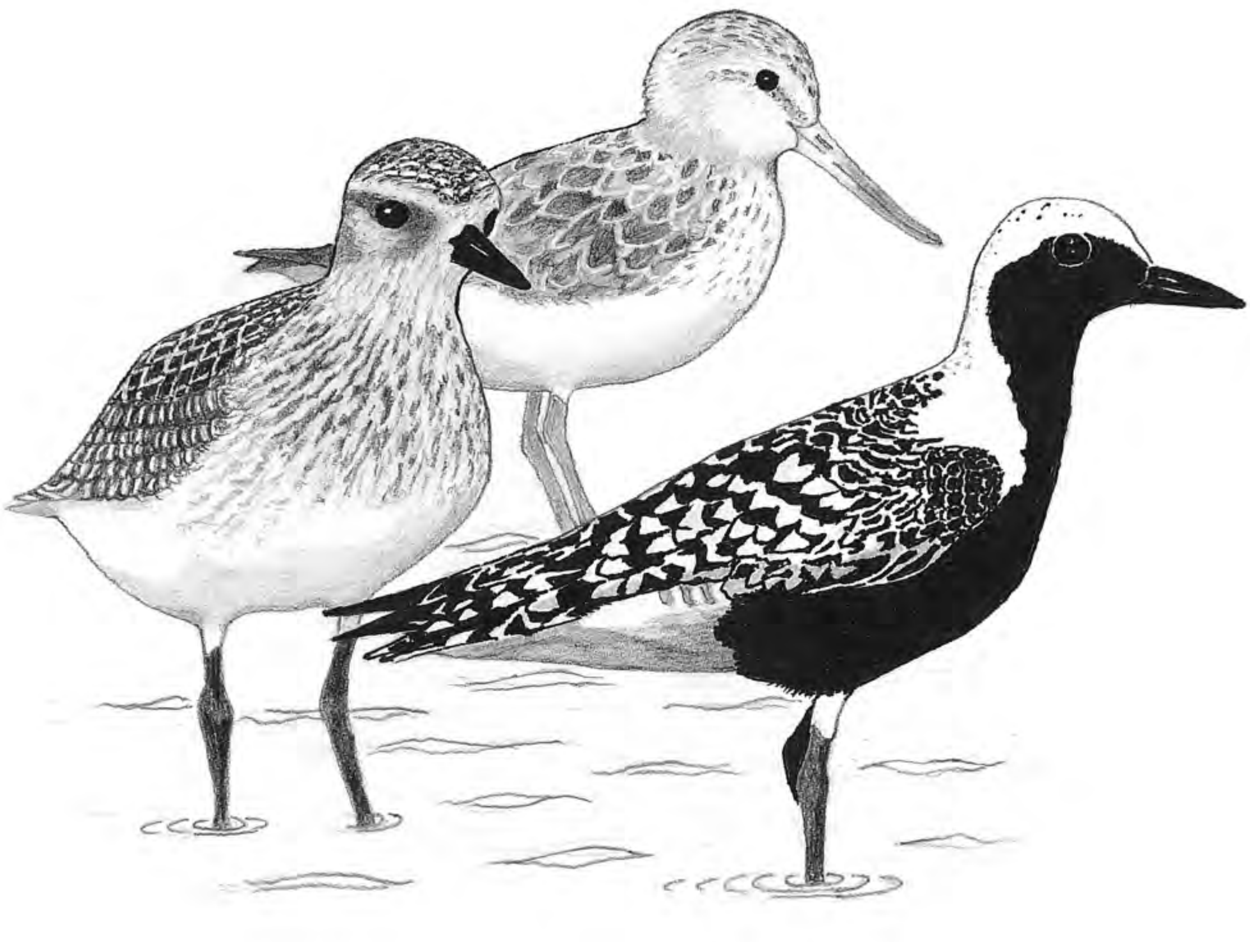
Stilt

The Journal for the East Asian-Australasian Flyway



Number 73-74 • November 2020

Australasian Wader Studies Group

Stilt

ISSN 0726-1888

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 annual bulletin *Stilt*, and the quarterly newsletter *Tattler*.

Please direct all membership enquiries to the Membership Manager at BirdLife Australia, Suite 2-05, 60 Leicester St, Carlton Vic 3053, AUSTRALIA.
Ph: 1300 730 075, fax: (03) 9347 9323
Email: membership@birdlife.org.au

Annual Subscriptions:	Australia & New Zealand	A$40.00
	Overseas	A$40.00
	Institutions	A$40.00

Published in November 2020

AWSG WEB SITE: awsg.org.au
Cover Illustration: Annie Rogers.

EDITORIAL

Welcome to the combined 2019 and 2020 edition of Stilt. As all our contributors, editors, reviewers and production team are volunteers, it can be difficult to put together this journal and I would like to thank everyone for their patience with the delay of the 2019 edition.

I would especially like to acknowledge and thank Dr Birgita Hansen who has had multiple roles within the AWSG in recent years including editing the Stilt journal. She has established an editorial board of experts who review and edit manuscripts from contributors. As the incoming editor I am in awe of her organisational skills and wide range of knowledge.

On behalf of the Stilt editorial team, I would also like to thank the outgoing Stilt editor Greg Kerr for his contribution. Greg was Stilt Editor from 2015 (issue 68) to 2019 (issue 72), and Greg managed many of the articles that appear in this combined issue.

I am a primary school teacher by trade based at a RAMSAR site on the west coast of the North Island of New Zealand. A fascination with the incredible bird history of New Zealand sparked a photographic interest and then a passion for waders - I didn't move to the Manawatu Estuary by accident! I can usually be found lying in the mud in the summer months as it is a great place to photograph waders without disturbing them.

I am delighted to be involved with the AWSG and I look forward to working with other passionate people. Dr Judit Szabo is our Scientific Editor and she will take a lead role in ensuring our procedures are robust and we maintain our reputation as a leading scientific journal.

Lastly, I would like to thank all our contributors, without whom we would not exist. I would like to encourage past contributors and new ones to get in touch with me to see how we can continue Birgita's work in improving the journal and expanding our readership.

Enjoy this 2019-2020 edition.

Imogen Warren
Editor

Bar-tailed Godwit, Foxton Beach, New Zealand, 18/03/2018 (Photo credits: Imogen Warren).

DR CLIVE DUDLEY THOMAS MINTON, AM, (7/10/1934 – 6/11/2019)

Dr Clive Minton, described as a father figure in global wader studies, was killed in a car crash on the 6 November 2019 at Dunkeld in Victoria, Australia. His wife Pat and a family friend were travelling with him at the time and were seriously injured although now in recovery. They were all returning from a short holiday on Kangaroo Island in South Australia.

Clive was a British and Australian metallurgist, administrator, management consultant and amateur ornithologist. Born in England, he attended Oundle School and went on to complete a degree in Metallurgy and a PhD at the University of Cambridge.

Clive was fascinated by birds from his early childhood. He quickly became an outstanding amateur ornithologist with an international reputation. Although involved in studies of various species of birds, his main focus was the migratory waders. He became the founding chairman of the Wash Wader Ringing Group (founded in 1959) and was associated with development of cannon-netting, as a means of catching large numbers of waders for banding and demographic studies. The Group's first catch using the cannon net was in 1967.

Clive Minton moved to Australia as managing director of Imperial Metal Industries Australia in Melbourne, Victoria. There, he revitalised wader studies, in large part through the introduction of cannon-netting to the Victorian Wader Study Group (VWSG), which became one of the most active banding groups in the world. He was instrumental in the establishment of the Broome Bird Observatory and was an active member of the Royal Australasian Ornithologists' Union (RAOU), serving on its Research Committee 1980–1988 and as vice-president of the RAOU from 1989–1995.

In 1980-81 the Australian Wader Studies Group was formed as a special interest group of the then RAOU, (now BirdLife Australia) and Clive was elected as the inaugural Chair. Clive continued in this role into the 1990s when he convinced the late Mark Barter to take on the role of Chair. Clive continued to be a key committee member and actively contributed to the work of the AWSG Committee for 39 years!

Clive Minton was one of the great movers and shakers of shorebird research in the East Asian – Australasian Flyway (EAAF) and other flyways over many decades. His interests were diverse; he was a champion of shorebird monitoring, for example leading the first complete count of shorebirds in north-western Australia and co-leading the monitoring of Corner Inlet (Victoria's premier shorebird site) for nearly 40 years. However, he is best remembered for studies involving the capture, banding and release of shorebirds. Clive was the key initiator of the North-west Australia Shorebird Expeditions and, from the early 1980s, Clive led regular, almost annual, wader study expeditions to north-west Australia to catch and study the waders that migrate to and through the coastal strip between Roebuck Bay near Broome, Eighty Mile Beach and Port Hedland in the southern section of the East Asian – Australasian Flyway.

The field work from these expeditions dramatically increased knowledge of the importance of Roebuck Bay and Eighty Mile Beach as key non-breeding habitat of many species of migratory shorebirds. These expeditions, along with data collected in south-eastern Australia by the VWSG, have led to major governmental conservation initiatives along the Flyway, including the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory Bird Agreement (CAMBA) and recognition of Roebuck Bay as a Site of International Importance in the EAAF network of sites.

This work has continued annually or biannually for over 35 years and, through Clive's active encouragement, has involved many people from Asia and Europe. It provided inspiration to young shorebird conservationists in Australasia and other countries along the EAA Flyway. It has led to the development of the largest morphometric and movement data set for migratory shorebirds in the EAA Flyway. This work led to the establishment of Broome Bird Observatory and continues to be a legacy to the passion Clive had for migratory shorebirds. Clive was also involved in several international wader study expeditions in North America, South America and Russia.

Clive's work was recognised through many distinguished awards, including:

- 1975 - he was awarded the Bernard Tucker Medal for services to ornithology[1]
- 1998 - he was elected as a Fellow of the RAOU
- 2000 - he was awarded the John Hobbs Medal for outstanding contributions to ornithology as an amateur
- 2001 - he was elected a Member of the Order of Australia for 'services to ornithology, particularly in the study of migratory wading birds in Australia'
- 2003 - he was awarded an Australian Natural History Medallion
- 2012 - he was awarded the Eisenmann Medal
- 2013 - VWSG Life Member bestowed at the AGM
- 2014 - Awarded the Citizens United President's Award (New Jersey)

In 2003, British ornithologist Andrew Whittaker commemorated Clive Minton in the species epithet of the Cryptic Forest Falcon *Micrastur mintoni*.

Even these awards do not fully demonstrate Clive's impact. He published or co-authored many scientific publications, an even larger number of less formal reports and newsletter articles to share knowledge with the teams and volunteers he loved to work with, and probably even more emails and letters hounding people into action! His memory was extraordinary, and it is impossible to list all the projects that benefited from Clive's advice and ability to recall related research or workers that could be helpful. Above all he inspired multiple generations to take up 'shorebirding' as their passion or their career. His impact on shorebird research and conservation worldwide defies measurement.

Clive will always be remembered as a larger than life presence, generous with sharing his knowledge and passion for migratory waders and support for the many volunteers and researchers participating in banding and colour flagging of migratory waders.

He will be greatly missed by all who knew and valued him as he was a most warm and wonderful human being.

Alison Russell-French OAM

Chair, Australasian Wader Studies Group

TREASURER'S REPORT FOR 2018

At the end of 2018, the balance of funds for MYSMA was -$627.54
The balance of $81,833 carried forward at 31 December 2018 includes commitments of $5,000 to the Global Flyway Network and $US2000 to the EAAFP. (Expenses)
Other expenses includes GFN payment of $10,000 & additional MYSMA expenses
The opening balance in 2018 is higher than the closing balance for 2017 due to adjustments discussed with BLA finance.

Australasian Wader Studies Group
Income and Expenses
1 January 2018 - 31 December 2018

INCOME			EXPENSES		
Item	**2018 $**	**2017 $**	**Item**	**2018 $**	**2017 $**
Balance brought forward	46,916.19	47,528.09	Printing	4,408.56	2,814.00
Subscriptions	9,889.11	9,685.98	Postage/courier	0.00	2,304.94
Contracts - State Govts.	36,654.55	27,273.95	Surveys/reports/monitoring	22,459.09	44,570.57
Contracts - Other	0.00	0.00	Travel/accommodation/meals	15,067.54	8,441.45
Donations	60,360.00	39,460.00	Conferences	542.73	297.29
Conference/meetings	0.00	0.00	Donations		
Other income	16,227.17	2,239.62	Equipment/consumables	22,500.00	22,500.00
			Consultant fees		2,574.00
			Other expenses	23,236.00	4,083.91
Total income	123,130.83	78,659.55	Total expenses	88,213.92	87,586.16
Total accumulated funds	**170,047.02**	**126,187.64**		**170,047.02**	**147,160.24**
Balance carried forward	**81,833.10**	**38,601.48**			

Membership statistics:

Membership at the end of the year was:		**2018**	**2017**
	Australia/New Zealand	270	245
	Overseas (excl. NZ)	14	13
	Institutions	1	5
	Complimentary	56	53
	Total	**341**	**316**

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.

TREASURER'S REPORT FOR 2019

At the end of 2019, the balance of funds for MYSMA was -$1856.63
The balance of $81,337 carried forward at 31 December 2019 includes commitments of $5,000 to the Global Flyway Network.
Other expenses includes GFN payment of $5,000, EAAFP payment of $3085 & admininstration / bank fees of $1038

Australasian Wader Studies Group
Income and Expenses
1 January 2019 - 31 December 2019

INCOME			EXPENSES		
Item	**2019 $**	**2018 $**	**Item**	**2019 $**	**2018 $**
Balance brought forward	81,833.10	46,916.19	Printing	1,265.00	4,408.56
Subscriptions	9,846.10	9,889.11	Postage/courier	0.00	0.00
Contracts - State Govts.	0.00	36,654.55	Surveys/reports/monitoring	0.00	22,459.09
Contracts - Other	0.00	0.00	Travel/accommodation/meals	1,229.09	15,067.54
Donations	20,390.00	60,360.00	Conferences	0.00	542.73
Conference/meetings	0.00	0.00	Donations	0.00	
Other income	884.34	16,227.17	Equipment/consumables	20,000.00	22,500.00
			Consultant fees	0.00	
			Other expenses	9,122.52	23,236.00
Total income	31,120.44	123,130.83	Total expenses	31,616.61	88,213.92
Total accumulated funds	**112,953.54**	**170,047.02**		**112,953.54**	**147,160.24**
Balance carried forward	**81,336.93**	**81,833.10**			

Membership statistics:

Membership at the end of the year was:		**2019**	**2018**
	Australia/New Zealand	228	270
	Overseas (excl. NZ)	7	14
	Institutions	0	1
	Complimentary	56	56
	Total	**291**	**341**

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.

WATERBIRD SURVEYS OF THE CALEY VALLEY WETLAND IN WET AND DRY SEASONS, ABBOT POINT, QUEENSLAND

PENN LLOYD[1], CHRIS SANDERSON[1,2] AND LINDSAY POPPLE[1,3]

[1] *Biodiversity Assessment and Management Pty Ltd, P.O. Box 1376, Cleveland, QLD 4163, AUSTRALIA*
Email: penn@baamecology.com
[2] *Research School of Biology, The Australian National University, Acton, ACT 2601 and University of Queensland, St Lucia, QLD 4072, AUSTRALIA*
[3] *Natural Resource Assessments, PO Box 5678, Cairns QLD 4870, AUSTRALIA*

The Caley Valley wetland is a nationally important wetland that is described as one of the most important sites for waterfowl in north Queensland. Yet, the seasonal pattern of waterbird abundance within the wetland remains poorly understood. This study documents a series of five waterbird surveys of the Caley Valley Wetland from February to December 2012, including periods when the freshwater wetland basin was fully inundated or completely dry. The surveys recorded up to 41,000 waterbirds of 74 species using the wetland and adjacent coastline when the main freshwater basin was fully inundated, with a total estimate of a little over 50,000 waterbirds after extrapolating to unsurveyed portions. Particularly notable species counts or estimates included 24,550 ducks (of seven species), 2019 Black Swan *Cygnus atratus*, 6500 Eurasian Coot *Fulica atra*, 3184 Purple Swamphen *Porphyrio melanotus*, 4717 White-headed Stilt *Himantopus leucocephalus* and 35 Australian Painted Snipe *Rostratula australis* in June 2012, 1265 Sharp-tailed Sandpiper *Calidris acuminata* and 54 Latham's Snipe *Gallinago hardwickii* in March 2012. Sizeable nesting populations of Black Swan, Australian Pelican *Pelecanus conspicillatus*, Pied Cormorant *Phalacrocorax varius* and Australian White Ibis *Threskiornis molucca* occurred. The waterbird population reduced to approximately 1300 birds once the main freshwater basin dried out. The results of this study confirm the importance of the Caley Valley Wetland for a wide variety of waterbirds on the central Queensland coast and provide a snapshot of the seasonal change in waterbird use of the wetland as the main freshwater basin filled and dried out following a season of approximately average rainfall.

INTRODUCTION

The Caley Valley Wetland (sometimes also referred to as the Kaili Valley Wetlands; BMT WBM 2012) is a 5150 ha wetland on the central Queensland coast at Abbot Point. It comprises a mixture of intertidal mud-flats, sand-flats, estuary channels, mangroves and saltmarshes under tidal influence in its western extent (within the estuary and saltpan zones shown in Fig. 1), and a large fresh and brackish water wetland basin within an artificial bund in its eastern extent (Blackman *et al.* 1999). Saltwater Creek links the freshwater wetland basin to Euri Creek on the eastern side of the wetland (Fig. 1). During the wet season when water levels in Euri Creek are high, water flows north-westwards along Saltwater Creek and into the wetland. Fresh water also drains into the wetland from local runoff from the Salisbury Plain and the slopes of Mount Roundback and Mount Little to the south of the wetland (Environment Australia 2001). The hydrology of the wetland is influenced by two artificial bunds: (1) an outer, western bund; and (2) an inner bund or causeway (Fig. 1). The causeway bund was constructed in 1956 by the Bowen Gun Club to isolate what was originally a large coastal salt pan in the main wetland basin from tidal influences and allow it to flood seasonally with freshwater to a greater depth (GHD 2012). The western (outer) bund was constructed in the early 1980's to further impede saltwater intrusion into the main freshwater basin (GHD 2012). The causeway bund was apparently substantially higher than its current state when first constructed, it was refurbished in the early 1980's but has since fallen into disrepair (GHD 2010). The original aim of the causeway bund construction was to improve habitat suitability for waterfowl and increase waterfowl numbers for club shooting activities (GHD 2010). Waterfowl numbers reportedly began increasing shortly after construction of the causeway bund and continued increasing throughout the early 1960s (Lavery 1964, cited in GHD 2010) to the point where the Caley Valley Wetland is now regarded as one of the most important sites for waterfowl in north Queensland (Blackman *et al.* 1999) and a nationally important wetland (Environment Australia 2001).

While the waterbirds of the Caley Valley Wetland have been surveyed on several occasions (summarised in BAAM 2012), no previous survey has attempted to quantify the total numbers of wetland birds using the wetland during a full cycle of the wet and dry season. This study documents a series of five waterbird surveys of the Caley Valley Wetland from February to December 2012, including periods when the freshwater wetland basin was fully inundated or completely dry.

METHODS

Study area

The study area comprised two different portions of the Caley Valley Wetland, the predominantly freshwater wetland to the east of the causeway bund (freshwater basin zone, approximately 2000 ha) and an open area of intertidal mudflat / sandflat and saltpan between the causeway bund and the outer western bund (saltpan zone, approximately 400 ha), as well as the adjacent coastline (Fig. 2). The freshwater basin was split into two main zones, an open marsh zone and a closed marsh zone. The open marsh zone is an area of predominantly open water with a relatively narrower band of fringing sedges, dominated by *Schoenoplectus subulatus* but also including *Fimbristylis* spp., *Eleocharis plana* as well as herbs including *Tecticornia* spp. and *Sesuvium portulacastrum* and the grass *Sporobolus virginicus* (Fig. 3), located within the western section of the basin, immediately east of the causeway bund. The closed marsh zone is an area of predominantly sedge marsh dominated by the tall sedge *Schoenoplectus subulatus* with patches of open water channels, including Caley Lake, within the eastern section of the basin. Caley Lake is an area of deeper (max. depth approximately 1.5 m), open water surrounded by tall sedge marsh within the centre of the main freshwater basin (Fig. 4).

Survey approach

Five surveys were undertaken by a team of two observers, as follows: 21-24 February 2012 (four full days of survey), 5-10 March 2012 (five days), 26-29 June 2012 (four days), 19-21 November 2012 (three days) and 12-13 December 2012 (two days). The large survey area was divided into smaller survey sectors, each of which was subject to one of four different survey approaches (outlined below) depending on the habitat area. Open areas such as the open waters of the freshwater wetland, saltpan zone and coastline could be comprehensively surveyed using a spotting telescope mounted on a sturdy tripod at appropriately spaced vantage points. Areas of sedge marsh fringing the freshwater wetland perimeter and throughout the closed marsh zone could only be surveyed by flushing birds.

Open-water survey**:** a complete count of all birds on the open waters or open ground of the saltpan zone (survey areas S1 and S2 in Fig. 2), open marsh zone (survey areas O1 to O7) and Caley Lake, using a spotting telescope at appropriate vantage points around the open waters. The saltpan zone was surveyed within a four-hour period straddling low tide (i.e. within two hours either side of low tide) in the February, March and November surveys, and within a four-hour period straddling high tide in the December survey. Each open-water sector was surveyed immediately before the perimeter sedge-marsh was surveyed, to ensure birds flushed from the perimeter sedge-marshes and settling on the open waters were not double-counted. The open-water surveys obtained complete survey coverage of all open waters within the open marsh zone and Caley Lake on each survey occasion, and obtained complete survey coverage of the saltpan zone on each survey occasion except the June 2012 survey when the saltpan zone was not surveyed.

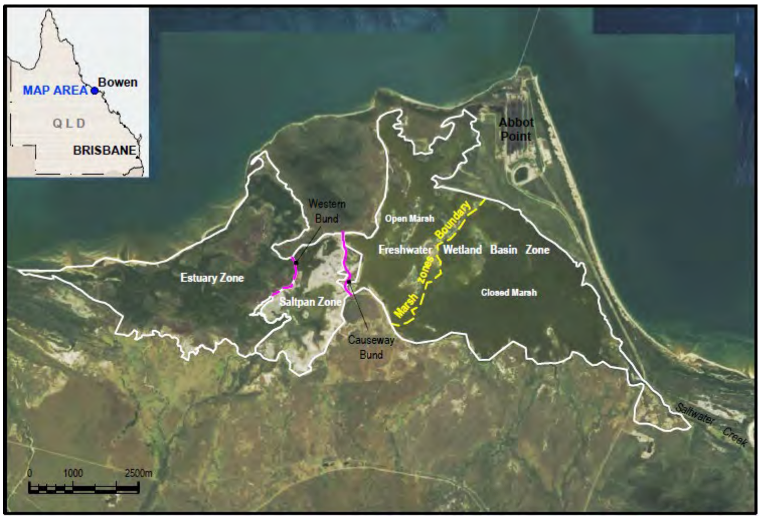


Figure 1. Overview map of the Caley Valley Wetland showing the locations of the estuary, saltpan and freshwater wetland basin zones, the closed marsh and open marsh portions of the freshwater basin zone, and the western and causeway bunds (pink lines).

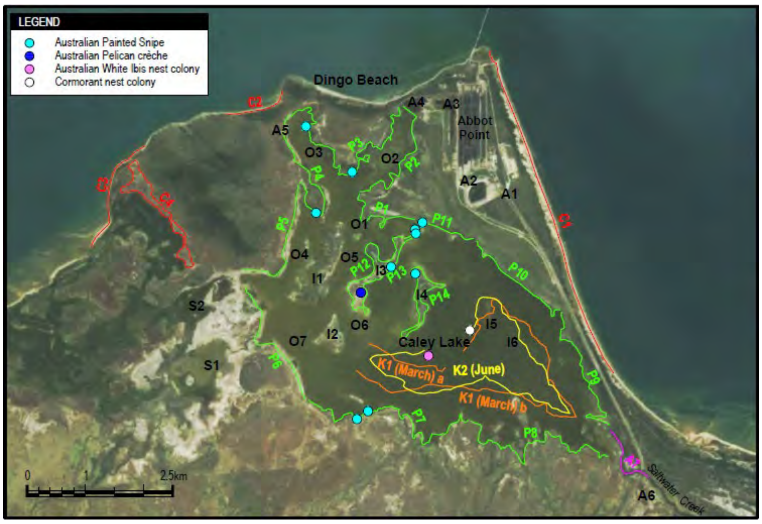


Figure 2. Map of the Caley Valley Wetland study area survey sectors, nesting colonies and Australian Painted Snipe records: coastal sectors (red, C1-C4); open freshwater areas (O1-O7, Caley Lake); freshwater basin perimeter sectors when inundated (green, P1-P14); kayak survey tracks through closed marsh (K1 and K2); saltpan areas (S1 and S2); islands in the freshwater basin when inundated (I1-I6); and adjacent sites (A1-A7).

Perimeter of wetland and islands survey**:** each sector of the perimeter of the main wetland basin and two islands (I3 and I4 in Fig. 2) that could be accessed by wading across shallow channels (survey sectors P1 to P14 in Fig. 2) was surveyed by a team of two observers walking briskly up to 20 m apart in areas where the water was shallow, one walking along the water's edge and the other walking through shallow waters between the water's edge and the outer edge of perimeter sedges. The aim of the perimeter surveys was to flush and count all waterbirds within the fringing band of sedges and shallows along the wetland perimeter when the freshwater basin was inundated. Any birds that flew forwards to land in an area of the perimeter that the observers were still moving towards were noted to ensure they were not double counted. When surveying the perimeter of the closed marsh zone, an approximate determination was made of the modal distance that individuals or groups of birds were observed / flushed from the perimeter edge. The perimeter survey tracks P1 to P14 shown in Fig. 2 show the location of the perimeter of the freshwater basin (i.e. the water's edge) when it was well inundated during the February, March and June surveys. The only perimeters not shown in Fig. 2 are the perimeters of four islands (I1, I2, I5, I6) that were not surveyed, two of which were under water in the March and June surveys.

Interior of closed marsh survey**:** the interior closed-marsh habitat zone was surveyed from kayaks during the March and June surveys (survey sectors K1 and K2 in Fig. 2). Two team members each paddled a single kayak in close proximity through the wetland. For all species, an approximate determination was made of the modal distance that individuals or groups of birds were observed / flushed before the approaching kayaks.

Coastline survey**:** a complete count of all birds on sections of sandy beach to the north of the Caley Valley wetland (survey sectors C1 to C4 in Fig. 2), accomplished by walking along the beaches or surveying the full length of the beaches using a spotting telescope from elevated vantage points. Coastline surveys were undertaken within a four-hour period straddling each of low tide (i.e. within two hours either side of low tide) and high tide.

Data extrapolations, assumptions and limitations

When the freshwater wetland was inundated in the wet season, the survey was unable to cover the full perimeter of the wetland or the full area of the closed marsh zone due to logistical constraints associated with undertaking a survey largely on foot within a limited timeframe (Table 1). To estimate the total population size for each waterbird species within the study area, it was necessary to estimate the total number of birds likely to be present in un-surveyed areas by extrapolating from the observed density in surveyed areas of similar habitat type and position.

Different assumptions were made for the perimeter surveys of each of the open marsh and closed marsh zones. In the open marsh zone, we assumed that all birds were flushed during the traverse of this habitat due to: (1) the relatively narrow width of the fringing sedges (Fig. 3); and (2) the ability to walk through the majority of this habitat in the sections of perimeter habitat surveyed. Population totals therefore represent minimum counts for species that inhabit only the shallow fringes, such as crakes, rails, White-headed Stilt, Common Greenshank, Marsh Sandpiper, Sharp-tailed Sandpiper, Latham's Snipe and Australian Painted Snipe. In the closed marsh zone, an approximate determination was made of the modal distance from the wetland edge that individuals or groups of birds flushed while the observers walked along the wetland edge. These modal distances were used to approximate species-specific buffers of the survey perimeter (Table 2). The perimeter survey was assumed to capture all birds within the perimeter buffer; the total count of birds beyond the perimeter buffer was estimated using the interior marsh survey approach outlined below. Thus, for a species with a modal flushing distance of 100 m, the perimeter survey represents a count of all individuals within 100 m of the perimeter of the closed marsh zone. The total number of birds within the interior of the closed marsh zone (i.e. beyond the 100 m perimeter buffer) was calculated from the density estimate derived from the kayak survey approach described below.

Figure 3. Open marsh zone with open water (background) and relatively narrow fringing sedge marsh (foreground). (by ©Penn Lloyd).

Figure 4. Caley Lake in November 2012, when the freshwater basin had dried out to an area of 35 ha, surrounded by tall, dense sedges of the closed marsh zone. (by ©Lindsay Popple)

For all species, an approximate determination was made of the modal distance that individuals or groups of birds were observed / flushed before the approaching kayaks. These modal distances were used to approximate species-specific buffers either side of the survey midline and thereby calculate a transect area for each species count that was then used to calculate a density estimate for each species. Finally, the density estimate was extrapolated across the area of interior marsh (excluding the perimeter buffer) to provide a total count.

While care was taken not to double-count birds moving within a survey sector, a further assumption relates to the potential for movement of birds between survey sectors, especially between sectors counted on different days. While species such as Purple Swamphen are relatively sedentary within the wetland, other species, particularly large flocks of ducks moved around the wetland as a whole. Therefore, it is possible for birds to move from an already surveyed sector into an unsurveyed sector on different days and be double counted, and equally for birds to move from an unsurveyed sector into an already surveyed sector and not be counted at all. We assumed that movement between sectors is random and the number of double-counted versus uncounted birds balanced out. These types of assumptions for dealing with survey limitations and constraints are common to large-scale surveys (e.g. Gregory *et al.* 2004, Reid *et al.* 2010, Milton *et al.* 2014).

Monthly rainfall data are reported as the average of monthly measurements from three weather stations (Bowen Australian Saltworks, Bowen Pump Station Alert, Bowen Airport AWS) located with a 2 km radius of one another near Bowen, approximately 15 km south-east of the study area (Bureau of Meteorology 2018).

RESULTS

Survey conditions

Rainfall within the local catchment of the Caley Valley Wetland is strongly seasonal, with most wet-season rainfall occurring within the 4-month period December to March (Fig. 5). Prior to the first survey of 21-24 February 2012, a total of 255 mm of rain had fallen since 1 December 2011 (82-89 mm each month including the first three weeks of February). The freshwater wetland was mostly inundated but not fully inundated, with water levels slowly receding following good rainfall in the first four days of February. Over the 10-day period between the first survey and the second survey of 5-10 March 2012, a total of 155 mm of rain fell, which resulted in the water levels rising an estimated 15-20 cm, but not fully filling the freshwater basin. After the March survey, a further 334 mm fell during the third week of March, which caused the Caley Valley Wetland to flood to its maximum extent. The floodwaters substantially overtopped the causeway bund at several locations as

Table 1. Explanation of assumptions and methods of extrapolation used to estimate waterbird numbers in unsurveyed portions of the main freshwater basin during the February, March and June surveys.

Areas not surveyed	Extrapolation used to derive waterbird abundance estimate for areas not surveyed
February 2012 survey	
Species abundance (x) on perimeter of two islands in the open marsh zone (I1, I2; total perimeter length of 5.96 km).	Species abundance (y) along perimeter of the open marsh zone on one island (P12; total perimeter length of 2.75 km). Equation: x = y * (5.96/2.75).
Species abundance (x) on perimeter of two islands in the closed marsh zone (I5, I6; total perimeter length of 5.23 km).	Species abundance (y) along perimeter of the closed marsh zone of two islands (sectors P13, P14; total perimeter length of 8.90 km). Equation: x = y * (5.23/8.90).
Species abundance (x) on perimeter of wetland basin perimeter (P8; total perimeter length of 4.4 km).	Species abundance (y) along perimeter of adjacent portion of wetland basin perimeter (P7; total perimeter length of 2.8 km). Equation: x = y * (4.4/2.8).
Interior of closed marsh zone in wetland basin.	No estimate made.
Lower Saltwater Creek (A7).	No estimate made.
March 2012 survey	
Species abundance (x) on perimeter of two islands in the open marsh zone (I1, I2; total perimeter length of 5.96 km); I5 and I6 not included as these were submerged by higher water levels.	Species abundance (y) along perimeter of the open marsh zone on one island (P12; total perimeter length of 2.75 km). Equation: x = y * (5.96/2.75).
Two soaks and a settling pond within the operating port facility (A1 to A3 in Fig. 2).	Count data for these sectors were assumed to be identical to data obtained 10 days earlier in the February survey.
June 2012 survey	
Species abundance (x) on perimeter of two islands in the open marsh zone (I1, I2; total perimeter length of 5.96 km); I5 and I6 not included as these were submerged by higher water levels.	Species abundance (y) along perimeter of the open marsh zone on one island (P12; total perimeter length of 2.75 km). Equation: x = y * (5.96/2.75).
Species abundance (x) on perimeter of wetland basin perimeter (P8; total perimeter length of 4.4 km).	Species abundance (y) along perimeter of adjacent portion of wetland basin perimeter (P7; total perimeter length of 2.8 km). Equation: x = y * (4.4/2.8).
Saltpan zone (sectors S1, S2).	No estimate made.
Two soaks and a settling pond within the operating port facility (A1 to A3 in Fig. 2).	No estimate made.

Table 2. Summary of buffer distances applied to perimeter and kayak surveys in the closed marsh zone, together with the kayak survey transect area and interior marsh area calculations used to estimate total population sizes in the interior closed marsh zone.

Species or species group	Perimeter buffer (m)	Kayak buffer (m)	Interior marsh area (ha)	March kayak transect area (ha)	June kayak transect area (ha)
Ducks, Black Swan, Purple Swamphen	200	200	633.91	392.88	303.23
Magpie Goose, egrets, Australian Pelican	200	100	633.91	196.44	303.23
Grebes, Eurasian Coot, Dusky Moorhen, Comb-crested Jacana	80	50	904.70	98.22	72.88

they flowed through the wetland and drained to Curlewis Bay, flushing the saline open pan zone of the wetland, particularly the hypersaline depression behind the northernmost section of the western bund with freshwater. Rainfall was minimal thereafter, with 4 mm in April, 43 mm in May and 30 mm in June. Overall annual rainfall (July 2011 to June 2012) was 806 mm, slightly less than the long-term average of 853 mm over the period 1961-2018 (Fig. 6).

During the June survey, the water level in the wetland had clearly receded from a peak following the late-March rainfall. Nonetheless, the water level was only slightly lower than that during the early-March survey, and the wetland was still well inundated. Minimal rainfall thereafter (Fig. 5) resulted in drying of the freshwater wetland. During the November survey, the wetland basin was largely dry, having retracted to an area of very shallow water of approximately 35 ha within the central basin of the wetland at Caley Lake. The channel of Saltwater Creek was still inundated east of a raised bar (the far eastern bund) at the point that Saltwater Creek enters the wetland proper. There was also a small area of saline water in a channel immediately east of the causeway pipe, a remnant from tidal inflow during the previous spring tides. The saltpan zone (sectors S1 and S2 in Fig. 2) contained moderate levels of saline water from the tidal flows that influence this zone, and the depression behind the northernmost section of the western bund (sector S2) was inundated with saltwater. During the December survey, the wetland basin zone was completely dry except for a small area immediately east of the causeway. Notably, Caley Lake in the central freshwater basin was completely dry. The high tide survey of the saltpan zone took place on a king high tide that overtopped the western bund wall through multiple breaches along its length to a depth of up to 1 m in places (Fig. 7). These tidal inflows rapidly filled the saltpan zone and in turn overtopped the pipe in the causeway bund, causing saltwater to flow into the main freshwater basin immediately east of the causeway bund.

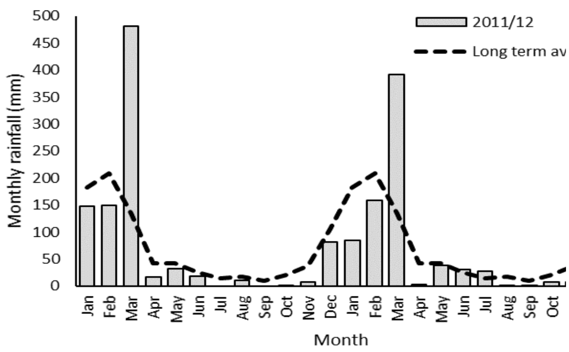


Figure 5. Monthly rainfall during 2011 and 2012 compared to the long-term average.

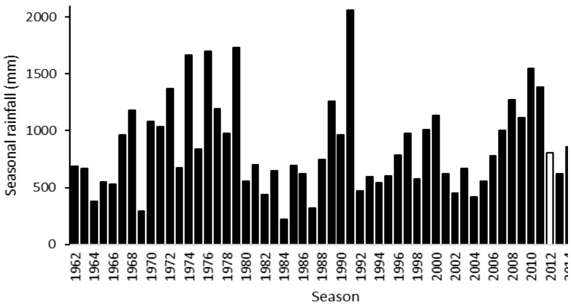


Figure 6. Seasonal rainfall (July-June) over the period 1962-2018.

Figure 7. Tidal flows from the estuary zone into the saltpan zone through breaches in the western bund wall during a spring tide in December 2012. (by ©Penn Lloyd)

Survey coverage and extrapolations

During the February and June surveys, a total edge length of approximately 37.2 km was surveyed on foot over three days around the main wetland basin perimeter and islands (70% and 78% of the total perimeter of the main wetland basin in February and June respectively), whereas during the March survey a total edge length of approximately 41.6 km was surveyed on foot (87% of the total perimeter). The kayak surveys of the interior closed marsh zone during one day of the March and June surveys comprised a total length of approximately 9.8 km, which excluded sections of the kayak path through areas of open water surveyed as part of the open-water surveys and a 1.3 km long survey down Saltwater Creek between the Abbot Point Road bridge and the start of the wetland (survey site A7). The November and December surveys achieved complete survey coverage of the freshwater wetland basin due to the basin drying out.

Freshwater basin and saltpan zones

The main freshwater basin and adjacent saltpan zone supported the greatest species richness and abundance of waterbirds using the Caley Valley Wetland. A total of 66 waterbird species were recorded during the five surveys (Table 3, Appendix 1). The total estimated number of waterbirds increased from around 18,500 in February to 25,000 two weeks later in March and 51,000 in June when the main freshwater basin was well inundated. All portions of the freshwater basin and saltpan zones were surveyed in February except for the closed marsh zone, a sizable portion of the freshwater basin for which waterbird estimates could not be derived. The March and June surveys included surveys to estimate waterbird numbers in the closed marsh zone, but the June survey did not include a survey of the saltpan zone due to time constraints. Waterbird numbers decreased dramatically to 2932 in November when the freshwater basin had mostly dried out, decreasing further to 1294 in December when the freshwater basin had dried out completely and most birds were recorded at a settling pond at the north-eastern edge of the wetland (site A4). During the months when the main freshwater basin was inundated, the waterbird group that feeds predominantly on aquatic plants, including ducks, geese, swans, grebes, coots, moorhens and swamphens dominated the waterbird community, comprising around 75% of the estimated total waterbird population, and their total numbers increased steadily between February and June (Table 4). Shorebirds and other birds including rails, ibises and spoonbills that feed predominantly on invertebrates in shallow waters or wet fringes of wetlands were the next most abundant group (Table 4). However, there was a notable decrease in the abundance of this waterbird group in the two weeks between the February and March surveys, when water levels increased following heavy rainfall and flooding of the wetland, before shorebird numbers increased again by June despite the emigration of most migratory shorebirds. The remaining waterbird groups that feed predominantly on vertebrates, including small fishes, increased steadily in numbers between March and June (Table 4).

Particularly notable species counts, or estimates included 24,550 ducks (of seven species), 2019 Black Swan, 6500 Eurasian Coot, 3184 Purple Swamphen, 4717 White-headed Stilt and 35 Australian Painted Snipe in June (Table 3). Migratory shorebird numbers were greatest in March, when estimates included 1265 Sharp-tailed Sandpiper, 689 Red-necked Stint and 54 Latham's Snipe. While the survey of lower Saltwater Creek recorded only 206 waterbirds in March, 1756 waterbirds were recorded in June, including 783 Plumed Whistling Duck, 391 Little Black Cormorant, a roost of 195 Nankeen Night Heron and 147 Dusky Moorhen. Sharp-tailed Sandpiper and Latham's Snipe occurred along the shallow wetland edges throughout the freshwater wetland basin, whereas Red-necked Stint occurred most abundantly in the saltpan zone.

The saltpan zone supported up to 2850 waterbirds, including up to 1276 migratory shorebirds. The main, southern portion of the saltpan zone (sector S1) experiences regular tidal inflows and was used as foraging habitat by large numbers of Red-capped Plover (up to 661) and Red-necked Stint (up to 1088), with smaller numbers of Sharp-tailed Sandpiper (up to 130). The open marsh and closed marsh zones of the main freshwater basin supported similar waterbird species assemblages and abundances when the freshwater basin was inundated, and there was substantial movement of birds between the two zones. Much of the western shoreline of the open marsh zone lacked fringing sedge marsh and generally supported smaller numbers of shorebirds. However, this more open western shoreline, particularly near the causeway, was used by large numbers of ducks on occasion for resting, and, after heavy rainfall had flooded the normally dry fringing saltmarsh, for foraging as well. The closed marsh zone supported particularly large numbers of waterbirds throughout, and the dense areas of sedge marsh provide the principal nesting area for several waterbird species.

While no Australian Painted Snipe were observed in March, a single group of three birds was flushed in February. During the June survey, 24 Australian Painted Snipe were flushed in groups of one to seven birds from wetland edge situations at widely scattered points throughout the perimeter of the main freshwater basin and its islands (see Fig. 2 for locations of all sightings), with an estimated total population of 35 birds after extrapolation to estimate numbers likely to have been present along the edges of two unsurveyed islands and an unsurveyed portion of the wetland perimeter. This extrapolation does not include a likely undercount in surveyed areas due to the cryptic nature of the species, which only flushed once approached within approximately 5 m. The only group observed well prior to flushing during the June survey included two juvenile birds that were noticeably smaller than the attendant adult.

Species confirmed as breeding within the main freshwater wetland basin included Magpie Goose, Black Swan, Pied Cormorant, Australian Pelican, Australian White Ibis, Purple Swamphen, Great Crested Grebe and Red-capped Plover. A few Black Swan nests were seen in March and by June many pairs were accompanied by broods of typically 3 to 5 cygnets. The total count of 1464 Black Swan in June comprised 986 adults and 478 cygnets. A crèche of 80 large and well-feathered Australian Pelican juveniles still too young to fly were present on one of the central islands in the wetland in June (see Fig. 2 for location), indicating successful breeding by this species on the wetland between the March and June surveys. In June, the tall, dense sedges fringing Caley Lake supported small nesting colonies of approximately 50 nests of Pied Cormorant, each with 4-5 eggs and / or young at one edge, and a smaller nesting colony of Australian White Ibis at another edge (Fig. 2).

Coastal areas

The four coastal areas surveyed, which included three sandy beach sections and one estuary zone section, supported relatively small numbers of migratory shorebirds and other waterbirds. These included up to 153 Pacific Golden Plover, two Whimbrel and two Beach Stone-Curlew on the beach south of the service jetty (sector C1 in Fig. 2), and up to 20 Whimbrel and four Eastern Curlew in sectors C3 and C4 (Appendix 2). While small flocks of migratory shorebirds, particularly Whimbrel were seen roosting on the western bund wall on spring high tides, no significant high tide roost sites were identified in the coastal zone. Dingo Beach, located midway between sectors C1 and C2, was not surveyed due to its cultural heritage significance, but observations from a high viewpoint on One Tree Hill during one survey identified only a handful of birds on Dingo Beach during both high and low tide, including a pair of Sooty Oystercatcher, a species that was not recorded elsewhere.

Table 3. Summary of the total number of waterbirds recorded within the main freshwater basin and saltpan zones of the Caley Valley Wetland during five surveys in 2012. Totals for the months of February, March and June represent the total estimates, with total counts in parentheses. Totals for the months of November and December are total counts. The column "%Pop" indicates the percentage of the national or Australasian population of the species (as reported by Wetlands International 2020) that the maximum estimate at the Caley Valley Wetland represents for species where the maximum estimate exceeds the 1% threshold for international significance for a waterbird (Ramsar Convention Bureau 2000) or 0.1% threshold for national significance for a shorebird (Clemens *et al.* 2008). See Appendix 1 for scientific names.

Common name	Feb	Mar	Jun	Nov	Dec	%Pop
Magpie Goose	798 (704)	1597 (1069)	748 (585)			
Grey Teal	194 (176)	210 (189)	7417 (6312)	447	119	
Pacific Black Duck	3717 (3047)	2548 (2239)	5084 (4169)	98	29	
Hardhead	228 (228)	591 (527)	3053 (2000)	1		
Australian Wood Duck	2 (2)		19 (6)			
Black Swan	1134 (1033)	1575 (1410)	2019 (1464)		1	
Wandering Whistling-Duck	521 (507)	3068 (2980)				
Plumed Whistling-Duck	1346 (816)	2887 (2383)	783 (783)			
Pink-eared Duck			36 (36)			
Green Pygmy-Goose				6		
Radjah Shelduck	1 (1)		1 (1)			
Ducks (Unidentified)	2226 (2226)	1690 (1690)	8157 (6687)			
Great Crested Grebe	9 (9)	50 (9)	161 (104)			
Australasian Grebe	202 (175)	359 (211)	1147 (205)	5		
Australasian Darter	16 (14)	40 (40)	170 (154)	3	1	
Little Pied Cormorant	242 (215)	153 (153)	375 (309)	4	3	
Great Cormorant	2 (2)					
Little Black Cormorant	334 (329)	1204 (1204)	1619 (1539)	6	25	
Pied Cormorant	107 (105)	141 (141)	132 (132)			
Australian Pelican	250 (249)	339 (323)	322 (303)	44	13	
Black-necked Stork	17 (11)	12 (12)	4 (4)	2	1	
Great Egret	355 (232)	333 (289)	526 (386)	7	16	
Intermediate Egret	14 (12)	92 (83)	255 (240)	10		
White-necked Heron			1 (1)			
Cattle Egret	2 (2)	36 (36)	139 (54)	6		
Striated Heron	3 (3)	3 (3)	1 (1)			
Little Egret	316 (242)	368 (311)	96 (71)	4	2	
White-faced Heron	54 (33)	18 (18)	53 (39)	10	5	
Eastern Reef Egret		1 (1)				
Nankeen Night Heron		2 (2)	195 (195)			
Royal Spoonbill	519 (315)	142 (122)	942 (715)	1	2	
Glossy Ibis	0 (0)	52 (41)	444 (335)		7	
Australian White Ibis	188 (123)	60 (38)	99 (89)	1		
Straw-necked Ibis	42 (31)	16 (16)	45 (42)		23	
Brolga	29 (26)	17 (17)	56 (36)	7	2	
Eurasian Coot	82 (82)	729 (269)	6500 (6500)			
Dusky Moorhen	28 (28)	68 (52)	159 (159)			
Buff-banded Rail	11 (10)	9 (9)		3	1	
Lewin's Rail	1 (1)					
Purple Swamphen	1413 (1190)	2821 (2469)	3184 (2136)	170	31	3.18%
Baillon's Crake		2 (2)	1 (1)			
White-headed Stilt	927 (694)	395 (239)	4717 (3201)	48	10	
Red-necked Avocet			7 (7)	320		
Greater Sandplover		1 (1)				
Red-capped Plover	755 (712)	702 (702)	139 (116)	659	533	
Black-fronted Dotterel	58 (58)	23 (14)	193 (142)	16	6	
Red-kneed Dotterel			14 (12)	5	7	
Pacific Golden Plover	1 (1)			2		
Masked Lapwing	506 (357)	317 (254)	670 (431)	32	67	
Comb-crested Jacana	0 (0)	31 (6)	301 (50)	11	2	
Australian Painted Snipe	8 (3)		35 (24)			1.75%
Sharp-tailed Sandpiper	1265 (781)	386 (351)	1 (1)	556	129	0.79%
Red-necked Stint	389 (389)	1224 (1224)	47 (47)	343	117	0.38%
Latham's Snipe	51 (29)	11 (7)		2	2	
Black-tailed Godwit	2 (1)		1 (1)	2		
Eastern Curlew	1 (1)	1 (1)		1	34	0.11%
Little Curlew		1 (1)				
Whimbrel	3 (3)	2 (2)		2	22	
Common Greenshank	40 (37)	35 (35)		14	3	
Marsh Sandpiper	16 (11)	10 (10)	5 (5)	26	3	
Australian Pratincole			14 (14)			
Whiskered Tern	31 (31)	17 (17)	941 (941)			
White-winged Black Tern		19 (19)				
Silver Gull	33 (32)	48 (48)	36 (32)		16	
Gull-billed Tern	32 (30)	87 (87)	70 (67)	56	59	
Caspian Tern	15 (14)	81 (81)	209 (204)	2	1	
Little Tern		48 (48)			2	
Total	**18,536 (15,363)**	**24,672 (21,505)**	**51,343 (41,088)**	**2932**	**1294**	

Table 4. Summary of the total number of waterbirds in different waterbird groups recorded within the main freshwater basin and saltpan zones of the Caley Valley Wetland during five surveys in 2012. Totals for the months of February, March and June represent the total estimates, with total counts in parentheses. Totals for the months of November and December are total counts.

Waterbird group	Feb	Mar	Jun	Nov	Dec
Ducks, geese, grebes, swans, coots, moorhens, swamphens	11,901 (10 224)	18,627 (15 497)	38,468 (31 147)	727	180
Shorebirds (excluding gulls, terns, pratincoles), rails, ibises, spoonbills	4783 (3557)	3420 (3075)	7661 (5219)	2044	968
Terns, gulls, pratincoles	111 (107)	300 (300)	1270 (1258)	58	78
Cormorants, pelicans	951 (914)	1877 (1861)	2618 (2437)	57	42
Egrets, herons, storks, cranes	790 (561)	882 (772)	1326 (1027)	46	26
Total	**18,536 (15,363)**	**25,106 (21,505)**	**51,343 (41,088)**	**2932**	**1294**

DISCUSSION

The large numbers of waterbirds, estimated to number up to approximately 51,000 birds confirm the importance of the Caley Valley Wetland for waterbirds on the central Queensland coast during periods when the main freshwater basin is inundated. The results provide a snapshot of the seasonal change in waterbird use of the main freshwater basin of the wetland as it filled and dried out following a season of approximately average rainfall. The large changes in the abundances of different waterbirds, including over short spaces of time such as the change in shorebird species abundances within ten days between the February and March surveys illustrate the dynamic nature of waterbird use of the wetland, which is typical of ephemeral wetlands in Australia (Kingsford and Porter 1993, 1994, Roshier *et al.* 2002). Many Australian waterbirds are highly nomadic, moving up to 2300 km between wetlands to exploit spatial and temporal variation in both foraging and breeding opportunities (Roshier *et al.* 2002, 2006, 2008a,b, Kingsford *et al.* 2010, Pedler *et al.* 2014). Therefore, the abundances of waterbirds using the Caley Valley Wetland at any point in time likely reflects a dynamic relationship between seasonal variation in foraging and breeding resources in the Caley Valley Wetland itself and alternative opportunities at other wetlands in the broader region. The 2012 surveys followed several consecutive seasons of above-average rainfall (Fig. 5) that was also experienced across much of the region. Since waterbird populations typically increase as a result of higher breeding productivity in years of above average rainfall (Kingsford *et al.* 1999a, Wen *et al.* 2011), the large numbers of waterbirds, particularly ducks, may also to some extent reflect larger regional population sizes following a ‘boom’ cycle (Kingsford *et al.* 1999b).

The surveys reported here recorded 66 waterbird species within the main freshwater basin and saltpan zones of the wetland, together with an additional six waterbird species along the coast. These included 13 migratory shorebird species, four of which (Greater Sandplover, Black-tailed Godwit, Little Curlew and Pacific Golden Plover) had not previously been recorded in the study area. At least a further 12 waterbird species have been recorded at the Caley Valley wetland (Environment Australia 2001, BAAM 2012, WBM BMT 2012).

A wetland may be considered internationally important for a species or subspecies of waterbird if it regularly supports 1% or more of the population of the waterbird (Ramsar Convention Bureau 2000), and may be considered nationally important in Australia for a species or subspecies of shorebird if it regularly supports 0.1% or more of the population of the shorebird (Clemens *et al.* 2008). Under these criteria, the Caley Valley Wetland could potentially qualify as an internationally important site for two waterbird species, Australian Painted Snipe and Purple Swamphen; the maximum estimates for these species represented 1.75% and 3.18% respectively of their estimated national population sizes as reported by Wetlands International (2020) (Table 3). Furthermore, the wetland could potentially qualify as a nationally important site for a further three shorebird species: Sharp-tailed Sandpiper, Red-necked Stint and Eastern Curlew (Table 3). However, further surveys are required to confirm whether the Caley Valley Wetland regularly supports the numbers of these species reported here.

The presence of family groups of Australian Painted Snipe including juveniles during the June survey suggests this species most likely nested in the wetland during 2012, although the possibility that the birds bred elsewhere and subsequently moved to the wetland cannot be excluded. A clutch of Australian Painted Snipe eggs collected on 9th April 1978 in the Caley Valley Wetland is catalogued in the Australian National Wildlife Collection (Atlas of Living Australia 2018), confirming that the species has bred in the wetland. Australian Painted Snipe typically nests in ephemeral wetlands with complex shorelines and a combination of very shallow water, exposed mud and dense low cover drying out after an influx of fresh water, with nests almost invariably placed on small islands (Rogers *et al.* 2005). These requirements were all present within the main freshwater basin of the Caley Valley Wetland. The count of 24 birds and estimated minimum total population size of 35 birds on the wetland in June 2012 is the largest aggregation of this species recorded in Queensland besides a flock of 40 birds observed roosting at Seven Mile Lagoon in the Lockyer Valley of South East Queensland in 2001 included in the Australian Painted Snipe database maintained by BirdLife Australia. The observed density of 6.5 birds per 10 km (24 birds along 37.2 km of wetland edge) in the Caley Valley Wetland in June 2012 is greater than the density of 1.9 birds per 10 km (44 birds along 232.5 km of wetland edge) recorded in rice fields of the Riverina region of New South Wales (Herring and Silcocks 2014). These observations suggest that the Caley Valley Wetland is a periodically important site for this endangered species in Australia (Lane and Rogers 2000, Rogers *et al.* 2003).

The Caley Valley Wetland also supports sizeable nesting populations of a variety of waterbird species, including Black Swan, Australian Pelican, Pied

Cormorant and Australian White Ibis within the main freshwater wetland basin (this study), Australasian Darter and Little Black Cormorant in trees lining Saltwater Creek, and Little Tern on a sand spit at the mouth of Mount Stewart Creek (the western end of sector C3) (BMT WBM 2012). The count of 986 adult Black Swans and 478 cygnets indicates successful breeding by this species on the wetland, confirming its importance as one of the most northerly breeding sites for Black Swan (Blackman *et al.* 1999). A nesting colony of approximately 50 adult Little Terns with numerous nests and three chicks recorded on a coastal sandspit in the estuary zone in October and November 2010 by BMT WBM (2012) confirms the Caley Valley Wetland as one of around five current nesting colony sites for Little Tern in Queensland (Turner 2002, Black 2009, Searle *et al.* 2015); however, this site was not surveyed during the Little Tern breeding season during the current study.

Factors that have potential to degrade waterbird habitat values in the main freshwater basin of the Caley Valley Wetland include: the presence of feral pigs, wild dogs and livestock; the potential for direct loss of wetland areas from future development associated with the neighbouring Port of Abbot Point (e.g. Commonwealth of Australia 2012, Eco Logical Australia and Open Lines 2012, State of Queensland 2014a) and the position of the wetland within the centre of the Abbot Point State Development Area established to facilitate large-scale industrial and port-related development at Abbot Point (State of Queensland 2010a,b, 2014b); downstream impacts from runoff from the coal terminal facilities at the Port of Abbot Point (e.g. State of Queensland 2017); and future sea level rise (BMT WBM 2012). Conversely, there are opportunities to improve the resilience of waterbird habitats within the wetland to future environmental changes through active management of these potential threatening processes. Extensive areas of feral pig diggings were apparent along the far eastern edges of the freshwater wetland in 2012, where feral pigs were also observed in groups of up to ten animals. Feral pigs degrade wetland habitats through their diggings and may prey on waterbird nests. Tracks of wild dogs were occasionally observed, as well as a single animal seen in the wetland during the November survey. Wild dogs may prey on waterbird nests and flightless young. Due to the low-lying nature of the wetland, the main freshwater basin faces a relatively high risk of increased tidal penetration resulting from predicted future sea level rise (BMT WBM 2012), although this risk could be managed through alterations to the causeway bund to more effectively manage tidal flows.

The construction of the western bund in 1984 impeded tidal flows into the saltpan zone of the wetland and resulted in the bund wall trapping saltwater within an impoundment area on the eastern side of the bund in the northern portion of the saltpan zone (sector S2 in Fig. 1). This alteration of tidal hydraulics caused approximately 46 ha of mangrove forest to die back within the impoundment area, which becomes hypersaline (BMT WBM 2012). The continued presence and operation of the western and causeway bunds has been identified as a significant barrier to the movement of aquatic fauna including fish, perceived to be a key threatening process that may lead to further changes in the ecological character of the Caley Valley Wetland (BMT WBM 2012). However, the March 2012 survey recorded 826 waterbirds using the impoundment area behind the western bund, including over 600 Pacific Black Duck and 53 Black Swan, suggesting that the impoundment does periodically support quite large numbers of waterbirds after it is flushed with freshwater when the causeway bund is overtopped during flood events. Removal of the western bund has been suggested as a management action for restoring and rehabilitating the environmental values of the Caley Valley Wetland, particularly the saltpan zone, subject to further technical and risk assessments to determine the potential positive and adverse impacts of various bund removal and mitigation strategies (GHD 2012). The causeway bund's role in impeding the intrusion of saline (marine) water from the west has contributed critically to the formation and maintenance of the freshwater aquatic environment in the main freshwater basin that supports the majority of the waterbirds recorded during these surveys. Given the importance of the causeway bund wall in particular for maintaining habitat values for waterbirds that use the main freshwater basin, any future bund removal and mitigation strategy should carefully consider the potential positive and adverse impacts on habitat values for waterbirds, particularly the main freshwater basin that supports large concentrations of waterbirds when periodically inundated.

In conclusion, the results of this study confirm the importance of the Caley Valley Wetland for a wide variety of waterbirds on the central Queensland coast and provide a snapshot of the seasonal change in waterbird use of the wetland as the main freshwater basin filled and dried out following a season of approximately average rainfall. This information is important for informing the future management of the Caley Valley Wetland to maintain or enhance the ecological values of the wetland as land uses and / or the local environment that influences the wetland changes into the future.

ACKNOWLEDGEMENTS

The surveys reported in this paper were commissioned and paid for by North Queensland Bulk Ports Corporation to inform an assessment of the ecological values of the Caley Valley Wetland and the adjacent coastline. However, the views expressed in this paper remain those of the authors, who were entirely responsible for the design and implementation of the survey programme, and do not imply endorsement by North Queensland Bulk Ports Corporation. Figures 1 and 2 were produced by Bentline Pty Ltd and include material © The State of Queensland, © CNES reproduced under licence from Airbus DS, all rights reserved, © 21AT © Earth-i, all rights reserved, 2017.

REFERENCES

Black, R. 2009. Little Tern makes a good comeback. The Observer. http://www.gladstoneobserver.com.au/news/little-tern-makes-a-good-comeback/422088/

Blackman, J.G., T.W. Perry, G.I. Ford, S.A. Craven, S.J. Gardiner and R.J. DeLai 1999. Characteristics of important wetlands in Queensland. Environmental Protection Agency, Queensland.

BAAM 2012. Cumulative Impact Assessment migratory shorebird and waterbird surveys, Caley Valley Wetland, Port of Abbot Point. Appendix *In*: Preliminary Abbot Point Cumulative Impact Assessment Report. Report prepared for the Abbot Point Working Group by Eco Logical Australia and Open Lines.

BMT WBM 2012. Kaili (Caley) Valley Wetlands Baseline Report. Report prepared for Office of the Coordinator-General, Department of State Development, Infrastructure and Planning by BMT WBM Pty Ltd, February 2012.

Bureau of Meteorology 2018. Climate Data Online for the weather stations Bowen Australian Saltworks (station 033094), Bowen Pump Station Alert (station 033264) and Bowen Airport AWS (station 033327). Available at: http://www.bom.gov.au

Clemens, R.S., A. Haslem, J. Oldland, L. Shelley, M.A. Weston and M.A.A. Diyan 2008. Identification of significant shorebird areas in Australia: mapping, thresholds and criteria. Birds Australia report to the Australian Government's Department of Environment and Water Resources.

Commonwealth of Australia 2012. Approval decision for Alpha Coal Mine and Rail proposal, Galilee Basin, Queensland (EPBC Act referral 2008/4648). Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Eco Logical Australia and Open Lines 2012. Preliminary Abbot Point Cumulative Impact Assessment Report. Report prepared for the Abbot Point Working Group.

Environment Australia 2001. A Directory of Important Wetlands in Australia, Third Edition. Environment Australia, Canberra.

GHD 2009. Terrestrial ecology. Section 4.10 in Abbot Point Coal Terminal X110 Expansion: Infrastructure Development Project Draft Voluntary Environmental Assessment.

GHD 2010 Proposed Abbot Point Multi Cargo Facility Environmental Impact Statement. North Queensland Bulk Ports Corporation Limited.

GHD 2011. Caley Valley wetland freshwater aquatic flora and fauna assessment for rail loop. Appendix AI in Alpha Coal Project (Rail) Supplementary Environmental Impact Statement, Volume 2.

GHD 2012. Abbot Point Cumulative Impact Assessment: Wetland Hydrology and Water Quality. Appendix *In*: Preliminary Abbot Point Cumulative Impact Assessment Report. Report prepared for the Abbot Point Working Group by Eco Logical Australia and Open Lines.

Gregory, R.D., D.W. Gibbons and P.F. Donald 2004**.** Bird census and survey techniques. Pp. 17-55. *In*: Sutherland, W.J., I. Newton and R. Green. (eds). Bird Ecology and Conservation: A Handbook of Techniques. Oxford University Press, Oxford.

Herring, M. and A. Silcocks 2014. The use of rice fields by the endangered Australian Painted Snipe (*Rostratula australis*): a rare opportunity to combine food production and conservation? *Stilt* 66:20–29.

Kingsford, R.T. and J.L. Porter 1993. Waterbirds of Lake Eyre, Australia. *Biological Conservation* 65:141-151.

Kingsford, R.T. and J.L. Porter 1994. Waterbirds on an adjacent freshwater lake and salt lake in arid Australia. *Biological Conservation* 69:219–228.

Kingsford, R.T., A.L. Curtin and J.L. Porter 1999b. Water flows on Cooper Creek in arid Australia determine 'boom'and 'bust' periods for waterbirds. *Biological Conservation* 88: 231-248.

Kingsford, R.T., D.A. Roshier and J.L. Porter 2010. Australian waterbirds–time and space travellers in dynamic desert landscapes. *Marine and Freshwater Research* 61:875-884.

Kingsford, R.T., P.S. Wong, L.W. Braithwaite and M.T. Maher 1999a. Waterbird abundance in eastern Australia, 1983–92. *Wildlife Research* 26:351-366.

Lane, B.A. and D.I. Rogers 2000. The Australian Painted Snipe *Rostratula (benghalensis) australis*: an endangered species. *Stilt* 36:26-34.

Milton, D.A., P.V. Driscoll and S.B. Harding 2014. The importance of Bowling Green Bay and Burdekin River Delta, North Queensland, Australia for shorebirds and waterbirds. *Stilt* 65:3-16.

Pedler, R.D., R.F.H. Ribot and A.T.D. Bennett 2014. Extreme nomadism in desert waterbirds: flights of the Banded Stilt. *Biology Letters* 10:20140547.

Ramsar Convention Bureau 2000. Strategic Framework and Guidelines for the Future Development of the List of Wetlands of International Importance. Ramsar Convention Bureau, Gland, Switzerland.

Reid, J.R.W., R.T. Kingsford and R.P. Jaensch 2010. Waterbird surveys in the Channel Country floodplain wetlands, autumn 2009. Technical report for the Australian Government Department of Environment, Water, Heritage and the Arts by the Australian National University, University of New South Wales and Wetlands International.

Rogers, D., I. Hance, S. Paton, C. Tzaros, P. Griffioen, M. Herring, R. Jaensch, L. Oring, A. Silcocks and M. Weston 2003. The breeding bottleneck: Breeding habitat and population decline in the Australian Painted Snipe. Pp. 15–23. *In*: Straw, P. and D. Milton. (Eds). Status and conservation of shorebirds in the East Asian–Australasian Flyway, Proceedings of the Australasian Shorebirds Conference, 13–15 December 2003, Canberra, Australia. Wetlands International Global Series 18, International Wader Studies 17. Sydney, Australia.

Roshier, D., M. Asmus and M. Klaassen 2008. What drives long-distance movements in the nomadic Grey Teal *Anas gracilis* in Australia? *Ibis* 150:474-484.

Roshier, D.A., V.A. Doerr and E.D. Doerr 2008. Animal movement in dynamic landscapes: interaction between behavioural strategies and resource distributions. *Oecologia* 156:465-477.

Roshier, D.A., N.I. Klomp and M. Asmus 2006. Movements of a nomadic waterfowl, Grey Teal *Anas gracilis*, across inland Australia–results from satellite telemetry spanning fifteen months. *Ardea* 94:461-475.

Roshier, D.A., A.I. Robertson and R.T. Kingsford 2002. Responses of waterbirds to flooding in an arid region of Australia and implications for conservation. *Biological Conservation* 106:399-411.

Searle, J.B., J.B. Prince, D. Stewart and P. Lloyd 2016. Breeding success of a subtropical Little Tern, *Sternula albifrons sinensis*, colony. *Emu* 116:81-85.

State of Queensland 2010a. Abbot Point State Development Area Multi-user Infrastructure Corridor Study, November 2010. Department of Infrastructure and Planning, Brisbane.

State of Queensland 2010b. Land and Infrastructure Planning Study for the Central Portion of the Abbot Point State Development Area, November 2010. Department of Infrastructure and Planning, Brisbane.

State of Queensland 2014a. Abbot Point Port and Wetland Project EPBC Act referral 2014-7355. Department of State Development, Infrastructure and Planning, Brisbane.

State of Queensland 2014b. Abbot Point State Development Area Development Scheme, November 2014. Department of State Development, Infrastructure and Planning, Brisbane.

State of Queensland 2017. Preliminary assessment of impacts to Caley Valley Wetlands from Abbot Point Coal Terminal post Tropical Cyclone Debbie. Department of Science, Information Technology and Innovation, Brisbane.

Turner, M. 2002. Coastal bird monitoring strategy for the Great Barrier Reef World Heritage Area. Great Barrier Reef Marine Park Authority, Townsville.

Wen, L., K. Rogers, N. Saintilan and J. Ling 2011. The influences of climate and hydrology on population dynamics of waterbirds in the lower Murrumbidgee River floodplains in Southeast Australia: implications for environmental water management. *Ecological Modelling* 222:154-163.

Wetlands International 2020. Waterbird Population Estimates. Retrieved from wpe.wetlands.org on 24/01/2020.

Appendix 1. Scientific and common names of species recorded during the 2012 surveys of the Caley Valley Wetland and adjacent coastline.

Species	Common name	Status*
Anseranas semipalmata	Magpie Goose	
Anas gracilis	Grey Teal	
Anas superciliosa	Pacific Black Duck	
Aythya australis	Hardhead	
Chenonetta jubata	Australian Wood Duck	
Cygnus atratus	Black Swan	
Dendrocygna arcuata	Wandering Whistling-Duck	
Dendrocygna eytoni	Plumed Whistling-Duck	
Malacorhynchus membranaceus	Pink-eared Duck	
Nettapus pulchellus	Green Pygmy-Goose	
Tadorna radjah	Radjah Shelduck	
Podiceps cristatus	Great Crested Grebe	
Tachybaptus novaehollandiae	Australasian Grebe	
Anhinga novaehollandiae	Australasian Darter	
Phalacrocorax melanoleucas	Little Pied Cormorant	
Phalacrocorax carbo	Great Cormorant	
Phalacrocorax sulcirostris	Little Black Cormorant	
Phalacrocorax varius	Pied Cormorant	
Pelecanus conspicillatus	Australian Pelican	
Ephippiorhynchus asiaticus	Black-necked Stork	
Ardea modesta	Great Egret	
Ardea intermedia	Intermediate Egret	
Ardea pacifica	White-necked Heron	
Ardea ibis	Cattle Egret	
Butorides striatus	Striated Heron	
Egretta garzetta	Little Egret	
Egretta novaehollandiae	White-faced Heron	
Egretta sacra	Eastern Reef Egret	
Nycticorax caledonicus	Nankeen Night Heron	
Platalea regia	Royal Spoonbill	
Plegadis falcinellus	Glossy Ibis	M
Threskiornis molucca	Australian White Ibis	
Threskiornis spinicollis	Straw-necked Ibis	
Grus rubicunda	Brolga	
Fulica atra	Eurasian Coot	
Gallinula tenebrosa	Dusky Moorhen	
Gallirallus philippensis	Buff-banded Rail	
Lewinia pectoralis	Lewin's Rail	
Porphyrio porphyrio	Purple Swamphen	
Porzana pusilla	Baillon's Crake	
Esacus magnirostris	Beach Stone-Curlew	
Haematopus fuliginosus	Sooty Oystercatcher	
Haematopus longirostris	Australian Pied Oystercatcher	
Himantopus leucocephalus	White-headeded Stilt	
Recurvirostra novaehollandiae	Red-necked Avocet	
Charadrius leschenaultii	Greater Sandplover	V, M
Charadrius ruficapillus	Red-capped Plover	
Elseyornis melanops	Black-fronted Dotterel	
Erythrogonys cinctus	Red-kneed Dotterell	
Pluvialis fulva	Pacific Golden Plover	M
Vanellus miles	Masked Lapwing	
Irediparra gallinacea	Comb-crested Jacana	
Rostratula australis	Australian Painted Snipe	E
Calidris acuminata	Sharp-tailed Sandpiper	M
Calidris ruficollis	Red-necked Stint	M
Gallinago hardwickii	Latham's Snipe	M
Limosa limosa	Black-tailed Godwit	M
Numenius madagascariensis	Eastern Curlew	CE, M
Numenius minutus	Little Curlew	M
Numenius phaeopus	Whimbrel	M
Heteroscelus incanus	Wandering Tattler	M
Tringa nebularia	Common Greenshank	M
Tringa stagnatilis	Marsh Sandpiper	M
Stiltia isabella	Australian Pratincole	
Chlidonias hybrida	Whiskered Tern	
Chlidonias leucopterus	White-winged Black Tern	M
Chroicocephalus novaehollandiae	Silver Gull	
Gelochelidon nilotica	Gull-Billed Tern	M
Hydroprogne caspia	Caspian Tern	M
Sternula albifrons	Little Tern	M
Thalasseus bengalensis	Lesser Crested Tern	
Thalasseus bergii	Crested Tern	

* Conservation status under the Australian *Environment Protection and Biodiversity Conservation Act 1999*: CE = critically endangered, E = endangered, V = vulnerable, M = migratory

Appendix 2. Species abundance in the different coastline sectors surveyed at each of high tide (HT) and low tide (LT) phases of the tide cycle.

Date	**21/02/2012**								**20/11/2012**				**13/12/2012**		**12/12/2012**	
Tide	**High tide (HT)**				**Low tide (LT)**				**HT (2.68m)**		**LT (1.02m)**		**HT (3.36m)**		**LT (0.77m)**	
Sector	**C1**	**C2**	**C3**	**C4**	**C1**	**C2**	**C3**	**C4**	**C1**	**C2**	**C1**	**C2**	**C1**	**C2**	**C1**	**C2**
Australasian Darter									1		1		1			
Little Pied Cormorant							1									
Little Black Cormorant			2													
Pied Cormorant		20	1			10	10									
Black-necked Stork				2				2								
Striated Heron							1									
Little Egret				1												
White-faced Heron				2						1	1	1			1	1
Eastern Reef Egret			1				1									
Beach Stone-Curlew			1		2						2				2	
Australian Pied Oystercatcher	2	2			2	2	2		3		5	1	4		4	2
Red-capped Plover			24				20				21				4	
Pacific Golden Plover							7		2		153				75	
Masked Lapwing														2		
Red-necked Stint											8				2	
Eastern Curlew			1	3			4									
Whimbrel			11	9			11	4		1	2	1		1	2	1
Wandering Tattler			1		1		2									
Silver Gull									1	1		2	1			
Gull-billed tern							13		7		7				15	
Caspian Tern							5		3	1	2	1	1			
Lesser Crested Tern			3				3									
Crested Tern			1												9	3
Total	**2**	**22**	**46**	**17**	**5**	**13**	**80**	**6**	**17**	**5**	**202**	**6**	**9**	**3**	**117**	**7**

CHANGES IN MIGRATORY SHOREBIRD NUMBERS AND DISTRIBUTIONS IN SOUTH-EAST TASMANIA (1965 – 2014)

MIKE NEWMAN[1], ERIC J. WOEHLER[2], SUSAN DRAKE[2] AND ALAN FLETCHER[2].

[1]72 Axiom Way, Acton Park, Tasmania 7170, AUSTRALIA.
Email: omgnewman@bigpond.com
[2]BirdLife Tasmania, GPO Box 68 Hobart, Tasmania 7001, AUSTRALIA.

Migratory shorebirds are primarily found at five locations in south-east Tasmania. Analysis of annual summer and winter shorebird counts indicated that species-specific changes have occurred in the distribution of shorebirds among the five locations. Overall, Holarctic breeding migratory shorebirds have decreased in south-east Tasmania during the last 55 years. Examples include the Curlew Sandpiper *Calidris ferruginea* and Eastern Curlew *Numenius madagascariensis*, both listed as Critically Endangered. Curlew Sandpipers, formerly the second most numerous species with numbers exceeding 1000, have become rare visitors to the region. Similarly, the number of Eastern Curlew has decreased by more than 90% compared with around 300 in the 1960s. As their numbers decreased larger species consolidated into a single flock and favoured locations with least disturbed roosts. Smaller species continued to exploit all suitable habitat. At all five locations, there is evidence of deterioration in habitat quality. The decreases in migratory shorebird numbers in south-east Tasmania are consistent with those experienced throughout the East Asian-Australasian Flyway, but exaggerated by its position at southern extremity of the Flyway. While the causes of these decreases at flyway scale may lie primarily outside south-east Tasmania, it is uncertain whether its shorebird habitats remain capable of supporting the peak population levels recorded in the earlier decades of this study. This is of concern if the Flyway's migratory shorebird populations recover and predicted changes in climatic conditions occur shift shorebird distributions towards the southern limits of their range.

INTRODUCTION

The south-east Tasmanian shorebird populations occur at the southern extremity of the East Asian-Australasian Flyway (EAAF). This provides an advantage for understanding changes in population sizes because there are no passage birds (Thomas 1968 and 1970). Furthermore, changes in population sizes may act as a precursor for changes throughout the flyway (Close and Newman 1984; Reid and Park 2003).

Newman and Woehler (2016) suggested that a leapfrog migration mechanism, in which a species' range contracted as its Flyway population size decreased, might explain variations in the size of the south-east Tasmanian population of the Red-necked Stint *Calidris ruficollis*. Central to the leapfrog migration proposition is the concept that juveniles actively seek locations where shorebird densities are below carrying capacity when selecting locations where they establish long term "territories" for that portion of their life cycle spent in Australia. As populations fall below carrying capacities at more northern latitudes in Australia, juveniles no longer need to travel to more southern sites in south-east Tasmania.

In this paper, we examine the results of shorebird count data spanning 50 years. During this period, there have been significant decreases in shorebird population sizes in south-east Tasmania (Reid and Park 2003, Newman and Woehler 2016) coupled with corresponding decreases elsewhere in Australia (Clemens *et al.* 2016; Wilson *et al.* 2011). Differences in the distribution of shorebird species among locations supporting various species in south-east Tasmania are examined in an attempt to identify factors influencing the observed changes in distributions as numbers decrease. In particular, we examine the possibility that as population densities decrease, species may consolidate at those locations that provide the best foraging and roosting opportunities until the carrying capacity for the location is reached.

While shorebird species breeding in the northern hemisphere are the primary focus of this paper, the analysis also considers the Double-banded Plover *Charadrius bicinctus*, a trans-Tasman Sea migrant, whose population dynamics are not influenced by conditions at stop-over locations elsewhere in the Flyway. The study excludes the resident shorebird species (e.g. Australian Pied Oystercatcher *Haematopus longirostris*), where other factors like nest site availability drive changes in population dynamics and regional distribution (Fletcher and Newman 2010).

Banding studies in south-east Tasmania, have predominantly involved cannon net catches (Harris 1982; 1983a and 1986). These provide important insights into movements of shorebird both locally and elsewhere in the flyway. The two most numerous species, Red-necked Stint and Curlew Sandpiper were the targets of most catches with the objective of recovering individuals previously banded. Only low numbers of other species were captured. The age of birds was determined by their plumage to determine juvenile proportions. Immediately before migration in 1984, a high number of Red-necked Stint and Curlew Sandpiper were colour-dyed and a number were subsequently observed elsewhere in the EAAF (Harris 1986).

