Notornis, 2020, Vol. 67: 635-642
0029-4470

A comparison of spring (November), summer (February), and winter (June) wader counts from Farewell Spit, 1998–2019

ROB SCHUCKARD
PO Box 98, Rai Valley 7145, New Zealand

DAVID S. MELVILLE
1261 Dovedale Road, RD2 Wakefield, Nelson 7096, New Zealand

PENELOPE BILTON
167A Taieri Road, Kaikorai, Dunedin 9010, New Zealand

DARRYL MacKENZIE
Proteus, PO Box 7, Outram 9062, New Zealand

WILLIE COOK
23 Eden Road, RD 1, Richmond, Nelson, New Zealand

STEVE WOOD
260 Hursthouse Street, RD2, Upper Moutere 7175, New Zealand

DON COOPER
1/26 William Street, Richmond, Nelson 7020, New Zealand

Abstract: Co-ordinated counts of waders across New Zealand have been undertaken in November and June since 1983; the consistent timing of counts aimed to reduce variation from the effect of seasonal changes in bird numbers. The Australian Shorebird census and the wider Asian Waterbird Census, however, are conducted in January, making direct comparison with the New Zealand counts potentially problematic, especially if an attempt is to be made to assess total flyway populations. Since 1998 waders on Farewell Spit (40°30.5´S, 172°45´E to 40°33.5´N 173°02´E) have been counted in February as well as in November and June. Counts of bar-tailed godwit and ruddy turnstone were on average 20% and 35% higher in February compared to November, respectively. Also, counts of the endemic migratory South Island pied oystercatcher were 15% higher in February compared to June. The improvement of data for overall population assessments is not only important for establishing trends of species but is also important for applying the 1% population criterion for wader site assessments.

Schuckard, R.; Melville, D.S.; Bilton, P.; MacKenzie, D.; Cook, W.; Wood, S.; Cooper, D. 2020. A comparison of spring (November), summer (February), and winter (June) wader counts from Farewell Spit, 1998–2019. *Notornis 67(4)*: 635–642.

Key words: Farewell Spit, wader count, bar-tailed godwit, *Limosa lapponica*, red knot, *Calidris canutus*, ruddy turnstone, *Arenaria interpres*, South Island pied oystercatcher, *Haematopus finschi*

Received 19 October 2019; accepted 26 June 2020
*Correspondence: *rschckrd@xtra.co.nz*

INTRODUCTION

Nationwide co-ordinated counts of waders in New Zealand started in 1983 in response to increasing impacts of human activities on wader habitats and a lack of information about wader populations (Sagar *et al.* 1999). These counts, initiated by the Ornithological Society of New Zealand (OSNZ), now Birds New Zealand, aimed to determine, 1) the numbers and distribution of waders occurring at coastal sites throughout New Zealand, 2) seasonal changes in the distribution of numbers of waders, and 3) annual changes in the numbers of waders (Sagar *et al.* 1999).

Two counts have been undertaken annually: a count in November/early December (previously called a 'summer' count but more correctly this is a 'spring' count) and a 'winter' count in June/early July (Sagar *et al.* 1999; Southey 2009; Riegen & Sagar 2020). November 'was accepted as being a period when wader numbers appeared to be stable in most localities' (Sagar 1983), this being in line with the timing of counts of the Manukau Harbour and Firth of Thames (Veitch 1978), although it was recognised that total numbers were greater in January and February than November (Sagar *et al.* 1999). Subsequently Veitch (1999), having reviewed monthly count data for the Firth of Thames over six years, recommended that future counts should be 'as close as possible to the identified median dates of previous counts: 25 June and 19 November'. Whilst this was based on an extensive time series of counts for the Firth of Thames, the question as to whether this was generally applicable across the country was not addressed.

The austral 'spring' count in New Zealand (November/early December) is earlier than the counts undertaken as part of the Asian Waterbird Census (AWC) (including the Australian Shorebird census). AWC was initiated in 1987 and includes waders (Perennou *et al.* 1994). The AWC follows the timing established in 1967 by the International Waterfowl Research Bureau (IWRB) for surveys initially targeted at Anatidae and coots (*Fulica atra*) in the northern hemisphere – that census being undertaken when birds in the Western Palearctic have finished their migration and populations are thought to be largely static (Atkinson-Wiles 1986). The January AWC count coincides with the objective to count trans-Equatorial migratory waders in Australia and New Zealand during the middle of their non-breeding season (between December and February) when wader populations are thought to be largely stable (Watkins 1993; Bamford *et al.* 2008; Wilson *et al.* 2011). New Zealand wader counts from November and June have been integrated in the AWC since 1991 (Perennou & Mundkur 1992). However, the disparity in timing of the November counts versus January for the AWC raises questions as to how well New Zealand count data may contribute to overall assessments of East Asian-Australasian Flyway (EAAF) populations.

