Marchant & Higgins 1990), and although locally common and widely distributed in the West Coast Region (Robertson *et al.* 2007), only 52 were recorded on this survey. The only sizeable concentration was 46 birds at Orowaiti Estuary.

Double-banded Plover *Charadrius bicinctus*

This plover breeds locally on beaches as well as riverbeds, bare ground and short grassland habitats inland (Marchant & Higgins 1990). Found at six sites, a total of 159 were counted with largest numbers at Karamea Estuary (90 birds) and Orowaiti Estuary (32).

Wrybill *Anarhynchus frontalis*

Wrybill are known to breed only on the eastern side of the South Island (Dowding & Moore 2006, Robertson *et al.* 2007). The two birds observed at Karamea Estuary are likely to have crossed the main divide from breeding areas in the Canterbury or Otago Regions.

Whimbrel *Numenius phaeopus*

An uncommon migrant to New Zealand (Southey 2009), one individual of the Asiatic *variegatus* subspecies was observed amongst Bar-tailed Godwits at Okari Estuary.

Bar-tailed Godwit *Limosa lapponica baueri*

The second most numerous species, recorded at five sites including flocks of 205 at Karamea Estuary, 93 at Orowaiti Estuary, 69 at Okari Estuary and 39 at Okarito

Lagoon. Although the total of 426 represents less than 1% of the New Zealand over-summering population (Southey 2009), this is by far the most numerous and widely distributed of the holarctic migratory waders visiting the West Coast Region (Robertson *et al.* 2007).

Red Knot *Calidris canutus*

A party of 10 Red Knot were found at Karamea Estuary. Small flocks also regularly occur at Okarito Lagoon and Okari Estuary (AC unpubl. data), but despite careful searches, none were located at these sites during the February 2006 survey.

Wader Abundance and Species Richness

Sagar (1999) noted that relatively small numbers of a few species of wader occur in the West Coast Region of New Zealand's South Island. Our February 2006 survey, made during the time of year when numbers and species richness are likely to be highest, found just ~2700 birds of nine species, confirming Sagar's (1999) assessment.

The sighting of two Wrybill at Karamea Estuary and the relatively large numbers of South Island Pied Oystercatcher found on the survey suggest that the source areas of some waders are not necessarily confined to the West Coast Region. It seems probable that some birds fly over the Southern Alps (the mountain chain running longitudinally along the length of the South Island and reaching 3724 m at Mount Cook) from breeding grounds on the eastern side of the island to the western side. Some other waterbirds have been recorded doing this and we have observed both Kelp Gulls *Larus dominicanus* and Great Egret *Ardea alba* fly over mountain passes in the Southern Alps (AC unpubl. data). Further observations and colour-banding / geolocator research is required to confirm and quantify this suspected alpine crossing movement of waders.

We found wader numbers in the central and southern parts of the West Coast Region to be particularly low, perhaps due to isolation in the far south-west of the country. Distances are great from the main migration routes of both native and arctic waders within New Zealand, these routes tending to run from the northern North Island through the middle reaches of the country to the eastern and southern parts of the South Island, bypassing the western side of the island. In terms of density of birds per hectare, wader habitat in the southern West Coast appears greatly under-utilised. Okarito Lagoon for example, is a large coastal lagoon, surrounded by extensive salt-marsh and temperate rainforest, virtually untouched by development and still in an almost pristine pre-human settlement condition (Cromarty & Scott 1996). It is the largest unmodified wetland in New Zealand (Nathan 2015). Although Okarito Lagoon covers 3240 ha and has extensive mudflats, wader numbers are usually very low, typically <300 birds. (AC unpubl. data.). Like nearby Saltwater and Three-mile Lagoons (both flooded during the survey period), Okarito's potential as a major wader habitat appears limited because it doesn't have typical estuarine food resources such as shellfish beds or crab populations. This is because the outlet closes for long periods, causing periodic inundation of the mudflats and a sudden change from a tidal environment to an imponded fresh / brackish environment (Cromarty & Scott 1996). However, this lagoon was fully tidal when surveyed on 21 February 2006 and the >500 ha of mudflats present should be expected to support many more than the 173 waders of just four species observed. Elsewhere in New Zealand, species that are not dependant on shellfish beds, like White-headed Stilt, Double-banded Plover and Bar-tailed Godwit, would occupy a habitat of that size in much greater numbers. Likewise, the inter-tidal mudflats of Okuru Estuary, 130 km further south-west, have the potential to support several hundred waders, yet held only 16 birds of four species on the survey.

This survey found that the West Coast's main wader concentrations were located on the chain of small estuaries in the northern third of the region. Here 2504 waders were counted, comprising 92% of the region's total. Three sites held over 500 waders - Karamea Estuary (801 birds), Okari Estuary (769) and Orowaiti Estuary (641). Besides having sizeable areas of inter-tidal sand / mudflats with an abundance of estuarine food resources, these northern estuaries have much better connectivity to New Zealand's main internal wader migration routes (Crossland 1992) than sites further south and are relatively close (*c.*75-150 km in straight line distances) to major wader habitats in the Nelson Region at the top of the South Island (eg; Westhaven Inlet, Farewell Spit, Golden Bay and Tasman Bay). It is likely that there is regular interchange of waders between the northern West Coast and Nelson. Certainly, Double-banded Plovers from the West Coast Region have been regularly recorded in the non-breeding season at Farewell Spit and Golden Bay (Pierce 1999).

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A SURVEY OF WADERS ON PART OF GUADALCANAL AND THE FLORIDA GROUP, SOLOMON ISLANDS

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Wader data for the Solomon Islands are scarce with most published records to date being incidental observations. Here we present results from a survey of 23 coastal and inland wetland sites on Guadalcanal Island (Guadalcanal Province) and the Florida Island Group (Central Province) carried out between 25 February and 21 March 2015. We found a total of 462 waders of 16 species. The most numerous species were Pacific Golden Plover *Pluvialis fulva*, Lesser Sand Plover *Charadrius mongolus*, combined Tattler species *Tringa brevipes / incana* and Common Sandpiper *Actitis hypoleucos*. Within the context of there being few known sites where concentrations of waders occur in the Solomons, we suggest that Henderson Airport on Guadalcanal, as well as Lake Kolaoka and the wider area around Mbalekama Point on Nggela Pile are probably of national importance. Although hitherto considered part of the West Pacific Flyway and to lie beyond the eastern boundary of the East Asian-Australasian Flyway (Wetlands International 1995; Bamford *et al.* 2008), our survey findings indicate that the Solomon Islands host migratory shorebird species from both flyways and should be recognised as an overlap region between the two.

INTRODUCTION

The Solomon Islands comprise a 1500 km double chain of six main islands (Choiseul, New Georgia, Santa Isabel, Guadalcanal, Malaita and Makira) and over 900 smaller islands, located between latitudes 5° and 13° S, and longitudes 155° and 169° E in the western Pacific Ocean. The country is located east of Papua New Guinea, north-west of Vanuatu, and north-east of Queensland, Australia. Although many wader species have been recorded in the Solomon Islands (Bull 1948; Mayr 1949; Doughty 1999; Dutson 2011; Tarburton 2014c), most records are by way of incidental observations and very little data exist on numbers and distribution (Dutson 2011). Assessment of protected natural areas within coastal and wetland environments have tended to focus on coral reef and lagoon systems, mangroves, swamp forest, freshwater lakes and small islands supporting breeding sea birds, turtles or other wildlife (Scott 1993; Ellison 2009; Birdlife International 2012). Estuarine, beach and inter-tidal habitats have not received much attention. Furthermore, although some identification of important sites for seabirds and other wildlife has occurred (Bayliss-Smith & Christensen 2008), there has been little research on wader abundance and distribution, and no internationally important sites for migratory wader species are identified within the country to date. This paper reports on a survey of waders carried out between 25 February and 21 March 2015 on coastal, riverine and inland wetland sites in the central northern side of Guadalcanal, and at several coastal sites in the Florida Group. We hope that this paper will encourage further survey work and publication of wader records from the Solomon Islands. Many more counts and observations are needed before a definitive assessment of wader species occurrence, abundance and distribution can be made for this country.

METHODS

Study Area

We surveyed 23 sites including 15 sites on the central part of the eastern side of Guadalcanal Island and eight sites on the Florida Group (Figure 1). Potential wader sites within the study area were identified by studying topographical maps and Google Earth images, but final selection of sites surveyed was very much dependent on our ability to access them (i.e. both logistically and in terms of gaining landowner permission). Although our survey was supported by provincial government officials who facilitated landowner permission for access, this was only for some sites - notably on the eastern side of Nggela Pile Island and on some of the rivers on Guadalcanal. There were other potential wader sites that could not be visited because of a lack of permission or because we could not physically reach them due to no road access, flooded rivers, and potential danger from crocodiles, etc. Thus, this survey represents a sample of coastal and inland sites rather than a systematic survey of all potential wader habitat within the study area. Although not ideal, within the context of very sparse existing data on the status of waders in the Solomon Islands, any new information is useful.

With the exception of Henderson airfield, Utuha Passage and shoreline sections on Nggela Pile Island, as well as some of the river-beds on Guadalcanal which were the largest study sites, most other sites were relatively small, being less than 50 ha in size. Ten of the sites on Guadalcanal were inland with only five being coastal. Although Guadalcanal is one of the larger islands in the Solomon Islands it has very limited suitable estuarine and exposed coral reef habitat on the northern and southern coastlines, including within our survey area. The few coastal wader habitats here consist of river-mouths and shingle / sandy beaches. Areas surveyed within the Florida Group comprised four sites on Nggela Pile Island, one site on Nggela Sule Island, part of Tulagi Island, Leghale Island and the length of the Utuha Passage. These sites were generally island shoreline habitats, comprising exposed reef, rocks and sand. An exception was the 19 ha Lake Kolaoka, which is a shallow lake located *c.*400 m inland from the coast, but connected to the sea by a narrow, mangrove-lined tidal creek (Butcher *et al.* 2015).

Habitats available for migratory waders are typical of other tropical island regions such as the Indonesian archipelago and Fiji. However, short coastal grassland is restricted mainly to airfields and cultivated farmland, while grazed coastal grasslands, rice fields and aquaculture ponds, so common in South-east Asia, are virtually non-existent throughout the Solomon Islands with the few examples of these habitats mainly found on Guadalcanal. The habitat types surveyed during this study can be grouped into ten main types, including:

1. Open coastline with exposed coral reef, sandy beach or rocky shoreline;
2. Small river-mouth lagoons;
3. Large river-mouths;
4. Mangroves with narrow mudflat margins;
5. Tidal coastal lakes and estuarine mudflats;
6. Small islands;
7. Open grassland and agricultural areas (including airfields);
8. Freshwater riverbed with exposed sand, shingle and stones;
9. Aquaculture ponds and created waterways; and
10. Freshwater lakes, ponds and swampland.

Survey

During the study period the weather was warm with limited rainfall interrupting the research. The most significant rainfall occurred while visiting Govu, an inland village on Guadalcanal. This rainfall caused localised river flooding which prevented us from making a more extensive exploration of an inland river system and from reaching coastal river-mouth habitats in the south-eastern part of the island.

All wader counts were made by a survey team of two to five personnel, using 30x spotting scopes and 10x42 binoculars. Survey methods closely followed those outlined in Howes & Bakewell (1989), and used ground-based counts of roosting or feeding shorebirds and involved personnel scanning flocks from as close as possible without creating disturbance that would cause birds to take flight. Two sites (Utuha Passage and

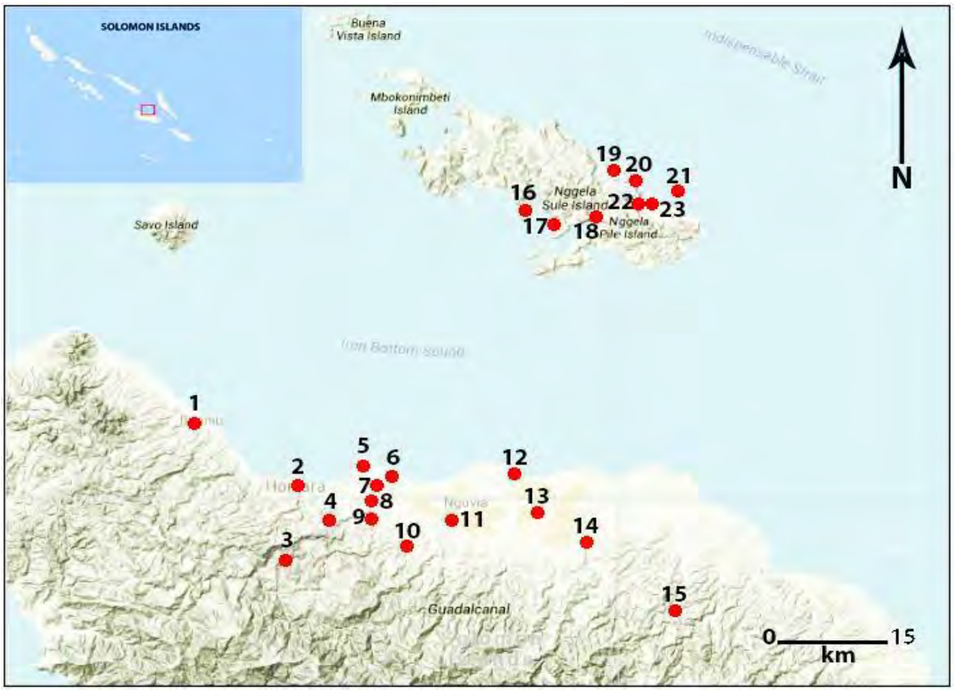

Figure 1. Map of study area showing sites surveyed. Site numbers – 1. Ruaniu fish ponds (habitat type 9); 2. Honiara waterfront (2); 3. Upper Lungga River (8); 4. Betikama Wetland (10); 5. Lungga River-mouth (3); 6. Aligator River-mouth (2); 7. Henderson Airport (7); 8. Airport Oxbow Lake (10); 9. Lower Lungga River (8); 10. Windy Ridge Lake (10); 11. Ngalimbiu River (8); 12. Gavagha River-mouth (2); 13. Mbalasuna River (8); 14. Barada River (8); 15. Govu River (8); 16. Tulagi Island (6); 17. Taroniara (1); 18. Utuha Passage (4); 19. Mbalekama Point (1); 20. Tavulea to Vatundavala Point (1); 21. Leghale Island (6); 22. Lake Kolaoka (5); 23. Tavulea to Malimono Bay (1).

Honiara waterfront) were surveyed by boat. Specific details of dominant habitat type, site coverage, time and stage of tide for each are outlined in Appendix 1. Birds were counted individually at all sites and species identifications confirmed by two or more members of the team. Survey times were variable, depending on size of site and search effort required to find and identify all wader species present. Four of the team members were experienced ornithologists, each with 20-30 years wader survey experience. Survey dates were 25-26 February, 1-4 March and 21 March 2015 on Guadalcanal, and 26-28 February 2015 on the Florida Islands.

RESULTS

The survey recorded a total of 462 waders of 16 species (Table 1). Only one species (Beach Stone-curlew *Esacus magnirostris*) is resident in the Solomons, the remainder were all seasonal migrants from the Northern Hemisphere. Pacific Golden Plover *Pluvialis fulva* (210 birds) and Lesser Sand Plover *Charadrius mongolus* (75 birds) were the most numerous species, together comprising 61.5% of all the waders counted. Other species in numbers over 20 were combined tattler species *Tringa brevipes / incana* (53), Common Sandpiper *Actitis hypoleucos* (37), Ruddy Turnstone *Arenaria interpres* (26), Red-necked Stint *Calidris ruficollis* (21) and Whimbrel *Numenius phaeopus* (20).

Table 1. Waders counted on part of the Florida Islands and Guadalcanal.

Species	Florida	Guadalcanal	Total	Relative abundance
Beach Thick-knee *Esacus magnirostris*	4	0	4	0.9%
Grey Plover *Pluvialis squatarola*	1	0	1	0.2%
Pacific Golden Plover *Pluvialis fulva*	26	184	210	45.5%
Lesser Sand Plover *Charadrius mongolus*	75	0	75	16.2%
Greater Sand Plover *Charadrius leschenaultii*	1	0	1	0.2%
Whimbrel *Numenius phaeopus*	19	1	20	4.3%
Far-eastern Curlew *Numenius madagascariensis*	1	0	1	0.2%
Marsh Sandpiper *Tringa stagnatilis*	1	0	1	0.2%
Common Greenshank *Tringa nebularia*	2	0	2	0.4%
Terek Sandpiper *Xenus cinereus*	1	0	1	0.2%
Common Sandpiper *Actitis hypoleucos*	16	21	37	8.0%
Grey-tailed Tattler *Tringa brevipes*	13	1	14	3.0%
Wandering Tattler *Tringa incana*	1	0	1	0.2%
Tattler sp.	38	0	38	8.2%
Ruddy Turnstone *Arenaria interpres*	26	0	26	5.6%
Red-necked Stint *Calidris ruficollis*	21	0	21	4.5%
Sharp-tailed Sandpiper *Calidris acuminata*	9	0	9	1.9%
Total	255	207	462	

Waders were found at ten of 15 sites surveyed on Guadalcanal, and at seven of eight sites surveyed in the Florida Group (Appendix 1). Surveyed sites on Guadalcanal totalled 207 waders, while sites on the Florida Islands totalled 255 waders. The most important sites for waders were Henderson Airport (169 birds) on Guadalcanal and Lake Kolaoka (156) and Mbalekama Point (65) on Nggela Pile. Greatest species richness was recorded at Lake Kolaoka (13 wader species) and Mbalekama Point (nine wader species).

Of ten habitat types surveyed (Table 2), we encountered waders on seven – (type 1) open coastline with exposed coral reef, sandy beach or rocky shoreline; (type 2) small river-mouth lagoons; (type 3) large river-mouths; (type 5) tidal coastal lakes and estuarine mudflats; (type 6) small islands; (type 7) open grassland and agricultural areas, including airfields; and (type 8) freshwater riverbed with exposed sand, shingle and stones. Highest wader numbers were on tidal coastal lakes / estuarine mudflats (156 birds of 13 species), open coastline with exposed coral reef, sandy beach or rocky shoreline (94 birds of nine species), and open grassland (169 birds of just one species, Pacific Golden Plover *Pluvialis fulva*).

Table 2. Wader species richness and abundance for ten habitat types on the Florida Islands and Guadalcanal. (type 1) open coastline with exposed coral reef, sandy beach or rocky shoreline; (type 2) small river-mouth lagoons; (type 3) large river-mouths; (type 4) mangroves with narrow mudflat margins; (type 5) tidal coastal lakes and estuarine mudflats; (type 6) small islands; (type 7) open grassland and agricultural areas, including airfields; and (type 8) freshwater riverbed with exposed sand, shingle and stones; (type 9) aquaculture ponds and created waterways; (type 10) freshwater lakes, ponds and swampland.

Species	Habitat										Total
	1	2	3	4	5	6	7	8	9	10	
Beach Thick-knee	2					2					4
Grey Plover	1										1
Pacific Golden Plover	9		13		12	5	169	2			210
Lesser Sand Plover	14				61						75
Greater Sand Plover					1						1
Whimbrel	14	1			5						20
Far-eastern Curlew					1						1
Marsh Sandpiper					1						1
Common Greenshank					2						2
Terek Sandpiper					1						1
Common Sandpiper	17	5	2		1			12			37
Grey-tailed Tattler	9				4			1			14
Wandering Tattler	1										1
Tattler sp.	11				27						38
Ruddy Turnstone	16				10						26
Red-necked Stint					21						21
Sharp-tailed Sandpiper					9						9
Total	94	6	15	0	156	7	169	15	0	0	462

The three habitat types where no waders were found were (type 4) mangroves with narrow mudflat margins; (type 9) aquaculture ponds and created waterways; and (type 10) freshwater lakes, ponds and swampland. The latter two types comprised five inland freshwater wetland and lake / pond habitats on Guadalcanal where, although waders were absent, other waterbird species such as egrets, herons, cormorants and ducks were present. Seasonally high water levels at these sites and / or the prevalence of tall vegetation are the likely reason for the absence of waders during the survey period as several species have been observed at some of these sites at other times of the year (SB unpubl. data). The single mangrove with narrow mudflat margins habitat we visited was the 16 km long Utuha Passage in the Florida Islands. Although we recorded terns in this narrow tidal waterway, we found no waders whatsoever and assume this absence was due to it being near high tide when we visited (on 26 and 28 February 2015). Our visual assessment of the site, combined with study of topographical maps and Google Earth imagery, indicate that much of the shoreline comprises steep banks with overhanging forest. Mudflats are limited to narrow strips adjacent to mangrove stands in small embayments. They are likely to support small numbers of waders only.

DISCUSSION

Species Accounts

Beach Stone-curlew *Esacus magnirostris*

Previously recorded on both Guadalcanal and the Florida islands (Tristram 1892; Mayr 1949; Tarburton 2014a, 2014b), we recorded this species only at Mbalekama Point, Nggela Pile (two birds roosting near other shorebirds on 26 February 2015) and on Leghale Island - one pair, known to be long-term residents (JK unpubl. data).

Grey Plover *Pluvialis squatarola*

We only recorded this species once – a single bird roosting amongst other waders at Mbalekama Point, Nggela Pile on 26 February 2015. This appears to be a first record for the Florida Islands. We found none on Guadalcanal, although the species has previously been recorded there (Tarburton 2014a).

Pacific Golden Plover *Pluvialis fulva*

The Pacific Golden Plover was the most abundant and the second-most widely distributed wader species recorded on the survey (Figure 2). This species is one of the most abundant waders on islands across Melanesia and the wider Pacific Ocean (Pratt *et al.* 1997; Engilis & Naughton 2004; Dutson 2011). The 210 birds counted comprised 45.5% of all waders recorded. We observed this species at seven locations in a variety of habitats including coral reefs, sandy beaches, mudflats, the muddy fringes of mangrove, river-mouths, a shingle riverbed inland, and on the open short grassland habitats of a sports field and alongside an airport runway. We observed Pacific Golden Plovers within the perimeter of Henderson Airport near Honiara over several days and made a full census on 3 March 2015, counting a minimum 169 birds. This flock comprised parties of birds that had been foraging over short grassland beside the runway all afternoon, as well as 80+ that flew in from the west just before dusk. We are not sure where they came from, possibly from coastal sites west of Honiara or from other open grassland areas, such as the grounds of King George VI National High School or the Honiara golf course where daytime feeding flocks have been previously reported (Tarburton 2014a; SB pers. obs.), or possibly from the Betikama wetlands (3.5 km inland) where they also regularly occur (SB unpubl. data.). Other sites where we recorded small flocks of Pacific Golden Plover included the Lungga River-mouth on Guadalcanal (13 birds) and Lake Kolaoka on Nggela Pile (12). We also found two birds 6.6 km inland (or 22.5 km upstream along the river's course) on the shingle bed of the Govu River on Guadalcanal.

Figure 2. Pacific Golden Plovers and Lesser Sand Plover roosting on dead coral reef, near Vatundavala Point, Nggela Pile Island, 27 February 2015 (A.C. Crossland).

Lesser Sand Plover *Charadrius mongolus*

This widespread holarctic species is considered uncommon in the Solomons and in Melanesia generally (Doughty 1999; Dutson 2011), but surprisingly it was the second most abundant wader found during this survey. We counted 75 birds at three sites on Nggela Pile Island including a flock of 61 at Lake Kolaoka which may represent the largest number recorded at a single site in the country to date. Lesser Sand Plover comprised 16.2% of all waders counted on the survey. Our observations add the Florida Group to seven islands in the Solomons where Lesser Sand Plovers have been previously recorded (Tarburton 2014c, S Butcher in prep.). Surprisingly, the species has not yet been observed on Guadalcanal and we failed to find any during our survey. Given the numbers we found on Nggela Pile we suspect that the species has been overlooked on the much larger Guadalcanal and is likely to be found in areas where wader habitat is more extensive such as Marau Sound and various river-mouth lagoons in the south-eastern part of the island. All individuals for which good views were obtained appeared to be of the nominate sub-species *C.m.mongolus* (Figure 2).

