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## Movements of New Zealand ruddy turnstones (*Arenaria interpres*)

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**Abstract:** Ruddy turnstone (*Arenaria interpres*) is the third most numerous Arctic-breeding wader that occurs in New Zealand. Numbers of turnstones in New Zealand have declined but identification of potential causal factors is hampered by lack of information of the migration routes used. Re-sights of marked birds indicate that some New Zealand turnstones pass through East Asia and Australia on both northward and southward migration. Information on possible migration through the Pacific is lacking.

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### INTRODUCTION

The ruddy turnstone (*Arenaria interpres*, hereafter turnstone) is the third commonest Arctic-breeding shorebird occurring in New Zealand, after bar-tailed godwit (*Limosa lapponica*) and red knot (*Calidris canutus*) (Riegen & Sagar 2020). Numbers of turnstones in New Zealand during the non-breeding season (Austral summer) have declined from about 5,000 in the early 1990s (Sagar *et al.* 1999) to some

2,500 in the late 1990s/early 2000s (Southey 2009), to 1,500 in the late 2000s (Riegen & Sagar 2020). The reduction in numbers appears to be generally consistent across the country.

Declines also have been recorded in Australia (Wilson *et al.* 2011; Cooper *et al.* 2012; Minton *et al.* 2012; Britton & Hunter 2016; Clemens *et al.* 2016; Rogers & Cox 2018), where Garnett *et al.* (2011) listed turnstone as 'Near Threatened'. Elsewhere in the East Asian-Australasian Flyway (EAAF) turnstone numbers are also thought to be in decline (Amano *et al.* 2012), and the species was identified as a priority species for conservation efforts by Conklin *et al.*

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(2014), who noted that 'The population using the EAAF appears to be sufficiently declining to qualify for Vulnerable status at the regional level (criterion A2). However, lack of phenotypic differentiation from other flyways suggests exchange of individuals from other (possibly non-declining) populations, and so a downgraded regional status of Near Threatened has been recommended'.

Wetlands International (2020) currently estimates the EAAF population as 28,500 birds; however, Hansen *et al.* (2016) suggest that the figure should be 30,000. Since New Zealand supports <25% of the flyway population for <50% of its life-cycle its conservation status is not assessed by the Department of Conservation, it simply being categorised as a 'migrant' (Robertson *et al.* 2017). BirdLife International (2020) notes the population trend as 'decreasing', but currently lists turnstone as 'Least Concern'; this assessment however is based on the total global population status.

Declines in populations of many shorebirds in the EAAF are thought to be associated with habitat loss and degradation in the Yellow Sea, where the majority of the populations of many species stage on migration (Studds *et al.* 2017). Conklin *et al.* (2014), however, suggest that only some 1-20% of the EAAF population stage in the Yellow Sea. Turnstones marked with geolocators in Southeast Australia mostly migrate northwards through Taiwan and the mainland Chinese and Korean coasts making little use of Japan (Minton *et al.* 2010a, 2011a; Zhao 2016) – nonetheless large numbers of turnstones occur in Japan on northward migration (Brazil 1991; Conklin *et al.* 2014) and there are a considerable number of re-sights of birds marked in Australia (Minton *et al.* 2011b). More use may be made of the Yellow Sea on southward migration (Zhao 2016).

Some other non-breeding turnstone populations are also reported to be declining, for example in Namibia (Simmons *et al.* 2015) and South Africa (Harebottle *et al.* 2006), whereas populations in western Europe are increasing and those in West Africa fluctuating, although some breeding populations in Feno-Scandia are declining (van Roopen *et al.* 2015). Turnstones in the West Atlantic Flyway are also in decline; this appears to be at least partly in response to reduced food supplies in Delaware Bay (Niles *et al.* 2009). Although there is a high incidence of avian influenza in this population (Krauss *et al.* 2010) this does not appear to result in increased mortality (Maxted *et al.* 2012). The trend of the Alaskan breeding population is unknown (Andres *et al.* 2012), as is the non-breeding population of the US Pacific islands (Engilis & Naughton 2004).