The fact that the New Zealand wader census includes endemic species, some of which are migratory, as well as Arctic-breeding trans-Equatorial migrants adds to the complexity in determining their timing. An additional count in February has been undertaken at Farewell Spit (40°30.5´S, 172°45´E to 40°33.5´S, 173°02´E), Tasman District, South Island since 1999. Farewell Spit is an important site for both endemic and trans-Equatorial migrant waders, holding some 6.5% of the national wader population in June, 13.2% in November and 10.2% in February (Schuckard & Melville 2013). This paper compares three counts (June, November, and February) undertaken over 21 years at Farewell Spit and considers potential implications for the timing of future counts.

STUDY AREA AND METHODS

Farewell Spit is a ~30km long sand spit extending eastwards from the northern tip of the South Island of New Zealand (40°31′S, 172°45′E to 40°35′S, 173°04′E) (Petyt 1999). The north beach is narrow and deeply shelving, but the southern area has tidal flats extending in places up to *c.* 7 km which are the main foraging area for shorebirds (Battley 1996; Battley *et al.* 2005). Counts are made on high spring tides when waders are pushed from the tidal flats onto roosts in dune slacks and along the northern ocean beach at several well-defined roost areas along the length of the spit (Fig. 1). Farewell Spit is counted over one or two days, dependent upon the number of counters available. Counting usually starts one hour before high tide and is finished within two hours after high tide.

This study compares counts made in November (1998–2018) and February (1999–2019) of three trans-Equatorial migrants: bar-tailed godwit (*Limosa lapponica*), red knot (*Calidris canutus*), and ruddy turnstone (*Arenaria interpres*). To investigate whether there are consistent differences in seasonal bird counts over the time span of the survey, we used ratios rather than absolute differences in numbers to allow for annual variation in the overall magnitude of the counts. The ratio (R_1) of the November count to the following February count for each year was calculated.

We also consider one endemic migrant: South Island pied oystercatcher (*Haematopus finschi*). In contrast to the trans-Equatorial migratory species, most South Island pied oystercatchers are on the breeding grounds during November and for this species February counts (highest numbers passing through on migration) were compared with the June counts (non-breeding populations including

