Numbers of waders in New Zealand 1994–2003

Ian Southey

DOC RESEARCH & DEVELOPMENT SERIES 308

Published by
Science & Technical Publishing
Department of Conservation
PO Box 10420, The Terrace
Wellington 6143, New Zealand

DOC Research & Development Series is a published record of scientific research carried out, or advice given, by Department of Conservation staff or external contractors funded by DOC. It comprises reports and short communications that are peer-reviewed.
Individual contributions to the series are first released on the departmental website in pdf form. Hardcopy is printed, bound, and distributed at regular intervals. Titles are also listed in our catalogue on the website, refer www.doc.govt.nz under *Publications*, then *Science & technical*.

ISSN 1176–8886 (hardcopy)
ISSN 1177–9306 (web PDF)
ISBN 978–0–478–14575–5 (hardcopy)
ISBN 978–0–478–14576–2 (web PDF)

This report was prepared for publication by Science & Technical Publishing; editing and layout by Amanda Todd, and distribution maps by Arawana Ltd. Publication was approved by the General Manager, Research and Development Group, Department of Conservation, Wellington, New Zealand.

In the interest of forest conservation, we support paperless electronic publishing. When printing, recycled paper is used wherever possible.

CONTENTS

Numbers of waders in New Zealand 1994–2003

Ian Southey

82 Red Hill Road, Papakura 2110, New Zealand. Email: iansouthey@yahoo.co.nz

A B S T R A C T

Populations of waders, especially migratory species, tend to be in decline worldwide, and there has been concern for some time about the status of some endemic species in New Zealand. Counts of waders in estuaries throughout New Zealand were made during summer (November–December) and winter (June–July) from November 1994 to June 2003, and compared with results from the previous decade. Populations of most species that breed in New Zealand appeared to be stable or increasing, but banded dotterels (*Charadrius bicinctus bicinctus*) had clearly declined. No species of Arctic migrant appeared to have increased in number, and only eastern bar-tailed godwits (*Limosa lapponica baueri*) and pectoral sandpipers (*Calidris melanotos*) appeared to have arrived in similar numbers to the previous decade; numbers of the other species had declined, some substantially. There were disproportionate local gains and losses between sites in several species that suggest local habitat change. In winter, lesser knots (*Calidris canutus*) had become much more concentrated on Manukau Harbour and turnstones (*Arenaria interpres*) seemed to have moved away from Southland. Species that depend on a small number of sites nationally, especially wrybill (*Anarhynchus frontalis*) and lesser knot, are particularly vulnerable to changes at their wintering sites. Some declines in Arctic migrants clearly reflect problems elsewhere on their routes, but there is growing recognition internationally that impacts on non-breeding sites are critical. Consequently, recent changes to coastal environments in New Zealand are of concern.

Keywords: New Zealand, waders, count results, population trends

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

1. Introduction

There has been a long history of counting waders in New Zealand. Following a period of exploration and discovery during the 1940s, regular counts were established by the Ornithological Society of New Zealand (OSNZ) at a number of sites. Since 1960, counts have been undertaken twice a year (Veitch & Habraken 1999). From 1983 to 1994, OSNZ widened this work by initiating a national wader count scheme. The aims of this project were to determine the numbers and distribution of waders at coastal sites within New Zealand, and seasonal changes in the distribution and numbers of waders (Sagar et al. 1999). This project improved our knowledge of population sizes and distributions of waders, and included species that had not previously been studied in this way. It also provided an excellent baseline for assessing changes in the distribution and abundance of waders in New Zealand.

OSNZ also coordinated large-scale banding schemes on two New Zealand breeding waders—banded dotterels *Charadrius bicinctus bicinctus* (Pierce 1999) and pied stilts *Himantopus himantopus leucocephalus* (summarised in Dowding & Moore 2004)—which have considerably clarified the movement patterns of these previously understudied species and have improved the interpretation of counts. The banding of Arctic migrants (Riegen 1999) has also continued and has been integrated into a flyway-wide programme (Anon. 2001; Milton 2003). Leg flagging, another marking technique, has allowed much of the migratory pathways and staging sites along the flyway to be traced for eastern bar-tailed godwits (*Limosa lapponica bauerí*) and lesser knots (*Calidris canutus*). This has shown that those species that regularly winter in New Zealand probably undertake some of the longest and most spectacular continuous flights known (Gill et al. 2005) and has highlighted the massive energetic demands involved in preparation for and recovery from these migrations.