Two subspecies of turnstone are currently recognised by most authorities: *A. i. morinella*

breeds in northeast Alaska and across most of Arctic Canada and winters from South Carolina south to South central Chile and northern Argentina; while *A. i. interpres* breeds from the northern Canadian Arctic, across Arctic Eurasia to northwest Alaska, and spends the non-breeding season on the coasts of western Europe, Africa, south Asia, Australasia and the Pacific Islands (Nettleship 2000; del Hoyo & Collar 2014). Although the New Zealand Checklist Committee (OSNZ) (2010) states that 'both visit Australasia', giving Higgins & Davies (1996) as the source, this is incorrect as they state: 'Differences in measurements between birds from Vic[torial] and nw. Aust[ralia] indicate that populations from se Aust[ralia] may come from different areas of the breeding range than those from nw Aust[ralia] (Houston & Barter 1990), but both sets of measurements are consistent with nominate *interpres*'. It thus seems likely that it is nominate *interpres* that occurs in New Zealand. It should be noted that Russian ornithologists usually regard the form breeding in the eastern half of the Eurasian Arctic to be of the form *oahuensis* (Portenko 1981; Tomkovich & Serra 1999; Lappo *et al.* 2012), but this taxon is not recognised by most other authorities (Peters 1934; del Hoyo & Collar 2014).

Turnstones of the form *interpres* are widely distributed through the Pacific during the non-breeding season, occurring along all flyways (Baker 1953, National Museum of Natural History undated). Until recently knowledge of turnstone movements in the East Asia-Pacific region was largely based on Thompson's (1973) study of 16,152 turnstones banded on the Pribilof Islands, Alaska which suggested a generally clockwise migration with birds moving south through the central Pacific and returning north along the east coast of Asia. Subsequently extensive deployment of geolocators in Australia has provided much information on movements of birds spending the non-breeding season in Victoria, South Australia and King Island, Tasmania (Minton *et al.* 2010a, 2011a, 2013; Zhao 2016; Gosbell *et al.* 2018).

The present paper summarises records of movements of marked turnstones from and to New Zealand.

## METHODS

Relatively few turnstones have been marked in New Zealand, the total to 1 June 2020 being 216 (Michelle Bradshaw, New Zealand National Bird Banding Scheme, Department of Conservation *pers. comm.*). Since 1996, 110 turnstones in the Auckland region, North Island have been marked with a geographic cohort plain white Darvic leg flag, and three birds with white over green leg flags in the

Nelson region, South Island. Since 2009, a further 11 have been marked in the Auckland region with a white flag bearing an engraved three letter code allowing individual recognition. Individual colour band combinations have been used since 2004 on 50 turnstones in the South Island (24 at Motueka Sandspit, Tasman Bay and 26 at Awarua Bay, Southland) and 16 in the North Island (12 at Parengarenga Harbour, Far North, three in Manukau Harbour, Auckland and 1 at Manawatu estuary).

## RESULTS

### Movements to/from Asia

Up to 1 June 2020, there had been seven records of individually marked turnstones banded in New Zealand re-sighted in East Asia (Table 1) and 35 records of birds with a geographic cohort flag (Appendix 1). There have been 35 records in New Zealand of birds marked in Asia with geographic cohort flags (Appendix 2). Birds marked in New Zealand have been reported from Taiwan, South Korea and Japan, and birds marked in Japan, South Korea, and mainland China were reported from New Zealand (Fig. 1).

**Table 1.** Records of ruddy turnstones individually-marked in New Zealand and re-sighted in Asia.

| Re-sighting location      | Mark   | Date   | Banding location                              | Date        |
|---------------------------|--------|--|---|-------------|
| South Korea               |        |  |   |             |
| Aphaedo, Mokpo            | W2BYYY | 10 May 2005<br>14 May 2005   | Karaka, Manukau Harbour,<br>North Island      | 12 Mar 2005 |
| Saemangeum                | W2BYWW | 10 May 2008  | Clark's Bay, Manukau Harbour,<br>North Island | 6 Jan 2007  |
| Mokpo                     | CMK    | 29 Apr 2017<br>30 Apr 2017<br>1 May 2017<br>2 May 2017<br>3 May 2017 | Karaka, Manukau Harbour,<br>North Island      | 9 Apr 2016  |
| Japan                     |        |  |   |             |
| Kitadaitou Is., Okinawa   | CSR    | 25 Mar 2018  | Manukau Harbour, Auckland,<br>North Island    | 21 Feb 2015 |
| China, Taiwan             |        |  |   |             |
| Wanggong, Changhua County | W1BYWR | 25 Apr 2009<br>27 Apr 2009<br>5 May 2009<br>3 May 2011               | Awarua Bay, Southland,<br>South Island        | 4 Nov 2006  |
| Han Pao, Changhua County  | W1BYRW | 21 Apr 2011  | Awarua Bay, Southland,<br>South Island        | 24 Oct 2010 |
| Wanggong, Changhua County | W1BYWB | 3 May 2011   | Awarua Bay, Southland,<br>South Island        | 4 Nov 2006  |