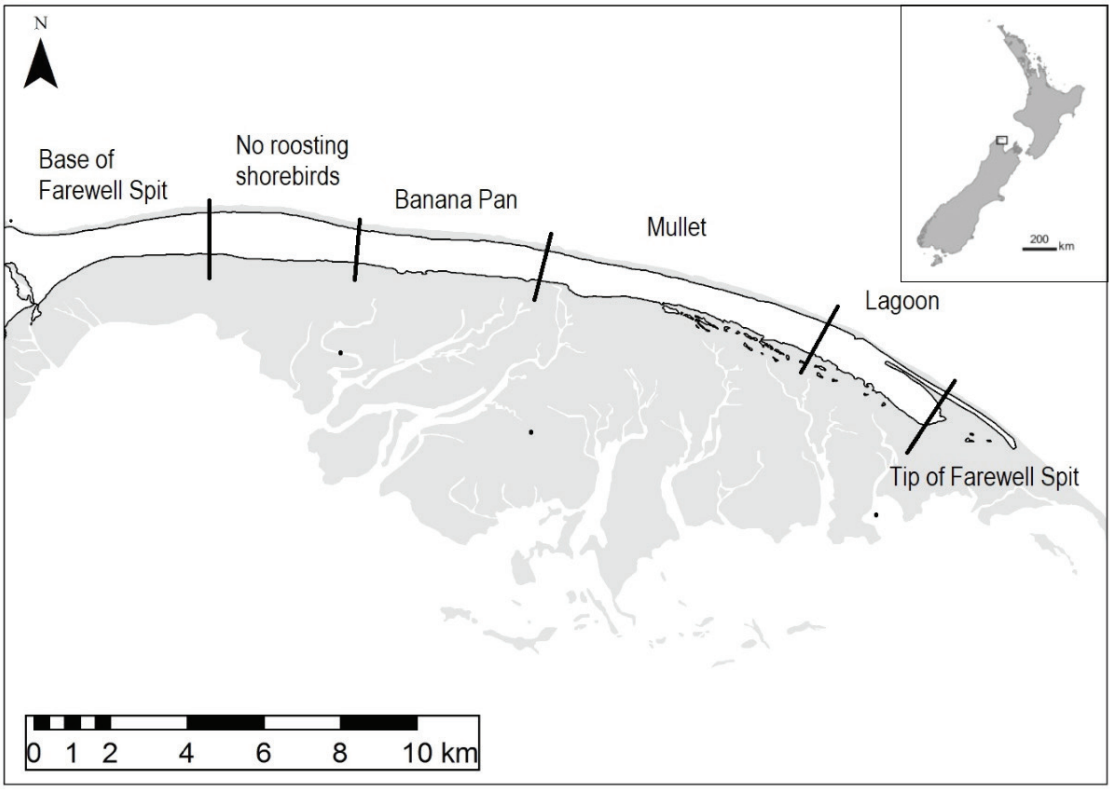

Figure 1. Farewell Spit (40°30.5´S, 172°45´E to 40°33.5´S, 173°02´E) showing the five sections (separated by dark lines) counted during the National Wader Count Scheme. Shaded areas represent the intertidal area of about 10,000 ha.

juveniles of the same year). Between 1998 and 2019, the ratio (R_2) of the February and June counts of the same year was calculated.

RESULTS

Bar-tailed godwit

The mean number (and standard deviation) of bar-tailed godwits was 9,652 ± 2,776 in November and 12,259 ±2,525 in February (Fig. 2). The February counts are generally higher than those of the preceding November count (mean of R_1 = 0.80 (SE 0.05), $P < 0.05$) (Table 1; Fig. 3 & 4).

Red knot

The mean number (and standard deviation) of red knots was 7,755 ± 2,563 in November and 8,293 ± 1,945 in February (Fig. 2). There is no evidence that the February counts are generally greater or lesser than those of the preceding November count (mean of R_1 = 0.97 (SE 0.08), $P > 0.05$) (Table 1; Fig. 3 & 4).

Ruddy turnstone

The mean number (and standard deviation) of ruddy turnstones was 388 ± 223 in November and 630 ± 226 in February (Fig. 2). The February counts are generally higher than those of the preceding November count (mean of R_1 = 0.65 (SE 0.08), $P < 0.05$) (Table 1; Fig. 3 & 4).

South Island pied oystercatcher

The mean number (and standard deviation) of South Island pied oystercatchers was 7,331 ± 1,716 in February and 6,577 ± 1,896 in June (Fig. 2). The February counts are generally higher than those in the subsequent June count (mean of R_2 = 1.15 (SE 0.06), $P < 0.05$) (Table 1; Fig. 3 & 4).

DISCUSSION

The Farewell Spit count data demonstrate that numbers of both bar-tailed godwit and ruddy turnstone are generally lower in November than in February (20% and 35% respectively). This could result from local movements within New Zealand,