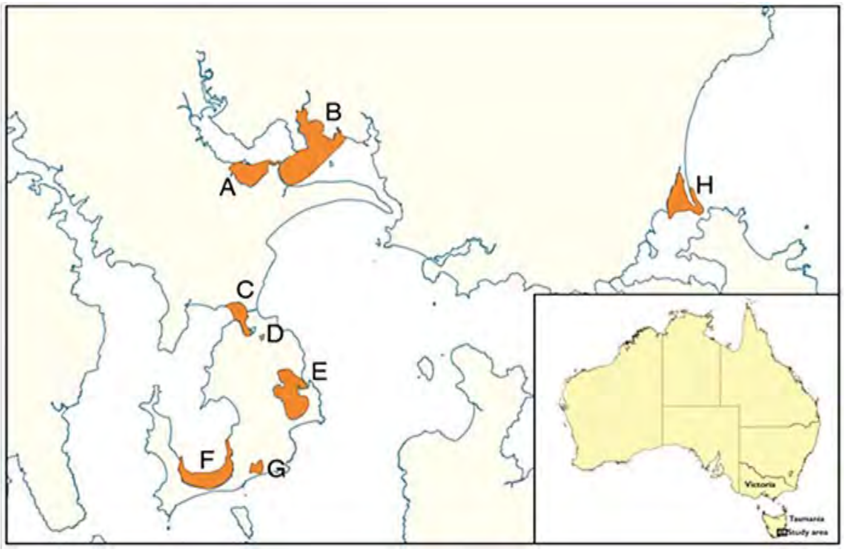


Figure 1. Shorebird Areas in south-east Tasmania: Pitt Water (A Barilla Bay and B Orielton Lagoon), South Arm (C Lauderdale, D Clear Lagoon, E South Arm Neck, F Pipeclay Lagoon and G Calvert's Lagoon) and on the east coast (H Marion Bay).

METHODS

Description of shorebird habitat

The shorebird areas discussed in this paper geographically fall into two categories, Pitt Water and South Arm, both having several sub-areas in close proximity (Fig. 1). Physical separation is a factor determining the partition of migratory shorebirds among the available habitat options.

Pitt Water areas

The Pitt Water shorebird areas are at the northern extremity of Frederick Henry Bay, which is separated from the Derwent Estuary by the South Arm Peninsula. Approximately 250 ha of sand and mudflat are exposed at low tide extending from Iron Creek in the east to Five Mile Beach in the west. These areas are separated from Orielton Lagoon at the north by a causeway linking the residential areas of Midway Point and Sorell. There are extensive areas of saltmarsh at the northern extremity of Orielton Lagoon through which Orielton and Frogmore Creeks flow (Prahalad and Pearson 2013).

Roosts are located at the mouth of Sorell Creek within Frederick Henry Bay and at several locations within Orielton Lagoon (Park 1983). As the shorebirds regularly alternate between the use of these roosts, Orielton Lagoon and Sorell are reported as a single shorebird site when assessing the results of high tide counts. A breeding colony of Kelp Gulls *Larus dominicanus* became established at the northern end in the 1980s. Use of roosts at Iron Creek and Five Mile Beach seldom involves substantial numbers of migratory shorebirds.

Barilla Bay, which lies to the west of Midway Point, is also separated from Frederick Henry Bay by a causeway. It receives more tidal flushing than Orielton Lagoon and extends northward towards Richmond, where it is fed by the Coal River. The important areas for migratory shorebirds are in the south-west of the bay, bounded to the south and west by the Hobart and Cambridge Airports. A narrow peninsula, Railway Point, forms the northern boundary. The habitat is varied with areas of mud flat and saltmarsh containing intermittently flooded pools and a claypan that is usually dry (Patterson 1982). There is limited public access and the area is relatively less disturbed than the other shorebird locations described in this paper. Patterson (1982) described the use of a number of roosts the most important of which is the stony northern end of an islet at the tip of Railway Point, but notes that the saltmarsh lagoons and claypan are used on occasions. Paterson (1982) considered Barilla Bay to be a discrete shorebird location with no regular diurnal movement of shorebirds to other parts of the Pitt Water area.

South Arm areas

The summary of a report prepared by Priscilla Park and the late Bill Wakefield (Bird Observers' Association of Tasmania 1982) provides an excellent historical overview of the various habitats in the South Arm area from the 1970s and 1980s, which include Lauderdale, the South Arm Neck and Pipeclay Lagoon. In addition, there are two ephemeral wetlands, Clear and Calvert's Lagoons (Fig. 1). Lauderdale and South Arm Neck are part of Ralphs Bay which connects to the Derwent Estuary. They are separated by approximately 5km of coastline which includes several sandy beaches; the largest of which is Gorringes Beach, but these seldom support migratory shorebirds. Pipeclay Lagoon located on the eastern side of the South Arm Peninsula opens into Frederick Henry Bay at Cremorne.

Lauderdale is an embayment with extensive tidal mudflats. A road on the eastern edge passes over a causeway separating the bay from an area known as East Marsh, which is dominated by a large shallow lagoon (Prahalad and Pearson 2013). Culverts under the causeway provide intermittent tidal flow into the lagoon, which is surrounded by saltmarsh. At Lauderdale, the most important roost is a spit that extends into the bay on the northern side of a canal intended to link the Derwent Estuary with Frederick Henry Bay, construction of which was completed in 1924. The project was unsuccessful because of the near-immediate siltation at the canal's Frederic Henry Bay entrance.

The spit, which was constructed from canal dredging spoil, has been steadily eroded and is now totally inundated during storm-driven high tides. The sides of the spit no longer provide a reliable high tide roost. Small migratory shorebird species now roost on a shell grit beach shelf immediately to the north of the canal. However, this beach can be completely inundated and reconfigured by storm-driven tides. When larger shorebird species (e.g. Eastern Curlew and Bar-tailed Godwit) roost at Lauderdale, their numbers are low, sometimes involving solitary birds, which hide within the saltmarsh on the spit and at the southern end of the bay adjacent to Doran's Road. The northern side of East Marsh Lagoon provides an alternative and is often used by Australian Pied Oystercatchers. However, when gale force winds exacerbate tidal inundation of the spit, there is no shelter on East Marsh and birds must seek other options; Australian Pied Oystercatchers move to the sheltered hillside above Doran's Road and may even roost on the road (Newman 2015).

Extensive tidal mudflats at South Arm Neck are bordered by the South Arm Road. The most important roost for this area was a secluded bay on private property, where an extensive shell grit bank had formed in front of an area of saltmarsh. At intermediate tides, the shorebirds roosted on temporary spits extending into the bay from the shore adjacent to the South Arm Road. Following the progressive erosion of historical roosts, small shorebirds now regularly roost on a small rocky spit near the extremity of the South Arm peninsula, approximately 3 km from the main roost formerly used by birds feeding at South Arm Neck (Newman 2015). The small bays surrounding this new roost have steeply shelving sandy beaches and do not provide feeding opportunities.

Pipeclay Lagoon, the third major shorebird habitat in the South Arm area, is a large land-locked tidal lagoon with a narrow entrance. It contains extensive areas of mudflat and several areas of saltmarsh and claypans. During the last 50 years, the perimeter of the lagoon has been progressively developed, particularly around Bicheno Street in the south-east, and at Cremorne near the entrance in the north-east. Historically, the main roost was on a shell grit bank near the Lagoon's entrance on the southern side. However, this roost has become increasingly disturbed following the development of oyster leases for aquaculture in the lagoon, which are serviced from the vicinity of the shorebird roost. The most important alternative high tide roost involves a claypan bordering saltmarsh at the north-eastern corner of the lagoon on farmland adjacent to Cremorne Road.

Clear Lagoon is a small reserve near Lauderdale that floods intermittently and provides excellent supra-tidal habitat when it is drying out. It is located near East Marsh at Lauderdale. Recently it has flooded less regularly, probably because of changed drainage diverting flood water into Pipeclay Lagoon located to the south. Hence, it is less important to migratory shorebirds than during Thomas' studies (1964-68).

Calvert's Lagoon is located between Pipeclay Lagoon and South Arm Neck, and still floods regularly, although the establishment of dams on acreage developments in the catchment is likely to have decreased the amount of run-off water entering the lagoon. It is an extensive lagoon with small areas of peripheral saltmarsh. Its surrounds are relatively undeveloped and despite passive recreational activities occurring within the reserve, it is relatively undisturbed

Survey protocols

Thomas conducted surveys at five sites in the South Arm area (Lauderdale, Pipeclay Lagoon, Ralphs Bay Neck, Calvert's Lagoon and Clear Lagoon) and at two sites in the Pitt Water area (Orielton Lagoon/Sorell and Barilla Bay) between July 1964 and December 1968 (Fig. 1). Surveys were conducted throughout the year, with typically at least eight counts at each location annually. Peak counts for two periods January / February and June / July were used to calculate the mean five-year summer population sizes for migratory shorebird species breeding in the northern hemisphere and a winter population for the Double-banded Plover, a visitor from New Zealand, respectively. Annual population estimates were made by Thomas and were checked by the authors against his raw data (which are held by BirdLife Tasmania) in order to understand his methodology. His estimates were based on species annual maxima. Duplicate counts, which appeared to involve local movements among sites, were disregarded. Summaries of Thomas' results were published in Thomas (1968 and 1970).

The Bird Observers' Association of Tasmania (BOAT) commenced Summer Wader Counts (SWCs) in 1972 (a pilot count) and Winter Wader Counts (WWCs) in 1980. These counts involved synchronised counts of shorebirds at high tide roosts by individuals or teams allocated to the shorebird locations identified in Thomas (1968). Where possible, SWCs occurred in February as Thomas' work indicated that populations peaked at this time as birds accumulated before migration. However, this finding has not been confirmed since 1985. WWCs were made in June and July before migrants breeding in the northern hemisphere returned.

BOAT formed a Shorebird Study Group that conducted monthly surveys for a period of five years in the early 1980s. Each area had an assigned counter who developed an intimate knowledge of their area and was encouraged to document habitat descriptions including the area used for roosting and feeding (e.g. Bird Observers' Association of Tasmania 1982, Park 1983, Patterson 1982, Woehler 2014). Newman and Woehler (2016) provide further details on the shorebird counts, which were progressively expanded to include Five Mile Beach, Iron Creek and Marion Bay. Five Mile Beach and Iron Creek were not surveyed by Thomas and are of minor importance to migratory shorebirds. Marion Bay is more important but is excluded from this analysis because there appears to be limited movement between that area and the sites discussed in this paper. SWC and WWC data and summaries are periodically reported in the Tasmanian Bird Report Series (e.g. Woehler and Drake 2015).

Table 1. Changes in the relative importance of the Pitt Water and South Arm habitats to migratory shorebirds in south-east Tasmania for the period 1965 to 2014.

Species	1965/69	1970/74	1975/79	1908/84	1985/89	1990/94	1995/99	2000/04	2005/09	2010/14
Eastern Curlew	0.80 P[1]	N.D.[3]	0.92 P	0.91 P	0.92 P	0.97P	0. 96P	0.95P	0.95 P	0.98 P
Bar-tailed Godwit	0.80 P	N.D.	0.74 P	0.57 S[2]	0.99 P	1.00 P	0.95 P	0.91 P	0.91 P	0.97P
Common Greenshank	0.80 P	N.D.	0.78 P	0.62 P	0.71 P	0.90 P	1.00 P	1.00 P	1.00 P	1.00 P
Pacific Golden Plover	0.80 P	N.D.	0.65 P	0.94 P	0.99 P	0.99 P	0.87 P	1.00 P	1.00 P	1.00 P
Double-banded Plover	0.68 S	N.D.	N.D.	0.58 P	0.67 P	0.70 P	0.66 P	0.68 P	0.65 P	0.59 P
Curlew Sandpiper	0.73 P	N.D.	0.55P	0.83 S	0.75 S	0.63 P	0.65 S	0.78 S	0.84 S	N.R.[4]
Red-necked Stint	0.80 P	N.D.	0.73 S	0.70 S	0.74 S	0.58 S	0.55 S	0.57 S	0.60 P	0.51 P

[1] 0.80 P indicates 80% of population present at Pitt Water locations. Dark grey shading indicates > 50% of population at Pittwater locations.
[2] 0.57 S indicates 57% of population present at South Arm locations. Light grey shading indicates > 50% of population at South Arm locations.
[3] N.D. indicates no data
[4] N.R indicates no records.

Analysis of results

Five-year means of SWCs and WWCs were used to determine temporal changes because of the error in shorebird counts involving many observers (Rogers *et al.* 2006a). There was a five-year gap between Thomas SWC surveys (1965/69) and the first reliable data set generated by the BOAT members (1975/79) and a 10-year gap to the corresponding WWC data set (1980/84).

RESULTS

There were decreases in all species of migratory shorebirds as shown in Figures 2a-i. As these decreases occurred, some species, particularly the larger species consolidated into a single flock favouring one or two locations as summarised in Table 1 which provides an overview of changes in the relative importance of the Pitt Water and South Arm habitats to migratory shorebird species over the 50-year period 1965 to 2014. Red Knot *Calidris canutus* and Sharp-tailed Sandpiper *C. acuminata* were excluded from Table 1 because of insufficient data for Red Knot and the high inter-annual variation in the population size for Sharp-tailed Sandpiper.

Pacific Golden Plover *Pluvialis fulva*

Orielton Lagoon / Sorell has been the favoured location for Pacific Golden Plovers throughout the last 50 years (Fig. 2a and Table 1). However, Thomas recorded them regularly in the South Arm area during the period 1965-69, particularly at Pipeclay Lagoon and to a lesser extent at South Arm Neck, but not at Lauderdale. The use of the South Arm locations decreased during 1980-84, and since then it has been an occasional visitor to that area. Following a decrease exceeding 80% compared with peak population size, which occurred during 1995-99, the species has been recorded almost exclusively from Orielton Lagoon / Sorell. Pacific Golden Plovers are a difficult species to survey as they often forage and roost away from the main high tide roost sites and they could be missed if their foraging habits and preferred roosts changed. The problem of detecting this and other cryptic species is exacerbated in the saltmarsh at Orielton Lagoon where the presence of a Kelp Gull colony prevents a close approach to feeding and roosting shorebirds without them being disturbed.

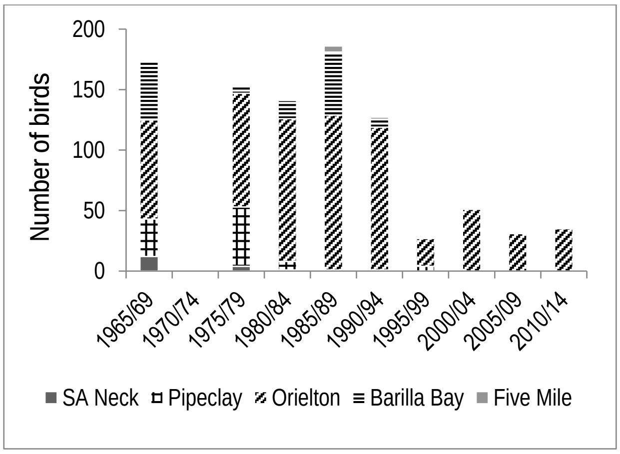


Figure 2a. Changes in the distribution of Pacific Golden Plovers (No SWCs Summer wader counts 1970–74).

Double-banded Plover *Charadrius bicinctus*

Double-banded Plover numbers peaked in the period 1990-94, before decreasing to 37% of their peak value in 2010-14 (Fig. 2b and Table 1). They occurred in modest numbers (typically fewer than 50) at all the locations. In Thomas' studies (1965-68), the species was more numerous at South Arm sites, but by 1980-84 this situation was reversed with Pitt Water sites preferred. When the population experienced a period of sustained decrease post 1990-94, the rates of decrease were similar in both areas.

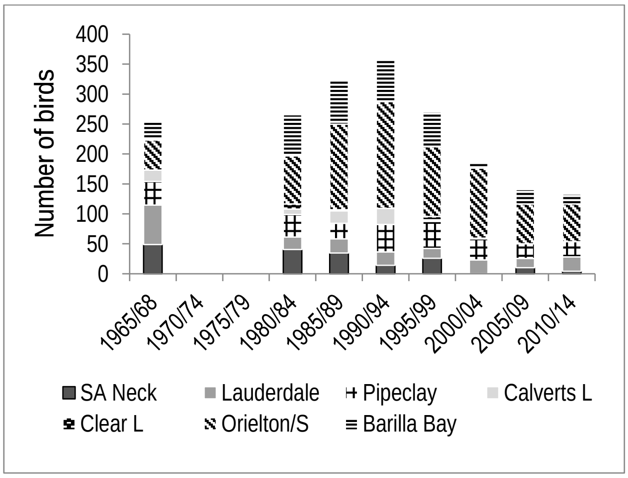


Figure 2b. Changes in the distribution of Double-banded Plover (No WWCs 1970-1979).

Eastern Curlew *Numenius madagascariensis*

Eastern Curlew numbers have decreased steadily from above 250 in 1965-69 to fewer than 20 at the present time (Fig. 2c and Table 1). Initially around 20% of the population was regularly recorded in the South Arm area, but as numbers decreased, the Pitt Water sites were used almost exclusively. Most of the Pitt Water records were from Orielton Lagoon / Sorell, with until 2014 infrequent occurrences at Barilla Bay and more occasionally Five Mile Beach. However, since 2014 the use of Barilla Bay has increased with 5-19 regularly present. In the South Arm area, most of the Eastern Curlew records were from Lauderdale and South Arm Neck, with Thomas' surveys suggesting regular movement between these adjacent locations; Pipeclay Lagoon was seldom used. In the last 25 years, occurrences at the South Arm sites have been occasional and involving very low numbers of birds.

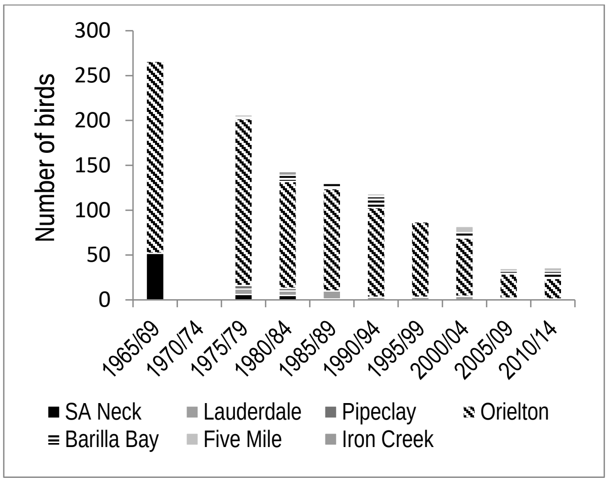


Figure 2c. Changes in the distribution of Eastern Curlew (No SWCs Summer wader counts 1970–74).

Bar-tailed Godwit *Limosa lapponica*

Bar-tailed Godwit numbers have decreased by approximately 50% over the study period (Fig. 2d) and / Sorell were the species' preferred location, although the South Arm sites supported about 30% of the population initially. However, as the total population decreased from a peak of around 120, the Pitt Water sites were increasingly favoured, and godwits were seldom recorded at the South Arm sites. Thomas' monthly counts indicated a movement of godwits from the South Arm area to Pitt Water around January ahead of their autumn departure. The use of the December 1968 count (in the absence of subsequent counts for that summer) to determine the mean summer population level by Thomas (1968 and 1970) may have slightly increased the reported proportion using South Arm for the period 1965-69.

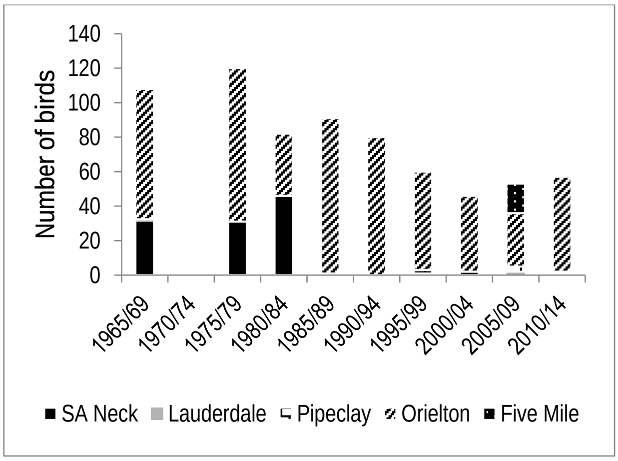


Figure 2d. Changes in the distribution of Bar-tailed Godwit (No SWCs Summer wader counts 1970–74).

Red Knot *Calidris canutus*

Never a numerous species, Red Knot numbers have decreased since Thomas' studies in the 1960s (Fig. 2e). Since 2000, its status has become that of an occasional visitor, seldom recorded during SWCs. Thomas predominantly recorded the species at Orielton Lagoon / Sorell, whereas in the other period when it was more numerous (1975-79), with most records from the South Arm Neck.

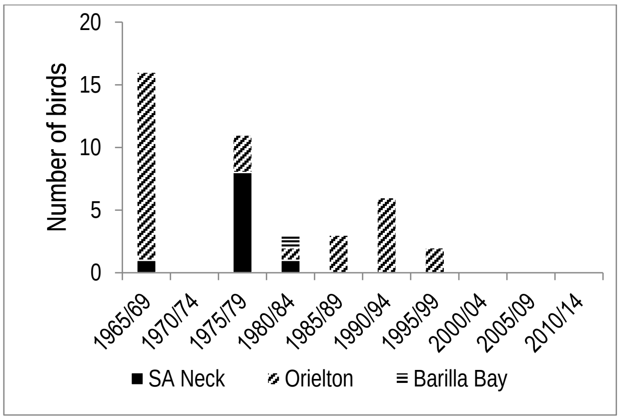


Figure 2e. Changes in the distribution of Red Knot (No SWCs Summer wader counts 1970–74).

Sharp-tailed Sandpiper *Calidris acuminate*

Even when Sharp-tailed Sandpiper were relatively numerous (1965-69 and 1985-89 SWCs), there was considerable inter-annual variation in their population size (Fig. 2f). Most of the records were from the Pitt Water sites with both Orielton Lagoon / Sorell and Barilla Bay being regularly favoured. Since 2000, Sharp-tailed Sandpipers have been occasional visitors, seldom recorded in SWCs.

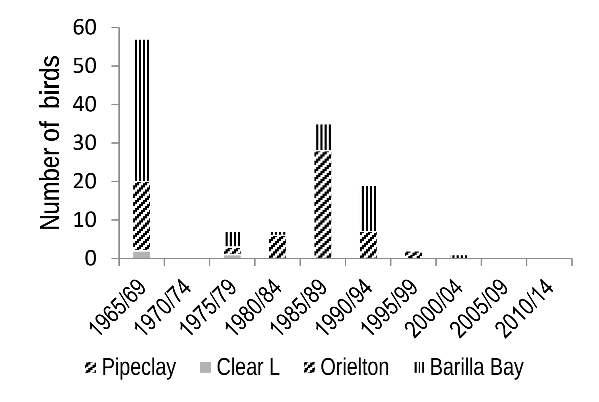


Figure 2f. Changes in the distribution of Sharp-tailed Sandpiper (No SWCs Summer wader counts 1970–74).

Curlew Sandpiper *Calidris ferruginea*

Thomas predominantly recorded Curlew Sandpiper at the Pitt Water sites in the period 1965-69 (Fig. 2g and Table 1). His monthly data indicated that they used supra-tidal feeding opportunities when the ephemeral wetlands at Clear and Calvert's Lagoons were drying out. He also recorded low numbers at Lauderdale, adjacent to Clear Lagoon. In contrast, by 1975-79 the use of the South Arm sites had increased, and they supported 45% of the population. This trend continued and in the 10-year period 1980-89, South Arm supported over 75% of the birds, primarily at South Arm Neck and Pipeclay Lagoon. The ephemeral Calvert's Lagoon, which lies between these two sites, was used when conditions there were suitable. The population decreased steadily over the next 20 years with the South Arm sites usually, but not exclusively, supporting most of the population. By 2010-14 the species had become rare in south–east Tasmania and was no longer reported in SWCs after 2010 other than of occasional birds.

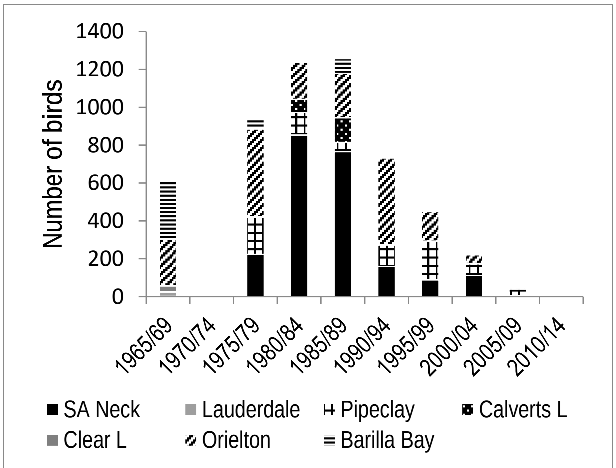


Figure 2g. Changes in the distribution of Curlew Sandpiper (No SWCs Summer wader counts 1970–74).

Red-necked Stint *Calidris ruficollis*

The distribution of Red-necked Stint among the shorebird sites was similar to that of the Curlew Sandpiper (Fig. 2h and Table 1). In Thomas' studies, stints were predominantly found at the Pitt Water sites, with Barilla Bay favoured. However, when systematic survey effort resumed in 1975-79, the population, which had increased in size, was mainly present at the South Arm locations and the numbers of birds found at the Pitt Water sites had decreased. As the population decreased post 1985-89, losses were more pronounced at the South Arm sites than at Pitt Water. Throughout the study, Red-necked Stints continued to frequent all the five locations originally identified by Thomas, namely South Arm Neck, Pipeclay Lagoon, Lauderdale, Orielton Lagoon / Sorell and Barilla Bay although there were fluctuations in the proportion of the population using each. Clear and Calvert's Lagoons both provided ephemeral supra-tidal foraging, which was exploited opportunistically when conditions were suitable. The use of other areas like Five Mile Beach and Iron Creek was minor. The main difference from Curlew Sandpipers was at Lauderdale where stints were regularly observed while Curlew Sandpipers seldom occurred.

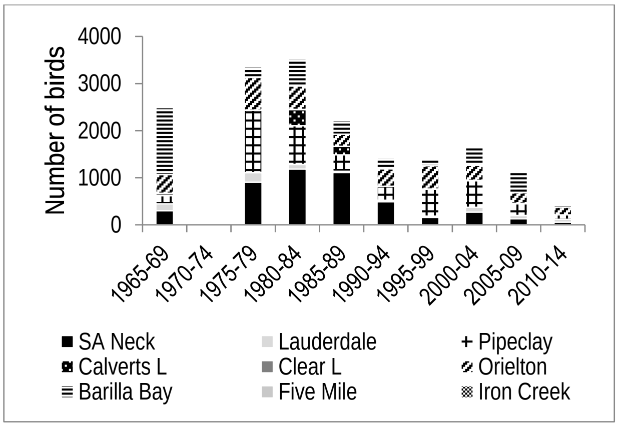


Figure 2h. Changes in the distribution of Red-necked Stint (No SWCs Summer wader counts 1970–74).

Common Greenshank *Tringa nebularia*

The Common Greenshank has never been a numerous species in the study area, with a peak mean of 81 birds for the period 1980-85 (Fig. 2i and Table 1). During the next 30 years, their numbers decreased steadily and by 2010-14 the mean population was 16, an 80% decrease. Pitt Water sites were preferred, but during the first 30 years the species was regularly present in the South Arm area, mainly at the Neck. The most favoured sites were South Arm Neck and Orielton Lagoon / Sorell, although Thomas regularly recorded the species at Barilla Bay.

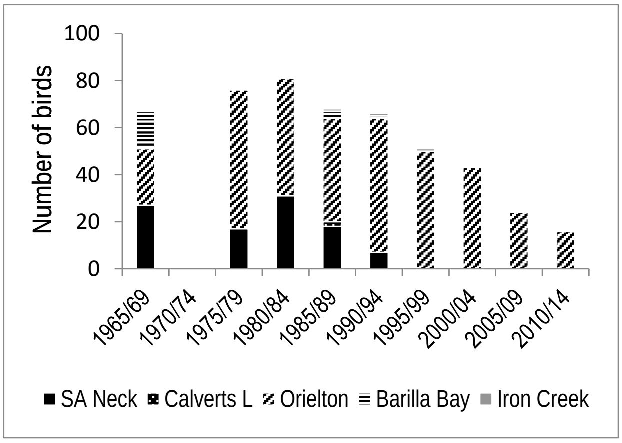


Figure 2i. Changes in the distribution of Common Greenshank (No SWCs Summer wader counts 1970–74).

DISCUSSION

In Thomas' baseline studies in south-east Tasmania, the sizes of migratory shorebirds populations were generally stable throughout the Austral summer (Thomas 1968 and 1970). Subsequently, it was demonstrated that the birds were usually faithful to the region, returning annually (Harris 1983 and 1984, Newman and Woehler 2016). As their populations decreased during this study, some species consolidated their populations in one of the two shorebird areas, Pitt Water and South Arm (Fig. 1) with the larger species (e.g. Eastern Curlew and Bar-tailed Godwit) preferring the Pitt Water area. In contrast, smaller species such as Red-necked Stint and Curlew Sandpiper tended to be more widely distributed across the available shorebird habitat and for extended periods, but not always, most of their populations preferred the South Arm area.

The following discussion is primarily based on the distribution of shorebirds at the time of the SWC (February) and WWC (June / July), drawing where appropriate on the more detailed surveys conducted throughout the year by Thomas in the 1960s and the BOAT Shorebird Study Group in the 1980s.

Small Holarctic migrants - Red-necked Stint and Curlew Sandpiper

The change in the preference of the two most numerous species of migratory shorebird, Red-necked Stints and Curlew Sandpipers from predominantly occurring at the Pitt Water locations in the period 1965-1969 to favouring the South Arm area between 1975 and 1989 was surprising. Both species tend to occur across the range of available habitat, thus minimising their foraging densities at individual sites. Consequently, the absorption of the increased numbers of both species into the South Arm area post-1975 suggests that the carrying capacities of that area may have increased or may not have been reached before then. Improvements in the environmental quality of Derwent Estuary, stemming from the progressive implementation of measures to decrease industrial discharges in the 1970s (Lockley *et al.* 1993) provide one possible explanation for the observed increases at South Arm Neck and Lauderdale, but not at Pipeclay Lagoon, which is not connected to the Derwent Estuary.

However, the more than two-fold increase in the populations of both species between Thomas' studies (1965-1969) and the period (1980-1989) is attributed to increased numbers of juvenile birds migrating to south-east Tasmania in search of overwintering opportunities (Newman and Woehler 2016), rather than the increased carrying capacities of the local shorebird habitats. This conclusion is supported by the similarities in the population cycles and juvenile recruitment patterns of these species in south-east Tasmania and in Victoria on the Australian mainland (Newman and Woehler 2016; Rogers and Gosbell 2006).

Detailed comparisons of the temporal changes in the distributions of Red-necked Stints and Curlew Sandpipers among the available areas of shorebird habitat reveal a difference between the two species. As discussed previously, the proportion of both species using the South Arm shorebird habitats increased post-1975. Subsequently, Red-necked Stints were distributed in generally similar proportions among the five main shorebird locations (Fig. 2h), although some medium-term differences in the proportion of birds using a specific location are apparent (e.g. preference for Pipeclay Lagoon increased over the period 1975-84 and 1995-2004). It is possible that this distributional pattern was driven by the feeding mode of the Red-necked Stint which forage in wet mud (Dann 2000) and when feeding is spatially constrained to a narrow band at the water's edge. Hence, it may be advantageous for them to minimise their density when feeding by spreading out across all available habitat.

Curlew Sandpipers appear to be more selective in their choice of feeding and roosting habitats (Fig. 2g). For instance, they were seldom recorded at Lauderdale and at Barilla Bay post-1975. However, in Thomas' studies during the 1960s, Barilla Bay was their preferred location. Curlew Sandpipers also feed at the water's edge but, being a longer-legged and longer-billed species, they can feed in deeper water than stints (Dann 2000). This is particularly advantageous when ephemeral shallow lagoons provide supra-tidal feeding opportunities where Curlew Sandpipers can spread out and exploit a larger proportion of the lagoon's surface than Red-necked Stint.

Supra-tidal feeding opportunities are an important resource for both species and are the preferred habitat when conditions are suitable, particularly when ephemeral lagoons are drying out near migration time and the birds need to increase their food intake to increase their fat reserves rapidly. During Thomas' study in the 1960's the abundances of both species at Clear Lagoon, as it dried out after flooding, were consistent with the movement of birds from their normally preferred Pitt Water habitats. In the 1980s, Calvert's Lagoon, which is located between the South Arm Neck and Pipeclay Lagoon (Fig. 1) on the South Arm Peninsula, provided similar supra-tidal feeding opportunities and was temporarily the preferred location for both species. In this case, banding studies showed the movement of the birds was from the adjacent locations of Pipeclay Lagoon and South Arm Neck (Fig. 1) which supported most of the population at that time.

For these and other species there may have been a net loss of available feeding habitat. For instance, increased sea levels reduce the amount available intertidal habitat in shallow bays, the dominant type of shorebird habitat in south-east Tasmania. At Pipeclay Lagoon and Barilla Bay, these losses have been exacerbated by the establishment of extensive oyster leases. In addition, drier climatic conditions and changes in drainage conditions have decreased the frequency with which the ephemeral lagoons flood, decreasing supplementary supra-tidal feeding opportunities.

Recent studies (2015 onwards) in the South Arm area have demonstrated how Red-necked Stint have adopted new roosting strategies to overcome the physical degradation and increased disturbance of high tide roosts, even though this may involve travelling increased distances between feeding and novel roosting locations (Newman 2015).

Small trans-Tasman migrant – Double-banded Plover

The Double-banded Plover is of similar size to the Red-necked Stint and Curlew Sandpiper, but unlike those species it is a trans-Tasman (longitudinal rather than latitudinal) migrant. Hence, variations in its population size are not influenced by south-east Tasmania's position at the southern extremity of the EAAF. In other words, the number of juveniles reaching our region is not influenced by habitat loss at migration stop-over locations and variations in the availability of over-wintering territories at higher latitudes in Australia and elsewhere in the Flyway, e.g. Clemens *et al.* (2016), Studds *et al.* (2017).

Double-banded Plovers were found at all the shorebird locations used by Red-necked Stint and Curlew Sandpiper. Their WWC numbers peaked in 1990-94, subsequently decreasing by approximately 50%. Double-banded Plovers' habitat preference were less specialised than those of the Red-necked Stint and Curlew Sandpiper, at times feeding and roosting away from the water's edge in saltmarshes and away from the coast. This raises the possibility that the decreases post-1995 may be associated with under-reporting in the south-east Tasmanian WWCs. However, the observed post-1995 decrease is persistent and in general the losses occur uniformly across all the locations surveyed in South-east Tasmania, suggesting that they reflect a genuine decrease in the local population rather than a shift in roosting sites. A similar decrease has been observed in a tidal embayment on the south-east Australian mainland (Hansen *et al.* 2015).

In Thomas' studies (1964-69), Double-banded Plovers were more numerous in the South Arm area. However, since 1980, the Pitt Water area has been preferred, with Orielton Lagoon the most important location. This probably reflects the larger expanse of relatively undisturbed saltmarsh at that location. The lack of saltmarsh options for roosting may explain the decrease of Double-banded Plover numbers at the South Arm locations as exemplified by the shift of the Lauderdale population to Pipeclay Lagoon when the Lauderdale roost became unviable. Similar factors probably explain the progressive decrease in Double-banded Plovers numbers at the South Arm Neck post 1990-94.

Large Holarctic migrants – Eastern Curlew and Bar-tailed Godwit

Both these species, especially the Eastern Curlew, have decreased during the last 50 years. While their south-east Tasmanian habitat preferences are similar, both preferring the Pitt Water locations, subtle differences exist.

Throughout the study, at least 80% of the Eastern Curlews occurred in the Pitt Water area, but as their numbers decreased the proportion frequenting the South Arm area decreased and by 1990, the species had become infrequent in that area with very low numbers being recorded (Fig. 2c). Throughout the study, most SWC records were from Orielton Lagoon / Sorell, while South Arm Neck was the most important location in the South Arm area. Large shorebird species such as Eastern Curlew are easily disturbed when roosting (Peters and Otis 2007; Weston *et al.* 2012), and it is suggested the species' consolidation in the Pitt Water area may be associated with the presence of roosts, which are subject to fewer disturbances.

Superficially variations in the distribution Bar-tailed Godwit based on SWC data (Fig. 2d) are like those of the Eastern Curlew, but there are important differences. It has also decreased, but to a lesser extent than the Eastern Curlew. Initially, the proportion of Bar-tailed Godwits recorded in the South Arm area was higher than for Eastern Curlew, reaching 57% in the period 1980-84. However, subsequently Pitt Water was almost exclusively preferred.

Monthly monitoring in the 1960s and 1980s indicated that the proportion of the Bar-tailed Godwit population using the South Arm area decreased towards the end of summer with birds moving to Pitt Water before the autumn migration (and before the SWC). Recent monthly monitoring at Lauderdale post 2015 (M. Newman *unpubl. data*) suggests that a few godwits may continue to adopt this pattern of intra-seasonal movement. Possible reasons for this behaviour include seasonal changes in food abundance and type at South Arm, and increased disturbance at roosts during the summer holiday season.

At times Bar-tailed Godwits will use all the available shorebird habitats in south-east Tasmania, but as numbers have decreased, they have preferred the Orielton Lagoon / Sorell area in similar manner to the Eastern Curlew, presumably for the same reasons (e.g. roosts are less disturbed).

Other Holarctic migrants – Pacific Golden Plover, Sharp-tailed Sandpiper, Red Knot and Common Greenshank

This eclectic group of species, except for the Sharp-tailed Sandpiper, are intermediate in size between the species. Collectively changes in the distribution of this group follow the trends of the larger species in preferring the Pitt Water area. Generally, the numbers of these species have always been modest, typically involving fewer than 100 individuals, with the exception of the Pacific Golden Plover where the population was around 150 until 1995-99. Plover numbers subsequently decreased to approximately one quarter of their former level.

Until 1985-89, the Pacific Golden Plover population was split between Pitt Water (the preferred area) and South Arm where up to one third of the population resided (Fig 2a). The preferred locations were Orielton Lagoon and Barilla Bay at Pitt Water and Pipeclay Lagoon in the South Arm area. These locations have areas of saltmarsh providing roosting options, which are relatively free from disturbance. Lauderdale, where there is an extensive saltmarsh separated from the estuarine mudflats by a causeway, is not used other than by an occasional bird. As discussed for the Double-banded Plover (in WWCs), it is possible that this species is under-recorded in SWCs because there are more roosting options available.

Sharp-tailed Sandpipers (Fig. 2f) are another species that favours flooded saltmarsh areas and most records were from the Pitt Water area with relatively few South Arm records.

The Common Greenshank distribution (Fig. 2h) followed the pattern previously described for several species (e.g. Eastern Curlew and Bar-tailed Godwit) of consolidation in the Pitt Water area, where Orielton Lagoon / Sorell became the stronghold, as numbers decreased. In contrast, most of the Red Knot population shifted from Pitt Water to South Arm in the period 1975-79 before reverting to Pitt Water (Fig. 2e). A possible explanation of this difference is that improvements in the environmental quality of the Derwent Estuary increased the availability of food at the South Arm Neck in the 1970s. The change in preference for that location was like that shown by Red-necked Stints and Curlew Sandpipers during the same period. Possible explanations of the Red Knot's reversion to a preference for Pitt Water may stem from either the enhanced availability of suitable food being short-term or roosting preferences. Both the Common Greenshank and Red Knot were examples of a species consolidating into a single flock as their numbers decreased.

Factors impacting distribution of species among shorebird locations

In the previous sections, we have discussed potential reasons for the observed differences in the distributions of shorebird species among sites at Pitt Water and South Arm in south-east Tasmania. Although the distributions and temporal changes in distributions are species-specific, some distinct patterns emerged. For instance, the smaller species (e.g. Red-necked Stint) were widely distributed exploiting all suitable habitats, while the larger species (e.g. Eastern Curlew) consolidated their numbers in the less disturbed habitats of Pitt Water. We suggest that the migratory shorebird species' distributions in south-east Tasmania are driven by three factors: the presence of food, the availability of undisturbed high tide roosts adjacent to feeding areas and being a member of a flock.

a) Prey availability

In the absence of benthic studies, it is not possible to establish definitive conclusions with respect to the extent that differences in food availability determine the distributions of shorebirds among available habitats and the temporal changes in those distributions. Improvements in the environmental quality of the Derwent Estuary in the 1970s and 1980s associated with decreases in industrial discharges may have contributed to increased food availability, favouring species such as Curlew Sandpiper, Red Knot and Red-necked Stint. Increases in the breeding range of the Australian Pied Oystercatcher in the Derwent Estuary further support this hypothesis (Fletcher and Newman 2010).

However, other discharges, such as untreated sewage, may have also impacted on food availability, in this case positively. These discharges were not limited to the Derwent Estuary (e.g. at Midway Point into Orielton Lagoon). Implementation of tertiary sewage treatment mostly occurred later than industrial effluent treatment and it is possible that the period in the 1980s and 1990s when the Derwent Estuary supported peak numbers of Red-necked Stints and Curlew Sandpipers was a unique time when the benefits of sewage discharges were not off-set by the detrimental impacts of effluents from the metallurgical industry. The loss of sea grass in the Derwent Estuary over the period of this study (P. Watson *pers. comm.*), which is attributed to high nutrient levels, is a parallel indicator that there have been profound ecological changes in the ecology of the Derwent Estuary sediments, inevitably impacting on the availability of prey to migratory shorebirds.

The situation at Lauderdale is even more complicated. Several factors may have impacted adversely on the saltmarsh particularly the lack of adequate tidal flushing through a single culvert under the causeway separating the saltmarsh from the bay. This resulted in the formation of a green algal mat between the 1970s and the 1990s, which resulted in the loss of snails (*Salinator fragilis*) and other molluscs and crustaceans (A. Richardson *pers. comm.*). A municipal waste dump was operated adjacent to the saltmarsh at East Marsh Lagoon between 1969 and 1996. Polluted leachate and run-off may have contributed to the deterioration of the saltmarsh as well, but is thought less important than the role of tidal flushing (P. Watson *pers. comm.*). These factors may explain why the saltmarsh presently appears under-utilised by migratory shorebird species. Inadequate tidal flushing through culverts under a causeway is also an issue at Orielton Lagoon and impacts on the quality of saltmarsh at that location (see M. Newman, *unpubl. data*).

However, the situation is further complicated by storm water accumulation diluting the salinity of the lagoon. Variations in the water levels and salinity in the lagoon not only impact on the quality of the saltmarsh but also on the amount of exposed mud providing supra-tidal feeding opportunities for small species like Red-necked Stints.

b) Undisturbed roosts

The importance of undisturbed high tide roosts proximate to feeding areas (Rogers *et al.* 2006b) is a recurring theme in this study, particularly for larger species such as the Eastern Curlew. It has been suggested that the Pitt Water area has more and superior roost options. This may be a contributing factor in the preference of the larger species for the Orielton Lagoon / Sorell area. The smaller shorebird species appear more locally resilient to the loss of roosting options immediately adjacent to feeding grounds, as evidenced by the movement of Red-necked Stints to the Arm End spit (Newman 2015), and the relocation of Double-banded Plovers from Lauderdale to Pipeclay Lagoon.

Quantitative documentation of this resilience is rare and requires species-specific studies, which lie outside the scope of this analysis of SWCs and WWCs. If we are to conserve our shorebird habitats, it is important to invest in this type of study and in the documentation of other factors that are degrading shorebird habitat at the local level. While the Pitt Water roosts are currently more viable, being less prone to erosion and human recreational disturbance, that situation may change rapidly. The township of Sorell and surrounding areas are growing rapidly with proposed developments encroaching to within 30 m of the Orielton Lagoon foreshore. Our experience is consistent with the suggestion by Peters and Otis (2007) that the choice of roosts and responses to factors influencing changes in roost use may be species specific. Milton and Harding (2011) document the negative impact of persistent disturbance of a high tide roost, with less tolerant shorebird species abandoning the area.

c) Flocking at roosts

Peters and Otis (2007) discuss the advantages to survival of species forming large flocks in open areas. For instance, this strategy provides a full view of approaching predators, minimises thermoregulatory costs and decreasing the risk of predation through dilution or detection effects. Newman and Lindsey (2009) documented an example of the later effect in which a Black Falcon selectively targeted and successfully predated one of 13 Curlew Sandpipers on the edge of a flock of around 800 Red-necked Stint.

CONCLUSION

As shorebird numbers in south-east Tasmania decreased, larger bodied species such as Eastern Curlew and Bar-tailed Godwit tended to consolidate their populations in the Pitt Water area, abandoning locations formerly occupied on the South Arm Peninsula. These changes in distribution have been attributed to the presumed advantages of maintaining flock size and the availability of less-disturbed high tide roosts, particularly at Orielton Lagoon / Sorell. In the absence of benthic studies, no conclusions can be drawn concerning the extent to which changes in food availability have driven the observed changes in distributions among sites with available habitat.

In contrast, Red-necked Stint, Curlew Sandpiper and Double-banded Plover continued to be broadly distributed across all suitable shorebird habitats in south-east Tasmania as their numbers fluctuated, and in the case of the Curlew Sandpiper decreased to the status of being an occasional visitor. These smaller species appear to be less impacted by the loss of high tide roost options. They have more successfully adapted their roosting strategies to accommodate changes in coastal topography and to tolerate increased disturbance at roosts.

Intermediate sized shorebirds, comprising Pacific Golden Plover, Common Greenshank and Red Knot showed similar changes in distributions to the larger shorebird species, consolidating their remaining populations in the Pitt Water area. Most of these species have undergone substantial decreases and were never numerous (e.g. peak populations of <300). As for the larger shorebirds, we suggest that the preference for Pitt Water stems from the advantage of forming a single flock in an area with less-disturbed high tide roost options adjacent to foraging habitat.

Although several factors affecting the quality of shorebird habitat have changed over the last 50 years, they are not considered to have been the primary cause of the decreases in shorebird diversity and abundance that have occurred in recent decades. There is strong evidence that habitat loss and environmental changes elsewhere have caused decreases in EAAF populations (Clemens *et al.* 2016 and Studds *et al.* 2017), the effect of which is exacerbated in south-east Tasmania because of its geographic position at the southern extremity of the flyway. South-east Tasmania provides an early indication of future population trends and responses elsewhere in the Flyway, including mainland Australia.

However, if shorebird populations recovered, or their ranges were shifted southwards in response to changes associated with global warming, it is questionable whether south-east Tasmania would be capable of supporting the peak populations which occurred historically. It is imperative that the obligations of habitat custodianship associated with migratory shorebird treaties and the Ramsar listing of the Pitt Water area are met at all levels of government. Proactive management and conservation of wetlands and inter-tidal foraging and roosting habitats must ensure these habitats survive into the future as their importance as climate refugia will increase.

ACKNOWLEDGEMENTS

Thanks to Alastair Richardson, Tim Reid, Phil Watson, Denis Abbott and Bob Patterson for comments and advice on previous drafts of this paper, especially for comments on changes in the ecological quality of the shorebird habitats. We are enormously indebted to the late David Thomas for his vision and the legacy of baseline data which are the foundation of this study. Priscilla Park, Ken Harris, Bob Paterson and the late Bill Wakefield were stalwarts of the BOAT Shorebird Study Group. Clive Minton inspired and helped kick off our banding studies. An anonymous referee made a number of useful suggestions and identified additional supporting literature. Many people, too numerous to name individually, contributed to our counts and the collation of the data over the 50 years. All are thanked for their enthusiasm and sustained contributions.

REFERENCES

Bird Observers' Association of Tasmania 1982. Birds and their habitats in the South Arm Area. *Occasional Stint* 1: 38-47.

Clemens, R.S., D.I. Rogers, B.D. Hansen, K. Gosbell, C.D.T. Minton, P. Straw, M. Bamford, E. J. Woehler, D.A. Milton, M.A. Weston, W. Venables, D. Weller, C. Hassell, W. Rutherford, K. Onton, A. Herrod, C.E. Studds, C.-Y. Choi, K.L. Dhanjal-Adams, G. Skilleter, and R.A. Fuller 2016. Continental-scale decreases in shorebird populations in Australia. *Emu* 116:119-135.

Close, D. and O.M.G. Newman 1984. The decline of the

Eastern Curlew in south-eastern Australia. *Emu* 84:38-40.

Dann, P. 1999. Foraging behaviour and diets of Red-necked Stints and Curlew Sandpipers in south-eastern Australia. *Wildlife Research* 27:61-68.

Fletcher, A.W.G. and M. Newman 2010. Studies of Australian Pied Oystercatcher in South-east Tasmania. *Stilt* 58: 18-23.

Hansen, B.D., P. Menkhorst, P. Moloney and R.H. Loyn 2015. Long-term declines in multiple waterbird species in a tidal embayment, south-east Australia. *Austral Ecology* 40:515-527.

Harris, J.G.K. 1982. Wader and Shorebird Banding in Southern Tasmania up to 30/6/82. *Occasional Stint* 1:11-20.

Harris, J.G.K. 1983a. Banding by B.O.A.T. Shorebird Study Group 1/7/82 to 31/12/82. *Occasional Stint* 2:2-8.

Harris, J.G.K. 1983b. Mortality rates of Red-necked Stint determined by rocket net catches. *Occasional Stint* 2:56-64.

Harris, J.G.K. 1984. Mortality rates of Curlew Sandpiper (*Calidris ferruginea*) determined by rocket net catches. *Occasional Stint* 3:41-44.

Harris J.G.K. 1986. Banding by B.O.A.T. Shorebird Study group 1/7/83 to 30/6/85. *Occasional Stint* 4:32-45.

Kimberly, A., A. Peters and D.L Otis 2007**.** Shorebird roost-site selection at two temporal scales: is human disturbance a factor? *Journal of Applied Ecology* 44:196-207.

Lockley, J.V., D.J. Palmer and O.M.G. Newman 1993. Effluent Treatment System at Pasminco Metals – EZ. World Zinc '93:385-390. The Australian Institute Mining and Metallurgy Publication Series No 7/93.

Milton, D.A. and S.B. Harding 2011. Death by a thousand cuts: the incremental loss of coastal high tide roosts for shorebirds in Australia: Sandfly Creek Environmental Reserve, Central Queensland. *Stilt* 60:22-33.

Murray, N.J., C.E. Studds, R.A. Fuller, R.S. Clemens, K.Dhanjal-Adams, K.B. Gosbell, C.J. Hassell, T. Iwamura, C.D.T. Minton, D.I. Rogers, E.J. Woehler and P.P.Marra 2016. The role of global environmental changes in the decline of a long-distance migratory shorebird. *Ecography* 40:001-009 http://dx.doi.org/10.1111/ecog.02957

Newman, M. and A. Lindsey 2009. Curlew Sandpiper predated by a Black Falcon. *The Whistler* 3:58.

Newman, M. 2015. High tide roosts and nest sites; South Arm birds run out of options. Tasmanian Bird Report 37:8-9.

Newman, M. and E.J. Woehler 2016. Red-necked tint and Curlew Sandpiper in South-East Tasmania: Part 1 Red-necked Stint – population trends and juvenile recruitment. *Stilt* 69/70:7-19.

Park, P. 1983. Orielton Lagoon and Sorell Wader areas. *Occasional Stint* 2:15-33.

Patterson, P. 1982. A survey of the wader population of Barilla Bay. *Occasional Stint* 1:21-28.

Prahalad, V. and J. Pearson 2013. Southern Tasmanian Saltmarsh Futures. A preliminary strategic assessment. NRM South.

Reid, T.A. and P. Park 2003. Continuing decline of Eastern Curlew, *Numenius madagascariensis*, in Tasmania. *Emu* 103:3279-283.

Rogers , D.I., K.G. Rogers, K.B. Gosbell and C. J. Hassel 2006a. Causes of variation in population monitoring surveys: Insights from non-breeding counts in north-western Australia, 2004-2005. *Stilt* 50:176-193.

Rogers, K., G. Gosbell and K. Gosbell. 2006. Demographic models for Red-necked Stint and Curlew Sandpiper in Victoria. *Stilt* 50:176-193.

Rogers, D. I., P. F. Battley, T. Piersma, J. A. Van Gils and K. G. Rogers 2006b. *Animal B*ehaviour 72:563-575.

Studds, C. E., B. E. Kendall, N.J. Murray, H. B. Wilson, D. I. Rogers, R. S. Clemens, R.S. Gosbell, K. Hassell, R. Jessop, D. S. Melville, D. A. Milton, C.D.T. Minton, H.P. Possingham, A.C. Riegen, P. Straw, E.J. Woehler and R.A. Fuller 2017. Nature Communications 8:14895 http://dx.doi.org/10.1038/ncomms14895

Thomas, D.G. 1968. Waders of Hobart. *Emu* 68:95-126.

Thomas, D.G. 1970. Fluctuations of numbers of waders in south-eastern Tasmania. *Emu* 70:79-85.

Weston, M. A., E. M. McLeod D. T., Blumstein and P.-J. Guay. 2012. A review of flight-initiation distances and their application to managing disturbance to Australian bird. *Emu* 112:269–286.

Wilson, H.B., B.E. Kendall, R.A. Fuller, D.A. Milton and H.P. Possingham 2011. Analyzing variability and the rate of decline of migratory shorebirds in Moreton Bay, Australia. Conservation Biology 25:758-66. http://dx.DOI.org/10.1111/j.1523-1739.2011.01670.x

Woehler, E.J. 2014. Resident shorebirds and seabirds of the Pitt Water–Orielton Lagoon Nature Reserve and Ramsar site. *Tasmanian Bird Report* 36: 40-58.

Woehler, E.J. and S. Drake 2015. Summer and Winter Wader Counts 2015. *Tasmanian Bird Report* 37:53 – 59.

SUMMER MIGRANTS – THE IMPORTANCE OF ROTTNEST ISLAND FOR TRANS-EQUATORIAL BIRD SPECIES

SUZANNE MATHER

3 Hardy Rd., Nedlands 6009 WA AUSTRALIA.
Email: suzannemather@bigpond.com

Rottnest Island provides an important habitat for the non-breeding populations of trans-equatorial migratory shorebirds, referred to as waders. Several species within this suite of birds are declining in abundance as the foraging areas of extensive mud flats in their East Asian-Australasian Flyway are lost to industrial development in Republic of Korea and China. In Western Australia, these birds have lost much of their south-west habitat with increasing human coastal population, urban development, declining groundwater levels and farming. BirdLife Australia's Western Australian Branch has conducted bi-annual Rottnest Island shorebird counts since 1998. The data from this work add to the national BirdLife Australia database and to the Rottnest Island Authority (RIA) records. Results from the bi-annual censuses on the Island suggest its protected environments act as a refuge for migratory shorebirds when compared with declining mainland sites. Trend analysis shows that the abundance of the Red-necked Stint *Calidris ruficollis*, a 30 g migratory species, has increased over the last ten years on the Island. This increase could be commensurate with the loss of habitat in the nearby Swan River Estuary, where the abundance of the species has declined. In contrast, the abundance of the Curlew Sandpiper *Calidris ferruginea* on the Island has declined, as it has done on the Swan River, but this is consistent with a world population decline. The continued environmental management of the Island has secured this habitat by limiting and controlling tourist activity in the species' habitats and through monitoring the water quality in the lakes. Continued census helps researchers understand what the important habitats for this suite of birds are, and Rottnest Island administration shows how tourism and shorebird protection can co-exist.

INTRODUCTION

Rottnest Island is one of a chain of limestone offshore islands on the Western Australian coast. However, it differs from the other islands in that it has a saline lake system, part of the greater wetland system that encompasses the Swan River Estuary and Swan Coastal Plain (SCP) lakes. This estuary and system of lakes support waders, both trans-equatorial migrants and species that undergo movements within Australia only, and they move throughout this area depending on tide variation, seasonal change in water level of lakes, disturbance and food availability (Bamford 1999). The Estuary, and particularly Alfred Cove, provides foraging habitat during persistent low tides that are a feature of the peculiar tidal regime in the region, with tidal amplitudes of <0.5 m and persistent low tides caused by slow-moving high-pressure systems. Such conditions are intermittent, however, and the Estuary is subject to high levels of human disturbance (Bamford *et al.* 2003). Bamford (1999) also noted regular, daily movement between the Estuary and the Island's lakes, and suggested that the lakes provided a secure roosting area in comparison with the more disturbed Estuary. Lakes on the mainland provide foraging habitat for waders for a short window of time as lake water levels fall and before the lakes dry up in late summer / autumn. Therefore, the salt lakes on Rottnest Island, which are permanent and vary only slightly in level over the year, provide a stable wader environment in a region where other such environments on the mainland are changeable. In addition, since the early 2000s, many of the mainland lakes have become unsuitable for waders due to low water levels that have allowed vegetation to colonise the lake bed, while rising sea levels have reduced the frequency of persistent low tides on the Estuary (Storey *et al.* 1993, La Sorte and Jetz 2010).

Shorebirds in the region were surveyed intermittently for many decades through the 20th Century, but more consistently in recent times. Lawson (1905) surveyed shorebirds on Rottnest Island during a two-week period in 1905, and Storr (1964) recorded bird observations on the Island over 275 days between 1953 and 1963. Saunders and de Rebeira (2009), counted shorebirds on the Island between 1981 and 1987 over 37 visits to the lakes and 33 to the coast, and compared records with Storr's earlier work. Consistent annual counts began on the Swan River Estuary in the early 1980s with the BirdLife Australia shorebird project (Lane and Starks 1985) and South-West Waterbird Project (Jaensch *et al.* 1988). BirdLife Western Australia had surveyed birds on Rottnest Island since the late 1970s on an occasional basis, with no consistency in the survey methods or reporting. A request from the Australian Wader Studies Group resulted in a part island survey in 1997, but in 1998 this formalised into a non-breeding season shorebird survey of the entire island, lakes and beaches (Davis 1998). Since 1998 the biannual count has been extended to include seabirds such as terns under the protocol of the BirdLife Australia Shorebird 2020 initiative. However, this paper addresses specifically the trans-equatorial migratory waders on the Island.

Declines in shorebird abundance have been well-documented, both at the very local scale of a single site (Creed and Bailey 2009, Singor 2009), and at a continental and flyway scale. For example, it is estimated that 12 trans-equatorial shorebird species out of 41 in the East Asian-Australasian Flyway (EAAF) have declined significantly (Amano *et al.* 2010, Moores *et al.* 2016), and this decline is also shown in southern Australia with decreases in abundance of 17 of the 20 species over the last 15 years (Rogers *et al.* 2011, Clemens *et al.* 2016) and an estimated Australia wide decline in the Threatened Bird Index of 70% since 1985 (tsx.org.au 2018). Declines on a local scale, such as at Pelican Point on the Swan Estuary (Creed and Bailey 2009), reflect a change in pattern of local usage, which may or may not be related to a regional population decline. Broad scale changes reflect flyway population declines thought to result from the loss of major foraging areas used by some species during migration (Moores *et al.* 2016). Population trends are derived from analysis of long-term count data, but the very long-term and consistent data from Rottnest Island and the Swan Estuary provides an opportunity to examine how wader abundance and environmental usage are changing over time at the local level in a region where some wader habitats are changing, whilst others (on Rottnest Island) are stable.

Understanding the role of Rottnest Island in this changing system is important as while the Island is an A Class Reserve under the administration of the Western Australian Government, it is also a tourist resort under the appointed Rottnest Island Authority. While recognising that natural assets such as birds on the salt lakes are part of the attraction, the stated purpose of the Island is to 'grow visitor numbers by providing best-in-class tourism products' (Rottnest Island Authority 2017/2018). The potential for conflict is thus considerable.

METHODS

Study area

Rottnest Island, 32º 00' 7" S; 115º 31' 1" E, 18 km west of the port of Fremantle, is the largest island in a chain of small limestone islands and reefs on the continental shelf that runs from Jurien Bay (220 km north) to Rockingham (40 km south). The Island separated from the mainland about 6500 years ago (Playford and Leech 1977), is 11 km long and 4.5 km at its widest point with 63 sheltered beaches and 20 bays. The land area is 1900ha but encompassed in this is an inland lake system of 200 ha or about 10.5% of the land mass (Playford and Leech 1977). The lakes were formed by the collapse of the Tamala limestone cave system, creating depressions (Playford and Leech 1977). Fresh groundwater seepage flows into some of the lakes, depending on the rainfall. The average summer salinity of the lakes, about 155,000 mg l^{-1}, is more than four times that of the sea. The annual mean rainfall is 717 mm, mostly falling in May to August (Playford and Leech 1977).

The wader habitats on the Island are the 12 salt lakes and some of the coastal shoreline. The lakes used by waders are: Serpentine, Baghdad, Vincent, Pink, Herschel, Pearce, Government House and Garden, with depths ranging from 1.0 to 7.6 m. Three other lakes, Pink, Negri and Sirius, are seasonal and often dry out in the summer. The reef system off the Island coastline is exposed at low tide and has been shown to support foraging waders. The coastal areas surveyed encompass Thomson Bay, West End bays, and Porpoise through to Strickland Bays. The northern beaches are surveyed but wader species are not usually seen there. These are either steep beaches, such as Ricey, or are subject to recreational disturbance such as Geordie and Longreach Bays (Fig. 1).

Waders feed predominantly on invertebrates by touch and feel, (Higgins and Davies 1996). They have adapted to prey on invertebrates both along shorelines and saline lakes. Forty-three invertebrate taxa, the food for trans-equatorial waders, were recorded in a study on the salinity and temperature levels and the fauna dependent on the lakes (Edwards 1983). Edwards (1983) showed that the 43 invertebrate freshwater species found indicated that they had adapted to tolerating the high salinity levels with salinity level ranges of from <1% to >100% of seawater, fluctuating seasonally (Edwards 1983). The invertebrates recorded in the lakes and known as food for waders are Oligochaete (*Artemis* sp.), Allelida (Polychaeta sp., Crustacea sp.) and Insecta, but it could be assumed that the variation in foraging methods of different wader species makes all of this rich invertebrate community population would be potential wader food (Edwards 1983, Lane 1987). The Brine Shrimp *Artemis salina* was shown to be the most abundant invertebrate along with *Chironomid* and *Culicidae* larvae (Avenant

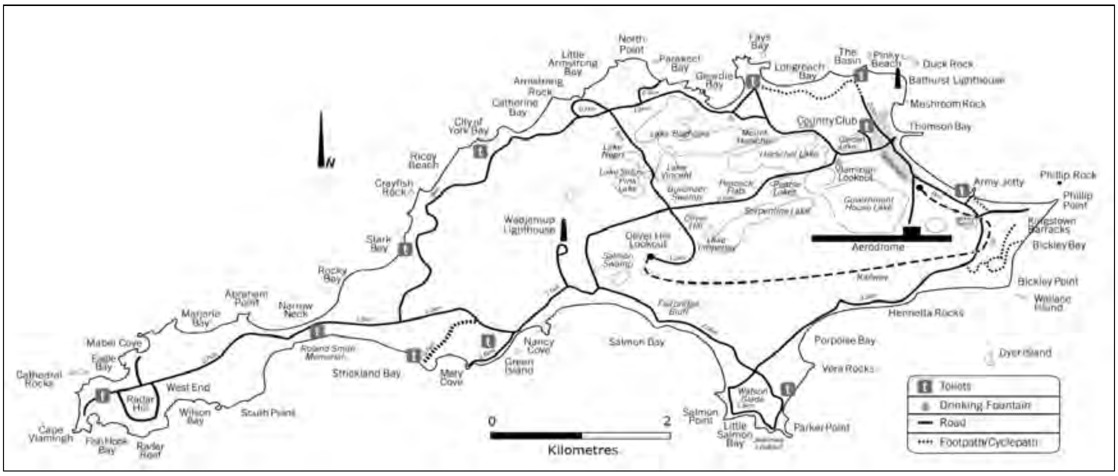


Figure 1. Rottnest Island showing wader, lake and beach foraging areas. Source: Rottnest Island Authority.

2012). Strong winds tend to blow the Brine Shrimp across the lakes influencing where shorebirds forage (*pers. obs.*), therefore emphasising the importance of the whole lake system for waders, not just those species with the highest abundance in a specific lake at a particular time. Wader species favouring the coastal habitat are dependent for food on invertebrates found along the reef and shoreline. The invertebrates in the coastal habitat, particularly on the intertidal zone, were resurveyed in 2007 showing 45 mollusc species (Edwards 1983). Previous work in 1982 had shown that there were twice as many marine molluscs on Radar Reef and four times as many on Cape Vlamingh than on the adjacent mainland (Irvine *et al.* 2008). This was attributed to the Leeuwin Current flow dispersing tropical molluscs' planktonic larvae along the margin of the continental reef, just offshore from this location. The tropical species had decreased in the 2007 surveys, but it is suggested that this was caused naturally (Irvine *et al.* 2008). This area is now a marine protected zone.

Survey method

The whole island was surveyed in a one to three-hour period in the early morning. This involved between 12 and 18 volunteers, therefore representing approximately 540 volunteer hours per survey. The lakes and coastline were surveyed by teams of two experienced volunteers allocated to each lake or length of shoreline known to be utilised by waders. The surveys were conducted on foot, with binoculars and spotting scopes used. Participants recorded time of start and finish, observers' names, significant movements of flocks of birds, wind speed and direction, presence and abundance of all shorebirds including waders, noting any flagged birds, pest species and disturbance. This report summarises and discusses the survey effort that has been sustained from 1999 to 2022.

Whilst the areas were surveyed individually, the waders and other shorebirds can move between the areas and the coastline, depending on the wind and the tide. For example, the coastal shallow reefs were used by waders at very low tides but as the tide rises the Red-necked Stint in particular, move to the adjacent salt lakes (*pers. obs.*). This possible movement was considered when deciding the timing of the surveys. Seven wader species, Grey Plover, Whimbrel, Bar-tailed Godwit, Ruddy Turnstone, Curlew Sandpiper, Red-necked Stint and Sanderling were recorded regularly on the Island and are discussed in detail.

Confidence was felt in the survey method used taking into account Rogers *et al.* (2006) causes of count data variation. The differences in individual counts at each site were 'within-situation-error' clarified by repeat counts with different volunteers (Rappoldt *et al.* 1985). Site-specific and bias error were minimised by counting early in the morning with clear light. The lakes were counted individually so observers were within easy binocular and spotting scope distance.

Data from the Swan River Estuary comes from the Shorebirds 2020 database and the maximum count across the estuary in each summer is used in this report. Survey effort on the Estuary has varied. The nomenclature used follows Christidis and Boles (2008). The scientific names of each species are shown in Table 2.

Data management

All records were entered into the BirdLife 2020 database and included in the Rottnest Island BirdLife annual report results. Species presence, abundance and richness were evaluated for each site. To facilitate the RIA records an Excel spreadsheet recording the presence and abundance was transferred into the 'Bird Monitoring' Microsoft Access database.

Information gathered from these survey events was submitted to the BirdLife database under the Shorebird 2020 section and fed into the RIA Terrestrial Management Plan thus providing records concerning the management of breeding sites and counts outside the settlement area.

Analysis of population trends for each shorebird species were fitted to negative binomial models in R version 3.6.2 using the package *MASS* (Venables and Ripley, 2002) (Fig. 3).

RESULTS

The census Figures from 22 years of bi-annual surveys (1999-2020) showed an abundance variation between 806 (1998) and 2280 (2014) (Fig. 2) indicating an overall decline in the trans-equatorial wader abundance on the Island.

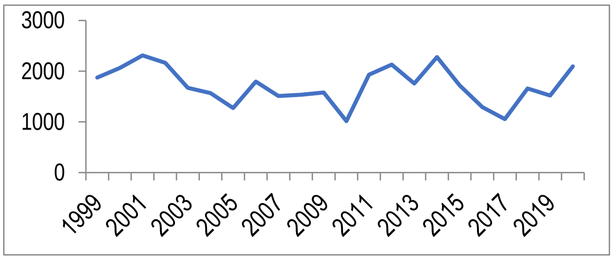


Figure 2. Variation in abundance of trans-equatorial waders 1999-2020.

Population trend analysis of the 20 species was established (Table 1), categorising species into showing no change in population, a decline or insufficient data to establish a trend.

Fig. 3 shows the trend line of 14 species between 1999 and 2020 where there was enough data. The Red-necked Stint population showed no change and was significantly above the trend line in 2000, 2014 and 2020. The Sanderling population also showed no change and was significantly above the trend line in 2012 (238), 2013 (284) and 2020 (207). The Whimbrel, Bar-tailed Godwit, Red-necked Phalarope and Common Greenshank populations showed no change. The Grey-tailed Tattler, Curlew Sandpiper, Ruddy Turnstone, Greater and Lesser Sand Plovers all showed a highly significant population trend decline. Grey Plover and Common Sandpiper showed a highly significant population trend decline, whilst Terek Sandpiper showed a significant decline. The data were too poor to establish a population trend for Oriental Pratincole, Pectoral Sandpiper, Sharp-tailed Sandpiper, Red and Great Knots and Pacific Golden

Plover. The Sanderling population also showed no change and was significantly above the trend line in 2012 (238), 2013 (284) and 2020 (207). The Whimbrel, Bar-tailed Godwit, Red-necked Phalarope and Common Greenshank populations showed no change. The Grey-tailed Tattler, Curlew Sandpiper, Ruddy Turnstone, Greater and Lesser Sand Plovers all showed a highly significant population trend decline. Grey Plover and Common Sandpiper showed a highly significant population trend decline, whilst Terek Sandpiper showed a significant decline. The data were too poor to establish a population trend for Oriental Pratincole, Pectoral

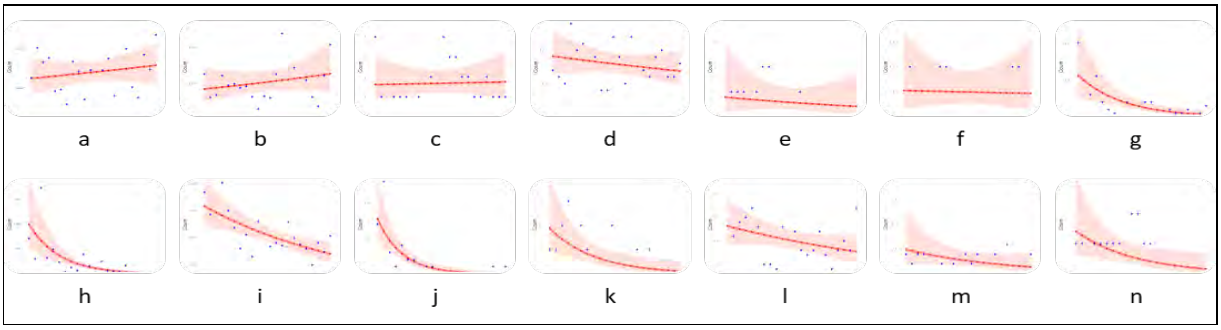


Figure 3. Population trend of (a) Red-necked Stint, (b) Sanderling, (c) Whimbrel, (d) Bar-tailed Godwit, (e) Red-necked Phalarope, (f) Common Greenshank, (g) Grey-tailed Tattler, (h) Curlew Sandpiper, (i) Ruddy Turnstone, (j) Greater Sand Plover, (k) Lesser Sand Plover, (l) Grey Plover, (m) Common Sandpiper, (n) Terek Sandpiper.

Table 1. The population trends for each Rottnest Island trans-equatorial species.

Species	Slope	Std.Error	Zvalue	Pvalue	Change	Trend
Oriental Pratincole	0.038	0.160	0.235	0.814	2.125	data to poor
Red-necked Phalarope	-0.030	0.057	-0.524	0.600	0.553	no change
Common Greenshank	-0.005	0.049	-0.111	0.911	0.896	no change
Grey-tailed Tattler	-0.136	0.038	-3.609	0.000**	0.065	significant decline
Common Sandpiper	-0.060	0.043	-1.392	0.164**	0.299	significant decline
Terek Sandpiper	-0.102	0.049	-2.080	0.038*	0.129	significant decline
Pectoral Sandpiper	-0.693	0.707	-0.980	0.327	0.000	data too poor
Sanderling	0.020	0.022	0.902	0.367	1.479	no change
Red-necked Stint	0.007	0.008	0.779	0.436	1.141	no change
Curlew Sandpiper	-0.199	0.030	-6.575	4.881**	0.019	significant decline
Sharp-tailed Sandpiper	0.045	0.084	0.530	0.596	2.438	data too poor
Red Knot	0.099	0.104	0.955	0.339	7.285	data too poor
Great Knot	-0.210	0.135	-1.557	0.119	0.015	data too poor
Ruddy Turnstone	-0.039	0.011	-3.526	0.000**	0.46	significant decline
Bar-tailed Godwit	-0.013	0.015	-0.884	0.377	0.767	no change
Whimbrel	0.004	0.026	0.141	0.888	1.077	no change
Greater Sand Plover	-0.251	0.051	-4.923	8.531**	0.007	significant decline
Lesser Sand Plover	-0.136	0.051	-2.641	0.008**	0.066	significant decline
Pacific Golden Plover	-0.049	0.061	-0.797	0.426	0.377	data too poor
Grey Plover	-0.026	0.016	-1.647	0.100	0.6	data too poor

Significance codes: * = p<0.05, **= p<0.01

Table 2. Rottnest Island trans-equatorial migratory species abundance and species richness 1999-2022

Species	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Grey Plover	24	11	14	15	17	13	5	5	4	13	3	12	8	7	8	12	7	4	8	10	8	17
Pacific Golden Plover	1	0	0	0	0	0	1	1	1	0	0	0	2	0	0	1	0	0	0	0	0	0
Lesser Sand Plover	1	1	2	3	0	2	1	0	0	0	2	0	0	0	1	0	1	0	0	0	0	0
Greater Sand Plover	7	13	3	1	4	2	2	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1
Whimbrel	4	1	0	1	1	1	0	1	0	2	5	4	3	3	2	2	1	1	2	1	1	1
Bar-tailed Godwit	7	6	5	14	10	11	15	9	4	4	12	9	5	12	0	7	6	9	10	6	6	7
Ruddy Turnstone	367	285	430	402	299	236	159	211	129	260	66	167	181	170	258	198	175	158	99	181	147	180
Great Knot	0	0	5	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Red Knot	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	0	0	0	0	0
Sharp-tailed Sandpiper	0	17	0	0	0	0	1	0	0	1	0	0	53	1	26	16	4	1	0	0	0	3
Curlew Sandpiper	141	60	345	64	98	46	8	25	13	77	30	6	50	11	9	9	33	2	2	1	0	3
Red-necked Stint	1125	1504	1324	1380	958	978	791	1331	1207	852	1225	629	1222	1374	897	1900	1494	1008	875	1422	1234	1672
Sanderling	125	60	67	121	94	98	87	91	62	28	64	59	125	238	284	143	6	108	61	36	121	207
Pectoral Sandpiper	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Terek Sandpiper	1	1	0	1	1	1	1	1	0	2	2	1	1	0	0	0	0	0	0	0	0	0
Common Sandpiper	2	1	2	2	0	10	1	0	1	0	2	1	2	0	0	2	0	3	0	0	0	2
Grey-tailed Tattler	20	27	6	11	4	2	1	0	4	0	0	4	4	0	0	2	1	1	2	0	1	3
Common Greenshank	2	1	0	0	0	0	1	1	0	0	0	2	0	0	0	0	0	0	1	1	2	0
Red-necked Phalarope	0	1	1	1	0	1	2	2	0	0	0	0	1	0	0	0	0	0	4	0	0	0
Oriental Pratincole	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Total	**1827**	**1990**	**2204**	**2016**	**1486**	**1401**	**1077**	**1678**	**1426**	**1240**	**1411**	**1015**	**1932**	**2129**	**1757**	**2280**	**1722**	**1291**	**1056**	**1659**	**1520**	**2096**
Species richness	**14**	**16**	**12**	**13**	**10**	**13**	**16**	**11**	**10**	**10**	**10**	**11**	**15**	**9**	**8**	**11**	**11**	**10**	**10**	**9**	**8**	**11**

Sandpiper, Sharp-tailed Sandpiper, Red and Great Knots and Pacific Golden Plover.

The observed population decline is also reflected in a decline in the species richness from 1999 to 2020, mirroring the population decline overall (Fig. 2 and Table 1). The species richness each year, ranged from eight (2013) to 16 (2000, 2005) species (Table 2). The Rottnest trans-equatorial migratory species have been categorised as regular migrants, uncommon migrants and vagrant migrants. Fig. 4 shows the percentage, ranging from five to 100, of a possible occurrence in 22 years of surveys for each of the 20 species. Two uncommon species, Pacific Golden Plover (27%) and Red-necked Phalarope (36%) are of interest as they could be vagrant but are considered uncommon migrants (Table 3). Of the 20 wader species recorded historically, seven were considered regular migrants to the Island based on their 100% presence, except Bar-tailed Godwit (91%) and Whimbrel (86%) in the 22 surveys. Species that were considered uncommon, occurred in >20% of surveys and those species that could be vagrant migrants occurred occasionally (Table 3).

Table 3. Percentage of surveys species recorded in 22 years of Rottnest Island BirdLife WA February surveys and status.

Common name	Scientific name	Count	%Surveys (N=22)	Status
Pacific Golden Plover	*Pluvialis fulva*	7	30	Un
Grey Plover	*Pluvialis squatarola*	212	100	R
Lesser Sand Plover	*Charadrius mongolus*	14	45	Un
Greater Sand Plover	*Charadrius leschenaultii*	39	55	Un
Bar-tailed Godwit	*Limosa lapponica*	165	95	R
Whimbrel	*Numenius phaeopus*	36	85	R
Terek Sandpiper	*Xenus cinereus*	14	60	Un
Common Sandpiper	*Actitis hypoleucos*	31	65	Un
Grey-tailed Tattler	*Tringa brevipes*	90	75	Un
Common Greenshank	*Tringa nebularia*	10	40	Un
Ruddy Turnstone	*Arenaria interpres*	4606	100	R
Great Knot	*Calidris tenuirostris*	8	15	V
Red Knot	*Calidris canutus*	4	15	V
Sanderling	*Calidris alba*	2034	100	R
Red-necked Stint	*Calidris ruficollis*	23,934	100	R
Sharp-tailed Sandpiper	*Calidris acuminata*	120	45	Un
Pectoral Sandpiper	*Calidris melanotos*	1	5	V
Curlew Sandpiper	*Calidris ferruginea*	1120	100	R
Red-necked Phalarope	*Phalaropus lobatus*	13	40	Un
Oriental Pratincole	*Glareola maldivarum*	1	5	V
TOTAL IN 22 YEARS		**32,452**		

Presence based on number of surveys recorded
R=Regular migrant, Un=Uncommon migrant, V=Vagrant migrant

The Island habitats fall into two broader categories, coastal and inland lakes and swamps. Survey results over twenty-two years show the habitat preferences of the species that favour the coast were Whimbrel and Bar-tailed Godwit whilst Grey Plover, Sanderling and Common Greenshank were recorded using both habitats in similar percentages (Fig. 5). The species found predominantly in the lake's habitat were Lesser and Greater Sand Plovers, Ruddy Turnstone, Sharp-tailed Sandpiper, Curlew Sandpiper, Red-necked Stint, Common Sandpiper and Grey-tailed Tattler.