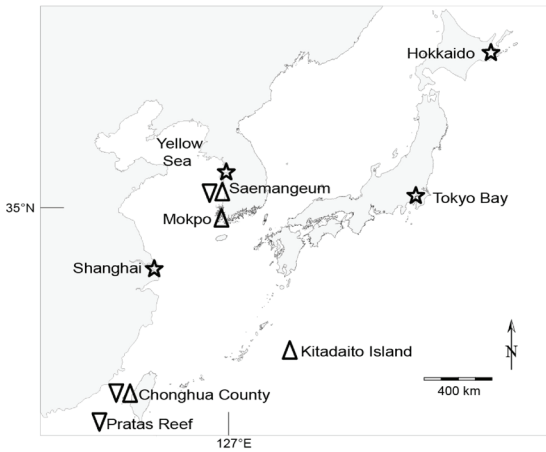
The repeat reports of W1BYWR on northward migration in Taiwan in two years are notable as this bird was also seen on southward migration in Roebuck Bay, Australia (Table 3).

The only records of individually identifiable turnstones from East Asia being reported in New Zealand are two birds marked on 17 April 2018 at Chongming Dongtan National Nature Reserve, Shanghai, China which have been photographed at Riverton Estuary, Southland on 20 February 2019 (one bird) and on 16 March 2020 (both birds).

The Asian records demonstrate that turnstones spending the non-breeding season in New Zealand may pass through East Asia on both northward and southward migration.

### Movements to/from Australia

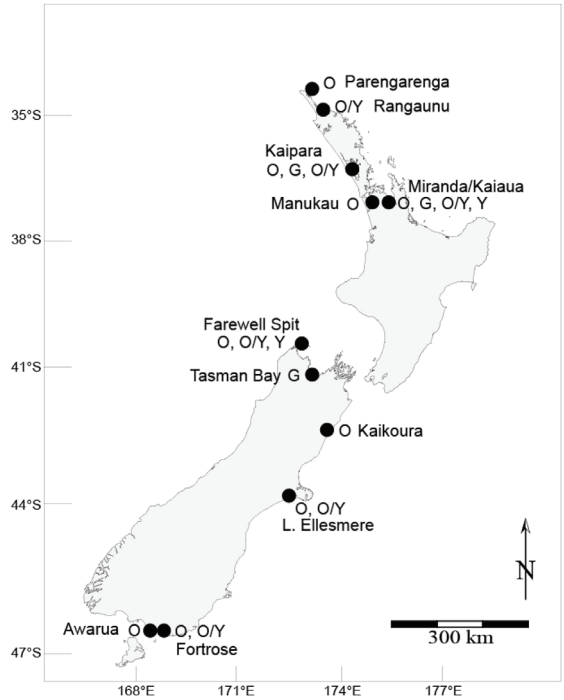
There are 49 records of turnstones marked with geographic cohort flags in Australia re-sighted in New Zealand, with most occurring in the austral summer, but one bird in June is likely to have been an immature bird that did not migrate (Table 2). Australian-banded birds have been seen from coastal sites throughout New Zealand (Fig. 2).



**Figure 1.** Locations in East Asia where ruddy turnstones marked in New Zealand have been recorded and/or where ruddy turnstones have been marked and subsequently seen in New Zealand. Upward triangle – bird marked in New Zealand reported on northward migration; downward triangle – bird marked in New Zealand reported on southward migration; star – location where a bird was marked that was subsequently reported in New Zealand.

Six birds individually marked in Victoria, one in South Australia and one on King Island, Tasmania have been reported from New Zealand, three being reported multiple times from the same site in different years during the austral summer (Appendix 3). This suggests a high degree of site faithfulness, as has been found for non-breeding turnstones elsewhere (Burton & Evans 1997; Pearce-Higgins 2001), unless there is a food shortage in which case birds may move (Burton *et al.* 2005).