Greater Sand Plover *Charadrius leschenaultii*

This species has previously been recorded from nine islands in the Solomons but not from Guadalcanal or the Florida Group (Tarburton 2014c). Our sighting of one bird at Lake Kolaoka, Nggela Pile on 27 February 2015 is the first record for the Florida Islands.

Whimbrel *Numenius phaeopus*

Considered a widespread and common migrant across Melanesia (Doughty 1999; Dutson 2011), this species was found on Nggela Pile where three sites totalled 19 birds, and also on Guadalcanal where one bird was seen at the Gavagha River-mouth on 21 March 2015. All were of the white-rumped Asian-breeding *variegatus* race (Figure 3).

Figure 3. Whimbrel, Mbalekama Point, Nggela Pile, 26 February 2015 (A.C. Crossland).

Far-eastern Curlew *Numenius madagascariensis*

This species is classed as a rare vagrant to the Solomons with records from six islands, but none previously recorded in our study area (Dutson 2011, Tarburton 2014c). We photographed one individual on Lake Kolaoka, Nggela Pile on 27 February 2015 (Figure 4) foraging in shallow water around the roots of mangroves and keeping separate from other waders.

Figure 4. Far-eastern Curlew, Lake Kolaoka, Nggela Pile Island, 27 February 2015 (A.C. Crossland)

Marsh Sandpiper *Tringa stagnatilis*

One seen at Lake Kolaoka, Nggela Pile on 27 February 2015 constitutes the sixth record for the Solomons and the first from the central part of the country (Butcher *et al.* 2015).

Common Greenshank *Tringa nebularia*

Listed as a rare migrant in Melanesia by Dutson (2011) and previously reported from only three islands in the Solomons (Tarburton 2014c). This species had not hitherto been recorded within the study area. Our sighting of Common Greenshank at Lake Kolaoka on 27 February 2015 is notable for involving two birds and for being the first record for the Florida Group.

Terek Sandpiper *Xenus cinereus*

Another vagrant to the Solomons, with only three previous records (Tarburton 2014c, Butcher in prep.). We found one individual feeding in loose association with Red-necked Stints and Lesser Sand Plovers at Lake Kolaoka on 27 February 2015.

Common Sandpiper *Actitis hypoleucos*

The most widespread of the 16 wader species recorded on the survey, Common Sandpipers were found at 14 of 23 sites visited, including both tidal and inland freshwater wetland and riverine habitats (Figure 5). This ubiquitous species is widely recognised by Solomon Islanders and given local names in most provinces. Common Sandpipers generally occur in small numbers at any one site, but their very wide distribution across the Solomons (Dutson 2011; SB unpubl. data) suggests that after Pacific Golden Plover, they are probably the second most abundant wader species in the country.

Figure 5. Common Sandpiper, Govu River-bed, Guadalcanal, 2 March 2015 (A.C. Crossland).

Grey-tailed Tattler *Tringa brevipes* and Wandering Tattler *T. incana*

In total, 53 tattlers were recorded from four coastal sites in the Florida Group and from one inland riverbed site on Guadalcanal. Collectively they constituted the third most abundant wader, comprising 11.6% of all birds counted. These two species are very similar and at times hard to determine in the field. We used identification criteria presented in Marchant *et al.* (1986) and Pratt *et al.* (1987);basing identification on call, nasal groove length and plumage features, particularly whether white superciliary stripes were unbroken and met over the bill (denoting Grey-tailed Tattler) or whether they were mottled with dark grey and did not cross over the forehead (denoting Wandering Tattler). All but one bird identified to species (n = 14) were Grey-tailed Tattlers. The lone individual confirmed as a Wandering Tattler was seen foraging on dead coral reef at Mbalekama Point, Nggela Pile Island on 26 February 2015. In addition to the birds seen on our survey, SB observed a single tattler sp. with Pacific Golden Plovers and Sharp-tailed Sandpipers *Calidris acuminata* at Betikama Wetland on Guadalcanal on 19 October 2014. This freshwater ephemeral wetland, fringed with extensive reed beds and tall grasses, would seem unusual habitat for tattlers, but as we also found a bird well inland on a river-bed (Figure 6), it is clear that as with elsewhere in the Pacific (Engilis & Naughton 2004), tattlers are likely to utilise a broad array of habitats in the Solomons. We recommend that future observers be aware of their potential presence on freshwater habitats well away from the coast.

Figure 6. Grey-tailed Tattler on inland freshwater habitat, Govu River-bed, Guadalcanal, 2 March 2016 (A.C. Crossland).

Ruddy Turnstone *Arenaria interpres*

Ruddy Turnstones were found at two sites on Nggela Pile Island - 16 birds roosting and foraging over dead coral reef, sandy beach and mudflat habitat at Mbalekama Point on 26 February 2015, and 10 birds foraging on mudflats at Lake Kolaoka on 27 February 2016. Although widely recorded in the Solomons, these appear to be the first records of turnstone in the Florida Group (Tarburton 2014b).

Red-necked Stint *Calidris ruficollis*

Previously recorded from eight islands in the Solomons, including Guadalcanal (Tarburton 2014c), our sighting of 21 birds at Lake Kolaoka on Nggela Pile, is the first record for the Florida Group (Tarburton 2014b), and a notable concentration of what is generally an uncommon, but regular migrant to the Solomons and Melanesia (Dutson 2011).

Sharp-tailed Sandpiper *Calidris acuminata*

The Sharp-tailed Sandpiper is a fairly common migrant to the Solomon Islands, recorded on many islands including Guadalcanal, but not previously in the Florida Group (Dutson 2011, Tarburton 2014c). We found them only at one site - nine birds feeding and roosting with other waders at Lake Kolaoka on Nggela Pile on 27 February 2016. Four months prior to our survey SB observed *c.*50 Sharp-tailed Sandpipers at the Betikama Wetlands on Guadalcanal and three others at Henderson Airport on 18-19 October 2014. Although we re-surveyed these sites on 26 February 2015 and 3 March respectively, we failed to find these birds. Sharp-tailed Sandpipers breed in Siberia and migrate to Australia with first-year birds following a unique “dog-leg” route via western Alaska, the Aleutian Islands, western and central Pacific (Pyle & Pyle 2009). Dutson (2011) reported that they are commonest in Melanesia during the period September to November. Presence of a flock at Betikama Wetlands in mid-October, but absence in February probably reflects the migration pattern of this species, with the October record being birds on passage to Australia.

New Species Records

Previous authors (Bull 1948; Mayr 1949; Buckingham *et al*. 1990; Dutson 2011; Tarburton 2014a; Lepage 2015) have reported the following wader species from Guadalcanal: Beach Thick-knee, Grey-tailed Tattler, Wandering Tattler, Common Sandpiper, Sharp-tailed Sandpiper, Red-necked Stint, Ruddy Turnstone, Grey Plover, Pacific Golden Plover, Whimbrel, Little Whimbrel *Numenius minutus*, Swinhoes Snipe *Gallinago megala* and Bar-tailed Godwit *Limosa lapponica*. Our survey added no new species to this list. In contrast, previous wader records from the Florida Islands are sparse with just Beach Thick-knee, Whimbrel and Common Sandpiper recorded from the Nggela Islands (Bull 1948; Tarburton 2014b), and Pacific Golden Plover and Bar-tailed Godwit *Limosa lapponica,* recorded from Tulagi Island (Bull 1948; Tarburton 2014d). Our survey added 12 wader species to the list for the Nggela Islands (Grey Plover, Large Sand Plover, Lesser Sand Plover, Far-Eastern Curlew, Sharp-tailed Sandpiper, Red-necked Stint, Grey-tailed Tattler, Wandering Tattler, Terek Sandpiper, Common Greenshank, Marsh Sandpiper and Ruddy Turnstone), but no new species to the Tulagi list.

Important Sites

Wader habitats, and wetlands in general, have received only limited research attention in the Solomon Islands to date (Scott 1993; Ellison 2009; Dutson 2011). Consequently, inventorial assessment of habitats is tentative and systematic survey data on waders are almost non-existent. Study of topographical maps and Google Earth images indicate that most islands have rugged coastlines with very limited extent of inter-tidal mudflats, estuaries or river-mouth lagoons. Concentrations of >100 waders have rarely been reported. Within this context of limited wader habitats and low numbers of waders nationally, three of the sites visited on our survey are potentially of national importance for waders.

Henderson Airport on Guadalcanal, with its expansive area of short grassland is a well-known flocking site for Pacific Golden Plover and has an impressive list of other wader species recorded over the last 60 years, including several first records for the country (Buckingham *et al.* 1990; Tarburton 2014a). We recorded 169 Pacific Golden Plover there and it is likely the site supports larger numbers during peak migration passage periods.

Lake Kolaoka on Nggela Pile is a near pristine habitat, which is unusual in that it is a shallow lake surrounded by forest and mangrove and linked to the sea by a tidal creek. It is notable for its high wader species richness relative to other surveyed sites in the Solomons for which wader records are published (13 species recorded on a single day during this survey with more species likely to occur). Waders recorded at Lake Kolaoka include several species for which there are very few records in the Solomons and in Melanesia generally (eg; Lesser Sand Plover, Far-Eastern Curlew, Terek Sandpiper, Common Greenshank and Marsh Sandpiper). The lake also supports other wetland bird species including Osprey *Pandion haliaetus,* Striated Heron *Butorides striata*, and Pacific Black Duck *Anas superciliosa*. Several wader species recorded on Lake Kolaoka generally favour estuarine mudflats rather than coral reef or sandy beach environments which are much more prevalent habitat type in the Solomons. Consequently, sites like Lake Kolaoka may have high local conservation value. A recent proposal to commence bauxite mining in the near vicinity has potential to threaten this habitat and the bird populations it supports.

Mbalekama Point at the northern tip of Nggela Pile Island held 71 waders and small number of terns when surveyed on 26 February 2015. However, this is only one roost site in a much larger area of mudflat, sand bar, beach and coral reef habitat on both sides of Mlboli Harbour. This forms the northern entrance to Utuha Passage, the narrow mangrove-lined channel that separates Nggela Pile from the larger Nggela Sule Island. Local people report much larger numbers of waders in the area than we counted and it seems likely that several hundred seasonally occur in the wider area. The wetlands of Nggela and particularly Utuha Passage have been listed by the South Pacific Regional Environment Programme and other international conservation agencies (Scott 1993) as a potentially important wetland site, but information on flora and fauna are data deficient. Further survey work is required to ascertain shorebird numbers and habitat use in the area and also to assess the conservation importance of populations of other wildlife including Estuarine Crocodile *Crocodylus porosus* and Dugong *Dugong dugon,* both of which are present (JK pers. obs.).

Within Which Flyway do the Solomon Islands Belong?

Generally considered part of the West Pacific Flyway (Wetlands International 1995), the question as to whether the Solomon Islands also lie within the East Asian-Australasian Flyway (EAAF) has not been satisfactorily resolved. Bamford *et al.* (2008) excluded the Solomons from countries considered in their review of the EAAF, stating that "*a number of Pacific Island nations are situated at the eastern margin of the EAA Flyway but, as there was insufficient information on shorebird numbers, they have not been included in the review"*. They consequently published maps of the EAAF's boundary which included New Britain and Bougainville to the north but excluded the Solomons to the south-east. However, others have taken a different view and defined the EAAF's boundaries to include the Solomons (e.g. Ferris *et al.* 2003; Li & Mundkur 2007; Li *et al.* 2009).

Minton *et al.* (2006) provided distributional maps for many of the waders that migrate to Australia. Maps of only five of the 26 species covered showed the Solomon Islands within the boundaries of the species' migration flyway. Three of these (Pacific Golden Plover, Ruddy Turnstone, Bar-tailed Godwit) are birds characteristic of both the EAAF and the West Pacific Flyway. One species (Red-necked Stint) is an EAAF species that regularly occurs in the Solomons in small numbers (Dutson 2011, SB unpubl. data). The other (Curlew Sandpiper *Calidris ferruginea*) was erroneously mapped as it is in fact a very rare visitor to the Solomons, with records from only four islands to date (Tarburton 2014a; SB unpubl. data). While the findings of our survey on Guadalcanal and the Florida Group confirm that species characteristic of the West Pacific Flyway are present and widespread, it is also clear that many EAAF species also occur in the Solomons. With more survey effort, some of these, such as Common Sandpiper, Lesser Sand Plover, Sharp-tailed Sandpiper and Red-necked Stint may prove to be widespread and relatively common across the Solomon chain. Clearly the Solomon Islands have now been shown to host migratory waders from both the East Asian-Australasian and the West Pacific Flyways and therefore the country should now be acknowledged as being situated within the zone where these two flyways overlap.

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Appendix 1. Site count data for a wader survey of part of Guadalcanal and the Florida Islands, from 25 February to 21 March 2015. Seventeen of 23 sites held waders and data are presented below. No waders were found at 6 other wetland sites: Betikama Wetland (habitat type 10), Ruaniu fish ponds (9), Mbalasuna River (8), Airport oxbow lake (10), Windy Ridge Lake (10) and the Utuha Passage (4).

	Guadalcanal											Florida Group								
	Honiara Waterfront	Upper Lunga River	Alligator River-mouth	Govu River	Barada River	Ngalimbiu River	Lower Lungga River	Henderson Airport	Lungga River-mouth	Gavagha River-mouth		Taroniara, Nggela Sule	Mbalekama Pt, Nggela Pile	Tavulea to Vatundavala Pt	Tavulea to Malimono Bay	Lake Kolaoka, Nggela Pile	Leghale Island	Tulagi Island		
Date	28/2/15	26/2/15	26/2/15	2/3/15	3/3/15	3/3/15	3/3/15	3/3/15	4/3/15	21/3/15		26/2/15	26/2/15	27/2/15	27/2/15	27/2/15	28/2/15	28/2/15		
Dominant habitat type	1	8	2	8	8	8	8	7	3	2		1	1	1	1	5	6	6		
Approx. total site area	n.a.	14.5 ha	2.3 ha	51 ha	7.5 ha	5.7 ha	40 ha	110 ha	47 ha	8.5 ha	Total	1 ha	85 ha	36 ha	57 ha	19 ha	3.8 ha	n.a.	Florida Total	Grand Total
% survey coverage	5%	100%	100%	100%	100%	100%	60%	70%	60%	80%		80%	70%	80%	60%	90%	100%	80%		
Time of day	17:00	9:30	9:00	13:00	12:00	13:00	15:00	18:00	16:00	15:00		13:00	15:00	15:00	9:00	11:00	10:00	13:00		
Tide stage	mid tide	n.a.	low tide	n.a.	n.a.	n.a.	n.a.	n.a.	high tide	mid tide		high tide	high tide	mid tide	mid tide	low tide	low tide	high tide		
SPECIES																				
Beach Thick-knee													2				2		4	4
Grey Plover													1						1	1
Pacific Golden Plover				2				169	13		184		7	2		12		5	26	210
Lesser Sand Plover													13	1		61			75	75
Greater Sand Plover																1				1
Whimbrel										1	1		12	2		5			19	20
Far-eastern Curlew																1			1	1
Marsh Sandpiper																1			1	1
Common Greenshank																2			2	2
Terek Sandpiper																1			1	1
Common Sandpiper	2	2	4	4	3	1	2		2	1	21	2	6	6	1	1			16	37
Grey-tailed Tattler				1							1		7	2		4			13	14
Wandering Tattler													1						1	1
Tattler sp.													6	4	1	27			38	38
Ruddy Turnstone													16			10			26	26
Red-necked Stint																21			21	21
Sharp-tailed Sandpiper																9			9	9
Total	2	2	4	7	3	1	2	169	15	2	207	2	71	17	2	156	2	5	255	462

Habitat types
1. Open coastline with exposed coral reef, sandy beach or rocky shoreline.
2. Small river-mouth lagoons.
3. Large river-mouths.
4. Mangroves with narrow mudflat margins.
5. Tidal coastal lakes/estuarine mudflats
6. Small islands
7. Open grassland and agricultural areas (including airfields).
8. Freshwater riverbed with exposed sand, shingle and stones
9. Aquaculture ponds and created waterways.
10. Freshwater lakes, ponds and swampland.

GAIZHOU, LIAODONG BAY, LIAONING PROVINCE, CHINA – A SITE OF INTERNATIONAL IMPORTANCE FOR GREAT KNOT *CALIDRIS TENUIROSTRIS* AND OTHER SHOREBIRDS

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Following the closure of the Saemangeum seawall in South Korea in 2006 the Yalu jiang National Nature Reserve, Liaoning, China became the most important staging site in the EAAF for Great Knots *Calidris tenuirostris* on northward migration. Biomass of their main bivalve prey species *Potomacorbula laevis* at Yalu jiang NNR has decreased greatly in recent years and in 2015 some tagged Great Knots moved to Gaizhou at the head of Liaodong Bay, northern Bohai. Our surveys of this previously unknown site show that it is of international important for Great Knots as well as four other shorebirds and two gulls, however it is threatened by development. The discovery of this site highlights the value of continued satellite tagging of shorebirds to locate key staging sites and understand how birds respond to habitat loss and degradation.

INTRODUCTION

The Great Knot *Calidris tenuirostris* is endemic to the East Asian-Australasian Flyway (EAAF), breeding in northeast Siberia and north Far East Russia (Tomkovich 1997). The majority (*c*.95%) of the population spends the non-breeding season in Australia (Bamford *et al.* 2008), with small numbers in Southeast Asia (Bamford *et al.* 2008, CMS 2014, Round 2006). Barter (2002) estimated that about 31% of the flyway population staged at the Mangyeung and Dongjin River estuaries, South Korea – these being the most important staging sites on northward migration. Following closure of the Saemangeum seawall across these two estuaries in April 2006, numbers of Great Knots declined severely (Moores *et al*. 2008, 2016) and the Yalu Jiang Estuary National Nature Reserve, Liaoning Province, China (hereafter Yalu Jiang NNR) (Figure 1) became the most important site in the Flyway for the species on northward migration. During the period 1999-2010 the peak count at Yalu Jiang NNR was 55,000 (in 1999), and Riegen *et al.* (2014) estimated that a total of 70,000 to 80,000 Great Knots used the site during northward migration, however Choi *et al.* (2014) suggested that the average number of Great Knots using the site in 2010-2012 was 44,000 – an 18% decline from 1999.

Great Knots are specialist bivalve feeders, although they will also consume gastropods and occasionally other invertebrates (Tulp & de Goeij 1994, Zhang *et al.* 2011, Choi 2014, HBP & SDZ unpublished). At Yalu Jiang NNR the clam *Potomacorbula laevis* was found to be the most important prey item in the years 2011 and 2012, at which time it occurred in high densities (average individuals 605 m^{-2}) (Choi 2014, Choi *et al.* 2014). In 2014 numbers and biomass of *P. laevis* were much lower than in 2012 (Peng *et al.* 2014), and population levels and biomass were even lower in boreal spring 2015 (HBP and PH unpublished). The reason(s) for this dramatic decline in *P. laevis* remain unknown.

METHODS

The observations reported here were incidental to ongoing programmes of research on shorebird ecology in the Yellow Sea being undertaken by Fudan University, the University of Gronigen and the Netherlands Institute for Sea Research. Observations were made at Yalu Jiang NNR (39.66º–39.96º N, 123.56º–124.12º E), where during April and early May 2015 daily checks were made for Great Knots that had been fitted with radio tags (BD-2 Holohill Systems, Ontario, Canada) at Chongming Dongtan National Nature Reserve (hereafter Chongming NNR), Shanghai (31.461225ºN, 121.930027ºE) in April. At the same time observations were made on waders

Figure 1. Location of Yalu Jiang National Nature Reserve and Gaizhou, Liaoning, China.

foraging at Yalu Jiang NNR; periodic surveys and benthic sampling was also undertaken. Once it appeared that some Great Knots might have moved to Gaizhou, exploratory surveys were conducted along the coast from Gaizhou north to the mouth of the Daliao River, Yingkou. Access to much of the coast was not possible due to the presence of extensive areas of aquaculture ponds. Birds were observed both at high tide roosts and when foraging on the tidal flats. In 2016 the same areas at Gaizhou were surveyed as well as an offshore bank at the mouth of the Liao He River (HBP, YCC unpublished – details to be presented elsewhere).

RESULTS

By late April 2015 most Great Knots were found in the western part of the Yalu Jiang NNR, likely in response to depleted food resources in the eastern and central areas. At this time seven Great Knots fitted with radio tags at Chongming NNR in April 2015 and subsequently recorded at Yalu Jiang NNR, could not be found (PH unpublished). Migratory departures of Great Knots from Yalu Jiang NNR are usually about 14 – 21 May (Ma *et al.* 2013; Choi *et al.* 2015), thus it seemed unlikely that the disappearance of these birds was a result of migration. One Great Knot fitted with a satellite tag (Microwave Telemetry), as part of study by YCC, had been recorded at Yalu Jiang NNR since 14 April; this bird moved to Gaizhou, Liaodong Bay, Liaoning in early May – a straight line distance of *c.*160 km (Figure 1). Subsequent field surveys of the Gaizhou area in early May resulted in 30,000 – 60,000 Great Knots being recorded (Table 1) – equivalent to about 20% of the world population (Wetlands International 2016). Of the seven radio-tagged Great Knots which had disappeared from Yalu Jiang NNR in late April, six were subsequently found at Gaizhou between 10 and 20 May 2015 (PH unpublished). A further six radio-tagged birds from Chongming NNR (out of a total of 78 tagged) that had not been recorded at Yalu Jiang NNR were also present at Gaizhou (PH unpublished).

Table 1. Numbers of Great Knots recorded at Gaizhou, Liaodong Bay, Liaoning in April 2015

Date	**9 May**	**10 May**	**11 May**	**22/23 May***
Count	*c.*60,000	30,100 +	55-60,000	1200-1500

*the reduction in numbers in late May probably results from emigration, whereas the variation in early May likely reflects movements of birds between different sites and differences in tidal conditions when counts were conducted.

Great Knots were recorded roosting at two sites at Gaizhou: inside an active land claim area at about 40.45544° N, 122.25349° E, and along the coast near the Huaneng Yingkou Power Station at 40.59098° N 122.16446° E (Figure 1). The majority of birds were recorded foraging about 1.5 km offshore near the tide edge (40.44031° N 122.23169° E) where they were taking *P. laevis*. Further observations in May 2016 confirmed the importance of the coast adjacent to the Power Station, both as a roost and an intertidal bank *c.* 2 km offshore as a foraging area.

Observations by QQB in May 2015 and 2016 also showed that internationally important numbers (>1% of the flyway population) of a further four shorebird and two gull species were present along the Gaizhou coast (Table 2).

Table 2. Internationally important numbers of shorebirds and gulls recorded at Gaizhou 2015 and 2016

Species	**Max number**	**1% threshold***	**Date**
Bar-tailed Godwit *Limosa lapponica*	2930	2790	8 May 2016
Far Eastern Curlew *Numenius madagascariensis*	900	320	8 May 2016
Great Knot *Calidris tenuirostris*	c.60,000	2900	9 May 2015
Broad-billed Sandpiper *Calidris falcinellus*	383	250	11 May 2015
Lesser Sandplover *Charadrius mongolus*	830	385	11 May 2015
Saunders's Gull *Saundersilarus saundersi*	690	85	11 May 2015
Relict Gull *Larus relictus*	250	120	11 May 2015

*From Wetlands International (2016)
The counts are the maximum number recorded during our surveys, however we were unable to access much of the coast and so it is expected that additional birds were present.

DISCUSSION

Barter *et al.* (2005) surveyed shorebirds along the coast in front of the Erdao Saltworks (Figure 2) on 3-5 May 2005 and recorded 7330 Great Knots, accounting for >1% of the then global population and thus making the site of international importance. However, it appears that their survey area did not include the Gaizhou area (Barter *et al.* 2005, Figure 2) and so more birds could have been present.