Worldwide, populations of wader species tend to be in decline, particularly those of the long-distance migrants (Zöckler et al. 2003). In New Zealand, there has been concern for some time about the less common endemic species, such as the wrybill (*Anarhynchus frontalis*) and New Zealand dotterel (*Charadrius obscurus*). To date, the research and management of these species, which has been coordinated by the Department of Conservation, has focused mainly on their breeding sites (Dowding & Murphy 2001). The counts made by OSNZ can be used to monitor these populations, particularly when they flock after breeding, providing an assessment of the effectiveness of this management and indicating areas of concern. For the Arctic-breeding waders, counts at their southern hemisphere wintering sites have been the primary form of population monitoring. An increased global interest in these species is now beginning to allow local trends to be placed in context with the wider populations.

In this report, the numbers and distribution of waders in New Zealand between November 1994 and June 2003 have been considered using available counts made by OSNZ. These have been compared with the results of Sagar et al. (1999) for the period November 1983 to June 1994, and an attempt has been made to discuss the trends in an ecological context.

2. Methods

This work was a continuation of Sagar et al.'s (1999) study, and essentially followed the same methodology during the period from November 1994 to June 2003. Censuses were carried out by experienced amateur ornithologists, largely at sites at which counts had previously been made. Place names for the sites counted are shown in Fig. 1. Coverage of sites in different regions was uneven over the period of this study (Table 1), as the results are from regional projects rather than a national scheme, such as was undertaken during the previous decade. Counts were not available for less common species at Farewell Spit over a 7-year period (November 1994 to November 2000), and few counts were returned from sites in the Far North and Southland regions, which are remote and have few active OSNZ members.

As far as possible, summer counts were made in November and winter counts in June or occasionally July. However, when no other data were available, counts that had been made at other times were used. The timing of these summer and winter counts matched the timing of long-running census programmes in the Firth of Thames and Manukau Harbour, and coincided with periods of relative stability in the numbers of Arctic migrants (Veitch 1999; Veitch & Habraken 1999).

To obtain reliable population estimates, all sites and habitats need to be monitored (Sagar et al. 1999). Since the participants had detailed local knowledge, the counts generally achieved this and also tracked any changes in the locations of roosts over time. In tidal areas, counts were made at high tide, when waders congregate on roosts and can be counted more easily. Experienced counters were placed at the largest roost sites, where possible, to ensure more accurate counting of the larger flocks (Underhill & Prŷs-Jones 1994). A bigger concern is the potential to miss flocks entirely (Underhill & Prŷs-Jones 1994), as birds may move between adjacent harbours to roost (Veitch & Habraken 1999). However, observers attempted to account for this by monitoring bird movements during the count period to detect departing flocks (Tony Habraken, OSNZ, pers. comm.). Longer term flock movements between sites, which especially occur with lesser knots (as detected by banding; Phil Battley, OSNZ, pers. comm.), cannot be accounted for in this way. Censuses were synchronised as much as possible to avoid missing or repeatedly counting such birds, but in some regions the pool of observers was too small to manage this entirely. Consequently, the census results are actually an index rather than a total count (Underhill & Prŷs-Jones 1994). However, by including many sites and large proportions of populations, they should give a reasonable indication of population changes over time.

An important part of this work was to compare these results with those summarised by Sagar et al. (1999) for the previous 10 years. Distributions and relative abundances over the past 20 years were compared. Differences in coverage between the two studies generally precluded comparisons of total counts for species, but where numbers for species at specific sites were given by Sagar et al. (1999) they have been compared with the results from this study. Other sites that were not mentioned by Sagar et al. (1999) but that had similar numbers of birds were also tabulated. Some sites were grouped into OSNZ regions