There are eight records of turnstones marked with a geographic cohort flag in the North Island



**Figure 2.** Locations where ruddy turnstones marked in Australia have been re-sighted in New Zealand. Letters refer to geographic cohort colour flags: G = green (Queensland), O = orange (Victoria), Y = yellow (Northwest Australia), O/Y = orange/yellow (South Australia).

and re-sighted in Australia, five records from King Island, Tasmania and three from Darwin, Northern Territory (Appendix 4). Five individually marked turnstones from Awarua Bay, Southland have been reported from Australia (Table 3).

**Table 2.** Number of re-sight reports each month in New Zealand of ruddy turnstones marked with a geographic cohort colour flag(s) in Australia. “–” indicates no sightings.

|                 | J | F | M | A | M | J | J | A | S | O | N | D |
|-----------------|---|---|---|---|---|---|---|---|---|---|---|---|
| NW Australia    | 1 | 1 | - | 1 | - | - | - | - | - | - | 2 | - |
| Queensland      | 2 | 1 | 1 | - | - | - | - | - | - | 1 | - | - |
| South Australia | - | 4 | 3 | - | 1 | 1 | - | - | - | 1 | 8 | 3 |
| Victoria        | - | 6 | 8 | 1 | - | - | - | - | 1 | 3 | 3 | 2 |

**Table 3.** Records of ruddy turnstones individually-marked in New Zealand and re-sighted in Australia

| Marking location      | Mark         | Marking date  | Age when banded | Re-sighting date     | Re-sighting location                  |
|-----------------------|--------------|---------------|-----------------|----------------------|---------------------------------------|
| Awarua Bay, Southland | W1BYYW       | 4 Nov 2006    | 2+              | 15 Sep 2007          | Roebuck Bay, NW Australia             |
|                       |              |               |                 | 17 Sep 2007          | Roebuck Bay, NW Australia             |
|                       |              |               |                 | 3 Sep 2009           | Roebuck Bay, NW Australia             |
|                       |              |               |                 | 9 Sep 2009           | Roebuck Bay, NW Australia             |
|                       |              |               |                 | 11 Sep 2009          | Roebuck Bay, NW Australia             |
|                       |              |               |                 | 17 Aug 2010          | Roebuck Bay, NW Australia             |
|                       |              |               |                 | 8 Oct 2010           |                                       |
|                       |              |               |                 | 11 Sep 2014          | Roebuck Bay, NW Australia             |
|                       |              |               |                 | 12 Sep 2015          | Killarney Beach, Port Fairy, Victoria |
|                       |              |               |                 | 24 Aug 2016          | Roebuck Bay, NW Australia             |
| Awarua Bay, Southland | W1BYYY       | 4 Nov 2006    | 2+              | 29 Sep – 10 Oct 2007 | Newcastle Beach, New South Wales      |
|                       |              |               |                 | 11 Sept 2009         | Killarney Beach, Port Fairy, Victoria |
| Awarua Bay, Southland | W1BYWR       | 4 Nov 2006    | 2+              | 6 Sep 2010           | Roebuck Bay, NW Australia             |
| Awarua Bay, Southland | A uncertain* | 24 Oct 2010** | 2+              | 18 Mar 2015          | Darwin, Northern Territory            |
| Awarua Bay, Southland | B uncertain* | 4 Nov 2006    | 2+              | 5 Sep 2019           | Roebuck Bay, NW Australia             |
| Awarua Bay, Southland | B uncertain* | 4 Nov 2006    | 2+              | 23 Jun 2020          | Broome, NW Australia                  |

\* Three records of birds with one band missing. The identity of these individuals remains uncertain, but at least two different birds are involved. They were definitely marked at Awarua Bay.

\*\* Probable banding date – uncertain as one band missing when re-sighted.



**Figure 3.** Ruddy turnstones at Awarua Bay, Southland. Left: bird marked at Port MacDonnell, South Australia. Right: bird marked on King Island, Tasmania. For details see Appendix 3. (Photographs: Glenda Rees).