The low levels of *P. laevis* in spring 2015 at Yalu Jiang NNR resulted in an apparent food shortage for Great Knots and are thought to have prompted some birds to move elsewhere, including to Gaizhou. Information about benthos in Liaodong Bay is limited, but Cai *et al.* (2013) reported relatively high benthic biomass along the Gaizhou coast compared with that further west off Shuangtaizihekou National Nature Reserve.

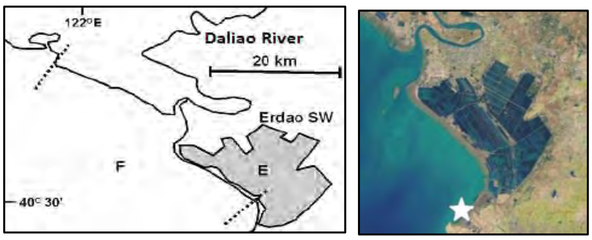

Figure 2. Northeast Liaodong Bay survey area (after Barter *et al.* 2005) – E = Erdao Saltworks, F = coast. Landsat image of the area on 1 May 2005 when Barter *et al.* were undertaking their surveys. Dark blue area is salt ponds; white star shows the area where Great Knots occurred in May 2015 – outside the area surveyed by Barter *et al.* Landsat image from US Geological Survey: http://landsatlook.usgs.gov/viewer.html [accessed 26 December 2015]

The head of Liaodong Bay appears to be of international importance for Great Knots. Barter *et al.* (2000) reported 719 and 24,915 Great Knots in late April 1998 and early May 1999 respectively at the Shuangtaizihekou NNR (*c.* 50-80 km west of Gaizhou). Some 80,000 Great Knots were recorded there on 27 April 2013 (Bai *et al.* 2015, YC, YCC, DSM unpublished), and on 29 / 30 April 2013 there were about 74,900 at Yalu Jiang NNR (Bai *et al.* 2015); these two areas thus accounted for ~53% of the world population of this species (Wetlands International 2016) assuming that no birds had moved between the two sites. We think that large scale movement between the two sites is unlikely as there was no obvious change in the number of Great Knots at Yalu Jiang NNR at this time. Whilst recognising the logistical challenges, it would be very valuable to conduct surveys at the head of Laiodong Bay (Gaizhou and Shuangtazihekou NNR) coasts simultaneously with Yalu Jiang NNR.

Sites that are internationally important for endangered species should be recognised in 'Ecological Red Lines' (CCICED 2014), however a recent assessment of the Liaoning coast did not identify the Gaizhou area as having any biodiversity values, and classified it as having the lowest ecological value (Wang *et al.* 2015).

The Liaoning (Yingkou) Coastal Industry Base is one of the 'Five Points' in Liaoning's 'Five Points and One Line' coastal development strategy (Anon. 2007a) which is contributing to the national 'policy for the revitalization of the Northeast' (Anon. 2007b). Rika (2006) noted 'Liaoning Province's greatest strengths are its long coastline… along the coast are many areas of sand dunes and desolate saltpans, which have been left untouched, and it is anticipated that in the future these may be transformed into 'international industrial relocation sites' and 'new-style industrial zones''.

Development of the Yingkou area began in 2006 and, so far, has resulted in the loss of about 70 km^2 of salt ponds, and the development of about 33 km^2 of aquaculture ponds on former intertidal flats in front of the Erdao Saltworks (Figure 3), while port development at Yingkou extends *c.* 5 km from the former coastline (Suo & Zhang 2015). The remaining area of unmodified coast where Great Knots occurred in 2015 was still undeveloped in May 2016 and was being used for culturing the clam *Mactra veneriformis* – the seed animals being harvested from the wild in Hebei Province and put out at Gaizhou in 2015 (S.D.Z. unpublished), however there was no evidence that Great Knots were feeding on them in either 2015 or 2016. We were advised by local people in May 2016 that there are no plans to impound this area of coast at present, and this appears to be supported by the 2010-2030 planning map for the Beihai New Area (Figure 4). However much more extensive development extending ~8 km off-shore appears to be proposed further north towards the administrative boundary with Yingkou – which is likely to impact hydrology and sediment dynamics in the area.

Liaodong Bay suffers from considerable pollution as the Liao and Daliao Rivers that discharge at the head of the bay pass through the largest industrial areas for metallurgy, machinery, petrochemical and construction materials in northeast China (He *et al.* in press). Pollution is likely to worsen as a result of increased industrial development, especially in the Yingkou area. Liu *et al.* (2007) reported elevated levels of cadmium and phthalate esters, which are potential endocrine disruptors, from

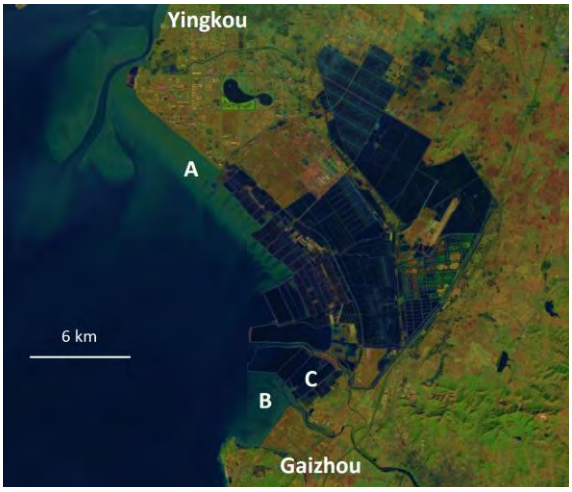

Figure 3. Areas where Great Knots were recorded in May 2015. A - Roost site by Huaneng Yingkou Power Station; B - foraging area on tidal flats; C - roost within land claim area for aquaculture ponds. Image dated 29 October 2016 – at the time of our observations in May 2015 the outermost seawall (1.5 km) of the southern aquaculture ponds were still being formed. Compared with May 2005 (Figure 2), about 60 km^2 of ponds have been infilled, and most of those remaining are now deep water and are used for aquaculture, not salt production. [Landsat image from US Geological Survey [accessed 26 December 2015]: http://landsatlook.usgs.gov/viewer.html

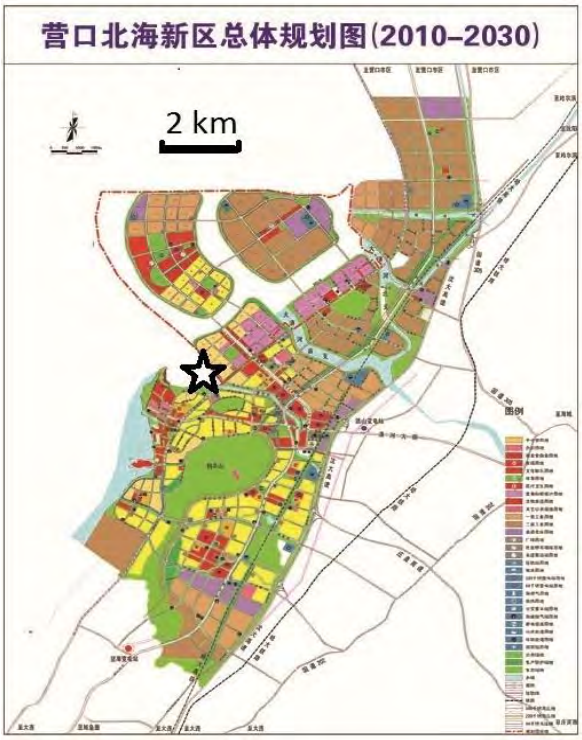

Figure 4. Planning map of Beihai New Area 2010-2030 (Beihai Government undated). Star shows where foraging Great Knots were observed in May 2015 and 2016.

shellfish samples. They also noted evidence of recent inputs of DDT, which probably result from its continuing use in anti-fouling paint on wooden vessels (Anon. 2007c). Gao *et al*. (2014) reported elevated levels of cadmium, copper and zinc in whelks *Rapana venosa*. Han *et al.* (2014) found elevated levels of nickel, copper and zinc in the Daliao River, and Lin *et al.* (2012) suggested that levels of arsenic and nickel in sediments at the mouth of the Daliao River could be potentially toxic to biota such as amphipods. Zhang *et al.* (2016) noted that perfluorocarbolic acids might pose an ecological risk to organisms at higher trophic levels in Liaodong Bay, and Pan *et al*. (2010) reported elevated levels of perfluorooctanoic acid in shellfish at Yingkou. Pyrethroids were reported in levels toxic to Chironomid larvae (He *et al.* in press).

With continuing loss of tidal flats to land claim and further degradation of those flats remaining (Melville *et al.* 2016) the future for Great Knots and other shorebirds is uncertain.

Great Knot was listed as 'Lower Risk / Least Concern' when first assessed by BirdLife International / IUCN in 1988 and was retained in this category until 2010 when it was up-listed to 'vulnerable' following a reduction in the global population apparently resulting from the closure of the Saemangeum sea wall (Moores *et al.* 2008, 2016). In 2015 it was listed as 'endangered' (BirdLife International 2015, IUCN 2015), and the Australian Government listed Great Knot as 'critically endangered' under the *Environment Protection and Biodiversity Conservation Act 1999* in May 2016 (Anon. 2016), however it is listed as 'vulnerable' in China's Red List (Jiang *et al*. 2016). Sadly, there seems to be little light at the end of the tunnel at present.

The movement of Great Knots from Yalu Jiang NNR to Gaizhou would not have been recognised had it not been for the presence of a satellite-tagged bird. This highlights the importance of tagging birds in the EAAF to locate key staging sites and understand how birds are responding to continued habitat loss and degradation, especially in the Yellow Sea region.

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AQUACULTURE POND BANKS AS HIGH-TIDE ROOSTS: WHAT PHYSICAL CHARACTERISTICS ARE MORE ATTRACTIVE TO SHOREBIRDS?

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During the high-tide period, shorebirds that forage on intertidal flats move to sites known as high-tide roosts, which play an important role in their survival. Understanding how shorebirds use high-tide roosts at stopover sites is crucial for their effective conservation and management. As there is a lack of natural roosting habitats along much of the Chinese coast of the northern Yellow Sea, shorebirds have to use aquaculture pond banks. During northward migration in 2014, we investigated the preference of migrating shorebirds for six physical characteristics of pond banks that function as high-tide roosts at Yalu Jiang Estuary Wetlands National Nature Reserve, a key stopover site for migratory shorebirds. We found that shorebirds showed a preference for long banks with little vegetation cover for high tide roosts in aquaculture ponds. This information can be used to guide management for migrating shorebirds that use artificial habitat as high-tide roosts.

INTRODUCTION

During the non-breeding season, most migratory shorebirds forage on intertidal flats but at high tide move to high-tide roosts (Rogers *et al.* 2006a), where they rest when there is little opportunity to forage. Availability of high-tide roosting sites is essential for the survival of shorebirds (Wiersma & Piersma 1994). As many migratory shorebird species worldwide are facing rapid habitat loss and undergoing rapid population decline (Kirby 2011; MacKinnon *et al.* 2012; Hua *et al.* 2015), evidence-based conservation management is needed. High-tide roosts used by shorebirds may differ over time, locations and between species (Handel & Gill 1992; Burger 1997; Rehfisch *et al.* 2003; Smit & Visser 1993). During migration shorebirds encounter a variety of staging and stopover sites, at which their high-tide roosting habitats may differ. Understanding the preference of migrating shorebirds for high-tide roost site characteristics is important for effective and targeted conservation management.

Yalujiang Estuary Wetlands National Nature Reserve (hereafter YLJ), located on the Chinese coast of the northern Yellow Sea, is a key staging site for over 250,000 northward migrating shorebirds in the East Asian–Australasian Flyway (EAAF) (Riegen *et al.* 2014; Choi *et al.* 2014). While staging at YLJ, shorebirds feed on the intertidal mudflats, but during high tides, when the mudflats are not available, they are forced to stay on the banks of aquaculture ponds along the coast. Such man-made high-tide roosting habitats are used by shorebirds during their staging at YLJ because the natural roosting habitats, such as saltmarsh or alkaline flats, have been destroyed through land claim (Melville *et al.* 2016). The banks of aquaculture ponds within the reserve differ from each other in their physical characteristics (e.g. vegetation cover). However, few studies have investigated how shorebirds use pond banks as high-tide roosts. For the conservation of migrating shorebirds staging at YLJ, it is important to know the effects of the physical characteristics on the use of an aquaculture bank by shorebirds as high-tide roost. During northward migration in 2014 we investigated the relative attractiveness of six characteristics of pond banks at YLJ to migrating shorebirds.

METHODS

Study Area

YLJ is located at the Chinese side of the China-North Korea border (Figure 1A). At YLJ, extensive tidal flats are backed by a seawall, landward of which is a band of aquaculture ponds (stretching from the east to the west end of the reserve) that were constructed following land claim in the late 1990s (US Geological Survey 2016). The ponds are used to culture various economic aquaculture species, including sea cucumber, clams, jellyfish, fish and shrimps. The ponds are constructed by excavating soil which is used to form earth banks. The tops of some banks have paths and tracks. Vegetation cover, which includes annuals, such as seablight *Suaeda* sp. and perennials, such as reed *Phragmites communis*, varies considerably depending on how recently a bank has been constructed (and thus the length of time that plants have had to colonize). Vegetation cover also depends on the management protocol – in some instances dry vegetation is burned, thus opening up the banks. On neap tides birds can usually roost on flats outside the seawall, but during spring tides they are forced off the flats (Riegen *et al.* 2014) and many roost on the pond banks. We selected aquaculture ponds in the middle part of YLJ (E123°49’49’’-E123°57’46’’, N39°48’33’’-N39°50’52’’) as the study area (Figure 1B). This area is adjacent to the main intertidal foraging grounds of shorebirds. When mudflats are not accessible, shorebirds frequently roost in this area.

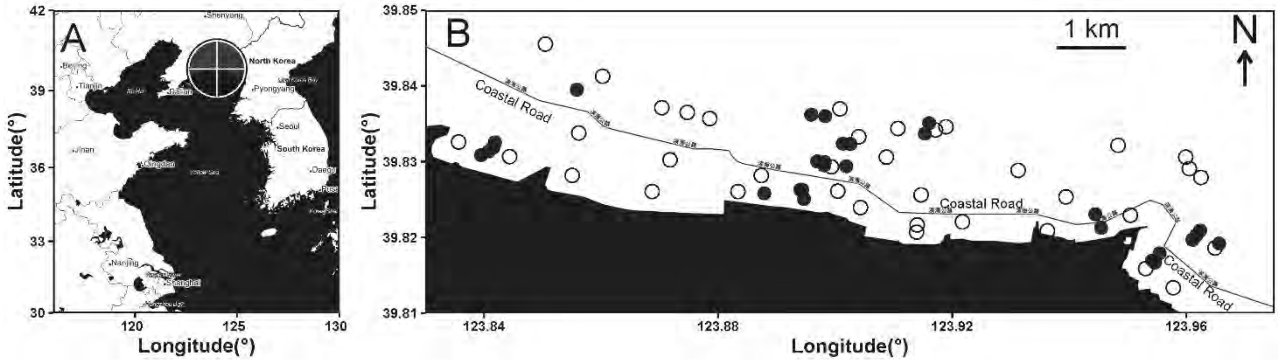

Figure 1. (A) Location of Yalujiang Estuary Wetlands National Nature Reserve (crosshair) on the northern coast of the Yellow Sea. (B) The study area. Roosting banks are shown as black dots while the non-roosting banks sampled are shown in open circles. *Map source: Stamen*.

Bank Survey and Characteristic Quantifying

In April and May 2014, we scanned the pond banks with telescopes and binoculars during the high-tide period in the study area to identify pond banks that were used by shorebirds as high-tide roosts. During the low-tide period, we also searched along pond banks for droppings that were left by shorebirds to confirm these sites functioned as high-tide roosts (shown in Figure 1B). We sampled 28 roosts on pond banks and 37 randomly selected pond banks that were not used as roosts within the study area. We quantified six characteristics to describe the appearance of an aquaculture pond bank: 1) *flatness*: flatness levels of the surface of each bank by visual check, with each a score from 1 to 5, where 1 represents the most rugged and 5 is flat; 2) *vegetation*: a visual estimate of the percent of vegetation coverage on each bank; 3) *width*: measured width of each bank across the crest in metres; 4) *soil*: a visual estimate of the proportion of soil coverage on the surface of each bank - on some banks rocks, rubble and other construction waste had been dumped to improve vehicle access; 5) *length*: length of each bank measured on Google Earth (Google Inc. 2015) in metres; 6) *distance*: distance in metres between the mid-point of each bank and the nearest point of the coastal road measured on Google Earth (Google Inc. 2015), which is a proxy measurement of potential vehicle disturbance.

Data Analysis

A multiple logistic regression model was selected and fitted to the data in the analysis. The six characteristics of the pond banks were treated as explanatory variables (*flatness*, *vegetation*, *width*, *soil*, *length*, *distance*), while *roost* was a binary response variable, with the value of 1 if the bank was used as a high-tide roost by shorebirds and 0 if the bank was not used. We performed stepwise regression and employed Akaike Information Criterion (AIC) to identify the candidate model that best interpreted the data. AIC rewards goodness-of-fit but at the same time includes the penalty for more complicated models (Agresti 1996). We used the simplest but most robust model (with the smallest AIC and the largest Akaike weight) to predict the probability of a given aquaculture bank being used as high-tide roost by shorebirds. All statistical analyses were performed in R (R Core Team 2015).

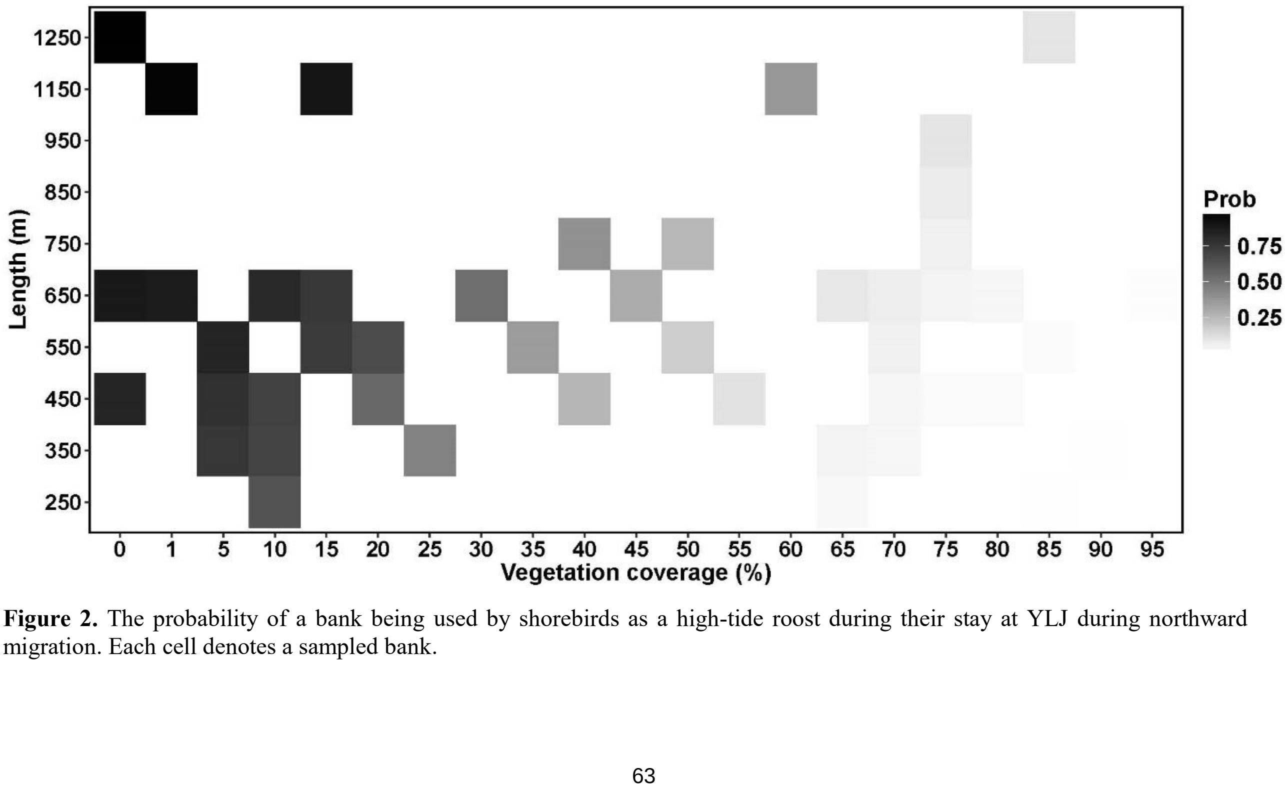

Figure 2. The probability of a bank being used by shorebirds as a high-tide roost during their stay at YLJ during northward migration. Each cell denotes a sampled bank.

RESULTS

The explanatory variables *vegetation* and *length* in the model yielded the minimum AIC and the largest Akaike weight (Table 1). The vegetation coverage of a given aquaculture bank showed a negative relationship with the probability of being used as high-tide roosts by shorebirds while the length of an aquaculture bank has a positive relationship (Table 2; Figure 2).

Table 1. Model selection based on AIC. K is the number of parameters estimated in the models; AICw_i is the Akaike weight; ΔAIC is the difference of AIC between a given candidate model and the best model (which has the minimum AIC); Cum*wi* is cumulative Akaike weight; LogLikh is log-likelihood.

No	Model	K	AIC	AICw_i	ΔAIC	Cumw_i	LogLikh
1	*roost ~ vegetation + length*	3	54.90	0.38	0.00	0.38	-24.45
2	*roost ~ flatness + vegetation + length*	4	55.27	0.32	0.38	0.70	-23.64
3	*roost ~ flatness + vegetation + soil + length*	5	56.36	0.18	1.46	0.89	-23.18
4	*roost ~ flatness + vegetation + width + soil + length*	6	58.00	0.08	3.11	0.97	-23.00
5	*roost ~ flatness + vegetation + width + soil + length + distance*	7	59.83	0.03	4.93	1.00	-22.91

Table 2. The estimated parameters and their statistical tests.

Variable	Estimate	Std. Error	z value	Pr (>|z|)
(Intercept)	0.639	0.887	0.720	0.472
vegetation	-6.959	1.658	-4.198	<0.001
length	0.003	0.002	1.405	0.160

DISCUSSION

Vegetation cover had a significant negative effect on the choice of a roost site bank by shorebirds at YLJ, which is consistent with the findings of Whitfield (2003) and Rogers *et al.* (2006b). Predation risk is considered to be a major determinant in the choice of roost site (Rosa *et al.* 2006). At high-tide roosts, vegetation can significantly reduce the ability of birds to see approaching aerial and terrestrial predators, which may result in an increased predation risk. Aerial predators in the study area include Peregrine Falcon *Falco peregrinus*, Eastern Marsh Harrier *Circus spilonotus,* Short-eared *Asio flammeus* and Long-eared Owls *A. otus*. In addition to these avian predators there is also Siberian Weasel *Mustela sibirica*, a mammal. Previous studies have shown that disturbance may affect the use of high-tide roost sites (Smit & Visser 1993; Rehfisch *et al.* 2003; Rogers 2003; Rogers *et al.* 2006a; Saintilan 2009). The fact that shorebirds at YLJ showed a strong preference for longer banks can probably be explained by lower levels of disturbance by human activities, as disturbance usually occurs at the two ends of the bank.