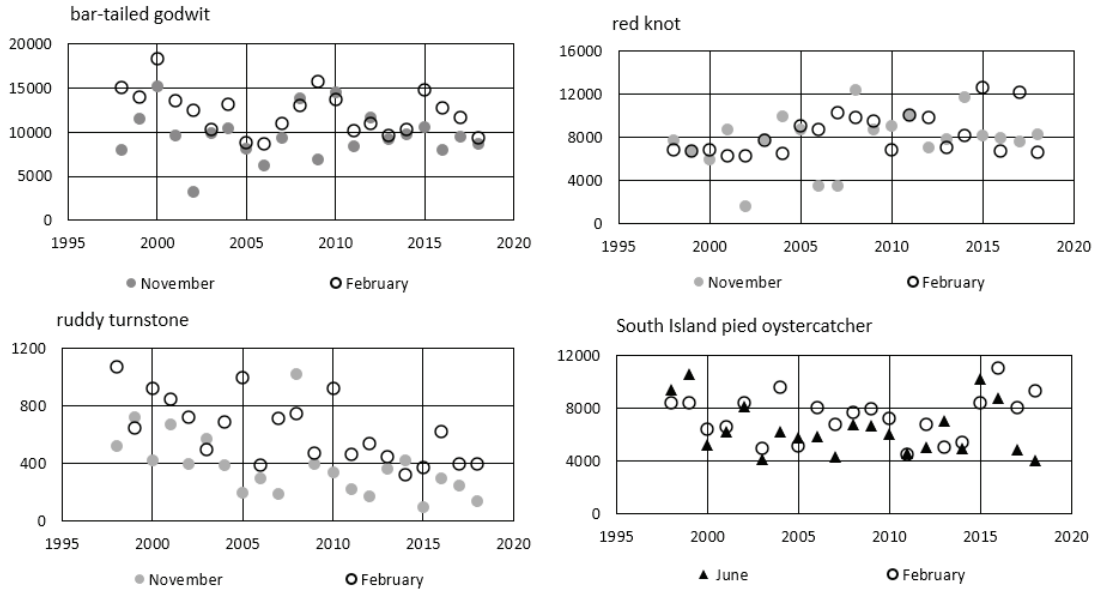

Figure 2. Bar-tailed godwit, red knot, ruddy turnstone numbers in November and February from 1998/99 to 2018/19 and South Island pied oystercatcher numbers in February and June from 1998/99 to 2018/19 at Farewell Spit.

Table 1. Farewell Spit summary statistics for count ratios of different species (SE – mean ratio associated standard error, lower and upper limits of a 95% confidence interval of the mean).

Species	Ratio	Mean	SE	Lower	Upper
Bar-tailed godwit	Nov/Feb	0.80	0.05	0.71	0.90
Red knot	Nov/Feb	0.97	0.08	0.81	1.14
Ruddy turnstone	Nov/Feb	0.65	0.08	0.49	0.81
South Island pied oystercatcher	Feb/Jun	1.15	0.06	1.02	1.27

new arrivals from overseas, or a combination of the two.

New Zealand is at the end of the world's longest migration routes for a number of waders: bar-tailed godwits of the subspecies *baueri* undertake non-stop trans-oceanic flights of 8,000–12,000 km (Gill *et al.* 2009; Battley *et al.* 2012), red knots of the subspecies *rogersi* that occur in New Zealand undertake single flights of >6,000 km (Tomkovich *et al.* 2011), while ruddy turnstones may undertake single stage flights of 7,500 km (Minton *et al.* 2011). Whilst there is a growing body of information on migration routes, there is still relatively little detail, especially regarding the timing of migration, and stopovers en route to final non-breeding grounds, and movements within New Zealand before they settle at a final destination for the Austral summer.

Alcorn *et al.* (1994) reviewed Australian count data and reported: 'substantial numbers of bar-tailed godwits departed from east coast sites November–December, with smaller departures evident from south-eastern coastal mudflats in the same period, and from Gulf of St Vincent sites over a broader period from October–January. Departures at this time are most readily explained by movements of a proportion of the eastern Australian population to New Zealand in the November–December period'. This is further supported by records of individually marked birds moving from the east coast of Australia to New Zealand (Minton *et al.* 2006; Battley *et al.* 2011; Birds New Zealand *unpubl. data*).