DISCUSSION

The overall decline in wader species on Rottnest Island can be seen as a reflection of the worldwide decline in this suite of birds (Amano *et al.* 2010, Clemens 2016, Delaney and Scott 2006, Gosbell and Clemens 2006). Current research is suggesting that, for waders that spend

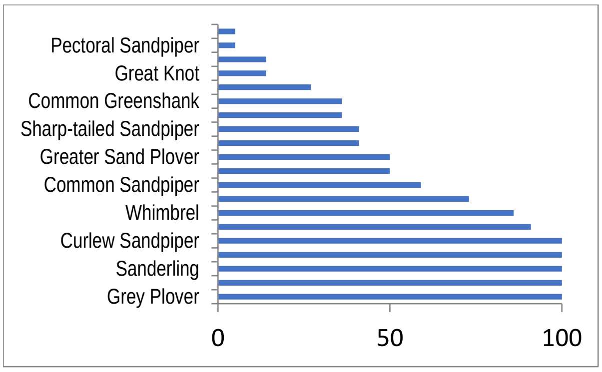


Figure 4. Percentage of possible occurrence of 20 trans-equatorial wader species on Rottnest Island 1999-2020.

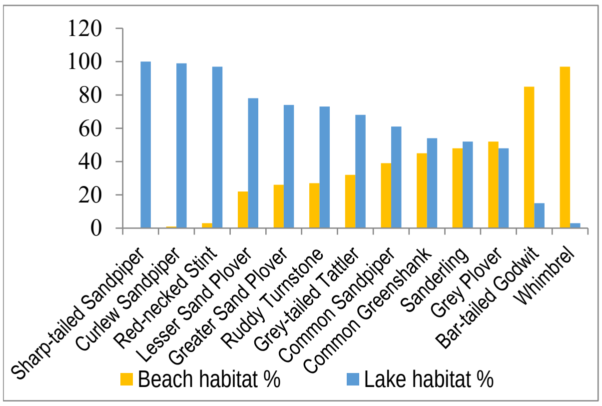


Figure. 5. Comparison of percentage of trans-equatorial species' abundance in coastal and lakes habitats.

the Austral summer in Australia, this decline is due predominantly to habitat loss in the East Asian-Australasian Flyway. The migration foraging area (Rogers *et al.* 2008) supports at least 500,000 waders in their northward migration, possibly double this figure as they migrate south (Barter *et al.* 1998, Moores 2006, Rogers *et al.* 2006, Melville *et al.* 2016). However, it has also been shown that hunting in some of the 22 countries through which these birds migrate, can also result in species decline, particularly if the rate of hunting exceeds the possible recruitment rate of the species (Szabo *et al.* 2016, Turrin and Watts 2016). Dunlop (2009) has shown that climate change is influencing the southward flowing Leeuwin Current, thus possibly affecting both the sea level and the invertebrate fauna on Rottnest Island. Bi-lateral agreements, designed to protect wader species, in many of these countries, are not always enforced. Therefore, Australia is a vital staging area for many species including those that are found at Rottnest Island.

The species richness, ranging from eight to 16 over the 22 survey years, could be explained by survey error in observers missing. For example, small sand plovers, which are not recorded each year, could be easily overlooked. Another explanation for this variation is that some species may be staging temporarily on the Island *en route* to their migration departure point. There has been a decline in the overall population of this suite of birds but the important factor for Rottnest Island that it provides a continuing habitat, particularly for the species that do not show a declining trend (Fig. 3).

Red-necked Stint *Calidris ruficollis*

Rottnest regularly supports >0.1% (475) of the EAAF population (Hansen *et al.*2016). Clemens *et al.* (2016) showed that the numbers of Red-necked Stint in Australia had declined by 70% over the last 20 years, an annual decrease of 3.35%). The importance of conserving this species' habitat is shown with the realisation that over 80% of the non-breeding population occurs in Australia (Bamford *et al.* 2008). The Australian Wader Studies work in north-west Australia indicated the annual breeding success in waders from the percentage of juvenile birds recorded in sample catches and the abundance of each species. These results fluctuate correlating with breeding success (Minton *et al.* 2005) and could be an explanation for the non-breeding variation in wader species counted at Rottnest (Table 2) (Minton *et al.* 2006). Red-necked Stint arrive in the south-west in two stages, between September and October and then between December and January. It is thought that this second arrival could be birds from further south and east beginning their northward migration (Alcorn *et al.*1994). Therefore, it is important that the Rottnest non-breeding surveys are undertaken in February when the maximum count is possible. The upward trend of Rottnest birds (Fig. 3) was also reported in Minton *et al.* (2003), who suggested this was a reflection of the species' ability to spread extensively to new habitats, as also demonstrated in Tasmanian population trends (Newman *et al.* 2016).

While the Red-necked Stint population has shown an upward trend at Rottnest, recent surveys have shown that it has declined in the Swan River Estuary system of which Rottnest is included. For example, Alfred Cove on the Swan River recorded 10,000 birds in a January count between 1981-1985 (Jaensch *et al.* 1988), compared with zero in 2018. Birdata 2018 summer counts show that this species has declined in other SCP habitats, for example Yalgorup 2606 in 2003, 70 in 2018, Peel-Harvey Estuary 5962 in 2014, 2195 in 2018 and Yalgorup 2656 in 2008 and 700 in 2018. This decline is evident generally in southern Australia (Clemens *et al.* 2016).

Records show that Red-necked Stint was common on the Island between 1912 and 1920. Storr in 1957 recorded 'some thousands' and showed that 80.5% of the population was found on the lakes, commensurate with the present study, which showed 97% on the lakes (Table 2) (Alexander 1921, Storr 1965). Saunders and de Rebeira (1986), however, recorded 66% on the lakes. They also reported local movement of Red-necked Stint, based on the recordings of the movement of a leucistic bird. This movement in response to tide was confirmed by Bamford (1999) who also suggested the flocks may have flown to the Rottnest lakes. However, as the Swan Estuary no longer supports this species it is suggested that the only local movement observed is between the exposed reefs on very low tides and the lakes.

Ruddy Turnstone *Arenaria interpres*

Rottnest Island is particularly important for Ruddy Turnstone when it is realised that 73% of the non-breeding EAAF population is found in Australia and New Zealand (Bamford *et al.* 2008) and that the Island regularly supports >0.1% (30) of the EAAF population (Hansen *et al.* 2016). The number recorded on Rottnest over the last ten years has remained stable ranging from 66 birds in 2009 to 181 in 2018. But this is a decline from the 2001 record on 430 and reflects the 1973-2014 records showing a 3.17% per annum decline nationally (Clemens *et al.* 2016). This species moves on the island between the coast and lake habitats, dissimilar to other south-west locations where it has not been recorded in summer Shorebird 2020 counts (Birdata). Alexander (1921) reports the species as 'not being plentiful' but Storr suggested that 'its abundance on the Island may be recent'. Saunders & de Rebeira (2009) showed, looking at past records that it had not changed in abundance. Storr, in 1957, noted it was 'extremely rare on the opposite mainland' (Storr 1965). However, the present study shows a highly significant declining trend (Table1) and confirms earlier work in that the species favours the lakes habitat (Storr 1965, Saunders & de Rebeira 1986).

Curlew Sandpiper *Calidris ferruginea*

Storr (1965) described Curlew Sandpiper as being common at Rottnest, favouring the lakes. The population has shown a sharp downward trend, from 345 in 2001 to three in 2020, commensurate with recent surveys showing it has declined in Australia at a rate of 3% per year (Gosbell and Clemens *et al.* 2006, Minton *et al.*2003). This trend has continued with a 9.53 % decline each year in the population (Clemens *et al.* 2016). Locally, for example Alfred Cove on the Swan River recorded 1078 Curlew Sandpiper in a non-breeding count between 1981-1985 (Jaensch *et al.* 1988) compared with zero in 2018 (Birdata), a 100% decline in < 40 years. The present study shows a highly significant population decline on the Island.

Sanderling *Calidris alba*

Rottnest regularly supports >0.1% (30) of the EAAF Sanderling population and showed a population increase in 20 years. This is a species that favours both the coast and lake habitats, so the population could reflect a loss of both suitable beach and lake habitats on the mainland. The SCP has had significant urban and peri-urban development over the last 20 years, predominantly along coastal areas. This Sanderling increase is reflected in a 0.08% Australian increase between 1973 and 2014 (Clemens *et al.* 2016) with no change at Rottnest. A comparison between Storr's 1953-1962 and Saunders & de Rebeira 1981-1984 results also showed a population increase (Storr 1965, Saunders & de Rebeira 1986).

Grey Plover *Pluvialis squatarola*

The important non-breeding sites for this species are in northern Australia (Bamford *et al.* 2008). However, the regular recording of this wader, both in the February and June surveys, show that even though a small population is present, it is regular, suggesting that the island provides an important habitat for this species that is decreasing on the Island.

Bar-tailed Godwit *Limosa lapponica*

Flagging and recovery sightings of Bar-tailed Godwit in Broome suggest that the birds recorded at Rottnest arrive in north-west Australia, then move down the coast as there has been little movement recorded between the east and west coast populations (Minton *et al.* 2006, Wilson *et al.* 2007). The Siberian breeding sub-species *menzbieri,* regularly recorded on the Kimberley coast, is rare in eastern Australia so it could be assumed that the Bar-tailed Godwit recorded at Rottnest is of this sub-species (Rogers *et al.* 2011). This 22-year work has seen Bar-tailed Godwits, albeit in small numbers, regularly and on the north-western beaches as with Whimbrel (Table 3). Storr (1965) and Saunders and de Rebeira (2009) describe these species as uncommon. However, with no change in the population trend (Table 1) they could be considered as regular migrants.

CONCLUSION

A shorebird or wader habitat is internationally important if it supports >1% of the population and nationally important under the Wildlife Conservation Plan for Migratory Shorebirds if it regularly supports >0.1% of the EAAF population (Hansen *et al.* 2016). Three Rottnest wader species fulfil this second category of national importance: Red-necked Stint, Ruddy Turnstone and Sanderling. While the remaining wader species recorded in the non-breeding counts over 22 years were not seen each year, their occasional presence indicates that the Island provides a suitable non-breeding habitat for them.

It has become vital that the salt lakes and the favoured areas of coastal habitat continue to be protected from the increasing visitor population and development on Rottnest Island. As is always asked with bird species in an island habitat, what are the threats to the continued survival of this suite of birds? The overall threat to waders is the destruction of their EAAF staging areas as they migrate from their breeding grounds to the non-breeding grounds of which Rottnest Island is significant for the species that move to the SCP. This is probably reflected in the decline in 14 of the Island's twenty wader species. Threats on the Island include human disturbance, water pollution, invasive plants and animals such as cats. Domestic cats *Felis catus*, undoubtedly a predator for roosting waders, were eradicated from the Island in 2001 and 2002 with continuing rigid control of possible re-introduction through pleasure craft (Algar *et al.* 2011). Unlike the Swan River Estuary where indications are that human disturbance affects roosting waders (Bamford *et al.* 2003), the Rottnest Island habitats are not currently subjected to boating, people walking, kitesurfing or fishing. The Rottnest Island Authority is to be congratulated on the protection of both the lake and beach habitats, vital for the continuing presence of trans-migratory waders, a natural asset for the Island. The value of the Island for ecotourism cannot be underestimated with an annual visitor number of 734 637 in 2017/18.

ACKNOWLEDGEMENTS

I am deeply grateful to Dr Jeremy Ringma from BirdLife Western Australia who has transformed the statistical analysis of these 22 years of data. However, this work would not have been possible without the willing support of volunteer bird surveyors. I would particularly like to pay tribute to the late Colin Davis, who initiated this work in 1997. Mike Bamford's work in this area, particularly in the Swan estuary, has been invaluable. The Western Australian Branch of BirdLife Australia has given continuing in-kind support. This work has drawn the attention of the Rottnest Island Authority to this valuable tourist resource. BirdLife has provided annual data to the RIA and it has provided unfailing logistical support in accommodation and transport resulting in efficient and reliable surveys over this time.

REFERENCES

Alcorn, M., R. Alcorn and M. Fleming 1994. Wader Movements in Australia. Australasian Wader Studies Group, RAOU, Melbourne.

Alexander, W.B. 1921. The Birds of the Swan River District, Western Australia. *Emu* 20:149-168.

Algar, D., G.J. Angus and M.L. Onus 2011. Eradication of feral cats on Rottnest Island, Western Australia. *Journal of the Royal Society of Western Australia.* 94**:**419-423.

Amano, T., T. Székely, K. Koyama, H. Amano and W.J. Sutherland 2010. A framework for monitoring the status of populations: An example from wader populations in the East Asian-Australasian flyway. *Biological Conservation*, 145:278-295.

Avenant, C. 2012. Analysis of Wetlands Chemistry and Associations with Invertebrate Diversity on Rottnest Island. Central Institute of Technology unpublished report.

Bamford, M. 1999. Movement of waters on the Swan Estuary. *Western Australian Bird Notes* 89:10-11.

Bamford, M.J., A.R. Hanford and W. Bancroft 2003. Report on Swan Estuary Marine Park; human usage, waterbirds and disturbance study 2002-2003. Department of Conservation and Land Management, Fremantle.

Bamford, M., D. Watkins, W. Bancroft, G. Tischler and J. Wahl 2008. Migratory shorebirds of the East Asian-Australasian Flyway: population estimates and Internationally Important Sites. Wetland International, Oceania.

Barter, M.A., D. Tonkinson, J.Z. Lu, S.Y. Zhu, Y. King, T.H. Wang, Z.W. Li, and X.M. Meng 1998. Shoreline numbers in the Huang Hi (Yellow River) delta during the 1997 northward migration. *Stilt* 33:15-26.

Birdata 2018. BirdLife Australia**.** http://www.birdlife.org.au/conservation/science/data-extraction-services

Christidis, L. and W.E. Boles 2008. Systematics and taxonomy of Australian birds. CSIRO Publishing, Collingwood.

Clemens, R.S., D.J. Rogers, B.D. Hansen, K. Gosbell, C.D.T. Minton, P. Straw, M. Bamford, E.J. Woehler, D.A. Milton, M. Weston, B. Venables, D. Weller, C. Hassell, B. Rutherford, K. Onton, A. Herrod, C.E. Studds, C. Choi, K.L. Dhanjal-Adams, N.J. Murray, G.A. Skilleter and R.A. Fuller 2016. Continental-scale decreases in shorebird populations in Australia. *Emu* 116:119-135.

Creed, K.E. and M. Bailey 2009. Continuing decline in wader populations at Pelican Point, Western Australia, since 1971. *Stilt* 56:10-14.

Davis, C. 1998. Rottnest wader survey, 8 February 1998. *Western Australian Bird Notes* 86:9-10.

Delany, S. and D. Scott 2006. Wetlands International. Waterbird Population Estimates - Fourth Edition. Wetlands International, Wageningen, The Netherlands.

Dunlop, J.N. 2009. The Population dynamics of tropical seabirds establishing frontier colonies on islands of south-western Australia. *Marine Ornithology* 37:99-105.

Edwards, D.H.D. 1983. Inland water of Rottnest Island. *Journal of the Royal Society of Western Australia*. 66:41-47.

Gosbell, K. and R. Clemens 2006. Population monitoring in Australia: some insights after 25 years and future directions. *Stilt* 50:162-175.

Hansen, B.D., R.A. Fuller, D. Watkins, D.I. Rogers, R.S. Clemens, M. Newman, E.J. Woehler and D.R. Weller 2016. Revision of the East Asian-Australasian Flyway Population Estimates for 37 listed Migratory Shorebird Species. Unpublished report for the Department of the Environment. BirdLife Australia, Melbourne.

Higgins, P.J. and S.J.J.F. Davies Eds. 1996. Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipes to Pigeons. Oxford University Press, Melbourne.

Irvine, R.T., J.K. Keesing, and F.E. Wells 2008. Assessment of Invertebrate Populations on Intertidal Platforms at Rottnest Island, Western Australia. Report to Swan Catchment Council Inc.

Jaensch, R.P., R.M. Vervest and M.J. Hewish 1988. Waterbirds in nature reserves of south-western Australia 1981-1985: reserve accounts. *RAOU Report* 30:49.

Lane, B.A. 1987. Shorebirds in Australia. Thomas Nelson, Australia.

Lane, B.A. and J. Starks 1985. Report on the winter, 1985 national wader count. *Stint* 7:2-7.

La Sorte, F.A. and W. Jetz 2010. Projected range contractions of montane biodiversity under global warming. The Royal Society Proceedings Biological Science. 3401–3410. Published online 2010 Jun 9. doi:10.1098/rspb.2010.0612 PMCID: PMC2982223

Lawson, F. 1905. A Visit to Rottnest Island, W.A. *Emu* 3:129-132.

Melville, D.S., Y. Chen and Z. Ma 2016. Shorebirds along the Yellow Sea coast of China face an uncertain future – a review of threats. *Emu* 116:100-110.

Minton, C, R. Jessop and P. Collins 2003. Variations in apparent annual breeding success of Red-necked Stints and Curlew Sandpipers between 1991 and 2001. *Stilt* 43:30-33.

Minton, C. R. Jessop, P. Collins and K. Gosbell 2005. Monitoring shorebird breeding productivity by the percentage of first year birds in populations in S.E. Australian non-breeding areas. Pp. 73-85. *In:* P. Straw (Ed.) Status and Conservation of shorebirds in the East Asian-Australasian Flyway, Proceedings of the Australasian Shorebirds Conference 13-15 December 2003, Canberra.

Minton, C, R. Jessop, P. Collins and C. Hassell 2006. Arctic breeding success in 2005, based on juvenile ratios in waders in Australia in the 2005/2006 Austral summer. *Stilt* 49**:**32-35.

Minton, C., J. Wahl, Jessop, R., C. Hassell, P. Collins and H. Gibbs 2006. Migration routes of waters which spend the noon-breeding season in Australia. *Stilt* 50:135-157.

Moores, N. 2006. South Korea's shorebirds: a review of abundance, distribution, threats and conservation status. *Stilt* 50:62-72.

Moores, N., D.I. Rogers, K. Rogers and P.M. Hasbro 2016. Reclamation of tidal flats and shorebird declines in Saemangeum and elsewhere in the republic of Korea. *Emu* 116:136-146.

Newman, M. and E.J. Woehler 2016. Red-necked Stint and Curlew Sandpiper in south-east Tasmania: Part 1 Red-necked Stint – population trends and juvenile recruitment. *Stilt* 69-70:7-19.

Playford, P.E. and R.E.J. Leech 1977. Geology and hydrology of Rottnest Island. Geological Survey of Western Australia, Report 6.

Rappoldt, C., M. Kersten and C. Smit 1985. Errors in large scale shorebird counts. *Andrea* 73:13-24.

Rogers, D., N. Moores and P.F. Battley 2006. Northward migration of shorebirds through Saemangeum, The Geum Estuary and Gomso Bay, South Korea in 2006. *Stilt* 50:73-89.

Rogers, D., C. Hassell, J. Oldland, R. Clemens, A. Boyle and K. Rogers 2008. Monitoring Yellow Sea Migrants in Australia (MYSMA). North-western Australia shorebird surveys and workshops. http://awsg.org.au/pdfs/Report_on_MYSMA_surveys.pdf

Rogers, D.I., C.J. Hassell, A. Boyle, K. Gosbell, C. Minton, K.G. Rogers and R.H. Clarke 2011. Shorebirds of the Kimberley Coast – populations, key sites, trends and threats. *Journal of the Royal Society of Western Australia* 94:377-391.

Rottnest Island Terrestrial Conservation Action Plan. 2016. http://ria.wa.gov.

Rottnest Island Authority Annual Report 2017/2018. Rottnest Island Authority State Government of Western Australia 2018 http://ria.wa.gov.au/policy-and-reports/annual-reports

Saunders, D.A. and C.P. de Rebiera 1986. Seasonal occurrence of members of the suborder Charadrii (Waders or Shorebirds) on Rottnest Island, Western Australia. *Australian Wildlife Research* 13:225-244

Saunders, D.A. and C.P. de Rebeira 2009. A Case study of the conservation value of a small tourist resort island: Birds of Rottnest Island, Western Australia 1905-2007. *Pacific Conservation Biology*, 15:11-31.

Singor, M. 2009. Decline in wader numbers on the Swan River Western Australia between 1981 and 2009. *Stilt* 55: 3-7.

Storey, A.W., R.M. Vervest, G.B. Pearson and S.A. Halse 1993. Wetlands of the Swan Coastal Plain, Vol. 7. Water Authority of Western Australia, Environment Protection Authority, Perth.

Storr, G.M. 1964. The Avifauna of Rottnest Island, Western Australia I Marine birds. *Emu* 64:48-64.

Storr, G.M. 1965. The Avifauna of Rottnest Island, Western Australia II Lake and Littoral birds. *Emu* 64:105-113.

Szabo, J.K., P.F. Battley, K.L. Buchanan, and D.I Rogers 2016. What does the future hold for shorebirds in the East Asian-Australasian Flyway? *Emu* 116:95-99.

Thomas, D.G. and A.J. Dantnell 1971. Moult of the Red-necked Stint. *Emu* 71:49-53.

Threatened Species recovery Hub 2018. Natural Environmental Science Program https://tsx.org.au/visualising-the-index/2018-tbx/

Turrin, C. and D. Watts 2016. Sustainable mortality limits for migratory shorebird populations within the East Asian-Australasian Flyway. *Stilt* 68:2-17.

Venables, W.N and B.D. Ripley 2002. *Modern Applied Statistics with S*, 4th ed. Springer, New York. ISBN 0-387-95457-0, http://www.stats.ox.ac.uk/pub/MASS4

Wilson, J.R., S. Nebel and C.D.T. Minton 2007. Migration ecology and morphometrics of two Bar-tailed Godwit populations in Australia. *Emu* 107:262-274.

THE LOCAL AND MIGRATORY MOVEMENTS OF EASTERN AUSTRALIAN PACIFIC GOLDEN PLOVER *PLUVIALIS FULVA* SPENDING THE NON-BREEDING SEASON IN MORETON BAY, SOUTH-EAST QUEENSLAND

JONATHAN T. COLEMAN[1] AND ROBERT BUSH[2]

[1] 22 Parker Street, Shailer Park, QLD, 4128, AUSTRALIA
Email: JanetandJon@hotmail.com
[2] 39 Barrinia Street, Manly, QLD, 4179, AUSTRALIA.

This study provides further insights into the migration of Pacific Golden Plover spending the non-breeding season in Eastern Australia using leg flag resightings and Platform Terminal Transmitters (PTTs). Four Pacific Golden Plover in Moreton Bay, Queensland, Australia were fitted with 5g PTTs and their local non-breeding season movements and migration monitored. Three of the four birds migrated, with two failing to complete the first migration leg and one reaching Guam where it stopped over for nine days before flying to Japan. In Japan, it utilised three stopover sites before leaving and flying to Gareloi Island, one of the Aleutian Islands in Alaska. Migration speeds of between 49.4 $km.hr^{-1}$ and 83.7 $km.hr^{-1}$ were recorded at different points in the migration. Local movements prior to migration indicated that the birds were faithful to their primary roosting sites and typically only ranged within a few kilometres of that location. The usage of both artificial and natural roosting and feeding areas is discussed and the importance artificial sites for migratory shorebirds highlighted. Differences in foraging behaviour at night were also identified and potentially were linked to disturbance factors.

INTRODUCTION

The Pacific Golden Plover is a medium sized shorebird (Higgins and Davies 1996) that has a breeding range extending from western Alaska as far west as the Yamal Peninsular in Russia, covering much of Siberia (Jukema *et al.* 2015). In the non-breeding season, the species range extends throughout the Pacific Islands, New Zealand, Australia and coastal areas in south-east Asia (Higgins and Davies 1996).

The species has an estimated world population of between 166,000 and 216,000 birds (Delaney and Scott 2002), although a recent estimate places the current population at somewhat less with 120,000 individuals (Hansen *et al.* 2016). Bamford *et al.* (2008) estimated the East Asian-Australasian Flyway population to be 100,000 individuals. The Hawaiian Islands are recognised as one of the most significant wintering areas for this species with up to 70,000 estimated there in the non-breeding season (Johnson 2003). By contrast, only 9000 individuals are believed to spend the austral summer in Australia (Higgins and Davies 1996).

The migration of the species has been well studied in Hawaii with birds there breeding in Western Alaska and flying direct and non-stop between the breeding and non-breeding grounds (Johnson *et al.* 2011). Work by the same authors (Johnson *et al.* 2012) has identified a different migration route taken by Pacific Golden Plover that spend the non-breeding season in the central and south Pacific Islands. These birds take a more westerly northward route and rely on stopover sites in Japan and the Yellow Sea en-route to Alaskan breeding grounds. The species also appears to be remarkably faithful to their non-breeding wintering locations with between year return rates documented at between 70 and 90% in one study (Johnson *et al.* 2006).

In contrast, Pacific Golden Plover that spend the non-breeding season in Asia migrate mainly over land to Siberian breeding grounds with staging of birds known to occur in large numbers in Mongolia on northward migration (Byrkjedal and Thompson 1998). Morphometric comparisons on the two populations indicate that the Pacific birds have longer wings than their Asian counterparts (Jukema *et al.* 2015), suggesting ongoing sub-speciation in response to different migration strategies.

In contrast to the studies on Pacific Islands, the species has not been studied in detail in Australia and so there is uncertainty over which population Australian birds belong to. To date (23 June 2019) only 938 Pacific Golden Plover have been banded in Australia, resulting in only 74 recoveries of banded birds (Australian Bird and Bat Banding Scheme 2019).

Morphometric evidence suggests at least some birds in Australia form part of the Pacific population breeding in Alaska (Barter 1988) and limited evidence from banding recoveries also support this hypothesis but do not eliminate the possibility that Australian found birds could be from either population (Minton *et al.* 2006).

This study aimed to provide further insights into the migration of Pacific Golden Plover spending the non-breeding season in Eastern Australia using leg flag resightings and solar-powered Platform Terminal Transmitters (PTTs).

METHODS

Since 2006 the Queensland Wader Study Group have routinely caught Pacific Golden Plover as part of their long-term banding and flagging program in Moreton Bay, near Brisbane in Queensland. Birds are captured at high tide roosts using a combination of night-time mist-netting and daytime cannon netting. Pacific Golden Plover caught during this period at two locations, the Port of Brisbane (-27.361408°S, 153.198603° E), reclamation area, popular roosting site for the species, and Manly Marina (-27.453519° S, 153.194463° E) another artificial roost site created specifically for shorebird roosting.

In December 2016 and March 2017, Pacific Golden Plover were specifically targeted for capture at the Manly location, for the purpose of fitting PTTs. Birds were caught on a rising tide at night in December, using mist nets and during the daytime in January using cannon nets.

Each bird caught was fitted with a metal band issued by the Australian Bird and Bat Banding Scheme on the left tarsus and a green engraved leg flag on the right tibia. A series of measurements were also taken from each bird and the bird weighed to the nearest gram. Only birds greater than 130g were selected for PTT placement. Measurements included flattened wing chord, total head and bill length and tarsus, all measured to the nearest 0.1 mm and according to the methodology described in Lowe (1989). Birds were aged using plumage characteristics and the timing of moult according to the criteria published in Higgins and Davies (1996).

Two birds were caught in the December catch and were fitted with 5 g solar PTTs supplied by Microwave Telemetry using the leg loop harness method successfully used on shorebirds in other studies (Sanzenbacher *et al.* 2000). The remaining two devices were fitted to the two heaviest birds caught in the March 2017 cannon net catch. To maximise battery life all devices were pre-programed to a cycle tie of 10 h transmitting followed by 48 h off. All the birds fitted with PTTs were aged as adult birds but were not sexed.

RESULTS

Since 2006, the Queensland Wader Study Group have caught and fitted individually engraved leg flags to a total of 98 Pacific Golden Plovers. Fifty-nine of these have been captured at the Port of Brisbane with the remainder banded at the Manly marina roost (Fig. 1). This total includes the four birds fitted with PTTs in December 2016 and March 2017, all of which were fitted at Manly marina.

Morphometrics and weight gain

Ninety-four of the 98 Pacific Golden Plover were measured and weighed at the time of banding (Table 1). Flattened wing chord length varied between 147 and 184 mm with a mean of 168.5 mm. Tarsus varied between 40.1 and 49.8 mm and total head and bill length between 53.8 and 61.6 mm. There was no indication of sexual dimorphism in wing length or any of the other morphometrics taken.

Table 1. Morphometric Measurements of Pacific Golden Plover caught in Moreton Bay, Queensland between 2006 and 2019

	Flattened Wing Chord (mm)	Total Head and Bill Length (mm)	Tarsus Length (mm)
Mean	168.5	57.6	45.3
Standard Error	0.7	0.1	0.3
Range	147.0-184.0	53.8-61.6	40.1-49.8
Number	94	94	94

Mean body mass was calculated by month, irrespective of the year of capture, for all 94 Pacific Golden Plover. Mean body mass varied with month of capture with mean body mass increasing from January onwards as would be expected. Mean body mass was consistent from October to December (123.3 g, 123.3 g and 122.8 g respectively) with the peak body mass recorded in March where the mean had increased to 157.4 g (Fig. 2).

Two individuals fitted with PTTs on 29th December 2016 were recaptured on the 12th March 2017, providing an opportunity to look at their weight gain between the two dates. Data from the PTTs showed that birds left between the 26th and 27th April, unfortunately there were no recaptures of these birds after March so weight gain in the 45 days prior to departure could not be assessed. The birds (leg flags DAA and DAB) weighed 131 and 132 g in December 2017 with their body mass on recapture increasing to 146 and 142 g respectively. This represented a percentage increase in body mass of 11.5% and 7.6% for the two individuals over a 73-day period.

Number of birds banded, recaptured and resighted through leg flag observations

Of the 98 birds banded since 2006, five have been recaptured, all at the site they were originally banded at, one at the Port of Brisbane (3 years after its original banding) and the remaining three at Manly Marina. All were recaptured in the same nonbreeding season in which they were banded.

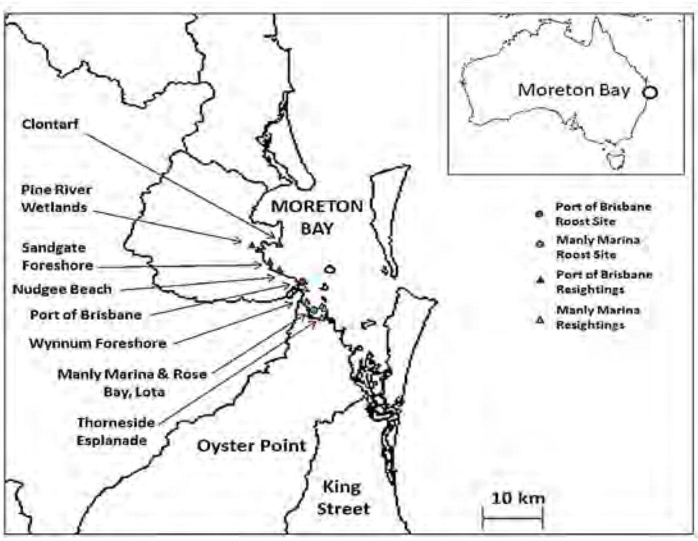


Figure 1. Map showing Moreton Bay catching locations and local resightings of individually leg flagged Pacific Golden Plovers.

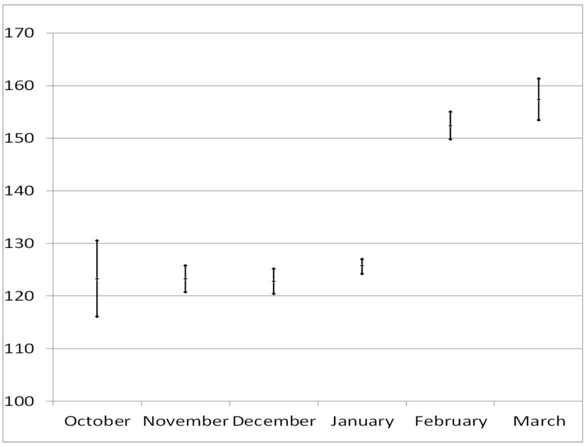


Figure 2. Mean (± SE) Monthly Body Mass (g), calculated across all years in which Pacific Golden Plover were caught and weighed in Moreton Bay (N = 94 Pacific Golden Plover caught between 2006 and 2019).

Figure 3. Non-breeding season local movements, between December 29th 2016 and April 26th 2017, for all four Pacific Golden Plover carrying PTTs fitted at Manly Marina.

These 98 birds have generated a total of 354 individual resightings from 56 individuals with 42 not seen or recaptured since banding. Resightings have all been local to the point of capture with birds typically recorded only a few kilometres from their roosting site (Fig. 1).

Pacific Golden Plover banded at Manly Roost were recorded primarily at the original banding location (227 records). Resightings away from Manly Roost included Lota Beach, 0.5 km south (5 records), Rose Bay, 0.5 km north (5 records), Thorneside Esplanade, 3 km S (2 records) and Wynnum Esplanade, 1 km N (89 records). There were no overseas resightings of Pacific Golden Plover banded at Manly.

Pacific Golden Plover banded at the Port of Brisbane were recorded in different locations to those banded at Manly. Birds were recorded to the north at Nudgee Beach (8 km north, 1 record), Sandgate Foreshore (10 km north, 20 records), Clontarf (14 km north, 1 record) and Pine River Wetlands (10 km NE, 3 records). Only one bird was resighted at the Port of Brisbane and there were no records to the south of the banding location.

One bird banded at the Port of Brisbane in February 2016 was recorded two months later in Ibariki, near Osaka, Japan. This is the only overseas resighting of a Queensland banded Pacific Golden Plover to date. The only other overseas record of an individually identifiable bird was a bird banded in Nome, Alaska in June 2008 and resighted at Burnett Heads, Queensland, in January 2016.

Non-breeding season movements derived from PTTs

Two birds were fitted with PTTs on the 29th December 2016 (leg flags DAA and DAB) and a further two PTTs fitted on the 12th March 2017 (leg flags BSA and BHM), all fitted at Manly Marina. These four devices provided a total of 984 data points for the birds prior to their migration (Fig. 3). Three birds provided data until their departure from Moreton Bay, but one bird (DAB) stopped transmitting on the 10th April and was believed to have been predated due to the unusual inland location of the transmitter for several days, prior to its failure.

The individual carrying the leg flag BHM provided 153 data points prior to migration. It remained very close to its original banding location at Manly with all data points at high tide being in the Manly marina area, indicating a high degree of faithfulness to its roost site in the non-breeding season. Away from the roost site, almost all data points (96.7%) were within 3 km of the roost site, with most resightings to the north on the Wynnum foreshore area. There were five records (3.3% of all local resightings) of the bird further north when the bird was recorded near to the Port of Brisbane some 7 km away on five different dates.

By contrast, the individual leg flagged BSA, which provided 155 pre migration data points, ranged further, albeit still within the local area. Data points recorded at high tide, when the bird would be roosting were at Geoff Skinner Reserve at Wellington Point, another shorebird roost site 5.7 km to the south west of Manly Roosting site. This showed that the bird changed roost site following its capture although it still visited the site regularly at other times in the tidal cycle. The majority of the feeding records were also in the Wellington Point and Thorneside Esplanade area with the bird ranging as far north as Manly (Figs 1 & 3). All except eight data points (94.8%) were within 7 km of the Wellington Point roost site with the majority of those points within 5 km. As with BHM, the remaining eight data points were recorded over five dates in the Port of Brisbane area.

The two birds fitted with PTTs in December 2016 (leg flags DAA and DAB) provided 369 and 307 pre migration data points respectively. For DAB, again most data points (71.0%) were within a 4 km radius of the Manly high tide roost site with most records to the north, along the Wynnum Foreshore (Figs 1 & 3). As with the previous two individuals there were occasional records (11 records: 3.6%) at the Port of Brisbane on six different dates between December and April. This individual also displayed a different behaviour at night with 16 records (5.2%) over 14 separate dates where the bird was recorded 12 km inland, along the Brisbane river spending the night on a large golf course complex (Fig. 3). From the 22nd March until the 10th April the PTT on this bird recorded data points in unsuitable habitat between the Golf Course and Manly sites at which point the device stopped responding.

DAA, the fourth bird providing data in the pre-migration period displayed a similar profile to DAB with most resightings, within a 4 km radius of the Manly roost, with all high tide records close to Manly, suggesting strong fidelity to the roost site. As with DAB there were records inland, on the same golf course on the Brisbane River with 44 records (11.9% of the records) over 18 dates recorded for this location. As with DAB, all these records were overnight records with no daytime records recorded away from the normal coastal feeding locations.

Departure dates and northward migration: stage one

Of the three birds that successfully migrated, all left Moreton Bay in late April with departure dates between 26-27th April: BHM and DAA departing on 26th April and BSA departing on 27th April. All three birds flew due north for approximately 3000 km flying over the Solomon Sea between Papua New Guinea and the Solomon Islands. All three birds crossing the Equator on the 30th May and then changed bearing north-westwards across the Pacific Ocean (Fig. 4).

One individual (leg flag BHM), flew north west for 1800 km towards Yap Island in the Federated States of Micronesia, where on the 1st May the bird was only 600 km from the coast. The bird then turned south west towards West Papua flying 800 km and was last recorded on the 5th May 2017 just 300 km north east from the coast of West Papua, a total distance of 5600 km in 10 days.

The second individual (leg flag BSA) followed the same route as the previous bird heading towards Yap Island, also being approximately 600 km from the coast on the 1st May 2017. This individual then turned due west towards Palau with its last signal on the 3rd May 2017, 500 km from the coast of Palau. This bird had flown a total distance of 5300 km in eight days.

The final bird (leg flag DAA) flew north west, making landfall on the island of Guam on the 2nd May having flown 1800 km in two days. The bird remained on Guam until the 11th May before leaving and flying NNW towards Japan. Most of the resightings on Guam were centred around the Sasa Bay area (13.456480° N, 144.673820° E), a low lying coastal marine reserve on the central north coast of the island. The bird had flown 4800 km in seven days to complete the first leg of its northward migration.

Northward migration: stage two

From Guam, the remaining bird then flew 2300 km north making landfall on the south coast of Japan near Fuji (35.127690° N, 138.657010° E) on 14th May, remaining there until the 16th May. This was 2300 km flown in three days. The data points received suggested that the bird was utilising open spaces and parkland within the urban areas adjacent to the coast while at this location.

The bird then relocated 250 km north east, remaining in the Toride area (35.906990° N, 140.084150° E), north east of Tokyo for at least one day on the 18th May, moving around agricultural fields in that area. On the 21st May the bird had moved to a third stopover location near Minami (37.820920° N, 139.078150° E) 230 km NNW of the Toride location. The third stopover location was utilised from the 21st to the 27th May with the bird frequenting agricultural land again (Fig. 4).

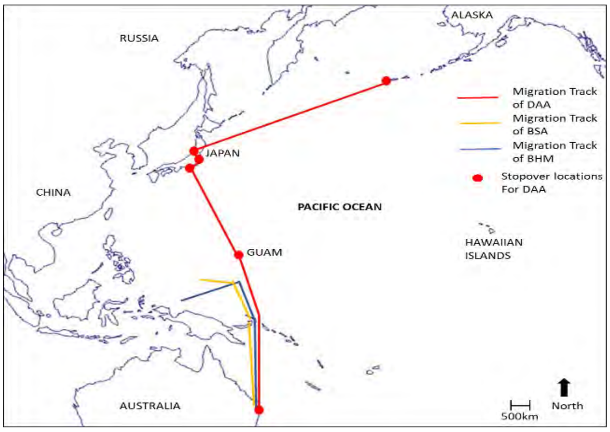


Figure 4. Migratory movements of three Pacific Golden Plover, fitted with PTTs at Manly Marina, Moreton Bay, Queensland.

Northward migration: stage three

The final component of the journey involved the bird flying east north east from Japan, leaving on the 27th May and arriving on Gareloi Island, Alaska (51.751560° N, -178.826330°W), one of the islands in the Aleutian Island chain on the 31st May. This was 3600 km covered in four days. The bird remained on Gareloi Island until the 9th June, favouring an area on the south coast of the island. No further signals were received from the PTT after this date (Fig. 4).

Migration speed

The use of PTTs to monitor migration also provided an opportunity to examine the migration speeds on the different migration legs, Brisbane to Guam, Guam to Japan and Japan to Alaska. Overall, the individual with leg flag DAA took 35 days to complete its migration to Gareloi island, covering 8800 km and spending 18 of those days at four stopover locations. On average the bird covered 251 km.day^{-1} over the whole migration period and this was a mean distance of 517 km.day^{-1} when the bird was in active flight.

On the Brisbane to Guam stage between 28th April 03:25 AEST and 30th April 05:45 AEST, at two points when the bird was flying over open ocean the bird covered 2470 km (1235 km.day^{-1}) a speed of 49.4 km.hr^{-1}. On the second stage from Guam to Japan the bird arrived in Japan during the devices off cycle, so the flight speed was calculated for the bird as it was flying from the coast of Guam on the 12th May. Between 09:48 AEST and 15:03 AEST the bird covered 262 km which was a calculated speed of 49.9 km.hr^{-1}, only 0.5 km.hr^{-1} faster than the calculated speed on stage one. By contrast, the calculated speed on the 29th May, between 05:22 AEST and 08:52 AEST, on the flight from Japan to Alaska was considerable faster with a calculated speed of 83.7 km.hr^{-1}.

DISCUSSION

Morphometrics and weight gain

For birds measured at Moreton Bay sites the mean flattened wing chord length of 168.5 mm was shorter when compared with data from Hawaii, other islands across the Pacific and catching sites in south east Australia (Jukema 2015). However, the Moreton Bay Pacific Golden Plovers had a longer flattened wing chord length than Pacific Golden Plovers measured in Western Indonesia and in Siberia. This appears to confirm the hypothesis by Barter (1988) that Australian birds residing during the austral summer on the north eastern Australian coast, based on their morphometrics, are most likely to be part of Pacific flyway population breeding in Alaska.

In this study, weight gain started in January and by March, recaptured individuals had increased their body mass by 7.6 to 11.5%. Unfortunately, there were no data available from when birds departed in April. However, there is one record in April of 172 g (Higgins and Davies 1996), suggesting birds may increase their body mass by up to 40% prior to departure.

Non-breeding season movements

Data from both leg flag resightings and PTT locations demonstrated that birds were loyal to their roost sites. They used the same roost site regularly, and typically fed within a few kilometres' radius of the roost site. This has been shown in other species within Moreton Bay (Coleman and Milton 2012) where the species studied remained local to their primary roosting site, but utilised other roosts and feeding sites in their area in response to local conditions. Two of the three roost sites used by Pacific Golden Plover in this study (Manly Marina and the Port of Brisbane) were artificial sites, demonstrating the importance of these sites for migratory shorebirds in Moreton Bay. The parochial nature of this species was also noted by Johnson *et al.* (2006) who also demonstrated a strong fidelity to their wintering locations between years with return rates of between 72 and 90% in the following non-breeding season.

The use of PTTs provided an opportunity to examine the behaviour of this species to see if there were differences in their behaviour at night. While in most cases there was not, two birds did move onto a large golf course within an urban landscape at night on a regular basis. Being over 10 km inland from their normal foraging areas this may be a further demonstration of the importance of artificial sites alongside natural foraging areas for some species of migratory shorebird. Much of the work by Johnson *et al.* (1997, 2006) has involved catching birds that are primarily using grassy areas such as playing fields and lawns over much of their non-breeding Pacific range. The use of foreshore by the birds in this study therefore appears unusual and the usage of grass areas only at night may be a response to the disturbance of those areas during the day.

Northwards migration and staging areas

The birds in this study departed Moreton Bay on the 26th and 27th April. This was like birds tracked on Oahu, Hawaii which departed between the 26th and 29th April, but much later than birds tracked from the Mariana Islands which departed from the 14th April (Johnson *et al.* 2006). The reasons for these differences are unclear and it could be expected that those from sites further north and closer to the breeding grounds, would migrate later. However, it is more likely that this reflects the usage of different stopover sites (Johnson *et al.* 2004, 2006) and breeding sites within the range with birds from different locations requiring similar time to complete their northward migration.

The importance of stopover sites was clearly demonstrated in this study with birds stopping in Guam and Japan on northwards migration. This route broadly follows that proposed in Jukema (2015) and is also supported by the two resightings of leg flagged or colour banded birds, one from Moreton Bay seen in Japan, and one from Alaska seen in south east Queensland. Work by Johnson and McFarlane (1967) suggested that this species could fly for between 5800 and 10,000 km non-stop depending on the body mass the individual achieved in pre-migratory fattening. Given the distance travelled by the individual leg flagged DAA exceeded 11,000 km at least one stopover site would be required on northward migration. The two stopover locations may well reflect the need to maintain body condition for arrival on the breeding grounds. Unfortunately, southward migration was not captured in this study and it would be interesting to see if this was shorter and completed with only one stopover reflecting the energetic needs of the bird for migration without breeding.

Migration speeds

In this study, migration speeds between 49.4 and 83.7 $km.hr^{-1}$ were recorded, with a mean flight speed of 61 $km.hr^{-1}$. While estimated possible air speeds of between 93 and 100 $km.hr^{-1}$ were calculated for this species (Johnson and McFarlane 1967), actual recorded values are much lower. Johnson *et al.* (2004) recorded average flight speeds of 56 $km.hr^{-1}$ between Hawaii and Alaska and 80 $km.hr^{-1}$ in an earlier study on the same migration track (Johnson *et al.* 1997). These results compared well with the data collected in this study.

ACKNOWLEDGEMENTS

The Port of Brisbane Pty Ltd, along with the Queensland Wader Study Group provided the funding that made this project possible and we are grateful to these organisations for their financial support. The Australian Bird and Bat Banding Scheme provided the metal bands used in this study.

The Queensland Wader Study Group also provided a pool of willing volunteers who helped and continue to help catch shorebirds. Without the help of these volunteers no fieldwork would have been possible and although too numerous to mention everyone involved, the authors express their sincere appreciation for the support and hard work, often under long, arduous field conditions.

REFERENCES

Australian Bird and Bat Banding Scheme 2019. http://www.environment.gov.au/biodiversity/science/abbbs/abbbs-search.html

Bamford M., D. Watkins, W. Bancroft, G. Tischler and J. Wahl 2008. Migratory Shorebirds of the East Asian - Australasian Flyway: Population estimates and internationally important sites. [Online]. Canberra, ACT: Department of the Environment, Water, Heritage and the Arts, Wetlands International-Oceania. Available from: http://www.environment.gov.au/biodiversity/migratory/publications/shorebirds-east-asia.html.

Barter, M.A. 1988. Biometrics and moult of Lesser Golden Plovers *Pluvialis dominica fulva* in Victoria *Stilt* 13:15-19.

Byrkjedal, I., and D.B.A. Thompson 1998. Tundra Plovers: The Eurasian, Pacific and American Golden Plovers and Grey Plover. T. and A. D. Poyser, London, UK.

Coleman J.T. and D.A. Milton 2012. Feeding and roost site fidelity of two migratory shorebirds in Moreton Bay, South-Eastern Queensland, Australia. *The Sunbird* 42:41-51.

Delany, S. and D. Scott 2002. Waterbird population estimates, 3rd ed. Wetlands International Global Series No. 12, Wageningen, The Netherlands.

Hansen, B.D., R.A. Fuller, D. Watkins, D.I. Rogers, R.S. Clemens, M. Newman, E.J. Woehler, and D.R. Weller 2016. Revision of the East Asian-Australasian Flyway Population Estimates for 37 listed Migratory Shorebird Species. Unpublished report for the Department of the Environment. BirdLife Australia, Melbourne.

Higgins, P.J. and S.J.J.F. Davies Eds. 1996. Handbook of Australian, New Zealand and Antarctic birds. Vol. 3: Snipe to Pigeons. Oxford University Press, Melbourne.

Johnston, D.W. and R.W. McFarlane 1967. Migration and Bioenergetics of Flight in the Pacific Golden Plover. *The Condor*. 69:156-168.

Johnson, O.W. 2003. Pacific and American Golden-Plovers: reflections on conservation needs. *Wader Study Group Bull.* 100:10-13.

Johnson, O. W., N. Warnock, M.A. Bishop, A.J. Bennett, M. Johnson, and R.J. Kienholz 1997. Hawaii to Alaska migration by radio-tagged Pacific Golden-Plovers and their subsequent survival. *Auk* 114:521-524.

Johnson, O.W., R. Goodwill, and P.M. Johnson 2006. Wintering ground fidelity and other features of Pacific Golden-Plovers *Pluvialis fulva* on Saipan, Mariana Islands, with comparative observations from Oahu, Hawaiian Islands. *Wader Study Group Bull.* 109:67-72.

Johnson, O.W., L. Fielding, J.W. Fox, R.S. Gold, R.H. Goodwill, and P.M. Johnson 2011. Tracking the migrations of Pacific Golden-Plovers (*Pluvialis fulva*) between Hawaii and Alaska: New insight on flight performance, breeding ground destinations, and nesting from birds carrying light level geolocators. *Wader Study Group Bull.* 118:26–31.

Jukema, J., G. van Rhijn, and T. Piersma 2015. Geographic variation in morphometrics, molt, and migration suggests ongoing subspeciation in Pacific Golden-Plovers (Pluvialis fulva). *The Auk: Ornithological Advances* 132:647-656.

Lowe K.M. 1989. The Australian Bird Banders Manual, Australian Bird and Bat Banding Scheme Publication, Canberra.

Minton, C.D.T., J. Wahl, R. Jessop, C. Hassell, P. Collins and H. Gibbs. 2006. Migration routes of waders which spend the non-breeding season in Australia. *Stilt*. 50:135-157.

Sanzenbacher, P. M., S.M. Haig and L.W.O. Ring 2000. Application of a modified harness design for attachment of radio transmitters to shorebirds. *Wader Study Group Bull.* 91:16–20.

THE EAST COAST OF NORTH SUMATRA PROVINCE: AN IMPORTANT NON-BREEDING AREA FOR GREY-HEADED LAPWING *VANELLUS CINEREUS* IN INDONESIA

CHAIRUNAS ADHA PUTRA*, DESY HIKMATULLAH

*Sumatran Shorebird Research & Conservation Project, Yayasan Warisan Hidup Sumatra (WHiS), Jalan Tempuling No. 169, Medan 20222, North Sumatra, Indonesia.*Email: chairunasadha@ymail.com*

The eastern coast of North Sumatra, Indonesia, is known to support internationally significant congregations of migratory waterbirds in the East Asian-Australasian Flyway (EAAF), including several globally threatened species such as the Great Knot *Calidris tenuirostris*, Far-eastern Curlew *Numenius madagascariensis* and Asian Dowitcher *Limnodromus semipalmatus*. Yet, the present status of many species on Sumatra's coast is still poorly understood. During 2018–2020, we undertook extensive surveys covering the eastern coast of northern Sumatra to determine the occurrence and congregations of migratory shorebirds at potential areas of coastal wetlands. Further records of Grey-headed Lapwing *Vanellus cinereus* at five sites in North Sumatra Province, Indonesia, confirm that the species spends the non-breeding season in Sumatra. The highest single record of 407 individuals at Kresek Beach on the eastern coast highlights the potential global importance of the area for this species.

INTRODUCTION

The Grey-headed Lapwing *Vanellus cinereus* breeds in north-eastern Asia and spends the non-breeding season in southern China, Indochina, Myanmar, Bangladesh, India, Nepal, Peninsular Malaysia and Northern Sumatra (Robson 2010, Bamford *et al*. 2008, Crossland & Sitorus 2011). According to Delany & Scott (2006) the global population was estimated at 25,000-100,000 individuals, with the largest non-breeding sites concentrated in Bangladesh, India, Thailand and the Malay Peninsula (Bamford *et al*. 2008, Mundkur *et al*. 2017).

Grey-headed Lapwings have been recorded several times in Indonesia. The first record was in Gorontalo Province, Sulawesi in 1869 (Sukmantoro *et al*. 2007). The second was nearly 140 years later in December 2008, when a total of 20 birds were found in rice fields at Alui Putih in northern Aceh Province (Iqbal *et al*. 2009). Subsequently, Crossland & Sitorus (2011) counted a total 29 Grey-headed Lapwings on intertidal mudflats at four separate locations in North Sumatra Province in October 2010.

Iqbal *et al.* (2009) considered the Grey-headed Lapwing a vagrant to Sumatra. Based on the records in 2010, Crossland & Sitorus (2011) suggested that the species may have recently expanded its boreal winter range to Sumatra, and regularly spends the non-breeding season on the island. Based on Asian Waterbirds Census data, the population number of Grey-headed Lapwing increased in Malay Peninsula from 45 individuals in 2008 to 681 individuals in 2015 (Mundkur *et al*. 2017). Our recent surveys since 2011 have found the species can be regularly recorded in Sumatra, further confirming the observations of Crossland & Sitorus (2011). Our findings suggest that the coastline and coastal lowlands of North Sumatra province support for up to 1% of the total global population of Grey-headed Lapwing.

METHODS

Our main dataset comes from comprehensive shorebird surveys on the eastern coast of northern Sumatra during periods of January to April in 2018, from December 2018 to March 2019 in North Sumatra Province (Putra & Hikmatullah 2018, Putra & Hikmatullah 2019), and from October 2019 to January 2020 in Aceh Province (Putra & Hikmatullah 2020). In addition, we recorded shorebirds in the Deli-Serdang Coastline from 2011 to 2020 (Putra *et al*. 2015, Putra *et al*. 2017). Coastal wetlands, inland marshes and rice fields were also visited in the Deli-Serdang, Batubara and Asahan areas from September-November 2012, March 2017 and September - October 2018 (A. Crossland *unpubl. data*)

A total of 53 survey sites were visited in the eastern coastal areas of North Sumatra. The most common habitat was intertidal mudflat (37 sites). Meanwhile in the Eastern Coast of Aceh Province, we visited 49 sites and the most common habitat was fishpond (28 sites). During surveys, we also recorded birds at man-made and/or natural wetlands, such as marshes, rice fields and estuaries. We gathered all data of Grey-headed Lapwing records from scientific publications, the grey literature, as well as our observations, and existing datasets available from the Asian Waterbird Census (Li *et al*. 2009, Mundkur *et al*. 2017) and ebird database (Sullivan *et al.* 2009).

RESULTS

From our literature and data search, we found there were three records of Grey-headed Lapwing during the boreal winter in 2012: four birds at Sejarah Beach, Batubara District, on 29 November (A. Crossland *pers. comm.*); 25 at Sei Tuan Village, Deli Serdang District on 9 December (C.A. Putra & D. Hikmatullah *pers. obs.*) and 30 at Bagan Percut mudflats, Deli Serdang on 10 December (J.B.C. Harris per eBird 2012).

Between 2014 and 2020, we recorded a total of 951 Grey-headed Lapwings at ten sites along the eastern coast of northern Sumatra, including two sites in Aceh Province and eight sites in North Sumatra Province (Table 1, Fig. 1). Most Grey-headed Lapwings were recorded on intertidal mudflats. Seven birds were recorded in fish ponds at three locations: Bunga Beach

Figure 2. A flock of over one hundred Grey-headed Lapwings roosting with terns on intertidal mudflat in Durian Village, North Sumatra, Indonesia. Photo was taken on 22 January 2020 (by ©Chairunas Adha Putra).

Figure 3. Flight flock of Grey-headed Lapwing in Durian Village, North Sumatra, Indonesia. Photo was taken on 22 January 2020 (by ©Chairunas Adha Putra).

and Batubara District (North Sumatra), Kuala Parek and Tanjung Keramat village in East Aceh, and Aceh Tamiang Districts, respectively. We also found 128 individuals resting in rice fields at Kelambir Village. In addition, there was another record of three birds in a rice field at Kampung Dame, Serdang-Bedagai District (North Sumatra Province) on 4 October 2018 (A. Crossland *pers. comm.*). This site is 29 km away from the coast and the record is the furthest inland to date.

The highest count (407 birds) was recorded on intertidal mudflats at the river mouth of Durian Village on 22 January 2020 (Figs 2 & 3). We also counted a total of 157 individuals in flight the day before at Nenas Siam Village. Their flight direction was from the river mouth at Durian village to inland. It is uncertain whether these birds were part of the large flock found the following day or they were from a different group. According to the plumage, most birds in the Durian Village flock were adults while at least 10 individuals were juveniles. Grey-headed Lapwings were also observed roosting with large flocks (hundreds) of terns, particularly White-winged Tern *Chlidonias leucopterus*, Whiskered Tern *C. hybrida*,

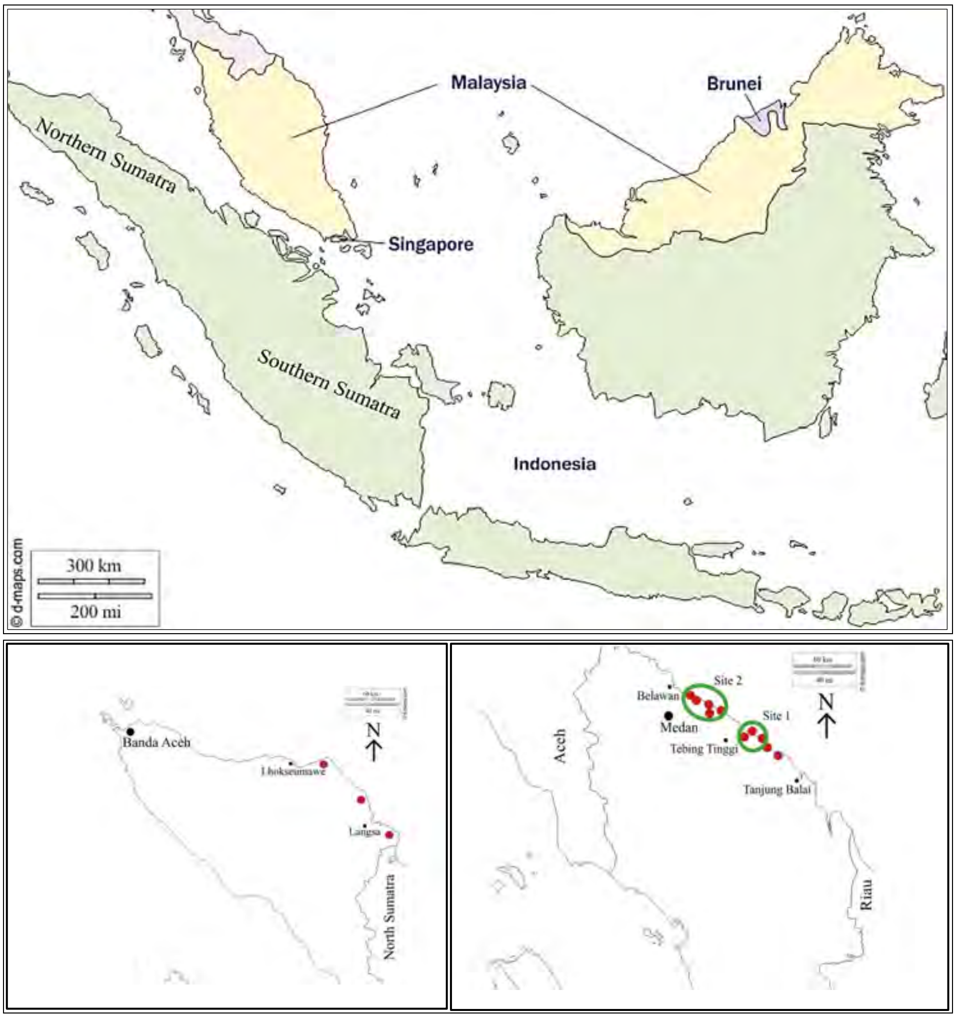


Figure 1. Distribution map of Grey-headed Lapwing in Northern Sumatra (Aceh and North Sumatra provinces). The red dots indicate the location records of Grey-headed Lapwing and green circles are the important sites for the species; Site 1; Durian mudflat, Nenas Siam and Sujono beach, Site 2; Kelambir rice field, Sei Tuan mudflat and West Indah Ancol beach.

Table 1. Records of Grey-headed Lapwings on the eastern coast of northern Sumatra (Aceh and North Sumatra Provinces).

Date	Location (coordinates)	Habitat	Number of birds	Source
In 2008				
31 Dec	Alui Putih, North Aceh, Aceh. (5°08'N, 97°23'E)	Rice field	20	Iqbal *et al*. 2009
	Total Count		**20**	
In 2010				
08 Oct	Sejarah Beach, Batubara, North Sumatra. (3°15'N, 99°32'E)	Mudflat	7	Crossland *& Sitorus* 2011
	Labu Baru Beach, Dei Serdang, North Sumatra. (3°40'N, 98°54'E)	Mudflat	3	Crossland & Sitorus 2011
14 Oct	Ancol Indah West Beach, Deli Serdang, North Sumatra. (3°41'N, 98°51'E)	Mudflat	14	Crossland & Sitorus 2011
	Bagan Serdang, Deli Serdang, North Sumatra. (3°42'N, 98°50'E)	Mudflat	5	Crossland & Sitorus 2011
	Total Count		**29**	
In 2012				
29 Nov	Sejarah Beach, Batubara, North Sumatra	Mudflat	4	A. Crossland *pers. obs.*
09 Dec	Sei Tuan Village, Deli Serdang, North Sumatra. (3°42'N, 98°49'E)	Mudflat	25	This study
10 Dec	Bagan Percut, Deli Serdang, North Sumatra	Mudflat	30	B. Harris per eBird 2012
	Total Count		**59**	
2014-2020				
20/11/2014	Sei Tuan Village, Deli Serdang, North Sumatra. (3°42'"N, 98°49'E)	-	67	Putra *et al*. 2017
28/01/2018	Bunga Beach, Batubara, North Sumatra. (3°13'N, 99°34'E)	Fish pond	1	Putra & Hikmatullah 2018
07/02/2018	Kresek Beach, Batubara, North Sumatra. (3°23'N, 99°22'E)	Mudflat	17	Putra & Hikmatullah 2018
04/10/2018	Kampung Dame, Serdang Bedagai, North Sumatra	Rice field	3	A. Crossland *pers. obs.*
02/01/2019	Kresek Beach, Batubara, North Sumatra. (3°24'N, 99°23'E)	Mudflat	67	Putra & Hikmatullah 2019
20/10/2019	Kuala Parek, East Aceh, Aceh. (4°39'N, 97°56'E)	Fish pond	4	Putra & Hikmatullah 2020
13/11/2019	Kelambir Village, Deli Serdang, North Sumatra. (3°40'N, 98°51'E)	Rice field	128	This study
10/01/2020	Sujono Beach, Batubara, North Sumatra. (3°23'N, 99°25'E)	-	98	This study
21/01/2020	Nenas Siam Village, Batubara, North Sumatra. (3°23'N, 99°21'E)	-	157	This study
22/01/2020	Durian Village, Batubara, North Sumatra. (3°24'N, 99°21'E)	Mudflat	407	This study
30/01/2020	Tanjung Keramat Village, Aceh Tamiang, Aceh. (4°25'N, 98° 9'E)	-	2	This study
	Total Count		**951**	

Little Tern *Sternula albifrons*, Common Tern *Sterna hirundo* and Gull-billed Tern *Gelochelidon nilotica*.

The second highest count was 128 in a rice field at Kelambir village, Deli Serdang District on 13 November 2019. Grey-headed Lapwings were observed roosting with a small number of Whimbrel *Numenius phaeopus*, Common Redshank *Tringa totanus* and Pacific Golden Plover *Pluvialis fulva*. The roosting site was close to the intertidal mudflat at Labu Baru Beach, Ancol Indah West Beach and Bagan Serdang, where Crossland & Sitorus (2011) recorded small numbers of Grey-headed Lapwings in 2010. It is also close to the mudflats at Sei Tuan where we recorded a flock of 25 birds in 2012 and a flock of 67 birds in 2014. The distance from Kelambir rice field to the nearest mudflat is 5.8 km.

DISCUSSION

The number of Grey-headed Lapwings on the eastern coast of northern Sumatra appears to have increased substantially over the past decade. From 2010 to 2012, no more than 30 birds were recorded in one survey and then 67 birds were recorded at a single survey in 2014. Between November 2019 to January 2020, large flocks of over 100 birds were recorded three times, with 128, 157 and 407 birds being counted. The increase of Grey-headed Lapwings in northern Sumatra is consistent with the increase of birds on the Malay Peninsula in the recent decade (Asian Waterbird Census database: Li *et al*. 2009, Mundkur *et al*. 2017, D. Bakewell *pers. comm.*). In concurrence with Crossland & Sitorus (2011), our findings indicate that now the Grey-headed Lapwing is a regular non-breeding visitor in Sumatra, especially in north Sumatra and Aceh where there are suitable coastal and lowland habitats for the birds.

Former studies have indicated that the typical habitats of the Grey-headed Lapwings include rice fields, marshes, wet grassland, river banks and open farmland (Eaton *et al*. 2016, Hayman *et al*.1986, Lee *et al*. 2018, Robson 2010, Rosair & Cottridge 1995, Sonobe & Usui 1993). For example, the birds were regularly found on rice fields at Kampung Bukit Pelanduk in Penang, Malaysia (eBird) and in Vellayani-Punchakkari, India (Roshnath 2017). However, we found Grey-headed Lapwings were mostly recorded on intertidal mudflats in northern Sumatra, which is consistent with the records from Crossland & Sitorus (2011). The widely distributed intertidal mudflats in Sumatra may explain the biased survey efforts, although records of 128 and 20 individuals were recorded in coastal and inland rice fields, respectively, during our surveys. This suggests our surveys mainly on coastal intertidal mudflats might under-estimate the number of Grey-headed Lapwings in northern Sumatra.

There were no records of Grey-headed Lapwing in Indonesia from 1987 to 2015 in the Asian Waterbird Census database (Li *et al*. 2009, Mundkur *et al*. 2017). There have been no records of the species at sites other than northern Sumatra in Indonesia since 2000 (Iqbal *et al*. 2012, Janra *et al*. 2018, Setiawan *et al*. 2016). In 1984-1998, bird surveys in the eastern coast of Riau, Jambi and South Sumatra did not record Grey-headed Lapwing (Silvius 1988, Verheugt *et al*. 1993). However, most of these surveys were conducted in coastal areas while there was a lack of surveys in inland areas (e.g. rice fields, marshes, wet grassland, river banks and open farmland), which is the typical habitat for the species. The greater numbers of Grey-headed Lapwing recorded in this study are likely due to better exploration for internationally important sites for migratory shorebirds in northern Sumatra since 2018 compared to southern Sumatra. However, an extensive area of typical habitat of the species in the southern part of Sumatra might potentially support another population.

The global population of Grey-headed Lapwing was estimated at between 25,000 - 100,000 individuals, with the 1% criterion for the EAAF setting at 250 individuals (Delany & Scott 2006, Bamford *et al*. 2008). Our highest count of 407 individuals at Durian village on 22 January 2020 is equal to 1.6 % of the EAAF population estimate (Bamford *et al*. 2008). This suggests the intertidal mudflats at Durian village meet the criteria for an internationally important site for the Grey-headed Lapwing. We encourage both ornithologists and birdwatchers to pay attention to the species in Sumatra, especially in inland habitat. This will help improve population estimates of the species by collecting data from new non-breeding sites. Bird records can be reported to us directly, or via eBird, so that the current status of the species in Indonesia can be well documented.

ACKNOWLEDGEMENTS

We are sincerely grateful to Christoph Z. (Manfred-Hermsen Stiftung), East Asian-Australasian Flyway Partnership and Hong Kong Bird Watching Society for financially supporting shorebird surveys in North Sumatra and Aceh Province. We thank Vivian Fu, Sayam U. Chowdhury, Yann Muzika, Yong Ding Li, Paul Insua Cao (RSPB) and Neil Sheffield for their support and attending the fieldwork. We thank the field teams on eastern coast of North Sumatra (Raja, Surya, Dedi and Gilang) and Aceh Province (Fajarudin, Arico, Feriadi, Wiro and Juhardy). We thank Andrew Crossland and one reviewer for comments on an earlier version of this manuscript.

REFERENCES

Andrew, P. 1992. The Birds of Indonesia. A Checklist (Peter's Sequences). The Indonesian Ornithological Society, Jakarta.

Bamford, M., D. Watkins, W. Bancroft, G. Tischler & J. Wahl. 2008. Migratory shorebirds of the East Asian–Australasian flyway; population estimates and internationally important sites. Wetlands International–Oceania, Canberra, Australia.

Crossland, A.C. & A.W. Sitorus. 2011. More Grey-headed Lapwings (*Vanellus cinereus*) in Northern Sumatra - vagrants or an extension of wintering range? *Stilt* 60:34-36.

Delany, S. & D. Scott. 2006. Waterbird Population Estimates - Fourth edition. Wetlands International, Wageningen, The Netherlands.

Eaton, J.A., B. van Balen, N.W. Brickle & F.E. Rheindt. 2016. Birds of the Indonesian Archipelago. Lynx Editions, Barcelona, Spain.

eBird. 2017. eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org. Accessed: Date 29 May 2017.

Hayman, P., J. Marchant & T. Prater. 1986. Shorebirds: an identification guide to the waders of the world. Houghton Mifflin Company, New York, USA.

Iqbal, M., A. Nurza, & T.M. Sanir. 2009. Second record after 139 years of Grey-headed Lapwing *Vanellus cinereus* in Indonesia. *Wader Study Group Bulletin* 116:40-41.

Iqbal, M., D. Priatna & R. Dedi. 2012. Notes on the early northward migration of Sumatran waders on the east coast of Jambi Province, Indonesia, in 2011. *Stilt* 61:45-50.

Janra, M.N., A. Mursyid, Aadrean, G. Indra, M. Ringga & M. Ikhsan. 2018. Shorebird surveys at the coast of West Sumatra Province, Indonesia: 2017-2018. *Stilt* 72:27-32.

Lee, W.S., C.Y. Choi & H. Kim. 2018. A field guide to the waterbirds of ASEAN. ASEAN-Korea Environmental Cooperation Unit (AKECU), Seoul, Republic of Korea.

Li, Z.W.D, A. Bloem, S. Delany, G. Martakis & J.O. Quintero. 2009. Status of Waterbirds in Asia - Results of the Asian Waterbird Census: 1987-2007. Wetlands International, Kuala Lumpur, Malaysia.

Mundkur, T., T. Langendoen, & D. Watkins. 2017. The Asian Waterbird Census 2008-2015 results of coordinated counts in Asia and Australasia. Wetlands International, Ede.

Putra, C.A., D. Hikmatullah, D.M. Prawiradilaga & J.B.C. Harris. 2015. Surveys at Bagan Percut, Sumatra, reveal its international importance to migratory shorebirds and breeding herons. *Kukila* 18:46–59.

Putra, C.A., D. Perwitasari-Farajallah & Y.A. Mulyani. 2017. Habitat use of migratory shorebirds on the coastline of Deli Serdang Regency, North Sumatra Province. *Hayati Journal of Biosciences* 24:16-21.

Putra, C.A. & D. Hikmatullah. 2018. Survey of waterbird and waterbird hunting problem on the Eastern Coastline of North Sumatra, Indonesia (January–April 2018). Unpublished report to The Manfred-Hermsen Stiftung Foundation, Birding Sumatra/Sumatra Wild Heritage Foundation, North Sumatra, Indonesia.

Putra, C.A. & D. Hikmatullah. 2019. Monitoring of shorebirds species and shorebird hunting problem on the Eastern Coastline of North Sumatra, Indonesia (December - March 2019). Unpublished report to The Manfred-Hermsen Stiftung Foundation, Birding Sumatra/Sumatra Wild Heritage Foundation, North Sumatra, Indonesia.

Putra, C.A. & D. Hikmatullah. 2020. Survey and Hunting Assessment of Shorebirds with special focus on Spoon-billed Sandpiper in Northern Sumatra (Aceh Province), Indonesia. Unpublished report to the EAAFP, Sumatra Wild Heritage Foundation, North Sumatra, Indonesia.

Robson, C. 2010. A field guide to the birds of South-East Asia. New Holland Publishers, London, UK.

Rosair, D. & D. Cottridge. 1995. Hamlyn Photographic Guide to the Waders of the World. Hamlyn, London.

Roshnath, R. 2017. Wintering of the Grey-headed Lapwing *Vanellus cinereus* (Aves: Charadriiformes: Charadriidae) in Kerala, India. *Journal of Threatened Taxa* 9:10613–10617.

Setiawan, D., H. Marisa & M. Iqbal. 2016. A note on the shorebirds of the Tanjung Putus Wetlands, Indralaya, South Sumatra, Indonesia. *Stilt* 68:22-24.

Silvius, M. 1988. On the importance of Sumatra's east coast for waterbirds, with notes on the Asian Dowitcher *Limnodromus semipalmatus*. *Kukila* 3:117–137.

Sonobe, K. & S. Usui. (Eds.) 1993. A Field Guide to the Waterbirds of Asia. Wild Bird Society of Japan, Tokyo, Japan.

Sukmantoro, W., M. Irham, W. Novarino, F. Hasudungan, N. Kemp & M. Muchtar. 2007. Daftar Burung Indonesia No. 2. The Indonesian Ornithologist's Union/LIPI/OBC Smythies Fund/Gibbon Foundation, Bogor, Indonesia.

Sullivan, B.L., C.L. Wood, M.J. Iliff, R.E. Bonney, D. Fink & S. Kelling. 2009. eBird: a citizen-based bird observation network in the biological sciences. *Biological Conservation* 142:2282-2292.

Verheugt, W.J.M., H. Skov & F. Danielsen. 1993. Notes on the birds of the tidal lowlands and floodplains of South Sumatra Province, Indonesia. *Kukila* 6:53–84

SHOREBIRD SURVEYS CONFIRM SIGNIFICANCE OF THE MACLEAY COAST, NORTHERN NEW SOUTH WALES, AUSTRALIA

DAVID ROHWEDER[1] AND NICHOLAS PRIEST[2]

[1] *Sandpiper Ecological Surveys, PO Box 401, Alstonville 2477. Email: David@sandpipereco.com.au*
[2] *NSW Environment Protection Authority, 1/49 Victoria Street Grafton 2460*

The Macleay River estuary, situated on the NSW mid-north coast, has not been the subject of systematic shorebird population surveys. To obtain information on the shorebird population and important habitats for migratory and threatened shorebirds, Kempsey Shire Council initiated shire-wide population surveys during the 2018 / 2019 non-breeding season. Surveys were undertaken by two observers using a boat and 4WD vehicle to access estuarine, floodplain, and ocean beach habitats. Five, three-day surveys were conducted between 5 December 2018 and 22 February 2019. Twenty species of shorebird, consisting of eight resident and 12 migratory species, were recorded. The maximum shorebird population estimate over the sample period was 1822 individuals, with between 1068 and 1478 individuals recorded during individual surveys. The most abundant species were Sharp-tailed Sandpiper *Calidris acuminata* (951 individuals), Black-winged Stilt *Himantopus himantopus* (330 individuals), and Pacific Golden Plover *Pluvialis fulva* (211 individuals). Federally-listed threatened species recorded include Far Eastern Curlew *Numenius madagascariensis* (25 individuals), Bar-tailed Godwit *Limosa lapponica* (25 individuals), and Curlew Sandpiper *Calidris ferruginea* (1 individual). State-listed threatened species included Australian Pied Oystercatcher *Haematopus longirostris* (12 individuals), Sooty Oystercatcher *Haematopus fuliginosus* (10 individuals), and Broad-billed Sandpiper *Calidris falcinellus* (1 individual). Based on the 2018 / 2019 counts, the Macleay River estuary and nearby floodplain support an internationally significant population of Sharp-tailed Sandpiper *Calidris acuminata* and a nationally significant population of Pacific Golden Plover *Pluvialis fulva*. Floodplain wetlands may be particularly important for both species.

INTRODUCTION

Shorebirds in the East Asian – Australasian Flyway (EAAF) are experiencing substantial population declines (Clemens *et al.* 2016). It is therefore critical that surveys be conducted in areas where there is limited published information to identify important sites for conservation and contribute to population estimates. The Macleay estuary and floodplain, situated on the mid-north coast of New South Wales (NSW), has not been the subject of a comprehensive systematic shorebird survey and as a consequence there is limited published data on the area's shorebird community (Rohweder 2009).

Some sites in the Macleay estuary are renowned for shorebirds and 45 species of shorebird have been recorded in the Kempsey Local Government Area (KLGA), including several (vagrant) migratory species that are uncommon on the east coast of Australia (Rohweder & Priest 2019). The KLGA is known to support nine shorebird species listed on the Commonwealth *Environment Protection and Biodiversity Conservation (*EPBC*) Act 1999* and 14 shorebird species listed on the NSW *Biodiversity Conservation (*BC*) Act 2016* (Rohweder & Priest 2019).

Lawler (1994) conducted one of the few documented systematic surveys of the Macleay River estuary in March 1993 and February 1994 and recorded a maximum count of 492 individuals, including single species counts of 184 Whimbrel *Numenius phaeopus*, and 68 Bar-tailed Godwit *Limosa lapponica*. Handreck and Weller (2017) state that the Macleay River estuary is significant for Far Eastern Curlew *Numenius madagascariensis* and Terek Sandpiper *Xenus cinereus*. The estuary is not recognised as containing significant numbers of shorebirds in any state, national, or flyway population analysis (Lane 1987, Smith 1991, Watkins 1993, Bamford *et al.* 2008, Hansen *et al.* 2016).