Shorebirds face many conflicting demands in their daily activities, and have to weigh costs and benefits before making decisions. We hypothesized that wider, flatter banks with more soil on the surface would be used by shorebirds as high-tide roosts. However, we found that these factors had little effect on the use of roosting banks compared to the amount of vegetation and the length of the bank. This may be because shorebirds at YLJ are under high predation risk and they have to trade-off. Moreover, energy conservation could also affect the use of high-tide roosting site. As cold winds are characteristic of much of the northward migration period (winds > 5.5 ms^{-1} occur on about half of the days in March and April; Meteoblue 2016), birds may seek the greater level of shelter available amongst topographically varied pond banks when compared with flat pond banks. It is common to see shorebirds roosting on the more exposed flatter top of the bank, but others amongst the rougher slope on the lee side (Figure 3). The distance between the banks and the coastal road, which was used as an indicator of the level of vehicle disturbance, had no

Figure 3. A mixed flock of shorebirds, including Bar-tailed Godwit, Great Knot and Dunlin roosting on the bank of an aquaculture pond, Yalu Jiang Estuary Wetlands National Nature Reserve (2 May 2014). Photo by Peng He.

significant effect on the use of roosting banks by shorebirds suggesting that birds were little affected by vehicle movements and associated noise (distances ranging from 129 m to 1204 m, with 516 ± 344 m (mean ± sd)).

Conflicts between coastal wetland exploitation and conservation interests for migratory shorebird are widespread (MacKinnon *et al*. 2012; Melville *et al.* 2016). A key to conserving migratory shorebirds at specific stopover sites lies in an improved understanding of habitat preferences to inform management activities. Our study shows that shorebirds staging at YLJ during northward migration prefer to roost on long banks with little or no vegetation. Future management should focus on encouraging pond operators to maintain the banks without vegetation and adjust their daily activities as far as possible to leave the banks un-disturbed during the spring high tide period. Although the ponds are within the reserve boundary the nature reserve has no day-to-day management control of activities, thus there is a need for reserve staff to raise public awareness, especially with pond managers.

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ESTABLISHING THE IMPORTANCE OF THE GREATER MAPOON AREA FOR WATERBIRDS THROUGH COLLABORATION WITH INDIGENOUS LAND AND SEA RANGERS

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The Gulf of Carpentaria region is sparsely populated and holds important areas of waterbird habitat that are generally under-surveyed. Here we describe one such area whose importance is becoming better known as a result of a collaboration that started in 2012 involving the Mapoon Land and Sea Rangers, the North Australian Indigenous Land and Sea Management Alliance Ltd and BirdLife Australia. Annual surveys from the Greater Mapoon area in western Cape York from 2012-2015 suggest that the area is of national and international significance for waterbirds (based on criteria under the EPBC Act and Ramsar Convention on Wetlands, respectively), particularly migratory shorebirds. Although the area's remoteness and intense wet seasons make more frequent counting across the area challenging, the phenology of its waterbirds requires further research to determine the specific role and significance of the site within migration cycles.

INTRODUCTION

The Gulf of Carpentaria region contains some of the most important habitat for waterbirds (including shorebirds, waterfowl, herons and allies, gulls and terns) in Australia. A complete survey of Australia's northeast region including the entire Gulf of Carpentaria in the early 1980s recorded over 250,000 migratory shorebirds in December and February (Garnett 1987). Aerial and ground surveys in the Northern Territory completed over more than a decade showed important waterbird aggregations in the western Gulf of Carpentaria – for example nearly 94,000 shorebirds and over 37,000 waterbirds and five large waterbird breeding colonies were recorded in the survey block around Borroloola, NT (Chatto 2003; Chatto 2006).

The importance of the southeast portion of the Gulf has been especially recognised. Ground and aerial surveys from 1998-99 pointed to its importance by recording over 200,000 shorebirds in March (Driscoll 2001); subsequent aerial surveys in 2013 (March and April) indicated that 16 migratory shorebird species use the area in internationally significant numbers (>1% of the flyway population) and 2015 surveys (August and September) identified additional roosts where this threshold was met (Detlef 2013; Keates 2015). The Gulf Plains, a large coastal strip in the southeastern Gulf, was listed as an Important Birds Area in 2009 based on its importance to shorebirds and waterbirds (BirdLife International 2016). Five subsequent years of surveys (2009-2013) showed that many breeding colonies of herons and allies met criteria for international importance as per the Ramsar Convention on Wetlands (1971) (Jaensch & Richardson 2013). In 2015, cooperation between the Normanton Land and Sea Rangers of the Carpentaria Land Council, the Morr Morr Pastoral Company (operated by Traditional Owners) and the Australasian Wader Studies Group led to the declaration of the "South-East Gulf of Carpentaria: Karumba-Smithburne (Delta Downs)" East Asian-Australasian Flyway Network Site (EAAFP 2016; Jaensch and Driscoll 2015), further increasing recognition for the area.

Yet despite these efforts, the spatial and temporal coverage of the vast Gulf of Carpentaria coast is still limited and it is highly likely that critically important waterbird habitats are still unidentified and / or undocumented. Cape York Penninsula, whose western coast makes up the northeast portion of the Gulf of Carpentaria, is particularly understudied despite its globally significant ecological value (Valentine *et al.* 2013). Indigenous people make up over half of Cape York Penninula's population (Queensland Treasury and Trade 2011), and it is charactertised by small towns with many areas inaccessible by road during the wet season. Improving knowledge of waterbird populations in the region therefore depends on the active engagement of Indigenous people who live locally and manage wildlife and habitats through a range of community-based initiatives (eg. see Australian Government 2016).

One such town is Mapoon, situated about 90 km north of Weipa (11.3500° S; 142.3333° E) on western Cape York, with a population of ~270 people made up largely of Traditional Owners. Land tenure comprises Mapoon Aboriginal Freehold lands and Mapoon Aboriginal Shire Council Trust lands (see Mapoon Land & Sea Program (2013) for details and tenure maps). The Old Mapoon Aboriginal Corporation and Mapoon Aboriginal Shire Council jointly make management decisions for the township of Mapoon and surrounding areas, hitherto referred to as the 'Mapoon area'.

The Mapoon Land & Sea Rangers are the active management body on ~1800 km^2 of the Mapoon area, and their goals for natural and cultural management are outlined in the *Mapoon Country Plan 2013-2020*, which also maps the management area (Mapoon Land & Sea Program 2013). This plan notes that presence and abundance of shorebirds are an indicator of Mapoon beach health, and indicates that roosting (and nesting) shorebirds can be at risk from vehicle traffic on beaches (Mapoon Land & Sea Program 2013).

In 2012 a partnership was formed involving the Mapoon Land and Sea Program, BirdLife Australia, and the North Australian Indigenous Land and Sea Management Alliance Ltd. (NAILSMA) as part of a broader project involving several Indigenous ranger groups in Gulf of Carpentaria region (NAILSMA 2014 pp. 142-149).

The purpose of the partnership was threefold: to build the capacity of the Mapoon Land and Sea Rangers to monitor and protect shorebirds in their management area; to document and promote the importance of the Greater Mapoon area for shorebirds; and, to contribute to migratory shorebird population estimates within this poorly documented region of northern Australia. Here we present survey results and reflections from 2012-2015 resulting from this collaboration.

METHODS

Waterbird surveys were completed at sites around Mapoon from October 2012-October 2015. Survey methods followed BirdLife Australia's Shorebirds 2020 Program (BirdLife Australia 2016). Workshops were held in Mapoon on shorebird ecology, and training in bird identification, counting techniques and data entry was provided for Mapoon Land and Sea Rangers. In turn the rangers outlined accessible areas around Mapoon of importance for waterbirds, particularly shorebirds, and the Mapoon Shorebird Area (MSA) and associated Count Areas were established accordingly.

Site Description

Count Areas at Leginjar, Vraithi and Namaletta were established based on known shorebird aggregation sites and site accessibility using ranger vehicles (Figure 1). The current resulting outline of the MSA (Figure 1) represents the area where shorebirds could reasonably be expected to move to from these Count Areas and forage. We expect that there are additional aggregations of waterbirds in swamps and estuarine areas that have not yet been surveyed, and boundaries of the MSA may be

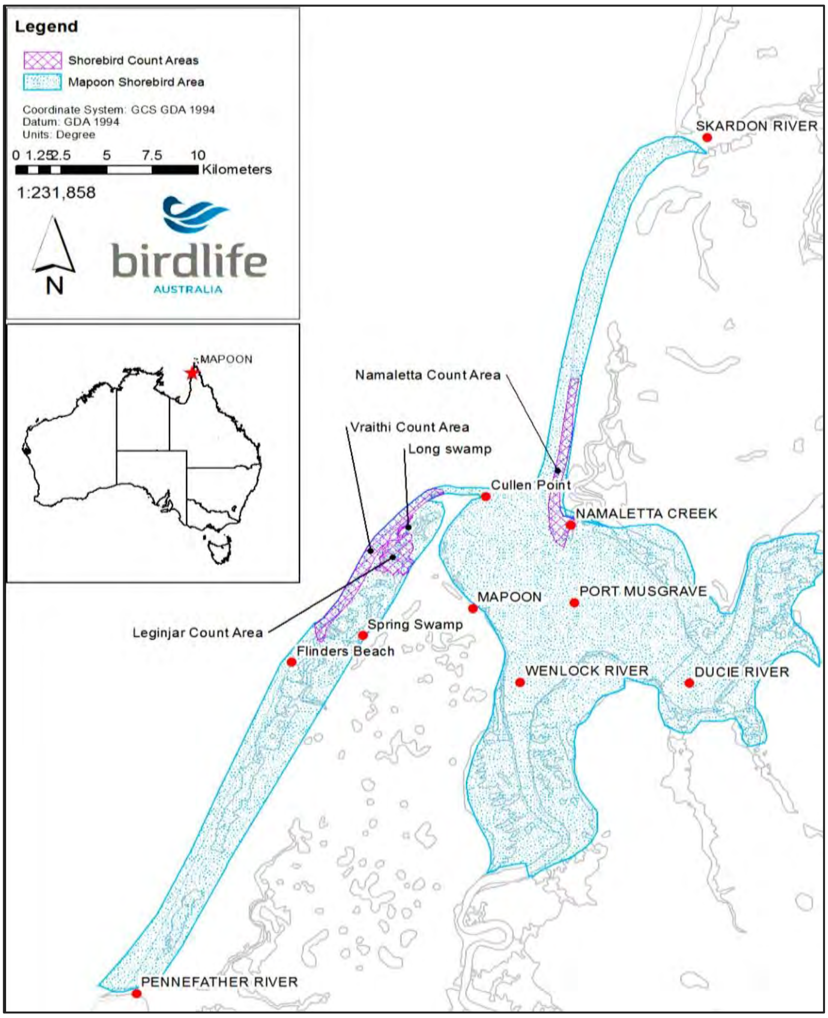

Figure 1. Mapoon Shorebird Area and associated Count Areas.

revised over time if more areas are able to be surveyed and as knowledge of local movement behaviour becomes better known. The current MSA includes about 64 km of beach bordered to the south by the Pennefather River and to the north by the Skardon River. In general, the MSA is low-lying with wetlands varying in salinity from hypersaline tidal pools to freshwater swamps.

The desktop application of CyberTracker™ software (Cape Town, South Africa) was used to electronically 'draw' georeferenced areas that were saved as ESRI shape files and lodged with BirdLife Australia as the MSA and associated Count Areas. This was completed as a collaborative exercise involving Mapoon Land and Sea Rangers, BirdLife Australia and NAILSMA staff.

All Count Areas except Namaletta were accessed by 4WD vehicles and surveyed on foot from one location using a spotting scope and binoculars. The Namaletta Count Area encompasses a long (5 km) narrow stretch of beach without road access. This site was accessed using a barge to transport 4WD quad bikes from Mapoon to the beach and then travelling on the quad bikes, stopping at regular intervals over several hours to count shorebirds using spotting scopes and binoculars.

Counts

Counts were generally completed within the designated Count Areas, but other accessible sites were also surveyed opportunistically. For each count all waterbirds including shorebirds, waterfowl, herons and allies, gulls and terns were recorded. Birds were recorded to species level if possible; however, shorebirds were recorded as small, medium or large 'unidentified waders' in the rare cases where species level identification was not possible due to distance, accessibility and / or heat haze. In the results presented below, any recorded 'unidentified waders' are included with migratory shorebirds as this is the group they would most likely belong to. Any birds belonging to other groups that were recorded opportunistically (for example raptors and seabirds) are not presented here.

Due to resource and access constraints, timing of counts focussed on shorebird aggregations that occur during southward migration, i.e. when cyclones are less likely.

Using the data form of the Shorebirds 2020 program (BirdLife Australia 2016) as a guide, a sequential electronic data collection application was developed by NAILSMA through their I-Tracker program (NAILSMA 2014) using CyberTracker™ software and used for collection of count data. The application was customised to reflect the species present in the Cape York Peninsula and designed to assist data collectors to enter data accurately. A second I-Tracker application was also developed to assist participants with shorebird identification skills and included photos, drawings and a list of key features of shorebirds, terns and gulls. During surveys, both applications were used on ruggedized (waterproof / dustproof) Personal Data Assistants.

Following counts, data were downloaded into a local PC-based CyberTracker™ database. Microsoft Excel spreadsheets of Count Survey Data and Observation Data were then exported from the local database and emailed to BirdLife Australia, where the data were integrated with the Shorebirds 2020 database (accessible through an online log-in system).

Table 1. Count completed in the MSA 2012-2015. Counts with >15 migratory shorebird species or 2000 migratory shorebirds (criteria for national significance) are in bold.

Count Area	Coordinates	Count Date	No. of observers	Maximum tide height	Migratory Shorebirds (species)	Resident Shorebirds (species)	Waterfowl, Herons & allies (species)	Gulls & Terns (species)	Total (species)	Average species richness
Cullen Point.	-11.95; 141.8999	14 Oct 2015	1	n/a	n/a	n/a	3870 (1)	n/a	n/a	1
Flinders Beach	-12.0324; 141.8225	15 Oct 2015	4	unrecorded	101(11)	30 (4)	312 (7)	1130 (7)	1573 (29)	29
Leginjar Count Area	-11.9891; 141.8633	18 Oct 2012	2	n/a	n/a	80 (1)	167 (4)	n/a	247 (5)	10.3
		15 Oct 2014	8	n/a	133 (4)	145 (1)	70 (3)	n/a	348 (8)	
		12 Oct 2015	5	n/a	141 (6)	171 (3)	1327 (8)	1 (1)	1640 (18)	
Long Swamp	-11.9698; 141.8693	15 Oct 2014	8	n/a	38 (5)	109 (3)	1029 (9)	52 (2)	1228 (19)	19
Namaletta Count Area	-11.9432; 141.9447	24 Oct 2012	1	2	1425 (15)	50 (2)	21 (5)	343 (5)	1839 (27)	29.2
		2 Nov 2012	1	2	2380 (13)	103 (4)	244 (7)	236 (5)	2963 (29)	
		16 Nov 2012	2	2.5	609 (10)	15 (4)	10 (2)	106 (6)	740 (22)	
		28 Oct 2013	unrecorded	unrecorded	7188 (17)	297 (5)	60 (2)	n/a	7545 (24)	
		30 Oct 2013	unrecorded	unrecorded	1766 (12)	36 (4)	41 (2)	655 (6)	2498 (24)	
		21 Oct 2014	4	2.8	17,196 (19)	723 (5)	143 (8)	1834 (8)	19,896 (40)	
		14 Oct 2015	6	unrecorded	1236 (13)	179 (5)	196 (11)	543 (7)	2154 (36)	
		15 Oct 2015	4	unrecorded	3619 (16)	147 (3)	32 (5)	292 (7)	4090 (31)	
Spring Swamp	-12.0379; 141.8426	12 Oct 2015	4	n/a	20 (4)	86(2)	599 (4)	n/a	705 (10)	10
Vraithi Count Area	-11.9850; 141.8591	18 Oct 2012	2	2.7	200 (3)	50 (3)	53 (1)	n/a	303 (7)	18.9
		9 Nov 2012	2	2.3	113 (8)	69 (5)	47 (6)	124 (6)	353 (25)	
		18 Mar 2013	3	3	53 (3)	6 (3)	n/a	292 (7)	351 (13)	
		8 Apr 2013	13	2.4	53 (5)	17 (4)	141 (7)	28 (5)	239 (21)	
		9 Apr 2013	8	2.4	93 (5)	40 (4)	22 (5)	139 (6)	294 (20)	
		2 Feb 2014	1	3.2	210 (7)	51 (3)	1 (1)	5 (1)	267 (12)	
		5 Feb 2014	5	2.2	2284 (9)	6 (1)	n/a	174 (5)	2464 (15)	
		16 Oct 2014	7	2.8	852 (13)	60 (5)	12 (4)	1101 (7)	2025 (29)	
		13 Oct 2015	5	unrecorded	69 (9)	39 (3)	105 (9)	1595 (7)	1080 (28)	

RESULTS and DISCUSSION

Twenty four counts were completed and lodged in the Shorebirds 2020 database from October 2012 to October 2015 (Table 1). Across the MSA 24 species of migratory shorebird, 10 species of resident shorebird, 25 species of waterfowl, Herons and allies, and 11 species of gulls and terns were recorded (Table 2). Namaletta emerged as the most diverse and productive site within the MSA with an average species richness of 29.2 (Table 1).

Our counts over the four years of the project demonstrate that the MSA is of national and international significance for migratory shorebirds and waterbirds, though logistical restrictions have limited the evidence to support this claim to the period of the shorebirds' southward migration.

Under the significant impact guidelines for migratory shorebirds of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), 'nationally important habitat' for migratory shorebirds is defined as regularly supporting: (1) 0.1% of the flyway population of a single species of migratory shorebird; (2) 2000 migratory shorebirds; or, (3) 15 migratory shorebird species (Commonwealth of Australia 2015). All of these criteria were met for the MSA during our 2012-2015 surveys. With respect to (1), flyway populations to assess national significance are currently derived from Bamford *et al.* (2008), though these are in the process of being updated (Hansen *et al.* 2016). In our surveys, 12 species appeared in numbers above 0.1% of the flyway population, though Broad-billed Sandpiper would not meet this threshold using the Hansen *et al.* (2016) estimate (Appendix 1). With respect to (2), five counts (one at Vraithi and four at Namaletta), including at least one in each of the surveyed years, had more than 2000 migratory shorebirds (Table1). With respect to (3), four counts had at least 15

Table 2. Waterbirds species recorded in the MSA 2012-2015.

Migratory Shorebirds	Resident Shorebirds	Waterfowl, Herons & allies	Gulls & Terns
Asian Dowitcher	Beach Stone-curlew	Australasian Darter	Bridled Tern
Limnodromus semipalmatus	*Esacus magnirostris*	*Anhinga novaehollandiae*	*Onychoprion anaethetus*
Australian Pratincole	Black-fronted Dotterel	Australian Pelican	Caspian Tern
Stiltia isabella	*Elseyornis melanops*	*Pelecanus conspicillatus*	*Hydroprogne caspia*
Bar-tailed Godwit	Black-winged Stilt	Australian White Ibis	Common Tern
Limosa lapponica	*Himantopus himantopus*	*Threskiornis moluccus*	*Sterna hirundo*
Black-tailed Godwit	Bush Stone-curlew	Black Bittern	Crested Tern
Limosa limosa	*Burhinus grallarius*	*Ixobrychus flavicollis*	*Thalasseus bergii*
Broad-billed Sandpiper	Comb-crested Jacana	Black-necked Stork	Gull-billed Tern
Calidris falcinellus	*Irediparra gallinacea*	*Ephippiorhynchus asiaticus*	*Gelochelidon nilotica*
Common Greenshank	Masked Lapwing	Brolga	Lesser Crested Tern
Tringa nebularia	*Vanellus miles*	*Antigone rubicunda*	*Thalasseus bengalensis*
Common Sandpiper	Pied Oystercatcher	Cattle Egret	Little Tern
Actitis hypoleucos	*Haematopus longirostris*	*Bubulcus ibis*	*Sternula albifrons*
Curlew Sandpiper	Red-capped Plover	Eastern Great Egret	Roseate Tern
Calidris ferruginea	*Charadrius ruficapillus*	*Ardea modesta*	*Sterna dougallii*
Far Eastern Curlew	Red-kneed Dotterel	Glossy Ibis	Silver Gull
Numenius madagascariensis	*Erythrogonys cinctus*	*Plegadis falcinellus*	*Larus novaehollandiae*
Great Knot	Sooty Oystercatcher	Grey Teal	Whiskered Tern
Calidris tenuirostris	*Haematopus fuliginosus*	*Anas gracilis*	*Chlidonias hybrida*
Greater Sand Plover		Intermediate Egret	White-winged Tern
Charadrius leschenaultii		*Ardea intermedia*	*Chlidonias leucopterus*
Grey Plover		Little Black Cormorant	
Pluvialis squatarola		*Phalacrocorax sulcirostris*	
Grey-tailed Tattler		Little Egret	
Tringa brevipes		*Egretta garzetta*	
Lesser Sand Plover		Little Pied Cormorant	
Charadrius mongolus		*Microcarbo melanoleucos*	
Little Curlew		Magpie Goose	
Numenius minutus		*Anseranas semipalmata*	
Marsh Sandpiper		Pacific Black Duck	
Tringa stagnatilis		*Anas superciliosa*	
Pacific Golden Plover		Pied Cormorant	
Pluvialis fulva		*Phalacrocorax varius*	
Red Knot		Pied Heron	
Calidris canutus		*Egretta picata*	
Red-necked Stint		Radjah Shelduck	
Calidris ruficollis		*Radjah radjah*	
Ruddy Turnstone		Royal Spoonbill	
Arenaria interpres		*Platalea regia*	
Sanderling		Straw-necked Ibis	
Calidris alba		*Threskiornis spinicollis*	
Sharp-tailed Sandpiper		Striated Heron	
Calidris acuminata		*Butorides striata*	
Terek Sandpiper		Wandering Whistling-Duck	
Xenus cinereus		*Dendrocygna arcuata*	
Whimbrel		White-faced Heron	
Numenius phaeopus		*Egretta novaehollandiae*	
		White-necked Heron	
		Ardea pacifica	

species (Table 1).

Species protected under the EPBC Act for their threatened status were regularly present. Far Eastern Curlew *Numenius madagascariensis*, listed as critically endangered under the EPBC Act, was present at all Namaletta counts including at numbers that exceeded the 1% population threshold; Curlew Sandpiper *Calidris ferruginea,* listed as critically endangered under the EPBC Act, was present at seven of eight counts and appeared in numbers exceeding 0.1% of the flyway population (once very close to the Hansen *et al.* (2016) 1% criteria); Lesser Sand Plover *Charadrius mongolus*, listed as endangered under the EPBC Act, appeared in numbers exceeding 1% of the flyway population; and, Greater Sand Plover *Charadrius leschenaultii*, listed as vulnerable under the EPBC Act, appeared in numbers exceeding 1% of the flyway population, though it would only exceed the 0.1% threshold using the Hansen *et al.* (2016) estimate (Appendix 1).

We also found that the MSA likely meets global significance criteria as defined by the Ramsar Convention on Wetlands (1971) and BirdLife International (BirdLife International 2016). Six species of migratory shorebirds were found at Namaletta at numbers above 1% threshold for the flyway population estimate (as per Bamford *et al.* 2008) including Far Eastern Curlew, Lesser Sand Plover, Greater Sand Plover, Red-necked Stint *Calidris ruficollis*, Common Greenshank *Tringa nebularia* and Sharp-tailed Sandpiper *Calidris acuminata*. Using Hansen *et al.* (2016) estimates, this list changes only for a few species: Greater Sand Plover and Common Greenshank would not, but Whimbrel *Numenius phaeopus* would, meet this threshold. Moreover, two species listed globally as endangered and seven species listed globally as near threatened occurred in the area (IUCN 2016) (Appendix 1).

The area also has significant numbers of other waterbirds. Although incomplete, a count of Brolgas *Antigone rubicunda* carried out when the birds were leaving the Leginjar area to roost near the Ducie and Wenlock Rivers in October 2015 resulted in 3870 birds recorded, >3.5% of the most optimistic published global population estimate (Wetlands International 2016). Information from long-term residents suggests that this is not unusual, and that waterfowl including Magpie Geese *Anseranas semipalmata* and several duck species also occur seasonally in high numbers (Blackwood *pers.obs.*). We expect that cumulative counts in the MSA at multiple sites including beaches and inland swamps would exceed 20,000 birds at peak times (as they did in October 2015).