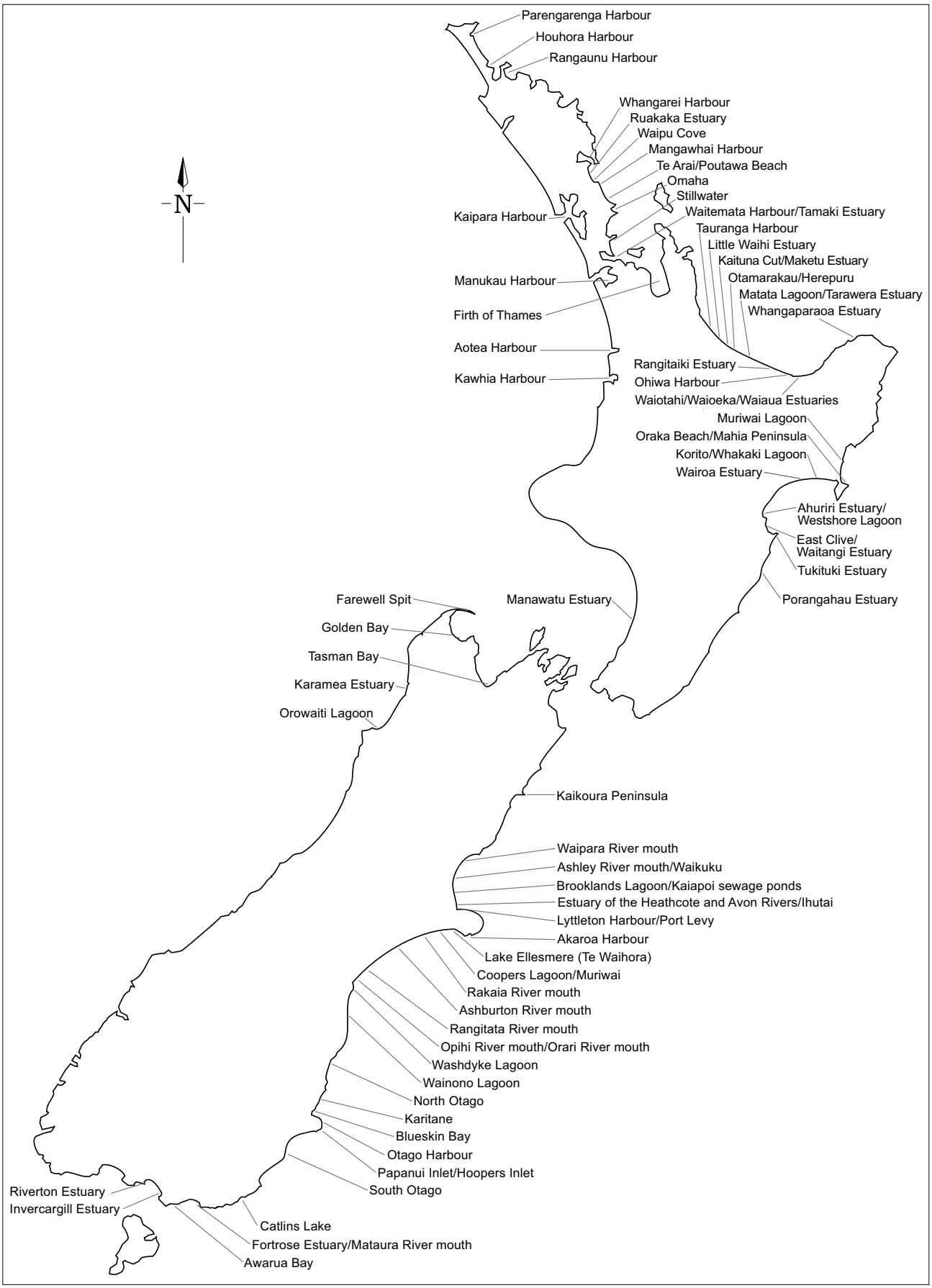


Figure 1. Locations and names of sites in New Zealand where waders were counted between November 1994 and June 2003.

TABLE 1. NUMBER OF WADER COUNTS MADE AT NEW ZEALAND SITES BETWEEN NOVEMBER 1994 AND JUNE 2003. SITES ARE LISTED BY ADMINISTRATIVE REGIONS OF THE ORNITHOLOGICAL SOCIETY OF NEW ZEALAND.