Kempsey Shire Council recently completed the Macleay River Estuary Migratory and Threatened Shorebird Species Management Strategy (InSight Ecology 2017). The strategy recommended that targeted shorebird surveys be undertaken to confirm the abundance, species richness, community structure, and habitat use of shorebirds on the Macleay estuary and floodplain. This paper summarises the results of those surveys.

METHODS

Study area

Kempsey Shire is situated on the mid-north coast of NSW (Fig. 1). The Shire has approximately 80 kilometres of coast extending from just north of Grassy Head to Point Plomer. The Macleay River estuary is a major feature of Kempsey Shire and is characterised by a network of mangrove lined tidal channels, mangrove islands, saltmarsh, and seagrass. The lower floodplain is characterised by numerous freshwater wetlands and tidal lagoons. Primary land uses in the study area are agriculture, tourism and conservation.
The study area is predominantly undeveloped and consists of extensive sandy beaches interspersed with rocky shores and headlands. The major coastal residential areas of the shire include South West Rocks, Hat Head and Crescent Head. Virtually the entire coastline south of Smoky Cape is National Parks estate (Fig. 1).

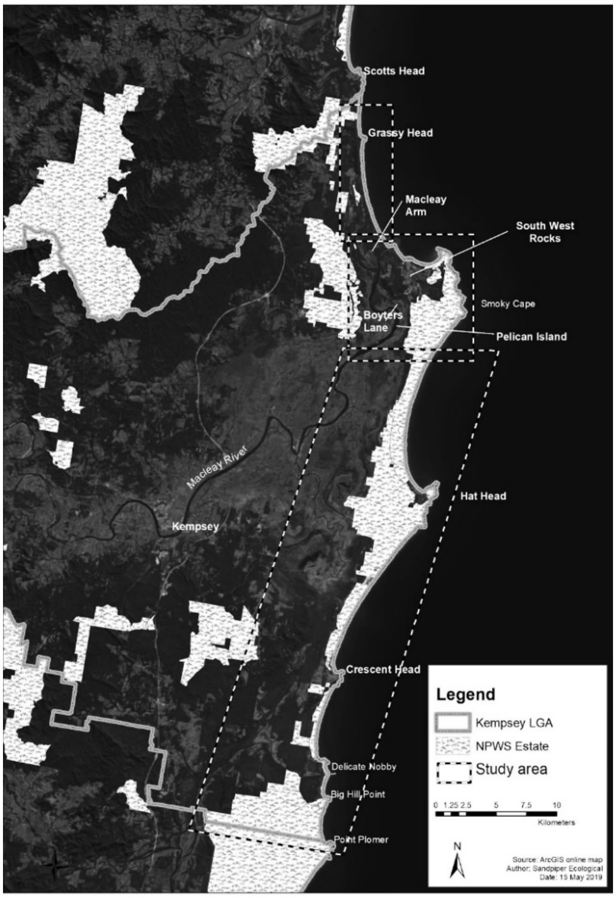


Figure 1. The study area showing key locations and part of the Kempsey Shire boundary. South West Rocks is located at 30^0 53' N, 153^0 02' E

Survey design and timing

Shorebirds were surveyed during five three-day periods between 5 December 2018 and 21 February 2019. Survey times were selected so as to coincide with both the spring and neap tide cycles. Due to time limits, sites within the Macleay River estuary and immediately adjacent coastline were surveyed at both high and low tide, ocean beaches at low tide only, and all remaining sites at either high or low tide. Surveying the Macleay River estuary and immediately adjacent coastline at both high and low tide was necessary in order to account for potential movement between the estuary and adjacent coastline between tide phases. All tidal lagoons near the Macleay River estuary were surveyed at the same time as estuarine and adjacent ocean beach sites. A total of 63 sites across estuarine, floodplain, rocky shore, and ocean beach habitats were surveyed.

Macleay River estuary and adjoining coast

Two observers surveyed sites within the Macleay River estuary and adjacent coastline, one in a boat and one on land. High tide surveys commenced 2 hours prior to high water (HW; Roads and Maritime Services 2018) and were completed 1-2 hours after HW. Low tide surveys were conducted within 1.5 hours either side of low water (LW). Boat-based surveys commenced in the lower reaches of the Macleay Arm and were completed upstream of Pelican Island in the Macleay River. Land-based surveys commenced at Boyters Lane and concluded at Smoky Cape.

Care was taken to select the most appropriate observation points at each site to try to avoid flushing birds. If birds were flushed, an approximate count and direction of flight was recorded to assist in determining if they were counted later at another site. Generally, birds at a site were counted several times until consistency in counts was achieved. Disturbance of birds by observers was rare. Observations were conducted using a 20-60×80mm spotting scope and 10×42mm binoculars. Data collected at each site included: number of individuals and species, wind speed and direction, tide stage, human and domestic dog activity, and location (easting & northing) determined using a Garmin Montana GPS.

Coastline and floodplain wetlands

The timing of coastline and floodplain surveys south of Smoky Cape was dictated by the need to survey ocean beaches at low tide, with other sites surveyed as they were encountered, moving north to south. Surveys were conducted by one or two observers and commenced at Smoky Cape two hours prior to low tide. Ocean beaches were surveyed by a 4WD vehicle continuously travelling at a maximum speed of 40 km hr^{-1}.

Data summary and analysis

Data was entered into Site × Species spreadsheets in Microsoft Excel for each survey and were checked for accuracy. Prior to determining population estimates, data was vetted to remove potential double-counts. Population estimates were derived for each shorebird species during each survey by summing the number of individuals of each species recorded at each site.

RESULTS

Maximum counts

The maximum cumulative count of shorebirds recorded during the sample period was 1822 individuals (Table 1). A total of 20 species were recorded; eight resident and 12 migratory species (Table 1). Six threatened species were recorded, three listed on the NSW *Biodiversity Conservation Act* (Australian Pied Oystercatcher *Haematopus longirostris*, Sooty Oystercatcher *Haematopus fuliginosus*, & Broad-billed Sandpiper *Calidris falcinellus*), and three listed on the Commonwealth *EPBC Act* (Bar-tailed Godwit *Limosa lapponica*, Far Eastern Curlew *Numenius madagascariensis*, & Curlew Sandpiper *Calidris ferruginea*). The maximum count for migratory shorebirds was 1332 individuals and for resident shorebirds 490 individuals (Table 1).

Species diversity was consistent across the first four surveys, with a slight decrease recorded during the final survey. Maximum counts of all shorebirds ranged from 1068 in survey one to 1478 in survey two. Maximum counts per survey for migratory shorebirds ranged from 1142 in survey two to 633 in survey five. Abundance and species richness of migratory shorebirds decreased from mid-January (sample two) to late February (sample five; Fig. 2). Survey two coincided with a high spring tide.

The most abundant species across the entire period were Sharp-tailed Sandpiper Calidris acuminata *Calidris acuminata* (951 individuals), Black-winged Stilt *Himantopus himantopus* (330 individuals), Pacific Golden Plover *Pluvialis fulva* (211 individuals), and Masked Lapwing *Vanellus miles* (119 individuals). Both Bar-tailed Godwit *Limosa lapponica* and Far Eastern Curlew *Numenius madagascariensis* had maximum counts of 25 individuals. Maximum counts of Australian Pied *Haematopus longirostris* and Sooty Oystercatcher *Haematopus fuliginosus* were 12 and 10 birds respectively.

The numbers of Far Eastern Curlew *Numenius madagascariensis*, Whimbrel *Numenius phaeopus*, Bar-tailed Godwit *Limosa lapponica*, and Sharp-tailed Sandpiper *Calidris acuminata* were lowest in late February (Figs. 3 & 4). The opposite trend occurred for Pacific Golden Plover *Pluvialis fulva* (Fig.4). Abundance of Grey-tailed Tattler *Tringa brevipes* remained stable between surveys three to five. Abundance of Whimbrel *Numenius phaeopus*, Grey-tailed Tattler *Tringa brevipes*, and Sharp-tailed Sandpiper *Calidris acuminata* peaked in sample two during a high spring tide.

Table 1. Counts of individual shorebird species recorded during each of the surveys.

Common name	Max. Count	Survey Number and Date				
		1	2	3	4	5
		4-7/12/18	21-23/1/19	29/1-1/2/19	12-14/2/19	19-21/2/19
Australian Pied Oystercatcher	12	12	12	9	10	10
Sooty Oystercatcher	10	10	8	8	8	9
Black-winged Stilt	330	261	251	305	299	330
Red-necked Avocet	1	1	0	0	0	0
Red-capped Plover	7	7	0	7	0	0
Black-fronted Dotterel	4	0	4	2	4	1
Red-kneed Dotterel	7	7	7	2	5	6
Masked Lapwing	119	26	54	119	18	107
Total resident species	**8**	**7**	**6**	**7**	**6**	**6**
Pacific Golden Plover	211	133	42	67	7	211
Double-banded Plover	1	0	0	0	0	1
Latham's Snipe	6	2	6	3	2	1
Bar-tailed Godwit	25	25	17	25	11	0
Whimbrel	58	41	58	42	37	20
Eastern Curlew	25	10	20	25	25	6
Grey-tailed Tattler	41	9	41	25	30	27
Common Greenshank	6	0	6	2	3	0
Red-necked Stint	6	6	0	0	1	0
Sharp-tailed Sandpiper	951	517	951	624	772	367
Curlew Sandpiper	1	0	1	0	0	0
Broad-billed Sandpiper	1	1	0	0	0	0
Total migratory species	**12**	**9**	**9**	**8**	**9**	**7**
Total species	**20**	**16**	**15**	**15**	**15**	**13**
Total individuals	**1822**	**1068**	**1478**	**1265**	**1232**	**1096**

Table 2. Maximum counts for selected shorebird species that exceeded the 1% (international significance) and 0.1% (national significance) thresholds (grey shading).

Species	Macleay Coast Max. Count	EAAF Population	1% of EAAF	0.1% of EAAF
Pacific Golden Plover	211	120,000	1200	120
Sharp-tailed Sandpiper	917	85,000	850	85

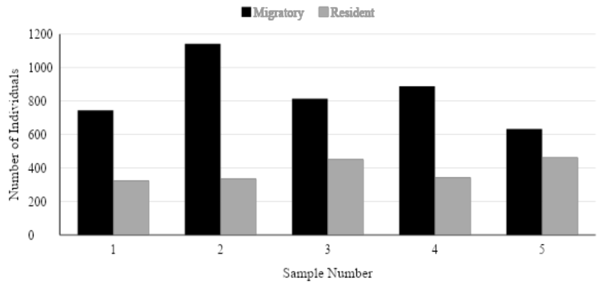


Figure 2. Maximum count of migratory and resident shorebirds recorded in the study area between December 2018 and February 2019.

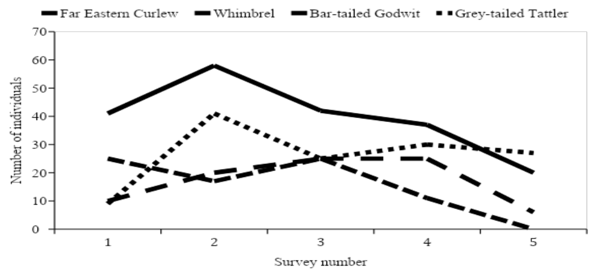


Figure 3. Maximum counts of Far Eastern Curlew *Numenius madagascariensis*, Whimbrel *Numenius phaeopus*, Bar-tailed Godwit *Limosa lapponica* and Grey-tailed Tattler *Tringa brevipes* during each of five surveys between December 2018 and February 2019.

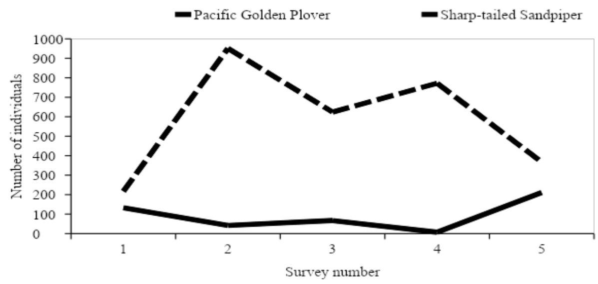


Figure 4. Maximum counts of Pacific Golden Plover *Pluvialis fulva* and Sharp-tailed Sandpiper *Calidris acuminata* during each of five surveys between December 2018 and February 2019.

DISCUSSION

Variation in shorebird abundance

The abundance of several species varied throughout the survey period, most notably Pacific Golden Plover *Pluvialis fulva*, Bar-tailed Godwit *Limosa lapponica*, Grey-tailed Tattler *Tringa brevipes* and Sharp-tailed Sandpiper *Calidris acuminata*. Variation in abundance is attributed to changes in roosting habits between spring and neap tides, the presence of unknown roosts, and the way shorebirds utilise estuarine and floodplain habitats.

Significance of the Macleay Coast to shorebirds

The Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia 2015) and Ramsar Convention consider sites to be of international importance if they support 1% of the EAAF population and nationally important if they support 0.1% of the EAAF population of an individual species. Based on the latest EAAF population estimates (see Hansen *et al.* 2016) the Macleay River estuary and adjoining floodplain wetlands support internationally important numbers of Sharp-tailed Sandpiper *Calidris acuminata*, and nationally important numbers of Pacific Golden Plover *Pluvialis fulva* (Table 2). Based on area of potential habitat, the study area may also be nationally important for Latham's Snipe *Gallinago hardwickii*. Better survey coverage of floodplain wetlands is likely to substantially increase the Latham's Snipe *Gallinago hardwickii* population estimate.

In a regional context, the Macleay Coast supports a high number and diversity of shorebirds. The maximum count of 1822 individuals means that the Macleay Coast ranks second in shorebird abundance to the Clarence Estuary for known sites on the north coast of NSW (Rohweder 2009). Species diversity in the Macleay estuary is also comparable to, or greater than, other estuaries in northern NSW (Rohweder 2009).

The shorebird population estimate for the Macleay Coast is likely to increase with better survey coverage of floodplain wetlands. According to Birch (2010), the floodplain contains almost 900 ha of swamp and spike rush-water couch communities that are potential habitat for Sharp-tailed Sandpiper *Calidris acuminata*, Pacific Golden Plover and Latham's Snipe *Gallinago hardwickii*. Approximately 10% of these communities were surveyed during this study.

Targeted surveys of floodplain wetlands would be worthwhile to enable the shorebird value of the Macleay Coast to be fully assessed. Accurate sampling of floodplain wetlands may indicate that the Macleay Coast is one of the most important shorebird habitats in coastal NSW. With permission from landowners, drones may be a cost-effective means of determining the presence / absence of shorebirds on floodplain wetlands.

Although historical data is limited, it appears that declines in abundance of some species mirror those recorded for other sites in eastern Australia (Hansen *et al.* 2016, Clemens *et al.* 2016). Bar-tailed Godwit *Limosa lapponica*, Whimbrel *Numenius phaeopus* and Far Eastern Curlew *Numenius madagascariensis* have all declined in abundance, whilst Curlew Sandpiper *Calidris ferruginea* and Sand Plovers may have always been uncommon in the Macleay River estuary. Shorebirds were absent from the important roosts identified by Lawler (1994) in the north arm of the Macleay River and observation during this study suggests that those sites are no longer suitable for roosting.

Sites of high conservation value

Tidal lagoons adjoining Boyters Lane support nationally significant numbers of Sharp-tailed Sandpiper *Calidris acuminata*. The count of 768 Sharp-tailed Sandpiper *Calidris acuminata* at the Boyters Lane sites on 13 February 2019 is very close to the 1% EAAF threshold of 850. Whilst the number of Sharp-tailed Sandpiper *Calidris acuminatas* present in 2018 / 2019 was likely elevated by drought conditions across much of eastern Australia and subsequent movement of birds from inland to coastal wetlands, historical counts of 1200 Sharp-tailed Sandpiper *Calidris acuminata* have been recorded at Boyters Lane (K. Shingleton *unpubl. data*). Other important sites include Pelican Island sandspit which supported >0.1% of the EAAF population of Pacific Golden Plover *Pluvialis fulva* on two occasions, and sandflats in the lower Macleay Arm which provide critical foraging habitat for most of the estuary's Far Eastern Curlew *Numenius madagascariensis*, Whimbrel *Numenius phaeopus* and Bar-tailed Godwit *Limosa lapponica* population.

CONCLUSION

The combination of floodplain and estuarine wetland in the lower Macleay valley provide internationally important habitat for Sharp-tailed Sandpiper *Calidris acuminata* and nationally important habitat for Pacific Golden Plover *Pluvialis fulva.* Systematic sampling of floodplain wetlands may increase population estimates for both the aforementioned species, and possibly also Latham's Snipe *Gallinago hardwickii*. The Boyters Lane wetlands are likely to be nationally important for Sharp-tailed Sandpiper *Calidris acuminata* and would benefit from preparation of a management strategy that establishes a framework for ongoing management of the various lagoons.

ACKNOWLEDGEMENTS

The authors would like to thank Kempsey Shire Council for funding the surveys and Ron Kemsley (Kempsey Shire Council) for initiating the surveys and acting on recommendations from the Estuarine and Coastline Management Plans. Caroline and David Adams kindly provided access to wetlands on their property. Ian Bradshaw provided information on shorebird records and historic counts undertaken by the late Ken Shingleton. Brendan Taylor provided valuable feedback on a previous version of this paper. Comments from Danny Rogers and an anonymous referee substantially improved the manuscript.

REFERENCES

Birch, M. 2010. *Macleay River Estuary and floodplain ecology study*. Report prepared by Aquatic Science and Management and GeoLink for Kempsey Shire Council.

Bamford, M., D. Watkins, W. Bancroft, G. Tischler, & J. Wahl. 2008. Migratory shorebirds of the East Asian – Australasian Flyway: population estimates and internationally important sites. Wetlands International-Oceania, Canberra, Australia.

Clemens, R.S., D.I. Rogers, B.D. Hansen, K. Gosbell, C.D.T. Minton, P. Straw, M. Bamford, E.J. Woehler, D.A. Milton, M.A. Weston, B. Venables, D. Weller, C. Hassell, B. Rutherford, K. Onton, A. Herrod, C.E. Studds, C-Y, Choi, K.L. Dhanjal-Adams, N.J. Murray, G.A. Skilleter & R.A. Fuller. 2016. Continental-scale decreases in shorebird populations in Australia. *Emu Austral Ornithology* 116:119-135.

Commonwealth of Australia 2015. Wildlife Conservation Plan for Migratory Shorebirds. Australian Government, Canberra.

Handreck, P. & D. Weller. 2017. Priority habitat assessment for eleven migratory shorebird species in New South Wales. Report prepared for New South Wales Office of Environment and Heritage by Birdlife Australia.

Hansen, B.D., R.A. Fuller, D. Watkins, D.I. Rogers, R.S. Clemens, M. Newman, E.J. Woehler & D.R Weller. 2016. Revision of the East Asian-Australasian Flyway Population Estimates for 37 listed Migratory Shorebird Species. Unpublished report for the Department of the Environment. BirdLife Australia, Melbourne.
InSight Ecology 2017. Macleay River Estuary Migratory and Threatened Shorebird Species Management Strategy. Report prepared by InSight Ecology for Kempsey Shire Council.
Lane, B. 1987. Shorebirds in Australia. Thomas Nelson, Melbourne.
Lawler, W. 1994. Shorebird counts on New South Wales North Coast Estuaries from the Shorebird Habitat Study. NSW National Parks and Wildlife Service.
Roads and Maritime Services 2018. Tidal predictions for Sydney Harbour: July 2018 to June 2019. NSW Government.
Rohweder, D.A. 2009. Shorebird data audit, northern New South Wales. Report prepared for the Northern Rivers Catchment Management Authority.
Rohweder, D.A. & N.M. Priest. 2019. Macleay River estuary migratory and threatened shorebird species strategy – follow-up shorebird survey 2018/19. Report prepared by Sandpiper Ecological for Kempsey Shire Council.
Smith, P. 1991. The biology and management of waders (Suborder Charadrii) in NSW. NSW National Parks and Wildlife Service, Hurstville.
Watkins, D. 1993. A national plan for shorebird conservation in Australia. Australian Wader Studies Group, RAOU Report No. 90.

AN OVERVIEW OF THE LATHAM'S SNIPE POPULATION IN SAKHALIN, EASTERN RUSSIA

BIRGITA D. HANSEN [1]*, ZOYA REVYAKINA [2], OLGA KULIKOVA [3], PAVEL KTITOROV [3]

[1] *Centre for eResearch and Digital Innovation, Federation University, PO Box 691, Ballarat 3353 Vic., Australia. Email: b.hansen@federation.edu.au*

[2] *Information and Research Center Fauna LLC, Russia, Yuzhno-Sakhalinsk, Komsomolskaya, 241a, 14*

[3] *Institute of the Biological Problems of the North, Magadan, Portovaya, 18 Russia, 685000*

Latham's Snipe (Японский бекас) *Gallinago hardwickii* was historically considered to breed mostly in Japan with a small proportion of breeding records in Russia. Since the 1950s, the species has been expanding its range northward and the current distribution of snipe encompasses most of the island of Sakhalin. At the same time, the species has experienced a breeding range contraction in Japan. During May 2019, opportunistic snipe surveys were conducted during a nine-day field trip of Sakhalin. Snipe were recorded either as incidental observations or during a 10' point count. The highest numbers of snipe were found on the south-west coast of Sakhalin in the Tomarinskiy and Korsakovsky regions. All records were made in mosaic meadow-forest and modified grassland habitats, and none were obtained from forest or intact woodland. Comparison of these snapshot data to breeding surveys conducted between 1993 and 2012 demonstrate the species to be relatively widespread across Sakhalin, and in most areas not dominated by continuous forest. However, the conditions under which snipe breed successfully are more restricted than would be expected based on these broad habitat associations and numbers of displaying males. Agricultural intensification, spring burning of meadowlands and illegal shooting of snipe all reduce breeding success. While a significant proportion of the Latham's Snipe global population appears to occur on Sakhalin (potentially as high as 18%), when considered in the broader context of species decline documented in Japan, it is likely that the global trend for this species is generally downward.

INTRODUCTION

Migratory shorebirds in the East Asian-Australasian Flyway are among the most threatened taxa globally, due largely to habitat loss and modification. Species utilising the Yellow Sea for staging on migration are particularly vulnerable due to "land reclamation", and a number of species migrating through this region are experiencing significant population declines (Amano *et al.* 2010, Murray *et al.* 2014, Studds *et al.* 2017).

The ecology of, and threats to predominantly coastal species are relatively better understood than for inland grassland and wetland species. Latham's Snipe *Gallinago hardwickii* is a good example of this, and is less well-known due to its cryptic habits, especially outside the breeding season. Latham's Snipe breeds in northern Japan and in parts of eastern Russia during the months April-July and migrates to Australia where it spends the non-breeding season predominantly in shallow, vegetated freshwater wetlands in south-eastern Australia (Higgins & Davies 1996). The population is declining in Japan (Ura *et al.* 2018), and the breeding range is now centred on the northern island of Hokkaido, with fewer breeding records from the main island of Honshu (Nakamura & Shigemori 1990, Iida 1995). The population trend in Australia is also considered to be declining. However, the difficulty of monitoring the species has precluded any trends analysis in the country.

In Russia, the species was historically found only in most southerly parts of the island of Sakhalin, and in small numbers on the lower Kuril Islands and on the coastal Russian mainland in Primorye (Nechaev 1994). The first record of the species in the Kuriles goes back to the end of the 19th century (Snow 1897). However, no details were provided. The southernmost part of Sakhalin was colonized in 1950-60 (Nechaev 1994), and during the 1970s to 1980s, records of snipe extended approximately 300 km north (Nechaev 1994). Latham's Snipe advanced to the southern coast of Nabilsky Bay, along the rivers Nabil and Vazi, where for the first time a displaying male was recorded on June 24, 1994 (Revyakina & Zykov 2012).

In 2000, during an environmental impact assessment of the north-south Sakhalin gas pipeline by Amur-Ussury Center for Biodiversity Latham snipe were recorded in the central part of the island, near Tymovskoe, 180 km to the north from the previously known distribution limit near Poronaysk and Uglegorsk (Valchuk *et al.* 2016). Five years later it was recorded breeding another 50 km to the north, near Nysh village (Valchuk *et al.* 2016). In 2008-2009, further records were obtained in the east near Nysh Vesnskoe village. In 2013, Latham's snipe were observed doing breeding display flights in nearby Val village, north of Nogliki on the north-east coast (Valchuk *et al.* 2016).

Until relatively recently, the northernmost sightings of displaying snipe were known from Chayvo bay on the east coast of Sakhalin. During surveys of the nature reserve in May to June 2016 in the extreme north of Sakhalin, displaying birds were recorded both in the north and the south of Schmidt Peninsula (Fig. 1), which is separated from more southerly records by a 200 km gap of unsuitable habitat (mostly continuous larch and birch forest) (Ktitorov *et al.* 2019). In June 2018, Latham's Snipe were recorded nesting in the city of Okha in the far north of Sakhalin (Revyakina *unpubl. data*). It is worth noting that some areas in the north-west of the island are still unoccupied, despite availability of suitable grassland habitat and warmer climate (Ktitorov & Zdorikov *unpubl. data*). During the same time period, Latham's snipe records had extended up the southern Kurile islands as far as Urup island (Zdorikov 2019) (Fig.1). On mainland Russia, the species has undergone a northward range shift such that numbers have decreased in the southern limit of its range (Primorye) while increasing northward and into the Amur River basin as far as Khabarovsk (Gluschenko *et al.* 2016, Nazarenko 2016, Valchuk *et al.* 2016).

The current distribution of Latham's Snipe encompasses fairly diverse biotopes, which includes river valleys, hillslopes and on the sea coasts. It is most often found in floodplains and coastal mixed meadows. It sporadically nests on the edges and clearings among larch woodlands, in thickets of undersized bamboo, and vegetated marshes (Revyakina & Zykov 2012).

Latham's snipe arrive on Sakhalin in the second half of April, and the males immediately begin to display (Nechaev 1994, P. Ktitorov *pers. obs.*). In the most optimal habitats, group displays are observed, in which between two to ten males take part. In between flights, snipe may also display on the ground, from treetops and on infrastructure such as power poles, fences, and building roofs. These behaviours make surveys during this period the most optimal time to get an estimate of relative abundance.

Information on current status and population trends of this species is patchy and opaque. While the population of Latham's Snipe is declining in Japan, and anecdotal evidence suggests it is also declining in Australia, it is expanding its range in Sakhalin and the Kuril Islands. In this study, we performed an opportunistic survey of the island of Sakhalin to capture a current snapshot of relative abundance and density of Latham's Snipe, based on observations and counts of displaying males, and to document apparent habitat associations. These snapshot data were compared to a previous study from 2012, commissioned by the Ministry of Forestry (Revyakina & Zykov 2012), to make inferences about the current population size and distribution, breeding habitat associations and potential threats to breeding snipe on Sakhalin.

METHODS

Study region

The island of Sakhalin is relatively under-populated and contains large areas that are undeveloped. It is 950 km in length and encompasses nearly 10 degrees of latitude from south to north (45°40' to 54°30'N). There are two main mountain ridges (600-1000 m high) with depressions in between that stretch along eastern and western sides in the southern and central parts of the island. The northern part is a hilly plateau with the mountains covered by sediments and only in the very northern tip (Schmidt Peninsula, 50 km long) the two mountain ridges emerge again showing the same structure with a depression in the middle. The climate is monsoon type with cold subarctic winters and relatively warm wet summers (average annual rainfall 500-

Figure 1. The key sightings locations and range expansion of Latham's snipe. Latham's Snipe absence is depicted by grey shading on Sakhalin Island and the Kuril Islands – no information is presented for the Russian mainland or Japan. Overall, the Latham's snipe was shifting the northern border of the breeding range by average of 15 km per year and colonised most of Sakhalin Island from 1950s until 2016.

Figure 2. Map of Sakhalin showing the 15 mainland districts of Sakhalin and overlaid with the distribution of Latham's Snipe (in red). Mesh survey locations are shown in crosses and incidental records made outside mesh surveys are shown in circles.

1200mm). Snow cover occurs from December until the end of April in the south and from October until the end of May in the north. It is locally strongly affected by the cold wind streams of the Sea of Okhotsk in the east and the sheltering effect of the mountains making it more continental inside the depressions. The vegetation of Sakhalin is diverse. The southern part is dominated by mixed broadleaf-coniferous forest and its flora is common to northern Hokkaido. The central part is dark coniferous taiga, gradually replaced by larch taiga in the north and again with spruce taiga in the Schmidt peninsula. At the time of this visit (May 2019), there were still large patches of snow in low lying areas. Despite a long preceding period of snow cover and overall high humidity, the island was experiencing dry and warm conditions, and several forest fires were burning, particularly in the northern part of the island (which is common at this time of year: Kharuk *et al.* 2007).

Snipe surveys 2019

Between May 1 and 10, a north-south distance of approximately 600 km was traversed in a vehicle along the main routes from the capital Yuzhno-Sakhalinsk to the west coast at Kholmsk and through the island centre to Nogliki in the north-east (total bounding area 46º – 52º N, 142º - 144º E). Snipe were recorded using two approaches, (1) incidental records made while either moving or stationary usually of displaying males, and (2) using 10' point counts within a 1km grid ("mesh" method used in Japan by the Wild Bird Society of Japan: Ura *et al.* 2018). Due to the nature of the visit, it was not possible to pre-determine the locations of mesh surveys and thus, they were also conducted opportunistically. Exact point locations for conducting meshes were chosen at random and every mesh centroid was located ≥1 km apart.

During mesh surveys, snipe were recorded as the maximum number of displaying males either heard, perching or in display flights. Snipe flushed by the observer were excluded from the mesh total. Great care was taken to ensure that displaying males were not double counted by watching where birds were flying at the same time as noting the approximate location of males calling from the ground or a perch. Mesh counts were expressed as the number of displaying males per square kilometre.

Broad habitat types and land use at each mesh location were recorded. As most opportunistic incidental records were made from roadsides, habitat types were determined from site photos and satellite imagery in GIS.

Snipe surveys 1993-2012

Methods used in the previous study are briefly described here (Revyakina & Zykov 2012). Surveys to determine distribution and abundance of Latham's Snipe were conducted in April to August between 1993 and 2012, as part of an environmental impact assessment for the north-south gas pipeline. Survey transects of (usually) 400m in width and varying length were undertaken in most Sakhalin districts: Anivsky, Korsakov, Dolinsky, Nevelsky, Kholmsky, Tomarinsky, Uglegorsky, Makarovsky, Poronaysky, Smyrnykhovsky, Tymovsky, Nogliksky.

The area of the species' habitat was estimated based on the analysis of publicly available Landsat satellite images. As the objective of these surveys was to obtain maximum survey coverage (by surveying different locations in different years), the data were pooled prior to estimating breeding population size. An expert assessment approach was used to estimate the total number of breeding snipe per square kilometre based on four variables: the area of potential nesting habitat (determined from analysis of satellite images), the area of nesting habitat where breeding males were recorded, and the minimum density of nesting sites in any given survey area, and the average density of nesting sites in any given survey area (Revyakina & Zykov 2012).

The density of snipe recorded during the 2019 survey was used to estimate the total number of breeding males for any matching district, using a similar extrapolation approach and the same breeding habitat area values as in the Revyakina & Zykov (2012) study.

RESULTS

Snipe surveys 2019

A maximum of 89 snipe were recorded during the May 2019 visit, either as incidental records (n=55) or during mesh surveys (n=34). This excludes any potential double-counts between nearby incidentals records and / or mesh counts. As all but one bird was displaying when recorded, then it is reasonable to assume counted birds were males and that this represents an actual count of 177 snipe. The density of displaying males from mesh surveys was equivalent to 1.9 snipe per square km (from 35 × 1 km^2 mesh grids).

The highest numbers of snipe in individual mesh surveys occurred in the regions of Makarov-sky (n=4), Poronaysky (n=3), Dolinsky (n=3) and Korsakovsky (n=3 & 5). The Nogliksky region in the north was the only region that had all zero count mesh surveys (eight mesh surveys) (Fig. 2). The highest numbers of snipe from incidental records were obtained in the south-west regions of Kholmsky and Tomarinsky, and numbers decreased moving northward such that no snipe were recorded north of Tymovsky (Fig. 2).

The most common habitats that snipe were recorded in during mesh surveys were coastal and modified grasslands, grassland / woodland mix (with or without low-intensity agriculture) and urban areas (both sparse and medium density settlements) (Fig. 3). No snipe were recorded in Taiga forest, regardless of whether it was open, partly cleared, continuous, near or distant from floodplains. Similarly, a single visit (two meshes) to the extensive estuarine flats north of Nogliki did not produce any snipe records.

Snipe surveys 1993-2012

A total of 277.2 km of transects, and a survey area of 93 km^2, was surveyed between 1993 and 2012 (Revyakina & Zykov 2012). Individual survey dates in each district are spread across multiple years. For example, Dolinsky, which had the highest estimate overall, was surveyed in the years 2003, 2004, 2009, 2011 and 2012. Similarly, Anivsky, which had the second highest estimate, was surveyed in 2002, 2004 and 2007. This survey effort produced a cumulative total of 407 displaying males (7.25 snipe per square km). The highest counts of males, corrected by total transect distance were in the southern Sakhalin regions of Anivsky, Korsakovsky, Yuzhno-Sakhalinsk and Dolinsky (3.6-1.8 males / km of transect).

A total of 5469 breeding males were estimated across the 12 districts, based on survey data compiled from multiple survey years (Fig. 4). This population estimate is mainly based on surveys conducted over the five years prior to 2012 within previously known habitats, as well as in the northern parts of the island that have been colonised by snipe only in recent years.

The highest densities of displaying males occurred in the more southerly districts of Korsakovsky (1.8–14.6 males/km^2), Aniva (4.4–12.5 males/km^2), Dolinsky (2.3-11.3 males/km^2) and Yuzhno-Sakhalinsk city (4.3–6.3 males/km^2). More northerly districts, as well as areas on the west coast, were characterised by lower densities and in general, there was a decreasing trend in the number of nesting snipe from south to north. As estimates were based on transect counts performed in the same districts in different years and many cases, in different places, no comparison between years was possible.

While there were no systematic searches for nests during this study, nesting was occasionally discovered during surveys. This included in modified landscapes like in the capital Yuzhno-Sakhalinsk, where nests were found on the outskirts of petrol stations, on the sidelines of roads and railways, and within the liquefied natural gas plant in the Korsakovsky district (Fig. 5).

Comparative snipe survey data

The survey data collected during the two different studies used different survey methods in different districts, and the time scale for data collection varied greatly. The population estimate derived from the 2019 data, using the extrapolation approach of Revyakina & Zykov (2012) produced numbers of breeding males ranging from 810 in Dolinsky (*c.f.* 1385 from 2012) to 60 in Tymovsky (*c.f.* 248 from 2012). A total of 1724 breeding males was estimated in 2019 using this method (Fig. 4), extrapolated from a survey area of 35 km^2. This is comparable to the estimate of 5469 in the 2012 study, which was over a much greater area (93 km^2) but was split over multiple years so may therefore represent some repeated counts of individuals between years.

DISCUSSION

Latham's Snipe occupied almost all habitat types in surveyed regions with the exception of moderately to heavily forested areas (taiga). While snapshot surveys conducted in May 2019 did not locate any snipe north of Tymovsky in the north-central part of Sakhalin, the earlier 2012 surveys found snipe in the three northern regions of Sakhalin: Noglikisky, Okhinsky and Alexandrovsk-Sakhalinsky. Collectively, the two

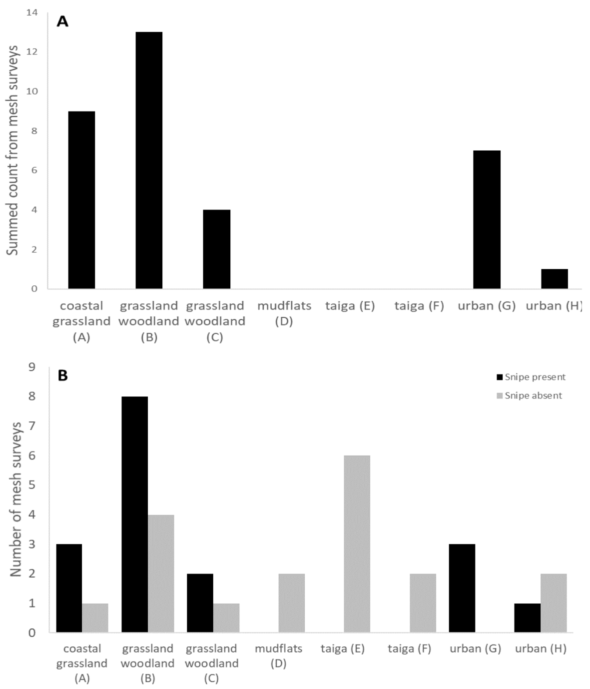


Figure 3. Broad habitat associations of snipe recorded during mesh surveys in 2019. A = total count of snipe across all meshes in different habitats. B = presence and absence of snipe across mesh surveys in different habitats. Details of habitat types: A = coastal grasslands; B = mosaic meadow-forest complexes (hay/grazing); C = grassland, marshland &/or riparian / floodplain woodland; D = estuarine mudflats; E = open, partly cleared or continuous taiga; F = open, partly cleared or continuous taiga, floodplain woodland; G = sparse settlement / nearby infrastructure; H = urban areas.

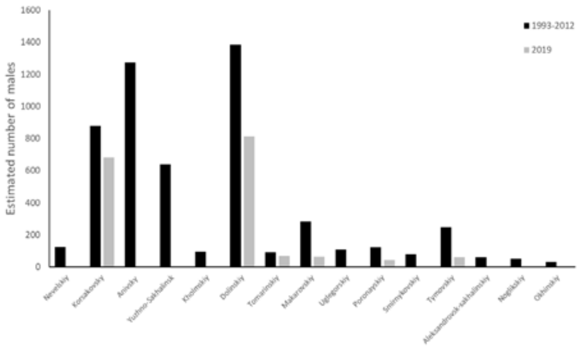


Figure 4. Estimated number of breeding Latham's Snipe on Sakhalin (by region), based on survey data from 1993-2012 (with most records obtained between 2007-2012) and 2019.

Figure 5. Satellite imagery of southern Sakhalin. The inset shows nesting sites of Latham's Snipe (white dots) near the borders of the plant for the production of liquefied natural gas in the Korsakovsky district (source Zykov & Revyakina 2009). The highest densities of snipe were recorded here in 2019.

datasets demonstrated that the greatest numbers of snipe occur in the southern regions of Sakhalin.

Current breeding distribution and abundance

The current EAAF population estimate for Latham's Snipe is 30,000 (Hansen *et al.* 2016), although recent breeding grounds surveys in Japan have estimated the population size to be 35,000 (Ura *et al.* 2018). The number of nesting snipe on Sakhalin island was estimated at 5400 breeding males in the 2012 study, based on surveys from the previous five years (Revyakina & Zykov 2012). This is equivalent to 5400 pairs if a 1:1 sex ratio assumed, although studies from Honshu breeding areas suggests the species is not monogamous (Nakamura & Shigemori 1990). Given that surveys were conducted in multiple years, the true population size is potentially less as it is possible some surveys double-counted birds between years. Using a similar extrapolation approach to that used in 2012, we estimated around 1700 breeding males based on a much smaller survey area but from a single time period in 2019. While these values from the two studies cannot strictly be compared, as they were derived from different survey types over different time periods, they nevertheless clearly indicate that a substantial population of snipe occurs on Sakhalin. Over the past 30 years, the breeding range of the Latham's snipe on Sakhalin has continued to expand north. Since completion of the 2012 study, breeding Latham's Snipe have been recorded in new locations at the extreme north of Sakhalin on Schmidt Peninsula (54ºN). Therefore, it seems highly probable that Sakhalin supports internationally significant numbers of Latham's Snipe, and that this could represent anything between 6 and 18% of the global population (based on the Hansen *et al.* 2016 population estimate).

In the southern regions of Anivsky, Korsakovsky, Dolinsky and in the territory of the Yuzhno-Sakhalinsk city, the highest average and maximum values of the abundance (individuals / km) and density (number of males per 1 km^2) were recorded. More northern areas, as well as areas of the west coast, had lower abundances and densities. In general, the number of birds decreases from south to north. In the Makarovsky and Poronaysky districts, in some areas most favourable for nesting, relatively high abundances and densities have been recorded previously (up to 5.7 individuals/km and up to 7.2 snipe/km^2, respectively) in the mosaic meadow-forest complexes of the lower reaches of the Gastellovka river (Gluschenko *et al.* 2010).

Factors affecting population size

Latham's Snipe actively populates anthropogenic landscapes, for example, agricultural land (pastures, crops of perennial grasses), outskirts of settlements, clearings under power lines, man-made disturbed territories reclaimed and overgrown with grassy vegetation, military training grounds, road and railroad lanes. In these areas, they forage in meadows, often using sparse vegetation along river banks, streams, small lakes, and roadside ditches (Revyakina & Zykov 2012). This apparent flexibility in habitat choice means that it has a higher probability of resettlement following the cessation of disturbance or restoration.

Egg laying begins in mid-May and chicks start hatching in late May to the first half of June, with fledglings recorded as late as the second half of September (Revyakina & Zykov 2012). One of the main anthropogenic causes of nest failure and fledgling death is spring burning of dry grass in open spaces, which are arranged by local residents for no obvious purpose (Revyakina & Zykov 2012). Usually, such fires occur in May, after the establishment of warm weather, when Latham's Snipe females are incubating. Livestock grazing also causes nest failure and death of chicks. For example, in one of the coastal meadows of the Korsakovsky district, which is a permanent nesting site, the introduction of grazing resulted in 100% mortality (Revyakina & Zykov 2012).

There was a significant decrease in agricultural production in Sakhalin in the 1990s and since that time, overgrowing fields and pastures have served as the favourite habitat of the species. Revyakina & Zykov (2012) found during surveys in the Korsakovsky district a rapid increase in the number of nesting snipe within 3-4 years after natural regeneration of disturbed lands overgrown with low-growing meadow vegetation. In areas like these, snipe breeding success tends to be high (Revyakina & Zykov 2012). However, when meadows are overgrown with tall grass, the success of snipe breeding was found to decline, and with the beginning of the formation of forest communities in such areas, the nesting of snipe eventually ceased. Intensification of agricultural production (e.g. intensive grazing, haymaking, plowing) can also lead to a decrease in habitat area and population decline.

Latham's Snipe are reasonably tolerant of certain levels of disturbance, which has allowed the species to populate residential areas and industrial zones. However, the prolonged presence of people and companion animals close to breeding territories can lead to the mortality of clutches and nestlings, or displacement of breeding birds (Revyakina & Zykov 2012). This is especially true for habitats located on coastal meadows, in river valleys and in open areas around cities, in places of traditional recreation for the population. Thus, weekends are periods when snipe experience greater disturbance due to large crowds of people and cars, dog walking, trampling and littering of the territory, as well as the lighting of fires. Crows also pose a threat to nesting snipe, especially for snipe nesting in the outskirts of settlements. Near the majority of settlements there are open dumps of household waste type, which contribute to an increase in the number of Jungle Crow (*Corvus macrorhynchos*) and Carrion Crow (*Corvus corone*).

While Latham's Snipe is listed in the Red Data Book of Sakhalin (Red Data Book of Sakhalin Oblast 2016), it was delisted from the Federal (Russian) Red Data Book in March 2020. Occasional shooting by hunters poses threats to Latham's Snipe, despite being protected in Sakhalin. Misidentification during hunting leads to the shooting of Latham's Snipe in the spring. Based on surveys of hunters, Revyakina & Zykov (2012) found that some hunters consider Latham's Snipe as woodcocks, some do not know that snipe are waders, and most do not know about the conservation status of this species. Cases of the shooting of Latham's Snipe are observed not only in the southern regions of Sakhalin, but also in the Aleksandrovsk-Sakhalinsk region, where this species has been recorded nesting (Revyakina & Zykov 2012).

To reduce Latham's snipe mortality from shooting, engagement activities that explain the importance of snipe conservation and focus on improving identification skills should be conducted before the hunting season commences. Displaying woodcock is the only wader species permitted to be hunted in Russia during spring. While autumn hunting for snipe are popular in the Russian mainland, it is much less common on Sakhalin due to relatively small gun dog culture, small size of game species and difficulties of shooting small and fast targets (P. Ktitorov *pers. obs.*).

Nest failure and death of chicks can occur for natural reasons, in the case of late cooling and prolonged rains (Revyakina & Zykov 2012). Adverse conditions and threats that birds encounter during migrations and wintering can also lead to a decrease in the population of Latham's snipe. Hunting for Latham's Snipe is prohibited in Japan (since 1974) and there is a moratorium on hunting in Australia. However, there are no restrictions on hunting of snipe in south-east Asian countries through which they migrate, nor on the island of Papua New Guinea, where they are known to stage (Latham's Snipe Project *unpubl. data*). Furthermore, habitat loss, associated with the drainage of wetlands, their removal for urban construction, agriculture and other purposes, and the replacement of meadow vegetation with trees and shrubs are significant threats to the species across its global range.

CONCLUSION

Latham's snipe are widely distributed across the island of Sakhalin, and likely to breed in most areas where there is low intensity land use and low disturbance from human activities. The species appears to have benefitted from some human activities, such as deforestation, which have opened up otherwise continuous forest. Current agricultural practices are relatively low in intensity and there is a tendency for human settlements to become abandoned rather than expand, and thus, the human "impact footprint" is fairly small on Sakhalin. In addition, the northward and eastward shift of Latham's Snipe breeding range might be facilitated by climatic factors, as similar patterns observed in many bird species globally (Hitch & Leberg 2007, Virkkala & Lehikoinen 2014). Collectively, these factors have probably contributed to the expansion of this population. However, the opposite pattern in land use is occurring on both Japanese breeding and Australian non-breeding grounds. Given the declining trends in the global population of the species, regular (once every 5 years) monitoring using standardised methods should be conducted in both the Japanese and Russian parts of the breeding range. Without coordinated monitoring, it will be difficult to determine whether the species is decreasing, increasing or stable but shifting its distributional range.

ACKNOWLEDGEMENTS

We would like to thank the folk who housed us during our tour of Sakhalin in 2019. BH would like to thank URA Tatsuya, TAJIRI Hironobu and TAKEMAE Asako for sharing and providing guidance on their monitoring methods in Hokkaido. BH would also like to thank the Centre for eResearch and Digital Innovation at Federation University for financial support to undertake the 2019 surveys. Our thanks to two anonymous reviewers and Jimmy Choi for many helpful comments that improved this manuscript.

REFERENCES

Amano, T., T. Székely, K. Koyama, H. Amano, W.J. Sutherland. 2010. A framework for monitoring the status of populations: An example from wader populations in the East Asian–Australasian flyway. *Biological Conservation* 143:2238–2247.

Gluschenko Y.N., I.N. Kalnitskaya, D.V. Korobov 2010. Bird population of the lower reaches of the Gastellovka river basin (Central Sakhalin) // Amurskii Zoologicheskii Zhurnal Vol.2. No. 4. P. 350-362.

Gluschenko, Y.N., V.A. Nechaev, Y.A. Red'kin. 2016. Birds of Primorsky Krai: brief review of the fauna. KMK Scientific Press Ltd. Moscow. [in Russian]

Hansen, B.D., R.A. Fuller, D. Watkins, D.I. Rogers, R.S. Clemens, M. Newman, E.J. Woehler, D.R. Weller. 2016. *Revision of the East Asian-Australasian Flyway population estimates for 37 listed migratory shorebird species*. Unpublished report for the Department of the Environment. BirdLife Australia, Melbourne, Victoria.

Higgins, P. J., S. J. J. F. Davies. 1996. *Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons*. Melbourne, Victoria: Oxford University Press.

Hitch, A. T., P.L. Leberg 2007. Breeding distributions of North American bird species moving north as a result of climate change. *Conservation Biology* 21(2):534-539.

Iida, T. 1995. Ecological Significance of Daily Periodicity in Display Flight of the Latham's Snipe *Gallinago hardwickii*. *Japanese Journal of Ornithology* 44:219-227. https://doi.org/10.3838/jjo.44.219

Kharuk, V.I., E.S. Kasischke, O.E. Yakubailik 2007. The spatial and temporal distribution of fires on Sakhalin Island, Russia. *International Journal of Wildland Fire* 16(5):556-562.

Ktitorov P.S., V.V. Dolinin, A.M. Golub, A.Y. Zhukov 2019. Annotated list of bird species of the Schmidt Peninsula, Northern Sakhalin, based on the 2016 survey. *Proceedings of Sakhalin Museum* 4:186 – 202.

Murray N.J., R.S. Clemens, S.R. Phinn, H.P. Possingham, R.A. Fuller 2014. Tracking the rapid loss of tidal wetlands in the Yellow Sea. *Frontiers in Ecology and the Environment* 12:267–272.

Nakamura, H., K. Shigemori 1990. Diurnal Change of Activity and Social Behaviour of Latham's Snipe *Gallinago hardwickii* in breeding Season. *Journal of the Yamashina Institute for Ornithology* 22:85-113.

Nazarenko, A.A., V.G. Tat'âna, V.A. Nečaev, S.G. Surmach, A.B. Kurdûkov. 2016. *Handbook of the Birds of Southwest Ussuriland. Current Taxonomy, Species Status* *and Population Trends*. National Institute of Biological Resources, Incheon.

Nechaev, V.A. 1994. Latham's Snipe in the Russian Far East. *Stilt* 25:37-39.

Red Data Book of Sakhalin Oblast. Animals 2016. BukiVedi, Moscow [in Russian].

Revyakina Z.V., V.B. Zykov 2012. Monitoring of the Latham's Snipe population within the Sakhalin region, with the exception of Federal protected areas. Unpublished report by the Information and Research Centre "Fauna" commissioned by the Ministry of Forestry and Hunting of the Sakhalin region. [in Russian]

Snow, H. J. 1897. Notes on the Kuril Islands. William Clowes and Sons, Limited, London.

Studds, C.E., B.E. Kendall, N.J. Murray, H.B. Wilson, D.I. Rogers, R.S. Clemens, K. Gosbell, C.J. Hassell, R. Jessop, D.S. Melville, D.A. Milton, C.D.T. Minton, H.P. Possingham, A.C. Riegen, P. Straw, E.J. Woehler, R.A. Fuller 2017. Rapid population decline in migratory shorebirds relying on Yellow Sea tidal mudflats as stopover sites. *Nature Communications* 8:14895. DOI: 10.1038/ncomms14895

Ura, T., A. Takemae, H. Tajiri, S. Nakamura, S. Hayama, K. Ohata, T. Tomioka 2018. Estimating the breeding population of Latham's Snipe in Hokkaido. Japan Ornithological Conference, 14-17 September 2018, Niigata University, Niigata. [in Japanese]

Valchuk O.P., V.N. Sotnikov, S.F. Akulinkin, K.S. Maslovsky 2016. History of expansion and current status of Latham's Snipe on Sakhalin Island. Pp. 80-87. *In:* Chernichko, I.I. & Mel'nikov V.N. (Eds.) Ecology, migration and conservation of waders in North Eurasia. Materials of the 10th Jubilee Conference of the Working Group on Waders of Northern Eurasia, Ivanovo, 3–6 February 2016. Ivanovo: Ivanovo State University, Russia. [in Russian]

Virkkala, R., A. Lehikoinen 2014. Patterns of climate-induced density shifts of species: Poleward shifts faster in northern boreal birds than in southern birds. *Global Change Biology* 20(10):2995-3003.

Zdorikov A.I. 2019. Updating the status of several species of birds in the Sakhalin region. *Proceedings of Sakhalin Museum* 4:203–217.

Zykov V. B., Z.V. Revyakina 2009. Prospects for restoring the breeding population of Japanese snipe in the area of construction of a natural gas liquefaction plant in the Sakhalin region. Kuliki Severnaya Evrazii: ecology of migration and protection. Abstracts of the VIII International scientific conference. Rostov-on-don: publishing house of the southern scientific center of the Russian Academy of Sciences, 2009, 66-67.

A NOTE ON AVIFAUNAL COMMUNITY OF KHUKH LAKE IMPORTANT BIRD AREA, EASTERN MONGOLIA

ONOLRAGCHAA GANBOLD[1, 2], GI-CHANG BING[3], ERDENETUSHIG PUREVEE[2], ARIUNBOLD JARGALSAIKHAN[2], MUNKHBAATAR MUNKHBAYAR[2], TAMIR KHUJUU[2], AND WOON KEE PAEK[3]

[1] *Department of Animal Science, Chungnam National University, Daejeon 34134, KOREA*
Email: f.naumanni13@gmail.com
[2] *Departments of Biology, Mongolian National University of Education, Ulaanbaatar 210648, MONGOLIA*
[3] *The Ornithological Society of Korea, Daejeon 34135, KOREA*

Khukh Lake, an Important Bird Area (IBA) within the Mongol Daguur Ramsar Site, is the biggest saline lake in eastern Mongolia. Wetlands in eastern Mongolia play a key role by providing outstanding breeding and stopover sites for migratory waterbirds, in particular those of the East Asian-Australasian Flyway. We surveyed bird community of Khukh Lake in three consecutive surveys (April-May, June-July and September, corresponding to northward migration, breeding and southward migration) in 2016. We counted and recorded varied number of individual waterbirds (26,021 birds) that belong to 49 species from five orders during these surveys. Of these, 88.6 % of total counted waterbirds were Anseriformes, while 22 out of 49 species were Charadriiforms, with predominance of waders (17 species). According to this and previous studies, we highlight the crucial threats threatening avifauna at Khukh Lake. These included harvesting aquatic invertebrates, steppe fires, overgrazing and illegal fishing recorded at Khukh Lake.

INTRODUCTION

Mongolia had several outstanding biological eco-regions including (a) Altai Sayan Mountain, (b) Eastern Mongolian Grassland and (c) Mongol Daguur Ramsar site (Reading *et al*. 2006). Our study site belongs to the Eastern Mongolian Grassland ecosystem, located in the buffer zone of the Mongol Daguur Strictly Protected Area, and Mongol Daguur Ramsar site (Ramsar Site No. 924). In addition, early Mongolian avifauna studies were performed by mostly foreign ornithologists over the last two centuries (Przewalskii 1876; Kozlov 1930; Pevtsov 1951; Shagdarsuren 1961; Fischer 1970; Bold 1973; Sumiya & Skryabin 1989; Buckton 1998; Fishpool & Evans 2001; Gombobaatar *et al*. 2003). Yet, for avifauna we lack data on their population trends, distributions, seasonal movements and habitat use, particularly for wetland species (Ganbold *et al*. 2018). Mongolia is located at the junction of three migratory flyways: East Asian-Australasian Flyway, Central Asian Flyway and East Africa-West Asian Flyway (Gombobaatar & Monks 2011). Importantly, the country hosts a diversity of wetlands which are utilised as important breeding and stopover sites for eastern Palearctic birds (Gombobaatar & Monks 2011). According to previous studies, the country supports important breeding sites for several Globally Threatened Birds, including, Common Pochard *Aythya ferina* (Vulnerable), Great Bustard *Otis tarda* (Vulnerable), White-headed Duck *Oxyura leucocephala* (Endangered), Saker Falcon *Falco cherrug* (Endangered), Swan Goose *Anser cygnoides* (Vulnerable), White-naped Crane *Grus vipio* (Vulnerable) and Steppe Eagle *Aquila nepalensis* (Endangered) (Batbayar *et al.* 2006, Gombobaatar & Monks 2011, Ganbold *et al*. 2017, IUCN 2017).

Wetlands, including river basins and lakes, are important conservation sites due to the extensive food source and rich biodiversity they support (Getzner 2002). Mongolia became a contracting Party to the Ramsar wetland conservation convention on 8 April 1998.

To date, there has been no study to investigate the avifauna of Khukh Lake in consecutive seasons within one year. Several studies (Goroshko *et al*. 2003, Batbayar & Tseveenmyadag 2009) mention partial avifaunal community for Khukh Lake and threats they may face. We initiated three consecutive surveys at this site to (a) assess the avifaunal diversity in bird communities in different periods (pre-breeding, breeding, and post-breeding) at Khukh Lake in eastern Mongolia, and (b) to identify threats to the avifauna at this wetland.

METHODS

Study area

Our study was conducted at Khukh Lake IBA in eastern Mongolia (115.544º E, 49.499º N) which lies 38 km southwest of Ereentsaw village, Dornod province (Fig. 1). Tserensodnom (2000) reported Khukh lake covers an area of 51.6 km^2, being 10.3 km long and 8.0 km wide (recently the size of this lake has decreased likely because of droughts) The permanent lake has very mineralised or saline waters with slight turbidity (Miguel 2006). The average depth of the lake is around 8 m (Tserensodnom 1990, 2000). The Teeliin River feeds the lake, but it has no outflow (Tserensodnom 2000). A grassland steppe on low rolling hills surrounds Khukh Lake (this is a common landscape in Eastern Mongolia). Marshes with *Phragmites* occur where Teel River flows into the lake. *Suaeda* spp. is dense along the northern shoreline.

Many migratory and non-migratory birds breed, feed and even moult at the Lake. The Lake also supports human settlements, providing water resource for their animal husbandry (Batbayar & Tseveenmyadag 2009). Several introduced fish species from the Ulz River Basin are distributed in Khukh Lake (Tserensodnom 2000).

Mongolian and Russian scientists transferred six species, including Common Carp *Cyprinus carpio*, Prussian Carp *Carassius gibelio*, Pseudoras Bora *Pseudorasbora parva*, Lake Minnow *Phoxinus percnurus*, Baikal Omul *Migratorius georgi* and Northern Whitefish *Coregonus peled* to this lake from Baikal Lake and other lakes from Russia (Dulmaa 1999). This lake supports fish populations with numerous aquatic invertebrates including, *Gammarus* spp. (Dulmaa 1999). The *Gammarus* spp. also form the main prey of migratory waterbirds.

Since June 2014, Khukh Lake and its surrounding steppe were designated a Local Protected Area of the Dornod Province with an area covering 97 070 ha. It was also registered as an Important Bird Area (MN067) in 2009 with an 11,548 ha area (Batbayar and Tseveenmyadag 2009). IBAs are sites of international importance for the conservation of the biodiversity and are chosen by using agreed objective, quantitative and scientifically defensible criteria.

Data collection and analysis

Surveys were undertaken in April-May (2 days) as pre-breeding / northward migration, June-July (2 days) breeding or post breeding and September (1 day) southern migration. A total of six vantage points (point counting, Ralph *et al*. 1981) were selected on higher ground overlooking the Lake (Fig. 1). All point counting observation were undertaken for a duration of 35 minutes. All counted birds were recorded from those higher vantage points. Approximately 53% of the total lake surface was covered by the survey effort. There is a possibility of overlapped counting of birds from closely neighbouring counting points. We assume that < 1% of total counted waterbirds could be double counted. Field observation were made by spotting scopes (ED 25-75x82) and binoculars (10X42). We further used Canon camera (60D with 400 mm lens) to check field observation. For identification of birds several field guides were used (Brazil, 2009) whenever we could not directly identify the observed birds. The locations of bird communities and other key sites were recorded using a handheld GPS (Garmin GPSMAP). At the site, we recorded data on threats observed during the surveys, including number of herder families and herds of domestic animals (only at wetland), as well as harvesting of aquatic species. Chi-square test (χ^2) were used to test for differences among variables. The significance level accepted at P < 0.05.

RESULTS

A total of 26,021 counted individuals belonging to 49 species of five orders (Podicipediformes, Anseriformes, Gruiformes, Pelecaniformes and Charadriiforms) of waterbirds were recorded from three visits to the Khukh Lake IBA during the surveys (Table 1). Forty species, predominantly Passeriformes and Falconiformes (n=299) were also recorded during our surveys (data not shown).

Waterbird composition did not differ significantly among survey periods ($x^2 = 0.55$, d.f.= 2, $P > 0.05$), but significantly different populations of bird communities ($x^2 = 34.67$, d.f.= 2, $P < 0.05$) were recorded. Four thousand three hundred and forty-two individuals of 47 species were recorded in the first survey, 9858 individuals of 41 species in the second and 11,821 individuals of 41 species were recorded in the third, in April-May, July and September, respectively. The highest number of species were recorded in the pre-breeding (also northern migration) season in this study, while the highest number of birds were recorded in the September survey, considered as post-breeding or southern migration.

Among these five orders, Charadriiforms was predominant with 22 species (RDi= 23.6%), followed by Anseriformes (17 species) (Table 2). As a single group, waders were the most diverse (17 species) but in relatively low numbers. At the species level, most dominant species among Charadriiforms were Mongolian Gull (244 birds) and Common Greenshank (51 birds), while GBT Swan Goose (4626) and Common Goldeneye (3133) were the dominant waterfowl Anseriformes (Table 1).

Of the 27 globally threatened bird species recorded in Mongolia (Ganbold *et al*. 2017), six species were recorded in this study, with two additional species listed as near threatened (NT) (Table1). The Swan Goose and Common Pochard were the most abundant species (Table1).

Figure 1. Map of Khukh Lake study site and six counting points. Dot size in proportion to count of waterbirds only. Most waterbird communities were distributed on the western and southern side of Lake.

Figure 2. Shrimp *Gammarus* spp. harvesting net-trap at Khukh Lake, 15 July 2016.

Table 1. Bird list recorded from the Khukh Lake Important Bird Area.

Common Name	*Scientific Name*	IUCN status	Bird Count		
			May-Apr	June-July	Sept
Great Crested Grebe	*Podiceps cristatus*	LC	190	1	34
Horned Grebe	*Podiceps auritus*	LC	3	13	220
Eared Grebe	*Podiceps nigricollis*	LC	31	6	3
Great Cormorant	*Phalacrocorax carbo*	LC	108	54	126
Grey Heron	*Ardea cinerea*	LC	-	7	2
Whooper Swan	*Cygnus cygnus*	LC	51	241	84
Swan Goose	*Anser cygnoid*	**VU**	-	4038	588
Bean Goose	*Anser fabalis*	LC	5	-	3
Ruddy Shelduck	*Tadorna ferruginea*	LC	48	4364	2897
Common Shelduck	*Tadorna tadorna*	LC	119	141	148
Eurasian Wigeon	*Anas penelope*	LC	420	2	199
Falcated Duck	*Anas falcata*	LC	10	-	12
Gadwall	*Anas strepera*	LC	21	17	758
Eurasian Teal	*Anas crecca*	LC	22	12	453
Mallard	*Anas platyrhynchos*	LC	175	-	34
Northern Pintail	*Anas acuta*	LC	63	-	173
Garganey	*Anas querquedula*	LC	9	-	4
Northern Shoveler	*Anas clypeata*	LC	244	28	67
Common Pochard	*Aythya ferina*	**VU**	610	32	1975
Tufted Duck	*Aythya fuligula*	LC	843	85	187
Velvet Scoter	*Melanitta fusca*	LC	747	-	16
Common Goldeneye	*Bucephala clangula*	LC	267	499	2367
Common Quail	*Coturnix coturnix*	LC	3	4	2
Demoiselle Crane	*Anthropoides virgo*	LC	2	-	1
White-naped Crane	*Grus vipio*	**VU**	1	-	-
Common Coot	*Fulica atra*	LC	11	9	1378
Great Bustard	*Otis tarda*	**VU**	2	1	3
Black-winged Stilt	*Himantopus himantopus*	LC	11	13	9
Pied Avocet	*Recurvirostra avosetta*	LC	9	11	6
Pacific Golden-Plover	*Pluvialis fulva*	LC	8	5	5
Little Ringed Plover	*Charadrius dubius*	LC	14	16	4
Kentish Plover	*Charadrius alexandrinus*	LC	9	21	-
Black-tailed Godwit	*Limosa limosa*	NT	2	3	7
Asian Dowitcher	*Limnodromus semipalmatus*	NT	2	38	5
Spotted Redshank	*Tringa erythropus*	LC	4	2	9
Common Redshank	*Tringa totanus*	LC	3	11	10
Marsh Sandpiper	*Tringa stagnatilis*	LC	6	8	-
Common Greenshank	*Tringa nebularia*	LC	8	30	13
Wood Sandpiper	*Tringa glareola*	LC	5	27	4
Common Sandpiper	*Actitis hypoleucos*	LC	10	30	5
Temminck's Stint	*Calidris temminckii*	LC	2	2	-
Sanderling	*Calidris alba*	LC	3	39	-
Red-necked stint	*Calidris ruficollis*	LC	1	21	-
Ruddy Turnstone	*Arenaria interpres*	LC	2	4	-
Mongolian Gull	*Larus argentatus*	LC	222	15	7
Common Black-headed Gull	*Larus ridibundus*	LC	8	2	1
Relict Gull	*Larus relictus*	**VU**	4	1	-
Common Tern	*Sterna hirundo*	LC	2	3	1
White-winged Black Tern	*Chlidonias leucopterus*	LC	2	2	1

IUCN status: LC= least concern, NT= near threatened, VU= vulnerable, EN= endangered

Table 2. Relative diversity (RDi) of all avifaunal orders.

Orders	No. of species	RDi	No. of counted birds	Abundance %
PODICIPEDIFORMES	3	3.4	501	1.90
PELECANIFORMES	2	2.2	297	1.13
ANSERIFORMES	17	19.1	23,078	87.68
FALCONIFORMES	12	14.6	34	0.13
GALLIFORMES	1	1.1	9	0.03
GRUIFORMES	5	5.6	1408	5.35
CHARADRIIFORMES	22	23.6	728	2.77
COLUMBIFORMES	2	2.2	11	0.04
STRIGIFORMES	3	3.4	3	0.01
APODIFORMES	1	1.1	6	0.02
CORACIIFORMES	1	1.1	4	0.02
PASSERIFORMES	20	22.5	241	0.92
Total	**89**	**100**	**26,320**	**100**

Shrimp (*Gammarus* spp.) harvesting was the main threat recorded during our surveys. A shrimp harvesting camp using net-trap was observed on the western coast of Khukh Lake during our July and September surveys (Fig. 2). According to primary information from harvesters they harvested approximately 4 tonnes of shrimps every week (harvest end May to end September). The net-traps were placed along the western shore of the lake (115.56° E 49.53° N) which coincided with the highest density of bird community. Remains of fishes including their skull, bone and skin were left around the harvesting camp. No direct effects arising from overgrazing and steppe fire were recorded for this study. Four nomadic herder families with 150 horses, 260 sheep, 250 goats and 75 cows were observed nearby to the lake edge during surveys (May to September). Numbers of livestock in each survey varied, but the majority (80%-90%) were counted in June-July survey.

DISCUSSION

Avifaunal community

Before the 1990s, 90% of total faunal surveys on Mongolian avifauna were conducted in the Western and Central parts of Mongolia (Batbayar *et al*, 2006). Those expeditions were mostly led by Russian scientists (Adiya & Suran 2008). Since then, researchers and organisations have given more attention to faunal, in particularly avifaunal study in the Eastern part of Mongolia. This is driven by the recognition of the importance of this region as key breeding and stopover for migratory birds of the East Asian-Australasian Flyway (Batbayar *et al*. 2006).

Among 12 orders recorded in this study, Charadriiformes, in particular, waders with 17 species and Anseriformes, in particularly ducks with 12 species were recorded as predominant in the avifaunal communities at the site (Table 1). The number of recorded species decreased as summer progressed (May to September), while number of counted birds tended to increase. Which indicates the seasonal differences of migratory waterbirds (pre- and post-breeding migration) in eastern Mongolia, including our study site. Zhao *et al*. (2017) showed that migratory birds, especially shorebirds, tended to use much longer step lengths with fewer staging sites during their faster migrate in pre-breeding migration compared to post-breeding. This differences in migrating simply linked with strategies of time-minimising during pre-breeding, and energy-minimising during post-breeding migration (Zhao *et al.* 2017). Interestingly, less numbers of ducks were recorded in June-July period which may be considered as breeding season. Our field observations suggest the Lake is not a favourable breeding site for most of the duck species due to a lack of shallow depression, and the lack of breeding attempts observed. Thus, we postulate that ducks bred at neighbouring wetlands (lakes of Mongol Daguur with shallow depression), and that they visited Khukh Lake for foraging. Larger number of waders were counted in this period (June-July) compare to April-May and September observations. We postulate three possibilities to explain this observation: (i) these waders can be failed breeders, (ii) they may be sub-adults whose migration (to further northern or arctic) had been stopped near by our study site and / or (iii) our study site is suitable breeding grounds for waders (breeding attempts were not looked for during field observation). The relatively consistent bird communities recorded between the three surveys, indicates the importance of Khukh Lake to the migratory birds during the pre-breeding, breeding and post-breeding seasons.

The significance of Khukh Lake is demonstrated through the globally threatened Swan Goose and Common Pochard recorded as the most abundant species. The Swan Goose is considered the most vulnerable waterfowl in East Asia due to its nesting in densely populated and easily accessible flood plains, and intensive and uncontrolled hunting at its wintering grounds (Poyarkov 2006). Previous surveys found up to 2816 and 11 500 (Goroshko 2003, 2004) and 3804 (Batbayar *et al*. 2006) Swan Geese at Khukh Lake. Whereas, 4038 and 588 Geese were observed in June-July and September, respectively in this study. Batbayar and Tseveenmyadag (2009) emphasised that this IBA site hosts more than 1% populations of Great Crested Grebe, Great Cormorant, Whooper Swan, Swan Goose and Common Pochard. Species that were sighted in large number in this study. Together with these previous studies (Batbayar *et al*. 2006; Goroshko 2003), our study confirms that Khukh Lake is rightly considered an important site for moulting Swan Geese (no flightless birds observed, almost all birds located on the water ~ 30-500 m from the shore) and also during the fall migration, while no breeding attempts were observed.

Threats and conservation issues

The Eastern Mongolian steppe is one of the East Asian-Australasian Flyway's refuge sites for millions of migratory birds (Wilson *et al.* 1998; Bamford *et al*. 2008), but data collection on habitat changes and crucial threats is meagre, but needed to guide conservation action in the region. Previously studies (Reading *et al.* 2006; Nasanbat *et al*. 2016) mentioned threats at a region level for eastern Mongolia. In particularly, hazardous steppe fire and overgrazing that resulted from high density livestock were considered the main threats for the Eastern Mongolian Important Bird Areas (Batbayar *et al.* 2009). Furthermore, Nasanbat *et al*. (2016) reported that steppe fire became a threat to biodiversity, especially breeding birds. Seppe fire occurs almost every year in the Eastern Mongolian steppe (Batbayar *et al*. 2009).

Harvesting of *Gammarus* spp. and illegal fishing were recorded as potential threats this study (Fig. 2). A harvesting camp (with 3 men) (E115.57/N49.56) was located on the northern shore and net-traps were located on the western side of the lake. Harvesting of *Gammarus* spp. occurs between May to September. Harvesting shrimps and illegal fishing in protected area is illegal threaten the local avifauna particularly for ducks and waders through birds potentially being caught in the net-traps (not recorded). A previous study (Macneil *et al.* 1999) highlighted importance of *Gammarus* spp. for waterbirds' through their key role as a food resource of species from *Anas*, *Aythya*, *Calidris*, *Larus*, and *Tringa* spp. (Dirschl 1969, Helluy 1984, Ormerod & Tyler 1986). In contrast, the remains of harvested fish and shrimp are an attractive food source to the gulls. But very few gulls were recorded nearby harvesting camp. Harvesting of aquatic invertebrates that play a significant role as food resource of waders and ducks, as well as other waterfowls are recorded as a crucial threat. No direct effects from overgrazing, steppe fire, mining action, utility lines or roads (local roads around the lake and railway 800-1000 m way from west side of lake) were observed in this study.

Continuous monitoring to observe spatial and temporal variations in avifaunal community characteristics and to identify possible threats resulting in wetland degradation in this and other avifaunal hotspots in eastern Mongolia are required. Further bird monitoring at Khukh Lake IBA and its neighbouring wetlands is planned. The monitoring will involve capture and marking waders and ducks as well as recording threats. Previous studies emphasised the importance of waders to nature conservation as key species (Wilson & Barter 1998, Smart *et al.* 2006, Aarif 2009). Waders could be considered as global sentinels of environment change due to their migratory ecology and wide habitat use patterns (Piersma & Lindström 2004, Aarif & Prasadan 2015). Local herders and rangers will be important components for our future conservation study.

ACKNOWLEDGEMENTS

This study is funded by a small grant from the Mongolian National University of Education and The Ornithological Society of Korea. We are grateful for research assistants Munkhzul B, Namsrai J, and Solongo S from the Mongolian National University of Education. Also, special thanks to Dr. Batbayar Naymbayar for his comment on our early draft editing.

REFERENCES

Aarif, K. M. 2009. Some Aspects of Feeding Ecology of the Lesser Sand Plover *Charadrius mongolus* in Three Different Zones in the Kadalundy Estuary, Kerala, South India. *Podoces* 4:100-107.

Aarif, K. M. & P. K. Prasadan 2015. Silent Shores: Population Trend of Migrant Birds & Conservation Issues of Habitat. Partridge Publishing.

Adiya, Ya. & D. Suran 2008. Guidebook for Volunteer Rangers. Mongolian National University. Ulaanbaatar, (Mongolian).

Bamford, M., D. Watkins, W. Bancroft, G. Tischler, & J. Wahl 2008. Migratory shorebirds of the East Asian-Australasian flyway: Population estimates and internationally important sites. Canberra: Wetlands International, Oceania.

Batbayar, N., N. Tseweenmyadag, & K. P. Woon 2006. Final report of Swan Goose study in Eastern Mongolia. *Daejeon and Ulaanbaatar*.

Batbayar, N. B. & N. Tseveenmyadag (Eds) 2009. *Directory of Important Bird Areas in Mongolia: Key Sites for Conservation*. Ulaanbaatar: Wildlife Science and Conservation Center, Institute of Biology and BirdLife International.

Bold, A. 1973. Birds of Mongolia. Scientific Proceedings of the Institute of Biology of the Mongolian Academy of Sciences 7:139-166. (In Mongolian)

Buckton, S. 1998. Report of field trip to Lakes of the Gobi Valley (Taatsiin Tsagaan, Orog, Adgiin Tsagaan, and Boon Tsagaan lakes), terkhiin tsagaan and Ogii lakes. Ministry of Nature and Environment. Ulaanbaatar.

Brazil, M. 2009. Birds of East Asia: China, Taiwan, Korea, Japan, and Russia. A&C Black.

Dirschl, H. J. 1969. Foods of lesser scaup and blue-winged teal in the Saskatchewan River Delta. *The Journal of Wildlife Management*, pp.77-87.

Dulmaa, A. 1999. Fish and Fisheries in Mongolia. Fish and Fisheries at higher altitudes Asia. FAO Fisheries Technical Paper 385:187-236 (in Mongolian).

Finlayson, C. M., M. Everard, K. Irvine, R. J. McInnes, B. A. Middleton, A. A. van Dam, & N. C. Davidson (Eds.) 2019. The wetland book. 1: Structure and function, management and methods. *Springer*, Dordrecht, The Netherlands.

Fishpool, L. D. C & M. I. Evans (Eds.) 2001. Important Bird Areas in Africa and associated islands: priority sites for conservation. *BirdLife Conservation Series No*. 11, Pisces Publications and BirdLife International, Newsbury and Cambridge, UK.

Fischer, W. 1970. Ornithological observations and an attempted bird survey at the Mongolian desert lakes, Orog and Buuntsagaan. *Zoologische Abhandlungen Museum für Tierkunde Dresden* 30: 101-129.

Ganbold, O., G. C. Bing, J. H. Lee, M. Munkhbayar, I. H. Paik, A. Jargalsaikhan, E. Purevee, Z. Purevdorj & W.K. Paek 2018. An avifaunal survey of middle Mongolian wetlands: Important Bird Areas and threatened species. *Journal of Asia-Pacific Biodiversity* 11:340-345.

Ganbold, O., M, Munkhbayar, I. H. Paik, G. C. Bing, A. Jargalsaikhan, E. Purevee & W. K. Peak 2017. Globally threatened birds in Mongolia: a review. *Journal of Asia-Pacific Biodiversity* 10:435-440.

Getzner, M. 2002. Investigating public decisions about protecting wetlands. *Journal of Environmental Management* 64:237-246.

Gombobaatar, S., N. Tseveenmyadag, & B. Nyambayar 2003. Current status of research and future trends of Swan Goose *Anser cygnoided* and Baikal Teal *Anas Formosa* in Mongolia. 2003 International Anatidae symposium in East Asia and Siberia region. 31 October – 3 November 2003. Season. Korea. 79-82

Gombobaatar, S & E. M. Monks 2011. Regional Red List Series Vol.7. Birds. Zoological Society of London, National University of Mongolia and Mongolian Ornithological Society. (In English and Mongolian)

Goroshko, O. A. 2003. 2003 - Extremely unfavorable year for Swan Geese in Dauria trans-boundary region (Russia and Mongolia). Pages 83-92 *in* 2003 International Anatidae Symposium in East Asia & Siberia Region, Seosan, Korea.

Goroshko, O. A. 2004. Data for waterbirds at Buyr-Nuur (Eastern Mongolia). *Mongolian Journal of Biological Science* 2:67-68.

Helluy, S. 1983. Host-parasite interfaces of the trematode microphallus-papillorobustus. 2. Altered behavior in gammarus intermediate hosts and location of metacercriae. *Annales de Parasitologie Humaine et Comparée* 58:1-17.

IUCN 2017. The IUCN Red List of Threatened Species. Version 2017-3. http://www.iucnredlist.org. Downloaded on 05 December 2017.

Kozlov, E. V. 1930. Birds of South Western Baikal, Northern Mongolia and Central Gobi. Moscow. *Nauka* p. 7-361. (in Russian)

Macneil, C., J. T. Dick, & R. W. Elwood 1999. The dynamics of predation on *Gammarus* spp. (Crustacea: Amphipoda). *Biological Reviews* 74:375-395.