The phenology of migratory shorebirds in Mapoon requires further research. The geographic location of the area makes it likely the first suitable refuelling site for many migratory shorebird species returning to Australia. Conversely, during northward migration, it may be the last stop to recupprerate before the flight to Indonesia and beyond. Our data from counts during the southerward migration period suggest that at least some species of migratory shorebirds may use the area for only a short period of time on their way to non breeding sites further south. This complicates demonstrating that the site is used regularly, particularly as logistics limit the number of annual counts possible. Counts in general, and at Namaletta particularly, were usually limited to 1-2 counts per season (Table 1) and may easily have missed peak numbers. In 2015, for instance, anecdotal observations by Mapoon Land and Sea Rangers indicated that migratory shorebird numbers built up significantly soon after the count period. Unfortunately, at the time, operational requirements precluded conducting additional counts.

Our research to date has left two gaps in our knowledge that need to be filled to inform management of the site. Firstly, although logistically challenging, it is of importance to attempt counts during the austral summer (November-February) to determine how many shorebirds remain in the Mapoon area during the non-breeding season. Secondly, to date not a single leg flag has been sighted, so the migration route and wintering and breeding grounds of the migratory shorebirds that occur in Mapoon, and therefore important information on the birds' international conservation challenges, are completely unknown.

When assessing the importance of the MSA it is worth keeping in mind that numbers reported here are conservative since some roosts were probably missed in the counts (e.g. there are likely to be roosts behind mangroves and closer to the mouth of the Ducie or Wenlock rivers). In addition, the beach north of the Namaletta Count Area to the Skardon River has not yet been surveyed and it is unknown what waterbird numbers occur in this area. Additional resources are required, as the rangers have limited resources that they need to apply to a large range of other activities in their annual work plan, covering an enormous geographic area.

Additional exploration of threats and potential threats to shorebirds in the Mapoon area is also needed. Feral animals (pigs and horses occur in high density around Mapoon) and 4WD vehicles (often present on beaches) are monitored and managed by the rangers, but their impacts on shorebirds specifically have not been quantified. Bauxite mining is expected to commence inland and south of the Skardon River, with accompanying industrial activity likely to increase inland to and north of the Namaletta Count Area; shorebirds have not been surveyed in this area as part of this project. The effects of recent large-scale mangrove die-off events that have occurred in extensive areas of mangroves in NT and Qld sections of the Gulf of Carpentaria (ABC 2016) are also as yet unknown, but seem likely to impact availability of habitat for shorebirds on a regional level.

The overall importance of the MSA as documented through this collaborative effort indicates that it should be afforded high protection and careful management. Support for the Mapoon Land and Sea Rangers to continue and expand monitoring and management efforts for Mapoon's waterbirds is of critical importance. In addition, while non-binding instruments, consideration of the MSA as an Important Bird Area (BirdLife International 2016) and an East Asian-Australasian Flyway Network Site (EAAFP 2016) in future have the potential to further raise the profile and awareness of the area and its importance.

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Appendix 1. Counts of >2000 migratory shorebirds from the MSA 2012-2015. Based on estimates from Bamford *et al.* (2008), counts exceeding the 1% flyway population estimate (international significance) are in bold and counts exceeding the 0.1% flyway population estimate (national significance) are in italics.

Count Area	Count Date	Species		Count	EPBC Threatened Status	IUCN Status	1% Flyway Population (Bamford *et al.* 2008)
Vraithi	5 Feb 2014	Red-necked Stint	*Calidris ruficollis*	*1700*		NT	3250
		Lesser Sand Plover	*Charadrius mongolus*	*365*	EN	LC	1400
		Greater Sand Plover	*Charadrius leschenaultii*	*155* $^{-n}$	VU	LC	1100
		Great Knot	*Calidris tenuirostris*	53	CR	EN	3750
		Pacific Golden Plover	*Pluvialis fulva*	7		LC	1000
		Asian Dowitcher	*Limnodromus semipalmatus*	1		NT	240
		Bar-tailed Godwit	*Limosa lapponica*	1	VU/CR*	NT	3250
		Marsh Sandpiper	*Tringa stagnatilis*	1		LC	1000
		Whimbrel	*Numenius phaeopus*	1		LC	1000
TOTAL		9		2284			
Namaletta	2 Nov 2012	Greater Sand Plover	*Charadrius leschenaultii*	*561*	VU	LC	1100
		Sharp-tailed Sandpiper	*Calidris acuminata*	*512*		LC	1600
		Red-necked Stint	*Calidris ruficollis*	*371* $^{-n}$		NT	3250
		Lesser Sand Plover	*Charadrius mongolus*	*271*	EN	LC	1400
		Common Greenshank	*Tringa nebularia*	*196*		LC	600
		Terek Sandpiper	*Xenus cinereus*	*152*		LC	600
		Black-tailed Godwit	*Limosa limosa*	149		NT	1600
		Whimbrel	*Numenius phaeopus*	59		LC	1000
		Bar-tailed Godwit	*Limosa lapponica*	39	VU/CR*	NT	3250
		Far Eastern Curlew	*Numenius madagascariensis*	*39*	CR	EN	380
		Grey-tailed Tattler	*Tringa brevipes*	15		NT	500
		Grey Plover	*Pluvialis squatarola*	8		LC	1250
		Curlew Sandpiper	*Calidris ferruginea*	8	CR	NT	1800
TOTAL		13		2380			
Namaletta	28 Oct 2013	Red-necked Stint	*Calidris ruficollis*	*2575*		NT	3250
		Sharp-tailed Sandpiper	*Calidris acuminata*	1820		LC	1600
		Greater Sand Plover	*Charadrius leschenaultii*	1404 $^{-i}$	VU	LC	1100
		Common Greenshank	*Tringa nebularia*	*426*		LC	600
		Lesser Sand Plover	*Charadrius mongolus*	*220*	EN	LC	1400
		Whimbrel	*Numenius phaeopus*	*213*		LC	1000
		Black-tailed Godwit	*Limosa limosa*	142		NT	1600
		Far Eastern Curlew	*Numenius madagascariensis*	*136*	CR	EN	380
		Great Knot	*Calidris tenuirostris*	130	CR	EN	3750
		Pacific Golden Plover	*Pluvialis fulva*	66		LC	1000
		Grey Plover	*Pluvialis squatarola*	17		LC	1250
		Terek Sandpiper	*Xenus cinereus*	15		LC	600
		Grey-tailed Tattler	*Tringa brevipes*	10		NT	500
		Curlew Sandpiper	*Calidris ferruginea*	6	CR	NT	1800
		Ruddy Turnstone	*Arenaria interpres*	5		LC	350
		Marsh Sandpiper	*Tringa stagnatilis*	2		LC	1000
		Broad-billed Sandpiper	*Calidris falcinellus*	1		LC	250
TOTAL		17		7188			
Namaletta	21 Oct 2014	Red-necked Stint	*Calidris ruficollis*	5845		NT	3250
		Sharp-tailed Sandpiper	*Calidris acuminata*	3312		LC	1600
		Lesser Sand Plover	*Charadrius mongolus*	2366	EN	LC	1400
		Curlew Sandpiper	*Calidris ferruginea*	*862*	CR	NT	1800
		Whimbrel	*Numenius phaeopus*	*839* $^{+i}$		LC	1000
		Black-tailed Godwit	*Limosa limosa*	*802*		NT	1600
		Greater Sand Plover	*Charadrius leschenaultii*	*756*	VU	LC	1100
		Common Greenshank	*Tringa nebularia*	690 $^{-i}$		LC	600
		Marsh Sandpiper	*Tringa stagnatilis*	*480*		LC	1000
		Far Eastern Curlew	*Numenius madagascariensis*	461	CR	EN	380
		Terek Sandpiper	*Xenus cinereus*	*352*		LC	600
		Great Knot	*Calidris tenuirostris*	229	CR	EN	3750
		Grey Plover	*Pluvialis squatarola*	68		LC	1250
		Red Knot	*Calidris canutus*	48	EN	NT	2200
		Grey-tailed Tattler	*Tringa brevipes*	29		NT	500
		Broad-billed Sandpiper	*Calidris falcinellus*	*28* $^{-n}$		LC	250
		Sanderling	*Calidris alba*	16		LC	220
		Pacific Golden Plover	*Pluvialis fulva*	12		LC	1000
		Ruddy Turnstone	*Arenaria interpres*	1		LC	350
TOTAL		19		17196			

Appendix 1. Continued.

Count Area	Count Date	Species		Count	EPBC Threatened Status	IUCN Status	1% Flyway Population (Bamford *et al.* 2008)
Namaletta	15 Oct 2015	Red-necked Stint	*Calidris ruficollis*	*1335*		NT	3250
		Whimbrel	*Numenius phaeopus*	*483*		LC	1000
		Greater Sand Plover	*Charadrius leschenaultii*	*361*	VU	LC	1100
		Unidentified medium shorebird		310	n/a	n/a	
		Sharp-tailed Sandpiper	*Calidris acuminata*	*284*		LC	1600
		Far Eastern Curlew	*Numenius madagascariensis*	*171*	CR	EN	380
		Marsh Sandpiper	*Tringa stagnatilis*	*149*		LC	1000
		Black-tailed Godwit	*Limosa limosa*	136		NT	1600
		Curlew Sandpiper	*Calidris ferruginea*	110[+n]	CR	NT	1800
		Common Greenshank	*Tringa nebularia*	*105*[–n]		LC	600
		Lesser Sand Plover	*Charadrius mongolus*	103	EN	LC	1400
		Bar-tailed Godwit	*Limosa lapponica*	24	VU/CR*	NT	3250
		Great Knot	*Calidris tenuirostris*	21	CR	EN	3750
		Grey Plover	*Pluvialis squatarola*	15		LC	1250
		Terek Sandpiper	*Xenus cinereus*	6		LC	600
		Grey-tailed Tattler	*Tringa brevipes*	3		NT	500
		Red Knot	*Calidris canutus*	3	EN	NT	2200
TOTAL		16		3619			

*Bar-tailed Godwit subspecies *Limosa lapponica baueri* is listed as vulnerable and subspecies *Limosa lapponica menzbieri* as critically endangered under the EPBC Act; it is unknown which subspecies occurs in the Mapoon area

[–n] would not qualify for national significance using Hansen *et al*. (2016) population estimate

[+n] would qualify for national significance using Hansen *et al*. (2016) population estimate

[–i] would not qualify for international significance using Hansen *et al*. (2016) population estimate

[+i] would qualify for international significance using Hansen *et al.* (2016) population estimate

BIRD MORTALITY IN FISH NETS AT A SIGNIFICANT STOPOVER SITE OF THE SPOON-BILLED SANDPIPER *CALIDRIS PYGMAEA* IN THE YELLOW SEA, CHINA

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The tidal flats of the Yellow Sea in China are vitally important to migratory shorebirds in the East Asian–Australasian Flyway (EAAF) (Barter 2002, Bai *et al*. 2015), especially as staging and stopover sites (Ma *et al.* 2013). Hunting has previously been recognised as a significant cause of mortality for some shorebirds in the EAAF (Melville 1997), and probably the main cause of population decline in the critically endangered (IUCN 2016) Spoon-billed Sandpiper *Calidris pygmaea* (Zöckler *et al*. 2010). Here, I report the occurrence of incidental mortality of shorebirds in fishing gill nets in Jiangsu Province, East China.

STUDY AREA AND METHODS

This study was undertaken at Tiaozini intertidal mudflats, east of a seawall located 32.76143°N 120.95318°E to 32.72276°N 120.94591°E in Dongtai County, south coast of Jiangsu Province, China. This section of seawall is 4.4 km in length with mudflats extending some 7 km seaward. The location is considered to be the most important stopover site for Spoon-billed Sandpiper along the Rudong / Dongtai mudflats (Zöckler *et al.* 2015).

Fish nets were located on an opportunistic basis while conducting other research. Dead birds were extracted from nets and removed from the mudflats to ensure they were not counted during subsequent inspections. Live birds were released. Species, count, net length, net construction and GPS co-ordinates were recorded. Live and dead birds were photographed *in situ*. Fish nets were inspected on 10 non-consecutive days during the six-week period from 15 September to 29 October 2015.

RESULTS

In the 7 x 4.4 km study area a total of five nets were found. Nets were located on open intertidal mudflat at a distance varying from 100 m to 1.6 km seaward of the seawall (Figure 1). All nets were 1 m high; individual net length varied from 80 to 300 m. Construction was of fine transparent monofilament net with a mesh size of 20 x 20 mm sandwiched between two coarser monofilament nets 200 x 200 mm, stretched between bamboo poles approximately 10 m apart (Figure 2). The nets are set for a variety of fin-fish. The nets were submerged for an average of about 4 h during each high tide. Tides are semidiurnal, with two high and two low tides per day. Once erected, nets remained in position twenty-four hours a day unless damaged by spring tide or water borne debris. Damaged nets were re-installed in the same location or within a close proximity.

The combined length of nets inspected over 10 days was 5320 m.

A total of 149 birds of 17 species were found trapped; 132 dead birds were extracted and 17 live birds released (Table1). Of special note is the mortality of three Spoon-billed Sandpipers (one juvenile and two adults – Figure 3) accounting for ~*0.5%* of the global population (Green *et al.* 2015) within a period of six weeks.

Figure 1. Location of fish nets Tiaozini mudflat, Jiangsu Province, China, September-October 2015. Source: Google Earth 2016

Figure 2. Net 5, Tiaozini, length 290 m. Photo P. Crighton

Table 1. Birds trapped in fish nets at Tiaozini mudflats, Jiangsu, China, September-October 2015

Date	Species	Dead	Live	Length of individual nets (m)	Combined length of nets (m)
15 Sep	Spoon-billed Sandpiper *Calidris pygmaea*	1		300	300
16 Sep	Marsh Sandpiper *Tringa stagnatilis*	1			
	Kentish Plover *Charadrius alexandrinus*	3			
	Lesser Sandplover *Charadrius mongolus*	2		300	300
	Long-tailed Shrike *Lanius schach*		1		
	Barn Swallow *Hirundo rustica*	1			
5 Oct	Red-necked Stint *Calidris ruficollis*	2		300	300
	Greater Sandplover *Charadrius leschenaultia*	1			
9 Oct	Japanese Quail *Coturnix japonica*		1	80	80
12 Oct	Terek Sandpiper *Xenus cinereus*	1			
	Sanderling *Caldris alba*	4			
	Red-necked Stint	2			
	Dunlin *Calidris alpina*	7		80	
	Kentish Plover	6	1	300	680
	Lesser Sandplover	1		300	
	Little Tern *Sterna albifrons*	1			
	Barn Swallow	1			
19 Oct	Red-necked Stint	1			
	Dunlin	1		290	
	Kentish Plover	8		80	970
	Swinhoe's Storm-petrel *Oceanodroma monorhis*	2		300	
				300	
	Siberian Rubythroat *Luscinia calliope*	1			
	Barn Swallow	2			
21 Oct	Terek Sandpiper	1			
	Sanderling	2	1		
	Spoon-billed Sandpiper	2		80	
	Dunlin	3	1	300	970
	Kentish Plover	37	6	300	
	Greater Sandplover	5		290	
	Black-browed Reed Warbler *Acrocephalus bistrigiceps*		1		
24 Oct	Terek Sandpiper	1			
	Red-necked Stint	1	1	80	
	Dunlin	1	2	300	970
	Grey Plover *Pluvialis squatarola*		1	300	
	Kentish Plover	25	1	290	
	Barn Swallow	1			
26 Oct	Kentish Plover	2		80	
	Swinhoe's Storm-petrel	1		290	670
				300	
29 Oct	Barn Swallow	1		80	80
	Total	132	17	5320	

The capture of three Swinhoe's Storm-petrels *Oceanodroma monorhis* is noteworthy since this species apparently has not been recorded close inshore along the Jiangsu coast previously.

Shorebirds were observed to fly clear of nets during daylight and were found in nets only after high tides during the night. Passerines arriving on migration, however, were observed flying into nets during daylight when fatigued.

After discussion with fisherman at Tiaozini and from observation, it was evident that trapped birds are considered a nuisance by-catch. Birds are usually left in nets to decompose as extraction by fisherman causes damage to the fine mist net. If fishermen remove birds from nets, they are discarded onto the mudflats (Figure 4).

During a meeting with local fishermen, I was advised that this type of fish net is in use at this site only during the boreal autumn (August-October) - a key period of shorebird southward migration.

Figure 3. Dead Spoon-billed Sandpiper, Net 5, Tiaozini, 21 October 2015. Photo P. Crighton

Figure 4. Dunlin by-catch discarded on mudflat, Tiaozini, 19 October 2015. Photo P. Crighton

DISCUSSION

Incidental mortality in fish nets is a significant threat to migratory shorebirds at Tiaozini mudflats during the boreal autumn stopover period, August-October. Of particular concern is the vulnerability of the critically endangered Spoon-billed Sandpiper – most of the world population is thought to stage in this area and many (most?) adults moult here (Tong *et al.* 2012).

Extensive mist netting of shorebirds in Guangdong Province, China, poses a serious threat to Spoon-billed Sandpipers (Martinez & Lewthwaite 2013), and commercial hunting in Myanmar has been identified as a major factor in the decline of the population of this species (Zockler *et al.* 2010). These problems are being addressed through a combination of promoting alternative livelihoods (Myanmar) (Eberhardt 2016) and law enforcement (Guangdong) (Long 2016).

The situation at Tiaozini is different in that nets are set to catch fish and that bird capture is accidental – the fishermen would prefer not to catch birds as this interferes with their fishing activities. Incidental capture of shorebirds in fish nets and traps has also been reported elsewhere in the Bo Hai and Yellow Sea, with total captures thought to be in the order of tens of thousands of birds per year (Melville *et al.* 2016).

There is an urgent need for additional information to quantify the effect of fish nets and traps on migratory shorebird survival along the length of the China Yellow Sea coast and elsewhere in the EAAF. Addressing the issue will be complex, requiring not only raising public awareness of the problem, but also the development of novel, cost-effective fishing techniques that maintain rates of fish capture while reducing the risks of bird entrapment.

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BEHAVIOUR OF BREEDING JAVAN PLOVER *CHARADRIUS JAVANICUS* AT WONOREJO FISHPONDS, SURABAYA, INDONESIA

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INTRODUCTION

The Javan Plover *Charadrius javanicus* is an endemic species of Indonesia. It is known to occur in Java, the Kangean Islands, Madura, Bali (MacKinnon 1991), Lampung (Kennerley *et al* 2008), Sulawesi (Kennerley *et al* 2008, Coates & Bishop 2000, Tebb *et al* 2008), Sumbawa and Flores (Coates & Bishop 2000, White & Bruce 1986 in Iqbal *et al* 2011). The taxonomy of the Javan Plover is unclear and it has been suggested that the bird may well not merit full species status. The Javan Plover has been tentatively treated as a distinct species, but has also been included as a super species with *C. marginatus*, *C. alexandrinus* and *C. ruficapitallus* (del Hoyo, J. 1996). Morphologically, the Javan Plover appears quite different from those species and further research is required.

Generally, the species favours inland habitats, including the shores of rivers and lakes, marshes, dry plains and savannas, where preference is shown for sparsely vegetated open flats with a high cover of bare rock (del Hoyo, J. 1996). According to Iqbal *et al.* 2013, Javan Plover feed and breed near dry aquaculture ponds (e.g. on the east coast of Sumatra, the north coast of Java, the south coast of Sulawesi, and Timor-Leste). They have also been recorded breeding on dry saline land in Sape, Sumbawa (Coates & Bishop 2000).

Wonorejo is an Important Bird Area (IBA) (Rombang 1999) of 100 hectares situated on the east coast of Surabaya, on the island of Java, (-7º 18’ 56.5” S, 112º 50’ 19.8” E). It lies along the eastern shore of Surabaya city and is predominantly fish and shrimp ponds managed by traditional farmers. On 15 May 2009 this area was declared a conservation area by sub-district head of Rungkut, headman of Wonorejo and FKPM (*Forum Kemitraan Polisi Masyarakat*) Nirwana Eksekutif and inaugurated by the Mayor of Surabaya. Between 2004 and 2014 Wonorejo experienced a rapid change in land use from an aquacultural to residential area (Rachmatullah 2016), threatening wildlife, especially the Javan Plover.

This study documents the breeding behaviour of the Javan Plover in Wonorejo Fishpond.

METHODS

Observations of Javan Plover breeding behaviour were made between 1st and 30th May 2015 in Wonorejo, Surabaya. A 2 ha area was surveyed regularly once a week for the presence of breeding birds. Once nests were located they were monitored from egg-laying onwards by routine observation every Saturday and Sunday morning, from 07.00 a.m until 17.00 p.m. We recorded the colour of breeding plumage in adults, egg colour, incubation behaviour and post-fledging behaviour.

Adult males and females were separated based on plumage differences. In male Javan Plovers, part of the top of the head is darker than the female, while sections under the eyes are also darker, forming almost a collar, and part of the back of the head is redder and darker.

Figure 1. Observation area of breeding Javan Plover in Wonorejo Fishpond (red line)

RESULTS AND DISCUSSION

Nests were located for 20 nesting pairs. All nests were situated in one fishpond in Wonorejo (Figure 1). Nests were either in the middle of a dry to slightly muddy pond (12) or situated on bare pond embankments (8), that were rarely passed by people. Javan Plovers have previously been recorded nesting in dry coastal and inland habitats, including the shores of rivers and lakes, marshes, dry plains and savannas; and frequently areas dominated by fish and shrimp ponds (del Hoyo, J. 1996; Coates & Bishop 2000, Iqbal *et al*. 2011; Tebb *et al.* 2008; Trainor 2011; Iqbal *et al*. 2013).

Both the males and females prepared the selected nesting site, usually a small cavity dug to a depth of around 4 cm (Figure 2), and lined with shells of mud snails (*Certhidea cingulata*). In another observation in October 2014, at Wonorejo Surabaya, we found Javan Plover nests on the middle of *pematang tambak* and another open area. At both sites, there are similarities in the nests’ locations in that all of the nests are far from areas of human activity (between 3 to 5 km).

Egg Morphology

Typically, four eggs were laid (from centre to the edge). They were light beige in colour, with numerous very irregular black marking (resembling hieroglyphic characters) covering the eggs, and mixed with greyish tint. This is similar to previous descriptions from the Java Island with isabelline to dark olive cream in colour with

Figure 2. Javan Plover's nest and eggs

numerous very irregular black or almost black markings, often mixed with a grayish or sepia tint (Hellebrekers & Hoogerwerf 1967). Javan Plover's eggs colour camouflage them in salt scold, with the lightest colour of sandy brown matching that of the surrounding earth. Eggs were an average 23 mm in width and 40 mm in length.

Both parents took turns sitting on the eggs for an incubation period lasting between 21 and 23 days, often moistening their underparts with water before settling on the eggs, presumably as a means to keep them cool in the heat. This time was shorter than the incubation period for Kentish Plover's Egg which is 24-25 days (Székely *et al* 2008). Once hatched, fledglings are precocious and nidifugous, being immediately able to walk and move from the nest, and to forage for food, but remain accompanied by their parents for a period of up to three months.

During incubation and post-fledging, both parents are extremely territorial, protecting the area from others. Typically, if the parents detect danger, the chicks will stay motionless and quiet while the parents communicate with them. When a predator observed the chicks more closely, the parents started to perform apparent distraction behaviour, bobbing its head, moving away from us, while repeatedly calling with a single, soft rising note "tu-wit". This behaviour has previously been recorded (Taufiqurrahman and Subekti 2013). Besides protecting from human, the parents also protect the chick from other birds, even if those birds are larger in size. We observed birds like Long-tailed Shrike (*Lanius schach*), Slender-billed Crow (*Corvus enca*) and also the Small Asian Mongoose (*Herpestes javanicus*) predating chicks and the eggs.