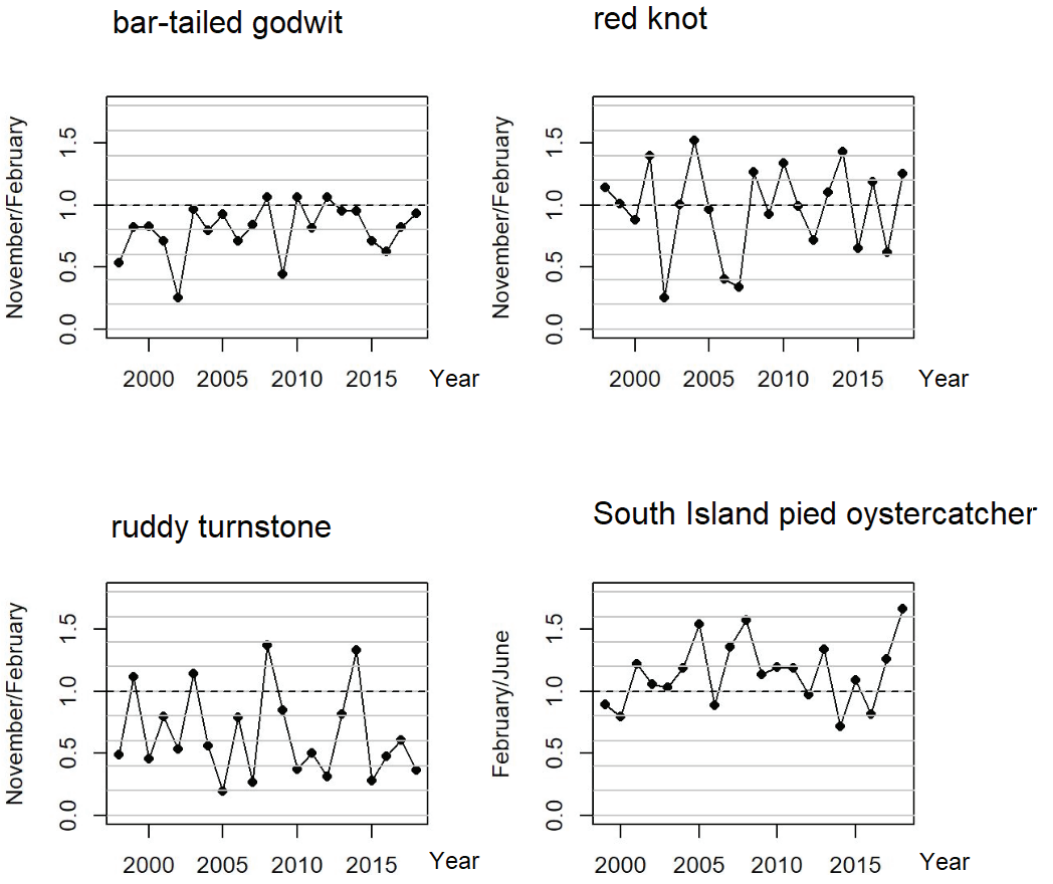

Figure 3. Time series plots of R_1 for bar-tailed godwit, red knot, ruddy turnstone, and of R_2 for South Island pied oystercatcher censused at Farewell Spit. Dashed line represents a ratio of 1, indicating no statistically significant difference between monthly counts.

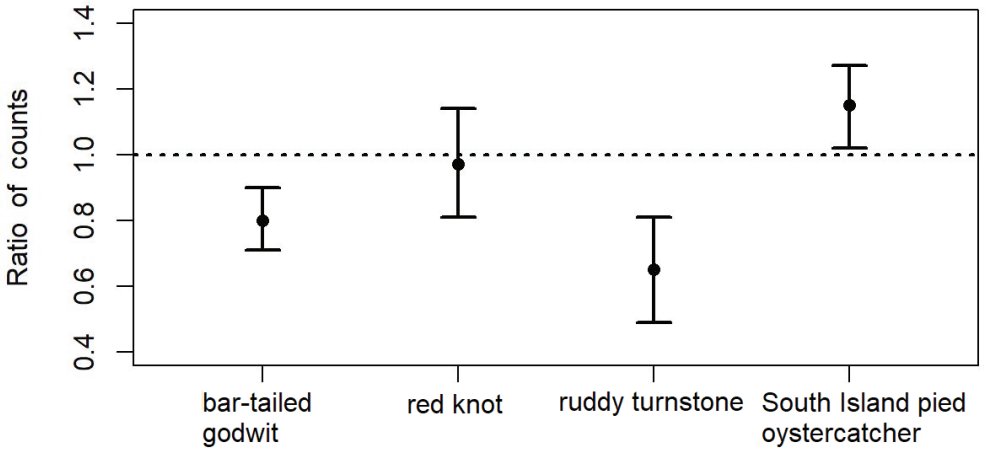

Figure 4. Mean and associated 95% confidence interval for the ratio of the census data for different species counted at Farewell Spit.

Based on count data, Alcorn *et al*. (1994) suggested that ruddy turnstones continued moving southwards down the east coast of Australia from the time of arrival until February, and further noted: 'the drop in numbers on south-east coastal mudflats December–January indicates further southward movement, perhaps to sites in the north-east coast of Tasmania, or to New Zealand…'. Such observation is supported by the data from Farewell Spit with a significant higher number of birds recorded in February compared to November.

There is thus evidence from eastern Australia to support the hypothesis that both bar-tailed godwit and ruddy turnstone migration to New Zealand continues after November. If birds are still arriving in New Zealand after the November count this needs to be considered when attempts are being made to determine flyway populations as there is a risk that populations will be under-represented. For example, birds that move to New Zealand from Australia after the November count will be missed in New Zealand but will have departed Australia prior to their January count. Based on our Farewell Spit data this appears to be possible with respect to both bar-tailed godwit and ruddy turnstone.

Population monitoring of waders within the EAAF is beset by logistical difficulties, particularly a limited number of counters, and often large geographical areas to cover. The *Action Plan for Conservation of Migratory Shorebirds in the East Asian-Australasian Flyway: 2001–2005* (Shorebird Working Group 2011) included Action 11: *Support implementation of statistically robust methodologies to monitor shorebird populations in priority countries (Australia, New Zealand, and Japan)*. Subsequently, a review of the Australian count data has found them to be 'of sufficiently high quality and spatial coverage to permit robust analysis of shorebird population trends across much of Australia' (Clemens *et al.* 2012), and the New Zealand data were similarly found to be sufficiently robust to be incorporated into an assessment of population trends (Studds *et al.* 2016).