Miguel, A., F. María, P. Antoni, N. Soninkhishig, L. P. Joan, & E. Soyolmaa 2016. Limnological catalog of Mongolian lakes, project. Water Research Center in Mongolian National University, Department of Ecology in University De Barcelona, Span. Online available at: http://oslo.geodata.es/mongolian_lakes/map/mongolia-map.php?lang=en

Nasanbat, E. & O. Lkhamjav 2016. Wild fire risk map in the eastern steppe of Mongolia using spatial multi-criteria analysis. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, pp.1-9.

Ormerod, S.J. & S.J. Tyler 1986. The diet of dippers *Cinclus cinclus* wintering in the catchment of the River Wye, Wales. *Bird Study* 33:36-45.

Pevtsov, M.V. 1951. Bird List Collected During the Expeditions Through Mongolia and China Between 1878-1879. *Omsk*, p.227-288. (in Russian)

Piersma, T. & Å. Lindström 2004. Migrating shorebirds as integrative sentinels of global environmental change. *Ibis* 146:61-69.

Poyarkov, N. D. 2006. The Swan Goose *Anser cygnoides* research and conservation programme in Russia. In Boere, G.C., C.A. Galbraith & D.A. Stroud (eds.), Proceedings of the Waterbirds around the world: a global overview of the conservation, management and research of the world's waterbird flyways, pp.482–483. The Stationery Office, Edinburgh. UK

Przewalskii, N. M. 1876. Materials for ornithological fauna in Mongolia and Tangut Country. V.2. (in Russian)

Ralph, C.J. & S. J. Michael (Eds) 1981. Estimating numbers of terrestrial birds. *Studies in Avian Biology* 6: 630.

Reading, R.P., D. J. Bedunah & S. Amgalanbaatar 2006. Conserving Biodiversity on Mongolian Rangelands: Implications for Protected Area Development and Pastoral Uses. USDA Forest Service Proceedings RMRS-P-39. 2006

Shagdarsuren, O. 1961. On the research of Wildlife in Khangai Mountain Range. *Scientific Proceeding of the Institute of Biology of the Mongolian Academy of Science* 1:43-47 (in Mongolian)

Smart, J., J. A. Gill, W. J. Sutherland, & A. R. Watkinson 2006. Grassland-breeding waders: identifying key habitat requirements for management. *Journal of Applied Ecology* 43:454-463.

Sumiya, D. & N. G. Skryabin 1989. Birds of Huvsgul Lake and its surrounding of the Mongolian People's republic. *Irkutsk*. 193pp. (in Russian)

Tserensodnom, J. 1990. Lakes of Mongolia. Mongolian Academy of Science Press. Ulaanbaatar. The People's Republic of Mongolia. (in Mongolian)

Tserensodnom, J. 2000. Catalog of Mongolian Lakes. Institute of Geography, Mongolian Academy of Science and Ministry of Environment Press. 2000. Ulaanbaatar. (in Mongolian).

Zhao, M., M. Christie, J. Coleman, C. Hassell, K. Gosbell, S. Lisovski, C. Minton & M. Klaassen 2017. Time versus energy minimization migration strategy varies with body size and season in long-distance migratory shorebirds. *Movement Ecology* 5:23.

Wilson, J. R. & M. A. Barter 1998. Identification of potentially important staging areas for 'long jump' migrant waders in the East Asian–Australasian Flyway during northward migration. *Stilt* 32:16-27.

EURASIAN CURLEWS *NUMENIUS ARQUATA* INGESTING LONG-TAILED TIT *AEGITHALOS CAUDATUS* AND ORANGE-FLANKED BUSH-ROBIN *TARSIGER CYANURUS*

DAVID S. MELVILLE[1], SHOU-DONG ZHANG[2] AND QING-QUAN BAI[3]

[1]1261 Dovedale Road, RD 2 Wakefield, Nelson 7096, NEW ZEALAND
Email: david.melville@xtra.co.nz
[2]Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, Coastal Ecosystems Research Station of the Yangtze River Estuary, Shanghai Institute of Eco-Chongming (SIEC), Fudan University, Shanghai, 200433, CHINA.
[3]Dandong Forestry and Grassland Bureau, Dandong, Liaoning, 118000, CHINA.

The Yalu Jiang National Nature Reserve, Liaoning Province, China is a site of international importance for Eurasian Curlew *Numenius arquata* on both northward and southward migration (Bai *et al*. 2015). Eurasian Curlews usually forage on intertidal flats in the nature reserve, where they take a wide variety of invertebrate prey, including polychaetes, crabs, shrimps, the brachiopod *Lingula anatine*, bivalves and gastropods (S.D. Zhang unpublished).

On 3 April 2017 we collected regurgitated pellets at a Eurasian Curlew roost on the banks of aquaculture ponds approximately 650 m from the sea in the Yalu Jiang National Nature Reserve. Among the 98 pellets collected, was one composed of a Long-tailed Tit *Aegithalos caudatus*. On examining the tit body, we found that there was little digestion and the bird was immediately identifiable. No other prey remains were mixed with the tit body.

We considered the possibility that the bird might have been regurgitated by a species other than Eurasian Curlew. A raptor is likely to have damaged the carcass before swallowing, and a much greater amount of digestion would be expected prior to regurgitation. A large gull (*Larus* sp,) could have swallowed the bird whole, as appears to have been the case, but the pellet did not appear similar to other gull pellets that we have found and gulls were not recorded roosting at the collection site – indeed, most large gulls at Yalu Jiang roost on the sea rather than pond embankments.

The Long-tailed Tit is both a resident species and a migrant in Liaoning. The site where the pellet was collected is some 5.5 km from the nearest woodland, and would not appear to provide any suitable habitat for the species – although Brazil (2009) notes it occurring in 'scrub and reedbeds' in winter, they have not been seen in such habitats in Liaoning (Q.Q. Bai unpublished). However, migrating birds might pass through the coastal area and a weakened migrant could become prey to Eurasian Curlew.

On 11th April 2019 SDZ collected 77 Eurasian Curlew pellets from another roost on an aquaculture pond bank where some 900 curlews had been roosting. One pellet consisted entirely of small feathers which were quite loosely compacted – unlike a typical raptor pellet. The feathers included several pale blue ones characteristic of an Orange-flanked Bush-robin *Tarsiger cyanurus.* The Orange-flanked Bush-robin is a common spring migrant through the Yalu Jiang area and small numbers had been seen the preceding week, as well as several being found drowned in shrimp nets set on the intertidal area – presumably low flying migrants coming off the sea. A Eurasian Curlew could have found the bird on the tidal flats or else in vegetation by the roost on the pond embankment.

These appear to be the first records of Eurasian Curlew eating adult birds, although it is unclear whether these were taken as carrion or alive. Previously, Hibbert-Ware & Ruttledge (1944) reported 'one young downy bird' (unidentified) in a pellet in Ireland, and there is one record of a Eurasian Curlew killing, but not eating, a White Wagtail *Motacilla alba* in England (King 2001).

REFERENCES

Bai, Q.Q., J.Z. Chen, Z.H. Chen, G.T. Dong, J.T. Dong, W.X. Dong, V.W.K. Fu, Y.X. Han, G. Lu, J. Li, Y. Liu, Z. Lin, D.R. Meng, J. Martinez, G.H. Ni, K. Shan, R.J. Sun, S.X. Tian, F.Q. Wang, Z.W. Xu, Y.T. Yu, J. Yang, L. Zhang, M. Zhang & X.W. Zeng 2015. Identification of coastal wetlands of international importance for waterbirds: a review of China Coastal Waterbird Surveys 2005-2013. *Avian Research* 6:12. DOI 10.1186/s40657-015-0021-2

Brazil, M. 2009. *Birds of East Asia*. Princeton University Press, Princeton.

Hibbert-Ware, A. & R.F. Ruttledge 1944. A study of the inland food habits of the Common Curlew. *British Birds* 38:22-27.

King, S. 2000. Eurasian Curlew capturing and killing Pied Wagtail. *British Birds* 93:399.

STATUS AND RESIGHTING RECORDS OF GREAT KNOT *CALIDRIS TENUIROSTRIS* IN CORINGA WILDLIFE SANCTUARY, ANDHRA PRADESH

P. SATHIYASELVAM[1], MAHESH BABU DIMMALA[2], SHUBHADEEP MUKHERJEE[3] AND GANESH PALLELA[4]

[1, 3]Bombay Natural History Society, Hornbill House, S.B. Singh Road, Mumbai – 400001 INDIA.
Email: p.sathiyaselvam@bnhs.org
[2 ,4]EGREE Foundation, No. 70-3-41, Vaidya Nagar – 1, Road No.2, Ramanayyapeta, Kakinada – 533005 INDIA.

The Great Knot *Calidris tenuirostris* is a long-distance migratory shorebird listed as 'Endangered' in the 'IUCN Red List of Threatened Species' (IUCN 2019). It breeds in North-East Siberia, Russia (Tomkovich 1996) and winters primarily in Australia, with smaller numbers wintering regularly throughout the coastline of South-East Asia, India, Bangladesh, Pakistan and the eastern coast of the Arabian Peninsula (Wetlands International 2018). In India, the species was considered as neither abundant nor a rare winter visitor, and was earlier reported from Assam, Kolkata, Chennai, Andaman and Lakshadweep Islands (Ali & Ripley 1983). Later, it was reported as a regular non-breeding visitor to the east and west coast of India (Balachandran 1997; Mohapatra & Rao 1993; Robson 1997; Zockler, *et al.* 2005; Balachandran *et al.* 2014; Sashikumar *et al.* 2011; Ganpule *et al.* 2011; Kasambe *et al.* 2014; Aarif *et al.* 2017). In recent years, over 1000 individuals have been reported from Point Calimere in Tamil Nadu and the Gulf of Kutch in Gujarat (Balachandran *et al.* 2014; Author's *pers. obs.*).

Coringa Wildlife Sanctuary (16° 57′ N 82° 16′ E) is a part of the Godavari delta (Fig. 1). This site shelters the second largest mangrove patch along the east coast of India after Sundarban. Kakinada Bay is located within the sanctuary. Tidal flats in and around the sanctuary support large congregation of waterbirds, particularly waders. It is one of the important non-breeding and stop-over sites for the migratory waterbirds along the east-coast of India (Sathiyaselvam & Sreedhar 2014).

Regular waterbird surveys were carried out in Coringa Wildlife Sanctuary and adjoining mudflats from January 2012 to February 2019. During the study period the occurrence of Great Knot was first recorded in January 2016, with a total of 25 individuals on the tidal mudflats at Kakinada Bay. In the subsequent migratory season (2016-2017), the arrival of Great Knot was observed during the first week of November 2016 and a peak number of 457 individuals was recorded during the first week of December 2016. The numbers declined in the last week of December. Over 190 individuals were seen up to the last week of January 2017. The same arrival and departure patterns were observed during the 2017-2018 and 2018-2019 migratory season (Fig. 2). Maximum numbers recorded were 500 during 2017-2018 and 470 during 2018-2019.

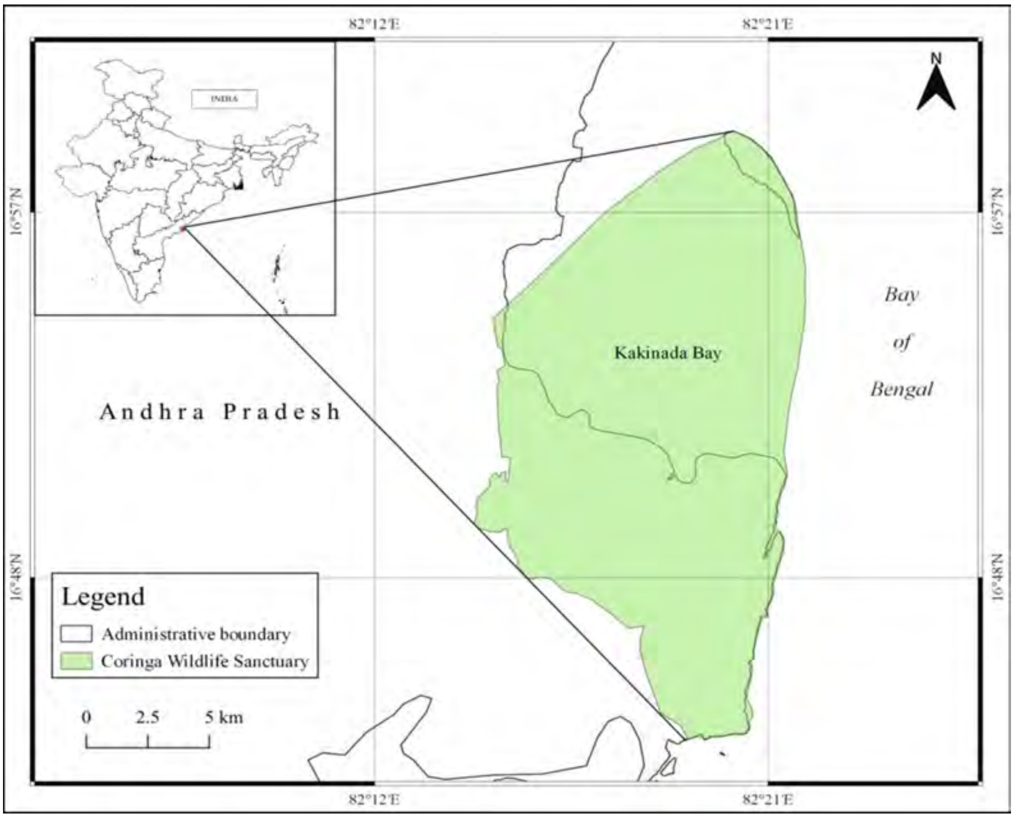


Figure 1. Coringa Wildlife Sanctuary and adjoining mudflats.

Sathiyaselvam & Rao (2014) reported the Great Knot as an occasional non-breeding visitor to Godavari Mangroves. The recent records indicate that the Coringa Wildlife Sanctuary, particularly the tidal flats in Kakinada Bay, has become an important site for the Great Knot along the east coast of India. Available records (Balachandran *et al* 2014; Author's *Pers. Obs.*) on the species suggest that Coringa Wildlife Sanctuary is now the third most important site for Great Knot in India after Gulf of Kutch and Point Calimere. Numbers of the Great Knot at Kakinada Bay have increased, from no birds in 2012 – 2016 -to several hundred occurring now regularly. There is an interesting parallel with the Gulf of Thailand and Peninsular Malaysia, where numbers of Great Knot have increased markedly since about 2010 (Round and Bakewell 2015).

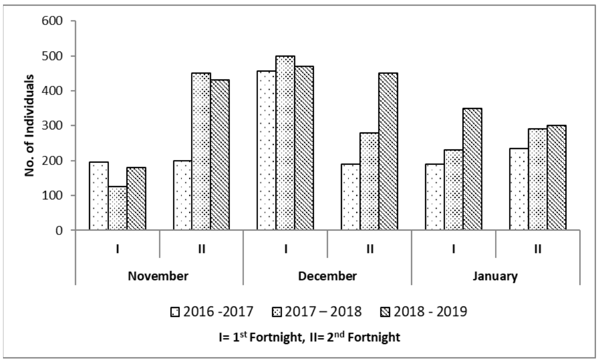


Figure 2. Fluctuations in Great Knot numbers in Kakinada Bay from 2016 to 2019. No bird was observed from 2012 - 2016.

On 6^{th} December 2016 two Great Knot with colour flags were sighted in Kakinada Bay: one with a yellow over white flag combination (indicating it had been banded in eastern Russia) and one with a single whiteflag (from China). One and two individuals with flags were recorded from the same area during the 2017-2018 and 2018-2019 migratory seasons respectively (Table 1, Fig. 3).

Table 1. Resighting records of colour flagged Great Knots in Coringa Wildlife Sanctuary

Sl No.	Resighting Date	Flag Combination	Flagging Place
1.	6^{th} December, 2016	Y/W (R)	Sakhalin Island, Russia 49°19´N 143°40´E
2.	6^{th} December, 2016	W/B (R)	Chongming Island, China 31°28´N 121°57´E
3.	22^{nd} December, 2017	W/B (R)	Chongming Dao, China 31°27´N 121°55´E
4.	27^{th} November, 2018	G/B (R)	Tiaozini, Dongtai County, Jiangsu China. 32°45´N 120°57´E
5.	27^{th} November, 2018	W/B (R)	Guandong, China 22°52´N 113°46´E

#Y= Yellow; W= White; G= Green; B= Black, R= Right Leg

According to Wetlands Internationals (2018), Great Knot have a small western population that migrates to Southwest Asia including India while the majority migrate to Southeast Asia and Australia. The resighting records of the colour flagged birds during the study suggest that the population on the east coast of India consists of birds that follow the East Asian-Australasian Flyway when migrating. Other sighting records of flagged birds both in the east (Point Calimere, Sundarban) and west (Coastal Maharashtra) coasts of India also support this interpretation (Balachandran *et al* 2018; Babre & Kasambe 2016). Research involving satellite tagging would be useful to understand the migratory routes of Great Knots from India to their breeding areas.

ACKNOWLEDGEMENTS

We thank GoI-UNDP-GEF-GoAP EGREE Project for funding this study. We are thankful to Ms. Lianchawii Chhakchhuak, Programme Analyst, UNDP and Shri. Tarun Kathula, Project Officer, GoI-UNDP-GEF-GoAP EGREE Project for their constant encouragement. We also thank the Forest Department Staff and local people and Ms. P. Prashanthi for their assistance during the work.

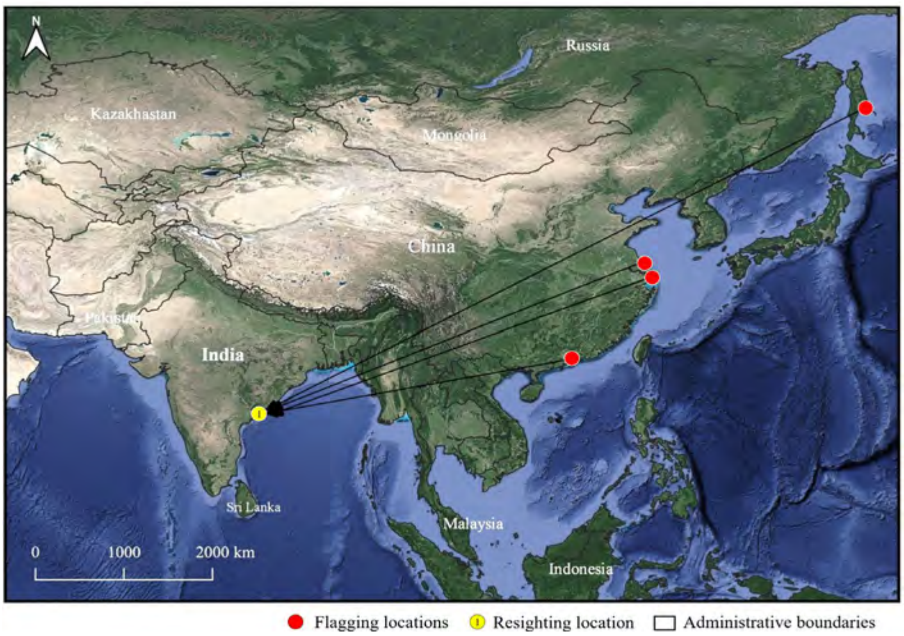


Figure 3. Map showing location of Coringa Wildlife Sanctuary (yellow dot labelled 1) and flagging sites of Great Knot (red dots with no label).

REFERENCES

Aarif, K.M., P.K. Prasadan, S.V. Abdul Hameed & R. Ravindran 2017. Avian Fauna of Kadalundi-Vallikkunnnu Community Reserve, West Coast of India. *Stilt* 71 (2017):25-32.

Ali, S. & S.D. Ripley 1983 Compact Handbook of the Birds of India and Pakistan. Oxford University Press, Delhi.

Babre, A.A. & R.M. Kasambe 2016 Resighting record of a Chinese flagged Great Knot (*Calidris tenuirostris*) along Western Coast of Maharashtra. *Newsletter for Birdwatchers* 56(5):51-53.

Balachandran, S. 1997. Population, status, moult, and measurements of Great Knot *Calidris tenuirostris* wintering in South India. *Stilt* 30:3-6.

Balachandran, S., Gangaiamaran, P. & Tarunsingh 2014. Studies on the waterbird population monitoring and avian disease surveillance at Chilika Lake with special emphasis for habitat Management. Govt of Odisha, Bhubaneswar, Bombay Natural History Society, Mumbai.

Balachandran. S., T. Katti & R. Manakadan 2018: Indian Bird Migration Atlas. Bombay Natural History Society, Mumbai and Oxford University Press, New Delhi. pp.xvi+216.

BirdLife International 2018. Species factsheet: *Calidris tenuirostris*. Downloaded from http://www.birdlife.org on 26/11/2018.

Ganpule, P., M. Varu, K.V. Zala & A. Trivedi 2011. Status and distribution of Great Knot Calidris tenuirostris in the Gulf of Kachchh, Gujarat, India. *Wader Study Group Bulletin* 118(3):192-193.

Kasambe, R., P. Damle & S. Surve 2014. Sight records of Great Knot in coastal Maharashtra. *Mistnet* 15(1) *IUCN Red List* 2019: e.T22693359A155482913. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22693359A155482913.en

Mohapatra, K.K. & P. Rao 1993. Some wader records from coastal Andhra Pradesh. *Journal of the Bombay Natural History Society* 89:250-251.

Robson, C. 1997. India. *Oriental Bird Club Bulletin* 26:60-61.

Round, P. & D. Bakewell 2015. Steep upward trajectory in Great Knot numbers at sites in South-East Asia. *Tattler* 35: 2-4.

Sashikumar, C., J. Praveen, M.J. Palot & P.O. Nameer 2011 Birds of Kerala: Status and Distribution. DC Publishers, Kottayam. Pp. 835.

Sathiyaselvam, P. & M. Rao 2014 Waterbirds of EGREE. EGREE Foundation, An initiative of Gol-UNDP-GEF-GoAP (EGREE) Project, Kakinada.

Sathiyaselvam, P. & S.S. Sreedhar 2014. Status of waterbirds in East Godavari River Estuarine Ecosystem (EGREE), Andhra Pradesh. envs bulletin. Wildlife and Protected Areas.

Tomkovich, P. S. 1997. Breeding distribution, migrations and conservation status of the Great Knot *Calidris tenuirostris* in Russia. *Emu* 97(4):265-282.

Wetlands International 2018. Waterbird Population Estimates. Accessed on 26 November 2018.

Zöckler, C., S. Balachandran., G.C. Bunting, M. Fanck, M. Kashiwagi, E.G. Lappo, G. Maheswaran, A. Sharma, E.E. Syroechkovski & K. Webb 2005. The Indian Sunderbans: an important wintering site for Siberian waders. *Wader Study Group Bulletin* 108:42-46.

UPDATING RECENT CHECKLIST OF SHOREBIRDS IN BANYUASIN DELTA (SEMBILANG), SOUTH SUMATRA, INDONESIA

MUHAMMAD IQBAL[1*], DENI MULYANA[2], HENNI MARTINI[3], ARUM SETIAWAN[4], INDRA YUSTIAN[4] AND HILDA ZULKIFLI[4]

[1]*Biology Program, Faculty of Science, Sriwijaya University, Jalan Padang Selasa 524, Palembang, South Sumatra 30139, INDONESIA.*
Email: kpbsos26@yahoo.com
[2]*Berbak Sembilang National Park, South Sumatra office, Jalan Tanjung Api-api komplek Imadinatuna No. 114, South Sumatra, INDONESIA*
[3]*Hutan Kita Institute (HAKI), Jalan Yudo No.9 H, Palembang, South Sumatra 30126, INDONESIA*
[4]*Department of Biology, Faculty of Science, Sriwijaya University, Jalan Raya Palembang-Prabumulih km 32, Indralaya, South Sumatra, INDONESIA.*

This paper updating recent checklist of shorebird species in Banyuasin delta (Sembilang), Sumatra, Indonesia. The shorebirds in Banyuasin delta has been surveyed from 1984 to 2008, recording 25 species. Surveys over the last decade (2009 to 2019) added three species of shorebirds in Banyuasin Delta, including: Pied Avocet *Recuvirostra avocetta*, Black-winged Stilt *Himantopus leucocephalus* and Spotted Redshank *Tringa erythropus*. Black-winged Stilt both feed and breed in the aquaculture habitat in Banyuasin Delta.

INTRODUCTION

Asia's eastern coastline serves as a migration flyway for the many species that nest in north-eastern Russia and Alaska, but spend the non-breeding season in Asia, or head south to Australasia (MacKinnon et al. 2012). Indonesia has sites of international importance for each of the 20 priority populations, across 17 countries in the East Asian-Australasian Flyway (Conklin et al. 2014). The most important sites are in Sumatra, including Banyuasin Delta or Sembilang (Bamford et al. 2008, Birdlife International 2019) which supports the highest shorebird diversity.

Indonesia recognised Banyuasin (200,000 ha) as a new network site in 2012 (EAAFP 2012). It contains important mangrove and intertidal ecosystems. Surveys from 1980s were replicated recently and confirmed the ongoing importance. The site supported up to 100,000 migratory waterbirds, with at least three populations at 1% level (Silvius 1988, Verheugt et al. 1990, EAAFP 2012). Banyuasin Delta is an important site in the East Asian–Australasian Flyway in Indonesia. It is a national park and a Ramsar Site (EAAFP 2012, Birdlife 2019) currently under management authority of Berbak Sembilang National Park. This paper reviews and updates the shorebird checklist in Banyuasin delta.

METHODS

We compare previous and recent reports of shorebird in Banyuasin delta, South Sumatra, Indonesia. Banyuasin delta administratively located in Banyuasin district, South Sumatra province, Indonesia (02°14'S, 104°50'E; Fig. 1). Previous reports were surveys from 1984 to 2008, and recent reports are surveys between 2009 to 2019.

RESULTS

A total of 29 shorebird species was recorded in Banyuasin delta (Table 1). Previous records (during 1984 to 2008) listed 25 shorebird species. The checklist

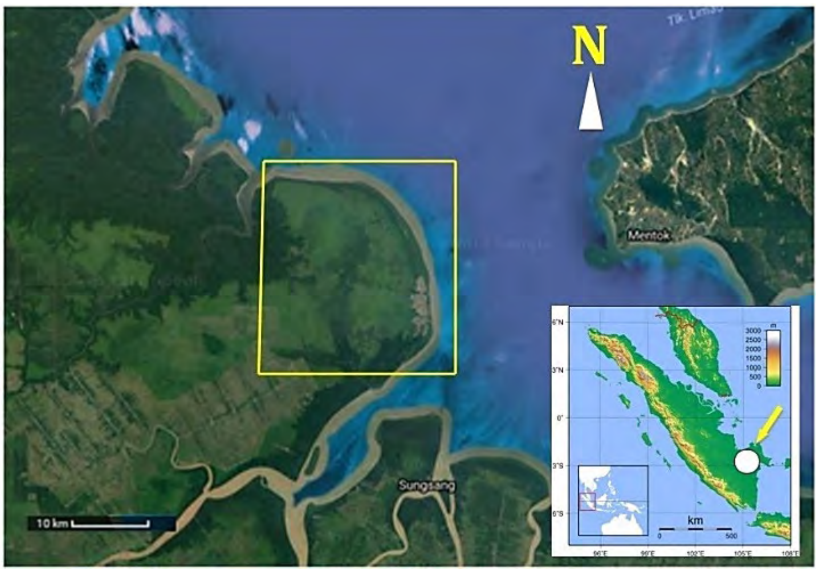


Figure 1. Map showing the Banyuasin Delta, South Sumatra, Indonesia.

Table 1. Recent checklist of shorebirds species in Banyuasin delta, South Sumatra province, Indonesia.

English Name	Scientific Name	Previous Report				Additional Species	
		Silvius 1988	**Verheugt 1990**	**Goenner et al. 2001**	**Iqbal et al. 2009**	**Imansyah & Iqbal 2015**	**Iqbal et al. 2019**
Pied Avocet	*Recurvirostra avosetta*					+	
Black-winged Stilt	*Himantopus himantopus*						+
Grey Plover	*Pluvialis squatarola*	+	+				
Pacific Golden Plover	*Pluvialis fulva*	+	+				
Kentish Plover	*Charadrius alexandrinus*		+				
Lesser Sandplover	*Charadrius mongolus*	+	+	+			
Greater Sandplover	*Charadrius leschenaultii*	+	+				
White-faced Plover	*Charadrius dealbatus*						
Whimbrel	*Numenius phaeopus*	+	+	+			
Eurasian Curlew	*Numenius arquata*	+	+	+			
Far Eastern Curlew	*Numenius madagascariensis*	+	+				
Bar-tailed Godwit	*Limosa lapponica*	+	+	+			
Black-tailed Godwit	*Limosa limosa*	+	+	+			
Asian Dowitcher	*Limnodromus semipalmatus*	+	+	+			
Common Sandpiper	*Actitis hypoleucos*	+	+	+			
Green Sandpiper	*Tringa ochropus*		+				
Spotted Redshank	*Tringa erythropus*				+		
Common Greenshank	*Tringa nebularia*	+	+	+			
Common Redshank	*Tringa totanus*	+	+	+			
Marsh Sandpiper	*Tringa stagnatilis*	+	+				
Spotted Greenshank	*Tringa guttifer*		+				
Terek Sandpiper	*Xenus cinereus*	+	+	+			
Ruddy Turnstone	*Arenaria interpres*	+	+				
Great Knot	*Calidris tenuirostris*	+	+				
Red Knot	*Calidris canutus*	+	+				
Broad-billed Sandpiper	*Calidris falcinellus*		+				
Sanderling	*Calidris alba*		+				
Red-necked Stint	*Calidris ruficollis*	+	+				
Curlew Sandpiper	*Calidris ferruginea*	+	+				

present in Table1 follow del Hoyo & Collar (2014) for taxonomy, English and scientific name. Four shorebird species have been added during a last decade: Pied Avocet *Recuvirostra avocetta*, Black-winged Stilt *Himantopus leucocephalus,* White-face Plover *Charadrius dealbatus* and Spotted Redshank *Tringa erythropus*.

DISCUSSION

As the largest area of mangrove and intertidal ecosystem in Southern Sumatra, Banyuasin delta support up to 100,000 waterbirds (Verheugt et al. 1990, EAAFP 2012; Fig. 2).

The Pied Avocet is a vagrant species in Indonesia. Record of Pied Avocet in Banyuasin delta on 14 June 2014 is not only a new record for this area, but also a first record for Indonesia (Imansyah & Iqbal 2015).

Figure 2. Shorebirds migration on 1 November 2008 in Banyuasin Delta, South Sumatra, Indonesia (by ©Muhammad Iqbal).

The first confirmed record of Black-winged Stilt in Banyuasin delta was of two birds in May 2010, followed by two in December 2012; after which numbers increased from 50 in 2012 to 500 in 2018 (Iqbal et al. 2019). There are no historical records of Black-winged Stilts in Sumatra before it was suggested they might occur in 1977. Recently it has been suggested that the Black-winged Stilt is expanding its range within Sumatra (Iqbal et al. 2013). The colonisation of the Banyuasin delta by Black-winged Stilts can be attributed to the conversion of large areas of mangrove forest into fishponds. These fishponds have proved attractive to Black-winged Stilts as both feeding and breeding sites (Iqbal et al. 2019).

The Spotted Redshank in Banyuasin delta on 31 October 2008 was the third record of this species in Sumatra after a break of 19 years (from 1989 to 2008) (Iqbal et al. 2009). It has been recorded in South Sumatran freshwater wetlands, but never been recorded in Banyuasin delta (Verheugt et al. 1993). Spotted Redshank is scarce visitor to Sumatra, Indonesia. However, this species is very similar to Common Redshank, thus possibly overlooked in the field by researchers.

New records of shorebird species in Banyuasin delta during last decade can be attributed to a rapidly increasing number of local Indonesian researchers and local birdwatchers in South Sumatra, as well as easier access to binoculars and cameras (Iqbal et al. 2009, Iqbal et al. 2010, Imansyah & Iqbal 2015).

REFERENCES

Bamford, M., D. Watkins, W. Bancroft, G. Tischler & J. Wahl 2008. Migratory shorebirds of the East Asian-Australasian flyway: Population estimates and internationally important sites. Wetlands International-Oceania, Canberra.

BirdLife International 2019. Important Bird Areas factsheet: Sembilang. Downloaded from http://www.birdlife.org on 19/04/2019.

Conklin, J.R., Y.I. Verkuil & B.R. Smith 2014. Prioritizing Migratory Shorebirds for Conservation Action on the East Asian-Australasian Flyway. WWF-Hong Kong, Hong Kong.

Crossland, A.C., S.A. Sinambela, A.S. Sitorus & A.W. Sitorus 2006. An overview of the status and abundance of migratory waders in Sumatra, Indonesia. *Stilt* 50: 90–95.

EAAFP 2012. Sixth Meeting of Partners, Palembang, Indonesia, 19-22 March 2012. East Asian–Australasian Flyway Partnership, Palembang.

Goenner, C. & F. Hasudungan 2001. Sembilang monitoring report No. 1. July/August 2001. Technical Report Project Document No. 18. The Greater Berbak Sembilang Project, Palembang, Indonesia.

del Hoyo, J. & N.J. Collar 2014. HBW and BirdLife International illustrated checklist of the birds of the World. Volume 1: Non-passerines. Lynx Edicions, Barcelona.

Hayman, P., J. Marchant & T. Prater 1986. Shorebirds - an identification guide to the waders of the world. Houghton Mifflin Company, Boston.

Iqbal, M., H. Mulyono, A. Zakaria, F. Takari & Rasam 2009. Record of Spotted Redshank Tringa erythropus in Sumatra (Indonesia) after 19 years. *Stilt* 56:19–22.

Iqbal, M., H. Abdillah, A. Nurza, T. Wahyudi, Giyanto & M. Iqbal 2013. A review of new and noteworthy shorebird records in Sumatra, Indonesia, during 2001–2011. *Wader Study Group Bulletin* 120:85–95.

Iqbal, M., H. Martini, D. Mulyana, G. Franjhasdika, R.S.K. Aji & E. Nurnawati 2019. From zero to abundance: successful colonization of the Banyuasin Peninsular, South Sumatra, Indonesia, by Pied Stilts *Himantopus* (*himantopus*) *leucocephalus. Wader Study* 126 (In prep).

Imansyah, T. & M. Iqbal. 2015. Pied Avocet *Recurvirostra avosetta* in Sumatra: a new species for Indonesia. *Wader Study* 122(2):161-162.

MacKinnon, J., Y.I. Verkuil & N. Murray 2012. IUCN situation analysis on East and Southeast Asian intertidal habitats, with particular reference to the Yellow Sea (including the Bohai Sea). Occasional Paper of the IUCN Species Survival Commission No. 47. IUCN, Gland.

Putra, A.C., D. Perwitasari-Farajallah & Y.A. Mulyani 2017. Habitat use of migratory shorebirds on the coastline of Deli Serdang Regency, North Sumatra Province. *Hayati Journal of Biosciences* 24:16-21

Silvius, M. 1988. On the importance of Sumatra's East coast for waterbirds, with notes on the Asian Dowitcher *Limnodromus semipalmatus*. *Kukila* 3:117-137.

Verheugt, W.J.M., F. Danielsen, H. Skov, A. Purwoko, R. Kadarisman & U. Suwarman 1990. Seasonal variations in the wader populations of the Banyuasin Delta, South Sumatra, Indonesia. *Wader Study Group Bulletin* 58:28-53.

Verheugt, W.J.M., H. Skov & F. Danielsen 1993. Notes on the birds of the Tidal Lowlands and Floodplains of South Sumatra Province Indonesia. *Kukila* 6:53-84.

AN UNUSUAL EURASIAN CURLEW *NUMENIUS ARQUATA ORIENTALIS* IN BANYUASIN PENINSULA, SOUTH SUMATRA, INDONESIA

MUHAMMAD IQBAL[1*], DENI MULYANA[2], HENNI MARTINI[3], ARUM SETIAWAN[4], INDRA YUSTIAN[4] & HILDA ZULKIFLI[4]

[1]*Biology Program, Faculty of Science, Sriwijaya University, Jalan Padang Selasa 524, Palembang, South Sumatra 30139, Indonesia.*Email: kpbsos26@yahoo.com*
[2]*Berbak Sembilang National Park, South Sumatra office, Jalan Tanjung Api-api komplek Imadinatuna No. 114, South Sumatra, Indonesia*
[3]*Hutan Kita Institute (HAKI), Jalan Yudo No.9 H, Palembang, South Sumatra 30126, Indonesia*
[4]*Department of Biology, Faculty of Science, Sriwijaya University, Jalan Raya Palembang-Prabumulih km 32, Indralaya, South Sumatra, Indonesia.*

An unusual looking small Curlew *Numenius* was observed and photographed on 22 November 2018 in a flock of Eurasian Curlew *Numenius arquata* at Barong river, Banyuasin Peninsular, Banyuasin district, South Sumatra province, Indonesia. This small curlew appeared to be very similar to the Whimbrel *Numenius phaeopus* (*N. p. phaeopus*, *N. p. variegatus* and *N. p. alboaxillaris*) and the Slender-bill Curlew *Numenius tenuirostris.* However, further careful identification indicates this small *Numenius* is a Eurasian Curlew. This case at first appears to be an aberrant curlew, but on careful examination of the photo, it is actually an interesting example of how photos can give the wrong impression. We provide a word of caution to local birdwatchers to pay careful attention to the use of photographs for species identification in Indonesia, as well as more broadly in south-east Asia.

INTRODUCTION

Eurasian Curlew *Numenius arquata* is a common large curlew of Eurasia, Africa and the Oriental region, farther east in Siberia, and in Australia (Hayman *et al.* 1986). It is a large to very large, bulky wader with a remarkably long and decurved bill, long legs and rather uniform plumage (Cramp & Simmons 1983). In South-east Asia, Eurasian Curlew is an uncommon to fairly common coastal winter visitor and passage migrant (Robson 2011). The bird is a locally common migrant in western parts of the Indonesian archipelagos (Greater Sunda) and is less common in eastern regions (Sulawesi) (MacKinnon & Phillipps 1993, Eaton *et al*. 2016).

In this paper, we provide a brief report on what appeared to be an unusual small *Numenius* curlew, sighted in and Banyuasin district, South Sumatra province (Indonesia). We discuss this sighting and review the literature about *Numenius* species in Indonesia.

METHODS

On 22 November 2018, an unusually small *Numenius* curlew was observed and photographed at Barong river, Banyuasin Peninsular, Banyuasin district, South Sumatra province, Indonesia (02°10' 46" S, 104°54' 21" E). The bird was in flight in a flock of Eurasian Curlew. Further identification has been critically reviewed based on the photograph taken (Figs. 1, 2 and 3).

RESULTS AND DISCUSSION

Compared to Eurasian Curlew, this bird looked significantly smaller, and somewhat similar to Whimbrel *Numenius phaeopus* in terms of size and its apparently smaller decurved bill. The was eliminated as one of potentially two subspecies of Whimbrel (*N. p. phaeopus* and *N. p. variegatus*) that occur in South-east Asia based on the more uniform head pattern and absent barring patterns in underwing. The other potential smaller *Numenius* subspecies without barring patterns on the underwing are the Slender-bill Curlew *Numenius tenuirostris* and the Steppe Whimbrel *Numenius phaeopus alboaxillaris*, but neither species has ever been recorded in the East Asian-Australasian Flyway. The smaller *Numenius* found in Banyuasin Peninsular was therefore not considered one of these species. The Slender-bill Curlew is a critically endangered (or possibly extinct) shorebird that breeds in Siberia (Taiga zone) and spends the non-breeding season in the Mediteranean basin (mainly Tunisia and Atlantic Morocco). A second migration route may lead from breeding grounds to the Middle East, where it may spend the non-breeding season in Iraq, Iran, Saudi Arabia and Oman (Hayman et al. 1986, Gils & Wiersma 1996, Birdlife International 2020). The bird sighted in our study shares characteristics with the Slender-bill Curlew by its smaller size and smaller bill shape, but differs chiefly in the face pattern and breast pattern. That is, the supercilium of Slender-billed Curlew is bolder than on Eurasian Curlew, tending to isolate the dark cap, and there is a fairly narrow dark bar crossing the lores in place of Eurasian Curlew's diffuse rounded dark area. The breast pattern of Slender-billed Curlew also differs by having a sharply defined dark brown breast streaking against an almost white background, sometimes lightly suffused with brown, contra brownish or buffish brown suffusion across the breast and having poorly defined streaking for Eurasian Curlew (Hayman *et al.* 1986, Gils & Wiersma 1996, Robson 2011, Corso *et al.* 2014, Chandler 2019).

The Steppe Whimbrel is a little known shorebird distributed in the mid-latitude (50–54°N) steppes of Russia and probably Kazakhstan (Cramp & Simmons

Figure 1. The unusual *Numenius* (yellow arrow) found on 22 November 2018 in Banyuasin peninsular, South Sumatra province, Indonesia (by ©Muhammad Iqbal).

Figure 2. The unusual *Numenius* has smaller decurved bill and plain white underwing without barred pattern (by ©Muhammad Iqbal).

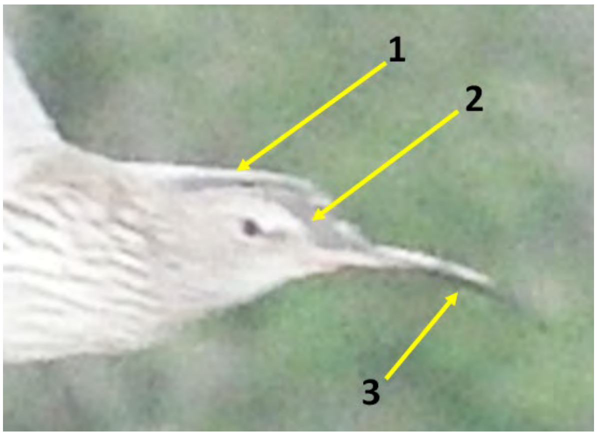


Figure 3. Close up head pattern and some remarks: 1. Left wing; 2. Underwing (in shade). This area is not a dusky crown; 3. Bill slope. A little foreshortened because it is slightly turned to the photographer, but also note that the dusky bill tip is pixellated and the camera sensors barely distinguish it from the background (by ©Muhammad Iqbal).

1983), and migrates to coastal south-east Africa for the non-breeding season (Allport 2017). The smaller *Numenius* sighted in Banyuasin peninsular was similar to Steppe Whimbrel by its smaller size and white underwing and axillaries, but as with other subspecies of whimbrel, the Steppe Whimbrel has strongly marked crown stripe and face pattern; contra lacking contrasting head pattern. These features were not evident on our curlew.

Corso *et al.* (2014) considered some small curlews that resemble Slender-billed Curlew based on field observations in Italy (from Scily and Puglia), and specimens in the Museo Civica di Zoologica di Roma (MCZR), and identified that the birds are Eurasian Curlew *N. a. orientalis*. Based on the literature, the small *Numenius* curlew sighted in Banyuasin peninsula is identified as Eurasian Curlew *N. a. orientalis* based on unbarred white underwing, the small decurved bill and slightly uniform head pattern (Hayman *et al.* 1986, Gils & Wiersma 1996, Robson 2011, Corso *et al.* 2014, Chandler 2019). This small shorebird is presumed a male (Garry Alport *pers.comm.*) as males have shorter bills than females (Hayman *et al.* 1986).

This record of an apparently unusual or atypical Eurasian Curlew in Banyuasin Peninsular, based on a single photograph, is important to note for future identification of *Numenius* in south-east Asia. Close inspection of the photo shows the bill to be a bit foreshortened and the rear-wing is just behind the head (Fig. 3). This makes the head look bigger and the bill look correspondingly smaller. The similarity in colour of bill tip to the background adds to the illusion that this is an atypical sized Eurasian Curlew. Thus, we conclude that this case is not so much an aberrant curlew, but an interesting example of how photos can give the wrong impression when used as the sole means of identifying a bird. This is something that should be addressed by local birdwatchers. We caution them to pay careful attention to shorebirds species identification from photographs, particularly in relation to population estimation and species assessment. In Indonesia, there has been an increase in recent years of birdwatchers with good photographic equipment, and the likelihood of photographic-based identifications is expected to increase. Incorrect identifications may result in false additions to country checklists (Iqbal *et al.* 2010, Imansyah & Iqbal 2015, Iqbal & Albayquni 2016, Putra *et al.* 2018), but this problem is never reported or rarely discussed. This interesting example is a good lesson for birdwatchers to use photos with caution and always getting these photographs verified by experts.

ACKNOWLEDGEMENTS

We are very grateful to the Hutan Kita Institute (HAKI) particularly for facilitating us conducting waterbird monitoring on the Banyuasin Peninsular during 2017-2018. We thank Gary Alport, Jesse Conklin, Luke J. Eberhart-Phillips, Humphrey Sitters and an anonymous reviewer for comments on an earlier draft. We also thank Danny Rogers and Birgita Hansen for their invaluable suggestions to improve this paper.

REFERENCES

Allport, G.A. 2017. Steppe Whimbrels *Numenius phaeopus alboaxillaris* at Maputo, Mozambique, in February–March 2016, with a review of the status of

the taxon. *The Bulletin of the African Bird Club* 24:27-37 ·
BirdLife International. 2020. Species factsheet: *Numenius tenuirostris*. (retrieved from http://www.birdlife.org on 26 May 2020).
Corso, A., J.J.F.J., Jansen & S. Kokay. 2014. A review of the identification criteria and variability of the Slender-billed Curlew. *British Birds* 107:339–370.
Chandler, R. 2009. *Shorebirds of the Northern Hemisphere*. Christopher Helm, London.
Cramp, S. & K.E.L. Simmons 1983. *Handbook of the Birds of Europe, the Middle East and North Africa. The Birds of the Western Palearctic. Vol III. Waders to Gulls*. Oxford University Press, Oxford.
Eaton, J.A., B. van Balen, N.W. Brickle & F.E. Rheindt. 2016. Birds of the Indonesian Archipelago: Greater Sundas and Wallacea. Lynx Edicions, Barcelona.
Gils, J. Van. & P. Wiersma. 1996. Scolopacidae (Snipes, Sandpipers and Phalaropes). Pp. 489–533. *In:* del Hoyo, J., A. Elliot & J. Sargatal (Eds.) Handbook of the birds of the world. Vol. 3. Hoatzin to Auk. Lynx Editions, Barcelona.
Hayman, P., J. Marchant & T. Prater. 1986. Shorebirds, An Identification Guide to the Waders of the World. Houghton Mifflin Company, New York.
Imansyah, T. & M. Iqbal. 2015. Pied Avocet *Recurvirostra avosetta* in Sumatra: a new species for Indonesia. *Wader Study* 122:161-162.
Iqbal, M. & A.A. Albayquni. 2016. First record of a Slaty-backed Gull *Larus schistisagus* for Indonesia. *Marine Ornithology* 44:135–136.
Iqbal, M., H. Abdillah & A. Nurza. 2010. Black-winged Stilt *Himantopus himantopus himantopus*, a new shorebird for Indonesia. *Wader Study Group Bulletin* 117:63–65.
Mackinnon, J. & K. Phillipps. 1993. A Field Guide to the Birds of Borneo, Sumatra, Java and Bali. Oxford University Press, Oxford.
Putra, C.A., D. Hikmatullah & M. Iqbal. 2018. Eurasian Oystercatcher *Haematopus ostralegus*: a new species for Indonesia. *Wader Study* 125:48-50.
Robson, C. 2011. A Field Guide to the Birds of South-East Asia. New Holland Publishers, UK.

COASTAL SHOREBIRD SURVEYS IN THE PROVINCES OF SOUTH HWANGHAE AND NORTH PYONGAN, DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA, MAY 2019

ADRIAN RIEGEN[1], DAVID S. MELVILLE[2], KEITH WOODLEY[3], WILLIAM PERRY[3], KWAK IL CHON[4], RI SONG IL[4], HONG HYO SONG[4], JU SONG I[4] and KIM JI HYANG[4]

[1]231 Forest Hill Rd, Waiatarua, Auckland 0612, NEW ZEALAND.
Email: riegen@xtra.co.nz
[2] 1261 Dovedale Road, RD2 Wakefield, Nelson 7096, NEW ZEALAND
[3]Pūkorokoro Miranda Naturalists' Trust, RD 3 Pokeno, NEW ZEALAND
[4]Nature Conservation Union of Korea, Kwangbok No.1 Dong, P.O Box 220-93-7-24, Mangyongdae District, Pyongyang, DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA.

INTRODUCTION

The Yellow Sea (West Sea as it is known in the Democratic People's Republic of Korea (DPRK)) and Bohai Bay are vital staging areas for shorebirds in the East Asian-Australasian Flyway (EAAF) during migration 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 the Republic of Korea have been well documented, particularly on northward migration (Barter 2002, Moores 2006, Conklin *et al.* 2014, Riegen *et al.* 2014, Bai *et al.* 2015) but less was known about shorebirds on the West Sea coast of the DPRK. The first coordinated counts of shorebirds using tidal areas of the West Sea were undertaken in 2009 (Riegen *et al.* 2009).

In 2015 the Nature Conservation Union of Korea (NCUK) and Pūkorokoro Miranda Naturalists' Trust (PMNT) of New Zealand, initiated a programme to survey shorebirds along the West Sea coast of DPRK. Prior to 2019, four surveys had been conducted along the coast from Nampo, due west of Pyongyang, north to Sindo Island in the Amnok/Yalu River estuary on the border with China (Riegen *et al.* 2016a, 2016b, 2018a, 2018b). The coastline south of Nampo remained to be surveyed. The coastline for the first 80 km or so south of Nampo is largely rocky with little suitable shorebird habitat, but in South Hwanghae Province there are large inlets with very extensive tidal flats, and it was five of these that we hoped to survey in 2019. However, due to various factors we were only granted permission to visit two sites: Chonghwa-ri approximately 35 km southeast of our base in Haeju; and Kurang-ri approximately 45 km northwest of Haeju. Staff from NCUK visited the South Hwanghae sites in March 2019 to ascertain the suitability of these sites for shorebirds and make the necessary administrative arrangements. We had allowed enough time in the planning stages to spend one day at each of the five southern sites but adjusted this plan to cover each of the sites we visited on two successive days. After which, we travelled 300 km north to North Pyongan Province to revisit two areas we had surveyed in April 2017. We surveyed Ansan-ri and Sokhwa-ri on 12 May but due to heavy rain making access tracks impassable; we had to abandon efforts to survey Komiyang-ri and Chongtae-ri on 13 May.

METHODS

Survey Sites

The 2019 South Hwanghae survey was undertaken along the southern coast of the province at two points. We were unable to explore further afield and find any high tide roosts at either site and so had to count shorebirds on the incoming and outgoing tides and in adjacent rice paddies.

Chonghwa-ri *(37.81 °N 126.04 °E)*

Seawalls at Chonghwa-ri have created two large reservoirs to supply fresh water to the rice paddies. One of these, the September 18th visited Reservoir Migratory Bird Reserve, is known particularly for ducks, swans, geese, shorebirds and Black-faced Spoonbill* (Ri *et al.* 2018). Inland there are extensive rice paddies, which were mostly dry or with small amounts of water but not planted during our visit. On 8 May, one team walked 2 km through the paddies on a raised bank, counting shorebirds and other waterbirds, where Wood Sandpipers and Long-toed Stints dominated the count. There was also a small reed-fringed lake, which had attracted a variety of waterfowl. The seawall gave us a vantage point for observing the very extensive flats (Fig. 1). The sea reached the seawall at least two hours before high tide and it was unclear where the shorebirds had gone to roost but we suspect a large area of salt extraction ponds some 8 km to the south may be used – a few small flocks were seen flying in that direction on the incoming tide. Local fishermen where seen walking across firm, ankle-deep sediment to fishing nets and traps set in channels scattered across the tidal flats for more than 3 km from the seawall. On the falling tide, shorebirds returned to feed, scattered along the entire coastline that we could see; we saw no major concentrations of birds. * *Scientific names for all species mentioned are found in Tables 1 and 2 and Appendix 1.*

Kurang-ri *(38.05°N 125.21°E)*

Kurang-ri is located at the eastern end of Taedong Bay, which is some 15 km long and 3 km wide with extensive tidal flats at the eastern end and surrounded by hilly farmland (Fig. 1). No people were seen on the tidal flats, so it was not possible to gauge the consistency of the substrate. A causeway approximately 2.5 km long had been recently constructed across a small inlet on the southern side, creating an aquaculture pond approximately 3 km^2. A mudbank in the pond was being used as a roost by shorebirds, but as the pond was being filled with water on the spring high tide, this site became inundated and the birds departed. After high tide, birds were seen returning to the tidal flats from a roost behind a seawall to the east, which we could not get to. Dunlin, Whimbrel and Far Eastern Curlew were the most numerous species, and these were counted on the incoming tide and again on the outgoing tide.

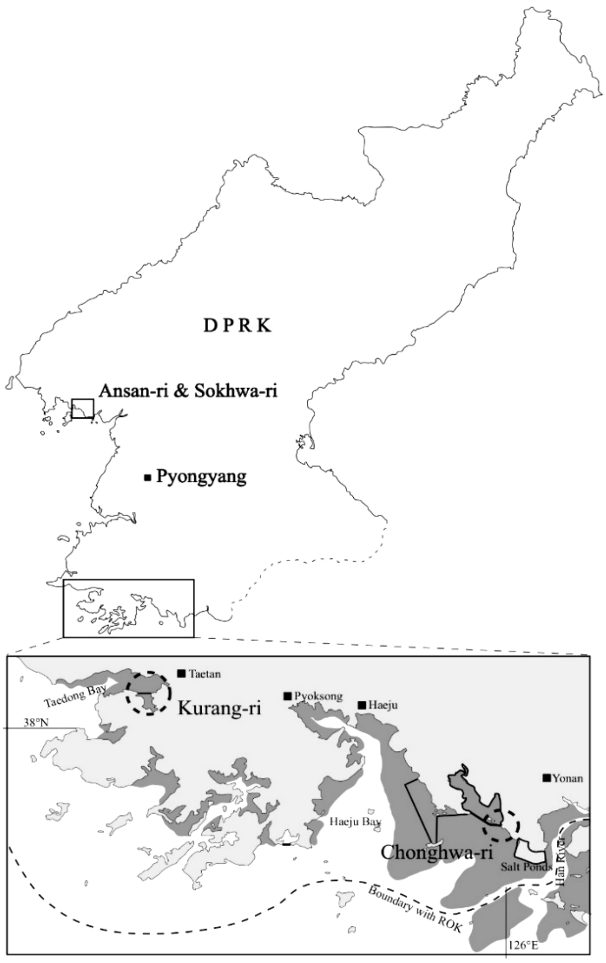


Figure 1. Above: Map of Democratic People's Republic of Korea and South Hwanghae coast. Inset: Sites in South Hwanghae Province. Dashed circles show approximate areas counted.

Sites in North Pyongan Province

Ansan-ri *(39° 42.4' N - 124° 49.0' E) and* ***Sokhwa-ri*** *(39° 39.9' N - 124° 53.5'E)*

A seawall completed in September / October 2015, running roughly northwest southeast and about 15 km long has enclosed an area of over 35 km^2 of mudflats. In 2017 this area was largely undeveloped, open mudflat, but some construction of internal walls had commenced. At the time of our 2019 visit, construction of ponds in the northern area was completed and it appeared that they were being used for jellyfish culture and much of the remaining dried mud was covered in vegetation (most of which appeared to be *Suaeda* sp.). However, there were still good numbers of shorebirds roosting along the water's edge. A new seawall is under construction offshore between islands, which when finished will claim another approx. 50 km^2.

Survey Methods

The survey at Chonghwa-ri and Kurang-ri were undertaken during high spring tides from 7-10 May 2019. We used predicted tides for Incheon, which is between 50 and 130 km to the southeast, as no other tide tables were available to us. The predicted high tide range at Incheon was 5.9-9.1 m during May 2019 and our surveys were conducted on predicted tides of 8.5-9.1 m. The high tide peaked around one hour earlier than predicted on the first day, so we adjusted our arrival times to suit. Spring tides were chosen as we hoped that no mud would remain exposed outside the seawalls and all birds would have to move inland or to highest points on the mudflats to roost, thus facilitating counting. At Ansan-ri and Sokhwa-ri in North Pyongan we used tide tables for Unmu Do, an island 40 km to the southeast, with predicted high tides ranging between 5.0-7.5 m during May 2019; predicted high tide was 6.3 m on 12 May during this survey.

RESULTS

The full results for Chonghwa-ri and Kurang-ri 7-10 May and Ansan-ri and Sokhwa-ri 12 May are shown in Table1.

Chonghwa-ri

A combined total of 3531 shorebirds were counted over the two days (taking the highest count of each species on the two days). Due to the extreme distance from our observation point, 1400 shorebirds were unidentified to species. Dunlin was the most abundant species with 880 counted, followed by 550 curlews. Only 50 were positively identified as Far Eastern Curlew, although based on observations when curlews were seen flying, we believe almost all were Far Eastern Curlew. The only other species with more than 50 individuals counted were Great Knot 200, Wood Sandpiper 155, Whimbrel 73 and Far Eastern Oystercatcher 55. Long-toed Stint is a species we have rarely seen in DPRK and the 33 we saw in the rice paddies were probably only a fraction of the number using that habitat. This represents a significant increase on the total of 13 seen during all other surveys. We only counted Black-tailed Godwit (19), all in rice paddies, and like Long-toed Stint they may favour this habitat.

Kurang-ri

The totals from both days we visited this site have been combined, taking the highest count of each species, giving a total of 1977 shorebirds. Dunlin dominated with 1300, Whimbrel 234, Far Eastern Curlew 162, Grey Plover 131 and Terek Sandpiper 80. These were the only species with counts over 50.

Ansan-ri and Sokhwa-ri

On 12 May 2019 we counted 9045 shorebirds of 17 species; Dunlin 6860, and Far Eastern Curlew 869 were the most numerous species. At these two sites on 28 April 2017 (Riegen *et al.* 2018a), we counted 20,008 shorebirds of 18 species, the two most abundant being Dunlin 13 770 and Far Eastern Curlew 4348. Although it is expected that many birds would have left for the breeding grounds by mid-May, Whimbrel numbers were

Table 1. Shorebird counts for South Hwanghae 7-10 May and North Pyongan 12 May 2019.

Species	Total 7-10 May	Chonghwa-ri 7-8 May Combined Max. count	Kurang-ri 9-10 May Combined Max. count	Ansan-ri and Sokhwa-ri 12 May Combined
Far Eastern Oystercatcher *Haematopus [ostralegus] osculans*	56	55	1	10
Pacific Golden Plover *Pluvialis fulva*	3	3		20
Grey Plover *Pluvialis squatarola*	152	21	131	306
Little Ringed Plover *Charadrius dubius*	4	2	2	
Kentish Plover *Charadrius alexandrinus*	6	1	5	6
Lesser Sand Plover *Charadrius mongolus*	42	36	6	44
Snipe sp. *Gallinago sp.*	10	10		
Black-tailed Godwit *Limosa limosa*	19	17	2	
Bar-tailed Godwit *Limosa lapponica*	66	35	31	7
Whimbrel *Numenius phaeopus*	307	73	234	523
Eurasian Curlew *Numenius arquata*				5
Far Eastern Curlew *Numenius madagascariensis*	212	50	162	869
Curlew sp.	480	480		
Spotted Redshank *Tringa erythropus*	6	6		
Common Redshank *Tringa totanus*	1	1		2
Common Greenshank *Tringa nebularia*	44	23	21	51
Nordmann's Greenshank *Tringa guttifer*				1
Wood Sandpiper *Tringa glareola*	155	155		
Grey-tailed Tattler *Tringa brevipes*	1		1	4
Terek Sandpiper *Xenus cinereus*	124	44	80	332
Common Sandpiper *Actitis hypoleucos*	2	2		
Ruddy Turnstone *Arenaria interpres*				1
Great Knot *Calidris tenuirostris*	200	200		
Red-necked Stint *Calidris ruficolls*	3	2	1	7
Long-toed Stint *Calidris subminuta*	33	33		
Sharp-tailed Sandpiper *Calidris acuminata*	2	2		
Dunlin *Calidris alpina*	2180	880	1300	6860
Unidentified shorebirds	1400	1400		
TOTALS	5,508	3,531	1,977	9,048

up from 326 in 2017 to 523 in 2019. We counted 332 Terek Sandpipers at this site; more than double all our counts since 2015 (153 counted at all sites).

Waterbirds

While counting shorebirds, the opportunity arose to count other waterbirds, but this was not a priority and so the list is not exhaustive (Table 2).

Colour banded and flagged birds

Most of the birds seen during this survey were too distant to see flags or colour bands and none were recorded.

DISCUSSION

Based on the current population estimate of 35,000 Far Eastern Curlew (Wetlands International 2018), the two southern sites we visited in South Hwanghae Province did not meet the Ramsar 1% population criterion for this or any other species, but the EAAF migration staging site criterion of 0.25% was reached at Kurang-ri for Far Eastern Curlew. As we visited these sites after most curlews had migrated, it is likely they would have met the 1% criterion in April. The 1% criterion for Far Eastern Curlew was met at Ansan-ri and Sokhwa-ri again in 2019, where just over 2% of the estimated population were counted.

One of the species that we had hoped to find in significant numbers during surveys in the DPRK was Red Knot. The Luannan coast of the Bohai, China is the main staging area for Red Knots known in the EAAF, but a significant proportion of the population does not appear to use this site, especially birds of the race *C.c. rogersi* (Rogers *et al.* 2010, Lok *et al.* 2019); where these birds occur remains unknown. No Red Knots were seen this year even though our survey was later than in previous years and during the period when migrating Red Knots are expected to be within the northern Yellow (West) Sea. Therefore, our total from six surveys stands at just 42 birds – it seems unlikely that large numbers of Red Knots are to be found on the West coast of the DPRK.

Table 2. Incidental waterbird counts at shorebird count sites 7-12 May 2019.

Species	Total 7-12 May	Chonghwa-ri 7-8 May Combined Maximum counts	Kurang-ri 9-10 May Combined Maximum counts	Ansan-ri and Sokhwa-ri 12 May
Common Shelduck *Tadorna tadorna*	18	4		14
Greater Scaup *Aythya marila*	3	3		
Garganey *Spatula querquedula*	4	4		
Northern Shoveler *Spatula clypeata*	2	2		
Gadwall *Mareca strepera*	90	90		
Falcated Duck *Anas falcata*	40	40		
Eurasian Wigeon *Anas penelope*	100	100		
Eastern Spot-billed Duck *Anas zonorhyncha*	35	20	6	9
Little Grebe *Tachybaptus ruficollis*	7	6	1	
Great Crested Grebe *Podiceps cristatus*	11	11		
Black-faced Spoonbill *Platalea minor*	23	11	12	
Black-crowned Night Heron *Nycticorax nycticorax*	2	2		
Grey Heron *Ardea cinerea*	8	3	5	
Great White Egret *Ardea alba*	31	27	4	
Intermediate Egret *Ardea intermedia*	2	2		
Little Egret *Egretta garzetta*	5	5		
Chinese Egret *Egretta eulophotes*	3	3		
Great Cormorant *Phalacrocorax carbo*	30	30		
Common Coot *Fulica atra*	82	80	2	
Moorhen *Gallinula chloropus*	9	9		
Saunders's Gull *Saundersilarus saundersi*	22	20		2
Black-headed Gull *Chroicocephalus ridibundus*	46	27		19
Black-tailed Gull *Larus crassirostris*	42	40		2
Herring Gull (type) *Larus sp.*	75	60	15	
Mongolian Gull *Larus mongolicus*	6	6		
Little Tern *Sternula albifrons*	4	4		20
TOTALS	741	615	60	66

Two Spoon-billed Sandpipers *Calidris pygmaea,* fitted with satellite transmitters on the Chukotka breeding ground in 2018 were known to have spent at least two months in Yonan County and adjacent areas including Chonghwa-ri on southward migration in 2018 (Green *et al.* 2018). We had hoped it might be possible to investigate whether this was an important staging site similar to Rudong on the Jiangsu coast, China (Chang *et al.* 2019), however, as the tidal flats were so vast at Chonghwa-ri there seemed little chance of finding them unless they roost on the salt ponds, which we did not visit.

We hope to investigate other sites in South Hwanghae Province in the future, particularly the salt ponds at the estuary of the Imjin / Han River, preferably in April and the other three areas that we were not able to visit in 2019. Since 2015 we have covered most of the potential shorebird sites along the entire Yellow / West Sea coast of DPRK, and consequently we now have a much better understanding of migratory shorebirds staging in the country during northward migration.

ACKNOWLEDGEMENTS

The Pūkorokoro Miranda Naturalists' Trust and Nature Conservation Union of Korea wish to thank Fonterra and the New Zealand Department of Conservation, for partially funding the 2019 survey through their joint Living Water project.

REFERENCES

Bai, Q. Q., J.Z. Chen, Z.H. Chen, G.T. Dong, J.T. Dong, W.X. Dong, Y.Q. Fu, Y.X. Han, G. Lu, J. Li, Y. Liu, Z. Lin, D.R. Meng, J. Martinez, G.H. Ni, K. Shan, R.J. Sun, S.X. Tian, F.Q. Wang, Z.W. Xu, R.D. Yu, J. Yang, Z.G. Yang, L. Zhang, M. Zhang, and X.W. Zeng 2015. Identification of coastal wetlands of international importance for waterbirds: a review of China Coastal Waterbird Surveys. 2005–2013. *Avian Research* 6, 12. doi:10.1186/s40657-015-0021-2

Barter, M.A. 2002. *Shorebirds of the Yellow Sea – Importance, threats and conservation status*. Wetlands International Global Series 9, International Wader Studies 12, Canberra, Australia.

Chang, Q., G.Q.A. Anderson, K. Brides, J.A. Clark, N.A. Clark, R. Hearn, K. Leung, D.S. Melville, E. Weston, J. Weston and R.E. Green 2019. A high proportion of the world population of the Spoon-billed Sandpiper occurs at Tiaozini, China during the post-breeding moult. *Wader Study* 126:35-42.

Conklin, J.R., Y.I. Verkuil and B.R. Smith 2014. *Prioritizing migratory shorebirds for conservation action on the East Asian-Australasian Flyway*. WWF-Hong Kong, Hong Kong.

Green, R., N. Clark, G. Anderson, E. Weston and B. Hughes 2018. Satellite tagging of spoon-billed sandpipers reveals importance of intertidal habitats in the Democratic People's Republic of Korea for migration and post-breeding moult. *Spoon-billed Sandpiper Task Force News Bulletin* 19:31-33.

Lok, T., C.J. Hassell, T. Piersma, R. Pradel and O. Gimenez 2019. Accounting for heterogeneity when estimating stopover duration, timing and population size of red knots along the Luannan Coast of Bohai Bay, China. *Ecology and Evolution* 9:6176-6188.

Moores, N. 2006. South Korea's shorebirds: a review of abundance, distribution, treats and conservation status. *Stilt* 50:62-72.

Riegen, A., D. Lawrie, A. Habraken, T.G. Ri, and J.H. Chon 2009. Report of the first shorebird survey at Mundok, North Korea by Miranda Naturalists' Trust and Korean Natural Environment Conservation Fund. 26–29 April 2009. *Stilt* 56:32-36.

Riegen, A.C., G.R. Vaughan and K.G. Rogers 2014. *Yalu Jiang Estuary Shorebird Survey Report 1999 – 2010*. Yalu Jiang Estuary Wetland National Nature Reserve, China and Miranda Naturalists' Trust, New Zealand.

Riegen, A., D.S. Melville, K. Woodley, S.I. Ju, S.H. Kim, S.I Pak and U. Pak 2016a. Shorebird Survey of the Onchon County Coast of the Democratic People' Republic of Korea May 2015. *Stilt* 68:39-44.

Riegen, A., D.S. Melville, K. Woodley, B. Postill, S.I. Ju, H.S. Hong, S.H. Kim, and U. Pak 2016b. Coastal Shorebird Survey in the Provinces of North and South Pyongan, the Democratic People' Republic of Korea April 2016. *Stilt* 69-70:37-43.

Riegen, A., D.S. Melville, W. Hare, N. Milius, C.K. Hong, S.I. Ju, H.S Hong. S.H. Kim and C.S. Ri 2018a. Coastal Shorebird Survey in the Province of North Pyongan, Democratic People's Republic of Korea, April 2017. *Stilt* 72:15-20.

Riegen, A., D.S. Melville, K. Woodley, S.I. Ri, S.I. Ju, C.J. Ri, J.H. Kim and C.S. Ri 2018b. Coastal Shorebird Survey in the Province of North Pyongan, the Democratic People's Republic of Korea, April 2018. *Stilt* 72:21-26.

Ri Kyong Sim, Yun Choi Nam, Kim Jong Chol, Ri Chung Song, Jong Jin Sam, Chae Ryong Jin, Ryu Jin, Ri Chol Ju, Pan Un Gyong, U Un Jong, Ri Un Chol, Choe Ji Hye, Ri Ju Hyok 2018. *A wetland inventory for DPR Korea*. Ministry of Land and Environmental Protection, Pyongyang, DPR Korea.

Rogers, D.I., H.Y. Yang, C.J. Hassell, A.N. Boyle, K.G. Rogers, B. Chen, Z.W. Zhang, T. Piersma 2010. Red Knots (*Calidris canutus piersmai* and *C.c. rogersi*) depend on a small threatened staging area in Bohai Bay, China. *Emu* 110:307-315.

Wetlands International 2018. Waterbird population estimates. http://wpe.wetlands.org (accessed 30/06/2018).

Appendix 1. List of shorebirds and waterbirds recorded during the coastal survey 7-12 May 2019.

English common name	**Scientific name**	**Korean common name**	**English transliterated common name**
Far Eastern Oystercatcher	*Haematopus [ostralegus] osculans*	까치도요	Kkachidoyo
Pacific Golden Plover	*Pluvialis fulva*	검은가슴알도요	Geomeun-gaseumaldoyo
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
Snipe sp.	*Gallinago sp.*	꺅도요류	kkiakdoyoryu
Black-tailed Godwit	*Limosa limosa*	검은꼬리도요	Komunkkoridoyo
Bar-tailed Godwit	*Limosa lapponica*	큰뒷부리도요	Kundaetburidoyo
Whimbrel	*Numenius phaeopus*	밭도요	Batdoyo
Eurasian Curlew	*Numenius arquata*	마도요	Madoyo
Far Eastern Curlew	*Numenius madagascariensis*	알락꼬리마도요	Allakkkorimadoyo
Spotted Redshank	*Tringa erythropus*	학도요	Hakdoyo
Common Redshank	*Tringa totanus*	붉은발도요	Bulunbatdoyo
Common Greenshank	*Tringa nebularia*	청다리도요	Chengdaridoyo
Nordmann's Greenshank	*Tringa guttifer*	흰꼬리청다리도요	Huinkkorichengdaridoyo
Wood Sandpiper	*Tringa glareola*	알락도요	Allakdoyo
Grey-tailed Tattler	*Tringa brevipes*	누른발도요	Nurunbaldoyo
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-necked Stint	*Calidris ruficollis*	좀도요	Jomdoyo
Long-toed Stint	*Calidris subminuta*	종달도요	Jongdaldoyo
Sharp-tailed Sandpiper	*Calidris acuminata*	메추리도요	Mechuridoyo
Dunlin	*Calidris alpina*	갯도요	Gaetdoyo
WATERBIRDS			
Common Shelduck	*Tadorna tadorna*	꽃진경이	Kotjingyongi
Greater Scaup	*Aythya marila*	검은머리알숭오리	Geomeunmeorialsungori
Garganey	*Spatula querquedula*	알락발구지	Allagbalguji
Northern Shoveler	*Spatula clypeata*	넙적부리오리	Neopjeokburiori
Gadwall	*Mareca strepera*	알락오리	Allagori
Falcated Duck	*Anas falcata*	붉은꼭두오리	bulgunkkokduori
Eurasian Wigeon	*Anas penelope*	알쑹오리	alsungori
Mallard	*Anas platyrhynchos*	청뒹오리	Cheongduingori
Eastern Spot-billed Duck	*Anas zonorhyncha*	검독오리	Kemdokori
Eurasian Teal	*Anas crecca*	반달오리	Bandalori
Northern Pintail	*Anas acuta*	가창오리	Gachangori
Little Grebe	*Tachybaptus ruficollis*	농병아리	Nongbyongari
Great Crested Grebe	*Podiceps cristatus*	뿔농병아리	Bulnongbyongari
Black-faced Spoonbill	*Platalea minor*	검은머리저어새	Jeo-eosae
Black-crowned Night Heron	*Nycticorax nyticorax*	밤물까마귀	Bammulggamagi
Grey Heron	*Ardea cinerea*	왜가리	Whaegari
Great White Egret	*Ardea alba*	대백로	Daebaenglo
Intermediate Egret	*Ardea intermedia*	중백로	jungbaengro
Little Egret	*Egretta garzetta*	쇠백로	Shoebaengro
Chinese Egret	*Egretta eulophotes*	노랑부리백로	norangburibaengro
Great Cormorant	*Phalacrocorax carbo*	갯가마우지	Gaetgamauji
Common Coot	*Fulica atra*	큰물닭	Kunmuldak
Moorhen	*Gallinula chloropus*	물닭	Muldak
Saunders's Gull	*Saundersilarus saundersi*	검은머리갈매기	Geomeunmeorigalmaegi
Black-headed Gull	*Chroicocephalus ridibundus*	붉은부리갈매기	Bulunburigalmaegi
Black-tailed Gull	*Larus crassirostris*	갈매기	Galmaegi
Mew Gull	*Larus canus*	갯갈매기	Gaetgalmaegi
Mongolian Gull	*Larus mongolicus*	-	-
Little Tern	*Sternula albifrons*	쇠갈매기	Saegalmaegi

SHOREBIRDS AT POINT DOURO, WESTERN AUSTRALIA

DON CARLSON[1] AND MARCUS SINGOR[2*]

[1]21 Cleveland Bay Avenue, Eaton, WA 6232, AUSTRALIA.
[2]149a Bishopsgate Street, Carlisle, WA 6101, AUSTRALIA.
**Email: msingor@bigpond.com*

Shorebirds were monitored at the Leschenault Estuary from August 2014 to June 2019. This is one of the most southerly migratory shorebird destinations on the Swan Coastal Plain in Western Australia. Totals of 21 migratory shorebird species and four Australian-breeding shorebird species were recorded. Red-necked Stint (600); Curlew Sandpiper (60); Red-necked Avocet (50); Grey Plover (24) and Bar-tailed Godwit (24) were the most prolific species observed.

Leschenault Estuary is an estuarine lagoon that is situated to the north of Bunbury (33˚ 19' 49" S, 115˚ 38' 25" E) Western Australia. The Leschenault Estuary system consists of two parts:

1) **Leschenault Estuary proper** which extends northwards and is about 13.5 km in length and has a maximum width of around 2.5 km and contains several tidal salt marshes. Leschenault Estuary includes the Collie River estuary, Preston River estuary, Bar Island, Pelican Point and Point Douro; and
2) **Leschenault Inlet south.** This southern section includes Anglesea Island which is a known Australian Pied Oystercatcher breeding site (Fig.1).

There is an exchange of shorebirds as they move between these sites, influenced by tidal movements. Bar Island is used as the main roost site. Eastern Curlew will roost in a saltbush marsh adjacent to Point Douro.

The shorebird sites covered in this article are at Point Douro and the Preston River estuary. Shorebird surveys were concentrated over the Austral spring and summer periods (October to February). The distribution of surveys at Point Douro was; January (10.4%), February (13.04%), March (8.69%), April (1.73%), May (5.21%), June (1.73%), July (1.73%), August (2.60%), September (6.08%), October (13.91%), November (20%), December (14.78%).

METHODS

Surveys were carried out using Bushnell 22x50 binoculars and followed a set transect across the mudflats which usually took one hour. Depending on tide levels several ad hoc winter surveys were conducted outside the peak shorebird migratory season.

Most of the observations were made at Point Douro with a lesser number made at the Preston River estuary. Generally, only one site was surveyed on the day. The sites were monitored several times a month during the migration period September to March.

Point Douro (33˚ 18' 05" S, 115˚ 41' 39" E) is located at the mouth of the Collie River. There is a large sandbank and mudflats at the mouth of the Collie River and this is where shorebirds congregate to feed at low tide. The area becomes attractive to shorebirds over summer with counts numbering in the hundreds including up to 21 migratory shorebird species and four Australian breeding shorebird species. The site becomes inundated at high tides and manmade channels allow ingress and egress of estuary water. Salt bush, some small shrubs and a few Tuarts Eucalyptus gomphocephala inhabit the area. Point Douro was surveyed 115 times from 2014 to 2019 (Table 1).

Preston River mouth (33˚ 19' 05" S, 115˚ 40' 51" E) - the Preston River has been diverted a couple of times. There is a lagoon on the western side of the Preston River estuary which was created when port dredging was in progress. This is now being colonised by the local White Mangrove (*Avicennia marina*). The river delta spreads

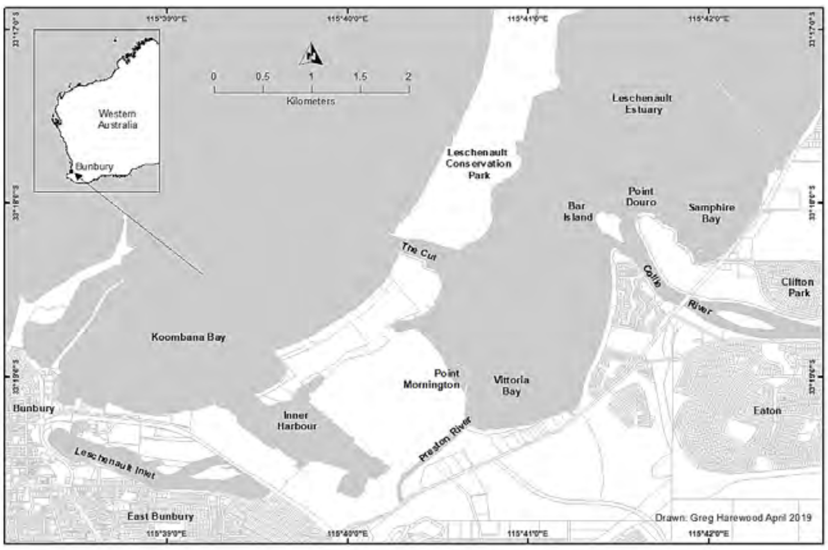


Figure 1. Map showing survey sites Point Douro and Preston River estuary.