Conservation Status

There are no data for population trends in the Javan Plover, but it is believed in decline owing to disturbance, particularly when nesting (Birdlife International 2016). In the field it is evident that their breeding habitat is very disturbed at Wonorejo IBA. Since 2009 ongoing development of a housing complex next to the Wonorejo IBA has been eroding and restricting habitat quality for Javan Plover and other birds at this site. Workers at the fishpond help to maintain the Javan Plover habitat, but this doesn't negate the growing threat from development. Local government has to be wise to remove these problems, and work with the local birding club to protect the habitat at the Wonorejo IBA for the Javan Plover and others birds.

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CHICK BROODING BY WHITE-HEADED STILTS *HIMANTOPUS LEUCOCEPHALUS*

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During nesting season, breeding birds develop a patch of featherless skin on the abdomen (brood patch), in which blood vessels on the surface enable heat transfer. Its role in egg incubation has been well-studied (Cooper & Voss 2013; Carter *et al.* 2014; Hill *et al.* 2014; Deeming & Reynolds 2015; Barrionuevo & Frere 2016). Shorebirds are also known to use their brood patches for brooding chicks during cooler temperatures and inclement weather (Colwell 2010). In this note, we present observations that suggest the use of brood patches by White-headed Stilts *Himantopus leucocephalus* for their chicks in southern Sydney.

The White-headed Stilt was rare in the Sydney area prior to the 1900's (Hindwood & Hoskin 1954), however breeding has been recorded regularly since the 1950's (Morris *et al.* 1981). Between April 1990 and April 1998, 46 observation sessions focussed on White-headed Stilts were conducted on various wetlands in southern Sydney on an *ad hoc* basis. Generally, stilts observed were in numbers of between two to 20 individuals (breeding individuals in 40% of observations). Observation sessions lasted between 30 to 90 minutes and were carried out at all times of the day. The observations presented here were recorded on a sand-mining site on the Kurnell Peninsula. There was no vegetation at the site and the stilts had nested on the excavated mud on the side of the sand-mining pool.

On 15 December 1991, a lone surviving chick that was only a few days old was observed. A parent bird squatted down as the chick swiftly approached. The chick pressed itself into the abdomen of the adult until only its legs were projecting out of the adult's feathers (Fig. 1), appearing to stand on tiptoe. The chick remained in this position for about 1 min, withdrawing momentarily before taking refuge again for 7 min.

On 22 December 1991, a similar-sized chick was located near an adult. The chick immersed itself in a parent bird's abdomen feathers. At first, the chick leaned forward, then straightened itself. The chick remained in this position for 9 mins. Its feet were completely off the ground. The chick withdrew and fed itself for about 10 mins before returning to the parent bird. The adult squatted down to allow the chick to immerse in the abdomen feathers again. The chick remained for 12 mins, with the adult maintaining the squatting position the entire time. The chick then foraged behind the adult for 7 min, but returned after the adult squatted down again and stayed immersed for 10 mins. Initially, the chick's feet both touched the ground, but for the most of the time, the chick stood on one foot.

Previous studies show that chick rearing in White-headed Stilts (Marchant & Higgins 1993) and Black-winged Stilts (*Himantopus himantopus*) (Cuervo 2003) is carried out by both male and female partners. Other authors have described brooding of the chicks in the Black-winged Stilt (Hamilton 1975; Pierce 1982; Kitagawa 1988; Cuervo 2003) and other members of the family Recurvirostridae (Makkink 1936; Gilliard 1958; Pedler *et al.* 2016). To our knowledge, chicks immersing into the abdomen feathers of the adults have not previously been described in this detail. This behaviour appears to be a means of maximising the chick's exposure to the brooding patch of the adult. Similar observations to ours have been recorded in Hong Kong (Y. Sim, pers. comm.).

Hamilton (1975) commented that chicks within their first week could be difficult to locate, as we found in our observations. Chicks are generally not found near the nest after more than one day of hatching (Hamilton 1975). Young chicks were scarce in our observations, even when visits coincided with the time of year that chicks had hatched and / or visits were just days after stilts were seen on nests. The lack of vegetation at the sand-mining site was advantageous for locating chicks and observing behaviour.

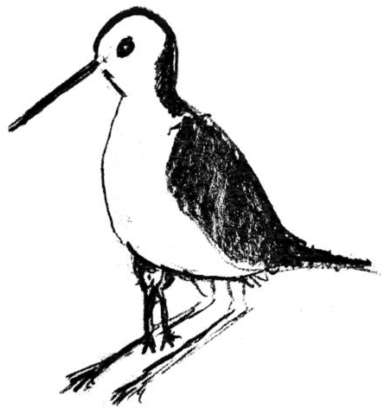

Figure 1. Sketch depicting a White-headed Stilt *Himantopus leucocephalus* chick nestled in the abdomen of an adult, such that only the legs were visible. Illustration: D.R. Waterhouse.

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UNUSUAL INLAND OCCURRENCE OF VARIABLE OYSTERCATCHER *HAEMATOPUS UNICOLOR*

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INTRODUCTION

The Variable Oystercatcher *Haematopus unicolor* is one of three oystercatcher taxa endemic to New Zealand (Gill *et al.* 2010). It is generally restricted to coastal environments where it occurs in low densities along open shorelines and in estuaries (Marchant & Higgins 1993; Dowding & Moore 2006; Robertson *et al*. 2007). Unlike its much more abundant congener, the South Island Pied Oystercatcher *H. finschi*, which occurs from sea coasts to inland mountain valleys (Heather & Robertson 1996), the only documented regular occurrence of Variable Oystercatcher away from the coast is on the shores of a few brackish lakes and lagoons. These include Lake Wairarapa in the southern North Island where they occur up to 30 km inland (Marchant & Higgins 1993; Heather & Robertson 1996), and Lakes Forsyth and Ellesmere in the eastern South Island where they occur inland up to 8 km and 14 km respectively (AC, NM unpubl. data). Variable Oystercatchers also occasionally forage and sometimes nest on the wide shingle riverbeds of braided rivers a short distance upstream of the sea (Dowding 2013).

In autumn-winter and following periods of prolonged rain at other times of the year, Variable Oystercatchers readily feed on coastal grasslands, particularly parkland, playing fields, golf courses and short grazing pasture (Crossland 1993; Dowding 2014). This behaviour seems to have become more prevalent since the 1980s (Crossland 2001), however birds are seldom reported far from the coast (Robertson *et al.* 2007). In this note we summarise recent observations of Variable Oystercatchers occurring much further inland on terrestrial (i.e. non lake shore) habitats than has hitherto been documented. All observations are from the Westland District of the South Island, an area that is predominantly covered with indigenous forest with farmland in river valleys and in coastal lowlands (Nathan 2015).

OBSERVATIONS

On 28 November 2006 we observed a group of five Variable Oystercatchers feeding on short grassy farmland in the Mahitahi Valley (43°39' S, 169°34' E) near Bruce Bay, South Westland. These birds were 6.6 km from the sea, about half way up the farmed (pasture) part of this narrow river valley.

On 8 November 2011 we made further observations of inland feeding Variable Oystercatchers: We found two birds on farmland at Fergusons (42°58' S, 170°43' E), 4.7 km inland, and two birds on farmland in the Karangarua River valley (43°34' S, 169°48' E). This latter location is 9.5 km from the sea in a straight line over forested hills but the more likely flight line would be a distance of 11.7 km following the course of the Karangarua River. During the period 2003 to 2009 we also occasionally observed Variable Oystercatchers on farmland at locations up to 19 km inland in the vicinity of Whataroa (43°15' S, 170°21' E) and near Harihari (43°08' S, 170°33' E). Precise dates were not recorded but observations were made in spring, summer and autumn. All these sites can be characterised as pasture in river valleys grazed by cattle, sheep and deer.

On 4 May 2015 we visited the Kokatahi Plain, inland from the town of Hokitika, and separated from the sea by a range of hills. While conducting an extensive search for a group of vagrant Plumed Whistling Ducks *Dendrocygna eytoni* reported in the area, we covered every back road in the locality and discovered a mixed wader flock comprising 13 Variable Oystercatchers (Figures 1 & 2), three South Island Pied Oystercatchers and several Masked Lapwing *Vanellus miles* feeding on farmland

Figure 1. Variable Oystercatchers feeding over pasture, Kokatahi Plain on 4 May 2015 (A. Crossland).

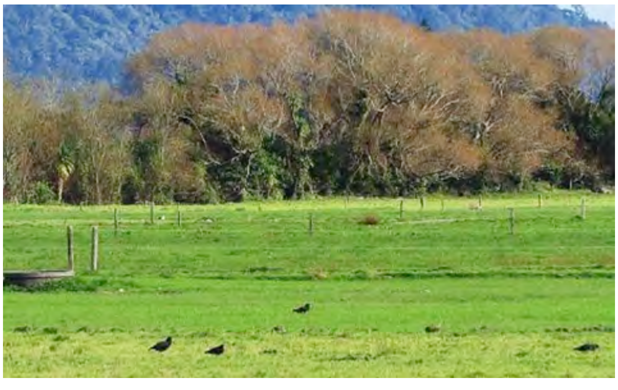

Figure 2. Part of flock of 13 Variable Oystercatchers on farmland at Kokatahi Plain, 4 May 2015. The nearest sea coast is 16.5 km north-west over the forested hills in the background (A Crossland).

adjacent to Bladier Road (42°52' S, 171°03' E). The Variable Oystercatcher party comprised mainly adults with at least two juveniles. This location in the mid part of the plain was 16.5 km from the sea over forested hills and approximately 21 km from the sea along a possible flight line following the Hokitika and Kokatahi Rivers (Figure 2). Similar observations over this time period have been reported to us by other observers, including Variable Oystercatchers on a dairy farm *c.*10 km inland near the Kakapotahi River (43°02' S, 170°42' E) (I. Southey pers. comm.), on farmland *c.*10 km inland near the Whataroa River (43°09' S, 170°22' E), and *c.*15 km inland in the Waitaha Valley (43°04' S, 170°43' E) (J. McCoy pers. comm.). Most recently, a pair of Variable Oystercatchers was sighted on the Waitaha riverbed, *c.*16 km from the coast on 16 July 2016 (J. McCoy pers. comm.).

DISCUSSION

Our inland observations of Variable Oystercatchers in the Westland District have been at straight line distances of between 4.7 and 19 km from the sea, with the longest likely flight line, if following a river course, being at least 21 km. These birds were all found much further inland than is normal for the species elsewhere in its range. Recent records of colour-banded Variable Oystercatchers moving between the Nelson and Kaikoura districts in the northern South Island could potentially involve birds flying much further inland. However, the straight-line distance of 130 km and the necessity to fly over mountains up to 2000 m a.s.l. make this unlikely. Current evidence is that these birds are following a much longer route around the entire coastline of the north-eastern South Island (D. Melville & L. Rowe pers. comm.). All the sites where we observed birds were characterised by being flat land, comprising short-sward pasture grazed by livestock and located on strips of farmland occupying the floors of river valleys. Others have seen birds feeding on stony riverbeds in these valleys. This series of observations, although small, may indicate a reasonably regular behaviour and not simply a coincidence of rare events.

We suggest two reasons why Variable Oystercatchers seem to have expanded their habitat preferences and now occur well away from the sea in the Westland District. Firstly, the coastline in this part of the South Island is very rugged, fully exposed to the high energy wave environments of the Tasman Sea and estuarine habitats are very limited. With very high annual rainfalls – up to 10,000 mm yr^{-1} in their mountain catchments (Nathan 2015) – rivers frequently flood. Fine sediments in river mouth lagoons are regularly flushed, meaning that typical wader food resources like shellfish, molluscs and crabs are not present (Crossland unpubl. data). These food resources are also absent or of limited abundance in most coastal lagoons due to the environmental stress of alternate periods (sometimes lasting years) of freshwater or tidal dominance, dependant on whether a lagoon is open or closed to ingress from the sea (MacPhearson 1981; Kain & Hart 2009). Additionally, increasing storm severity due to climate change (Renwick *et al*. 2016) may also make foraging in traditional coastal habitats more difficult and may force birds to utilise inland short grassland habitats. We speculate that some Variable Oystercatchers have begun to favour the wet grassland habitats within the river valleys with an abundance of earthworms and terrestrial invertebrates over the rocky and sandy shoreline habitats of the sea coast. However, the trigger for this change in behaviour needs further investigation.

The second reason why some Variable Oystercatchers appear to have moved inland may be related to the abundance of suitable breeding habitat to be found on inland riverbeds. The wide braided river beds of the Westland District offer expansive open shingle breeding habitat for waders and Variable Oystercatchers now nesting on some of these rivers. Observations on the Kakapotahi River 10+ km inland (I. Southey pers. comm.) and Whataroa River 15+ km inland (J. McCoy pers. comm.) confirm that breeding takes place at these locations. In addition, we found a pair of Variable Oystercatcher with a nest on the Haast Riverbed, 500 m above the river mouth lagoon (43°50' S, 169°02' E) in November 2003. Unlike parts of the eastern South Island where seven wader species breed on braided rivers, often in quite high densities (AC unpubl. data), just four species breed locally on rivers in the Westland District – South Island Pied Oystercatcher, White-headed Stilt *Himantopus leucocephalus,* Masked Lapwing and Double-banded Plover *Charadrius bicinctus* (Dowding & Moore 2006). Breeding densities of these species appear to be comparatively low (AC unpubl. data). As a larger and heavier species which aggressively defends its breeding territory, the Variable Oystercatcher would face little challenge from other waders if it were to colonise braided river beds in Westland. We encourage other observers to continue to monitor the inland occurrence of this species and to document breeding activity on river beds and potentially also on farmland. It will be interesting to see if the Variable Oystercatcher does indeed establish itself as an inland resident, or if our observations are simply records of aberrant behaviour of a few isolated pairs and groups of birds? It will also be interesting to see if the overlap in the local breeding distribution of Variable Oystercatcher and South Island Oystercatcher results in inter-breeding between these two taxa? This has already occurred in the Canterbury region of the eastern South Island where the expansion of the South Island Oystercatcher's breeding dispersion on to beaches has resulted in widespread interbreeding and hybridisation within the area where the two species occur together (Crocker *et al*. 2010).

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NORTH-WEST AUSTRALIA WADER & TERN EXPEDITION 2016 REPORT SATURDAY 6TH FEBRUARY TO SUNDAY 28TH FEBRUARY 2016

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INTRODUCTION

This truly was the 'best ever' NWA Expedition! This description has been used frequently in the winding up session on the last evening of many previous Expeditions. But all NWA 2016 participants, including the old-hands, agreed that the success and enjoyment this year surpassed all previous levels.

Everything went right. We achieved, or overachieved, on all of our objectives. We started our nine days of catching at 80 Mile Beach with the biggest catch there (535) instead of the intended small 'running-in the team' catch (Table 1). We quite quickly compiled reasonable samples of the main species and were able to progressively target 'special' species i.e. those species which we catch less frequently or with more difficulty. We made a successful catch on each day – in fact two catches, in quick succession, on one day when the first net fired produced a smaller catch than we wanted. Overall the 2409 birds caught at 80 Mile Beach was a record for that part of a NWA Expedition (Table 2).

After a welcome interlude of three days, when tides were too low for catching, we continued at Roebuck Bay, Broome, in the same vein. Again, the first catch was the largest (719) (Table 1). We caught on each day and on one day we made two catches. We had decided to target Greenshank, couldn't decide on the optimum location, and so divided the team into two. Both teams successfully caught Greenshank! Other targeted species on which we were successful were Grey Plover, Eastern Curlew, Ruddy Turnstone, Black-tailed Godwit and Pied Oystercatcher. Five satellite transmitters were deployed on the Grey Plovers. The total of 1894 birds caught in the period at Broome has only been bettered once in the past on a 'Broome section' of an Expedition. Naturally, therefore, the grand total of birds caught (4303) was a record (Table 2).

These results were obtained with a team which was slightly larger than in other recent years. A total of 32 individuals were involved, with a maximum team size of 29. Because of the strong work ethic, the experience and the personalities of those involved, the larger team did not prove to be unwieldly and in fact significantly helped create the above-average catching success.

Another feature of the NWA 2016 Expedition was the unprecedented dry, hot weather which we experienced throughout February – the month which is supposed to be the height of the wet season in northern Australia. No rain fell during any of our cannon netting activities.

For the second consecutive year we coincided with a massive congregation of Oriental Pratincoles on part of 80 Mile Beach. On 10 February there were estimated to be up to 600,000 Oriental Pratincoles roosting on the beach during the middle of the day between 20 km and 42 km south of Anna Plains Station. Other sections of the beach were not visited or counted in detail but certainly held large numbers of Oriental Pratincole also. At 42 km south of Anna Plains Station, for example, the huge numbers roosting on the beach appeared to continue on southwards as far as the eye could see. This is the fourth occasion in the last 12 years when we have encountered massive numbers of Oriental Pratincoles at 80 Mile Beach in February. It is not clear whether this has occurred by chance or whether this number of birds occurs in most years. It appears that the frequency of visitations by such numbers may be increasing.

MAIN ACHIEVEMENTS

Catching

Small-mesh cannon nets (with three cannons on each net) were used throughout the Expedition this year. Also, the keeping cages and the shade-cloth covering were erected at the same time as the nets were set at each catch location. This combination facilitated rapid emptying of the nets, into carrying boxes, after they had been fired and the rapid decanting of the birds into cool keeping cages. The covering of birds with shade-cloth immediately after firing was discontinued in order to speed-up the net emptying process and also because it tended to increase the temperature to which the birds in the net were subjected. On very hot days shade-cloth was temporarily held a metre or so above the ground, over the birds in the net, whilst extraction took place. On three occasions when the catch was considered too large to comfortably handle expeditiously in the hot conditions some unbanded birds (mostly Great Knot) were released directly from the net – a total of 300+ during the Expedition. As a result, no overheating of birds occurred at any time.

As already mentioned, catching success was 100%. Much more time than usual during an

Expedition was able to be devoted to targeting less-frequently caught species because we had obtained a satisfactory quota (for percentage juvenile estimates / survival rate analyses) early in the period at each location. With the numbers of Bar-tailed Godwit on the shores of 80 Mile Beach much reduced these days we even had to specially target this species, on two occasions, to obtain a satisfactory total. White-winged Black Terns (23) were a successful target on 10 February, Oriental Pratincole (89) on 11 February and Oriental Plover (15) on 12 February. Because the Oriental Pratincoles spread themselves out quite widely on the beach we actually fired two nets simultaneously on that occasion – something we rarely do in NWA. In contrast, our only 'failure' on 80 Mile Beach was Red Knot. For the first time ever there were almost no Red Knot on the mudflats or beaches north of 40 km south of the Anna Plains entrance or on the 20 km of beach north of the entrance. The comprehensive count of the beach in November 2015 had encountered all the Knots at 45 – 50 Kilometres south of Anna Plains – an area we do not normally visit due to logistical problems of driving on the soft sand on the beach in that region.

The Broome part of the Expedition also got off to an excellent start with an amazing 208 Curlew Sandpipers in the first catch, together also with 60 Red Knot and 17 Broad-billed Sandpiper. Successive targeted catches produced 14 Grey Plover on 21 February, 43 Eastern Curlew on 22 February, 77 Ruddy Turnstone on 23 February, 88 Black-tailed Godwit on 24 February, 49 Greenshank on 26 February and nine Pied Oystercatcher on 27 February. All of course were mixed with a good collection of other waders including especially Great Knot, Greater Sand Plover and Red-necked Stint.

The average cannon net catch was 240, markedly above the normal average of around 200 birds. Top species overall were 1642 Great Knot, 523 Greater Sand Plover, 487 Red-necked Stint and 380 Grey-tailed Tattler (Table 3).

A notable omission this year was that no Asian Dowitchers were caught. Terns were generally scarce at 80 Mile Beach and in Roebuck Bay. There was no real opportunity to target terns except on one occasion at 80 Mile Beach when White-winged Black Terns were concentrated in quite large numbers at high tide on the beach. A total of 40 were caught. Flocks of many hundreds together were regularly seen feeding over the Plains, which is the first time for two or three years, but numbers did not reach anywhere near the tens of thousands which occurred in 2011.

Recaptures and Controls

There were 461 wader retraps altogether (10.8%) (Table 3). However, as usual, the retrap rates were markedly different between the two catching locations – 19.2% at Broome compared to only 4.1% at 80 Mile Beach. This difference in retrap rates is because wader catching is carried out much less frequently at 80 Mile Beach and also because there are much larger total wader populations there than at Roebuck Bay.

Table 1: NWA 2016 Expedition catch totals

Catches	Location	Sub-site	New	Retrap	Total
8/02/2016	80 Mile Beach	6.5 km south of AP	508	27	535
9/02/2016	80 Mile Beach	23 km south AP	258	3	261
10/02/2016	80 Mile Beach	23 km south of AP	208	7	215
11/02/2016	80 Mile Beach	40 km south of AP	105	0	105
12/02/2016	80 Mile Beach	41 km south of AP	316	16	332
13/02/2016	80 Mile Beach	40 km south of AP	410	22	432
14/02/2016	80 Mile Beach	23 km south of AP	173	7	180
15/02/2016	80 Mile Beach	7.5 km south of AP	169	9	178
16/02/2016	80 Mile Beach	3 km south of AP	125	5	130
Sub-total			***2272***	***96***	***2368***
Terns			40	1	41
Total Anna Plains			***2312***	***97***	***2409***
20/02/2016	Broome	Wader Beach	583	136	719
21/02/2016	Broome	Stilt Viewing	88	11	99
22/02/2016	Broome	Minton Straight	40	4	44
23/02/2016	Broome	West Quarry	234	111	345
24/02/2016	Broome	Minton Straight	193	35	228
25/02/2016	Broome	Wader Beach	275	60	335
26/02/2016	Broome	West Quarry	29	0	29
26/02/2016	Broome	Greenshank Corner	78	8	86
27/02/2016	Broome	Nicks Beach	9	0	9
Total Broome			***1529***	***365***	***1894***
Total Waders			3801	461	4262
Total Terns			40	1	41
Total Waders and Terns			3841	462	4303

We were fortunate to recapture 13 birds carrying bands from overseas. Eleven of these were Great Knot from China, one was a Grey-tailed Tattler from Japan and another was a Red-necked Stint from Russia (Table 4). We still await banding information on these birds. We were also pleased to recapture a Curlew Sandpiper originally banded as a juvenile at Yanerbie in South Australia in November 2013. This bird has presumably changed its non-breeding area.

Four of the eleven Great Knot from China unfortunately had unreadable metal bands due to wear and corrosion. Fortunately, the Chinese have subsequently switched to stainless steel bands which are much more durable, in place of the easily degraded aluminium alloy bands.

Old Birds

We again had a good crop (26) of old birds (15 years or more) of a wide variety of species (10) (Table 5). This year the oldest bird, at 23 years, was a Bar-tailed Godwit. Surprisingly a 22-year-old Black-winged Stilt was the next oldest. Other notable old birds were Greater Sand Plover (21), Curlew Sandpiper (19), Eastern Curlew (18+ and 17) and Black-tailed Godwit (15+).

Surprisingly, given the much lower recapture rate, ten of the 26 old retraps were recaptured at 80 Mile Beach.