The re-sights of New Zealand-marked birds in Australia (Figure 4) show that birds pass through on both northward and southward migration (Table 3). The records of W1BYYW are particularly interesting as this bird was regularly reported on southward migration from Roebuck Bay, NW

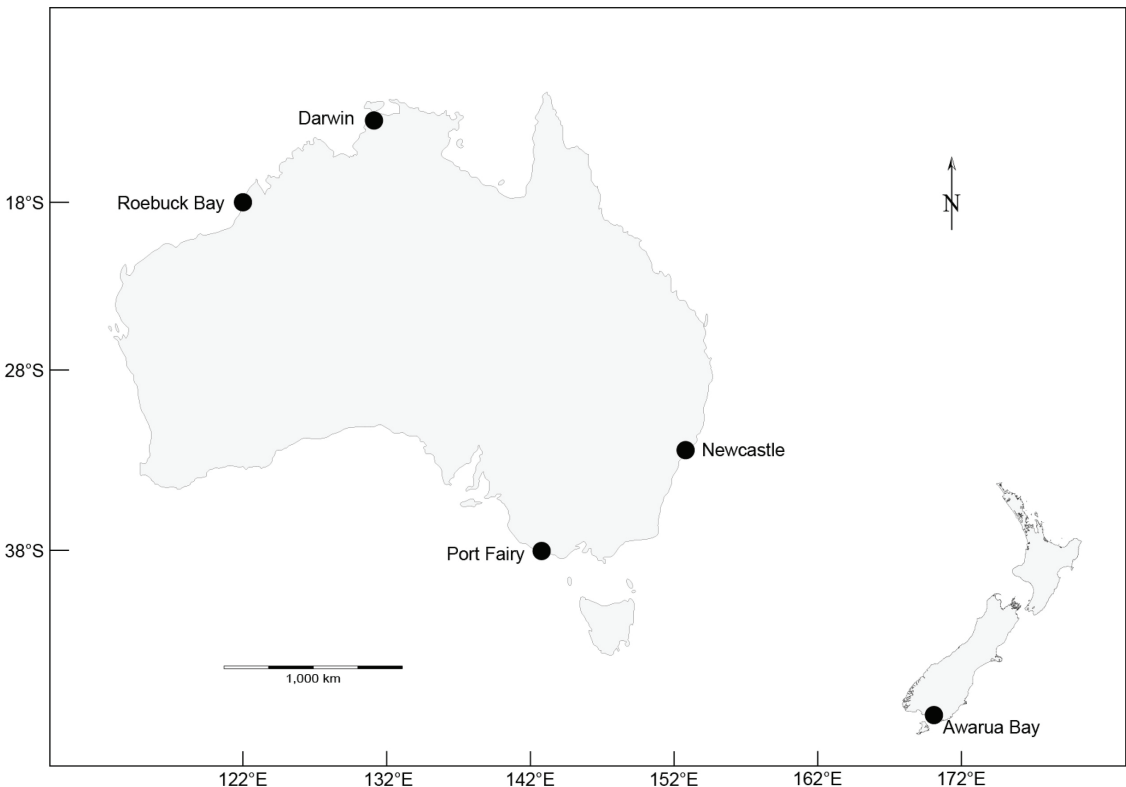
Australia, in five years but also twice from Victoria, although not during the same migration season. W1BYWR was also reported from Taiwan on northward migration (Table 1). One bird that could not be individually identified, seen at Broome on 23 June 2020 was at least 16 years old. The maximum

time between banding and recovery for a turnstone banded in Australia is 18 years and 7.4 months (ABBBS Database 2020), that in Britain 20 years and 3 days (BTO 2018), and in North America 16 years 11 months (US Geological Survey 2020). It is possible that the Broome bird may have not migrated to the breeding grounds due to old age.

One bird with multiple re-sights in Australia (W1BYYW) was seen back at Awarua Bay on 22 October 2010. Additionally, three different birds, but with only part of the colour band combination remaining, have been recorded there. However, there has been little re-sighting effort at Awarua Bay, Southland and so the lack of re-sights does not necessarily reflect an absence of birds. One bird marked only with a metal band at Pūkoro Mirānda, Firth of Thames, North Island on 28 October 1991, aged as an adult, was caught and released at Moreton Bay, Queensland on 19 September 1993 and recaptured back at Pūkoro Mirānda on 17 October 1993 (Riegen 1999) – this is the only overseas movement of a metal banded turnstone from New Zealand.