Table 1. The mean and maximum counts of each species at Point Douro from 2014 to 2019.

Common name/ *Scientific Name*	Aug. to Dec. 2014			Jan. to Nov. 2015			Feb. to Dec. 2016			Jan. to Dec. 2017			Jan. to Dec. 2018			Jan. to June 2019		
	Max	Mean	SD	Max	Mean	SD	Max	Mean	SD	Max	Mean	SD	Max	Mean	SD	Max	Mean	SD
Australian Pied Oystercatcher *Haematopus longirostris*	n/a	n/a		4	1.85	1.26	4	0.86	1.08	4	1	0.96	6	2.11	1.3	6	3	1.38
Red-necked Avocet *Recurvirostra novaehollandiae*	50	10.3	18.5	50	3.57		20	2.03	6.57	3	0.13		50	16.03	11.28	4	0.4	
Pied Stilt *Himantopus himantopus*	23	2.3		35	6.14	14.44	5	0.26	1.41	1	0.04		4	0.55	0.83	1	0.1	
Grey Plover *Pluvialis squatarola*	15	6.5	4.62	17	8.42	4.79	24	6.83	6.46	18	7.61	5.82	17	6.8	4.66	18	10	4.65
Pacific Golden Plover *Pluvialis fulva*	1	0.5	0	1	0.42	0	1	0.34	0	1	0.54	0	1	0.07	0	1	0.2	0
Red-capped Plover *Charadrius ruficapillus*	8	2	3.46	6	0.71	1.41	6	0.41	1.89	4	0.22	2.12	6	0.59	2.16	4	0.9	1
Greater Sand Plover *Charadrius leschanaultii*	1	0.1		2	0.14		4	0.37	1.51	0	0		0	0		0	0	
Whimbrel *Numenius phaeopus*	1	0.2	0	2	0.78	0.44	1	0.06	0	1	0.09	0	2	0.48	0.28	1	0.3	0
Eurasian Curlew *Numenius arquata*	0	0		0	0		1	0.84	0	1	0.31	0	1	0.55	0	1	0.6	0
Eastern Curlew *Numenius madagascarensis*	2	0.3	0.7	2	0.78		4	1.56	0.86	3	1	0.75	2	0.81	0.21	2	0.9	0.54
Bar-tailed Godwit *Limosa lapponica*	2	0.4	0	10	2.35	2.36	21	4.58	6.05	24	2.8	7.68	8	2.7	2.06	5	1.9	1.38
Black-tailed Godwit *Limosa limosa*	0	0		0	0		0	0		0	0		1	0.03		0	0	
Ruddy Turnstone *Arenaria interpres*	0	0		0	0		3	0.28	0.5	0	0		1	0.03	0	0	0	
Great Knot *Calidris tenuirostris*	8	2.4	2.44	10	1.64	3.43	13	1.58	3.31	9	1.27	2.58	11	1.59	3.46	18	8	5.88
Red Knot *Calidris canutus*	4	0.6	1.41	2	0.28	0	19	1.32	4.72	1	0.04		8	0.96	2.81	3	0.3	
Ruff *Philomachus pugnax*	0	0		0	0		1	0.15	0	0	0		0	0		0	0	
Sharp-tailed Sandpiper *Calidris acuminata*	0	0		0	0		6	0.53	2.21	0	0		1	0.03		6	0.8	2.82
Curlew Sandpiper *Calidris ferruginea*	2	0.4	0	0	0		70	9.86	25.6	30	3.45	12.67	4	0.29	1.22	1	0.1	
Red-necked Stint *Calidris ruficollis*	235	36.1	94.16	167	47.7	71.39	600	80.72	246.5	260	29.36	95.11	350	57.29	95.3	400	142.7	136.2
Sanderling *Calidris alba*	0	0		0	0		1	0.06	0	0	0		1	0.03		0	0	
Terek Sandpiper *Xenus cinereus*	4	0.5	2.12	2	0.14		2	0.09	0.7	0	0		4	0.37	1	1	0.1	
Common Sandpiper *Actitis hypoleucos*	1	0.1		3	0.85	0.92	4	1.03	0.99	3	0.68	0.7	4	1.14	1.06	2	0.8	0.51
Grey-tailed Tattler *Heteroscelus brevipes*	3	0.4	1.41	0	0		2	0.21	0.5	0	0		1	0.03		0	0	
Common Greenshank *Tringa nebularia*	10	1.5	3.93	3	0.64	0.75	4	0.7	1.02	4	0.63	1.01	2	0.29	0.37	2	0.8	0.37
Wood Sandpiper *Tringa glareola*	1	0.1		0	0		0	0		0	0		0	0		0	0	
Number of surveys		10			14			32			22			27			10	

Table 2. Overview of shorebird counts conducted at Preston River estuary (2015-2018).

Common name/ *Scientific Name*	2015			2016		2017									2018				
	6-Oct	19-Nov	29-Nov	21-Sep	2-Nov	10-Jan	27-Mar	3-Jun	1-Oct	9-Oct	30-Oct	14-Nov	6-Dec	19-Dec	15-Jan	8-Mar	12-Apr	13-Sep	10-Dec
Australian Pied Oystercatcher *Haematopus longirostris*			2	2	2				1	1	3	2	2	2	2	5	3		2
Pied Stilt *Himantopus himantopus*			30						2	1				8					26
Grey Plover *Pluvialis squatarola*							18									10	3		
Pacific Golden Plover *Pluvialis fulva*							1												
Red-capped Plover *Charadrius ruficapillus*		11		3	16	13			9			1	16	8					
Greater Sand Plover *Charadrius leschanaultii*									1										
Whimbrel *Numenius phaeopus*			2																
Eurasian Curlew *Numenius arquata*							1												
Eastern Curlew *Numenius madagascarensis*							1								1				
Bar-tailed Godwit *Limosa lapponica*		10					10	4											
Great Knot *Calidris tenuirostris*			4				5												4
Red-necked Stint *Calidris ruficollis*		203			33	200			125			5	101	113					
Common Sandpiper *Actitis hypoleucos*	1	1	2	2		1				1	1		1					2	
Common Greenshank *Tringa nebularia*	8	2	1	1	1				1	1				11					
Total	9	227	41	8	52	214	36	4	139	4	4	8	120	142	3	15	6	2	32

out for several hundred metres at low tide. The exposed mudflats become a feeding ground for many migratory and some Australian breeding shorebirds. Three species of terns, gulls and other waterfowl (herons, swans, egrets, ibis) have been seen here. Preston River estuary was surveyed 19 times (Table 2).

RESULTS AND DISCUSSION

The mean and maximum counts of each species at Point Douro from 2014 to 2019 are shown in Table 1. The intensity of surveys at Point Douro was 2014 (10); 2015 (17); 2016 (34); 2017 (31); 2018 (32) and 2019 (10). An overview of the shorebird counts held at the Preston River estuary are shown in Table 2. Data for 2019 only covered the first six months of the year.

Bar-tailed Godwit *Limosa lapponica*

Typically, Bar-tailed Godwit first arrive in October and maintain a presence through till May. Maximum number observed was 24 in January 2017. Numbers generally fluctuate between 5-15 birds.

Common Sandpiper *Actitis hypoleucos*

The Common Sandpiper is one of the first migratory shorebirds to arrive with sightings ranging from July to March. Generally seen as a solitary bird though as many as four have been seen. A few remain over the Austral winter and can be found along the shoreline of the Leschenault Estuary and Inlet.

Grey Plover *Pluvialis squatarola*

Grey Plover arrived from August/September onwards and were present up to May. Point Douro maintained a stable population of Grey Plover during the study period and numbers were in the range of 10-15. A maximum of 24 Grey Plover were seen in March 2016. In early October some Grey Plover were still showing partial breeding plumage.

Red-necked Stint *Calidris ruficollis*

Red-necked Stint arrive from September onwards and had largely gone by the end of February. Numbers were highest over the months October to January when more than 600 Red-necked Stint were seen at Point Douro. At the Preston River estuary these numbers were less, the highest count was over 200 Red-necked Stint.

Great Knot *Calidris tenuirostris*

Great Knot typically arrive in September and remained till March with one late sighting in May. Maximum numbers 10-18. In contrast Red Knot showed up over a shorter time frame (October to January) and in lower numbers.

Common Greenshank *Tringa nebularia*

Common Greenshank typically arrive in September and have been reported till May. Numbers were in the range of 1-4.

Pacific Golden Plover ***Pluvialis fulva***

A solitary bird showed up each year during the study period. The earliest arrival was in late September and it was present till late March. The Pacific Golden Plover was seen at Point Douro and the Preston River estuary.

Eurasian Curlew ***Numenius arquata*** **and Eastern Curlew** ***Numenius madagascariensis***

A single bird was sighted at Point Douro in 2016, 2017, 2018 and 2019. Observations indicate it overwintered in 2016 (Fig. 2). The combined sightings fall in two continuous periods e.g. January 2016 to March 2017 and September 2018 to January 2019.Whether this was the same bird that migrated back in the following years is unknown. The monthly sightings of the Eurasian Curlew at Point Douro are shown in Table 3.

Figure 2. Eurasian Curlew (L) and Eastern Curlew (R) present at Point Douro on 26 February 2016 (by ©Shelley Pearson).

Table 3. Record of monthly sightings of Eurasian Curlew *Numenius arquata* at Point Douro (2016-2019).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	X	X	X	X	X		X	X	X	X	X	X
2017	X	X	X									
2018									X	X	X	X
2019	X											

Australian breeding shorebirds – combined sites

Australian breeding shorebirds observed were Australian Pied Oystercatcher, Pied Stilt, Red-capped Plover and Red-necked Avocet. Pied Stilt and Red-necked Avocet populations fluctuated during the year and both species are known to roost on Bar Island. Small flocks (20-50) of Red-necked Avocet have been sighted, though they were not present each year. Red-necked Avocet were mainly recorded during the Austral spring and summer months with the highest recordings made in 2018.

There have been occasional sightings of Black-tailed Godwit, Grey-tailed Tattler, Ruff, Sanderling, Sharp-tailed Sandpiper, Terek Sandpiper and Wood Sandpiper. A Ruff was observed on 21 February 2016 and from 5 November 2016 till 23 November 2016 on the mudflats at Point Douro.

During the Austral winter months (June, July and August) a few migratory shorebirds were still found at Point Douro and the Preston River estuary, though in small numbers. These were Bar-tailed Godwit (4), Common Greenshank (2), Common Sandpiper (1), Eastern Curlew (2) and Grey Plover (2).

There are a few other sites around the Leschenault Estuary and Leschenault Inlet where shorebirds can be seen. At the northern end of the Leschenault Estuary where water levels become shallow Bar-tailed Godwit, Pied Stilt and Common Greenshank have been observed.

Along the north western side of the Leschenault Estuary (towards Belvedere) Pied Stilt and Red-necked Avocet can be seen in the shallow pools found in the samphire fringes of the estuary.

The north eastern section of the Estuary has nesting sites for Red-capped Plover.

Australian Pied Oystercatcher are known to nest on Bar Island.

At the Leschenault Inlet small numbers of shorebirds are found along the edges of Anglesea Island.

The Bunbury Port Authority proposes to extend the inner harbour at Point Mornington and this might impact on the Preston River mudflats.

ACKNOWLEDGEMENTS

Most of the shorebird surveys were conducted by Don Carlson. These were supplemented with incidental records obtained from Western Australian Bird Notes and eBird (eBird 2019) made by the observers: Meir Altman, Shelley Altman, Plaxy Barratt, Bob Dawson, Barry Deacon, Hedley & Irena Earl, Darryl Eggins, Stewart Ford, Athena Georgiou, Ken Glasson, John Goldie, John Graff, Bruce Greatwich, Geoffrey Groom, Greg Howell, Ross Jones, Brenton Laslett, Lan Lowson, Daniel Mantle, Richard Norton, Margot Oorebeek, Laurie Ross, Jennifer Smith, Roy Sonnenburg, Vicki Stokes, Ray Turnbull, Peter Taylor and Kathy Walter. Bruce Buchanan, Sue Kalab, Anne Lee-Steere, Jane Putland and Chris Tate provided information on local shorebird distribution. In addition, we would like to thank Greg Harewood for producing the site map and Shelley Pearson for supplying the photo.

REFERENCES

eBird. 2019. eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org. Accessed: 24 May 2019.

Western Australian Bird Notes 2016 and 2017. Unusual bird sightings. Issue: 158 to 161.

Western Australian Bird Notes 2018 and 2019. Unusual bird sightings. Issue: 168 and 169.

DARWIN SHOREBIRD CATCHING: EXPEDITION REPORT 2018

AMANDA LILLEYMAN[1], GRACE MAGLIO[2], ROBERT BUSH[3], ROZ JESSOP[2], PRUE WRIGHT[2] AND CLIVE D. T. MINTON[2]

[1] *Threatened Species Recovery Hub, National Environment Science Programme, Charles Darwin University, Ellengowan Drive, Casuarina, Northern Territory 0909, AUSTRALIA*
Email: Amanda.Lilleyman@cdu.edu.au
[2] *Australasian Wader Studies Group*
[3] *Queensland Wader Study Group*

Shorebird expeditions have been run in the Northern Territory sporadically since 1995 and have focussed on birds from five sites along the Top End coastline. Over the years, there has been 2510 shorebirds caught from 19 species from a combination of cannon netting and mist netting. From 2014 onwards, we applied engraved leg-flags to shorebirds and this has allowed for a more detailed understanding of site fidelity on the non-breeding grounds and migration pathway connectivity. Since that time, there has been more than 3403 leg-flag resightings from six countries in the East Asian-Australasian Flyway. In 2018, the objective of the expedition was to capture the critically endangered Far Eastern Curlew *Numenius madagascariensis* to attach GPS tracking devices to birds to learn about their local movements on the non-breeding grounds of Australia. One GPS tag was deployed on a Curlew during this expedition. Shorebird catching expeditions allow researchers to collect useful data on age demographics within populations, and to target species for more detailed studies such as those on movements of birds.

INTRODUCTION

“ *The team started the expedition with the aim of catching the world’s largest shorebird, the Far Eastern Curlew, and we finished the week in the field catching the world’s smallest shorebird – the Little Stint*. **Dr Clive Minton** ”

A team of researchers from the Australasian Wader Studies Group (AWSG) joined Amanda Lilleyman in Darwin to cannon net Far Eastern Curlew in November 2018. The expedition was timed to maximise the chances of catching curlew and catching in November meant that adult and juvenile birds would be in Darwin for the non-breeding season of the austral summer. November is typically a humid time of the year and is characterised as the ‘build-up’ period; however, it was unseasonably wet during the catching week with rain during net-setting times and on one occasion the team had to retreat to cars as a severe storm passed over Darwin Harbour.

The main catching site during this expedition was Darwin Port’s East Arm Wharf and the secondary catching site was Lee Point beach, in Casuarina Coastal Reserve (Fig. 1). In early November the high tides occurred during the mornings and evenings and it was a new moon spring tide period. Most of the equipment preparations occurred in the mornings and net setting occurred during the day. Most catches were made in the evenings on the incoming high tide and the very last catch on the morning high tide.

The team was made up of five interstate experts (3 Vic 1 QLD, 1 WA), one local researcher (AL), accompanied by a team of Indigenous rangers from the local Larrakia Rangers program from Larrakia Nation Aboriginal Corporation and local volunteers. A daily team of 15-25 people were involved.

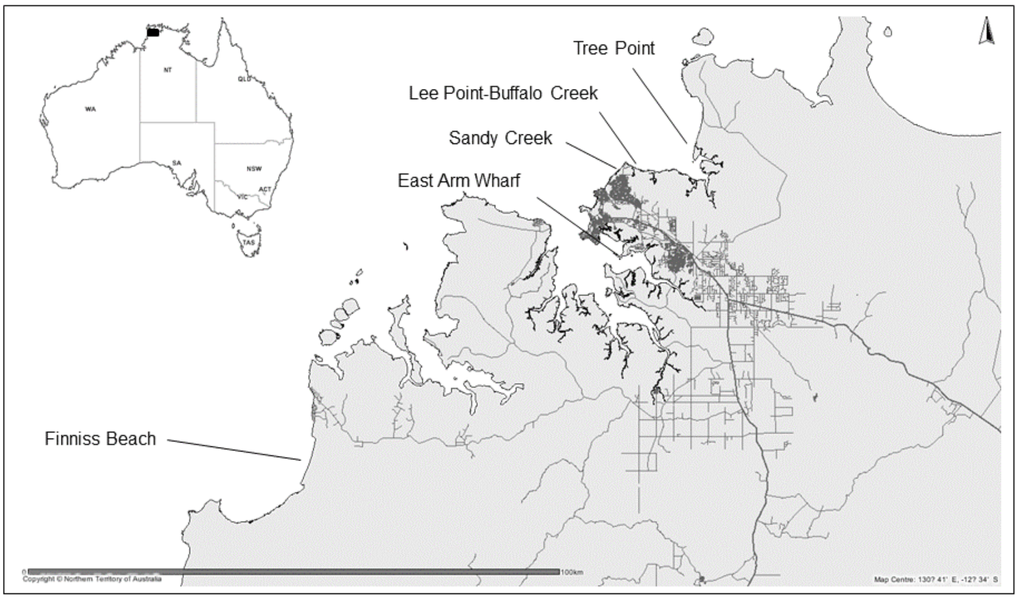


Figure 1. Map of all expedition catching sites in the Northern Territory. Map also shows main roads and housing in the Darwin region.

Darwin – importance of catching and banding

Darwin's geographical position creates an opportunity to explore the mixing of several subspecies of migratory shorebird. Until the 2014 and 2015 catching and flagging, there was no understanding of the proportion of the two Red Knot subspecies that occur in Australia (*rogersi* and *piersmai*). The individual engraved leg-flag marking allowed us to gain resighting data on this species and estimate the subspecies ratio for the region (Global Flyway Network, *pers. comm.*).

Darwin is a known staging site in northern Australia and while this concept was once only considered through anecdotal evidence, it has now been confirmed with resighting data from terminal sites in southern Australia and in New Zealand.

Historical background

Researchers first caught shorebirds in the Top End of the Northern Territory in 1995, then again in 1996, 2008, 2014, 2015, 2018. These mini expeditions were led by a local Darwin researcher and team members from the Australasian Wader Studies Group and were undertaken for a range of objectives (Clive Minton, *pers. comm.*).

The main aim of the 1995 and 1996 expeditions was to catch shorebirds and waterbirds to collect blood samples to detect avian-borne diseases for the Northern Territory Quarantine and Inspection Services (now known as Northern Australia Quarantine Strategy) and to collaborate with the Conservation Commission of the Northern Territory (now known as Parks and Wildlife). Similarly, the 2008 expedition had the same aims but also set out to flag shorebirds using plain yellow over blue leg flags.

The aim of the 2014 and 2015 expeditions was to catch and flag as many shorebirds as possible to contribute to a PhD study on the movement of shorebirds in the Darwin region (Lilleyman, *in prep*). Data from these expeditions also contributed to continental-wide analysis of body condition in shorebirds. The 2014 and 2015 expeditions had advanced from previous expeditions through the application of engraved yellow over plain blue leg flags. These were placed on all shorebirds, except Red-necked Stint, that had plain yellow over blue leg flags applied.

All shorebirds were caught on beaches or wetlands along the Northern Territory coastline, in Darwin Harbour during all years, and in Fog Bay (Finniss Beach) during 1995-1996 (Fig. 1). Darwin Harbour is a mangrove-lined tropical estuary in the Northern Territory that is near-pristine in condition (Munksgaard *et al*. 2018). Darwin Harbour supports more than 10,000 migratory shorebirds during the austral summer (Chatto 2012) is also home to most of the human population in the Northern Territory. Most shorebirds in the Darwin Harbour catching sites occur in the land tenure of Casuarina Coastal Reserve, managed by Parks and Wildlife Commission of the Northern Territory (Parks and Wildlife Commission Northern Territory 2016). This area also has high human pedestrian traffic and consequently, anthropogenic disturbances to shorebirds are common at the site (Lilleyman *et al*. 2016).

Finniss Beach sits within Fog Bay to the west of Darwin Harbour and has historically supported up to 17,000 migratory shorebirds (Chatto 2012). It is at risk of increased disturbance through human visitation and increased housing at the nearby town of Dundee Beach (Chatto 2012).

2018 expedition objectives

The aim of the 2018 expedition was to catch the critically endangered Far Eastern Curlew to attach GPS tags to birds as part of the project 'strategic planning for the Far Eastern Curlew' under the National Environment Science Programme Threatened Species Recovery Hub (Threatened Species Recovery Hub (2020). An additional aim was to band and flag other species of migratory shorebird and to continue taking measurements for morphometric studies.

METHODS

Study sites

In the 2018 expedition we cannon-netted at Lee Point-Buffalo Creek beach (130.90° E, 12.33° S) and at East Arm Wharf (130.89° E, 12.48° S). Catching happened in the first week of November on best available high tides. This month was selected because most adult and juvenile shorebirds have returned to Darwin by November and those in the region would most likely stay, rather than continuing further south.

Field methods

All expeditions involved catching shorebirds using cannon nets, and in 2017 and 2018, the team also used mist nets to catch shorebirds. All cannon nets were set following standard methods (Australasian Wader Studies Group 2018). Mist nets were used when high tides occurred late in the night and it was not practicable to cannon net at night. We used mist nets to catch birds in 2017 and went out every month to either East Arm Wharf or a saltpan next to the EAW. We also used mist nets in 2018 when cannon netting was not practical due to high tides occurring in the night. We always mist-netted during evenings when the tide was rising. All captured shorebirds had biometrics taken: mass, wing length, head length, head-bill length, moult, age and sex (if known). Captured birds had a metal band, and from 2014 onwards had engraved yellow over plain blue leg flags applied.

RESULTS

In 2018 there were 142 shorebirds from 11 species caught and processed during the expedition (Table 1), including two Far Eastern Curlew, with one GPS tag deployed on a male bird.

Since 1995, there has been 2510 shorebirds caught from 19 species during expeditions, across five sites in the Northern Territory (Table 2). Since the 2014 expedition and application of engraved leg-flags, there has been approximately 3403 resightings of Darwin birds from across six countries in the East Asian-Australasian Flyway (EAAF) (Table 3). Most (>97%) of the resightings came from the Northern Territory in Australia.

Table 1. Darwin 2018 catch totals, method used and percent juveniles for each species.

Date/ Capture Method	Site	Species	New	Total	Juv	% Juv
6/11/2018 Cannon netting	Lee Point-Buffalo Creek	Greater Sand Plover *Charadrius leschenaultii*	19	19	0	0
		Lesser Sand Plover *Charadrius mongolus*	6	6	0	0
		Great Knot *Calidris tenuirostris*	2	2	2	100
		Red-necked Stint *Calidris ruficollis*	1	2	0	0
		Sharp-tailed Sandpiper *Calidris acuminata*	1	1	1	100
		Total	**29**	**30**	**3**	
9/11/2018 Cannon netting	East Arm Wharf (Pond E)	Far Eastern Curlew *Numenius madagascariensis*	2	2	0	0
		Total	**2**	**2**	**0**	
10/11/2018 Mist netting	East Arm Wharf (Pond K)	Greater Sand Plover *Charadrius leschenaultii*	7	1	1	100
		Sharp-tailed Sandpiper *Calidris acuminata*	7	7	1	14
		Red-necked Stint *Calidris ruficollis*	3	3	0	0
		Grey-tailed Tattler *Tringa brevipes*	2	2	1	50
		Whimbrel *Numenius phaeopus*	2	2	2	100
		Great Knot *Calidris tenuirostris*	1	1	1	100
		Lesser Sand Plover *Charadrius mongolus*	1	1	1	100
		Terek Sandpiper *Xenus cinereus*	1	1	0	0
		Total	**24**	**24**	**7**	
11/11/2018 Cannon netting	Lee Point-Buffalo Creek	Great Knot *Calidris tenuirostris*	40	40	4	10
		Red-necked Stint *Calidris ruficollis*	32	34	5	15
		Greater Sand Plover *Charadrius leschenaultii*	7	7	1	14
		Lesser Sand Plover *Charadrius mongolus*	2	3	0	0
		Little Stint *Calidris minuta*	1	1	1	100
		Red Knot *Calidris canutus*	1	1	0	0
		Total	**83**	**86**	**11**	
		TOTAL BIRDS	**142**			

Table 2. Number of species caught during expeditions per year and site in the Northern Territory.

	Year	**1995**			**1996**	**2008**		**2014**		**2015**			**2017**		**2018**	
Common name	**Scientific name**	Lee Point-Buffalo Creek	Finniss Beach	Tree Point	Lee Point-Buffalo Creek	Lee Point-Buffalo Creek	Finniss Beach	East Arm Wharf	Lee Point-Buffalo Creek	East Arm Wharf	Lee Point-Buffalo Creek	Sandy Creek	East Arm Wharf	GWA saltpan (EAW)	Lee Point-Buffalo Creek	East Arm Wharf
Bar-tailed Godwit	*Limosa lapponica*		1					2						7		
Broad-billed Sandpiper	*Calidris falcinellus*						3									
Common Greenshank	*Tringa nebularia*							13		19				7		
Common Sandpiper	*Actitis hypoleucos*															1
Curlew Sandpiper	*Calidris ferruginea*						2			1	1					
Far Eastern Curlew	*Numenius madagascariensis*												1	1		2
Great Knot	*Calidris tenuirostris*		391				40	1	98		229			4	44	1
Greater Sand Plover	*Charadrius leschenaultii*	27	74		13	111	52		189		95	10		3	26	8
Grey Plover	*Pluvialis squatarola*										3					
Grey-tailed Tattler	*Tringa brevipes*			4				6	5	6	1			14		2
Lesser Sand Plover	*Charadrius mongolus*	9			3	21			6		4				8	2
Little Stint	*Calidris minuta*														1	
Red Knot	*Calidris canutus*		272						2		45			1	1	
Red-necked Stint	*Calidris ruficollis*	2	16		42	209	37		73		37	2			37	3
Ruddy Turnstone	*Arenaria interpres*	2	2		12	2			11		9					
Sanderling	*Calidris alba*	3			2	1					16	4				
Sharp-tailed Sandpiper	*Calidris acuminata*										6			2	1	7
Terek Sandpiper	*Xenus cinereus*		18	11		1	2	16	13				2	3		7
Whimbrel	*Numenius phaeopus*												1	2		3
	TOTAL	**43**	**774**	**15**	**72**	**345**	**136**	**38**	**397**	**26**	**446**	**16**	**4**	**44**	**118**	**36**

Table 3. Count of resightings for each shorebird species across countries in the EAAF from 2014 onwards.

Common Name ***Scientific Name***	**NT Aust**	**VIC Aust**	**WA Aust**	**China**	**Japan**	**New Zealand**	**Russia**	**South Korea**
Bar-tailed Godwit *Limosa lapponica*	32				2			
Common Greenshank *Tringa nebularia*	38							
Curlew Sandpiper *Calidris ferruginea*	1							
Great Knot *Calidris tenuirostris*	1208		3	31			4	2
Greater Sand Plover *Charadrius leschenaultii*	1478			3				
Grey Plover *Pluvialis squatarola*	20							
Grey-tailed Tattler *Tringa brevipes*	29							
Lesser Sand Plover *Charadrius mongolus*	9							
Red Knot *Calidris canutus*	51	1		36		3		
Red-necked Stint *Calidris ruficollis*	74							
Ruddy Turnstone *Arenaria interpres*	219			5				
Sanderling *Calidris alba*	151			1				
Terek Sandpiper *Xenus cinereus*	2							
TOTAL	**3312**	**1**	**3**	**76**	**2**	**3**	**4**	**2**

The proportion of juvenile birds to adult birds in the total catch has changed over time (Table 4), from <6% juveniles caught in the total flock in 1995 to >22% in the total flock in 2018. In 2014 juveniles made up 11% of the total flock, and then in 2015 when the catching expedition was in October, juveniles made up 28.7% of the total flock.

Table 4. Percentage of juvenile shorebirds and adult shorebirds in the total catch over the expedition years.

Year	Juvenile %	Adult %
1995	5.4	94.6
1996	1.4	98.6
2008	13.9	86.1
2014	11.0	89.0
2015	28.7	71.3
2017	22.9	77.1
2018	22.1	77.9

DISCUSSION

Summary of achievements

The Darwin expeditions have proved to be highly important in improving the understanding of migratory shorebirds in northern Australia, with some leg-flag resightings from a range of sites in the EAAF. With this information we are starting to fill a gap of where birds from the Top End go on migration, and how faithful individual birds are to the Darwin non-breeding grounds. For example, resighting data from Darwin suggests that some shorebirds within the population are site faithful to the region, returning to the site of capture year after year. Additionally, we have learned that the Darwin region is a steppingstone for some individuals within the population; for example, Red Knot that were banded in Darwin have been resighted in New Zealand, which is most likely their migration terminus.

The use of tracking devices on birds allows a detailed understanding of movement patterns and habitat use – data which are vital to the conservation of migratory shorebirds. Results from the Far Eastern Curlew tracking study have already indicated that curlew depart Darwin late in the northward migration season (April, n=2), and one of the birds nested on the Kamchatka Peninsula, which is considered very far north on their breeding grounds (Lilleyman 2018).

The expeditions have also allowed researchers to collect biometric data on all shorebirds, which will help to describe the condition of Top End shorebirds compared to birds from sites at other locations on the non-breeding grounds.

On review of the conditions and number of birds caught in the Darwin region over the years, we have decided that October is the best month to cannon net shorebirds because 1) most shorebirds (adults and juveniles) have returned to the region, 2) while it is the build-up season, October is not as humid as November, and this may influence the condition of the birds upon release after processing, and 3) October has historically provided the highest percent of juvenile birds in the total catch and this will allow for the best estimate of breeding success, if this measure was to be estimated.

Future of catching and banding shorebirds in the Northern Territory

There is considerable interest in creating a regular shorebird catching program to allow researchers to catch, process and flag birds in the Northern Territory at least once a year. This would allow for a regular addition of marked individuals in the system and would further contribute to understanding the migration and site fidelity of shorebirds that visit or stay in the Northern Territory.

ACKNOWLEDGEMENTS

We acknowledge Darwin Harbour's traditional owners, the Larrakia people and their elders past and present. We thank our project partner Darwin Port. Thanks are also extended to the Threatened Species Recovery Hub, National Environmental Science Programme for funding this project on the Far Eastern Curlew (Project 5.1.1). Special thanks also to Stephen Garnett and Roanne Ramsey. Thanks to the volunteers from the Australasian Wader Studies Group, and to all local Darwin volunteers that have helped catch shorebirds over the years. Special thanks to Gavin O'Brien for expert recceing and twinkling over the years. Thanks to the Australasian Wader studies Group and the Victorian Wader Study Group for loaning equipment. We also thank Andrew Moss and Ray Chatto for their involvement in the early years of catching in the Northern Territory. Thanks to the generous help of all staff from the North Australia Quarantine Service that helped provide equipment and consumables over the years. Special thanks to the following people for their help at the very last-minute organising equipment: Damien Stanioch, Joe Schmidt, Cass Wittwer, Chris Hassell, Gayle Heron, Phil Vivian, Matt Northwood, and Rohan Badenhop and his metal works team.

REFERENCES

Standen, R., R. Jessop & C. D. T. Minton 2018. Australasian Wader Studies Group (including the Victorian Wader Study Group) Cannon-netting Induction Manual. Australasian Wader Studies Group. Victoria.

Chatto, R. 2012. Status of Northern Territory migratory shorebirds. Final report to Department of Sustainability, Environment, Water, Population and Communities. Darwin.

Lilleyman, A., D. C. Franklin, J. K. Szabo & M. J. Lawes 2016. Behavioural responses of migratory shorebirds to disturbance at a high-tide roost. *Emu* **116**:111-118.

Lilleyman, A. 2018. Progress Report 4: Strategic Planning for the Far Eastern Curlew. National Environment Science Programme, Threatened Species Recovery Hub. Brisbane.

Munksgaard, N. C., L. B. Hutley, K. N. Metcalfe, A. C. Padovan, C. Palmer & K. S. Gibb 2018. Environmental challenges in a near-pristine mangrove estuary facing rapid urban and industrial development: Darwin Harbour, Northern Australia. *Regional Studies in Marine Science* **25**:1-15.

Parks and Wildlife Commission Northern Territory 2016. Casuarina Coastal Reserve Management Plan 2016. Parks and Wildlife Commission Northern Territory, Darwin.

Threatened Species Recovery Hub (2020) Project: 5.1.1 Strategic planning for the far eastern curlew. https://www.nespthreatenedspecies.edu.au/projects/strategic-planning-for-the-far-eastern-curlew)

WADER BREEDING SUCCESS IN THE 2018 ARCTIC SUMMER, BASED ON JUVENILE RATIOS OF BIRDS WHICH SPEND THE NON-BREEDING SEASON IN AUSTRALIA

CLIVE MINTON[1], ROZ JESSOP[2], CHRIS HASSELL[3], ROB PATRICK [4], ROBYN ATKINSON[5] MAUREEN CHRISTIE[6] & ILA MARKS[7]

[1] 165 Dalgetty Road, Beaumaris, Victoria 3193, AUSTRALIA.
[2] Phillip Island Nature Park, PO Box 97, Cowes, Victoria, 3922, AUSTRALIA
Email: chairvwsg@gmail.com
[3] PO Box 3089, Broome, Western Australia 6735, AUSTRALIA
[4] 54 Myers Drive, Shoreham, Victoria, 3196, AUSTRALIA
[5] 31 Princess St, Drysdale, Victoria, 3222, AUSTRALIA
[6] Carpenter Rocks, Mount Gambier, South Australia 5291, AUSTRALIA
[7]50 Harold St, Thornbury, 3071, AUSTRALIA

INTRODUCTION

Each year wader banders in Australia attempt to collect 'percentage juvenile' data to measure the annual breeding success of wader populations which spend the non-breeding season in Australia. This is usually carried out in two different regions, some 3000 km apart. In South-east Australia (SEA) the Victorian Wader Study Group monitors breeding success in seven different species. All birds are caught by cannon netting between mid-November and March / early April (depending on the species) on the Victorian coast, on coasts around Port Macdonnell to Nora Creina in the South-east of South Australia and in the Bass Strait on King Island. The other area sampled by the Australian Wader Studies Group is in North-west Australia (NWA) in Roebuck Bay, Broome, and on the northern parts of 80 Mile Beach and the adjacent grassland plains of Anna Plains Station. Here a minimum of eight species are monitored annually.

In SEA birds were caught at a range of sites, mostly the same sites as in other recent years. No problems were experienced this year except that there were so few Red Knots around in the 2018/19 season that it was not possible to make a catching attempt on them. Weather conditions were greatly improved in NWA when compared with the previous season. This enabled all the main species to be caught in adequate numbers.

There were no significant interruptions in the sampling period in 2018/2019, as there were in the preceding year (when a cyclone considerably disrupted the NWA planned fieldwork programme). The usual techniques for catching / ageing birds etc. were employed in both regions.

This note gives the numerical data relating to catches made in the two regions during the 2018/19 wader non-breeding season. It also categorises the estimated breeding success of each population in the 2018 Arctic summer.

RESULTS & DISCUSSION

South-east Australia

A total of 2125 birds, of the seven species targeted for annual monitoring were caught in SEA in the sampling period (Tables 1 and 2). As usual, Red-necked Stint topped the catch total with 655 individuals caught during the monitoring period. The percentage juveniles (9.5%) was higher than last year (3.5%) but was still well below the long-term mean (14.7%). This is their second consecutive year of poor breeding success. Curlew Sandpipers have also had two successive poor breeding years. Though again there was a slight improvement in the most recent year from the 2017/18 season (9.9% juveniles this year compared with 5.4% last year).

In contrast, Sharp-tailed Sandpipers had a very successful breeding year (45.9% juveniles). This figure may have been affected by the widespread drought conditions being experienced in inland Australia during the last year. It was noticeable that there were far more Sharp-tailed Sandpipers at coastal locations during the 2018/19 season and it may be that these were preferentially (over adults) juvenile birds which were forced to the coastal regions. This apparent high breeding productivity in the Arctic summer of 2018 means that the long-term average percentage juveniles for Sharp-tailed Sandpipers is now higher than that of Red-necked Stint and Curlew Sandpiper (16.7% compared with 14.7% and 14.5% respectively).

With two good breeding seasons in succession there was a noticeable widespread marked increase in Sharp-

Table 1. Percentage of juvenile (first year) waders in cannon-net catches in south-east Australia 2018/2019.

Species	No. of catches		Total	Juveniles		Long-term Mean*		Assessment of 2018
	Large (>50)	Small (<50)	caught	No.	%	% juvenile (years)		breeding success
Red-necked Stint *Calidris ruficollis*	2	7	655	62	**9.5**	14.7	(41)	Poor
Curlew Sandpiper *C. ferruginea*	2	2	395	39	**9.9**	14.5	(39)	Below Average
Bar-tailed Godwit *Limosa lapponica*	1	0	100	3	**3.0**	20.9	(30)	Very Poor
Red Knot *C. canutus*	0	1	(1)	1	-	54.4	(20)	-
Ruddy Turnstone *Arenaria interpres*	3	21	596	153	**25.7**	16.3	(29)	Very Good
Sanderling *C. alba*	1	3	112	13	**11.6**	14.4	(27)	Below Average
Sharp-tailed Sandpiper *C. acuminata*	1	2	266	122	**45.9**	16.7	(35)	Exceptionally Good

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). *Includes the 2018/2019 figures.

tailed Sandpiper summer populations throughout Victoria. In contrast, with two bad years in succession, Red-necked Stints appeared to be scarcer than usual. Surprisingly, Curlew Sandpipers did not appear to be similarly affected by two successive poor breeding years, possibly because they were still benefitting from the exceptionally high breeding productivity of this species in the Artic summer of 2016.

Red Knot are typically the hardest species to catch and monitor and in the 2018/19 non-breeding season we were only able to catch one bird in the VWSG monitoring area. In contrast, we did well for Bar-tailed Godwits (100 caught) which are another species which it is particularly difficult to catch in adequate numbers. Unfortunately, the breeding success of these Godwits – which banding / flagging has shown to be almost exclusively from the Alaskan breeding location – was very poor in the Arctic summer of 2018 (only 3.0% juveniles).

Ruddy Turnstone was the outstanding success story of this year's monitoring season. A record 596 birds were caught, mostly on two highly successful visits to King Island and one to the South-east of South Australia. It was also another particularly good breeding season for this species with 25.7% juveniles. This is the second year of particularly good breeding success for this species in the last three years. It should result in a welcome halt to declining populations of this species.

Table 2. Percentage of juvenile (first year) birds in wader catches in south-east Australia 1998/1999 to 2018/2019.

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	16/17	17/18	18/19	*Mean (last 21yrs)*
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	28.6	7.0	25.7	*15.1*
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	31.3	3.8	9.5	*16.6*
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	47.6	5.4	9.9	*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	(-)	27.8	45.9	*19.9*
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	17.5	(-)	11.6	*14.9*
Red Knot *C. canutus*	(2.8)	38	52	69	(92)	(86)	29	73	58	(75)	(-)	(-)	78	68	(-)	(95)	(100)	(100)	90.3	33.3	(-)	*58.8*
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	12.5	20.4	3.0	*22.5*

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). Means (for 21 years) exclude figures in brackets (small samples) and include 2018/2019 figures

Table 3. Percentage of juvenile (first year) waders in cannon-net catches in north-west Australia 2018/2019.

Species	No. of catches: Large (>50)	No. of catches: Small (<50)	Total caught	Juveniles: No.	Juveniles: %	Long-term mean* % juvenile (years)	Assessment of 2018 breeding success
Great Knot *Calidris tenuirostris*	4	2	758	42	5.5	10.5 (21)	Poor
Bar-tailed Godwit *Limosa lapponica*	1	2	103	2	2.0	9.8 (21)	Very Poor
Red-necked Stint *C. ruficollis*	0	6	118	10	8.4	18.3 (21)	Poor
Red Knot *C. canutus*	0	4	66	1	1.5	15.1 (20)	Very Poor
Curlew Sandpiper *C. ferruginea*	0	8	58	8	13.8	17.2 (21)	Below Average
Ruddy Turnstone *Arenaria interpres*	0	1	16	4	(25.0)	-	(Probably very good)
Non-arctic northern migrants							
Greater Sand Plover *Charadrius leschenaultii*	1	9	225	34	15.1	21.4 (21)	Below average
Terek Sandpiper *Xenus cinereus*	0	7	34	9	26.5	13.2 (20)	Very good
Grey-tailed Tattler *Heteroscelus brevipes*	0	7	45	7	15.7	18.7 (20)	Average
Oriental Pratincole *Glareola maldivarum*	1	2	113	7	6.2	-	Poor?
Oriental Plover *Charadrius veredus*	0	6	25	1	(4.0)	-	(Poor?)

All birds cannon-netted in period 1 November to mid-March. *Includes the 2018/19 figures

Table 4. Percentage of juvenile (first year) birds in wader catches in north-west Australia 1998/1999 to 2018/2019.

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	16/17	17/18	18/19	Mean (last 21yrs)
Red-necked stint *Calidris ruficollis*	26	46	15	17	41	10	13	20	21	20	10	17	18	24	15	19	0	11.1	17.2	6.8	8.4	*18.3*
Curlew sandpiper *C. ferruginea*	9.3	22	11	19	15	7.4	21	37	11	29	10	35	24	1	1.9	23	8	0.7	40.3	8.1	13.8	*17.2*
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	9.0	2.6	5.5	*10.5*
Red knot *C. canutus*	3.3	14	9.6	5.4	32	3.2	(12)	57	11	23	2	52	16	8	1.5	8	3	2.7	21.6	5.4	1.5	*15.1*
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	11.0	3.0	2.0	*9.8*
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	12.4	13.2	15.1	*21.4*
Terek sandpiper *Xenus cinereus*	12	(0)	8.5	12	11	19	14	13	11	13	15	19	25	5	12	15	12	9.2	5.8	3.8	26.5	*13.2*
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	14.5	7.3	18.7	*18.7*

All birds cannon-netted in the period 1 November to mid-March. Means exclude figures in brackets (small samples) but include 2018/2019 figures.

For Sanderling catching adequate samples annually seems to be becoming more difficult each year. After the failure to obtain a useable sample last year we had one good catch, of 100 birds, this year. They seem to have had slightly below average breeding success in the 2018 Arctic summer.

Overall, for south-east Australia, breeding success in the Arctic summer of 2018 was slightly better than the extremely poor year of 2017. Nevertheless, four of the six species which were successfully monitored had breeding outcomes which were below average or worse. It is difficult to explain why, in contrast, Ruddy Turnstone and Sharp-tailed Sandpiper should have had much more successful breeding success than these other species.

North-west Australia

Wader populations which spend the non-breeding season in NWA had breeding outcomes which were generally below those of populations in SEA (Tables 3 and 4). Of the eight species monitored annually (those species shown in Table 3, excluding Ruddy Turnstone, Oriental Pratincole and Oriental Plover) only the Terek Sandpiper had an above average breeding success in the Arctic summer of 2018. Outcomes for four species were particular poor, with percentage juveniles in single figures (Table 3). It is presumed that the weather conditions and/or other breeding parameters were poor. Overall, 1561 waders were caught during the breeding success assessments in 2018/19.

Bar-tailed Godwits had a particularly bad breeding outcome (2.0% juveniles) in the 2018 breeding season. This is the second successive year with an extremely low breeding productivity. It was noticeable how relatively few Bar-tailed Godwits were present at high tide roosts, particularly along the area of 80 Mile Beach adjacent to Anna Plains Station. Gone are the days when the instruction to the cannon netting team was to ‘avoid catching any more Bar-tailed Godwit’!

Great Knot had another poor breeding year in 2018 (5.5% juveniles). It is now nine years since the average percentage juveniles was exceeded in this species.

In absolute terms Red Knot fared even worse (1.5% juveniles) during the most recent breeding season. This species is prone to rather wide fluctuations in breeding success from year to year and it was only two years ago that 21.6% juveniles were present in the summer populations in NWA.

Red-necked Stints in NWA had a second successive poor breeding year, as they have done in SEA.

The string of low annual productivity results continued in the Greater Sand Plover. It is now seven years since the long-term average percentage juveniles was exceeded.

Terek Sandpiper and Grey-tailed Tattler both continued a pattern of swinging quite markedly from year to year. Both had relatively good breeding success in 2018.

It is interesting that although the sample of Ruddy Turnstone was only small (16) in NWA they appeared to have had good breeding success in 2018. Similar high breeding success figures were also obtained for this species in SEA in the 2018/19 non-breeding season.

Figures are also included for Oriental Pratincole and Oriental Plover, two grassland species at Anna Plains / 80 Mile Beach which are not usually caught in sufficient numbers each year to be part of the regular monitoring programme. Both seem to have had relatively poor breeding success in 2018, but the norm for each species is of course not known at the present time.

CONCLUSION

It was disappointing that the overall breeding success results in the 2018/19 season were not a lot better in either SEA or NWA than the very poor results experienced in 2017/18. We will continue to monitor ‘percentage juveniles’ in the usual way in the 2019/20 non-breeding season. Let us hope this brings a significant improvement in the 2019/20 year.

ACKNOWLEDGEMENTS

As usual, the results are dependent on the fieldwork efforts of the Victorian Wader Study Group and the Australasian Wader Studies Group (especially the NWA 2019 Expedition). Their perseverance, often in adverse weather conditions, continues to be key to obtaining adequate data for an accurate assessment of annual breeding success.

All the relevant wildlife authorities are thanked for granting ethics and banding permits in Victoria, South Australia, Tasmania and Western Australia.

The financial assistance provided by the WA Parks and Wildlife Department was greatly appreciated. The Global Flyway Network is thanked for supporting Chris Hassell.

REFERENCES

Minton, C., R. Jessop, P. Collins & K. Gosbell 2005. Monitoring Wader Breeding Productivity by the proportion of first year birds in wader populations in S.E. Australian non-breeding areas. Pp. 73-85. *In:* Straw, P. (Ed.) Status and Conservation of Shorebirds in East Asian-Australasian Flyway. Proceedings of the Australian Shorebirds Conference, Canberra, Dec. 2003.IWSG Special Publication 17 and Wetlands International Global Series 18.

Minton, C., R. Jessop, P. Collins & C. Hassell 2000. 1999 Arctic breeding success from Australian perspective. *Arctic Birds* 2:19-20.

Minton, C & R. Jessop, C. Hassell, R. Patrick, R. Atkinson, & I. Marks 2018. Wader breeding success in the 2017 arctic summer, based on Juvenile ratios of birds which spend the non-breeding season in Australia. *Stilt.* 72:62-65.

Arctic Birds website: http://www.arcticbirds.net/doc.html

VWSG KING ISLAND TRIP 6-14 DECEMBER 2018

KATHERINE LEUNG[1], CLIVE MINTON[2], ROBYN ATKINSON[3], ROB PATRICK[4]

[1] Mai Po Nature Reserve, HONG KONG
[2]165 Dalgetty Road, Beaumaris, Victoria 3193, AUSTRALIA.
Email: atkinson.robyn@bigpond.com
[3] 31 Princess St, Drysdale, Victoria, 3222, AUSTRALIA
[4] 54 Myers Drive, Shoreham, Victoria, 3196, AUSTRALIA

The VWSG has been visiting King Island once or twice per year since March 2007. The prime objective has been monitoring the Ruddy Turnstone *Arenaria interpres* population (Fig. 1), which spends its non-breeding season there. This is the 12th year and 21st visit of this long-term study. The team of ten members visited King Island on 6-14 December 2018 aiming to achieve the following objectives:

1. to carry out a population count of Ruddy Turnstone on the complete west coast of King Island;
2. to evaluate the breeding success of Ruddy Turnstone in the 2018 Arctic breeding season by measuring the percentages of juveniles in catches;
3. to retrieve and deploy geolocators on Ruddy Turnstone; and
4. to facilitate Deakin University's research project on sampling of birds for the presence of avian diseases.
5. This report presents detailed results of the December 2018 visit, summaries of key data from all previous visits and some analysis of the % juvenile and weight data so far accumulated.

POPULATION COUNTS

A population count was carried out on the first day (6 December) during high tide as soon as the team arrived. All known sites along the west coast of the island at which Ruddy Turnstone are regularly present were visited. The total count was 671 individuals. Detailed results of the counts since 2008 are shown in Table 1 and Figure 2.

The total number of birds this year increased by 19% compared to 564 birds last December. Higher counts were recorded in the central and southern part of the island, while the number of birds in the northern part was like previous years. The count in the central part comprises over 50% of the total count.

It appears that the population has been recovering as a result of the very good Arctic breeding seasons in 2016 and 2018 (Fig. 2).

CATCHING

The visit was blessed with fine weather for most days, with five catches being made on six scheduled catching days. Catches were made at five locations across the central and southern part of the west coast of the island with catch sizes between 14 and 54 birds, and with a mean catch size of 38 birds (Table 2). The total number of birds caught was 193, including a record highest 191 Ruddy Turnstone caught in the November-December period, one Red-capped Plover and one Pied Oystercatcher (Table 3).

This visit brings the total number of Ruddy Turnstone caught on King Island since VWSG's first visit in 2007 to 3,462 individuals (with 254 individuals of other species of wader caught) (Table 4). A total of 123 catches has been made with an average catch size of 30 birds. Table 5 gives a breakdown of all catches made on King Island since the first visit in March 2007, in a total of 21 visits.

Table 1. Counts of Ruddy Turnstone on the west coast of King Island: Nov-Dec only. n.c.=not counted

Site West Coast	1985*	Nov-08	Nov-Dec 11	Nov-12	Nov-13	Nov-Dec 14	Nov-Dec 15	Nov-16	Dec-17	Dec-18
The Springs	-	-	61	-	55	3	25	28	45	45
Whistler Point	106	-	0	-	36	112	95	71**	80	0
Duck Bay, Green Island Point, South Whistler	260	-	130	-						81
Northern part TOTAL	**366**	**-**	**191**	**-**	**91**	**146**	**120**	**99**	**125**	**126**
Unlucky Bay	20	-	60	-	11	20	13	0	60	50
South Porky	28	-	0	-	37	20	0	5	8	50
Manuka – North (Whalebone)	-	-	5	-				35	27	59
Manuka - Central	67	-	60	-	88	145	127	50	25	30
Manuka - South	-	-	0	-				13	25	60
Currie Harbour	-	-	0	-	n.c.	n.c.	n.c.	0	0	0
Currie Golf Course (Burgess Bay)	330	-	35	-	69	80	90	69	80	50
Dripping Wells	-	-	90	-	60	55	60	60	70	60
Central part TOTAL	**445**	**-**	**250**	**-**	**265**	**320**	**290**	**232**	**295**	**359**
Seal Bay, Black Point	-	-	200	-	n.c.	n.c.	150	27	18	32
Surprise Bay (including Denby Beach)	-	-	12	-	125	182	1	113	55	130
Stokes Point to Surprise Bay	-	-	67	-	32	32	10	0	6	0
Stokes Point	-	-	0	-	33	74	60	30	65	24
Southern part TOTAL	**0**	**-**	**279**	**-**	**190**	**288**	**221**	**170**	**144**	**186**
TOTAL	**811**	**413*** **	**720**	**608*** **	**546**	**754**	**631**	**501**	**564**	**671**

* Count data by D.B. Whitchurch **plus 48 at Bungaroo, a site not regularly surveyed ***No site-specific data available

Figure 1. Ruddy Turnstone (by ©Mark Smith).

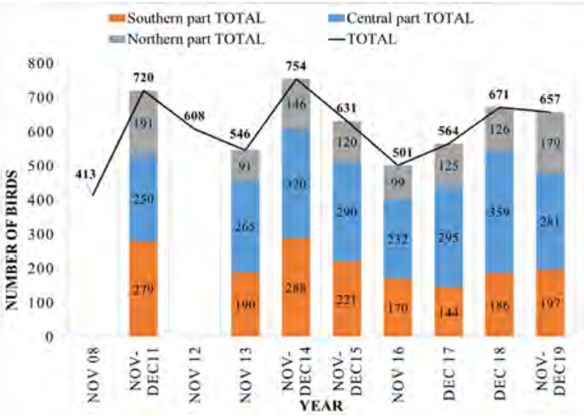


Figure 2. Population change in Ruddy Turnstone on King Island's west coast from 2008 to 2018.

Table 2. VWSG Catch Details: King Island Visit 6-14 December 2018.

Date	Location	Species	New	Re trap	Total	(Juv)	% Juv.
8 Dec	Burgess Bay	Ruddy Turnstone (2 geos retrieved)	14	13	**27**	10	**37.0**
9 Dec	Central Manuka	Ruddy Turnstone (3 geos retrieved)	6	8	**14**	3	**21.4**
9 Dec	North Manuka	Ruddy Turnstone (2 geos retrieved)	40	10	**50**	31	**62.0**
10 Dec	Surprise Bay	Ruddy Turnstone	46	8	**54**	21	**38.9**
12 Dec	Porky Beach	Ruddy Turnstone (2 geos retrieved)	18	28	**46**	13	**28.3**
		Red-capped Plover	1	0	**1**	0	-
		Pied Oystercatcher	1	0	**1**	0	-
		TOTAL	**20**	**28**	**48**		

Percentage Juveniles

An exceptionally high number of juveniles was recorded in the catches in this visit. There were 78 juveniles among the total of 191 Ruddy Turnstones caught (40.8%) indicating a very good breeding season for Ruddy Turnstone in the Arctic summer in 2018. This is especially encouraging after the low number of juveniles recorded in the previous year (5.7%).

Table 6 gives the percentage of juveniles over the past nine years. Only data from the November-December visits are included. The average juvenile percentage for November-December period was 17.7%.

Table 3. Catch Totals for King Island 6-14 December 2018.

Species	New	Retrap	Total	(Juv.)	% Juv.	5 catches
Ruddy Turnstone	124	67	**191**	78	40.8	9 geolocators retrieved on Ruddy Turnstone
Red-capped Plover	0	1	**1**	0	-	
Pied Oystercatcher	1	0	**1**	0	-	
TOTAL	**125**	**68**	**193**			

Note: All geolocators retrieved were replaced with new geolocators

Table 4. Catches on King Island 2007-2018.

Date of visit	Catches	Total Ruddy Turnstone caught	Total birds caught
March 2007	7	241	307
March 2008	8	419	434
March-April 2009	6	223	223
March 2010	8	211	217
November 2010	3	71	71
April 2011	8	197	211
November-December 2011	3	115	117
April 2012	7	118	118
November 2012	5	132	132
March-April 2013	10	255	285
November 2013	2	54	55
March 2014	6	173	181
November-December 2014	6*	147	151
February 2015	5*	119	154
November-December 2015	5	120	158
February 2016	4	74	78
November 2016	4	112	114
March-April 2017	7	218	229
December 2017	5	123	128
March 2018	9	149	160
December 2018	5	191	193
12 years (21 visits)	**123**	**3462**	**3716**
Average individual catch size:	**:**	**28**	**30**
Average catch total per visit		**165**	**176**

*Excludes 2 catches of Silver Gulls.
21 visits - 12 in February-April, 9 in November-December

This year's result continues to show that Ruddy Turnstone is a species subject to wide fluctuations in breeding success (Fig. 3). Based on November-December catches only, this is the second-best breeding season in the Arctic for Ruddy Turnstones, being exceeded only in 2013. This extreme variation in breeding success may be related to the Ruddy Turnstone breeding in the *higher* arctic regions of northern Siberia. Geolocator data has shown that the New Siberian Islands are the centre of the breeding area of the Ruddy Turnstones which spend the non-breeding season in south-east Australia.

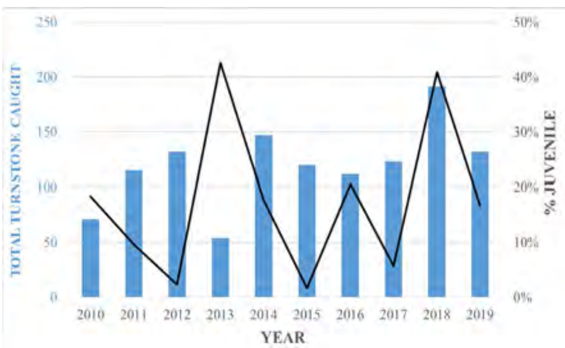


Figure 3. Total number of Ruddy Turnstone caught in Nov-Dec period 2010 to 2018 (blue bars). Black line shows the percentage juveniles in catches.

Table 5. Individual catch totals, by species, on King Island between March 2007 and December 2018.

Date	Number of catches	Species	New	Retrap	Total	Juv	% Juv
18-25 Mar 2007	7	Ruddy Turnstone	230	11	**241**	0	0
18-25 Mar 2007	-	Red-necked Stint	58	2	**60**	17	28.3
18-25 Mar 2007	-	Double-banded Plover	5	0	**5**	1	20
18-25 Mar 2007	-	Red-capped Plover	1	0	**1**	0	0
7-15 Mar 2008	8	Ruddy Turnstone	355	64	**419**	74	17.7
7-15 Mar 2008	-	Double-banded Plover	7	0	**7**	0	0
7-15 Mar 2008	-	Pied Oystercatcher	0	2	**2**	0	0
7-15 Mar 2008	-	Oystercatcher (not banded)			**6**		
26 Mar-2 Apr 2009	6	Ruddy Turnstone	124	99	**223**	0	0
16-23 Mar 2010	8	Ruddy Turnstone	123	88	**211**	30	14.2
16-23 Mar 2010	-	Double-banded Plover	5	0	**5**	4	80
16-23 Mar 2010	-	Sooty Oystercatcher	1	0	**1**	1	100
26 Nov-2 Dec 2010	3	Ruddy Turnstone	47	24	**71**	13	18.3
4-12 Apr 2011	8	Ruddy Turnstone	122	75	**197**	29	14.7
4-12 Apr 2011	-	Double-banded Plover	8	0	**8**	3	37.5
4-12 Apr 2011	-	Red-necked Stint	2	0	**2**	0	0
4-12 Apr 2011	-	Hooded Plover	2	0	**2**	0	0
4-12 Apr 2011	-	Red-capped Plover	2	0	**2**	0	0
27 Nov-2 Dec 2011	3	Ruddy Turnstone	49	66	**115**	11	9.6
27 Nov-2 Dec 2011	-	Other waders			**2**		
6-14 Apr 2012	7	Ruddy Turnstone	65	53	**118**	18	15.3
14-22 Nov 2012	5	Ruddy Turnstone	62	70	**132**	3	2.3
27 Mar-4 Apr 2013	10	Ruddy Turnstone	125	130	**255**	3	1.2
27 Mar-4 Apr 2013	-	Double-banded Plover	17	1	**18**	3	16.7
27 Mar-4 Apr 2013	-	Red-necked Stint	6	0	**6**	3	50
27 Mar-4 Apr 2013	-	Pied Oystercatcher	3	0	**3**	3	100
27 Mar-4 Apr 2013	-	Red-capped Plover	2	0	**2**	0	0
27 Mar-4 Apr 2013	-	Sooty Oystercatcher	1	0	**1**	0	0
18-24 Nov 2013	2	Ruddy Turnstone	31	23	**54**	23	42.6
18-24 Nov 2013	-	Other waders			**1**		
17-25 Mar 2014	6	Ruddy Turnstone	81	92	**173**	53	30.6
17-25 Mar 2014	-	Other waders			**8**		
23 Nov-1 Dec 2014	6	Ruddy Turnstone	76	71	**147**	26	17.7
23 Nov-1 Dec 2014	-	Pied Oystercatcher	3	0	**3**	0	0
23 Nov-1 Dec 2014	-	Red-capped Plover	1	0	**1**	0	0
7-16 Feb 2015	5	Ruddy Turnstone	56	63	**119**	17	13.4
7-16 Feb 2015	-	Red-necked Stint			**31**	7	22.6
7-16 Feb 2015	-	Pied Oystercatcher			**4**	0	0
26 Nov-3 Dec 2015	5	Ruddy Turnstone	53	67	**120**	2	1.7
26 Nov-3 Dec 2015	-	Red-necked Stint	14	3	**17**	2	11.8
26 Nov-3 Dec 2015	-	Pied Oystercatcher	15	2	**17**	0	0
26 Nov-3 Dec 2015	-	Sooty Oystercatcher	2	0	**2**	0	0
26 Nov-3 Dec 2015	-	Pacific Golden Plover	2	0	**2**	0	0
10-17 Feb 2016	4	Ruddy Turnstone	27	47	**74**	1	1.4
10-17 Feb 2016	-	Red-necked Stint	2	1	**3**	0	0
10-17 Feb 2016	-	Red-capped Plover	1	0	**1**	0	0
15-24 Nov 2016	4	Ruddy Turnstone	45	67	**112**	23	20.5
15-24 Nov 2016	-	Pied Oystercatcher			**1**		
28 Mar-6 Apr 2017	7	Ruddy Turnstone	125	93	**218**	68	31.2
28 Mar-6 Apr 2017	-	Hooded Plover	8	0	**8**	1	12.5
28 Mar-6 Apr 2017	-	Pied Oystercatcher	2	0	**2**	0	0
28 Mar-6 Apr 2017	-	Sooty Oystercatcher	1	0	**1**	0	0
4-13 Dec 2017	5	Ruddy Turnstone	61	62	**123**	7	5.7
4-13 Dec 2017	-	Pied Oystercatcher	5	0	**5**	0	0
17-26 Mar 2018	9	Ruddy Turnstone	86	63	**149**	4	2.7
17-26 Mar 2018	-	Double-banded Plover	8	1	**9**	0	0
17-26 Mar 2018	-	Red-capped Plover	1	0	**1**	1	100
17-26 Mar 2018	-	Sooty Oystercatcher	1	0	**1**	1	100
6-14 Dec 2018	5	Ruddy Turnstone	124	67	**191**	78	40.8
6-14 Dec 2018	-	Pied Oystercatcher	1	0	**1**	0	0
6-14 Dec 2018	-	Red-capped Plover	1	0	**1**	0	0

There seems to be some variation between the percentage juveniles recorded when comparing data in the November-December period to the February-April period in the same season (Table 7). Generally, the November-December percentages are slightly higher than the February-April figures. This could be explained partly by the fact that there are still a small number of juvenile birds on migration through King Island in November-December, on their way to other Tasmanian and New Zealand non-breeding areas.

Table 6. Juvenile proportions in Ruddy Turnstone catches on King Island in Nov-Dec period each year 2010 to 2018

Year	New	Retrap	Total	Juv	% Juv
2010	47	24	71	13	18.3%
2011	49	66	115	11	9.6%
2012	62	70	132	3	2.3%
2013	31	23	54	23	42.6%
2014	76	71	147	26	17.7%
2015	53	67	120	2	1.7%
2016	45	67	112	23	20.5%
2017	61	62	123	7	5.7%
2018	124	67	191	78	40.8%
TOTAL	**548**	**517**	**1065**	**186**	**17.7%**

Note: Only includes Nov-Dec catches, not Feb-Apr catches. Poor Arctic breeding years were 2012, 2015 and 2017.
Very good Arctic breeding years were 2013, 2016 and 2018

Table 7. Comparison of juvenile proportions in Ruddy Turnstone catches on King Island in Nov-Dec period to Feb-Apr period

Nov-Dec period			Feb-Apr period	
Year	**Total**	**% Juv**	**Total**	**% Juv**
2006-07	-	-	241	0%
2007-08	-	-	419	17.7%
2008-09	-	-	223	0%
2009-10	-	-	211	14.2%
2010-11	71	18.3%	197	14.7%
2011-12	115	9.6%	118	15.3%
2012-13	132	2.3%	255	1.2%
2013-14	54	42.6%	173	30.6%
2014-15	147	17.7%	119	14.3%
2015-16	120	1.7%	74	1.4%
2016-17	112	20.5%	218	31.2%
2017-18	123	5.7%	149	2.7%
2018-19	191	40.8%	-	-
TOTAL	**1065**	**17.7%**	**2397**	**11.9%**

Based on Feb/Apr data Poor Arctic breeding years were 2006, 2008, 2012, 2015 and 2017. Very good Arctic breeding years were 2013, 2016 and 2018.

Body Weight

A slightly higher mean body weight was recorded in juvenile Ruddy Turnstones (Mean ± se, 109.2 ± 1.3 g, range 77-137 g) than adult Ruddy Turnstones (101.1 ± 0.6 g, range 87-116 g) in this visit. A wider distribution of body weights can be observed among juvenile Ruddy Turnstones (Fig. 3).

In November-December, adult birds are at a constant low fat-free weight – as most waders are when they are carrying out their wing moult. Juvenile birds have a slightly higher body weight because a proportion of the juvenile population are still on southward migration and are therefore carrying fat reserves.

In the February-April period, the pre-migratory weight gain process in adult birds starts from the end of February and continues until birds have departed in mid-April. In contrast, juvenile birds do not put on any significant fat in the March-April period as they are not going to migrate in their first year (Fig. 4).

The typical fat-free weight of Ruddy Turnstones is in the range 95-100 g. The maximum mean body weight of a sample of adults recorded was 172 g. This is around a 70% addition of fat to the fat-free weight. The maximum individual weight of a Ruddy Turnstone recorded on King Island was 191 g. The average rate of weight increase of an adult Ruddy Turnstone during the fattening period is about 1g day^{-1}. This is equivalent to a 1% addition to the fat free weight per day.

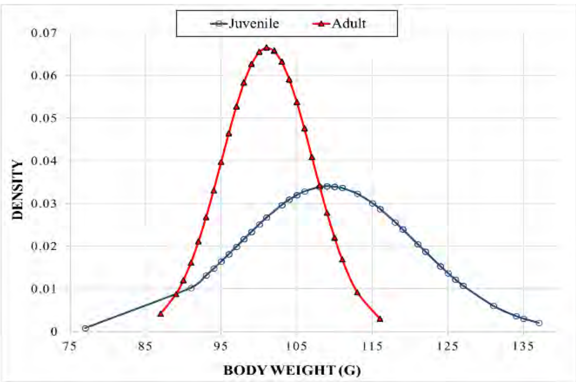


Figure 3. Body weight of adult and juvenile Ruddy Turnstones caught in December 2018.

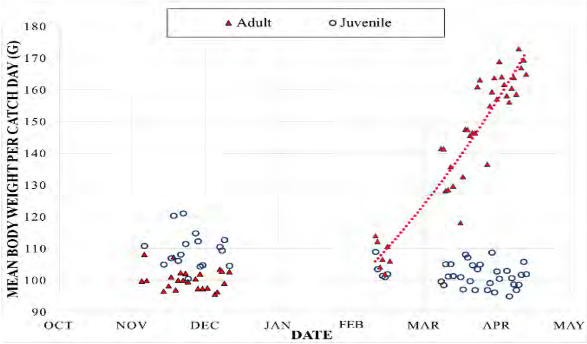


Figure 4. Comparison of adult and juvenile Ruddy Turnstone body weight in 2007-2018. Points on graph are means of weights of individual catches.

Geolocators

Nineold geolocators which were deployed in previous years (five on yellow flags and four on white flags) were retrieved on Ruddy Turnstone during this visit. Different flag colours for the geolocators are used each year. Of the nine geolocators, five could be downloaded but unfortunately four were either damaged or the battery had expired; these will be sent to the UK to obtain data. Of the five downloaded, preliminary results of the data are as follows:

- VRN and WEU: one year of data.
- WSV: two years of data (2016 and 2017 breeding seasons).
- XPV: two years of data (2017 and 2018 breeding seasons)
- YWY: two years of data (2017 and 2018 breeding seasons). Probable south migration through Japan and Papua New Guinea both years.

None of these birds have had a geolocator previously. More detailed results will be circulated in a separate report. A total of 385 geolocators have now been deployed on Ruddy Turnstone on King Island, with 166 retrieved (43%).

FLAG SIGHTINGS

Two hundred and thirty-three flag sightings were made during the visit, mainly via the regular and widespread scanning efforts of Katherine Leung and Marcel Klaassen. These sightings were recorded during the recce visits, in between catches and during rainy periods when no catch can be made. Sightings involved 129 Ruddy Turnstone, one Hooded Plover and 13 Pied Oystercatcher. Four of the Pied Oystercatchers had originally been marked in Victoria (Corner Inlet and Stockyard Point in Westernport). Ninety-seven of these Ruddy Turnstone individuals were not caught in any of the five catches and 24 of them are still carrying "old" geolocators (nine yellow and 15 white).

OTHER MATTERS

Deakin University studies on avian pathogens

As per other visits in the past years, Deakin University collected faecal swabs and blood to test for the presence of avian diseases (or the antibodies from previous infections) (Fig. 5), several papers already published (Wille *et al.* 2018).

Crested Terns

The Crested Tern breeding colony in Burgess Bay was again larger than normal – estimated at 1,800 pairs. This is slightly smaller than in 2017 (2,000 pairs) but still well above other recent years (800-1,000 pairs). 101 banded adults were recaptured and all had been previously banded as chicks in Victoria. Thirteen had also been previously recorded breeding at the Phillip Island colony (The Nobbies) and 3 at the Mud Islands colony. None of the 53 birds caught with bands in December 2017 were recaptured this year.

ACKNOWLEDGEMENTS

The VWSG thanks the following people and parties for their contribution towards another successful visit (not in particular order):

- Members of the field team for making themselves available for the visit and their financial contribution to cover their airfare, car hire, accommodation and daily living expenses;
- Jenny Marshall for kindly making her house available as headquarters for the team;
- Graeme and Margaret Batey for providing accommodation for two of the team members at their house;
- Margaret Bennett for providing space at her house for field equipment storage;
- King Island Airlines for transporting us and our equipment to and from King Island with great flexibility; and
- Roger Minton for arranging essential equipment to be sent from Melbourne mid-way through our visit.

FUTURE

It is hoped that a similar arrangement of two visits each year, one in February-April and one in the November-December period, will be continued to build up long-term valuable data and knowledge on the King Island Ruddy Turnstone population. Such long-term data will be increasingly important at a time of population change associated with habitat changes in the Flyway and climate change.

The King Island December 2018 Team

Clive Minton, Robyn Atkinson, Rob Patrick, Mark and Mem Smith, Prue Wright, Tessa Lamin, Marcel Klaassen, Michelle Wille and Katherine Leung, local King Island participants, including Graeme and Margaret Batey, Margaret Bennett and Liz.

REFERENCES

Wille, M., J.-S. Eden, M. Shi, M. Klaassen, A. C. Hurt & E. C. Holmes. 2018. Virus-virus interactions and host ecology are associated with RNA virome structure in wild birds. *Molecular Ecology* 27:5263-5278.

Figure 5. Collecting samples from Ruddy Turnstones (by ©Mark Smith).

NORTH-WEST AUSTRALIA WADER & TERN EXPEDITION 2019 SATURDAY 2ND FEBRUARY TO SUNDAY 24TH FEBRUARY 2019

CLIVE MINTON[1], ROZ JESSOP[2], CHRIS HASSELL[3], MIKE DAWKINS[4], PRUE WRIGHT[5] AND KATHERINE LEUNG[6]

[1] *165 Dalgetty Rd., Beaumaris Vic. 3193, Australia.*
Email: Chairvwsg@Gmail.Com
[2] *Phillip Island Nature Park, Po Box 97, Cowes, Vic. 3922, Australia.*
[3] *Po Box 3089, Broome, Western Australia 6725, Australia.*
[4] *15 The Boulevard, Wy Yung, Vic. 3875, Australia.*
[6] *Mai Po Nature Reserve, N.T., Hong Kong*

INTRODUCTION

After the challenging AWSG North-west Australia Expedition in 2018 – greatly impacted by unprecedented rains and a direct hit from a tropical cyclone – the NWA 2019 Expedition could only have been an improvement! In fact, it was a very successful and enjoyable event, greatly aided by almost unprecedented favourable, dry weather. Most of the key objectives were met, some exciting and unexpected results were obtained from our satellite transmitters and it happened to be an excellent year for the four species of migratory birds (Oriental Pratincole, Little Curlew, Oriental Plover and White-winged Black Tern) which feed almost exclusively on the insects of the coastal grasslands of Anna Plains Station (adjacent to 80 Mile Beach).

Low-lights (relative) were the below average catching success, particularly on 80 Mile Beach, brought about by two misfires (cartridges not going off when the net was fired) and by stronger than normal onshore winds (which prevented the net going out fully) for much of the period the team was based at Anna Plains. We also spent two days targeting Little Curlew for deploying PTTs which prevented us making general shorebird catches.

Overall, the NWA 2019 Expedition was a significant success and one on which many people have commented how much they enjoyed themselves.

OBJECTIVES

The specific objectives of this Expedition were to:

- obtain an estimate of the relative breeding success in the 2018 Arctic breeding season of all the main species of migratory waders. This is achieved by measuring the proportion of juveniles in catches;
- catch additional samples of species which are less frequently caught in NW Australia, e.g. Black-tailed Godwit, Whimbrel, Grey Plover, Common Greenshank, Oriental Plover, Eastern Curlew, Little Curlew and Oriental Pratincole; and
- continue the program of putting individually lettered/numbered yellow leg flags on all the main medium/large migratory wader species caught at Broome and, several species at 80 Mile Beach. This is to facilitate the collection and calculation of survival rate data in the future and to enhance the migration path information obtained from flagged birds seen overseas.

MAIN ACHIEVEMENTS

Catching

Having driven to Anna Plains on the day after the team arrived in Broome, 11 catches were made in the next 12 days. On two days two catches were made, with the two net sets being each fired separately at different times (though the two catches were pooled in the 'totals list'). On only one day was a catch missed.

However, the average catch size – close to 100 birds – was less than half the usual level for 80 Mile Beach. This was, as already mentioned, mainly because of the strong onshore winds (and the two misfires) restricting the net throw to only five or six metres instead of the usual ten metres.

The largest catch was 397 birds, including 304 Great Knot. Other particularly notable catches were 100 Greater Sand Plover, 131, 126 and 58 White-winged Black Terns (three separate catches), 149 Great Knot, 14 Little Curlew and, finally, 95 Oriental Pratincole. These were caught on one of the paddocks on Anna Plains Station where they were guzzling newly hatched grasshoppers! The catch was made at 17:30 on our last full day at Anna Plains, and because it was just before dusk, the birds were brought back to the Station homestead and housed overnight in keeping cages. The whole team was up and ready to start processing at 05:30 the next morning. This was one of the most memorable parts of the whole Expedition, with mist rising from the paddocks as the sky gradually lightened and another glorious day of blue skies and sunshine arrived. Overall, 1589 birds were caught at Anna Plains / 80 Mile Beach (Table 1). This is close to the average for the last five years. Daily totals are shown in Appendix 1.

Good catching success was also experienced at Broome, though catches were only made on four of the six available days. Disturbance by birds of prey was a problem throughout and cost us several promising opportunities. The biggest catch was 342 which included 188 Great Knot. Another notable catch was 170 White-headed Stilt. The interest level in this species has escalated recently as a result of the first overseas resighting, in Indonesia, indicating that at least a portion of the Australian population is migratory. Fourteen long-distance movements (mainly to the Perth area, 1400-1700 km) have also now accrued from recoveries and flag-sightings of White-headed Stilts originally marked in the Broome area. It was pleasing to be able to make two small catches of Eastern Curlew (4+6), a species which has only infrequently been caught on previous Expeditions.

The total catch at Roebuck Bay, Broome, was 539 birds, significantly below other recent years (Table 2). Daily totals are shown in Appendix 1.

Overall, the Expedition caught a total of 2128 birds, of which 1783 were waders (19 species) and 345 were terns (4 species) (Table 3).

The overall total was at the bottom end of the normal range (2000-4000) if the exceptionally poor year of 2018 is omitted.

Retraps and controls

Four birds carrying bands put on elsewhere were caught during the Expedition (Table 4). It was particularly nice to recapture a Terek Sandpiper originally banded at Rudong, Jiangsu Province in China in April 2017. It was also nice to recapture a Red-necked Stint which had originally been marked in South Australia in March 2016. This bird had presumably changed its non-breeding area, as northward migration of Red-necked Stint within Australia does not normally commence until April.

The proportion of retraps in our total catch was the lowest ever, at only 6.3%. This was partly because only 25% of the total catch during the Expedition was made at Roebuck Bay. The intensity of banding there has always been much higher than at 80 Mile Beach with a consequent order of magnitude difference often occurring in the retrap rate between the two locations. This year the retrap rate at 80 Mile Beach was 2.5% whereas it was still 17.6% at Roebuck Bay (and an average of 26% over the previous five years) despite poor catching there during the cyclone affected Expedition in February 2018.

Old birds

It is always particularly pleasing to see the old ages reached by some of the retraps we make (Table 5). The oldest bird this year was a Great Knot originally banded in July 1994 and now at least 26-years-old. This is the oldest Great Knot we've had so far during our wader studies in North-west Australia.

Not far behind it in age was a 25-year-old Bar-tailed Godwit. Of other species a 19-year-old Red Knot was particularly pleasing, and a 15-year-old Ruddy Turnstone and 15-year-old White-headed Stilt were notable.

We have had 15-year-old retraps in several species now over the years but only a few individuals ever get to the age of 20 years or more. Our oldest bird so far is a Bar-tailed Godwit at 28 years.

Table 1. NWA 2019 Expedition Catch Totals (Waders and Terns).