Table 2: Comparison of Catches between the 2006-2016 expeditions (including terns)

Catches	Year	New	Retrap	Total
Broome (1st period)	2006	857	174	1031
	2007	985	223	1208
	2008	807	184	991
	2009	1374	208	1582
	2011	6	3	9
	2012	48	27	75
	2013	168	80	248
	2014	1229	565	1794
	2015	623	288	911
	2016	***1529***	***365***	***1894***
80 Mile Beach	2006	1619	55	1674
	2007	1690	95	1785
	2008	1215	62	1277
	2009	604	28	632
	2011	1878	47	1925
	2012	1749	84	1833
	2013	1701	72	1773
	2014	1928	108	2036
	2015	1152	46	1198
	2016	***2312***	***97***	***2409***
Broome (2nd period)	2006	1120	176	1296
	2007	861	192	1053
	2008	567	88	655
	2009	1172	296	2068
	2011	1072	484	1556
	2012	1093	383	1476
	2013	741	398	1139
	2014		No 2nd period	
	2015		No 2nd period	
	2016		No 2nd period	
TOTAL	2006	3596	405	4001
	2007	3536	510	4046
	2008	2589	334	2923
	2009	3150	532	4282
	2011	2956	534	3490
	2012	2890	494	3384
	2013	2610	550	3160
	2014	3157	675	3830
	2015	1775	334	2109
	2016	3841	462	4303

Table 3: NWA 2016 Expedition - Wader and Tern catch details

Species	New	Retrap	Total	(juv)
Bar-tailed Godwit	184	10	194	20
Black-tailed Godwit	88	6	94	8
Black-winged Stilt	7	3	10	0
Broad-billed Sandpiper	27	3	30	13
Common Greenshank	52	0	52	4
Curlew Sandpiper	236	45	281	2
Eastern Curlew	42	3	45	5
Great Knot	1466	176	1642	93
Greater Sand Plover	463	60	523	55
Grey Plover	18	0	18	1
Grey-tailed Tattler	324	56	380	33
Lesser Sand Plover	6	1	7	2
Little Curlew	4	0	4	1
Marsh Sandpiper	1	0	1	0
Oriental Plover	32	0	32	14
Oriental Pratincole	92	0	92	24
Pied Oystercatcher	9	0	9	4
Red Knot	88	21	109	3
Red-capped Plover	25	0	25	7
Red-necked Stint	436	51	487	54
Ruddy Turnstone	61	23	84	2
Sanderling	7	0	7	0
Terek Sandpiper	128	3	131	12
Whimbrel	5	0	5	1
Sub-total	3801	461	4262	358
Gull-billed Tern	1	0	1	0
White-winged Black Tern	39	1	40	2
Sub-Total	40	1	41	2
TOTAL	3841	462	4303	360

Table 4: NWA 2016 controls (recaptures of birds banded elsewhere)

Species	Country of origin	Band number	Age at recapture	Recapture Date	Recapture location	Flags	Australian Replacement Band
Curlew Sandpiper	South Australia	042-29860	3+	20/02/16	Roebuck Bay, Broome	O/Y, O=AO	
Great Knot	China	F131250	2+	08/02/16	Shores of 80 Mile Beach	Bk/W, W=A48	
Great Knot	China	F127152	2+	08/02/16	Shores of 80 Mile Beach	Bk/W	
Great Knot	China	?	2+	08/02/16	Shores of 80 Mile Beach	Bk/W	062-26006
Great Knot	China	05·522	2+	12/02/16	Shores of 80 Mile Beach	W/Bk	063-26200
Great Knot	China	?	2+	12/02/16	Shores of 80 Mile Beach	W/Bk	063-26199
Great Knot	China	F127156	2+	13/02/16	Shores of 80 Mile Beach	Bk/W	
Great Knot	China	F131640	3+	13/02/16	Shores of 80 Mile Beach	Bk/W, W=L03	
Great Knot	China	F132771	3+	13/02/16	Shores of 80 Mile Beach	Bk/W, W=J43	
Great Knot	China	F131200	3+	24/02/16	Roebuck Bay, Broome	Bk/W, W=A97	
Great Knot	China	F132658	3+	25/02/16	Roebuck Bay, Broome	Bk/W, W=H78	
Grey-tailed Tattler	Japan	5A20537	2+	08/02/16	Shores of 80 Mile Beach	B/W B=J3	
Red-necked Stint	Russia	KS36966	2+	14/02/16	Shores of 80 Mile Beach	Y added	

* Banded as age 1, 17/11/13. Yanerbie, South Australia.

Proportion of Juveniles

The 2015 wader breeding season in Siberia appears to have been disastrous, with the overall proportions of juveniles recorded for most species being the lowest ever (Table 6). Data on the proportion of juveniles in catches in the non-breeding season (defined as November – February) has been systematically recorded for the past 19 years in North West Australia (Table 7). The 2015/16 counts, reflecting the outcome of the 2015 Siberian breeding season, were the lowest ever recorded for Curlew Sandpiper and Grey-tailed Tattler. Even for Greater Sand Plover there has only been one worse breeding season. There have only been two previous worse seasons for Red Knot and Terek Sandpiper and three for Red-necked Stint.

The high-Arctic breeding species had the worst performance of all (Curlew Sandpiper, Red Knot and Ruddy Turnstone). Bar-tailed Godwit was an exception, being the only Arctic species to record average breeding success

Table 5: Oldest recaptures during NWA 2016

SPECIES	BAND	DATE BANDED	BANDING LOCATION	AGE AT BANDING	RETRAP DATE	RETRAP LOCATION	MINIMUM AGE AT RETRAP
Bar-tailed Godwit	072-33180	12/03/1994	80 Mile Beach	1	16/02/2016	80 Mile Beach (3km S)	23
Great Knot	062-33249	3/04/1996	80 Mile Beach	2+	13/02/2016	80 Mile Beach (40km S)	22+
Black Winged Stilt	072-55113	28/05/1994	Broome	1	21/02/2016	Broome (Stilt Viewing)	22
Greater Sand Plover	051-85866	23/03/1996	Broome	1	25/02/2016	Broome (Wader Beach)	21
Great Knot	062-33838	21/08/1998	80 Mile Beach	3+	13/02/2016	80 Mile Beach (40km S)	20+
Greater Sand Plover	062-44070	7/09/1998	80 Mile Beach	3+	14/02/2016	80 Mile Beach (25km S)	20+
Great Knot	062-43023	25/08/1998	80 Mile Beach	2+	13/02/2016	80 Mile Beach (40km S)	19+
Greater Sand Plover	051-90539	3/05/1998	Broome	1	20/02/2016	Broome (Wader Beach)	19
Curlew Sandpiper	041-92766	12/08/1998	Broome	2	20/02/2016	Broome (Wader Beach)	19
Great Knot	062-71995	21/10/2001	80 Mile Beach	3+	13/02/2016	80 Mile Beach (40km S)	18+
Eastern Curlew	091-24367	29/10/2001	Broome	3+	22/02/2016	Broome (Minton's Straight)	18+
Great Knot	062-56631	18/07/1999	Broome	1	13/02/2016	80 Mile Beach (40km S)	18
Great Knot	062-58732	1/01/2001	Broome	2+	25/02/2016	Broome (Wader Beach)	17+
Bar-tailed Godwit	072-79853	1/01/2001	Broome	2+	21/02/2016	Broome (Stilt Viewing)	17
Bar-tailed Godwit	072-79517	15/05/2000	Broome	1	21/02/2016	Broome (Stilt Viewing)	17
Grey Tailed Tattler	062-58505	2/06/2000	Broome	1	26/02/2016	Broome (Greenshank Corner)	17
Eastern Curlew	091-20664	15/05/200	Broome	1	22/02/2016	Broome (Minton's Straight)	17
Grey Tailed Tattler	062-76165	23/11/2002	80 Mile Beach	3+	10/02/2016	80 Mile Beach (28km S)	16+
Eastern Curlew	091-24380	18/11/2002	Broome	2+	22/02/2016	Broome (Minton's Straight)	16+
Great Knot	062-75779	11/05/2002	80 Mile Beach	2+	10/02/2016	80 Mile Beach (28km S)	16+
Grey Tailed Tattler	052-71950	1/10/2001	80 Mile Beach	2	14/02/2016	80 Mile Beach (25km S)	16
Great Knot	062-57836	31/05/2000	80 Mile Beach	1	12/02/2016	80 Mile Beach (41km S)	16
Great Knot	062-74984	18/11/2002	Broome	2+	20/02/2016	Broome (Wader Beach)	15+
Black-tailed Godwit	072-81988	18/11/2002	Broome	2+	24/02/2016	Broome (Minton's Straight)	15+
Great Knot	062-75782	23/06/2002	Broome	1	13/02/2016	80 Mile Beach (40km S)	15
Great Knot	062-76553	3/07/2003	Broome	2+	20/02/2016	Broome (Wader Beach)	15

Table 6: Percentage juveniles in cannon net catches during NWA 2016. No. Juv. = number of juveniles, % Juv. = Percentage juveniles in total catch, Mean % Juv. = Mean percentage juveniles 1998/99-2014/15

Species	Total Catch	No. Juv.	% Juv.	Mean % Juv.	2015 breeding success
Monitored annually					
Great Knot	1642	93	5.7%	11.6%	Poor
Greater Sand Plover	523	55	10.5%	23.4%	Poor
Red-necked stint	487	54	11.1%	20.1%	Poor
Grey-tailed Tattler	380	34	8.9%	13.7%	Poor
Curlew Sandpiper	281	2	0.7%	17.6%	Very Poor
Bar-tailed Godwit	194	20	10.3%	10.8%	Average
Terek Sandpiper	131	12	9.2%	13.6%	Below average
Red Knot	109	3	2.7%	16.9%	Very poor
Ruddy Turnstone	84	1	1.2%	N/A	Very poor
Monitored in 2015/16					
Black-tailed Godwit	94	8	8.5%	N/A	Below average
Oriental Pratincole	92	24	26.0%	N/A	Average
Common Greenshank	52	4	7.7%	N/A	Below average
Eastern Curlew	45	5	11.1%	N/A	Good
Oriental Plover	32	14	44.0%	N/A	Very good
Broad-billed Sandpiper	30	15	50.0%	N/A	Very good
Grey Plover	18	1	7.1%	N/A	Below average

The only species which had a good breeding outcome in 2015 were Broad-billed Sandpiper (50% juveniles), Oriental Plover (44% juveniles) and Eastern Curlew (11.1% juveniles). Although Eastern Curlew are not regularly sampled the proportion of juveniles in all previous NWA (and South East Australia – VWSG) Eastern Curlew catches has been very low – usually less than 5%. For such a large long-lived wader 11.1% juveniles indicates an excellent breeding season for this southerly nesting species in 2015.

Whatever combination of adverse weather conditions, high predation rate etc. may have caused 2015 to be a poor breeding season for migratory waders from the northern hemisphere the effect seems to have occurred across a very wide geographical range.

Overall, for the eight species where the percentage juveniles are monitored annually in NWA, two breeding outcomes in 2015 were classed as 'very poor', four as 'poor', one as 'below average' and just one as 'average'. None were classed into any category above average. It was undoubtedly the worst breeding season which we have yet recorded for migratory wader populations which spend the non-breeding season in North West Australia.

Satellite Transmitters

Five satellite transmitters were deployed on Grey Plover. These were 5 g Microwave Telemetry units, as deployed on Little Curlew in the previous two years at Broome / 80 Mile Beach. Units were again mounted on the birds' back held in position by leg-loop harnesses and with the aerial projecting past the tail. This year, however, a plastic tray, to deflect feathers from obscuring the solar-powered battery, was not used. The units were deployed in Roebuck Bay, close to Crab Creek and just two kilometres to the east of Broome Bird Observatory.

Download transmissions occur every 2.5 days. One transmitter unfortunately stopped sending out signals a few days after deployment. Of the other four birds, three migrated non-stop 5000 kilometres to the Chinese coast in April. The fourth almost made it to China, but the signal ceased when it was still 200 kilometres from the southern China coast. Unfortunately, a transmitter on a third bird also ceased a week after it reached the Guangdong Province. As of 4 May the other two birds were still on the Chinese coast, having moved up into the Yellow Sea. We pray that the transmitters on these continue to send out signals for at least long enough for us to be able to detect where the breeding grounds of our Grey Plovers are and what route is used to get there from their Yellow Sea stopover.

The progress of these birds can be followed through postings on Birdlife Australia's special Migratory Shorebirds Website:
http://birdlife.org.au/campaigns/the-marvel-of-migration

We are disappointed, and perplexed, to have yet again encountered these premature 'failures' of birds carrying satellite transmitters. The same baffling occurrences were apparent in April 2015 on the six Little Curlew which were at that time carrying transmitters. Most satellite transmissions ceased when birds were at the end of a long migratory flight or soon after they had reached their destination. We consider the most likely explanation is that birds became so thin, due to the consumption of their fat reserves during the migratory flight, that the satellite transmitters became loose and were able to be shed by birds. We will be investigating alternative attachment methods for future satellite transmitters (and for the projected ICARUS tracking units).

Flag Sightings

Scanning of foraging and roosting waders for engraved leg flags and colour bands occurred with good results on 80 Mile Beach, where there were opportunities to scan from cars a few kilometres either side of the nets as well as from the hide in front of the catch area, while waiting for birds to move in with the rising tide. Scanning results from 80 Mile Beach are particularly useful as the remoteness of the beach limits scanning opportunities to a few times per year. Unfortunately, there were no Red Knot this year in *c.* 50 km of 80 Mile Beach which we visit during Expeditions so we were not able to obtain any colour band / flag sightings for this species this year.

Seventeen Chinese-banded birds were sighted at 80 Mile Beach, as well as a total of 68 locally banded birds from both 80 Mile Beach and Roebuck Bay.

There was one sighting of a Chinese banded bird with an engraved flag at 80 Mile Beach (Black/White K88). It was banded in April 2015 on Chongming Island, Shanghai, aged 2+ at the time of banding.

All birds caught during our time at Roebuck Bay during the Expedition were given engraved flags except for Red-capped Plover and Red-necked Stint which were given plain yellow flags. At 80 Mile Beach engraved flags were also used on most species, excluding Great Knot and Greater Sand Plover and small species such as Red-necked Stint and Red-capped Plover.

'Passerine' Banding

The NWA 2016 Expedition had a good year for 'passerine' banding, especially at Broome Bird Observatory. A total of 134 birds were caught with eight catches at Broome and three at Anna Plains Homestead. Highlights at Broome were five Rainbow Bee-eaters, an Olive-backed Oriole and 22 Rufous-throated Honeyeaters (Table 8). The much smaller catches at Anna Plains included a Pheasant Coucal and five Sacred Kingfishers.

Other Birds

A Kamchatka Leaf-warbler (*Phylloscopus examinandus*) was present at Broome Bird Observatory for most of the period when the Expedition was based there in late February. This species name results from the recent reclassification of 'Arctic Warbler'.

OTHER MATTERS

Participants

The 32 participants came from Australia (18) and six overseas countries (14). The 43% overseas origin is in the same ballpark as most other North West Australia Expeditions. From the 'old-hands' perspective the 40% 'younger generation' content was extremely welcome. This year the youngest participant was a 17-year-old schoolgirl from the UK. Details of origins are given below:18 Australia (9 WA, 4 Vic, 2 NT, 1 Qld, 1 NSW, 1 SA)

4 UK
3 China (mainland)
3 China (Hong Kong)
2 Taiwan
1 Estonia
1 Switzerland

Itinerary

Nine catching days were spent at Anna Plains / 80 Mile Beach and then, later, eight at Roebuck Bay, Broome. These were separated by three days, during which tides were too low for catching. One day was spent birdwatching at Anna Plains, the next in moving the team back to Broome and the third day birdwatching in the Broome area (including Roebuck Plains). This break, in the middle of the Expedition was excellent at rejuvenating the team for catching efforts required in the second half of the Expedition.

Talks

Evening talks were again a feature of the Expedition programme. Fourteen excellent talks were presented and time prevented at least another four prepared presentations being made. Subjects ranged from Little Owls on the Swiss / German / French borders to waders in various parts of the Yellow Sea and in Hong Kong. Other talks covered Sand Martins, Hooded Plover, Penguin Parade (in Victoria), seabirds on Puffin Island (north Wales), wildlife illustration and changes in the NSW environment.

Finances

The final surplus for the NWA 2015 Expedition was $5,525. This was after the Expedition had also made a $5,000 contribution to the cost of the satellite transmitters for Little Curlew. This surplus will be carried forward for subsequent use on NWA Expeditions / fieldwork.

Table 7: Percentage juveniles in N.W. Australia in previous years

Species	Survey Period																		
	98/ 99	99/ 00	00/ 01	01/ 02	02/ 03	03/ 04	04/ 05	05/ 06	06/ 07	07/ 08	08/ 09	09 /10	10/ 11	11/ 12	12/ 13	13/ 14	14/ 15	***Mean (17 yrs)***	15/ 16
Red-necked Stint *Calidris ruficollis*	26	46	17	17	41	10	13	20	21	20	10	17	18	24	14.8	16.5	10.3	*20.1*	11.1
Curlew Sandpiper *C. ferruginea*	9.3	24	11	19	15	7.4	21	37	11	29	10	35	24	1	1.9	25.1	18.5	*17.6*	0.7
Great Knot *C.tenuirostris*	2.4	4.4	18	5.2	17	16	3.2	12	9.2	12	6	41	24	7	6.6	4.0	6.5	*11.6*	5.7
Red Knot *C. canutus*	3.3	14	9.6	5.4	32	3.2	(12)	57	11	23	12	52	16	8	1.5	8.3	13.3	*16.9*	2.7
Bar-tailed Godwit *Limosa lapponica*	2	7.7	4.8	15	13	9	6.7	11	8.5	8	4	28	21	8	7.6	17.0	5.5	*10.8*	10.3
	Non-arctic northern migrants																		
Greater Sand Plover *Charadrius leschenaultii*	25	33	22	13	32	24	21	9.5	21	27	27	35	17	19	28.2	*23.6*	19.9	*23.4*	10.5
Terek Sandpiper *Xenus cinereus*	12	N/A	8.5	12	11	19	14	13	11	13	15	19	25	5	12.3	*15.2*	12.3	*13.6*	9.2
Grey-tailed Tattler *Heteroscelus brevipes*	26	N/A	17	17	9	14	11	15	28	25	38	24	31	20	17.8	*15.8*	19.0	*13.7*	8.9

All birds cannon-netted in the period 1 November to mid-March. Averages (for previous 14 years) exclude figures in brackets (small samples) and exclude 2010/2011 figures

Table 8: Results of mist-netting at Broome Bird Observatory and Anna Plains during the NWA 2016 Expedition

Site	Date	Species	New	Retrap	Total	Comments	Nets
Broome Bird Observatory	6/2/2016 am	Bar-shouldered Dove	2	0	2		
		Brown Honeyeater	3	0	3		
		Magpie Lark	2	0	2		
		Olive-backed Oriole	1	0	1	observed	
		Peaceful Dove	1	0	1		
		Rufous-throated Honeyeater	3	0	3		
		Singing Honeyeater	2	0	2		
		White-gaped Honeyeater	1	0	1		
Anna Plains Station (Homestead)	14/2/2016 am	Sacred Kingfisher	3	0	3		3x15m
		Pheasant Coucal	1	0	1		
	15/2/2016 am	Brown Honeyeater	1	1	2		3x15m
		Yellow-throated Miner	1	0	1		
		Sacred Kingfisher	2	0	2		
	16/2/2016 am	Brown Honeyeater	2	0	2		3x15m
		Yellow-throated Miner	1	0	1		
Broome Bird Observatory	18/2/2016 pm	Brown Honeyeater	2	0	2		1x6m
	19/2/2016 am	Rufous Whistler	1	0	1		1x6m
		Mistletoe Bird	2	0	2		
	21/2/2016 pm	Brown Honeyeater	4	0	4		1x6m
		Double-barred Finch	3	0	3		
	25/2/2016 pm	Little Friarbird	1	0	1		1x6m
		Rufous-throated Honeyeater	2	0	2		
		Double-barred Finch	3	0	3		
		Brown Honeyeater	26	2	28		
		Rufous Whistler	1	0	1		
		Rainbow Bee-eater	4	0	4		
		Bar-shouldered Dove	1	0	1		
		Peaceful Dove	1	0	1		
		Singing Honeyeater	0	1	1		
	26/2/2016 pm	Brown Honeyeater	15	0	15		1x6m
		Rufous-throated Honeyeater	5	0	5		
		Rainbow Bee-eater	1	0	1		
		Double-barred Finch	1	0	1		
		Bar-shouldered Dove	1	0	1		
		Peaceful Dove	0	1	1		
	27/2/2016 am	Brown Honeyeater	5	0	5		
	28/2/2016 pm	Brown Honeyeater	2	2	4		1x6m
		Rufous-throated Honeyeater	12	0	12		
		Double-barred Finch	1	0	1		
		Bar-shouldered Dove	1	0	1		
		Peaceful Dove	1	0	1		
		Little Friarbird	5	0	5		

The total income from participant's contributions to the NWA 2016 Expedition was $46,319. It is too early yet to estimate the final expenses, because a number of items of expenditure on equipment (e.g. leg flags, powder, fuses) etc. are still to be finalised. But it is confidently expected that income will adequately cover total costs. Preliminary calculations incidentally suggest that the daily cost of food was again kept to just under $20 per person.

NEXT EXPEDITION

It was universally agreed that visiting Anna Plains/80 Mile Beach for the first part of the Expedition and Broome for the second part is the optimum combination for future NWA Expeditions. It has proved difficult, however, to select dates for the 2017 Expedition. We have had to settle on mid-week start / finish dates because of the timing of the tides suitable for catching.

The NWA 2017 Expedition will start on **Wednesday 8 February at Broome and finish on Thursday 2 March, also at Broome.** The team will travel down to Anna Plains / 80 Miles Beach on Thursday 9 February and return to Broome on Tuesday 21 February. 20 February will be a 'day off' at Anna Plains / 80 Mile Beach and 22 February will be a day off at Broome. There will be ten catching days at 80 Mile Beach in 2017 and only six (possibly seven) at Broome.

As usual, we would like to start recruiting the team for NWA 2017 as soon as possible. Experience shows that doing this early results in a larger and higher quality team. So would everybody who was involved in the NWA 2016 Expedition please indicate as soon as possible whether they are likely to be able to come again next year? The greater the number of people in the team who have had previous NWA Expedition experience the more efficient it is. It is hoped that anyone who can't come again in 2017 will do their utmost to recruit a replacement. We shall be targeting a team of around 30 again in 2017.

ACKNOWLEDGEMENTS

The success of each Expedition depends upon a large number of factors.

The most important external contribution for the NWA 2016 Expedition came from the Western Australian Department of Parks and Wildlife (WADPW). They again generously paid the participation costs of two of the team members from China. They also this year provided three vehicles for use by the Expedition and two large trailers for carrying equipment to and from Anna Plains. They also made a financial input to other logistical costs.

Anna Plains Station again very generously allowed us to be based at their homestead where they kindly also made numerous facilities available to the team, including the swimming pool. The freedom to roam over and birdwatch on the 400,000-hectare property was also a wonderful bonus.

Broome Bird Observatory also hosted the Expedition for half of the period in NWA. Their flexibility to accommodate our varied needs was also greatly appreciated.

Helen McArthur is again thanked for the most generous and delightful pile of homemade cookies which sustained us through difficult periods throughout the whole of the Expedition. Her involvement in menu planning and early food purchasing was also extremely helpful.

The AWSG and Global Flyaway Network thanks the Yawuru, Karajarri and Nyangumarta traditional owners for permission to conduct research on their lands.

The WADPW and the Australian Bird and Bat Banding Scheme are thanked for providing research and banding permits.

Finally, enormous thanks to all members of the Expedition team. **You** made it the most enjoyable and successful ever.