SITES COVERED	NUMBER OF COUNTS	
	WINTER	SUMMER
Far North		
Parengarenga Harbour, Houhora Harbour, Rangaunu Harbour	2	2 (1 in Jan 1996)
Northland		
Whangarei Harbour, Ruakaka Estuary, Waipu Cove	9	10
Northland/Auckland		
Kaipara Harbour	9	10
Auckland*		
Mangawhai Harbour	5	6
Omaha	1	3
Waitemata Harbour/Tamaki Estuary	4	4
Auckland/South Auckland		
Manukau Harbour	9	10
South Auckland		
Firth of Thames	9	10
Bay of Plenty*		
Tauranga Harbour, Little Waihi Estuary, Kaituna Cut/Maketu Estuary, Matata Lagoon/Tarawera Estuary, Ohiwa Harbour	6	6
Waikato		
Aotea Harbour, Kawhia Harbour	9	9
Gisborne/Wairoa		
Muriwai Lagoon, Oraka Beach/Mahia Peninsula, Korito/Whakaki Lagoon, Wairoa Estuary	8	8
Hawke's Bay		
Ahuriri Estuary, Westshore Lagoon, East Clive, Waitangi Estuary, Tukituki Estuary	8	8
Porangahau estuary	8	7
Manawatu		
Manawatu Estuary	0	1
Marlborough		
Kaikoura Peninsula	1	0
Nelson		
Farewell Spit, Golden Bay, Tasman Bay	3+5†	3+7†
Canterbury*		
Estuary of the Heathcote and Avon Rivers/Ihutai, Lyttelton Harbour, Lake Ellesmere (Te Waihora)	6	8
Mouth of the Ashley River/Rakahuri, Brooklands Lagoon, Washdyke Lagoon, mouth of the Waipara River, Wainono Lagoon (Lake Ki-Wainono)	4+	6+
Otago		
Otago Harbour, Otago Peninsula	2	1
North Otago, Blueskin Bay, South Otago, Catlins Lake	1	1
West Coast		
Karamea Estuary, Orawaiti Lagoon	1	1
Southland		
Invercargill Estuary, Awarua Bay	2	2 (1 in Feb 1996)
Fortrose Estuary	1	1
Riverton Estuary/Aparima	0	1 (in Feb 1996)

* 4–13 smaller sites not always regularly counted.

† Part counts.

(Table 1) to show differences in the way counts changed between seasons in different parts of the country. Differences between counts were analysed using *t*-tests computed for samples with unequal variances (Kaps & Lamberson 2004).

Population estimates were made for the more common species. These were calculated using counts from all sites during the non-breeding season (winter for New Zealand breeding species and summer for Arctic migrants). To do this, missing counts were replaced with the site average for those counts that were taken during this 10-year period, following Sagar et al. (1999). Population trends between the 1994–2003 and 1983–1994 periods have been presented as the percentage change since the original count (i.e. the difference between the two counts divided by the initial count for specific site averages or summed site averages). Comparisons between summer and winter counts are simply proportions, usually of the overall site averages, expressed as percentages.

For each species, count data are presented for the sites where it was most abundant and a distribution map is given for the season in which it was most abundant; the only exceptions to this are spur-winged plover and black-fronted dotterel, which were poorly monitored by these counts. For some species, maps are also given for the alternate season to illustrate seasonal changes in distribution.

3. Results

3.1 COVERAGE

In total, 39 species of waders and two categories of hybrids were recorded in these counts (listed in Appendix 1), although many of these were uncommon. Most species of the more common waders were concentrated at relatively few sites during their non-breeding season, and good coverage was achieved for most of these sites. Complete series of counts were obtained from Kaipara, Manukau and Whangarei Harbours, the Firth of Thames, and, for the more common species, Farewell Spit, allowing population trends of these species to be monitored. The only possible exception was turnstones (*Arenaria interpres*), which have important sites in the more remote Far North and Southland regions, where they were counted twice only. Variable oystercatchers (*Haematopus unicolor*) and New Zealand dotterels were not very well covered because they are widely dispersed, with localised populations that may vary independently (Dowding & Chamberlin 1991).