Date	Location	Sub-site	New	Retrap	Total
4/02/2019	80 Mile Beach	8km south of AP	74	1	75
5/02/2019	80 Mile Beach	14km south of AP	117	2	119
6/02/2019	80 Mile Beach	22km south of AP	63	1	64
7/02/2019	80 Mile Beach	42km south of AP	382	15	397
8/02/2019	80 Mile Beach	42km south of AP	81	5	86
9/02/2019	80 Mile Beach	42km south of AP	54	2	56
10/02/2019	80 Mile Beach	42km south of AP	9	0	9
11/02/2019	80 Mile Beach	25km south of AP	170	7	177
12/02/2019	80 Mile Beach	23km south of AP	146	6	152
14/02/2019	80 Mile Beach	20km south of AP	14	0	14
15/02/2019	Anna Plains Station	17km south of AP	95	0	95
		Sub-total (waders)	***1205***	***39***	***1244***
Terns	80 Mile Beach		344	1	345
	Total Anna Plains/80 Mile Beach		***1549***	***40***	***1589***
18/02/2019	Broome	Minton Straight	2	2	4
19/02/2019	Broome	Stilt Viewing	139	31	170
21/02/2019	Broome	Campsite Beach	22	1	23
22/02/2019	Broome	Nick's Beach	281	61	342
		Sub-total (waders)	***444***	***95***	***539***
Terns	Broome		*0*	*0*	0
		Total Broome	***444***	***95***	***539***
		Total Waders	**1649**	**134**	**1783**
		Total Terns	**344**	**1**	**345**
		Total Waders and Terns	**1993**	**135**	**2128**

Table 2. Comparison of catches during the 2006-2019 Expeditions (including terns).

Catches	Year	New	Retrap	Total
Broome	2014	1229	565	1794
	2015	623	288	911
	2016	1529	365	1894
	2017	688	238	926
	2018	661	177	838
	2019	**444**	**95**	**539**
80 Mile Beach	2014	1928	108	2036
	2015	1152	46	1198
	2016	2312	97	2409
	2017	1598	54	1652
	2018	412	17	429
	2019	**1549**	**40**	**1589**
Total	2014	3157	675	3830
	2015	1775	334	2109
	2016	3841	462	4303
	2017	2286	292	2578
	2018	1073	194	1267
	2019	**1993**	**135**	**2128**

Table 3. NWA 2019 Expedition - Wader and Tern catch summary.

Species	New	Retrap	Total	Juvenile	% Juv
Great Knot	696	62	758	42	6%
Greater Sand Plover	225	7	232	34	15%
White-headed Stilt	139	31	170	25	15%
Red-necked Stint	110	8	118	10	8%
Oriental Pratincole	113	0	113	7	6%
Bar-tailed Godwit	88	15	103	2	2%
Red Knot	64	2	66	1	2%
Curlew Sandpiper	55	3	58	8	14%
Grey-tailed Tattler	43	2	45	7	16%
Terek Sandpiper	33	1	34	9	26%
Oriental Plover	25	0	25	1	
Red-capped Plover	17	0	17	0	
Ruddy Turnstone	15	1	16	4	
Little Curlew	14	0	14	0	
Eastern Curlew	8	2	10	0	
Grey Plover	1	0	1	0	
Lesser Sand Plover	1	0	1	0	
Sanderling	1	0	1	0	
Sharp-tailed Sandpiper	1	0	1	0	
White-winged Black Tern	318	1	319	11	3%
Whiskered Tern	21	0	21	0	
Little Tern	4	0	4	1	
Crested Tern	1	0	1	0	
TOTAL	**1993**	**135**	**2128**	**162**	

Proportion of juveniles

One of the key outputs of each year's NWA Expedition is the measurement of annual breeding productivity which we obtain via the percentage of juvenile / first year birds in catches (Table 6). We struggled to obtain an adequate catch sample for some of our regularly monitored species but overall did manage to get a reasonable estimate for 12 species (Table 6). It appears that the 2018 breeding success of the wader populations which come to North-west Australia was, on average, poor / very poor. Only two species (Terek Sandpiper 26.5% and Ruddy Turnstone 25.0%) had breeding outcomes which appeared to be satisfactory. This is the second time in the last three years that there has been an almost complete breeding failure in the wader populations which spend the non-breeding season in north-west Australia. This is likely to have an adverse effect on population numbers.

Satellite transmitters

A high priority was given during the Expedition to trying to deploy trackers on four species of waders.

Five satellite trackers were deployed, in AWSG's name, on Oriental Pratincoles (2 g PTT units) and another five on Little Curlew (5 g PTT units). Eight GPS trackers (15 g units) were put onto Eastern Curlews at Roebuck Bay on behalf of Amanda Lilleyman from Charles Darwin University, who is coordinating a national project. Unfortunately, the plan to deploy 20 GSM-GPS tracking units on Whimbrel on behalf of Professor Ma at Fudan University, China, was thwarted when a bird of prey disturbed the 100 or so birds which were gradually assembling in front of the cannon nets at Roebuck Bay.

So far (late April) the results from the Oriental Pratincole have been phenomenal! They started to move around widely in North-west Australia almost immediately after they had been caught (on February 8). Within two weeks one had already set off over the sea on northward migration and, amazingly, this bird reached a lake in Cambodia in less than five days (4200 km flown). By March 21 a second bird had reached Cambodia, another one had reached Thailand and the fourth one was moving north through Borneo (eventually landed in Vietnam). The fifth transmitter unfortunately failed soon after deployment, or the bird was predated.

For a time, all four birds were closer to each other on the Asian continent than they had been in North-west Australia! But then two parted with one going to the east to Taiwan and the other to south-west India. They are probably now close to the areas where they will breed. No wader visiting Australia has previously been recorded breeding in India.

Previously there had only been one overseas flag-sighting (a bird from Anna Plains which subsequently

Table 4. NWA 2019 controls (recaptures of birds banded elsewhere).

Species	Country and location of origin	Band number	Condition of band	Age at Capture	Retrap Date	Retrap location	Flags	Australian Band added	Banding date
Terek Sandpiper	China (Jiangsu)	E114607	Corroded	2+	5/02/2019	80 Mile Beach	Upper left - Green over Blue	052-81344	25/04/2017
Great Knot	China (Chongming Dongtan)	F131444	Good	2+	7/02/2019	80 Mile Beach	Upper right - Black over White C90	-	6/04/2014
Great Knot	China (Chongming Dongtan)	-	Corroded	Unknown	22/02/2019	Nick's Beach, Roebuck Bay	Upper right - Black over White	063-31681	Unknown
Red-necked Stint	Port Macdonnell, South Australia	036-92768	Good	2+	22/02/2019	Nick's Beach, Roebuck Bay	Upper right - Orange over Yellow	-	25/03/2016

Table 5. Oldest recaptures during NWA 2019.

Species	Band	Date Banded	Banding Location	Age at Banding	Retrap Date	Retrap location	Minimum age at Retrap
Great Knot	062-09414	28/07/1994	Roebuck Bay	1+	22/02/2019	Roebuck Bay (Nick's Beach)	26+
Bar-tailed Godwit	072-55884	6/03/1996	Roebuck Bay	2	22/02/2019	Roebuck Bay (Nick's Beach)	25
Great Knot	062-57589	30/05/2000	Roebuck Bay	2	6/02/2019	80 Mile Beach (20-25km S)	21
Bar-tailed Godwit	072-78928	18/01/2001	Roebuck Bay	2+	22/02/2019	Roebuck Bay (Nick's Beach)	20+
Red Knot	052-00657	30/05/2000	Roebuck Bay	1	12/02/2019	80 Mile Beach (20-25km S)	19
Bar-tailed Godwit	073-01006	1/12/2002	Roebuck Bay	2+	22/02/2019	Roebuck Bay (Nick's Beach)	18+
Bar-tailed Godwit	073-00800	13/02/2004	Roebuck Bay	2+	22/02/2019	Roebuck Bay (Nick's Beach)	17+
Bar-tailed Godwit	073-22267	27/08/2006	Roebuck Bay	3+	22/02/2019	Roebuck Bay (Nick's Beach)	15+
Ruddy Turnstone	052-40145	26/06/2005	Roebuck Bay	1	21/02/2019	Roebuck Bay (Nick's Beach)	15
Great Knot	063-00880	16/09/2007	Roebuck Bay	3+	22/02/2019	Roebuck Bay (Nick's Beach)	14+
Great Knot	062-89677	20/11/2006	Roebuck Bay	2+	22/02/2019	Roebuck Bay (Nick's Beach)	14+
Great Knot	063-03050	27/11/2007	Roebuck Bay	3+	22/02/2019	Roebuck Bay (Nick's Beach)	14+
Great Knot	062-89317	19/11/2006	80 Mile Beach	2	12/02/2019	80 Mile Beach (20-25km S)	14
White-headed Stilt	083-22389	1/08/2006	Roebuck Bay	2	19/02/2019	Roebuck Bay (Stilt Viewing)	14

Table 6. Percent juveniles in cannon net catches during NWA 2019 Expedition.

Species	Number cannon netted	Juveniles	% Juv	Mean % Juv 1998/99 to 2017/18	2018 breeding success
Great Knot	758	42	5.5%	10.7	Poor
Greater Sand Plover	232	34	14.7%	21.7	Poor
White-headed Stilt	170	25	14.7%	N/A	Probably average
Red-necked Stint	118	10	8.5%	18.8	Very poor
Oriental Pratincole	113	7	6.2%	N/A	?
Bar-tailed Godwit	103	2	1.9%	10.4	Very poor
Red Knot	66	1	1.5%	15.8	Very poor
Curlew Sandpiper	58	8	13.8%	17.4	Below average
Grey-tailed Tattler	45	7	15.6%	18.9	Below average
Terek Sandpiper	34	9	26.5%	12.5	Good
Oriental Plover	25	1	4.0%	N/A	Probably poor
Ruddy Turnstone	16	4	25.0%	N/A	Very good

bred in Taiwan) from 620 Oriental Pratincoles marked in North-west Australia. So at least we are beginning to find out something about the migration of this species which, with an estimated population of at least 2.8 million, is the most numerous migratory wader species visiting Australia. We are hoping the results may also throw some light on why the species only arrives in Australia during December and mostly leaves again (as our results have confirmed) in February, when there still seems to be voluminous food supplies available here.

The Little Curlew, Whimbrel and Eastern Curlew are now mostly also on the move. A report detailing the situation for each species (including Oriental Pratincole) is produced each week and circulated widely, including to all NWA 2019 Expedition participants. The ongoing results are also posted on the AWSG website. Already we've had an excellent dividend from this year's satellite tracking and we're only partly through the northward migration sector of the year!

Passerines

Leisure time enjoyment came from small scale mist netting around the Anna Plains homestead (Table 7). It was nice to recapture there a Pied Butcherbird originally banded there 12 years ago!

Table 7. AWSG Passerine Mist-netting 2019.

Location, Date and Species	New	Retrap	Total
Anna Plains Station Homestead			
13th February 5.00 am to 07.45 am			
Sacred Kingfisher	2	0	2
Pied Butcherbird	1	0	1
White-breasted Woodswallow	1	0	1
Yellow-throated Miner	1	0	1
Total	**5**	**0**	**5**
Anna Plains Station Homestead			
14th February 5.00 am to 6.45 am			
Red-winged Parrot	2	0	2
Pied Butcherbird (banded 2007)	0	1	1
Sacred Kingfisher	1	0	1
Total	**1**	**1**	**2**
Anna Plains Station Homestead			
15th February 5.00 am to 7.00 am			
Yellow-throated Miner	2	0	2
Total	**2**	**0**	**2**

OTHER MATTERS

Participants

A total of 28 people took part in the Expedition over the 23-day period. 24 of these were in the team at Anna Plains / 80 Mile Beach and four additional people only participated in the later, Broome section of the Expedition.

Only seven participants (25%) this year came from overseas – only about half the usual overseas content. This reduced proportion may be because the Expedition little advanced publicity this year because several editions of The Tattler newsletter were not produced.

The AWSG was assisted by regular involvement of rangers from the Karajarri, Ngarla & Nyangumarta, Yamatji Marlpa and Yawuru traditional owner corporations.

Victoria was particularly strongly represented this year in the Australian participants. The full details of origins are:

21 Australia (12 Vic, 4 WA, 2 Qld, 1NT, 1 ACT, 1 NSW)
2 China
2 Netherlands
1 Hong Kong, China
1 Bangladesh
1 Taiwan

Talks

A programme of evening talks (10) presented by Expedition members took place, although the talks were fewer in number than in previous years. This was not due to a shortage of offers: more to the long days in the field leaving the team too tired for presentations on some evenings!

Itinerary

This year the Expedition was able to follow the planned itinerary, spending the first twelve days at 80 Mile Beach (based at Anna Plains Station) and the final seven days at Broome (based at Broome Bird Observatory). A 'day off' was set aside for birdwatching at each location during the period of neap tides.

Finances

The Expedition incurred higher costs in 2019 primarily as a result of the planned change to having a professional caterer look after the food procurement and cooking for the Expedition. An extra significant cost was also incurred in hiring a large marquee from Anna Plains Station. Both these additions were greatly welcomed by Expedition participants, even though the full benefits of the marquee would only have been apparent if we had coincided with a period of wet weather. It is too early yet to ascertain whether the increased participant contributions have adequately covered these extra costs in 2019.

The NWA 2018 finances have now been closed. As expected, monies in hand at the end of the expedition have paid for satellite download time.

Weather conditions

As already mentioned, the weather was very favourable for the AWSG NWA Expedition this year! In 23 days we only had rain on four occasions, all of which were in the evening / at night and which therefore did not interfere with our planned fieldwork programme. On only one occasion was the rain significant – when we had a severe tropical thunderstorm for 1.5 hours around 21:00 one night at Broome. Fifty mm of rain fell in just over an hour, but the greatest problem arose from the 130 km/hr winds which persisted for most of this time. The continuous sheet lighting was something which most people had never experienced before and would have been quite entertaining if it had not been accompanied by such strong winds (which collapsed six of the nine tents).

NEXT EXPEDITION

The next Expedition to NWA (NWA 2020) will take place from Friday 7 February to Sunday 1 March. It will follow the usual format of a period at 80 Mile Beach (9 days) – based at Anna Plains Station – and a period at

Roebuck Bay, Broome (9 days) – based at Broome Bird Observatory. We hope to assemble another experienced team, preferably of 25-28 people with a significant proportion coming from countries outside Australia. We hope that as many people as possible who were on the NWA 2019 Expedition will return again in 2020 – or alternatively will try and arrange for an equally experienced person to participate in their place! A detailed brochure containing costs and the daily schedule is already available – contact any of the team leaders.

ACKNOWLEDGEMENTS

Considerable thanks are due to WA Department of Biodiversity, Conservation and Attractions not only for providing two vehicles and trailers but also for financially assisting the participation of four of the participants from the EAAF.

We are again enormously grateful to Stoate family of Anna Plains Station for hosting the Expedition.

AWSG acknowledges the Yawuru People via the offices of Nyamba Buru Yawuru Limited for permission to catch birds on the shores of Roebuck Bay, traditional lands of the Yawuru people. AWSG acknowledges the Karajarri and Nyangumarta people for permission to catch birds to be marked for this project on the shores of 80 Mile Beach, traditional lands of the Karajarri and Nyangumarta people.

The WA State Wildlife Authorities and the Bird Banding Office in Canberra are thanked for providing appropriate banding/study permits.

LIST OF PARTICIPANTS

Australia (21):

Vic: Bob Brinkman, Bretan Clifford, Mike Dawkins, Olivia Gourley, Roz Jessop, Ila Marks, Gary Matthews, Pat McWhirter, Eric Miller, Heidi Miller, Clive Minton and Prue Wright.

WA: Chris Hassell, Grace Maglio, Jill Rowbottom and Tegan Douglas.

Qld: Robert Bush and Micha Jackson

NT: Peter Newberry

NSW: Tom Clarke

ACT: Adam Leavesley

China:

Rainy Cai and Chuyu Cheng

Hong Kong, China:

Katherine Leung

Taiwan:

Chung Yu Chiang

Netherlands:

Loes de Jong and Annabel Slettenhaar

Bangladesh:

Bisharga Delip K. Das

Appendix 1. Daily catch details NWA 2019.

Location	Species	New	Retrap	Total	JUV	Comments	Nets set
80 MILE BEACH	Curlew Sandpiper	45	1	46	5		2 small mesh
04-02-19	Red-necked Stint	16	0	16	0		Nets fired = 2@10:00
8km S of AP	Greater Sand Plover	4	0	4	1		
	Red-caped Plover	4	0	4	0		
	Terek Sandpiper	4	0	4	0		
	Oriental Plover	1	0	1	0		
	Catch total	**74**	**1**	**75**			
80 MILE BEACH	Terek Sandpiper	6	1	7	*1*	1 oversea control from Jiangsu, China	2 small mesh
05-02-19	Greater Sand Plover	99	1	100	*16*		Net fired = 1@11:10
14km South of AP	Great Knot	4	0	4	*0*		
	Red-necked Stint	4	0	4	*0*		
	Curlew Sandpiper	3	0	3	*0*		
	Grey-tailed Tattler	1	0	1	*0*		
	Catch total	**117**	**2**	**119**			
80 MILE BEACH	Great Knot	29	1	30	0		2 small mesh
06-02-19	Greater Sand Plover	19	0	19	3		Net fired=1@ 11:25
22km South of AP	Grey-tailed Tattler	9	0	9	1		
	Oriental Plover	2	0	2	1		
	Lesser Sand Plover	1	0	1	0		
	Sanderling	1	0	1	0		
	Curlew Sandpiper	1	0	1	1		
	Terek Sandpiper	1	0	1	0		
	Wader total	63	1	64			
	White-winged Black Tern	4	0	4	0		
	Whiskered Tern	2	0	2	0		
	Tern total	6	0	6			
	Catch total	**69**	**1**	**70**			
80 MILE BEACH	Great Knot	292	12	304	12	1 oversea control from Chongming	2 small mesh
07-02-19	Greater Sand Plover	46	2	48	6	Dongtan, China	Net fired=1@ 12:45
42km South of AP	Red Knot	17	0	17	1		
	Terek Sandpiper	16	0	16	4		
	Grey-tailed Tattler	8	1	9	1		
	Oriental Plover	1	0	1	0		
	Curlew Sandpiper	1	0	1	0		
	Bar-tailed Godwit	1	0	1	0		
	Catch total	**382**	**15**	**397**			
80 MILE BEACH	Red-necked Stint	37	1	38	9		2 small mesh
08-02-19	Greater Sand Plover	16	2	18	0		Nets fired=1@ 12:10
42km South of AP	Oriental Pratincole	17	0	17	2	5 satellite tags deployed	=1@ 13:00
	Red-caped Plover	7	0	7	0		
	Oriental Plover	3	0	3	0		

	Curlew Sandpiper	0	1	1	0		
	Grey-tailed Tattler	0	1	1	0		
	Terek Sandpiper	1	0	1	0		
	Wader total	81	5	86			
	White-winged Black Tern	58	0	58	4		
	Whiskered Tern	5	0	5	0		
	Little Tern	3	0	3	0		
	Tern total	66	0	66			
	Catch total	**147**	**5**	**152**			
80 MILE BEACH	Red-necked Stint	27	2	29	0		2 small mesh
09-02-19	Oriental Plover	14	0	14	0		Nets fired=1@ 12:45
42km South of AP	Red-caped Plover	6	0	6	0		=1@ 13:15
	Greater Sand Plover	4	0	4	0		
	Curlew Sandpiper	2	0	2	1		
	Oriental Pratincole	1	0	1	0		
	Wader total	54	2	56			
	White-winged Black Tern	126	0	126	3		
	Whiskered Tern	4	0	4	0		
	Little Tern	1	0	1	1		
	Crested Tern	1	0	1	0		
	Tern total	132	0	132			
	Catch total	**186**	**2**	**188**			
80 MILE BEACH	Oriental Plover	4	0	4	0		2 small mesh
10-02-19	Greater Sand Plover	3	0	3	1		Nets fired=2@ 13:45
42km South of AP	Red-necked Stint	1	0	1	0		
	Sharp-tailed Sandpiper	1	0	1	0		
	Wader total	9	0	9			
	White-winged Black Tern	130	1	131	4		
	Whiskered Tern	10	0	10	0		
	Tern total	140	1	141			
	Catch total	**149**	**1**	**150**			
80 MILE BEACH	Great Knot	143	6	149	3		2 small mesh
11-02-19	Bar-tailed Godwit	15	1	16	1		Net fired=1@ 14:05
25km South of AP	Grey-tailed Tattler	6	0	6	1		
	Terek Sandpiper	2	0	2	2		
	Greater Sand Plover	2	0	2	0		
	Curlew Sandpiper	1	0	1	0		
	Red Knot	1	0	1	0		
	Catch total	**170**	**7**	**177**			
80 MILE BEACH	Great Knot	79	4	83	4		2 small mesh
12-02-19	Red Knot	40	2	42	0		Net fired=1@ 14:00
23km South of AP	Grey-tailed Tattler	18	0	18	4		
	Greater Sand Plover	6	0	6	1		
	Terek Sandpiper	3	0	3	2		
	Catch total	**146**	**6**	**152**			
80 MILE BEACH	Little Curlew	14	0	14	0	5 satellite tags deployed	2 small mesh
14-02-19	**Catch total**	**14**	**0**	**14**			Net fired=1@ 13:00
20km South of AP							
80 MILE BEACH	Oriental Pratincole	95	0	95	5		1 small mesh
15-02-19	**Catch total**	**95**	**0**	**95**			Net fired=1@ 17:45
AP Station							
BROOME	Eastern Curlew	2	2	4	0	4 satellite tags deployed	1 small mesh
18-02-19	**Catch total**	**2**	**2**	**4**			Net fired = 1 @ 09:15
Minton Straight							
BROOME	White-headed Stilt	139	31	170	25		1 small mesh
21-02-19	**Catch total**	**139**	**31**	**170**	**25**		Net fired = 1 @ 09:00
Stilt Viewing							
Campsite Beach	Ruddy Turnstone	15	1	16	4		2 small mesh
	Grey Plover	1	0	1	0		Net fired = 1 @ 10:10
	Eastern Curlew	6	0	6	0	4 satellite tags deployed	
	Catch total	**22**	**1**	**23**			
BROOME	Great Knot	149	39	188	23	26 released at net including 2 retraps	1 small mesh
22-02-19	Bar-tailed Godwit	72	14	86	1		Net fired = 1 @11:10
Nick's Beach	Red-necked Stint	25	5	30	1		
	Greater Sand Plover	26	2	28	6		
	Red Knot	6	0	6	0		
	Curlew Sandpiper	2	1	3	1		
	Grey-tailed Tattler	1	0	1	0		
	Catch total	**281**	**61**	**342**			

VWSG KING ISLAND VISIT REPORT, 22 – 31 MARCH 2019

CLIVE MINTON[1], ROBYN ATKINSON[2], KATHERINE LEUNG[3] AND ROB PATRICK[4]

[1]165 Dalgetty Road, Beaumaris, Victoria 3193, AUSTRALIA.
[2] 31 Princess St, Drysdale, Victoria, 3222, AUSTRALIA.
Email: atkinson.robyn@bigpond.com
[3] Mai Po Nature Reserve, HONG KONG
Email: kalidris_kl@yahoo.com
[4] 54 Myers Drive, Shoreham, Victoria, 3196, AUSTRALIA.
Email: rob@farmingminds.com.au

This visit was the 22nd to King Island by the VWSG and was one of the best-ever to King Island from both an enjoyment and from a successful fieldwork point of view. The highlights were the retrieval of 23 geolocators from Ruddy Turnstone, the third highest ever total catch of Ruddy Turnstone (249) and the deployment of a total of a further 58 geolocators. It was also extremely pleasing that the population count of Turnstones on the west side of King Island was the highest for many years, as a result of two particularly good breeding years (in the 2016 and 2018 artic summers – see percentage juveniles in catches data).

Below is a more detailed report on the ten days of fieldwork. It is intended that the twice-yearly visits (November / December and March / April) be continued into the future to extend our (current) thirteen-year dataset on the Ruddy Turnstones of King Island.

Figure 1. Ruddy Turnstones roosting on rock at South Porky, including one carrying a yellow geolocator (by ©Rob Bush)

POPULATION COUNTS

As usual, all the known locations for Ruddy Turnstone along the complete west coast of King Island were counted over the high tide period on 22 March (Fig 1). Some small gaps in this count were subsequently filled with counts at other times during the 'expedition'.

The total of 823 birds observed was only just below the 853 counted in March/April 2017. Previously the highest count in the March/April period was 890 in March 2010 (Fig. 2 and Table 1).

It seems likely that the higher population levels in recent years are the direct result of above average breeding productivity in three of the last four breeding seasons (see later section on Percentage Juveniles).

After lower populations in recent years it will be interesting to see if this higher level can be maintained in the future when breeding productivity levels will presumably return to more normal levels.

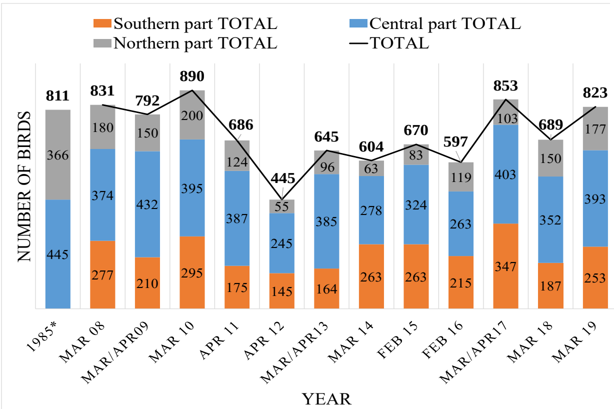


Figure 2. Population change in Ruddy Turnstone on King Island's west coast from 1985 to 2019.

Table 1. Counts of Ruddy Turnstone on King Island: Feb/Mar/Apr period. n.c.=not counted

West Coast	1985*	Mar 08	Mar/Apr09	Mar 10	Apr 11	Apr 12	Mar/Apr13	Mar 14	Feb 15	Feb 16	Mar/Apr17	Mar 18	Mar 19
The Springs	-	n.c.	n.c.	45	50	20	26	28	23	24	30	50	64
Whistler Point	106	180	55	40	4	0	0	0	0	42	2	45	0
Duck Bay, Green Island Point, South Whistler	260		95	115	70	35	70	35	60	53	71	55	113
Northern part TOTAL	**366**	**180**	**150**	**200**	**124**	**55**	**96**	**63**	**83**	**119**	**103**	**150**	**177**
Unlucky Bay	20	n.c.	20	10	48	15	25	15	19	1	40	28	7
South Porky	28	n.c.	40	0	9	40	25	0	38	35	70	65	35
Manuka – North (Whalebone)	-		65	15	60	35	30	60	63	33	60	32	116
Manuka - Central	67	220	68	150	50	50	70	50	84	58	54	36	39
Manuka - South	-		67	10	45	35	65	40	24	6	55	39	82
Dirty Bay	-	n.c.	22	30	13	n.c.	0	n.c.	0	0	0	8	
Currie Harbour	-	114	14	25	15	0	20	26	0	0	39	30	15
Currie Golf Course (Burgess Bay)	330		96	90	85	30	75	42	66	65	25	64	49
Dripping Wells	-	40	40	65	62	40	75	45	30	65	60	50	50
Central part TOTAL	**445**	**374**	**432**	**395**	**387**	**245**	**385**	**278**	**324**	**263**	**403**	**352**	**393**
Seal Bay	-	20	n.c.	60	n.c.	n.c.	12	43	77	56	68	5	48
Surprise Bay (including Denby Beach)	-	187	80	105	75	70	80	106	71	90	116	43	89
Stokes Point to Surprise Bay	-	70	40	110	70	25	12	52	66	29	91	67	84
Stokes Point	-		90	20	30	50	60	62	49	40	72	72	32
Southern part TOTAL	**0**	**277**	**210**	**295**	**175**	**145**	**164**	**263**	**263**	**215**	**347**	**187**	**253**
TOTAL	**811**	**831**	**792**	**890**	**686**	**445**	**645**	**604**	**670**	**597**	**853**	**689**	**823**

* Count by D.B. Whitchurch

CATCHING

In spite of losing two fieldwork days to bad weather (one day was the stormiest we've ever experienced on King Island) we still made ten cannon net catches (Table 2) of Ruddy Turnstones (equalling the previous record) and caught 249 altogether (the third highest visit total). All the main Ruddy Turnstone flock areas along the west coast were visited and catches were made at all of them except Surprise Bay. On the two days we tried there very few Ruddy Turnstones were present (probably due to the windy weather). We did, however, make two other catches in the nearby area of Stokes Point and Trough Bay, in the south- west of the island.

Table 2. VWSG Catch Details: King Island Visit 22-31 March 2019.

Date	Location	Geolocators	Species	New	Retrap	Total	Juv	% Juv	Male	Female	% Male
23/03/2019	North Manuka (Whale Bone)	3 geos retrieved, 27 deployed	Ruddy Turnstone	17	21	**38**	10	26.3	14	14	50.0
24/03/2019	South Manuka	3 geos retrieved, 15 deployed	Ruddy Turnstone	13	15	**28**	7	25.0	7	14	33.3
24/03/2019	South Manuka Gate	4 geos retrieved, 3 deployed	Ruddy Turnstone	6	18	**24**	2	8.3	7	15	31.8
26/03/2019	Stokes Point		Ruddy Turnstone	4	11	**15**	1	6.7	3	11	21.4
26/03/2019	Trough Bay		Ruddy Turnstone	12	4	**16**	5	31.3	2	9	18.2
27/03/2019	Duck Bay	3 geos retrieved, 3 deployed	Ruddy Turnstone	58	15	**73**	24	32.9	27	22	55.1
28/03/2019	Currie Harbour	6 geos retrieved, 6 deployed	Ruddy Turnstone	4	7	**11**	2	18.2	5	4	55.6
28/03/2019	Burgess Bay		Ruddy Turnstone	6	9	**15**	4	26.7	7	4	63.6
29/03/2019	Porky Beach	1 geo retrieved, 1 deployed	Ruddy Turnstone	7	18	**25**	8	32.0	8	9	47.1
			Pied Oystercatcher	3	0	**3**	0	0.0			
31/03/2019	Dripping Wells		Ruddy Turnstone	0	4	**4**	0	0.0	2	2	50.0
			Total Turnstone	127	122	**249**	63	25.3	82	104	44.1

Table 3. Catches on King Island 2007-2019.

Date of visit	Catches	Total Ruddy Turnstone caught	Total birds caught
March 2007	7	241	307
March 2008	8	419	434
March-April 2009	6	223	223
March 2010	8	211	217
November 2010	3	71	71
April 2011	8	197	211
November-December 2011	3	115	117
April 2012	7	118	118
November 2012	5	132	132
March-April 2013	10	255	285
November 2013	2	54	55
March 2014	6	173	181
November-December 2014	6*	147	151
February 2015	5*	119	154
November-December 2015	5	120	158
February 2016	4	74	78
November 2016	4	112	114
March-April 2017	7	218	229
December 2017	5	123	128
March 2018	9	149	160
December 2018	5	191	193
March 2019	10	249	252
13 years (22 visits)	**133**	**3711**	**3968**
	Mean individual catch size:	**28**	**30**
	Mean catch total per visit:	**169**	**180**

*Excludes 2 catches of Silver Gulls.
22 visits - 13 in February-April, 9 in November-December.

The equipment worked perfectly, with the net coming out fully on every occasion, in spite of some headwinds. This was partly because of the excellent setting of cannons by Rob Patrick who now goes to great trouble to pack each cannon in a cocoon of hefty rocks which means that it does not move significantly when the net is fired (Fig 3). The propulsion energy therefore all goes into propelling the projectiles and net forwards over the birds.

We've also gained a wealth of experience over the years on exactly where to set the net at each location and on appropriate twinkling activities to encourage the birds into the catching area (Fig 4). We are also now more experienced at judging when birds are in the catching area, particularly aided by the telescope viewing skills of Katherine Leung, often perched, but hidden, in areas where she can continuously scan the catching area and safety zone of the net.

Our biggest catch was 73 birds at Duck Bay, near Whistler Point in the north-west of the island. This has traditionally been a place where large catches could be made but we have not been successful there for three or four years. The most amazing catch was one of just 11 birds in Currie Harbour. Six of these had old geolocators on them, four with almost consecutive numbers.

A new development this year was the use of a half-size cannon net – large-mesh and with only two cannons. This can be deployed more quickly than a full-size net and can operate where there is only a limited space available where the Ruddy Turnstones feed in a dense flock. It will be a regular part of our King Island equipment on future visits. Table 3 shows a summary of all the catches since VWSG first visit in 2007.

Percentage juveniles

As in the December 2018 visit, we found that the proportion of juveniles in the catches was well above the long-term average (14%). The figure was not quite so high as is in December (40.8%, when it was known that a proportion of migrating individuals was still present in the population) but at 25.3% it was still well above the long- term average which means the breeding success of the King Island Ruddy Turnstone in 2018 is classed as very good (Table 4).

Table 4. Comparison of juvenile proportions in Ruddy Turnstone catches on King Island in Nov-Dec period to Feb-Apr period.

Year	Nov-Dec period		Feb-Apr period		% Juv per season
	Total	% Juv	Total	% Juv	
2006-07	-	-	241	0%	0%
2007-08	-	-	419	17.7%	17.7%
2008-09	-	-	223	0%	0%
2009-10	-	-	211	14.2%	14.2%
2010-11	71	18.3%	197	14.7%	15.7%
2011-12	115	9.6%	118	15.3%	12.4%
2012-13	132	2.3%	255	1.2%	1.6%
2013-14	54	42.6%	173	30.6%	33.5%
2014-15	147	17.7%	119	14.3%	16.2%
2015-16	120	1.7%	74	1.4%	1.5%
2016-17	112	20.5%	218	31.2%	27.6%
2017-18	123	5.7%	149	2.7%	4.0%
2018-19	191	40.8%	249	25.3%	32.0%
TOTAL	**1065**		**2646**		

Based on Feb/Apr data. Poor Arctic breeding years were 2006, 2008, 2012, 2015 and 2017. Very good Arctic breeding years were 2013, 2016 and 2018.

Sex ratios

Just as the percentage of juveniles varies quite markedly from one catch location to another so also does the sex ratio of the adults. This can be determined during a March/ April visit because the birds are already showing much of their breeding plumage and there are distinct differences between that of the male and female birds (more than in most species of waders) (Fig 5). There were more males than females in three of the catches but more females than males in five catches.

Figure 3: Rob Patrick building the cannon cocoon (by ©Roger Richards)

In almost all years there has been a predominance of females in the populations caught. This year this was quite marked (104 females vs 82 males) giving a male percentage of 44.1%. Only twice before has the proportion of males been lower than this (Table 5).

Figure 4. Laying the net. Processing the Turnstone after the catch'. (by ©Olivoa Gourley)

Figure 5. Male Ruddy Turnstone in breeding plumage surrounded by females and juveniles (by ©Rob Bush).

Table 5. Sex ratios of Ruddy Turnstone catches on King Island in Feb- Apr period 2007 to 2019.

Year	Male	Female	Total adult	% Male
2007	125	116	**241**	51.9
2008	181	163	**344**	52.6
2009	103	120	**223**	46.2
2010	90	91	**181**	49.7
2011	80	88	**168**	47.6
2012	43	57	**100**	43.0
2013	118	134	**252**	46.8
2014	46	74	**120**	38.3
2015	No data (Sex not determined at catches)			
2016	19	28	73	40.4
2017	70	79	**149**	47.0
2018	59	86	**145**	40.7
2019	82	104	**186**	44.1

Geolocators

We were especially lucky in our efforts to retrieve geolocators from birds which had already been carrying them from previous visits. A total of 23 geolocators were retrieved from birds and 22 of these were replaced with new geolocators. Additionally, a further 36 geolocators were placed on birds which had not previously carried them, meaning that 58 geolocators in total were deployed during the visit. With a long-term retrieval rate of 42% of geolocators on King Island we can look forward to some further successful geolocator retrievals in the future.

FLAG-SIGHTINGS

Opportunities were taken to record the engraved flags on birds in the field whenever possible (Fig 6). This was particularly successful at some locations and a total of 187 sightings involving 129 individuals were recorded in the field. Some of these birds were also subsequently cannon netted.

Figure 6. Counting and flag scanning (by ©Rob Bush).

OTHER MATTERS

Weather

Temperatures were close to average throughout our visit and rainfall only occurred for short periods. The notable feature, however, was the extremely strong winds encountered on 24-25 March (especially 25 March when 30-40 knot winds occurred almost all day and night, which prevented us even setting a net. The weather on King Island really does fit the Victorian maxim of 'If you don't like the weather, wait a minute'.

Deakin university study on avian pathogens

As in other years Deakin University again collected faecal swabs and blood samples to test for the presence of avian diseases or their antibodies (Fig 7).

Figure 7. Collecting blood samples from a Ruddy Turnstone (by ©Roger Richards).

ACKNOWLEDGMENTS

The VWSG thanks the following for their contribution towards another particularly successful visit to King Island.

Members of the field team endured some periods of particularly stormy weather but were not deterred. Graham and Margaret Batey again provided accommodation for three team members in their home. The team itself occupied new, rented premises opposite the Batey's home for this visit. Margaret Bennet again kindly stored our field equipment at her house. Tasmanian Parks and Wildlife again kindly loaned their trailer.

FUTURE

It is planned to continue November / December and March/ April visits to King Island into the foreseeable future. Arrangements have been made, with the generous help of the owner David Looker, to use the "Turnstone House" at Porky Beach as our base for future visits. This beautiful modern house has magnificent views over the sea and the western coastline of the island – and is situated only 100 m from one of our regularly counted and caught Ruddy Turnstone flocks!

The March 2019 King Island Team was:

Clive Minton, Robyn Atkinson, Rob Patrick, Penny Johns, Roz Jessop, Robert Bush, Katherine Leung, Marcel Klaassen, Michelle Wille, Roger Richards and Annabel Richards (Fig 8), local King Island participants, including Graeme and Margaret Batey, Margaret Bennett and Lizzie Cambra.

Figure 8. The team (by ©Roger Richards, ©Michelle Wille and ©Katherine Leung)

WADER BREEDING SUCCESS IN THE 2019 ARCTIC SUMMER, BASED ON JUVENILE RATIOS OF BIRDS WHICH SPEND THE NON-BREEDING SEASON IN AUSTRALIA

ROZ JESSOP[1], ROB BUSH[2], ROB PATRICK[3], ROBYN ATKINSON[4], MAUREEN CHRISTIE[5] & ILA MARKS[6]

[1] *Australasian Wader Studies Group PO Box 1088, Cowes, Victoria, 3922, Australia.*
Email: moonbird39@gmail.com
[2] *Australasian Wader Studies Group 39 Barrinia Street, Manly Queensland, 4179. Australia.*
Email: cphcrobert@gmail.com
[3] *Victorian Wader Study Group 54 Myers Drive, Shoreham, Victoria, 3196, Australia.*
Email: rob@farmingminds.com.au
[4] *Victorian Wader Study Group 31 Princess St, Drysdale, Victoria, 3222, Australia.*
Email: atkinson.robyn@bigpond.com
[5] *Friends of the Shorebirds South East. 3 Carpenter Rocks Road, Carpenter Rocks, South Australia 5291, Australia.*
Email: twinpeppercorns@gmail.com
[6] *Victorian Wader Study Group 50 Harold St, Thornbury, 3071, Australia.*
Email: ila@melbpc.org.au

INTRODUCTION

Each year wader banders in Australia attempt to collect 'percentage juvenile' data to measure the annual breeding success of wader populations which spend the non-breeding season in Australia. This is usually carried out in two different regions, some 3000 km apart. In south-east Australia (SEA) the Victorian Wader Study Group (VWSG) aims to monitor breeding success for seven species. All birds are caught by cannon netting between mid-November and March/early April (depending on the species) on the Victorian coast, on coasts in the south-east of South Australia (around Port Macdonnell to Nora Creina) and on the Bass Strait Island of King Island, Tasmania. The other area sampled, by the Australasian Wader Studies Group (AWSG), is in north-west of Western Australia (NWA), specifically Roebuck Bay, Broome, and the northern parts of 80 Mile Beach and the adjacent grassland plains of Anna Plains Station. Here a minimum of eight species are targeted for monitoring annually.

In SEA, birds were caught at a range of sites, mostly the same sites each year. The bushfires and weather in Victoria in 2019/2020 negatively impacted on the field season and no data were collected for Bar-tailed Godwit and Red Knot. This was because it was not possible to make field trips to the sampling locations due to entry restrictions to bushfire affected areas and the need for Parks Victoria staff to fight the bushfires (not available for boat transport duties). In addition, a new breeding colony of the endangered Fairy Tern (*Sternula nereis*) prevented cannon netting at one of the usual Bar-tailed Godwit catch sites. Travel restrictions brought in by Australian state governments to combat the Coronavirus disease (COVID-19) pandemic prevented the usual March field trip to King Island, Tasmania and to South Australia to sample Ruddy Turnstone. In NWA samples of the main species were successfully caught in adequate numbers during the AWSG NWA2020 Expedition (February-March 2020).

This note gives the numerical data relating to the relevant catches made in the two regions during the 2019/2020 wader non-breeding season. It also categorises the estimated breeding success of each population in the 2019 Arctic summer.

METHODS

In NWA, sampling was carried out between 7 February and 1 March 2020 during the planned fieldwork programme. The usual techniques for catching and ageing birds were employed in both regions (Minton *et al.* 2005). A sample of between 100 and 220 birds is the minimum used for percentage juvenile figures, and gives a juvenile fraction error range of 0.1 to 0.15 (Rogers & Standen 2019).

RESULTS & DISCUSSION

South-Eastern Australia (SEA)

A total of 1067 birds, of the seven species targeted for annual monitoring, were caught in SEA in the sampling period (Tables 1 & 3). As usual, Red-necked Stint topped the species catch total with 714 individuals caught during the mid-November to early April monitoring period. The percentage of juveniles (24.5%) was higher than last year (9.1%) and above the long-term average (17.1%) (Minton *et al.* 2020). This was an improvement after two consecutive years of poor breeding success. However, it should be noted that the four catches used in this estimate were made at Yallock Creek in Victoria, a location where juveniles are known to be at higher numbers than other sites usually sampled (VWSG *unpubl. data*). Due to fire and heatwave entry restrictions and changes in habitat management at the other major catch site (the Western Treatment Plant) no significant catches of Red-necked Stint were made. This site typically has fewer juveniles than Yallock Creek (VWSG *unpubl. data*).

Curlew Sandpipers had above average breeding success in 2019 (25.0%) compared to the long-term average breeding success of 16.9% (Table 1). This follows two successive poor breeding years (Table 3) (Minton *et al.* 2020). Sharp-tailed Sandpipers appear to have had very low breeding success in 2019 (2%: Table

Table 1. Percentage of juvenile (first year) waders in cannon-net catches in south-east Australia 2019/2020.

Species	No. of catches Large (>50)	No. of catches Small (<50)	Total Caught	Juveniles No.	Juveniles %	Long-term average* % juvenile	Long-term average* (no. years)	Assessment of 2019 breeding success
Red-necked Stint *Calidris ruficollis*	4		714	175	**24.5**	17.1	(22)	Above average
Curlew Sandpiper *C. ferruginea*		5	113	27	**23.9**	16.9	(21)	Above average
Bar-tailed Godwit *Limosa lapponica*			0					
Red Knot *C. canutus*		1	1					
Ruddy Turnstone *Arenaria interpres*	1	3	132	23	**17.4**	15.1	(22)	Average
Sanderling *C. alba*			0					
Sharp-tailed Sandpiper *C. acuminata*	1		99	2	**2.0**	19.2	(21)	Low

All birds cannon-netted in the period 2 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).
*Includes the 2019/2020 figures.

Table 2. Percentage of juvenile (first year) waders in cannon-net catches in north-west Australia 2019/2020.

Species	No. of catches Large (>=50)	No. of catches Small (<50)	Total Caught	Juveniles No.	Juveniles %	Long-term average* % juvenile (no. years)	Assessment of 2019 breeding success
Great Knot *Calidris tenuirostris*	4	5	331	7	2.1	10.0 (22)	Low
Bar-tailed Godwit *Limosa lapponica*	1	5	98	2	2.0	9.4 (22)	Low
Red-necked Stint *C. ruficollis*	1	8	203	28	13.8	18.2 (22)	Below average
Red Knot *C. canutus*	1	7	150	19	12.7	14.9 (21)	Average
Curlew Sandpiper *C. ferruginea*		4	21	1	(4.8)	17.0 (22)	-
Non-arctic northern migrants							
Greater Sand Plover *Charadrius leschenaultii*	6	3	951	256	26.9	21.5 (22)	Average
Terek Sandpiper *Xenus cinereus*	1	69	176	34	19.3	13.4 (21)	Below average
Grey-tailed Tattler *Heteroscelus brevipes*	2	5	195	60	31.0	19.4 (21)	Very good

All birds cannon-netted in period 9 February to 1 March 2020
*Includes the 2019/2020 figures

Table 3. Percentage of juvenile (first year) birds in wader catches in south-east Australia 1998/1999 to 2019/2020.

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	16/17	17/18	18/19	19/20	Average (last 22yrs)
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	28.6	7.0	25.7	17.4	*15.1*
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	31.3	3.8	9.5	24.5	*17.1*
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	47.6	5.4	9.9	23.9	*16.9*
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	(-)	27.8	45.9	2.0	*19.2*
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	17.5	(-)	11.6	(-)	*14.9*
Red Knot *C. canutus*	(2.8)	38	52	69	(92)	(86)	29	73	58	(75)	(-)	(-)	78	68	(-)	(95)	(100)	(100)	90.3	33.3	(-)	(-)	*58.8*
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	12.5	20.4	3.0	(-)	*22.5*

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 22 years) exclude figures in brackets (small samples) and include 2019/20 figures

Table 4. Percentage of juvenile (first year) birds in wader catches in north-west Australia 1998/1999 to 2019/2020

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	16/17	17/18	18/19	19/20	Average (last 22yrs)
Red-necked Stint *Calidris ruficollis*	26	46	15	17	41	10	13	20	21	20	10	17	18	24	15	19	10	11.1	17.2	6.8	8.4	14	*18.2*
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	40.3	8.1	13.8	(4.8)	*17.2*
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	9.0	2.6	5.5	2.1	*9.6*
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	21.6	5.4	1.5	12.7	*14.9*
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	11.0	3.0	2.0	2.0	*9.4*
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	12.4	13.2	15.1	26.9	*21.5*
Terek Sandpiper *Xenus cinereus*	12	(0)	8.5	12	11	19	14	13	11	13	15	19	25	5	12	15	12	9.2	5.8	3.8	26.5	19.3	*13.4*
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	14.5	7.3	18.7	30.8	*19.4*

All birds cannon-netted in the period 9 February to 1 March 2020. Averages exclude figures in brackets (small samples) but include 2019/2020 figures.

1) following on from last year's successful breeding year (45.9% juveniles: Table 3) (Minton *et al.* 2020).

We always find Red Knot the hardest species to catch and monitor and in the 2019/2020 non-breeding season we were not able to catch enough birds in the VWSG field sites. Similarly, we did not catch enough Bar-tailed Godwits or Sanderling to report on percentage juveniles in the populations.

A total of 132 Ruddy Turnstone were caught in December 2019 on King Island. The field trips in March to King Island and South Australia were cancelled due to Australian state government travel restrictions for the

COVID-19 pandemic. The breeding season appeared to be average (17.4%: Table 1) and is lower than last year's good breeding success for this species (25.7%: Table 3) (Minton *et al.* 2020).

Overall, for South-East Australia, breeding success in the Arctic summer of 2019 was average or above average for all but one of the four species successfully monitored, with one species (Sharp-tailed Sandpiper) having low breeding success.

North-West Australia (NWA)

Overall, 2125 waders of the eight target species were caught during the period for breeding success assessments in 2019/2020.

Of the five wader populations which breed predominantly above the Arctic Circle and spend the non-breeding season in NWA, two species had low breeding outcomes (Great Knot and Bar-tailed Godwit), one species was below average (Red-necked Stint) and one species was average (Terek Sandpiper). Insufficient Curlew Sandpipers were caught to determine percentage juveniles.

For the three species that breed predominantly below the Arctic Circle, Greater Sand Plover had an average breeding season, Terek Sandpiper below average and Grey-tailed Tattler a particularly good breeding season (Tables 2 & 4).

Bar-tailed Godwits had a bad breeding season in the 2019 breeding season (2.0%: Table 2). This is the third successive year with an extremely low breeding productivity (Table 4). It was noticeable how relatively few Bar-tailed Godwits were present at high tide roosts.

Great Knot also had another poor breeding year in 2019 (2.1%: Table 2) following on from 2018 (5.5%: Table 4) (Minton *et al.* 2020). It is now 10 years since the average percentage of juveniles was exceeded in this species.

In comparison Red Knot fared better in 2019 (12.7%: Table 2), which was close to the long-term average of 14.9% (Table 4). This species is prone to rather wide fluctuations in breeding success from year to year and in 2016/2017, 21.6% juveniles were present in the summer populations in NWA (Table 4).

Red-necked Stints in NWA had a slightly lower breeding season (13.8%) compared to the 22-year average of (18.2%: Table 2). This percentage of juveniles is lower than that recorded in SEA. However, this may be due to SEA samples all being from one site, Yallock Creek, as some sites have a higher proportion of juveniles than others (Rogers *et al.* 2005, Minton *et al.* 2005).

Greater Sand Plover had an above average breeding season with 26.9% juveniles, which is slightly above the long-term average of 21.5%. The 2019 season produced the highest number of juveniles in the population since 2012/2013 (Table 4).

Grey-tailed Tattler had a very good breeding year with 30.8% juveniles recorded, well above the long-term average of 19.4%. Terek Sandpiper had an above average breeding season 19.3%, compared to the long-term average 13.3%. This is the second year of above average breeding success (Table 4).

Insufficient Ruddy Turnstone were caught to assess breeding success.

Overall, breeding success results were mixed for 2019/2020. Non-Arctic migrants had average or slightly above average success whereas Arctic species were less successful.

ACKNOWLEDGEMENTS

We acknowledge the work of Dr Clive Minton, who was killed in a car crash in late 2019. As always, the results are dependent on the fieldwork efforts of the Victorian Wader Study Group and the Australasian Wader Studies Group (especially the AWSG NWA 2020 Expedition members). Their perseverance, in tropical weather conditions, continues to be key to obtaining adequate data for an accurate assessment of annual breeding success.

All the relevant wildlife authorities are also thanked for granting ethics, scientific and banding permits in Victoria, South Australia, Tasmania, and Western Australia. The Australian Bird and Bat Banding Scheme issued a project permit and supplied metal bands.

The financial assistance provided by the Western Australian Department of Biodiversity, Conservation, and Attractions for the NWA 2020 expedition is greatly appreciated.

VWSG and AWSG acknowledge the Traditional Owners of the land on which we conduct field research and pay our respects to Elders past and present.

REFERENCES

Minton, C., R. Jessop, P. Collins & K. Gosbell. 2005. Monitoring Wader Breeding Productivity by the proportion of first year birds in wader populations in S.E. Australian non-breeding areas. Pp. 73-85. *In:* Straw, P. (Ed.) Status and Conservation of Shorebirds in East Asian-Australasian Flyway. Proceedings of the Australasian Shorebirds Conference, 13–15 December 2003, Canberra. Wetlands International Global Series 18, International Wader Studies 17. Sydney, Australia.

Minton, C & Jessop, R. & Hassell, C. & Patrick, R & Atkinson, R & I. Marks. 2020. Wader breeding success in the 2018 arctic summer, based on juvenile ratios of birds which spend the non-breeding season in Australia. *Stilt 73-74*.

Rogers, D. I., Rogers, K. G., & Barter, M. 2005. Measuring recruitment of shorebirds with telescopes: a pilot study of age proportions on Australian non-breeding grounds. Pp. 63–72. *In:* Straw, P. (Ed.) Status and Conservation of Shorebirds in East Asian-Australasian Flyway. Proceedings of the Australasian Shorebirds Conference, 13–15 December 2003, Canberra. Wetlands International Global Series 18, International Wader Studies 17. Sydney, Australia.

Rogers, D. & R. Standen. 2019. VWSG Scientific Advisory Committee Research Priority Review, July 2019. *Victorian Wader Study Group Bulletin* 42:75-92.

NORTH-WEST AUSTRALIA WADER & TERN EXPEDITION 2020 REPORT FRIDAY 7TH FEBRUARY TO SUNDAY 1ST MARCH 2020

ROSALIND JESSOP[1], ROBERT BUSH[2], PRUE WRIGHT[3], MARCELL KLAASSEN[4], GRACE MAGLIO[5], ADRIAN RIEGEN[6], TOM CLARKE[7] AND TEGAN DOUGLAS[8].

[1]*PO Box 1088. Cowes. VIC 3922. AUSTRALIA.*
Email: moonbird39@gmail.com
[2]*9 Barrinia Street, Manly, QLD. 4179. AUSTRALIA.*
Email: cphcrobert@gmail.com
[3]*3 Alphington Street, Alphington, VIC 3078. AUSTRALIA*
[4]*Locked Bag 20000 Geelong VIC 3220*
[5]*PO Box 7419, Broome, WA 6725. AUSTRALIA*
[6]*231 Forest Hill Road, Waiatarua, Auckland 8. NEW ZEALAND*
[7]*3/71 Elizabeth Street, Tighes Hill, NSW 2297. AUSTRALIA*
[8]*167 Perry Lakes Drive, Floreat. WA 6014.AUSTRALIA*

INTRODUCTION

The aim of the Australasian Wader Studies Group (AWSG) North-west Australia (NWA) research program is to utilise the best science and field practices to advance the best conservation outcomes for increasingly threatened waders (shorebirds) and terns in Australia with a focus on two major shorebird areas of international significance in North-west Australia: Roebuck Bay and Eighty Mile (80 Mile) Beach. Together, these sites are the third most important site for waders (in terms of numbers) in the world. Birds migrate along the East-Asian Australasian Flyway – a network of stopover sites birds use to fly from their breeding grounds in the northern hemisphere to their "wintering" grounds in the southern hemisphere.

Specifically the project aimed to monitor the annual breeding success of waders breeding north of the equator in the East-Asian Australasian Flyway (productivity estimates); monitor survival through mark recapture; obtain information on site faithfulness; investigate migratory pathways of waders and terns and collect biometric data to assist with the monitoring of climate change. The project in NWA is included in a larger study by Deakin University evaluating the extent, structure and determinants of AIV (avian influenza) prevalence and genetic diversity in different ecological contexts.

Background

Eighty Mile Beach is a mega scale (220 km) linear sand-coast; the beach is 100 m wide and includes several muddy, microscale irregular embayments. Adjoining tidal mudflats vary from 1.1 to 5 km in width (Pearson 2003). The maximum width of the tidal flat was recorded at 3.8 km on low water spring tides in 1999, but probably exceeds 5 km (Rogers 2003).

Over 470,000 waders and terns of more than 20 migratory species have been counted along the beach. This represents around 20% of the total number of migratory waders visiting Australia each year and around 6% of the total East-Asian Australasian Flyway (EAAF) migratory wader population. Between 5500 and 6500 of these birds are terns and about 1000 gulls (Minton *et al.* 2013, Minton *et al.* 2003).

Roebuck Bay is a tropical marine embayment with extensive, biologically diverse, intertidal mudflats. The site is internationally important for at least 20 species of migratory waders with total numbers of waders using the site each year estimated at over 300,000 (Department of Conservation and Land Management 2003). This makes Roebuck Bay one of the most important sites for shorebird conservation in the EAAF.

A great deal has been learned about migration routes of waders and terns that come to Australia to spend their non-breeding season (northern hemisphere winter/Austral summer) alongside resident waders and terns. However, for some of these species crucial information on their movements is still lacking and for all of them knowledge on their population dynamics is essential to national and international conservation efforts. In particular data from the capture of birds enables an understanding of population changes and contributing factors – for example: (recruitment, adult survival, local movements, site faithfulness to a non-breeding location, sex and age structure at non-breeding sites, potential changes in morphology as a result of climatic variation, as well as changes in migration patterns, departures and breeding periods). Wader counts are also a necessary component of this process and the long-term study of birds in the field supports the interpretation of data collected during the *Migratory Shorebirds* count program run by the AWSG and BirdLife Australia. These count data (e.g. summarised in Clemens *et al.* 2016) sketch a bleak picture for many of these species that are facing rapidly changing habitats along their migratory routes in East Asia, highlighting the relevance of the data to be collected in the framework of this research project.

Another threat facing avian migrants travelling through East Asia is the increased exposure to pollutants and Avian Influenza Virus (AIV) as a result of booming poultry production particularly in Asia. Australia is therewith clearly sitting on a potential fault-line of viral emergence, yet the factors that drive the dispersal, emergence and evolution of AIV are still poorly understood. Although wild water birds (including waders and terns) are known to be the major reservoir of AIV, little is known about the factors, including factors associated with global change (such as increased pollution), that shape viral prevalence, genetic diversity and evolution in Australia.

Also, non-migratory wader and tern species that travel widely across Australia's inland wetlands and coasts have been reported as declining. However, only for Eastern Australia sufficient data for such evaluation has been available and a national assessment is lacking, including the remote North-west of Australia. These non-migratory species have generally been getting much less research attention by Australian shorebird researchers (Weston 2007).

Despite studies and grant programs that target threatened waders such as Hooded Plover *Thinornis rubricollis*, Beach Stone Curlew *Esacus magnirostris* and Plains Wanderer *Pedionomus torquatus,* there are few studies on non-migratory waders and terns reliant on inland and coastal wetlands such as Red-necked Avocet *Recurvirostra novaehollandiae*, Red-kneed Dotterel *Erythrogonys cinctus*, Black-fronted Dotterel *Elseyornis melanops*, Banded Stilt *Cladorhynchus leucocephalus*, Australasian Pied Stilt *Himantopus leucocephalus leucocephalus* and Whiskered Tern *Chlidonias hybrida*. This paucity of information leaves conservation managers with no real understanding of the variety of factors limiting populations of most non-migratory waders and terns.

Broome and 80 Mile Beach are experiencing rapid growth in tourism: "Over 250,000 visitors per year, of which only 3100 originate from international locations (Tourism WA Regional Fact Sheets). This mix indicates that the scope for increased volumes of international visitors (who contribute higher rates of spend) is very wide and this will drive growth in the value of the industry to roughly 300% of current levels by 2036." (Kimberley Development Commission 2018)._

Benchmarking of human visitation was undertaken at both 80 Mile Beach and Roebuck Bay in 2011-13 prior to establishment of the marine national park (Beckley 2015). Visitation to the 80 Mile Beach area was centred around access points such as Eighty Mile Beach Caravan Park, Cape Keruadren, Eco Beach, Barn Hill, Port Smith and Bidyadanga. With the exception of the resident community at Bidyadanga, the areas being used coincided with locations where campsites and/or tourist accommodation were available. The main activity was fishing: 46% of people. As increased camping sites and access become available visitation to these sites will also increase.

Information on both resident and migratory species is needed to assist in planning for infrastructure demand and increased access to beaches and wetlands. Threats that will accompany increased access include recreational driving on beaches and increased access to wetlands for shooting. As well as increasing tourism, economic development in the oil and gas industry is increasing annually.

Proposed developments affecting Roebuck Bay include the Kimberley Marine Support Base (KMSB) Pty Ltd, comprising a floating wharf, along with associated onshore terminal facilities. Further south in the Great Sandy Desert there is the proposed Theia Energy Pty Ltd fracking, ports, and oil pipeline project for west Kimberley which could impact on underground water, inland marshlands and freshwater oceanic outflows. These developments will also increase the demand for accommodation, services and recreational opportunities in the area.

OBJECTIVES

The objectives of the NWA expedition can be broken into two main themes: (1) the conservation of waders and terns; and (2) measuring avian influenza (AIV) and pollutants in waders. The specific objectives under each theme are detailed below.

Conservation of waders and terns

1. Monitoring of annual breeding success of migratory waders via the percentage of juveniles in the population in their non-breeding areas (wintering areas)
2. Obtain annual survival estimates of key species of waders and terns via recapture of birds already carrying bands and observations of flagged waders
3. Obtain information on the site faithfulness and use (e.g. sex differences in migration terminus) of non-breeding sites by migratory waders and terns by the recapture of birds already carrying bands or flags
4. Obtain more information on the migratory pathways and breeding areas of terns and shorebird species by marking birds with unique leg flags that can be observed and reported from throughout the flyway including across Australia.
5. Continue to collect biometric information on birds to assist with the monitoring of the effects of climate change on birds.

Avian Influenza and pollutants

The project in NWA is part of a larger study by Deakin University evaluating the extent, structure and determinants of AIV prevalence and genetic diversity in different ecological contexts. In NWA this focuses on waders in tropical North-west Australia. Using AIV prevalence and genome sequence data the project aims to determine:

- what AIV serotypes, lineages, and reassortants are present and how they change through time,
- how the viruses are connected to global AIV diversity,
- whether prevalence differ between individuals (based on age, sex, condition, pollution levels) and what environmental factors (e.g. pollution) shape these differences.

These scientific aims translate into the practical aim of catching and sampling (cloacal and buccal swabs for AIV prevalence; blood for prevalence of antibodies against AIV and pollutants) waders and terns and notably long-distance migratory waders, which are considered the second most-important AIV-reservoir in Australia and globally.

The pollutant data will allow linking species-specific pollutant levels to population dynamic parameters (i.e. recruitment or juvenile percentages, survival from banding data analysis, count data)

MAIN ACHIEVEMENTS

Conservation of waders and terns

Objective one was monitoring the annual breeding success of migratory waders via the percentage of juveniles in the population in their non-breeding areas (wintering areas). The aim of the field activities was to capture between 100 and 220 birds of each target species in order to estimate the relative breeding success of these species in the 2019 northern hemisphere breeding season (Rogers & Standen 2019). The outcome of the field activities was adequate and samples of seven of eleven target species were made (Table 1). An assessment for breeding season is provided in Table 2.

Table 1. Outcome of sampling against target species during NWA 2020.

Common name	Species Latin name	Species Type	Adequate sample obtained?
Bar-tailed Godwit	*Limosa lapponica*	Arctic Migrant	Yes
Curlew Sandpiper	*Calidris ferruginea*	Arctic Migrant	No
Great Knot	*Calidris tenuirostris*	Arctic Migrant	Yes
Red Knot	*Calidris canutus*	Arctic Migrant	Yes
Red-necked Stint	*Calidris ruficollis*	Arctic Migrant	Yes
Ruddy Turnstone	*Arenaria interpres*	Arctic Migrant	No
Sharp-tailed Sandpiper	*Calidris acuminata*	Arctic Migrant	No
White-winged Black Tern	*Chlidonias leucopterus*	Asian Migrant	No
Greater Sand Plover	*Charadrius leschenaultii*	Non-Arctic Migrant	Yes
Grey-tailed Tattler	*Tringa brevipes*	Non-Arctic Migrant	Yes
Terek Sandpiper	*Xenus cinereus*	Non-Arctic Migrant	Yes

Table 2. Seasonal assessment for northern breeding season success 2019. Error range 0.1-0.15% is equivalent to a sample size of 100-200 birds (after Rogers and Standen 2019).

	Number of catches			Juveniles		Long-tern average*	
	Large	Small					
Species	(>=50)	(< 50)	Total Caught	No.	% Juv	% juvenile (years of data)	Assessment of 2019 breeding success
Arctic northern migrants							
Great Knot *Calidris tenuirostris*	4	5	331	7	2.1	10.0 (22)	Poor
Red-necked Stint *Calidris rufficollis*	1	8	203	28	13.8	18.2 (22)	Below average
Red Knot *Calidris canutus*	1	7	150	19	12.7	14.9 (21)	Average
Bar-tailed Godwit *Limosa lapponica*	1	5	98	2	2.0	9.4 (22)	Very poor
Non-arctic northern migrants							
Greater Sand Plover *Charadrius leschenaultii*	6	3	951	256	26.9	21.5 (22)	Average
Terek Sandpiper *Xenus cinereus*	1	6	176	34	19.3	13.4 (21)	Above average
Grey-tailed Tattler *Tringa brevipes*	2	5	195	60	30.8	19.4 (21)	Very good
						* includes 2019/20	
All birds cannon netted in period 1 November to mid-March							

Objective two was to obtain annual survival estimates of key species of waders and terns via recapture of birds already carrying bands and observations of flagged waders. The aim of the field activities was to band and flag new birds targeted for the percentage juvenile study. Accumulation of recaptures over time will be used in the survival analysis. The outcomes of the field activities included recapture of 234 banded birds and 1957 new birds banded. Information for target species given in Table 3.

Table 3. Number of target species caught during NWA 2020.

Common name	Species Latin name	Species Type	Re traps	Total
Bar-tailed Godwit	*Limosa lapponica*	Arctic Migrant	29	98
Curlew Sandpiper	*Calidris ferruginea*	Arctic Migrant	4	21
Great Knot	*Calidris tenuirostris*	Arctic Migrant	64	331
Red Knot	*Calidris canutus*	Arctic Migrant	21	150
Red-necked Stint	*Calidris ruficollis*	Arctic Migrant	13	203
Ruddy Turnstone	*Arenaria interpres*	Arctic Migrant	0	5
Sharp-tailed Sandpiper	*Calidris acuminata*	Arctic Migrant	0	0
White-winged Black Tern	*Chlidonias leucopterus*	Asian Migrant	1	25
Greater Sand Plover	*Charadrius leschenaultii*	Non-Arctic Migrant	95	951
Grey-tailed Tattler	*Tringa brevipes*	Non-Arctic Migrant	1	195
Terek Sandpiper	*Xenus cinereus*	Non-Arctic Migrant	5	176

Objective three was to obtain information on the site faithfulness and use (e.g. sex differences in migration terminus) of non-breeding sites by migratory waders and terns by the recapture of birds already carrying bands or flags. The aim of the field activities was to band and flag new birds caught for the percentage juvenile study. Accumulation of recaptures over time will be used in the analysis. The outcomes of the field activities included recapture of 234 banded birds and resightings of over 1000 leg flagged birds. Recaptures included five overseas-tagged birds. Information for target species provided in Tables 4 and 5.

Table 4. Movements of recaptured birds between banding location and capture location NWA 2020.

Common name	Species Latin name	Species Type	Number observed or re-caught	Local move ment	Site to site e.g.Broome to 80 Mile
Bar-tailed Godwit	*Limosa lapponica*	Arctic Migrant	3	1	0
Curlew Sandpiper	*Calidris ferruginea*	Arctic Migrant	3	3	0
Great Knot	*Calidris tenuirostris*	Arctic Migrant	11	4	0
Red Knot	*Calidris canutus*	Arctic Migrant	3	3	0
Red-necked Stint	*Calidris ruficollis*	Arctic Migrant	10	4	0
Ruddy Turnstone	*Arenaria interpres*	Arctic Migrant	0	0	0
Sharp-tailed Sandpiper	*Calidris acuminata*	Arctic Migrant	0	0	0
White-winged Black Tern	*Chlidonias leucopterus*	Asian Migrant	1	0	0
Greater Sand Plover	*Charadrius leschenaultii*	Non-Arctic Migrant	22	8	0
Grey-tailed Tattler	*Tringa brevipes*	Non-Arctic Migrant	6	3	0
Terek Sandpiper	*Xenus cinereus*	Non-Arctic Migrant	3	0	0

Table 5. Overseas controls (birds caught with overseas bands) during NWA 2020.

Species	Country of origin	Band number	Condition of band	Age at Capture	Recapture Date	Recapture location	Flags	Australian Band	Banding details
Great Knot *Calidris tenuirostris*	China?	?806	corroded, not readable	3+	09-02-20	80 Mile Beach (-19.35; 121.34)	None	063-32516	Unknown (band too worn to read)
Great Knot *Calidris tenuirostris*	Chongming Island, China	F127170	worn	3+	14-02-20	80 Mile Beach (-19.48: 121.18)	Black/white	063-32733	Banded 01/04/2012 at Chongming Dongtan, Shanghai, China (31°42′52″N,121°15′58″E) 5499km
Great Knot *Calidris tenuirostris*	Chongming Island, China	F133243	worn	3+	22-02-20	Roebuck Bay, Eagles Roost (-19.97: 122.30)	Black/white (T12)	063-33722	Banded 01/04/2016 at Chongming Dongtan, Shanghai, China (31°42′52″N,121°15′58″E) 5499km
Great Knot *Calidris tenuirostris*	Chongming Island, China	F127144	good	3+	25-02-20	Roebuck Bay, Two Dog Hermit (-19.98: 122.30)	Black/white	None added	Banded 01/04/2012 at Chongming Dongtan, Shanghai, China (31°42′52″N,121°15′58″E) 5499km
Great Knot *Calidris tenuirostris*	Kamchatka, Russia	H5010483	good	3+	25-02-20	Roebuck Bay, Two Dog Hermit (-19.98: 122.30)	Black tibia/ yellow tarsus	None added	Banded 12/08/2014 at Sobolevskiy distr., Ustevoe, Russia (51°06′00″ N, 155°29′24″E) 8782km

Objective four was to obtain more information on the migratory pathways and breeding areas of wader and tern species by marking birds with unique leg flags that can be observed and reported from throughout the flyway including across Australia. The aim of the field activities was to send one team of four people out every day to search for and observe leg flagged birds. Accumulation of sightings over time will be used in the survival and site faithfulness analysis. The outcome of the field activities was a team of between two and four persons were deployed each catch to observe flags. A total of 1068 flagged or colour banded waders were observed (Table 6), which included 1038 birds from NWA, China (Chongming Dao 21, Taiwan 2 and Yalu Jiang 2), Russia (Kamchatka 2), and from elsewhere in Australia (Victoria 1). Only 703 engraved leg flags and 142 colour band combinations were clearly read (Table 6).

Table 6. Number of birds observed with engraved flags (AWSG) or colour bands (Global Flyway Network project) during NWA 2020.

Common name	Species Latin name	Species Type	AWSG Flags fully read	Global flyway network colour bands
Black-tailed Godwit	*Limosa limosa*	Sub-Arctic Migrant	9	60
Bar-tailed Godwit	*Limosa lapponica*	Arctic Migrant	154	40
Curlew Sandpiper	*Calidris ferruginea*	Arctic Migrant	0	Not studied
Great Knot	*Calidris tenuirostris*	Arctic Migrant	352	39
Red Knot	*Calidris canutus*	Arctic Migrant	17	3
Red-necked Stint	*Calidris ruficollis*	Arctic Migrant	Not engraved	Not studied
Ruddy Turnstone	*Arenaria interpres*	Arctic Migrant	0	Not studied
Sharp-tailed Sandpiper	*Calidris acuminata*	Arctic Migrant	0	Not studied
White-winged Black Tern	*Chlidonias leucopterus*	Asian Migrant	Not engraved	Not studied
Greater Sand Plover	*Charadrius leschenaultii*	Non-Arctic Migrant	126	Not studied
Grey-tailed Tattler	*Tringa brevipes*	Non-Arctic Migrant	22	Not studied
Terek Sandpiper	*Xenus cinereus*	Non-Arctic Migrant	20	Not studied
Australian Pied Oystercatcher	*Haematopus longirostris*	Resident	2	Not studied
Oriental Plover	*Charadrius veredus*	Non-Arctic Migrant	1	Not studied
TOTAL			703	142

The fifth objective was to continue to collect biometric information on birds to assist with the monitoring of the effects of climate change on birds. The aim of the field activities was to measure recaptured and new birds for the percentage juvenile study. Accumulation of data over time will be used in the analysis. The outcome of the field activities was to record the full biometric data for 1194 birds. All birds had their moult recorded. Information for target species given in Table 7.

Table 7. Number of birds for which full biometrics were recorded during NWA 2020.

Common name	Species Latin name	Species Type	Full biometrics recorded
Bar-tailed Godwit	*Limosa lapponica*	Arctic Migrant	98
Curlew Sandpiper	*Calidris ferruginea*	Arctic Migrant	16
Great Knot	*Calidris tenuirostris*	Arctic Migrant	152
Red Knot	*Calidris canutus*	Arctic Migrant	150
Red-necked Stint	*Calidris ruficollis*	Arctic Migrant	75
Ruddy Turnstone	*Arenaria interpres*	Arctic Migrant	5
Sharp-tailed Sandpiper	*Calidris acuminata*	Arctic Migrant	0
White-winged Black Tern	*Chlidonias leucopterus*	Asian Migrant	25
Greater Sand Plover	*Charadrius leschenaultii*	Non-Arctic Migrant	352
Grey-tailed Tattler	*Tringa brevipes*	Non-Arctic Migrant	154
Terek Sandpiper	*Xenus cinereus*	Non-Arctic Migrant	134

Avian Influenza and pollutants

A total of 406 samples were obtained for AIV analysis from birds caught for percentage juvenile analysis (Table 8).

Table 8. Number of birds sampled for avian influenza and pollutant studies during NWA 2020.

Common name	Species Latin name	Species Type	Number sampled
Bar-tailed Godwit	*Limosa lapponica*	Arctic Migrant	35
Curlew Sandpiper	*Calidris ferruginea*	Arctic Migrant	21
Great Knot	*Calidris tenuirostris*	Arctic Migrant	54
Red Knot	*Calidris canutus*	Arctic Migrant	71
Red-necked Stint	*Calidris ruficollis*	Arctic Migrant	113
Ruddy Turnstone	*Arenaria interpres*	Arctic Migrant	1
Greater Sand Plover	*Charadrius leschenaultii*	Non-Arctic Migrant	50

Permits and permissions

Due to changes in legislation in Western Australia which recently came into force extra permits were required this year. Permits or permissions were obtained from:

- Ethics Permit – was granted by Deakin University, Victoria to cover the dates of the expedition.
- A Fauna Taking (Scientific or other purposes) Licence under Regulation 25 of the Biodiversity Conservation Regulations was obtained from the WA Department of Biodiversity, Conservation and Attractions.
- An authorisation to take or disturb threatened species under Section 40 of the Biodiversity Conservation Act 2016 was obtained from the WA Department of Biodiversity, Conservation and Attractions.
- All participants were licenced with the Australian Bird and Bat Banding Scheme.
- Consultation with the Stoate family of Anna Plains Station for access and hosting the Expedition.
- Consultation with the Yawuru People via the offices of Nyamba Buru Yawuru Limited for permission to catch birds on the shores of Roebuck Bay, traditional lands of the Yawuru people.
- Consultation with the Karajarri and Nyangumarta people for permission to catch birds to be marked for this project on the shores of 80 Mile Beach, traditional lands of the Karajarri and Nyangumarta people.

Catching

We drove to Anna Plains on the day after the team arrived in Broome, five catches were made in the next nine days. On four days no catches were made, with two being due to disturbance by raptors, one due to birds moving further south than anticipated for the tide height and one due to the low height of the high tide. Two attempts were made to catch White-winged Black Tern *Chlidonias leucopterus* and Whiskered Tern *Chlidonias hybrida* on the "Brolga Dam" on the plains, however these were not successful. In contrast to previous years Black Kites *Milvus migrans* were often present along the beach hunting insects and lizards and the waders and terns were extremely wary of them. Their movement along the dunes in conjunction with the usual Sea Eagles *Haliaeetus leucogaster* and Brahminy Kites *Haliastur indus* cost us two catches by eventually disturbing the birds so much that they moved to alternate roosting locations and did not return to the catching site.

Good catching success was also experienced at Roebuck Bay, Broome, on four of the six available days. Catching was difficult once the tide exceeded 9.3m with birds moving off to roost at the mangroves at Crab Creek or Dampier Creek when disturbed by raptors. Catches had to be made before high tide which effectively reduced the time available for catching. Disturbance by birds of prey such as Black Kites *Milvus migrans* was a problem as in previous years and cost us several promising opportunities. Captured waders had to be released at alternate sites to those where the catch occurred to reduce predation opportunities for raptors. This procedure will be adopted for future catching in Broome.

Overall, the NWA 2020 Expedition caught a total of 2191 birds, of which 2162 were waders (17 species) and 30 were terns (three species) (Tables 9 to 11). The average catch size of just over 230 birds with target sample sizes met for seven of the 11 target species. The total of birds caught during NWA 2020 was comparable to previous years (Table 10).

Table 9. NWA 2020 Expedition Catch Totals.

Catches	Location	Sub-site	New	Retrap	Total
Waders		(km south of Anna Plains entrance onto beach)			
09-02-20	80 Mile Beach	20.75	193	5	198
10/02/20	80 Mile Beach	25	0	0	0
11/02/20	80 Mile Beach	35	0	0	0
12/02/20	80 Mile Beach	40.3	211	0	211
13/02/20	80 Mile Beach	41.5	157	5	162
14/02/20	80 Mile Beach	42.3	358	13	371
15/02/20	80 Mile Beach	21.0	0	0	0
16/02/20	80 Mile Beach	15	228	3	231
17/02/20	80 Mile Beach	6	0	0	0
Sub-total			**1147**	**26**	**1173**
Terns	80 Mile Beach		29	1	30
Total Anna Plains			1176	27	1203
		Site Name			
21/02/20	Broome	Wader Beach	198	27	225
22/02/20	Broome	Eagles Roost	86	58	144
23/02/20	Broome	Sandy Blowout	0	0	0
24/02/20	Broome	Wader Beach	297	49	346
25/02/20	Broome	Two Dog Hermit	200	73	273
26/02/20	Broome	Wader Beach	0	0	0
Sub-total			781	207	988
Terns	Broome		0	0	0
Total Broome			**781**	**207**	**988**
Total Waders			**1928**	**233**	**2161**
Total Terns			**29**	**1**	**30**
Total Waders and Terns			**1957**	**234**	**2191**

Table 10. Comparison of catches during the 2017-2020 NWA Expeditions (including terns).

Year	New	Retrap	Total
2017	2286	292	2578
2018	1073	194	1267
2019	2025	133	2158
2020	1957	234	2191

Table 11: NWA 2020 Expedition - wader and tern species details.