List of Participants

Australia

WA: Chris Hassell, Maurice O'Connor, Frank O'Connor, Grace Maglio, Peter Crighton, Jill Rowbottom, Milly Formby, John Graf, Plaxy Barrett

VIC: Clive Minton, Roz Jessop, Mike Dawkins, Joris Driessen

NT: Louise Finch, Peter Newberry

QLD: Robert Bush

NSW: Tom Clarke

SA: Graham Parkyn

UK: Richard du Feu, Stephen Dodd, Ros Green, Josie Hewitt

China (mainland): Bai Qingquan, He Peng, Zhang Shoudong

Hong Kong: Katherine Leung, Allen To, Fion Cheung

Taiwan: Emilia Lai, Charlene Lin

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WADER BREEDING SUCCESS IN THE 2015 ARCTIC SUMMER, BASED ON JUVENILE RATIOS OF BIRDS WHICH SPEND THE NON-BREEDING SEASON IN AUSTRALIA

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INTRODUCTION

Wader populations in many of the Flyways around the world are closely monitored. There is a strong downward trend in many populations, particularly over the last 20 years (Amano *et al.* 2010, Wilson *et al.* 2011, MacKinnon *et al.* 2012). Populations will only change if there are changes in one or more of the three key parameters – reproductive rate, survival rate or age of first breeding. If population changes are to be explained ongoing measurements of the above need to be made.

For the last 38 years in south-east Australia and 18 years in north-west Australia the main catching programs of the Victorian Wader Study Group and the Australasian Wader Studies Group respectively have been oriented to obtaining annually an estimate of the proportion of young birds in the population of each of the main migratory wader species during the non-breeding season. The proportion of juveniles in catches, albeit some six months on average after these birds have first fledged, is taken as a proxy for breeding success. This method of gaining an estimate of reproductive success is used because it is impractical to obtain comprehensive fledging rate data on the breeding grounds, particularly for a range of species on an annual basis and over an extended period of years.

Each year since 2000 the results of the 'percentage juvenile' monitoring have been published in Arctic Birds Bulletin and (or) on the Arctic Birds website, as well as in the AWSG journal Stilt (Minton *et al.* 2000, Minton Jessop & Hassell 2016). Earlier data, going back to the 1978 breeding season for some species in south-east Australia, were published in a previous paper (Minton *et al.* 2005). There are now, therefore, breeding success measurements for a range of species going back 38 years in south-east Australia and 18 years in north-west Australia.

This paper gives the results obtained during the 2015 / 2016 non-breeding season in Australia. These indicate the apparent breeding success of a wide range of wader species during the 2015 northern hemisphere wader breeding season.

METHODS

Throughout the period of monitoring a standard method of collecting data has been used so that results can be comparable from year to year and for each species / region. Details have been provided each year (Minton *et al.* 2000, 2016), and as the same methods were used in the 2015 / 2016 season they are not repeated here in detail. As usual, only birds caught by cannon-netting are included. Samples were obtained only when it is considered that virtually all adult birds and juvenile birds were present in the study area, and therefore were available for sampling.

Note, again, that the breeding success index obtained refers to the proportion of juvenile birds present in the population some six months after fledging. Actual breeding success will have been higher. Mortality is typically quite high in all species soon after fledging, especially if a long-distance migration has to be undertaken in this period. Since, however, the key information required in this study is comparative data (year-to-year and species-to-species variations, long-term trends) it does not matter if the figures are not the 'actual' reproductive rate. It can be reasonably expected that there are unlikely to be marked year-to-year variations in mortality between the date of fledging and the middle of the subsequent non-breeding season some six months later.

RESULTS

In south-east Australia results are given for the usual seven main study species (Table 1). The Red Knot sample was again small and, this year, Sanderling also proved particularly hard to catch. Nevertheless, the outcomes of the breeding season were especially clear, with five of the seven species having particularly poor breeding success. On Curlew Sandpiper and Ruddy Turnstone there was an almost complete breeding failure. In contrast, Bar-tailed Godwit had a good breeding outcome and Red Knot an especially good breeding success.

Good data were collected on all the usual main wader study species in north-west Australia (Broome and 80 Mile Beach). This year, good samples were obtained of seven additional species which are not usually able to be caught annually for breeding success estimates (Table 2). Breeding success rates were extremely low for many species, with only three out of seventeen species monitored being rated 'good' or 'very good' – Broad-billed Sandpiper, Oriental Plover and Eastern Curlew. As in south-east Australia, Curlew Sandpiper and Ruddy Turnstone had almost total breeding failures, and in this region Red Knot also.

Table 1. Percentage of juvenile (first year) waders in cannon-net catches in south-east Australia 2015/2016.

Species	No. of catches		Total caught	Juveniles		Long term median*		Assessment of 2015 breeding success
	Large (>50)	Small (<50)		No.	%	% juvenile	(years)	
Red-necked Stint *Calidris ruficollis*	7	7	1904	115	6.0	16.0	(37)	Poor
Curlew Sandpiper *C. ferruginea*	1	5	206	4	1.9	10.0	(36)	Very Poor
Bar-tailed Godwit *Limosa lapponica*	0	1	30	8	26.7	18.0	(26)	Good
Red Knot *C. canutus*	0	1	15	15	100	62.5	(19)	Very Good
Ruddy Turnstone *Arenaria interpres*	1	15	305	7	2.3	9.3	(25)	Very Poor
Sanderling *C. alba*	0	1	29	2	6.8	12.2	(24)	Poor
Sharp-tailed Sandpiper *C. acuminata*	3	3	459	41	8.9	14.8	(34)	Poor

All birds cannon-netted in the period 2th November to 25th March except Sharp-tailed Sandpiper and Curlew Sandpiper to end February only and some Ruddy Turnstone and Sanderling to early April and one Sanderling catch in late April (2015)
*Does not include the 2015/2016 figures.

Table 2. Percentage of juvenile (first year) waders in cannon-net catches in north-west Australia in 2015/2016.

Species	No. of catches		Total caught	Juveniles		Assessment of 2015 breeding success
	Large (>50)	Small (<50)		No.	%	
Great Knot *Calidris tenuirostris*	8	4	1,642	93	5.7	Poor
Bar-tailed Godwit *Limosa lapponica*	4	6	194	20	10.3	Average
Red-necked Stint *C. ruficollis*	4	4	487	54	11.1	Poor
Red Knot *C. canutus*	1	4	109	3	2.7	Very Poor
Curlew Sandpiper *C. ferruginea*	2	4	281	2	0.7	Very Poor
Ruddy Turnstone *Arenaria interpres*	1	4	84	1	1.2	Very Poor
Sanderling *C. alba*	0	5	7	0	-	Very Poor
Grey Plover *Pluvialis squatarola*	0	2	18	1	7.1	Below Average
Non-arctic northern migrants						
Greater Sand Plover *Charadrius leschenaultii*	5	5	523	55	10.5	Poor
Terek Sandpiper *Xenus cinereus*	0	10	131	12	9.2	Below Average
Grey-tailed Tattler *Heteroscelus brevipes*	3	7	380	34	8.9	Poor
Oriental Plover *C. veredus*	0	5	32	14	44	Very Good
Black-tailed Godwit *L. limosa*	1	2	94	8	8.5	Below Average
Oriental Pratincole *Glareola maldivarum*	1	2	92	24	26.0	Average
Common Greenshank *Tringa nebularia*	0	3	52	4	7.7	Below Average
Eastern Curlew *Numenius madagascariensis*	0	2	45	5	11.1	Good
Broad-billed Sandpiper *C. falcinellus*	0	5	30	15	50.0	Very Good

All birds cannon-netted in period 1 November to mid-March

DISCUSSION

The 2015 northern hemisphere breeding season was clearly the worst recorded so far in wader populations which migrate to Australia. Most of the high-Arctic breeding species had an almost total breeding failure. For Curlew Sandpipers in north-west Australia and in south-east Australia it was the lowest ever result (Table 3). It was noticeable that, unusually, Sharp-tailed Sandpipers fared slightly better than Red-necked Stint and Curlew Sandpipers. The poor results, however, seemed to occur almost throughout the northern hemisphere breeding range. Even Greater Sand Plover, mainly nesting in Mongolia and northern China, had their second lowest breeding success recorded in 18 years of monitoring (Table 4).

The only exceptions to the widespread disastrous 2015 breeding season were Bar-tailed Godwits in north-west Australia, which had an average result, and Bar-tailed Godwits and Red Knots in south-east Australia which were classed as 'good' and 'very good' respectively. The latter two of these breed further east than all the other species, with the Red Knot spending the breeding season in the far north-east of Siberia in Chukotka and the Bar-tailed Godwit in Alaska. With 'Presumably, whatever unfortunate combination of weather conditions and predation levels that produced this year's otherwise low breeding success, did not extend to those regions.

One of the important outcomes of these long data series of the percentage of juveniles in wader populations in the non-breeding areas in Australia is that there is no apparent downward trend in annual productivity (Tables 3 and 4 and Minton *et al.* 2005). This is somewhat surprising given the marked downward trajectory of many of these wader populations. It suggests that the decrease in population levels is entirely the result of reduced survival rates. This is logical given that the population decreases seem to be closely linked with extensive losses of intertidal feeding habitat at the critical migratory stopover locations for most species, in the Yellow Sea. The apparent lack of a trend in breeding success rate also suggests that this parameter is not density dependent on the breeding grounds for these wader populations.

CONCLUSION

It is particularly unfortunate that there should have been such a marked and widespread poor breeding outcome in 2015 for most of the wader populations which spend their non-breeding season in Australia.

Table 3. Percentage of juvenile birds in wader catches in south-east Australia 1998/1999 to 2015/2016.

Species	98/ 99	99/ 00	00/ 01	01/ 02	02/ 03	03/ 04	04/ 05	05/ 06	06/ 07	07 /08	08/ 09	09/ 10	10/ 11	11/ 12	12/ 13	13/ 14	14/ 15	15/ 16	***Mean (17yrs)***
Ruddy Turnstone *Arenaria interpres*	6.2	29	10	9.3	17	6.7	12	28	1.3	19	0.7	19	26	10	2.4	38	17	2.3	*14.7*
Red-necked Stint *Calidris ruficollis*	32	23	13	35	13	23	10	7.4	14	10	15	12	20	16	22	17	19	6.0	*17.5*
Curlew Sandpiper *C. ferruginea*	4.1	20	6.8	27	15	15	22	27	4.9	33	10	27	(-)	4	3.3	40	5.1	1.9	*16.5*
Sharp-tailed Sandpiper *C. acuminata*	11	10	16	7.9	20	39	42	27	12	20	3.6	32	(-)	5	18	19	16	8.9	*18.5*
Sanderling *C. alba*	10	13	2.9	10	43	2.7	16	62	0.5	14	2.9	19	21	2	2.8	21	14	6.8	*15.0*
Red Knot *C.canutus*	(2.8)	38	52	69	(92)	(86)	29	73	58	(75)	(-)	(-)	78	68	(-)	(95)	(100)	(100)	*58.1*
Bar-tailed Godwit *Limosa lapponica*	41	19	3.6	1.4	16	2.3	38	40	26	56	29	31	10	18	19	45	15	26.7	*23.9*

All birds cannon-netted between 15th November and 25th March, except Sharp-tailed Sandpiper and Curlew Sandpiper to end February only and some Ruddy Turnstone and Sanderling to early April and one Sanderling catch in late April (2015). Averages (for previous 17 years) exclude figures in brackets (small samples) and exclude 2015/2016 figures

Table 4. Percentage of first year birds in wader catches in north-west Australia 1998/1999 to 2015/2016

Species	98/ 99	99/ 00	00/ 01	01/ 02	02/ 03	03/ 04	04/ 05	05/ 06:	06/ 07	07/ 08	08/ 09	09/ 10	10/ 11	11/ 12	12/ 13	13/ 14	14/ 15	15/ 16	Mean (17yrs)
Red-necked Stint *Calidris ruficollis*	26	46	15	17	41	10	13	20	21	20	10	17	18	24	15	19	10	11.1	*20.1*
Curlew Sandpiper *C. ferruginea*	9.3	22	11	19	15	7.4	21	37	11	29	10	35	24	1	1.9	23	18	0.7	*17.6*
Great Knot *C. tenuirostris*	2.4	4.8	18	5.2	17	16	3.2	12	9.2	12	6	41	24	6	6.6	5	6	5.7	*11.6*
Red Knot *C. canutus*	3.3	14	9.6	5.4	32	3.2	(12)	57	11	23	12	52	16	8	1.5	8	13	2.7	*16.9*
Bar-tailed Godwit *Limosa lapponica*	2.0	10	4.8	15	13	9.0	6.7	11	8.5	8	4	28	21	8	7.6	17	5	10.3	*10.8*
Non-arctic northern migrants																			
Greater Sand Plover *Charadrius leschenaultii*	25	33	22	13	32	24	21	9.5	21	27	27	35	17	19	28	21	20	10.5	*23.4*
Terek Sandpiper *Xenus cinereus*	12	(0)	8.5	12	11	19	14	13	11	13	15	19	25	5	12	15	12	9.2	*13.6*
Grey-tailed Tattler *Heteroscelus brevipes*	26	(44)	17	17	9.0	14	11	15	28	25	38	24	31	20	18	16	19	8.9	*20.5*

All birds cannon-netted in the period 1 November to mid-March. Averages (for previous 17 years) exclude figures in brackets (small samples) and exclude 2015/2016 figures

Given the downward pressures on many of these populations, what is ideally needed is above average breeding output, preferably over an extended period. Let us hope that, in particular, the 2016 reproductive rates return to normal or, preferably, above normal levels. The VWSG and AWSG will continue their annual monitoring programs.

ACKNOWLEDGEMENTS

Greatest thanks are, as always, owed to the fieldwork teams of VWSG and AWSG which have persevered over many months each non-breeding season to obtain the necessary catch samples. This requires between 30 and 50 days of fieldwork by a large (15-25 people) team on each occasion, often working in less than comfortable climatic conditions. Repeated attempts sometimes have to be made to fill particularly difficult slots in the required spectrum of data.

Thanks are also due to the various Parks authorities in Victoria, Western Australia, South Australia and Tasmania who granted the necessary ethics and scientific research permits, as well as the Australian Bird and Bat Banding Scheme in Canberra.

Chris Hassell was again funded by the 2014 Spinoza Prize to Theunis Piersma from the Netherlands Organisation for Scientific Research (NWO).

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TREASURER'S REPORT FOR 2015

In 2015, total expenses exceeded income by $14,039.26. However, invoiced amount $13,965.37 for contract work was unpaid at the end of the year. The balance of $54,027.52 carried forward at 31 December 2015 includes commitments for future contract expenditure of $3,731.30. General accumulated funds were $50,296.22 at the end of the year.

Australasian Wader Studies Group
Income and Expenses
1 January 2015 - 31 December 2015

INCOME			**EXPENSES**		
Item	**2015**	**2014**	**Item**	**2015**	**2014**
	$	**$**		**$**	**$**
Balance brought forward	68,066.78	57,289.81	Printing	4057.10	3237.24
Subscriptions	8077.46	9306.17	Postage/courier	3563.68	1464.45
Contracts - State Govts.	38,205.86		Surveys/reports/monitoring	41,582.16	30,069.48
Contracts - Other		36,235.67	Donations		3000.00
Donations	32,142.37	12,500.00	Travel/accommodation/meals	14,819.82	15,366.42
Conference/meetings		18,151.00	Conference/meetings		13,610.27
Other income	667.77	17,553.98	Equipment/consumables	26,353.41	13,720.00
			Consultant fees		300.00
			Other expenses	2,756.55	2201.99
Total income	79,093.46	93,746.82	Total expenses	93,132.72	82,969.85
Total accumulated funds	147,160.24	151,036.63		147,160.24	151,036.63
Balance carried forward	54,027.52	68,066.78			

Membership statistics:

Membership at the end of the year was:		**2015**	**2014**
	Australia/New Zealand	264	217
	Overseas (excl. NZ)	21	15
	Institutions	18	12
	Complimentary	85	57
	Total	**388**	**301**

This summary of income and expenses for the past year is not an audited statement. It has been prepared for the information of AWSG members from records of transactions provided by BirdLife Australia relating to the Australasian Wader Studies Group. The AWSG is a special interest group of BirdLife Australia and members who wish to see the audited accounts of BirdLife Australia should refer to the Concise Financial Report included in the BirdLife Australia Annual Report 2015.

STILT - INSTRUCTIONS TO AUTHORS

Stilt is the journal of the Australasian Wader Studies Group and publishes material on all aspects of waders (shorebirds) of the East Asian-Australasian Flyway and nearby parts of the Pacific region. Authors should send their manuscript by email to the editor at gregkerr@adam.com.au. Authors are strongly encouraged to consult these instructions in conjunction with the most recent issue of *Stilt* when preparing their manuscripts. Authors are asked to carefully check the final typescript for errors and inconsistencies in order to minimise delays in publication. Authors are also encouraged to seek collegial advice on writing style and English before submitting manuscripts.

Material sent to *Stilt* is assumed to be original and must not have been submitted for publication elsewhere. All authors listed must agree to the publication of the material. Please refer to the *Stilt* Publication Ethics and Malpractice Statement for further information in relation to co-authorship and similar matters. The Publication Ethics statement is available at www.awsg.org.au/stilt.

Suitable material submitted before **1st February** or **1st August** will normally be published in the next issue of *Stilt* in April or October, respectively. Late submissions may be accepted at the editor's discretion.

Submissions should be presented in a Microsoft Word version compatible with Word 2003. All contributions, including table and figure captions and references, should be in 11 pt Times New Roman font. Tables should be in 10 pt Times New Roman. Please refer to the most recent version of *Stilt* for table styles. If photographs or grayscale images are to be included, please submit images in one of the following formats: jpg, jpeg, tiff, gif, bmp, pdf, pcx or eps. Figures, photos or other graphics exceeding 2 MB in size should be forwarded as separate files, clearly labelled to enable cross-referencing. Please ensure that photographs are of highest possible quality. Poor quality images will not be accepted.

Stilt publishes research papers, short communications, reports, book reviews, conference abstracts (usually only from the Australasian Shorebird Conference), notifications of AWSG committee matters and state-wide wader group reports. Research papers and short communications are peer-reviewed and authors are welcome to suggest one or more suitable reviewers. Other material will usually be edited only, although reports may receive one or more reviews at the editor's discretion.

RESEARCH PAPERS

Research papers should document the outcome of original research from wader scientific studies and monitoring of waders. Please note at present, *Stilt* does not publish keywords. Research papers should contain the following sections:

TITLE - in bold, capitalised type.

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RUNNING TITLE - a short version of the title of approximately 50 characters.

ABSTRACT - This will summarise the main findings of the study, preferably in fewer than 200 words.

INTRODUCTION - This should be a short section of about half a journal page to "set the scene" and explain to the reader why the study was important. It should end with a clear definition of the aims of the study.

METHODS - This will describe the methods used in the study in sufficient detail to enable the work to be repeated.

RESULTS - The key findings of the study are provided here. Where feasible, data should be presented in figures and/or tables.

DISCUSSION - This section explains the significance of the major results obtained, their relevance to other work, and implications for future research.

ACKNOWLEDGEMENTS - In this section the author(s) should thank others who have contributed to the work. If applicable, ethics committee approvals and funding sources should be detailed.

REFERENCES - This section gives details of all the literature cited in the paper. References should be in alphabetic and chronological order with multi-authored references after single author citations by the same author. Examples of the required format follow:

Single author papers: **Smith, F.T.H.** 1964. Wader observations in southern Victoria, 1962-1963. *Australian Bird Watcher* 2: 70-84.

Multi-authored papers: **Dann, P., R.H. Loyn & P. Bingham**. 1994. Ten years of water bird counts in Westernport Victoria 1973-83. II. Waders, gulls and terns. *Australian Bird Watcher* 15:351-67.

Books: **Kershaw, K.A.** 1964. Quantitative and dynamic ecology. Edward Arnold, London.

Reports: **Noor, Y.R**. 1994. A status overview of shore birds in Indonesia. Pp. 178-88. *In:* Wells, D.R. & T. Mundur. (Eds.) Conservation of migratory water birds and their wetland habitats in the East Asian-Australia Flyway. Asian Wetland Bureau, Malaysia.

Online material: **Dutson G., Garnett S. & Gole C.** 2009. Australia's Important Bird Areas: Key sites for bird conservation. Birds Australia (RAOU) Conservation Statement Number 15. Available at http://www.birdlife.org.au/document/OTHPUB-IBA-supp.pdf (accessed 10 August 2012).

TABLES - There should be no lines in the table except at the top and bottom of the table and below the column headings. All tables should be prepared using the word processing table function and included after the Reference section. Please do not produce tables created as lists using tab stops.

FIGURES - Figures should be placed after Tables. All maps should have a border, distance scale, reference latitude and longitude and/or inset map to enable readers unfamiliar with the area to locate the site in an atlas. Google Maps and Google Earth images will be accepted but are discouraged as they reproduce poorly in print. Line figures are preferred. At their minimum, Google Earth images should retain the Google trademark device and year of image publication.

APPENDICES - Appendices should supplement but not repeat material elsewhere (i.e. in tables and figures). Appendices should be accompanied by a self-explanatory caption. Formatting should follow that for other manuscript components. At this time, *Stilt* does not have the capacity to accommodate Supplmentary Material Online.

SHORT COMMUNICATIONS

These will present material, insufficient for a research paper, on any matters relating to the flyway and the shorebirds in it. They are not usually subdivided like research papers and do not require an abstract. Generally, short communications should be word documents less than 6 pages 1.5-spaced including all tables, figures and photographs.

REPORTS

Reports are intended to provide updates on wader group activities, regular monitoring and related topics. Reports will not usually be subject to peer-review, although the editor and editorial board reserve the right to send reports out for review if they feel another opinion on content is required. Reports should be written in the same style as research papers with the exception that an abstract is not required. Results and Discussion may be combined into a single section "RESULTS AND DISCUSSION". All other formatting should follow that described under Research Papers.

STILT STYLISTIC MATTERS

The terms "summer" and "winter" should be avoided, if possible. Instead, it is recommended that authors use the terminology "breeding" and "non-breeding". If this is not possible, a clear explanation of the month(s) referred to are necessary. East Asian-Australasian Flyway (**not** East-Asian Australasian Flyway) should be spelt out in full on first mention and then subsequently written as EAAF. Subsequent mention of the EAAF as the flyway should be title case, as in, Flyway. Directions should be lower case and hyphenated, as in "north-west" not "North West". Coordinates should be listed in degrees and minutes, usually with the northing (or southing) first followed by the easting, as in Bagan Serdang (3°42' N, 98 °50'E)

OTHER MATTERS

In general, nomenclature of Australian birds should follow **Christidis, L. & W. Boles.** 2008. Systematics and Taxonomy of Australian Birds. CSIRO Publishing, Australia. The first reference to a species in the text should have the scientific name in *italics* after the common name. Where alternative nomenclature is used, the appropriate reference(s) should be clearly cited.

For all manuscripts, first level headings should be **BOLD and UPPERCASE**, second level headings should be **Bold and lower case** and further subheadings in *italics.*

All measurements should be in metric units (e.g. mm, km, °C etc) and rates should be recorded as, for example, d^{-1} rather than /day or per day. Authors are encouraged to examine previous recent issues of *Stilt* for examples of the presentation of different types of material. The editor is happy to advise on issues that cannot be so resolved.

Please note:

- Views and opinions expressed in *Stilt* are those of the author(s) and not necessarily those of the AWSG or BirdLife Australia.
- Publication of data in *Stilt* does not constitute permission for the commercial use of those data. All such inquiries should be directed to the Editor.
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- The Editorial Team does its best to ensure the accuracy of information published in *Stilt*, but it is recommended that anyone wishing to cite material within *Stilt* contact the relevant authors.

Back Issues:

All back issues are available in PDF format from the AWSG website <www.awsg.org/stilt.php>. Most volumes are also available in print as back issues. Please contact the Secretary (stilt@birdlife.org.au) for details of costs and availability.

Deadlines:

The closing dates for submission of material are **1 February and 1 August** for the April and October editions respectively.

Extensions to these dates must be discussed with the Editor. Contributors of research papers and notes are encouraged to submit well in advance of these dates to allow time for refereeing. Other contributors are reminded that they will probably have some comments to consider, and possibly incorporate, at some time after submission. It would be appreciated if this could be done promptly.

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