The criteria for the identification of a 'wetland of international importance' under the Ramsar Wetland Convention, to which New Zealand is a Party, includes: Criterion 6. *A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird*. The East Asian-Australasian Flyway Partnership Site Network includes an additional criterion for a staging site: *A staging site should be considered internationally important if it regularly supports 0.25% of individuals in a population of one species or subspecies of waterbirds on migration*.

For these criteria there is a need for the development of flyway population estimates. All population estimates to date (e.g. Bamford *et al.* 2008; Conklin *et al*. 2014; Hansen *et al*. 2016; Wetlands International 2020) have had to draw data from a wide range of sources, often from a time period covering most of the non-breeding season (e.g. November–March, Hansen *et al.* 2016), thereby potentially risking double- or mis-counting. BirdLife Australia's National Shorebird Monitoring Program aims for counts in mid-January but recognises that this will not always be achievable and so will accept any counts in the period 1 December to 28 February (BirdLife Australia undated).

The most recent population estimates for waders in the EAAF were compiled by Wetlands International in 2012 (Wetlands International 2020). The 10th Meeting of the Partners of the EAAFP, in 2018, decided to develop a 'Conservation status review of migratory waterbird populations for the EAAFP' (EAAFP 2018), which will support revision and updating of Wetlands International's Waterbird Population Estimates.

The South Island pied oystercatcher is an endemic migrant. February counts of South Island pied oystercatcher at Farewell Spit are, on average, 15% higher than June counts. The higher numbers in February relate to birds staging and moulting (Birds New Zealand *unpubl. data*) before heading to non-breeding areas, probably in the North Island. Of six sites of international importance for the species in the northern South Island, only two reach the 1% threshold during the June census but six sites reach the threshold during the February census (Schuckard & Melville 2013). This further highlights the value of undertaking a February count.

Birds New Zealand faces logistic constraints in undertaking more than a June and a November wader count annually at a national level, although one such survey for bar-tailed godwits has been successfully completed (Schuckard *et al.* 2020). This study, however, demonstrates the value of undertaking a February count, especially if attempts are to be made to assess total populations, rather than just population trends, and use such data to identify sites of national and international importance.

ACKNOWLEDGEMENTS

We are very grateful to Hugh Robertson and an anonymous reviewer for their comments and critical review that significantly improved this manuscript. The surveys upon which this report is based required the generous donation of many thousands of hours by dedicated volunteers, undertaking fieldwork, at times in very challenging conditions. Without these volunteers this work would not be possible. We would like to thank the following people for their often-long-term commitment to the

Ornithological Society of New Zealand/Birds New Zealand wader census project in the northern South Island:

Bob Adam, Geoff Aitken, Jane Baird, Tim Barnard, Derek Batchelor, Don Bate, Phil Battley, Jacqueline Beggs, Brian Bell, Chris Bell, David Bell, Michael Bell, Richard Bell, Peter Bezier, Rose Blois, Anne Boniface, Jenny Bowker, Sam Bowker-Napp, Alvin Brett, Ruth Buchanan, June Bullock, David Butler, Bill Cash, Mick Clout, Stephen Colquhoun, Jesse Conklin, Peter Cook, Terry Cook, Shannel Courtney, Jim Cox, Nicky Crawford, Tony Crocker, Andrew Crossland, Annette Cunningham, Richard de Hamel, Betty de Liefde, Henry Dixon, Bryan Douglas, Kevin Durkan, Andrew Fidler, Charmaine Field, Peter Field, Paul Fisher, John Flux, Meg Flux, Bruce Fowler, Nathan Fry, Peter Fullerton, Samantha Gale, Patsy Garrett, Roger Gaskell, Matthew Gaze, Peter Gaze, Don Geddes, Ken George, Elsie Gibbon, Paddy Gillooly, Don Goodale, Enfys Graham, Warwick Greenwood, Lesley Hadley, Jenny Hawkins, Neville Haycock, Dave Haldane, Frank Harris, Shirley Hayward, Barrie Heather, Edwin Heatherbell, Eileen Heatherbell, Henk Heinekamp, Sandy Higgins, Linda Hogan, Glen Holmwood, Derek Howden, Peter Howden, William Hutchinson, Ingrid Hutzler, Carol Jackson, Jon Jackson, Terry Johnson, Robyn Jones, Rose Jorgensen, Tjesse van der Kamp, Amy Kennedy, Helen Kingston, Peter Langlands, Mike Lookman, Vicky Lawrie, Sam Leary, Jeroen Lurling, Sarah Lovibond, Jack Marks, Neil Martin, John Mason, Abby McCall, Cynthia McConville, Derek McLeod, Til Melis, Julia Melville, Vicky Melville, Ian Millar, Alec Milne, Sandra Morris, Janet Mossop, Allan Munro, Marie Neverman, Bev North, Nelson North, Mara Nydegger-Bell, Colin O'Donnell, Mike Ogle, Richard Parrish, Peter Paye, Sheila Petch, Chris Petyt, Suzi Philips, Ray Pierce, Margaret Pike, Gillian Pollock, Craig Potton, Ralph Powlesland, John Preece, Gail Quayle, Kelly Quayle, Tessa Quayle, Tim Quayle, Anna Reynolds, Patrick Riddett, Hugh Robertson, Debbie Rogers, Neville Rogers, Tim Rowe, Gerry Rushton, Paul Sagar, Pauline Samways, Anneke Schuckard, Eeuwe Schuckard, Tim Shaw, Anna Simmonds, David Sims, Natascha Sobrino, Ian Southey, Kaye Stark, Adela Steopan, Richard Stocker, Hans Stoffregen, Grace Suckling, Mick Symmons, Graeme Taylor, Rowley Taylor, Andrew Tilling, Gillian Vaughan, Dick Veitch, Yvonne Verkuil, Elspeth Waghorn, Kath Walker, Simon Walls, Simon Ward, Diana Watson, Sam Westcoast, Carol Widdett, George Wilkinson, Sam Williams, Zack Williams, Peter Wilson, Stuart Wood, Janice Woon, Trevor Worthy. We would also like to thank any others who we may have inadvertently omitted.

LITERATURE CITED

Alcorn, M.; Alcorn, R.; Fleming, M. 1994. *Wader movements in Australia. Final summary report of the regular counts project 1981–1990*. RAOU Report 94. Melbourne, Australasian Wader Studies Group, Royal Australasian Ornithologists' Union. 135 p.

Atkinson-Wiles, G.J. 1986. Introduction. *In*: Rüger, A.; Prentice, C.; Owen, M. Results of the IWRB international waterfowl census 1967–1983. *IWRB Special Publication* 6. Slimbridge, International Waterfowl Research Bureau.

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

Battley, P.F. 1996. Ecology of migrant shorebirds in New Zealand, focusing on Farewell Spit, North-West Nelson. Unpubl. MSc thesis. Massey University, Palmerston North, New Zealand.

Battley, P.F.; Melville, D.S.; Schuckard, R.; Ballance, P.F. 2005. Quantitative survey of the intertidal benthos of Farewell Spit, Golden Bay. *Marine Biodiversity Biosecurity Report No. 7*. Wellington, Ministry of Fisheries. 119 p.

Battley, P.F.; Schuckard, R.; Melville, D.S. 2011. Movements of bar-tailed godwits and red knots within New Zealand. *Science for Conservation* 315. Wellington, Department of Conservation. 56p.

Battley, P.F.; Warnock, N.; Tibbits, T.L.; Gill, R.E.; Piersma, T.; Hassell, C.J.; Douglas, D.C.; Mulcahy, D.M.; Gartrell, B.D.; Schuckard, R.; Melville, D.S.; Riegen, A.C. 2012. Contrasting extreme long-distance migration patterns in bar-tailed godwits *Limosa lapponica*. *Journal of Avian Biology 43*: 21–32.

BirdLife Australia. Undated. Counter resources. https://birdlife.org.au/projects/shorebirds/counter-resources Accessed: 30 November 2020.

Clemens, R.S.; Kendall, B.E.; Guillet, J.; Fuller, R.A. 2012. Review of Australia's shorebird survey data, with notes on their suitability for comprehensive population trend analysis. *Stilt 62*: 3–17.

Conklin, J.R.; Verkuil, Y.I.; Smith, B.R. 2014. *Prioritizing migratory shorebirds for conservation action on the East Asian-Australasian Flyway.* Hong Kong, WWF Hong Kong. 128 p.

East Asian Australasian Flyway Partnership. 2018. Decision 12 Development of a Conservation Status Review of Migratory Waterbird Populations for the EAAFP. https://www.eaaflyway.net/wp-content/uploads/2019/06/Decision.12-Development-of-an-EAAFP-Conservation-Status-Review-PDF.pdf Accessed: 24 June 2020.