Species	Scientific Name	New	Retrap	Total
Greater Sand Plover	*Charadrius leschenaultii*	856	95	951
Great Knot	*Calidris tenuirostris*	267	64	331
Red-necked Stint	*Calidris ruficollis*	190	13	203
Grey-tailed Tattler	*Tringa brevipes*	194	1	195
Terek Sandpiper	*Xenus cinereus*	171	5	176
Red Knot	*Calidris canutus*	129	21	150
Bar-tailed Godwit	*Limosa lapponica*	69	29	98
White-winged Black Tern	*Chlidonias leucopterus*	24	1	25
Curlew Sandpiper	*Calidris ferruginea*	17	4	21
Oriental Plover	*Charadrius veredus*	10	0	10
Sanderling	*Calidris alba*	9	0	9
Ruddy Turnstone	*Arenaria interpres*	5	0	5
Gull-billed Tern (affinis)	*Gelochelidon nilotica affinis*	4	0	4
Lesser Sand Plover	*Charadrius mongolus*	3	0	3
Black-tailed Godwit	*Limosa limosa*	2	1	3
Grey Plover	*Pluvialis squatarola*	2	0	2
Pacific Golden Plover	*Pluvialis fulva*	2	0	2
Far Eastern Curlew	*Numenius madagascariensis*	1	0	1
Gull-billed Tern (macro)	*Gelochelidon macrotarsa*	1	0	1
Whimbrel	*Numenius phaeopus*	1	0	1
Total		**1957**	**234**	**2191**

Recaptures and controls

Five birds, all Great Knot *Calidris tenuirostris*, carrying bands put on elsewhere were caught during the Expedition (Table 12). Four were from China and one from Russia.

Old birds

It is always interesting to see the old ages reached by some of the recaptures (Table 13). The greatest number of days between catching and recapture 7221 for a Great Knot *Calidris tenuirostris* originally banded in May 2000 as a bird in its first year and is now at least 21 years old. Not far behind in age were an 18-year-old Greater Sand Plover *Charadrius leschenaultii* and 17-year-old Bar-tailed Godwit *Limosa lapponica* and Great Knot *Calidris tenuirostris*. There were 38 birds retrapped that were more than 10 years old (Table 13).

Proportion of juveniles

One of the key outputs of each year's NWA Expeditions is the measurement of annual breeding productivity which is obtained using the percentage of juvenile/first year birds in catches (Table 14). We struggled to obtain an adequate catch sample for some of our regularly monitored species such as Ruddy Turnstone *Arenaria interpres* and Curlew Sandpiper *Calidris ferruginea* but overall did manage to get a reasonable estimate for 11 species (Table 14). It appears that the 2019 breeding success of the wader populations which come to North-west Australia and breed above the Arctic circle was average to poor, while those which breed below the Arctic circle was average to good.

Table 12. NWA 2020 controls (recaptures of birds banded elsewhere) (RB=Roebuck Bay, Broome; 80MB=80 Mile Beach).

Species	Country of origin	Band number	Condition of band	Age at Capture	Recapture Date	Recapture location	Flags	Australian Band	Banding details
Great Knot *Calidris tenuirostris*	China?	?806	corroded, not readable	3+	09-02-20	80MB (-19.35; 121.34)	None	063-32516	unknown
Great Knot *Calidris tenuirostris*	Chongming Island, China	F127170	worn	3+	14-02-20	80MB (-19.48: 121.18)	Black/white	063-32733	Banded 01/04/2012 at Chongming Dongtan, Shanghai, China (31°42′52″N,121°15′58″E) 5499km
Great Knot *Calidris tenuirostris*	Chongming Island, China	F133243	worn	3+	22-02-20	RB, Eagles Roost (-19.97: 122.30)	Black/white (T12)	063-33722	Banded 01/04/2016 at Chongming Dongtan, Shanghai, China (31°42′52″N,121°15′58″E) 5499km
Great Knot *Calidris tenuirostris*	Chongming Island, China	F127144	Good	3+	25-02-20	RB, Two Dog Hermit (-19.98: 122.30)	Black/white	None added	Banded 01/04/2012 at Chongming Dongtan, Shanghai, China (31°42′52″N,121°15′58″E) 5499km
Great Knot *Calidris tenuirostris*	Kamchatka, Russia	H5010483	Good	3+	25-02-20	RB, Two Dog Hermit (-19.98: 122.30)	Black tibia/ yellow tarsus	None added	Banded 12/08/2014 at Sobolevskiy distr., Ustevoe, Russia (51°06′00″ N, 155°29′24″E) 8782km

Table 13: Old or noteworthy recaptures during NWA 2020 (RB= Roebuck Bay, Broome, 80MB= 80 Mile Beach).

Species	Band	Date banded	Banding location	Age at banding	Retrap date	Retrap location	Minimum age at retrap
Bar-tailed Godwit *Limosa lapponica*	07367667	03-03-13	80MB - 40-45km S	3+	13-02-20	80MB - 40-45km S	10+
Bar-tailed Godwit *Limosa lapponica*	07364726	23-02-12	80MB - 20-25km S	2	13-02-20	80MB - 40-45km S	10
Bar-tailed Godwit *Limosa lapponica*	07300539	30-11-03	RB - Unspecified	1	22-02-20	RB - Eagles Roost	17
Curlew Sandpiper *Calidris ferruginea*	04292981	26-09-10	RB - Wader Beach	3+	21-02-20	RB - Wader Spit	13+
Curlew Sandpiper *Calidris ferruginea*	04261761	02-11-09	RB - Richard's Point	1	21-02-20	RB - Wader Spit	10
Curlew Sandpiper *Calidris ferruginea*	04264374	04-09-11	RB - Boiler Point	2	25-02-20	RB - Two Dog Hermit	10
Great Knot *Calidris tenuirostris*	06285529	19-11-05	Shores of 80MB	2+	13-02-20	80MB - 40-45km S	17+
Great Knot *Calidris tenuirostris*	06289880	20-11-06	RB - Stilt Viewing	2+	21-02-20	RB - Wader Spit	16+
Great Knot *Calidris tenuirostris*	06303115	27-11-07	RB - Unspecified	2+	22-02-20	RB - Eagles Roost	14+
Great Knot *Calidris tenuirostris*	06310041	17-11-09	RB - Sandy Blowout	2+	24-02-20	RB - Wader Beach	12+
Great Knot *Calidris tenuirostris*	06313903	11-03-11	RB - Campsite Beach	2+	25-02-20	RB - Two Dog Hermit	11+
Great Knot *Calidris tenuirostris*	06313578	06-08-11	RB - Eagles Roost	3+	25-02-20	RB - Two Dog Hermit	11+
Great Knot *Calidris tenuirostris*	06314141	06-08-11	RB - Eagles Roost	2	25-02-20	RB - Two Dog Hermit	10
Great Knot *Calidris tenuirostris*	06307974	16-11-09	RB - Eagles Roost	1	22-02-20	RB - Eagles Roost	11
Great Knot *Calidris tenuirostris*	06285576	29-11-05	RB - Unspecified	1	24-02-20	RB - Wader Beach	15
Great Knot *Calidris tenuirostris*	06278492	13-02-04	RB - Unspecified	1	24-02-20	RB - Wader Beach	17
Great Knot *Calidris tenuirostris*	06257441	16-05-00	RB - Unspecified	1	22-02-20	RB - Eagles Roost	21
Greater Sand Plover *Charadrius leschenaultii*	05250756	14-09-08	RB - Unspecified	3+	25-02-20	RB - Two Dog Hermit	14+
Greater Sand Plover *Charadrius leschenaultii*	05251486	14-09-08	RB - Unspecified	3+	25-02-20	RB - Two Dog Hermit	14+
Greater Sand Plover *Charadrius leschenaultii*	05253757	11-11-08	RB - Richard's Point	2+	24-02-20	RB - Wader Beach	13+
Greater Sand Plover Charadrius leschenaultii	05255145	15-11-09	RB - Richard's Point	2+	25-02-20	RB - Two Dog Hermit	12+
Greater Sand Plover *Charadrius leschenaultii*	05254655	05-11-09	80MB - 20-25km S	2+	13-02-20	80 Mile Beach 41.5 km S	13+
Greater Sand Plover *Charadrius leschenaultii*	05266610	22-09-10	RB - Quarry Beach	3+	25-02-20	RB - Two Dog Hermit	12+
Greater Sand Plover *Charadrius leschenaultii*	05266660	26-09-10	RB - Unspecified	3+	21-02-20	RB - Wader Spit	12+
Greater Sand Plover *Charadrius leschenaultii*	05266803	23-02-11	80MB - 20-25km S	2+	09-02-20	80 Mile Beach 25.5km S	11+
Greater Sand Plover *Charadrius leschenaultii*	05268234	19-09-11	RB - Campsite Beach	3+	25-02-20	RB - Two Dog Hermit	11+
Greater Sand Plover *Charadrius leschenaultii*	05265355	25-07-10	RB - Richard's Point	1	24-02-20	RB - Wader Beach	10
Greater Sand Plover *Charadrius leschenaultii*	05254540	02-11-09	RB - Unspecified	1	21-02-20	RB - Wader Spit	11
Greater Sand Plover *Charadrius leschenaultii*	05265926	22-09-10	RB - Quarry Beach	2	25-02-20	RB - Two Dog Hermit	11
Greater Sand Plover *Charadrius leschenaultii*	05254604	17-10-09	RB - Campsite Beach	2	25-02-20	RB - Two Dog Hermit	12
Greater Sand Plover *Charadrius leschenaultii*	05240969	01-12-05	RB - Unspecified	1	25-02-20	RB - Two Dog Hermit	14
Greater Sand Plover *Charadrius leschenaultii*	05226910	05-12-02	RB - Unspecified	1	21-02-20	RB - Wader Spit	18
Grey-tailed Tattler *Tringa brevipes*	06303752	18-11-08	80MB - 25-30km S	2+	13-02-20	80MB - 40-45km S	14+
Grey-tailed Tattler *Tringa brevipes*	06310993	29-08-10	RB - Quarry Beach	2	24-02-20	RB - Wader Beach	11
Red Knot *Calidris canutus*	05255249	16-11-09	RB - Eagles Roost	2+	21-02-20	RB - Wader Spit	13+
Red Knot *Calidris canutus*	05255167	16-11-09	RB - Eagles Roost	1	25-02-20	RB - Two Dog Hermit	11
Red Knot *Calidris canutus*	05240040	14-05-05	RB - Unspecified	1	25-02-20	RB - Two Dog Hermit	16
Red-necked Stint *Calidris ruficollis*	03648468	11-07-09	RB - Wader Beach	1	25-02-20	RB - Two Dog Hermit	11

Table 14. Percentage juveniles in cannon net catches during NWA 2020 Expedition.

Species	Number of catches Large (>=50)	Small (<50)	Total Caught	Juveniles No.	% Juv	Long-tern average* % juvenile (years)	Assessment of 2019 breeding success
Arctic northern migrants							
Great Knot *Calidris tenuirostris*	4	5	331	7	2.1%	10.0 (22)	Poor
Red-necked Stint *Calidris rufficollis*	1	8	203	28	13.8%	18.2 (22)	Below average
Red Knot *Calidris canutus*	1	7	150	19	12.7%	14.9 (21)	Average
Bar-tailed Godwit *Limosa lapponica*	1	5	98	2	2.0%	9.4 (22)	Very poor
Curlew Sandpiper *Calidris ferruginea*	0	4	21	1		17.0 (21)	
Non-arctic northern migrants							
Greater Sand Plover *Charadrius leschenaultii*	6	3	951	256	26.9%	21.5 (22)	Average
Terek Sandpiper *Xenus cinereus*	1	6	176	34	19.3%	13.4 (21)	Above average
Grey-tailed Tattler *Tringa brevipes*	2	5	195	60	30.8%	19.4 (21)	Very good

* includes 2019/20

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

Flag and Band Sightings

Members of NWA 2020 reported 1068 flag or colour-band sightings during the expedition at 80 Mile Beach and Roebuck Bay, with additional sightings at Broome Port and Coconut Wells, just north of Broome. The sightings fell into five categories: Engraved Leg Flag (ELF), ELF unread (or partially read ELFU), Colour Bands (CB), Colour bands Unread (or partially read CBU) and Plain Flags (PF). Not many of the plain flags seen in Roebuck Bay were recorded but most of those seen at 80 Mile Beach were recorded.

The 1068 sightings were of 13 waders and one tern species banded in six banding regions: China: Chongming Dao, China: Yalu Jiang: China, China: Taiwan, Russia: Kamchatka: Australia: Victoria and North-west WA. Some of these sightings were inaccurately recorded and faded or stained colour-bands and flags and similar looking letters on engraved flags such as X & K or M & W also contributed to errors. When light conditions are not ideal, or sightings are brief, errors can creep in but undoubtedly the majority will be accurately recorded, many birds were seen more than once by multiple observers. Tables 15 to 20 provide details of sightings of marked birds.

Table 15. Number of leg flag and colour-band sightings at each site.

Location	Number of sightings
80 Mile Beach	211
Broome - Roebuck Bay	851
Broome - Coconut Well	3 sightings of 3 birds
Broome – Broome Port	3 sightings of 1 bird

Table 16. Marking location of leg flag and colour-band sightings.

Location of marking	Number of sightings
NWA birds (Broome or 80 Mile Beach)	1,038
Chongming Dao: China	21
Taiwan: China	2
Yalu Jiang: China	2
Kamchatka: Russia	2
Victoria: Australia	1

Table 17. Categories of leg flag or colour-band sightings.

Location of marking	Number of sightings
Engraved Leg Flag fully read	707
Engraved Leg Flag partially or unread	47
Colour Bands fully read	139
Colour Bands partially or unread	19
Plain Flags	156

Table 18. Numbers of individuals sighted with engraved leg flags (ELF's).

Species	Number of sightings and individuals
Great Knot *Calidris tenuirostris*	352 of 255 birds
Bar-tailed Godwit *Limosa lapponica*	154 of 114 birds
Greater Sand Plover *Charadrius leschenaultii*	126 of 96 birds
Terek Sandpiper *Xenus cinereus*	20 of 12 birds
Grey-tailed Tattler *Tringa brevipes*	22 of 15 birds
Red Knot *Calidris canutus*	17 of 17 birds
Black-tailed Godwit *Limosa limosa*	9 of 5 birds
Australian Pied Oystercatcher *Haematopus longirostris*	2 of 2 birds
Oriental Plover *Charadrius veredus*	1 of 1 bird

Table 19. Number of individuals sighted with Global Flyway Network colour bands.

Species	Number of sightings and individuals
Black-tailed Godwit *Limosa limosa*	60 of 36 birds
Bar-tailed Godwit *Limosa lapponica*	40 of 30 birds
Great Knot *Calidris tenuirostris*	39 of 34 birds
Red Knot *Calidris canutus*	3 of 3 birds

Table 20. Number of plain yellow flags observed per species.

Species	Number of flags
Great Knot *Calidris tenuirostris*	47
Bar-tailed Godwit *Limosa lapponica*	37
Greater Sand Plover *Charadrius leschenaultii*	32
Red-necked Stint *Calidris rufficollis*	21
Terek Sandpiper *Xenus cinereus*	8
Grey-tailed Tattler *Tringa brevipes*	4
Curlew Sandpiper *Calidris ferruginea*	3
Grey Plover *Pluvialis squatarola*	1
Red Knot *Calidris canutus*	1
Oriental Plover *Charadrius veredus*	1
Little Tern *Sternula albifrons*	1

Sightings histories of some individually marked birds

Grey-tailed Tattler

The Grey-tailed Tattler *Tringa brevipes* seen with green over orange flags was one of seven banded at Yalu Jiang in China in May 2010 (1) or May 2012 (6) all as adults making it at least ten years old. Grey-tailed Tattler with a yellow engraved leg flag CNN was banded on 2 March 2013 aged 2+ on 80 Mile Beach at Anna Plains. It has been seen there three times and on 30 November 2017 the flag was noted as being worn and likely to fall off. On

5 December 2018 the same observation was made, and the flag was still hanging on when seen on 11 February 2020.

Grey-tailed Tattler with a yellow engraved leg flag DHW was banded in Roebuck Bay on 13 March 2013 aged 2+. It has been seen 15 times in Roebuck Bay since then but not since 17 March 2018.

Bar-tailed Godwit

One Bar-tailed Godwit *Limosa lapponica* records with a yellow engraved leg flag ANH was banded in Roebuck Bay aged 2+ on 14 November 2007. It has been seen 40 times in Roebuck Bay each year except 2009 but it was seen at Yalu Jiang National Nature Reserve, Dandong, CHINA on 9 May 2009. It was last seen in Roebuck Bay on 21 September 2019.

Bar-tailed Godwit with a yellow engraved leg flag DUK was banded in Roebuck Bay aged 1 on 3 July 2010. It has been seen 12 times in Roebuck Bay but not since 9 August 2016.

Great Knot

Great Knot *Calidris tenuirostris* with a yellow engraved leg flag 2YLYL was banded in Roebuck Bay aged 3+ on 10 October 2007 and was retrapped on 16 November 2009 and again on 20 February 2014. It is now at least 15 years old. It has been seen in Roebuck Bay 108 times in all years since first banding and was last seen in Roebuck Bay on 19 January 2020. It was seen once at Yalu Jiang National Nature Reserve, Dandong, CHINA on 8 April 2011.

Great Knot with a yellow engraved leg flag 7BRYL was first banded in Roebuck Bay aged 3+ on 21 November 1999 and was retrapped on 13 October 2019 when the colour bands were added. This is the first sighting since the bands were added and the bird is now at least 22 years old.

Great Knot with a yellow engraved leg flag AJS was banded in Roebuck Bay aged 2+ on 6 November 2006. It has been seen nine times in Roebuck Bay since then but not since 11 October 2013. One reason may be that the letters on the flag have lost their ink, which happened at least as far back as 2011. This makes the letters hard to read and so it has probably been overlooked. The light must be “just right”, and the bird close to the observer for the letters to be seen.

Great Knot with a yellow engraved leg flag CSD was banded in Roebuck Bay aged 2 on 12 August 2007. It has been seen in Roebuck Bay 26 times since then but not in 2009, 2013, 2017 or 2018. It was last seen on 5 September 2019. This is another flag with no ink since 2014, which may account for lack of sightings in some years.

Great Knot with a yellow engraved leg flag XKP was banded in Roebuck Bay aged 2+ on 9 March 2013 when it was fitted with a geolocator. It was caught again on 24 February 2020 when the geolocator was removed. It was seen 18 times in Roebuck Bay before it was retrapped. It was also seen at Yalu Jiang National Nature Reserve, Dandong, CHINA on 29 April 2014 and at Wang-Gong, Chang-Hua County, Taiwan (China) (23.95N, 120.32E).

Terek Sandpiper

Terek Sandpiper *Xenus cinereus* with a yellow engraved leg flag BC was banded in Roebuck Bay on 13 June 2010 aged 1. It has been seen eight times in Roebuck Bay since then but only in 2012 and 2015.

Red Knot

Red Knot *Calidris canutus* with a yellow engraved leg flag YJT was banded in Roebuck Bay on 21 June 2015 aged 1. It was fitted with a geolocator, which was removed on 25 February 2020. It is too early to say if there is any information still on the geolocator. It was seen 15 times in Roebuck Bay between catches.

Red Knot with a yellow engraved leg flag ZPC was perhaps the most interesting one of this selection. It was banded in Roebuck Bay on 28 August 2011 aged 2 and by 6 March 2012 it was seen in the Auckland region of New Zealand. It was seen 20 times in the region at several different sites each year until its last sighting on 26 December 2016. It was seen in Bohai, China on 3 & 24 May 2013 and was back in New Zealand by 2 December 2013.

OTHER MATTERS

Participants

A total of 33 people took part in the Expedition over the 23-day period. Unfortunately, Chinese participants were unable to attend due to the Coronavirus outbreak and consequent travel restrictions. Thus, there were only five participants from overseas.

The AWSG was assisted by regular involvement of elders and Department of Biodiversity Conservation and Attractions (Western Australia) rangers from the Karajarri, Ngarla & Nyangumarta, (Yamatji Marlpa) traditional owner corporations.

Details of origins are:

28 Australia (7 WA, 11 Vic, 1 NT, 1 Qld, 3 SA, 5 NSW)
2 New Zealand
2 United Kingdom
1 Switzerland.

Talks

A programme of evening talks presented by Expedition members took place. Thanks to all those who prepared and gave talks.

Training

The value of the training aspect of the expedition should not be underestimated. The conditions of NWA are extreme and provide a valuable training opportunity for many who rarely experience extremes of temperature while banding but could - without the experience gained here many more mistakes will be made globally by inexperience of extremes. There were three personnel with A Class cannon net licenses and 13 trainees with A Class basic capture method licenses.

In addition, rangers and elders from the Karajarri (9), Nyangumarta (Yamatii Marlpa) – (14), attended catches at 80 Mile Beach. Rangers from DBCA Ngarla (1) and Nyangumarta (2) attended catches in Broome.

Itinerary

This year the Expedition followed the planned itinerary. Due to predicted cyclonic weather the expedition finished two days earlier than originally planned and participants were moved to Broome township from the Broome Bird Observatory and those with cars departed south to avoid the predicted high rainfall. Many thanks to Helen and Graeme Macarthur and Grace Maglio for accommodating the team for two nights.

Finances

The Expedition costs in 2020 were similar to the previous year. A professional caterer was engaged to look after the food procurement and cooking for the Expedition.

Reflections

The NWA 2020 was the first AWSG Expedition since 1981 without Dr Clive Minton who passed away on 6 November 2019 in a fatal car accident. Clive had contributed his usual enthusiasm and organisational skills to the preparation of the 2020 expedition and liaison with potential expedition members, local land holders and indigenous groups. From this groundwork we were able to pick up the threads and continue with the core objectives of the expeditions. Activities such as satellite tracking were put on hold for this year as Clive was instrumental in obtaining funding for these projects and insufficient time was available to obtain funding in time to order the transmitters. In addition, a change in permit requirements in WA meant our application had to be kept as simple as possible to facilitate granting of the permits in a timely manner.

The team worked well together and had a high proportion of repeat visitors. Expeditioners are thanked for taking initiative and 'stepping up' in Clive's absence to make the expedition a great success.

Sadly, our Chinese participants in part sponsored by the Western Australian Department of Conservation, Biodiversity and Attractions (DCBA) were unable to attend due to the Chinese University and Australian Government travel restrictions in response to the Coronavirus outbreak (COVID 2019). We hope they may be able to attend in the future.

NEXT EXPEDITION

The next Expedition to NWA (NWA 2021) will take place in early 2021 – Covid-19 travel restrictions both within Australia and between Australia and international destinations will influence the format and dates. The format will be slightly changed to accommodate further satellite tracking study of Oriental Pratincole *Glareola maldivarum* and more effort in flag sighting at 80 Mile Beach.

We are hoping to deploy trackers on Oriental Pratincoles to follow on from the study instigated by Dr Clive Minton. The Oriental Pratincole is the most numerous migratory wader on the Australian non-breeding grounds, but there is little knowledge of this species, not only in terms of movements within Australia but also there was very limited information about migration routes and breeding sites. Over the last couple of years, the AWSG have lead world-first research on the tracking of this species. The team has discovered the migration paths of the individuals, including one bird that crossed over from the East Asian-Australasian Flyway to the Central Asian Flyway. The wader community has learnt a great deal from tagging just a few birds, but there is still more to learn. We are proposing to extend this research project to apply GPS tags to more Oriental Pratincoles at the NWA expedition in 2021. We are collaborating with Charles Darwin University to purchase more GPS tags and provide technical input to the study.

ACKNOWLEDGEMENTS

Considerable thanks are due to the Department of Biodiversity, Conservation and Attractions not only for providing three vehicles and trailers but also for offering to assist with finances to support the participation of international participants from the EAAF and guidance through the new permit process. Particular thanks to Naomi Findlay for her assistance at the Broome office. We are again enormously grateful to the Stoate family of Anna Plains Station for hosting the Expedition. We thank Chris Hassell of Global Flyway Network for pre-expedition preparation of catching equipment and banding and flagging supplies. We thank Tessa Lamin, Graeme Rowe, Margaret Rowe, Maureen O'Neill, Roz Jessop, and Graham Duell for making a thousand yellow leg flags prior to the expedition. Many thanks to Helen and Graeme Macarthur and Grace Maglio for accommodating the team for two nights, due to forecast extremely wet weather. AWSG acknowledges the Yawuru People via the offices of Nyamba Buru Yawuru Limited for permission to catch birds on the shores of Roebuck Bay, traditional lands of the Yawuru people. AWSG acknowledges the Karajarri and Nyangumarta people for permission to catch birds to be marked for this project on the shores of 80 Mile Beach, traditional lands of the Karajarri and Nyangumarta people. Deakin University, the WA Department of Conservation, Biodiversity and Attractions and the Australian Bird and Bat Banding Schemes Office in Canberra are thanked for providing appropriate ethics, scientific and project permits. ABBBS is thanked for the provision of numbered metal bird bands.

REFERENCES

Clemens, R., D. Rogers, B. Hansen, K. Gosbell, C. Minton, P. Straw, M. Bamford, E. Woehler, D. Milton, M. Weston, B. Venables, D. Wellet, C. Hassell, B. Rutherford, K. Onton, A, Herrod, C. Stubbs, C.Y. Choi, K. Dhanial-Adams, N. Murray, A. Skilleter & R.A. Fuller. 2016. Continental-scale decreases in shorebird populations in Australia". *Emu* 116: 119-135.

Beckley, L.E. (Ed) 2015. Final Report of Project 2.1.1 of the Kimberley Marine Research Program Node of the Western Australian Marine Science Institution, WAMSI, Perth, Western Australia. 121 pp.

Department of Conservation and Land Management. 2003. Information Sheet on Ramsar Wetlands – Australian Ramsar Site 33: Roebuck Bay -

http://www.environment.gov.au/water/topics/wetlands/database/pubs/33-ris.pdf . Accessed 1 April 2020.

Kimberley Development Commission. 2018. 2036 A regional investment blueprint for the Kimberley: https://kdc.wa.gov.au/wp-content/uploads/2018/12/2036-and-Beyond-A-Regional-Investment-Blueprint-for-the-Kimberley.pdf.

Minton, C., M. Connor, D. Price, R. Jessop, P. Collins, H. Sitters, C. Hassell., G. Pearson & D. Rogers. 2013. Wader numbers and distribution on Eighty Mile Beach, north-west Australia: baseline counts for the period 1981–2003. *Conservation Science Western Australia* 8:345–366.

Minton, C., R. Jessop & P. Collins, P. 2003. A summary of results of the Northwestern Australia Wader and Tern Expedition from 28 June to 19 July 2003. *Stilt* 44:64-76.

Pearson, G. 2003. In Information Sheet on Ramsar Wetlands – Australian Ramsar Site 34: 80 Mile Beach: http://www.environment.gov.au/water/topics/wetlands/database/pubs/34-ris.pdf Accessed 1 April 2020.

Rogers, D. 2003. In Information Sheet on Ramsar Wetlands – Australian Ramsar Site 34: 80 Mile Beach: http://www.environment.gov.au/water/topics/wetlands/database/pubs/34-ris.pdf Accessed 1 April 2020.

Rogers, D. & R. Standen. 2019. VWSG Scientific Advisory Committee Research priority review, July 2019. *VWSG Bulletin* 42: 75-92.

Weston, M.A. 2007. Are we neglecting the non-migratory shorebirds of the East Asian-Australasian Flyway? *Stilt* 50:215-223.

TRACKING SHOREBIRD MIGRATION: WHAT TECHNOLOGY IS OUT THERE AND WHAT CAN WE DO WITH IT

CATALINA AMAYA-PERILLA

Lotek Wireless
Email: AmayaC@sirtrack.com

For four decades VHF radio tracking has offered a much deeper insight into avifauna than binoculars and a notebook can offer. Since the turn of the century, new technologies have reduced in size and power consumption to the extent that they are becoming suitable for use on progressively smaller species. Tracking highly-migratory or dispersing species becomes a reality where it was difficult-to-impossible using beeper radio tracking. Improved location accuracy and reduced power consumption allow much finer spatial and temporal scale studies to be conducted. For small migratory shorebird species, the Motus Wildlife Tracking System provides an international collaborative research network that uses a coordinated array of automated logging radio-receivers to track the movement and behaviour of small flying organisms. Geolocators and Store on Board GPS provide a solution for small migratory shorebirds that can be recaptured after a long-term study. For bigger migratory shorebirds, GPS with remote download and PTT Satellite tags can provide a solution. However, the challenge of a wider range of options can make the selection of the most appropriate technology difficult. In this talk we look at the different technologies and discuss how they can be used for shorebirds no matter what their size.

ASSESSING THE SHOREBIRD HABITAT ON KING ISLAND USING A RANGE OF INFORMATION SOURCES

MARGARET BENNETT

BirdLife Tasmania, King Island
Email: margiejbenn51@protonmail.com

King Island, on the extreme western edge of Bass Strait, is near to the southernmost extent of the East Asian - Australasian Flyway. Overall, a decrease in migratory and resident shorebirds has occurred on the island; however, this can be difficult to quantify as the records, post-settlement in 1888, are highly variable. Some initial counts were made c.1970 and then from 1980 on, but there are significant gaps in the available data. To identify the role of the island's habitats are a reason for the observed decreases, I sought information from long term residents, local industry involved with kelp harvesting and PWS rangers. An assessment of the information indicates that the island's various shorebird foraging habitats are unlikely to be responsible for the observed decreases on the island. However, there are several local threats involving humans and feral animals that require more management and control to minimise their effects on the remaining shorebird populations.

MID-TERM REVIEW OF THE WILDLIFE CONSERVATION PLAN FOR MIGRATORY SHOREBIRDS

MARK J. CAREY

Migratory Species Section, Department of the Environment and Energy, Australian Government
Email: mark.carey@environment.gov.au

The Australian Government's Wildlife Conservation Plan for Migratory Shorebirds covers 35 species of migratory shorebird that regularly visit Australia. The plan provides a national framework identifying research and management actions to protect migratory shorebirds in Australia. Approved in December 2015, the plan outlines actions to support migratory shorebird conservation, and is used to ensure activities are integrated and remain focused on the long-term survival of these birds and their habitats. As we approach three years of the Plan being in place, the Department has undertaken a mid-term stocktake to track and understand progress towards meeting the various performance criteria contained in the plan. To date, the plan has been used to engage with relevant countries on how threats in the Yellow Sea region can be managed through practical action and community participation. The plan has also facilitated an update of shorebird population estimates and a new Directory of Important Habitats for Migratory Shorebirds. Over the next two years, focus will be given to actions that have received less attention, such as identifying knowledge gaps, reducing the levels of disturbance at important sites and surveying important habitats. A formal review will occur in 2020.

MIGRATORY SHOREBIRD CARRYING CAPACITY AT THE GLADSTONE REGION IN QUEENSLAND

C.-Y. CHOI[1,2], J. COLEMAN[3], M. KLAASSEN[1], D.J. MOFFITT[2], D. ROGERS[4], G. SKILLETER[2], R.A. FULLER[2]

[1] Centre for Integrative Ecology, School of Life and Environmental Sciences, Deakin University, Geelong, Vic. 3220, Australia
Email: c.choi@uq.edu.au
[2] School of Biological Sciences, The University of Queensland, Brisbane, Qld 4072, Australia
[3] Queensland Wader Study Group, 336 Prout Road, Burbank, Qld 4156, Australia
[4] Arthur Rylah Institute for Environmental Research, 123 Brown Street, Heidelberg, Vic. 3084, Australia

The large tidal flats around Gladstone on Queensland's coast support an impressive array of migratory shorebirds, serving both as a "stopover" site and a non-breeding destination. We estimated the capacity of this region to support migratory shorebirds by conducting shorebird and benthic surveys during the non-breeding season in 2015. We discovered that the region is operating close to its carrying capacity, with 1.2 - 2.4

times more food available for most bird species than currently required. This signals a system that is potentially vulnerable to any future threats that may impact on the quality or quantity of shorebird foraging habitat. Moreover, spatial heterogeneity in food availability was high, with much of the highest quality intertidal foraging habitat available for a limited time only; only 10%–25% of the suitable intertidal habitat was exposed at half tide. Our analyses highlight the importance of identifying high quality foraging habitats for conservation and management actions.

FROM FIELD OBSERVATION TO TRACKING SHOREBIRDS WITH TRANSMITTERS: HOW CHANGES IN FIELD SCIENCE SHAPES SHOREBIRD CONSERVATION MANAGEMENT IN MORETON BAY

JON COLEMAN, ROBERT BUSH

Queensland Wader Study Group, Brisbane

Queensland Wader Study Group members began observing shorebirds around Moreton Bay 26 years ago and quickly discovered and commenced regular counting of high tide roosting sites around its shorelines. Urban expansion has threatened several of these significant roosts along the urban coastal corridor. Toorbul in the north of Moreton Bay, the Port of Brisbane at the mouth of the Brisbane River and Manly Harbour to the south, among others, became sites where artificial roosts were established to protect shorebirds from urban intrusion and industrial development. The significance of these sites, spaced out across the length of the Bay, became clear as count data supported their importance to shorebirds. The use of engraved leg flags in Moreton Bay has helped observers to establish how different shorebird flocks used specific areas of the Bay, highlighting the parochial nature of many species. However, conclusions from analysis of leg flag data like this are limited to observer site selection, observer effort and many other factors. More recent studies involving the placement of Platform Terminal Transmitters on Pacific Golden-plover (*Pluvialis fulva*), Eastern Curlew (*Numenius madagascariensis*) and Whimbrel (*Numenius phaeopus*) from sites in the north and south of Moreton Bay has led to discoveries about how different species use the low tide mudflats and shorelines during different tide cycles, at night and through the day, providing new understanding of their localised behavioural ecology. The paper describes this transition in fieldwork technologies and the potential impact on changes in approach to conservation management.

OVERCOMING THE ODDS: A SEVEN-YEAR RECOVERY EFFORT TO IMPROVE HOODED PLOVER BREEDING SUCCESS ON THE FLEURIEU PENINSULA, SOUTH AUSTRALIA

M. CULLEN, R. MEAD, E. STEPHENS, G. MAGUIRE

BirdLife Australia, Leicester Street, Melbourne
Email: meghan.cullen@birdlife.org.au

Beach-nesting shorebirds are under increasing pressure from habitat loss, predation and recreational beach use. The Fleurieu Peninsula, south of Adelaide, is the most heavily populated coastal area in South Australia and experiences the highest levels of recreational beach use in the state. Many of these beaches are also critical habitat of the threatened Hooded Plover, leading to a human-wildlife conflict. Since 2009, the breeding success of Hooded Plover on the Fleurieu Peninsula has been monitored by citizen scientists. Over seven consecutive breeding seasons (2009/10 – 2015/16), a total of 232 breeding attempts have been monitored at 44 sites. Approximately 75% of nests and/or chicks were managed, via temporary rope fencing and signage, to mitigate the impacts of beach recreation. We explored variation in survival rates during egg and chick phases, and of site threat profiles over time. Results highlight the importance of management to improve breeding success of these threatened birds, with managed breeding pairs being 25% more likely to produce fledglings than unmanaged.

INVERTEBRATE DAILY VERTICAL DISTRIBUTION: IMPLICATIONS FOR SHOREBIRDS ACTIVITY WHEN FOOD IS ALWAYS AVAILABLE

SORA M. ESTRELLA, ROBERT A. DAVIS, PIERRE HORWITZ

Centre for Ecosystem Management, School of Science, Edith Cowan University
Email: s.marin-estrella@ecu.edu.au

The vertical distribution of benthic invertebrates in the sediment can limit prey availability for shorebirds. Several studies have found a daily change in this distribution: an increase in benthic invertebrate activity closer to the surface at night in intertidal habitats, attributed to anti-predator behaviour. This has been hypothesised as one of the two reasons why shorebirds feed at night. We studied the diel vertical distribution of benthic invertebrates in two non-tidal habitats, a salt lake and a saltpan. In contrast to intertidal habitats, polychaetes, amphipods and bivalves were continuously available for shorebirds. The highest densities were found in the first 5 cm of the sediment, independent of the time of the day. The implications of this finding for shorebirds foraging activity as well as the role of non-tidal habitats for shorebird conservation, are discussed.

INSIGHTS FROM TRACKING GREY PLOVER

TONY FLAHERTY[1], CLIVE MINTON[2], MAUREEN CHRISTIE[3], GRACE MAGLIO[4], KATHERINE LEUNG[4], KEN GOSBELL[4], INKA VELTHEIM[4], REECE PEDLER[3], CHRIS HASSELL[5]

[1]*Natural Resources Adelaide and Mt Lofty Ranges, South Australia*
Email: Tony.Flaherty@sa.gov.au
[2]*Victorian Wader Study Group, Melbourne*
[3]*Friends of Shorebird SE, Carpenter Rocks, South Australia*
[4]*Australasian Wader Studies Group, Melbourne*
[5]*Global Flyway Network, Broome, Western Australia*

Satellite telemetry of Grey Plovers from Australia has been undertaken using 5 gram solar powered Platform Terminal Transmitters, attached using 'leg-loop harnesses'. Ten PTTs were deployed on Grey Plover north of Adelaide, South Australia between 2015 and 2018. This was undertaken by the Victorian Wader Study Group and Friends of Shorebirds SE, supported by Adelaide Mt Lofty Ranges Natural Resources Management Board and the Australian Government. Five PTTs were deployed on Grey Plover at Roebuck Bay, north-western Australia in February 2016, through the Australasian Wader Studies Group, and BirdLife Australia. In 2016 two WA and two SA birds were tracked on northward migration to Arctic Siberia with initial observations presented at the 10th Australasian Shorebird Conference. This presentation will outline some observations on austral summer site fidelity and habitat use, Sino-Russian and south-east Asian stopover sites, and possible weather influences. The presentation will probably pose more questions than answers.

TRIALS AT A DECOMMISSIONED SALTFIELD TO PROVIDE SHOREBIRD HABITAT VALUES

TONY FLAHERTY[1], CHRIS PURNELL[2], LUKE MOSELEY[3], JASON QUINN[4], GRAHAM CARPENTER[2], GOLO MAURER[2], KASUN EKANAYAKE[2], ALEISA LAMANNA[2], GREG INGLETON[5]

[1]*Natural Resources Adelaide and Mt Lofty Ranges, South Australia*
Email: Tony.Flaherty@sa.gov.au
[2]*BirdLIfe Australia, Adelaide*
[3]*University of Adelaide, Adelaide*
[4]*Department of Environment and Water, South Australia*
[5]*South Australia Water*

Globally, coastal saltworks support significant numbers of shorebirds and waterbirds. The Dry Creek saltfields north of Adelaide have provided feeding and roosting habitat for significant numbers of shorebirds and a significant proportion of the total Gulf St Vincent shorebird population. With the decommissioning of the Dry Creek saltfields, South Australia, a state government, NGO and research collaboration initiated reconnection of a disused pond to reinstate tidal flows. This aimed to provide conditions for saltmarsh restoration provide shorebird habitat opportunities. Additionally, shorebird counts have been undertaken at nearby saltfield gypsum ponds where water managers have trialled discharge of treated wastewater for evaporation, with shorebird habitat benefits. This presentation will provide an overview of the tidal trial and preliminary observations of potential shorebird habitat benefit.

WING THREADS: FLIGHT AROUND OZ

AMELLIA FORMBY

Wing Threads, Newcastle, New South Wales
Email: amellia.formby@wingthreads.com

From March to September 2019, zoologist turned pilot, Amellia Formby will be flying a microlight around Australia for shorebird conservation. Departing from Broome when the shorebirds begin their northward migration, Amellia will attempt to do a lap of Australia in the same amount of time it take a group of satellite-tagged shorebirds to fly to the Arctic and back. Along the way, she will stop at major shorebird sites around the coast to run shorebird training workshops with indigenous ranger groups and visit schools to introduce students to migratory shorebirds in collaboration with BirdLife Australia. Join Amellia as she shares the life-changing events and challenges she has faced over the past three years on the road to becoming a pilot in bringing this dream to life.

SCIENCE FOR SAVING SHOREBIRDS: WHERE NEXT?

RICHARD A. FULLER

School of Biological Sciences, University of Queensland
Email: r.fuller@uq.edu.au

Since the pivotal last ASC meeting in Hobart in 2008, our scientific understanding of migratory shorebirds in the East Asian – Australasian Flyway has flourished, made possible by shorebird monitoring data collected by expert volunteers over many decades, and by the work of scientists from around the flyway and beyond. Research is clarifying shorebird migrations, revealing how their habitat is being lost, and showing that Yellow Sea-dependent species are decreasing the fastest. The science often makes for depressing reading, but demonstrates the crisis facing our birds, and starts to frame conservation solutions. Shorebird conservation in the EAAF is rightly focused on intertidal habitat protection. Yet there are many other threats, some maybe more severe than intertidal habitat loss. These include overharvesting, climate change, reduced food supply, disturbance, pollution, and supratidal habitat losses. We need to know how these threats operate, how they interact with each other, and they can be addressed. Shorebird researchers won't be out of a job for quite some time to come.

USING ART TO ENGAGE AUDIENCES WITH SHOREBIRD CONSERVATION

KATE GORRINGE-SMITH

The Overwintering Project
Email: overwinteringproject@gmail.com

Over the past 10 years, I have initiated three major art projects that engage artists and audiences with migratory shorebirds. The first, the Flyway Print Exchange, involved 20 artists from 9 EAAF countries, the second used migratory shorebirds as a unifying theme for works by migrant and refugee artists. The third, the current and ongoing Overwintering Project, links artists around Australia and New Zealand with their local shorebird habitat and each other. I have found artists and audiences engage readily with the stories of migratory shorebirds and the idea of the Flyway. I have also found that government and volunteer bodies trying to raise awareness of their local shorebirds and shorebird habitat leap at the opportunity to exhibit a tool such as the Flyway Print Exchange to help engage the public. Art provides a rich opportunity to engage communities with migratory shorebirds and their habitat.

INSIGHTS FROM GEOLOCATOR STUDIES IN AUSTRALIA, 2009 – 2017

KEN GOSBELL[1,2], CLIVE MINTON[1,2], SIMEON LISOVSKI[1,3], MAUREEN CHRISTIE1,[3], CHRIS HASSELL[4], MARCEL KLAASSEN[6]

1 Victorian Wader Study Group, Melbourne
Email: ken@gosbell.id.au
[2]Australasian Wader Studies Group, Melbourne
[3]Swiss Ornithological Institute
[4]Friends of Shorebirds SE, Carpenter Rocks, South Australia
[5]Global Flyway Network, Broome, Western Australia
[6]Centre for Integrative Ecology, School of Life and Environmental Sciences, Deakin University

Australia was one of the first countries to utilise light-level geolocators for tracking the movements of migratory shorebirds. Since 2009, we have deployed these instruments on a range of species at non-breeding locations around the country. This extensive program has gathered a wealth of information on the movements of nine of Australia's long-distance migratory species. The migratory tracks obtained, including an increasing number of multi-year tracks, allowed us to detail routes and strategies used along the East-Asian Australasian Flyway. Critically, this information has contributed to understanding the relative importance of stopover sites along the flyway - fundamental to developing conservation strategies. More recent studies have enabled assessment of breeding locations and incubation strategies, many of which were unknown given the remote, low density breeding sites used by these species. These insights have informed conservation measures flyway-wide and on a local scale. Recognising the constraints of light-level geolocators we go on to discuss the possible future use of light-level geolocation.

THE LATHAM'S SNIPE PROJECT NATIONAL SURVEYS

BIRGITA HANSEN[1], LORI GOULD[2], CHRIS DAVEY[3], JODIE HONAN[4], RICHARD CHAMBERLAIN[4], DON STEWART[4]

[1]Centre for eResearch and Digital Innovation, Federation University Australia, Ballarat, Victoria 3353
Email: b.hansen@federation.edu.au
[2]Woodlands and Wetlands Trust (Jerrabomberra Wetlands), Fyshwick, ACT 2609
[3]Canberra Ornithologists Group, Civic Square, ACT 2608
[4]South Beach Wetlands and Landcare Group, Port Fairy, Victoria 3284

The Latham's Snipe Project was initiated in 2014 to investigate the ecology and migration of the species in Australia. A substantial part of that project, which is ongoing, was the establishment of systematic surveys to collect baseline data on distribution and abundance, intended to underpin future trends analyses. Specific survey techniques were co-developed with experienced community group members, designed to enable a more robust comparison of population counts than is currently available in any other Australian monitoring program (including Shorebirds2020). In Canberra, monitoring has followed these protocols and delivered important insights about the population there. These include the discovery that the Jerrabomberra wetlands complex supports more than 0.05% of the population (18 birds, the national threshold for important sites). In addition, Jerrabomberra wetlands is a terminus for migrating snipe and hosts a "resident" population throughout the spring-summer season. Most importantly, volunteer monitoring has been critical to obtaining these insights.

LESSONS FROM DEPLOYMENT OF MIGRATION TRACKING DEVICES ON LATHAM'S SNIPE

BIRGITA HANSEN[1,5], LORI GOULD[2], CHRIS DAVEY[3], JODIE HONAN[4], RICHARD CHAMBERLAIN[4], DON STEWART[4], DAVID WILSON[5]

[1]Centre for eResearch and Digital Innovation, Federation University Australia, Ballarat, Victoria 3353
Email: b.hansen@federation.edu.au
[2]Woodlands and Wetlands Trust (Jerrabomberra Wetlands), Fyshwick, ACT 2609
[3]Canberra Ornithologists Group, Civic Square, ACT 2608

[4]*South Beach Wetlands and Landcare Group, Port Fairy, Victoria 3284*
[5]*Victorian Wader Study Group, Beaumaris, Victoria 3193*

Migration routes of Latham's Snipe are not well understood owing to the cryptic nature of this species, making observations of wild birds difficult. The Latham's Snipe Project was initiated to investigate the ecology and migration of the species in Australia. Four migration and movement tracking methods have been deployed with varying levels of success. Firstly, all snipe captured during field studies in Port Fairy and Canberra have been fitted with orange engraved leg flags. Secondly, a proportion of those captured birds were fitted with leg flag-mounted 1.0 or 0.7g light-level geolocators. Thirdly, some birds were also fitted with a 1.5g VHF transmitters, which were glued to the back of the bird. Lastly, several birds were fitted with 5g solar-powered PTTs using a backpack harness. Whilst leg flags, geolocators and radio transmitters have revealed important insights, satellite tracking presented some welfare issues and overall, proved to be relatively unsuccessful.

ARTIFICIAL COASTAL WETLANDS ARE AN INTEGRAL PART OF HABITAT CONSERVATION FOR THE MIGRATORY SHOREBIRDS OF THE EAAF

MICHA V. JACKSON[1], CHI-YEUNG CHOI[1,2], RICHARD A. FULLER[1]

[1]*School of Biological Sciences, The University of Queensland, Brisbane, Qld 4072*
Email: micha.v.jackson@gmail.com
[2]*Centre for Integrative Ecology, Deakin University, Geelong, Vic 3220*

Coastal migratory shorebirds have multiple habitat requirements. In non-breeding areas, many use both intertidal mudflats and supratidal wetlands for foraging and roosting. In the East Asian-Australasian Flyway these habitats face enormous development pressure, with habitat loss a key driver of population decreases in multiple species. But a number of prevalent coastal land uses create artificial wetlands that shorebirds can utilise. Large aggregations occur on commercial salt and aquaculture ponds, rice paddies and some industrial areas. But a flyway-scale understanding of the extent of use; functionality as roosting or foraging habitat; species composition; and, relative usefulness to different species of artificial habitats is currently lacking. From literature, count data, and field study we discovered that artificial wetlands in the EAAF are extensively utilised, particularly as roosting habitat in conjunction with intertidal feeding grounds. Extensive land reclamation in some countries has resulted in mudflat foraging grounds abutting long concrete seawalls with almost no natural supratidal wetlands remaining, so shorebirds must often utilise artificial supratidal habitat for roosting at high tide. From accessible count data, at least 31 species have been recorded on artificial habitats in internationally significant numbers across 30 sites in 6 countries, with our dataset unlikely to be exhaustive. But species occurrence is highly variable, with 8 non-vagrant species occurring at more than 70% of studied sites, but 22 appearing at <20%. These results have important conservation implications, suggesting that while artificial habitats should never be considered a replacement, they must be included alongside intertidal flats in the conservation and management of non-breeding areas. There are documented strategies for managing artificial wetlands to benefit shorebirds, and partnerships with local land users present opportunities for their maintenance and improvement.

GETTING THE ARTISTS ON BOARD

JACKIE KERIN

Email: biteback@bigpond.com

Hobsons Bay, close to the city of Melbourne, on the west side of the Yarra River, is responsible for several small wetlands that are host to many species of resident and migratory shorebirds. The pressure on these habitats is enormous as they are favoured recreational sites. The conservation rangers use many approaches to engage and educate the community but it's only recently that local artists have found a way to collectively get on board. For the past three years, the rangers have run an event marking World Migratory Bird Day supported by a voluntary committee of visual artists, science communicators, the local folk club, a children's music school and two choirs. Leaving the rangers to bring organisations like Birdlife to the day, the artists, bring, activities, stories and songs. This year over 300 people participated. The focus is always: the importance of habitat for the enduring survival of the birds. The artists bring information encoded playfully in story, song, drawing and painting. They bring people into the space that otherwise would not be there. A children's choir attracts parents, grandparents and friends. Stories bring an audience who are not drawn to lectures and artworks reach out to people who learn through their eyes. This presentation shares the history of our project, the ongoing enthusiasm and projected plans to continue growing the artists network supporting the local rangers. Delivered with the idea that we may inspire others to see the valuable role artists can play in raising awareness.

PLUGGING A GAP: RESTORING WETLANDS IN THE SW OF VICTORIA AND SE SA

GREGORY D KERR

Senior Ecologist, Nature Glenelg Trust, 86 Skene St, Dunkeld, Victoria 3294
Email: gregkerr@adam.com.au

The wetlands of SW Victoria and SE South Australia have been extensively drained and modified. Drainage, groundwater extraction, irrigation, plantations, cropping, and marked changes in associated terrestrial habitat have all combined to transform a predominantly wet landscape, with most wetlands gone and many of those remaining severely degraded.

Recent work across the region has seen a reversal in this story. Farmers and other land holders are realising they or their predecessors went too far in draining many wetlands. Funding to bring about change is becoming available and innovative restoration methods are being developed and applied. Recent projects are redressing the complexity of past management practices and restoring significant wetland areas. The news is good, the changes in wetlands positive. Community members are starting to realise that healthy productive wetlands can be restored from dry cropped paddocks. Drained wetlands which were rarely productive, can be and are better off, restored. The consequences for biodiversity are very positive.

RUDDY TURNSTONES IN TIMES OF CHANGE

MARCEL KLAASSEN[1], BETHANY HOYE[1], JAMIE WILLEY[1], KEN GOSBELL[2], MARGARET BENNETT[3], MEIJUAN ZHAO[1], MICHELLE WILLE[1], PENNY JOHNS[2], ROB PATRICK[2], ROBYN ATKINSON[2], SIMEON LISOVSKI[2], VEERLE JASPERS[2], CLIVE MINTON[2]

[1]*Centre for Integrative Ecology, School of Life and Environmental Sciences, Deakin University*
Email: marcel.klaassen@deakin.edu.au
[2]*Victorian Wader Study Group*
[3]*BirdLife Tasmania, King Island*

A range of global change processes are impacting migratory shorebirds. Starting 2006, Ruddy Turnstones (*Arenaria interpres*) spending the non-breeding season on King island, Tasmania, have been studied intensively by the Victorian Wader Study Group, with support from various international research institutes. Using banding, biometric, blood, cloacal and oropharyngeal swab, and geolocator data, we evaluate the potential threats that rapid Arctic climate change, habitat destruction, pollution and exposure to novel diseases pose to Ruddy Turnstones. The bottom line is that these threats are real and do impact the turnstones in a myriad of ways. However, at the population level the King Island Ruddy Turnstones are apparently still hanging on and are (not yet) being overstretched. At least in part, this result may be due to rapid evolutionary change.

NORTHWARD MIGRATION ROUTES AND HABITAT USE OF NON-BREEDING WHIMBRELS IN AUSTRALIA AS REVEALED BY SATELLITE TRACKING

FENLIANG KUANG[1], MIAN-JUAN KE[1], JONATHAN COLEMAN[2], CHRIS HASSELL[3], CLIVE MINTON[4], KATHERINE LEUNG[5], GRACE MAGLIO[6], ZHIJUN MA[1]

[1]*Coastal Ecosystems Research Station of Yangtze Estuary, Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, Institute of Biodiversity Science, Fudan University, No. 220 Handan Road, Shanghai 200433, China*
Email: 16110700092@fudan.edu.cn
[2]*Queensland Wader Study Group, 22 Parker Street, Shailer Park, Qld 4128*
[3]*Global Flyway Network, PO Box 3089, Broome*
[4]*Victorian Wader Study Group, c/o 165 Dalgetty Road, Beaumaris, Vic. 3193*
[5]*Australasian Wader Studies Group, Broome*
[6]*Independent researcher, Broome, Australia.*

To determine the migration routes and habitat use of the Whimbrel (*Numenius phaeopus*) during northward migration period, the non-breeding Whimbrels were captured at east and north-west Australia and tracked using satellite tracking technology. We found that the tracked Whimbrels departed from Australia between April 16 and April 28, and staged at the coast of south China, the Yellow Sea region and the Northeast China Plain. The Whimbrels used various habitats during the migration period, including mudflat, saltmarsh, farmland and grassland. The breeding sites, usually arrived by early June, were spread from eastern Chukotka to northwestern Sakha. Whimbrels that completed northward migration migrated for 41 ± 6 (mean ± SD) days to cover about 10000 ± 326 (mean ± SD) km. Total stopover duration was 26 ± 4 (mean ± SD) days.

BIRDS N' BICKIES

ALEISA LAMANNA, EMMA STEPHENS

BirdLife Australia and Natural Resources, Adelaide and Mt Lofty Ranges (NR AMLR)
Email: aleisa.lamanna@birdlife.org.au

The Samphire Coast Icon Project engaged a monumental 6000 people in shorebird and beach-nesting bird conservation during it 5 years of operation. Ending in June 2017, the project transitioned into a new Sharing our Shores with Coastal Wildlife project with an expanded focus and key objective of maintaining momentum for shorebird awareness and conservation. Last summer, a series of engagement sessions were launched known as "Birds n' Bickies". The aim of these sessions were three-fold; 1 - Facilitating and encouraging a comfortable learning environment for those new to shorebirds, 2- provide an opportunity for informal mentoring or knowledge sharing and 3 - up-skill volunteers to be able to confidently undertake shorebird counts. We will share more about this model for engagement and mentoring as an effective engagement strategy for shorebird conservation. We will also share the learnings from a recent survey of targeted participants in shorebird conservation and monitoring programs within the NR AMLR region and Gulf St Vincent area to explore the effectiveness of these programs, including the Birds n' Bickies series.

MIGRATORY SHOREBIRDS AND THE LNG BOOM: EIGHT YEARS OF MONITORING AND RESEARCH

ADAM LEAVESLEY, JIM RESIDE

Wildlife Unlimited, Bairnsdale, Victoria
Email: adam.leavesley@act.gov.au

A proposal to construct three LNG export plans and associated marine infrastructure near Gladstone was approved in 2010. One of the conditions of the approval for the dredging work was that an Ecological Research and Monitoring Program be implemented over 10 years in the region. Migratory shorebirds were amongst the target species. Monitoring commenced in 2011 with an intensive program of five surveys per year for the first two years, changing to a single summer survey for the following six years. We report on the monitoring and research results to this point. Total migratory shorebird summer abundance on the Curtis Coast has been stable during the program and is in the order of 12,000 birds consisting of 19-21 species. Greater than 95% of the records are of 10 species most of which have remained stable, though the last survey returned counts for Eastern Curlew and Great Knot at the bottom of the range. The program has two more years to run.

LOCAL MOVEMENTS OF THE FAR EASTERN CURLEW ON THE NON-BREEDING GROUNDS OF AUSTRALIA - PRELIMINARY RESULTS FROM GPS TRACKING

AMANDA LILLEYMAN

Threatened Species Recovery Hub, National Environmental Science Programme, Research Institute for the Environment and Livelihoods, Charles Darwin University, Ellengowan Drive, Casuarina NT 0909
Email: Amanda.Lilleyman@cdu.edu.au

Understanding when animals use specific habitats assists in the direction of management actions. Threatened migratory shorebirds can be assisted through targeted management plans, but a first step towards conserving them is to understand their relationship with the environment. The Far Eastern Curlew is a Critically Endangered shorebird that completes a long-distance migration between the northern and southern hemispheres every year. Migratory shorebirds require high quality habitat on their non-breeding grounds for successful migration and survival. Currently, little is known about their exact habitat requirements on the non-breeding grounds in Australia. Our project aims to understand how curlew use intertidal mudflats and saltpans in an industrialised harbour (Darwin Harbour, Northern Territory), so that we can provide strategic guidance to decision-makers regarding coastal development. In our pilot study, we tracked two curlew during the 2017-2018 austral summer season and found that these birds had restricted home ranges and spent most of their time in saltpans, despite intertidal mudflat being available close by. The daily commute of curlew from their roosting to feeding sites was shorter than local movements in Moreton Bay, Queensland, but similar to the commuting distances of curlew in Gladstone Harbour, Queensland. These preliminary results will help guide ongoing research on curlew habitat use and the preservation of coastal saltpans and mangrove areas.

WADERS AND GOLD MINING CYANIDE-BEARING TAILINGS DAMS: THE GOOD, THE BAD AND THE UGLY

DANIELLE MADDEN-HALLETT, DAVID DONATO

Donato Environmental Services
Email: info@peramelesconsulting.com.au

Cyanide is widely used in the gold extraction process. Mine waste solutions, containing cyanides, are disposed into tailings storage facilities (TSFs). To waders, these structures resemble wetlands and there is no reason to believe that birds can distinguish between TSFs and any other similar sized water body. Cyanide is a fast-acting asphyxiate. Wildlife deaths associated with cyanide-bearing mine waste solutions have plagued the gold mining industries for many years. Waders are the most abundant bird guild on these tailings dams.

The Good: The International Cyanide Management Code requires that gold mining operations protect wildlife that may inhabit tailings systems and that cyanide concentration must not exceed 50 mg/L WAD cyanide concentration.

The Bad: Australian second tier companies are not signatories to the Code.

The Ugly: Migratory and non-migratory waders can suffer considerable numbers of fatalities on TSFs. Deaths on non-Code-signatory operations are typically undetected, not reported, misidentified or grossly underestimated. State regulators do not require operations to protect wildlife on tailings systems.

A COMPARISON STUDY OF THE FEEDING ECOLOGY OF PACIFIC GOLDEN PLOVER AND GREY PLOVER ON ROEBUCK BAY, BROOME, WESTERN AUSTRALIA

GRACE MAGLIO

PO BOX 7419, Broome, WA 6725
Email: gracemaglio@hotmail.com

The vast mudflats of Roebuck Bay, North Western Australia, support 100,000 migratory waders throughout the year. They rely on the abundant and diverse macro invertebrate species of the bay to fuel their northward migration. In this presentation I present foraging and behavioural data for two of the 20 migratory shorebird species that rely on Roebuck Bay during the wintering and pre-migration periods: Grey Plover (*Pluvialis squatarola*) and the Pacific Golden Plover (*Pluvialis* *fulva*). There have been no previous foraging studies for either of these species in Roebuck Bay. Both Grey Plover and Pacific Golden Plover are visual foragers and feed as solitary birds across the tidal embayment. They are at their highest abundance during October to March and I recorded video footage of these birds during those months. From October 2015 to April 2017 I obtained 39 videos totalling approximately 200 minutes. I also took benthos samples during this period and found approximately 550 invertebrates from at least 75 species. There is currently little published on the foraging behaviours of these plovers, I present findings from this study and compare the foraging behaviour of the two species. Interesting records included the apparent targeting of Sea Cucumbers by Grey Plover.

SOME INSIGHTS INTO RED-NECKED STINT MIGRATION OBTAINED FROM GEOLOCATORS

CLIVE MINTON[1,2], KEN GOSBELL[1,2], SIMEON LISOVSKI[3],

[1]*Victorian Wader Study Group, Melbourne*
[2] *Australasian Wader Studies Group*
[3] *Swiss Ornithological Institute*
Email: ken@gosbell.id.au

The development by Migrate Technology of a lightweight Intigeo geolocator weighing 0.3g enabled the VWSG to study the migration characteristics of the smallest and most numerous shorebird that spends the non-breeding period in Australia. In 2016, 60 of these geolocators were deployed on this species at Yallock Creek, Westernport Bay. In four subsequent catches a total of 18 loggers were retrieved. Of these there were 11 viable datasets which enabled the northward and southward migration strategies to be determined. We will discuss the timing, tracks and stopover locations derived and their relative importance. Although this small wader makes more stops as expected, it still made a stage of up to 3,500km to the China coast on northward migration. The incubation characteristics indicated a relatively high success rate in this particular year. There is still much to learn about this species but this program has enabled a significant step forward in understanding their movements.

ACCOUNTABILITY FOR SHOREBIRD POPULATION LOSSES IN SOUTH-EAST TASMANIA

MIKE NEWMAN, ERIC WOEHLER, SUE DRAKE, ALAN FLETCHER

BirdLife Tasmania
Email: omgnewman@bigpond.com

Catastrophic losses in the migratory shorebirds have occurred in south-east Tasmania during the last 50 years. The Curlew Sandpiper, formerly the second most numerous species, is now a vagrant. Emphasis has been placed on habitat loss external to Australian, particularly at stop-over locations along the flyway, as the primary cause of these losses. However, in south-east Tasmania it is questionable whether our shorebird habitat could support historical levels if populations recovered. At South Arm, shorebird locations high tide roosts have been lost through a combination of rising sea levels, erosion, and disturbance from commercial and recreational activities. Oyster leases have contributed to a loss of intertidal mudflat foraging opportunities. Resident shorebird species, such as the Australian Pied Oystercatcher have also been adversely impacted through loss of breeding sites and increased recreational disturbance.

NATIONAL DIRECTORY OF IMPORTANT MIGRATORY SHOREBIRD HABITAT

DAN WELLER

BirdLife Australia
Email: dan.weller@birdlife.org.au

The revision of the flyway population estimates by Hansen et al. (2016) has provided the underpinning data to assess the importance of any shorebird habitat throughout Australia. The Directory of Important Habitat for Migratory Shorebirds is, therefore, the next logical step in the implementation of the WCP and is identified as a High priority action. Identification and mapping of important habitat for migratory shorebirds is required to deliver scientifically robust data for the Minister of the Environment in making referral decisions and better targeting of investment under the new National Landcare Program. Important habitats in Australia for migratory shorebirds under the EPBC Act include those recognised as nationally or internationally important. This project identifies all sites in Australia that meet national and significance criteria using species thresholds from the revised population estimates. Previous assessments (Watkins 1993, Bamford et al. 2008) of Australian sites of importance focused on international significance. The Shorebirds 2020 database has provided the main source of data for identifying sites of national and international significance for migratory shorebirds included in this report. The wider Birdata/Atlas database has also been used in this project, which includes data from eBird (up to June 2017), eremaea Birds, the original Birdata database, Atlas record forms and about 15 or so other databases from around the country. A special export query in the Birdata database uses the recently updated flyway population estimates and applies them through the 0.1% and 1% flyway population threshold criteria for each species, as well as the 2000/20,000 abundance criteria, and species diversity (>15 species) criteria, and then locates and extracts any surveys meeting these. Like the flyway population estimates revision project, we have had instruction to limit the time period of interest to the last 10 or so years – from November 2005 to now, i.e. contemporary data only. The outcome of this process is c.350 areas/sites meeting one or more of these criteria,

which for this project, means that each of these receives a 'site account' and a place in the directory.

LOCAL DRIVERS OF MIGRATORY SHOREBIRD ABUNDANCE AND POPULATION TRENDS IN THE GREAT SANDY STRAIT

BRADLEY K. WOODWORTH[1], SAM NICOL[2], RICHARD A. FULLER[1]

[1]*School of Biological Sciences, The University of Queensland, St Lucia QLD 4072*
Email: b.woodworth@uq.edu.au
[2]*CSIRO Land and Water, Dutton Park QLD 4102*

Loss of intertidal habitat in the Yellow Sea has largely driven decreases of migratory shorebirds in the East Asian Australasian Flyway, but wetlands in Australia are also threatened by disturbance and habitat degradation. We evaluated how local demographic and environmental factors affect spatial variation in abundance and population trends of migratory shorebirds in the Great Sandy Strait, a 90 km long sand estuary that supports >25,000 shorebirds each summer. Analysis of count data collected by the Queensland Wader Study Group from 1988-2018 revealed strait-wide annual decreases of at least -3.6%/year for 8 species, including Eastern curlew and Curlew sandpiper but not Great knot, whose abundance was stable. Initial results suggest that large roosts have decreased less severely than small roosts and that extent of intertidal habitat near roosts is positively correlated with abundance. These results are being used to prioritise management actions to aid in conserving Queensland's migratory shorebirds.

MIGRATION PHENOLOGY AND STOPOVER SITE USE OF SE AUSTRALIAN RUDDY TURNSTONES – A MULTI-POPULATION ASSESSMENT USING A NETWORK ANALYSIS APPROACH

MEIJUAN ZHAO[1], ROBYN ATKINSON[2], MARGARET BENNETT[3], MAUREEN CHRISTIE[4], KEN GOSBELL[2], PENNY JOHNS[2], MARCEL KLAASSEN[1], SIMEON LISOVSKI[4], CLIVE MINTON[2], ROB PATRICK[2], BETHANY HOYE[1]

[1]*Centre for Integrative Ecology, School of Life and Environmental Sciences, Deakin University*
Email: meijuanz@deakin.edu.au
[2]*Victorian Wader Study Group*
[3]*BirdLife Tasmania, King Island*
[4]*Swiss Ornithological Institute*

Identification of the chain of stopover sites along the migration route and the migratory timing are important to evaluate the constraints migrants face and to guide their conservation. We obtained individual tracks of Ruddy Turnstones (*Arenaria interpres*) from three non-breeding (i.e. wintering) populations in south-east Australia. From which, we evaluated the interconnectedness of the chain of stopover sites along the East Asian-Australasian Flyway using network analysis and built a comprehensive understanding of these populations' migratory timing, for both pre- and post-breeding migration separately. We identified a chain of key stopover sites of which the importance of some had previously been underestimated. Notably the southern East Asian coast (mainly along the Taiwan and Fujian coast) connects a high number of other stopovers during pre-breeding migration, indicating that habitat loss at this site would pose a high site constraint for migration. The synchronisation in space and timing use was more pronounced during pre- compared to post-breeding migration, indicating Ruddy Turnstones are under higher time constraint on their way towards the breeding grounds. Although mixed at the breeding grounds and staying there over a similar time period, the three wintering populations significantly differed in migration timing and stopover site use. Our study thus emphasises that even at relatively small spatial scales (here in terms of distances between non-breeding populations) patterns of migratory connectivity may exist, with each population exhibiting unique migration patterns, potentially requiring different conservation efforts. Such conservation efforts targeting endangered non-breeding and stopover sites should notably be considered for sites used during migration towards the breeding grounds since little tolerance in alternative timing and site use is allowed during this period.

POSTER ABSTRACTS

ALISON ELLIS

Email: alisonmellis1@gmail.com

Is lithography applicable to contemporary wildlife illustration? In this study, I seek to explore the potential of the nineteenth century form of printmaking, stone lithography, for making images of the migratory bird species under threat, through practice based studio research. I have chosen an older form of image making which recalls historical scientific illustration to make fine art prints both as individual artworks, and as a starting point for infographics on each of the birds; with an aim to engage the interest of the general viewer with their plight, and tell the fascinating stories of these endangered species.

THE IMPORTANCE OF NORTH-WEST TASMANIAN ESTUARIES TO THE AUSTRALIAN PIED OYSTERCATCHER *HAEMATOPUS LONGIROSTRIS*

HAZEL BRITTON

BirdLife Tasmania and Cradle Coast NRM
Email: hazpet@bigpond.com

The Australian Pied Oystercatcher has an estimated population of around 11,000, although it is believed to be

decreasing in some parts of its range. Tasmania a stronghold for the species.

The Duck River Estuary and the Rubicon Estuary support high numbers of this species, estimated to hold up to 8% of the population. Both estuaries occur within two of BirdLife Australia's IBAs, and monitoring suggests that the region is likely to support a further 660 (or 6%) individuals. The total for this region is approaching 14% of the estimated total world population. Under the Ramsar Convention, sites regularly supporting 1% of the population of a wetland species are considered as Internationally Important. This section of the Cradle Coast in North West Tasmania, with a minimum estimated 14% of the world population of Australian Pied Oystercatchers is thus of International Importance.

WHAT THE FLOCK – MIGRATING A NZ SHOREBIRD AWARENESS PROJECT TO AUSTRALIA

TONY FLAHERTY[1], ALEISA LAMANNA[2]

[1]*Natural Resources Adelaide and Mt Lofty Ranges, Email: Tony.Flaherty@sa.gov.au*
[2]*Sharing Our Shores and BirdLife Australia*

In New Zealand, Pūkorokoro Miranda Shorebird Centre created 'The Flock NZ' to help spread the message about the threats facing our resident and migratory shore birds. With their support, the concept migrated to South Australia as part of Natural Resources Adelaide and Mount Lofty Ranges and BirdLife Australia's conservation work. "Flock Oz" involves local community, wood groups, Men's Sheds to produce life size wood cut outs which are then brightly decorated by community groups and schools. The Flocks migrates to raise awareness of shorebird conservation including stopovers at the Adelaide Shorebird Festival, Adelaide Botanic Gardens and the OzAsia Festival. With the help of A Wader's Life, Flock Oz has also migrated to Broome. We hope to assist other groups to initiate flocks across Australia with templates of Australian bird shorebird species, information and advice.

THE LONGER FIRST LEG OF NORTHWARD THAN SOUTHWARD MIGRATION SUGGESTS THE IMPORTANCE OF NONBREEDING SITES FOR FUEL DEPOSITION OF MIGRATORY BIRDS

MIAN-JUAN KE, ZHIJUN MA

Coastal Ecosystems Research Station of Yangtze River Estuary, Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, Institute of Biodiversity Science, Fudan University, Shanghai 200433, China
Email: 14210700093@fudan.edu.cn

It is crucial for long-distance migratory birds to accumulate a great deal of fuel before migration. Although both breeding and nonbreeding sites supply abundant food for birds, birds select breeding habitat mainly depend on their special requirement for nesting and rearing chicks, thus the breeding site might be not the best for fuel deposition. To test this hypothesis, we compared the distance, duration and direction of the first leg of flight between north- and southward migration based on the migration tracking of seven shorebirds. Results showed that birds fly longer period and distance during the first bout of northward migration than that of southward migration. The flight direction of the first leg of northward migration is closer to the shortest migration route than southward migration. This study suggests that nonbreeding site contributes more to fuel deposition of migratory birds than breeding site, which could influence the migration strategies between northward and southward migration.

WHAT IS DRIVING SURVIVAL RATES IN CRESTED TERNS?

JESSICA RADFORD

Deakin University
Email: paje@deakin.edu.au

Our coastal ecosystems are increasingly vulnerable to anthropogenic-induced threats. Pollution, the destruction of habitat, and the effects of climate change are key drivers of biodiversity loss affecting the overall function and health of marine environments and ecosystems. Disturbances to lower levels of the food web can result in bottom-up effects. Therefore seabirds, as top-predators, serve as important ecological indicators of the health of an ecosystem. Crested terns in the Port Philip Bay and Western Port Bay areas may prove an exemplary model for such monitoring research. The Victorian breeding colonies in focus are in proximity to areas of the marine environment that see high levels of both public and commercial use. For more than 30 years the Victorian Wader Study Group (VWSG) has collected mark-recapture banding data of crested terns amongst breeding colonies in Port Phillip Bay and Western Port Bay. For my honours research I am working in conjunction with the VWSG, aiming to address the following questions in analysing the survival rate of crested terns: are there annual variations in survival rates of adult and young crested terns and if so, how do these compare across colonies and relate to (1) population dynamics in other marine life in the region (e.g. little penguins, fisheries statistics) and (2) large scale weather patterns (El Nino Southern Oscillation).

STILT - INSTRUCTIONS TO AUTHORS

Stilt is the journal of the Australasian Wader Studies Group. We welcome manuscripts presenting new information on the waders (shorebirds) of the East Asian-Australasian Flyway and nearby parts of the Pacific region from both amateurs and professionals. Authors should send their manuscript by email to the editor at info@imogenwarrenphotography.net. 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 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. All submissions are subject to peer review. If a revision is requested corresponding authors must submit the revised manuscript by the requested date or seek an extension.

Stilt is produced in one issue per year. Suitable material submitted before **1st July** will normally be published in the next issue of *Stilt* in November. Late submissions may be accepted at the editor's discretion.

Submissions should be presented in a Microsoft Word version compatible with Office 2010 (version 14) or later. If authors are unable to access newer versions of Word, then files in .rtf format may be acceptable following liaison with the editor. All contributions, including table and figure captions and references, should be double spaced 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.
AUTHORS NAME AND ADDRESS - JOHN SMITH[1], STEPHEN BROWN[2] AND MAX WELL[3]
[1] 1 Main St., Melbourne 3001 Victoria, AUSTRALIA
[2] Department of Biology, University of Queensland, St Lucia 4068 Qld. AUSTRALIA
[3] Birds Singapore, National University, Jurong N4321 SINGAPORE
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 then 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., S. Garnett & C. Gole** 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. *Stilt* does not have the capacity to accommodate Supplementary 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 six 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 must be in the metric system and SI units where appropriate (e.g. mm, km, °C etc). Rates should be recorded as, for example, d^{-1} rather than /day or per day. Whole numbers one to nine should be spelled out, unless associated with a unit (e.g. 5 g) and numbers 10 onwards given in numerals. Full binomial names should be given on the first occasion a common name for an organism is used. 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.

EDITORIAL TEAM

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.
-
- 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 is **1st July** for the **November** edition.

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.

Australasian Wader Studies Group

Stilt 73-74 November 2020

Table of Contents

Editorial - Imogen.. i
Dr Clive Dudley Thomas Minton, AM (7/10/1934 – 6/11/2019).. ii
Treasurer's report for 2018 - B. Hansen iv
Treasurer's report for 2019 - B. Hansen v

Research (6-58)

Waterbird surveys of the Caley Valley wetland in wet and dry seasons, Abbot Point, Queensland – P. Lloyd, C. Sanderson and L. Popple.. 6-17
Changes in migratory shorebird numbers and distributions in South-East Tasmania (1965 – 2014). – M. Newman, E. J. Woehler, S. Drake and A. Fletcher.. 18-28
Summer migrants – the importance of Rottnest Island for trans-equatorial bird species. – S. Mather.. 29-36
The local and migratory movements of Eastern Australian Pacific-Golden Plover *Pluvialis fulva* spending the non-breeding season in Moreton Bay, South-East Queensland. – J. T. Coleman and R. Bush.. 37-42
The east coast of North Sumatra province – confirmed as an important wintering area for Grey-headed Lapwing *Vanellus cinereus* in Indonesia. – C. A. Putra, D. Hikmatullah.. 43-46
Shorebird surveys confirm significance of the Macleay Coast, northern New South Wales, Australia. – D. Rohweder and N. Priest.. 47-51
An overview of the Latham's Snipe population in Sakhalin, eastern Russia. – B. D. Hansen, Z. Revyakina, O. Kulikova, P. Ktitorov.. 52-58

Short Communications (59-74)

A note on avifaunal community of Khukh Lake important bird area, Eastern Mongolia. – O. Ganbold, G-C. Bing, I-H Paik, E. Purevee and W. K. Paek.. 59-64
Eurasian Curlews *Numenius arquata* ingesting Long-tailed Tit *Aegithalos caudatus* and Orange-flanked Bush-robin *Tarsiger cyanurus.* – D. Melville, S-D. Zhang, Q-q. Bai.. 65
Status and re-sighting records of Great Knot *Calidris tenuirostris* in Coringa Wildlife Sanctuary, Andhra Pradesh. – P. Sathiyaselvam, M. B. Dimmala, S. Mukherjee, G. Pallela.. 66-68
Updating recent checklist of shorebirds in Banyuasin Delta (Sembilang), South Sumatra, Indonesia. – M. Iqbal, D. Mulyana, H. Martini, A. Setiawan, I. Yustian and H. Zulkifli.. 69-71
An unusual Eurasian Curlew Numenius *Arquata orientalis* in Banyuasin Peninsula, South Sumatra, Indonesia. – M. Iqbal, D. Mulyana, H. Martini, A. Setiawan, I. Yustian and H. Zulkifli.. 72-74

Reports (75-118)

Coastal shorebird surveys in the provinces of South Hwanghae and North Pyongan, Democratic People's Republic of Korea, May 2019. – A. Riegen, D. S. Melville, K. Woodley, W. Perry, K. I. Chon, R. S. Il, H. H. Song, J. S. I and K. J. Hyang.. 75-79
Shorebirds at Point Douro, Western Australia. – D. Carlson and M. Singor.. 80-82
Darwin shorebird catching: Expedition Report 2018. – A. Lillyman, G. Maglio, R. Bush, R. Jessop, P. Wright, C. Minton... 83-86
Wader breeding success in the 2018 Arctic summer, based on juvenile ratios of birds which spend the non-breeding season in Australia. – C. Minton, R. Jessop, C. Hassell, R. Patrick, R. Atkinson, M. Christie and I. Marks.. 87-89
VWSG King Island Trip 6-14 December 2018. – K. Leung, C. Minton, R. Atkinson and R. Patrick.. 90-94
North-West Australia wader and tern expedition 2019. – C. Minton, R. Jessop, C. Hassel, M. Dawkins, P. Wright and K. Leung.. 95-100
VWSG King Island visit report 22-31 March 2019. – C. Minton, R. Atkinson, K. Leung and R. Patrick.. 101-105
Wader breeding success in the 2019 arctic summer, based on juvenile ratios of birds which spend the non-breeding season in Australia. – R. Jessop, R. Bush, R. Patrick, R. Atkinson, M. Christie and I. Marks.. 106-108
North-west Australia wader & tern expedition 2020 report, Friday 7th February to Sunday 1st March 2020. – R. Jessop, R. Bush, P. Wright, M. Klaassen, G. Maglio, A. Riegen, T. Clarke and T. Douglas.. 109-1118

Abstracts (119-128)