## DISCUSSION

Data are limited, but it is clear that at least some turnstones visiting New Zealand during the austral summer are coming via East Asia, and Australia, and that some northward migrating birds are also passing through Australia on their way to Asia. It remains unclear what movements are taking place through the Pacific – the only record of a marked bird is one with plumage dye from the Pribilof Islands, Alaska which was seen in the North Island in 1968 (date and locality unknown) (McKenzie 1968; Thompson 1973). Turnstones are widespread across the South Pacific in the austral summer (Stickney 1943; eBird 2020), with small numbers occurring on the Kermadec Islands (Veitch *et al.* 2004). Three turnstones were seen flying south over the sea ~623 km north-north-east of Cape Reinga (New Zealand, 29.43°S, 175.70°E) on 27 November 1966 (Jenkins 1967) and a juvenile landed on a boat ~1,420 km north-north-east of Cape Reinga (22.20°S, 177.43°E) on 11 November 1970 and hitched a ride to the Hauraki Gulf, near Tiritiri Matangi Island (Jenkins 1971). A single turnstone was recorded flying southeast (towards New Zealand) on 18 September 1982, ~935 km northwest of Cape Reinga



**Figure 4.** Locations where ruddy turnstones marked at Awarua Bay, New Zealand have been recorded in Australia.

(27.75°S, 166.97°E; AMH and Tim Lovegrove *unpubl. data*).

Whilst there is limited information on routes used by turnstones when migrating to/from New Zealand, there is a considerable body of information for Australian turnstones from both marking (Minton *et al.* 2010b, 2011b) and the use of geolocators (Minton *et al.* 2010a, 2011a; 2013; Zhou 2016; Gosbell *et al.* 2018). Birds generally migrate northwards along a relatively narrow front to Taiwan, and then pass through the Yellow Sea before moving to breeding grounds in the Russian Far East. The southward migration shows more variation, with some birds returning through East Asia, while others pass through the central Pacific (Minton *et al.* 2011a; Gosbell *et al.* 2018).

Geocator tracked birds from Southeast Australia occurred on breeding grounds from the Gulf of Khatanga to the Gulf of Kolyma, Yakutia, and the New Siberian Islands (Zhao 2016). Turnstones marked in Japan have been reported from the breeding grounds from Yakutia east to Magadan, i.e. further east than the Southeast Australian birds (Biodiversity Center of Japan 2020), possibly suggestive of different populations. Zhao (2016) noted in relation to non-breeding populations in Australia: 'although belonging to one species and wintering within a small geographic range, populations can potentially be exposed to different threats and thus require a population specific conservation plan'.

Australian geocator data also suggest that turnstones are now migrating north earlier than previously, and that there may now be less birds staging in the Yellow Sea than formerly, possibly in response to habitat reduction and degradation (Zhao 2016). Numbers of turnstones at Saemangeum, South Korea decreased markedly following the closure of the reclamation seawall in 2006 (Moores *et al.* 2016). However, habitat loss due to land claim has greatly reduced in China since 2018 (Melville 2018).

Trapping of turnstones for food has been recorded previously in Tuvalu (Koch 1961) and for sport on Nauru (Stephen 1936; Buden 2008), while they were shot for food in Hawaii (Henshaw 1902). It is unknown if trapping continues there and/or elsewhere in the Pacific, but Pierce *et al.* (2012) reported that turnstones were not taken on Tokelau. Gallo-Cajiao *et al.* (2020) suggested that 285 turnstones were hunted in the mid-1980s to early 1990s in the three sites in the EAAF for which data were available (Pattani Bay, Thailand; West Java, Indonesia; Yangtze River delta, China), but current levels are unknown. In addition to deliberate harvesting turnstones are also caught accidentally in fish/crab traps on the Chinese coast (Melville *et al.* 2016), and possibly elsewhere. Turin & Watts

(2016) suggested that the maximum number of turnstones that could be harvested sustainably (Potential Biological Removal) within the EAAF was about 1,000 birds annually.

The current lack of detailed information about the migratory routes used by turnstones spending the non-breeding season in New Zealand is of concern in light of the continuing decline in their population (Riegen & Sagar 2020), the cause(s) of which are unknown (Conklin *et al.* 2014). There is an urgent need for a tracking study of the movements of turnstones that spend the non-breeding season in New Zealand to better understand their annual migrations, in particular potential use of the Pacific Flyway (Davidson & Gill 2008). This would assist in identifying possible causes of population decline.