Gill, R.E.; Tibbitts, T.L.; Douglas, D.C.; Handel, C.M.; Mulcahy, D.M.; Gottschalck, J.C.; Warnock, N.; McCaffery, B.J.; Battley, P.F.; Piersma, T. 2009. Extreme endurance flights by landbirds crossing the Pacific Ocean: ecological corridor rather than barrier? *Proceedings of the Royal Society B* 276: 447–457.

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

Minton, C.; Wahl, J.; Jessop, R.; Hassell, C.; Collins, P.; and Gibbs, H. 2006. Migration Routes of Waders which spend the Non-Breeding Season in Australia. *Stilt 50*: 135–157.

Minton, C.; Gosbell, K.; Johns, P.; Christie, M.; Klaassen, M.; Hassell, C.; Boyle, A.; Jessop, ER.; Fox, J. 2011. Geolocator studies on Ruddy Turnstones *Arenaria interpres* and Greater Sandplovers *Charadrius leschenaultii* in the East Asian-Australasia Flyway reveal widely different migration strategies. *Wader Study Group Bulletin 118*: 87–96.

Perennou, C.; Mundkhur, T. 1992. *Asian & Australasian waterfowl census 1992*. Slimbridge, International Waterfowl and Wetlands Research Bureau.

Perennou, C.; Mundkur, T.; Scott, D.A. 1994. *The Asian waterfowl census 1987–91: distribution and status of Asian waterfowl*. AWB Publication 86, Kuala Lumpur, Asian Wetland Bureau, and IWRB Publication 24, Slimbridge, International Waterfowl Research Bureau. 372p.

Petyt, C. 1999. *Farewell Spit: a changing landscape*. Tukurua, Terracottage Books.

Riegen, A.; Sagar, P. 2020. Distribution and numbers of waders in New Zealand 2005–2017. *Notornis 67(4)*: 591-634.

Sagar, P. 1983. National wader count – November 1983. *OSNZ News 28:* 8.

Sagar, P.M.; Shankar, U.; Brown, S. 1999. Distribution and numbers of waders in New Zealand, 1983–1994. *Notornis 46*: 1–43.

Schuckard, R.; Melville, D. S. 2013. Shorebirds of Farewell Spit, Golden Bay and Tasman Bay. Report prepared for Nelson City Council and Tasman District Council. https://tasmanbayguardians.org.nz/wp-content/uploads/2018/11/Top-of-South-Shorebird-Report-2013-1.pdf Accessed: 20 November 2020.

Schuckard, R.; Melville, D.S.; Riegen A.C.; Driscoll, P.; Driessen, J.; Kidd, L.R. 2020. Numbers of bar-tailed godwits (*Limosa lapponica baueri*) in New Zealand and Australia during austral summer 2019/2020. *Notornis 67(4)*: 643-650.

Shorebird Working Group of Wetlands International – Asia Pacific. 2001. *Action Plan for the Conservation of Migratory Shorebirds in Asia Pacific: 2001–2005.* Canberra, Environment Australia.

Southey, I. 2009. Numbers of waders in New Zealand 1994–2003. *DOC Research & Development Series* 308. Wellington, Department of Conservation. 70 p.

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

Tomkovich, P.S.; Porter, R.R.; Loktionov, E.Y.; Niles, L.J. 2011. Pathways and staging areas of Red Knots *Calidris canutus rogersi* breeding in southern Chukotka, Far Eastern Russia. *Wader Study Group Bulletin 120*: 181–193.

Veitch, C.R. 1978. Waders of the Manukau Harbour and the Firth of Thames. *Notornis* 25: 1–24.

Veitch, C.R. 1999. Annual cycle of waders at the Firth of Thames. *Notornis 46*: 71–78.

Watkins, D. 1993. A national plan for shorebird conservation in Australia. *RAOU Report* 90. Moonee Ponds, Victoria, Australasian Wader Studies Group, Royal Australasian Ornithologists Union, World Wide Fund for Nature.

Wetlands International. 2020. *Waterbird population estimates*. wpe.wetlands.org Accessed: 24 June 2020.

Wilson, H.B.; Kendall, B.E.; Fuller, R.A.; Milton, A.; Possingham, H.P. 2011 Analyzing variability and the rate of decline of migratory shorebirds in Moreton Bay, Australia. *Conservation Biology 25*: 758–766. doi: 10.1111/j.1523-1739.2011.01670.x