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**Appendix 1.** Records of ruddy turnstones marked in the Auckland region, New Zealand with a geographic cohort colour flag (plain white) and re-sighted in Asia.

| Re-sighting location         | Date        |
|------------------------------|-------------|
| South Korea                  |             |
| Dongjin Estuary              | 5 Sep 1997  |
| Mankyung Estuary             | 10 May 2001 |
| Mokpo City                   | 11 May 2003 |
| Mokpo City                   | 12 May 2003 |
| Mokpo City                   | 14 May 2005 |
| Mokpo City                   | 3 Apr 2006  |
| Mokpo City                   | 13 Apr 2006 |
| Mokpo City                   | 24 Apr 2006 |
| Simpoo, Saemangeum           | 2 May 2006  |
| Mokpo City                   | 3 May 2006  |
| Mokpo City                   | 5 May 2006  |
| Mokpo City                   | 10 May 2006 |
| Mokpo City                   | 15 May 2006 |
| Mokpo City                   | 18 Apr 2007 |
| Mokpo City                   | 2 May 2007  |
| Mokpo City                   | 5 May 2007  |
| Mokpo City                   | 10 May 2007 |
| Mokpo City                   | 15 May 2007 |
| Simpoo, Saemangeum           | 30 Apr 2008 |
| Hwaje, Saemangeum            | 20 May 2008 |
| Mokpo City                   | 4 Aug 2008  |
| Mokpo City                   | 22 Apr 2012 |
| China, Taiwan                |             |
| Han Pao, Changhua County     | 28 Aug 2008 |
| Han Pao, Changhua County     | 5 Sep 2008  |
| Dongsha Qundao (Pratas Reef) | 21 Aug 2009 |
| Han Pao, Changhua County     | 22 Aug 2009 |
| Han Pao, Changhua County     | 24 Aug 2009 |
| Han Pao, Changhua County     | 5 Sep 2009  |
| Han Pao, Changhua County     | 9 Sep 2009  |
| Han Pao, Changhua County     | 17 Sep 2009 |
| Han Pao, Changhua County     | 21 Feb 2010 |
| Han Pao, Changhua County     | 15 Aug 2010 |
| Han Pao, Changhua County     | 15 Sep 2011 |
| Han Pao, Changhua County     | 15 Aug 2015 |
| Han Pao, Changhua County     | 3 Apr 2016  |

**Appendix 2.** Records of ruddy turnstones marked in Asia with a geographic cohort colour flag combination and re-sighted in New Zealand.

| <b>Banding location</b>                             | <b>Re-sighting location</b>                            | <b>Date</b> |
|---|--|-------------|
| Japan   |  |             |
| Northern Japan, Eastern Hokkaido                    | Karaka, Manukau Harbour, North Island                  | 24 Feb 2011 |
|   | Clarks Bay, Manukau Harbour, North Island              | 29 Oct 2011 |
|   | Karaka, Manukau Harbour, North Island                  | 10 Mar 2012 |
|   | Karaka, Manukau Harbour, North Island                  | 22 Dec 2012 |
|   | Farewell Spit, South Island                            | 15 Feb 2014 |
| Tokyo Bay /Miyagi                                   | Big Sand Island, Tabora, Kaipara Harbour, North Island | 4 Mar 2006  |
|   | Karaka, Manukau Harbour, North Island                  | 13 Mar 2016 |
| South Korea   |  |             |
| South Korea   | Parengarenga Harbour, Far North, North Island          | 22 Sep 2002 |
| South Korea   | Karaka, Manukau Harbour, North Island                  | 8 Nov 2003  |
| China   |  |             |
| Chongming Dongtan National Nature Reserve, Shanghai | New River estuary, Invercargill, South Island          | 21 Feb 2008 |
|   |  | 20 Oct 2013 |
|   |  | 11 Nov 2013 |
|   |  | 22 Dec 2013 |
|   |  | 2 Jan 2014  |
|   |  | 4 Jan 2014  |
|   |  | 2 Feb 2014  |
|   |  | 16 Feb 2014 |
|   |  | 20 Oct 2014 |
|   |  | 2 Dec 2014  |
|   |  | 27 Dec 2014 |
|   |  | 26 Feb 2015 |
|   |  | 4 Apr 2015  |
|   |  | 26 Dec 2015 |
|   |  | 24 Jan 2016 |
|   |  | 13 Mar 2016 |
|   |  | 26 Mar 2016 |
| 18 Dec 2016   |  |             |
| 2 Jan 2017  |  |             |
| 1 Apr 2017  |  |             |
| 9 Apr 2017  |  |             |
| 14 Apr 2017   |  |             |
| 19 Nov 2017   |  |             |
| 21 Nov 2017   |  |             |
| 4 Feb 2018  |  |             |
| 1 Apr 2018  |  |             |

**Appendix 3.** Records of ruddy turnstones individually-marked in Australia and re-sighted in New Zealand

| Marking location                      | Mark | Marking date | Age when banded | Re-sighting date  | Re-sighting location                       |
|---------------------------------------|------|--------------|-----------------|---|--|
| Flinders, West Head, Victoria         | ANY  | 20 Oct 2009  | 2+              | 11 Jan 2012<br>18 Feb 2012<br>10 Nov 2012<br>10 Mar 2013<br>29 Mar 2013<br>28 Dec 2013<br>11 Jan 2014<br>6 Apr 2014<br>2 Jan 2015<br>31 Mar 2015<br>5 Apr 2015<br>7 Nov 2015<br>5 Mar 2016  | Big Sand Island, Taporā, Kaipara Harbour   |
| Killarney Beach, Port Fairy, Victoria | YHS  | 20 Oct 2013  | 1               | 6 Apr 2014<br>1 Jan 2015<br>7 Nov 2015<br>5 Mar 2016  | Big Sand Island, Taporā, Kaipara Harbour   |
| Killarney Beach, Port Fairy, Victoria | YRZ  | 26 Oct 2013  | 2+              | 15 Dec 2013<br>22 Dec 2013<br>2 Jan 2014<br>4 Jan 2014<br>2 Feb 2014<br>16 Feb 2014<br>26 Dec 2014<br>27 Dec 2014<br>7 Feb 2015<br>22 Feb 2015<br>26 Feb 2015<br>14 Mar 2015<br>29 Mar 2015<br>6 Apr 2015<br>31 Oct 2015<br>26 Dec 2015<br>10 Jan 2016<br>16 Jan 2016<br>13 Mar 2016<br>26 Mar 2016<br>1 Jan 2017<br>18 Mar 2017<br>1 Apr 2017<br>14 Apr 2017<br>21 Nov 2017<br>2 Jan 2018<br>14 Jan 2018<br>4 Feb 2018<br>1 Apr 2018<br>9 Feb 2018<br>15 Dec 2019<br>26 Dec 2019 | Kidds, Karaka, Manukau Harbour             |
| Barwon Heads, Victoria                | CMN  | 16 Apr 2010  | 2+              | 7 Mar 2011  | Riverton Rocks, Southland                  |
| Flinders, West Head, Victoria         | CMW  | 1 Nov 2010   |                 | 7 Mar 2011  | Invercargill, South Island                 |
| Flinders, West Head, Victoria         | WRU  | 20 Sep 2015  |                 | 5 Nov 2016  | Avon-Heathcote, Christchurch, South Island |
| Port MacDonnell, South Australia      | BEE  | 22 Sep 2018  | 2+              | 15 Feb 2020   | Awarua Bay, South Island                   |
| King Island, Tasmania *               | UAZ  | 9 Dec 2018   | 1               | 27 Jul 2019   | Awarua Bay, South Island                   |

\* see Figure 3.

**Appendix 4.** Records of ruddy turnstones marked in the Auckland region, North Island, New Zealand with a geographic cohort colour flag and re-sighted in Australia.

| <b>Re-sighting date</b>              | <b>Re-sighting location</b>               |
|--------------------------------------|---|
| 12 Mar 2008                          | North Bay, King Island, Tasmania          |
| 19 Nov 2008, 27 Mar 2009             | Whalebone Beach, King Island, Tasmania    |
| 19 Mar 2010                          | Surprise Bay, King Island, Tasmania       |
| 29 Nov 2011                          | Sea Elephant River, King Island, Tasmania |
| 5 Apr 2014, 28 Mar 2015, 29 Nov 2015 | East Point, Darwin, Northern Territory    |