3.2 EFFECTIVENESS

There has been no replication and little checking of the accuracy of census counts of waders in New Zealand, and concerns about count accuracy have been expressed (Riegen & Dowding 2003). During 3 years of the period of this project, there was a national wrybill census in addition to the counts reported here (Riegen & Dowding 2003). In 2 of the 3 years, the differences between counts were small, and all of the mid-points were close to the 10-year count average for this period (Table 2). A census of the northern New Zealand dotterel in October 2004 showed a 13% increase since 1996 at sites counted on both occasions (John Dowding, OSNZ, pers. comm.). Even though no more than a quarter of that number of birds was counted between 1994 and 2003, a similar level of increase (10%) was detected by these counts over a similar time period. While some individual counts may deviate, there is reason to believe that most counts generally do reflect population sizes reasonably well and certainly should indicate trends over several years.

TABLE 2. COMPARISON OF WRYBILL (*Anarhynchus frontalis*) COUNTS UNDERTAKEN BY THE ORNITHOLOGICAL SOCIETY OF NEW ZEALAND (OSNZ) AND THE NATIONAL WRYBILL CENSUS (RIEGEN & DOWDING 2003).

YEAR	OSNZ COUNT	NATIONAL WRYBILL CENSUS	DIFFERENCE
1994*	4197	5111	+22%
2001	4409	4143	–6%
2002	4372	4650	+6%

* Taken from Sagar et al. (1999).

TABLE 3. SUMMARY OF COUNTS AND POPULATION ESTIMATES OF WADER SPECIES BREEDING IN NEW ZEALAND BETWEEN NOVEMBER 1994 AND JUNE 2003.
Population estimates were derived from the winter counts and cover only those sites from which at least one count was returned (SEM = standard error of the mean). Population estimates for 1983–1994 are from Sagar et al. (1999). Separate estimates are made for the North Island (NI) and South Island (SI) populations of the New Zealand dotterel.

SPECIES	MEASURE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	MEAN	SEM	ESTIMATE 1983–1994
Pied oystercatcher	Winter count		92387	85821	78789	102001	89622	77153	72999	62338	89939	83450	3955	
	Summer count	17998	18768	19872	24926	15723	17695	16505	14026	10132	15480	17113	1228	
	Population estimate		100131	92853	80164	110060	93383	81587	83537	73481	96253	90161	3811	112675
Pied stilt	Winter count		19591	18811	21648	13756	13486	15286	14542	8892	18079	16010	1299	
	Summer count	5528	2743	5956	5869	2383	5203	4860	4304	4029	2949	4382	419	
	Population estimate		20110	21441	22000	17343	15719	18541	20837	14409	22008	19156	937	27906
Banded dotterel	Winter count		6220	6296	5357	2990	4835	5304	3034	2759	4121	4546	460	
	Summer count	749	335	1371	915	178	603	748	643	431	161	613	116	
	Population estimate		7335	6960	5551	5083	5437	5984	5852	5491	5406	5900	253	10843
Wrybill	Winter count		3483	4245	5066	4558	5005	3459	4409	4372	5732	4481	244	
	Summer count	114	73	235	195	164	189	57	459	135	150	177	36	
	Population estimate		3618	4641	5201	4793	5229	3853	4771	4798	6018	4769	240	3880
Variable oystercatcher	Winter count		1513	875	1434	1141	1572	1965	1039	1034	1378	1328	113	
	Summer count	1176	414	942	1110	1093	1064	785	1027	1218	1262	1009	79	
	Population estimate		1780	1741	1672	1829	2087	2540	2126	2110	2358	2027	99	3413
Spur-winged plover	Winter count		1005	1592	2216	834	737	941	571	856	1104	1095	169	
	Summer count	625	802	686	751	592	596	547	517	492	664	627	32	
	Population estimate		1211	1684	2294	1088	924	1352	1338	1544	1711	1461	136	
New Zealand dotterel	Winter count		369	248	318	253	433	333	271	334	347	323	20	
	Summer count	224	128	210	261	253	263	200	266	279	186	227	15	
	Population estimate NI		487	416	409	396	503	418	440	517	515	456	16	944
	Population estimate SI		24	20	27	24	24	24	24	25	25	24	1	26
Black-fronted dotterel	Winter count		34	214	11	48	40	102	0	3	91	60	23	
	Summer count	6	17	5	10	1	10	17	2	5	6	8	2	
	Population estimate		34	214	11	52	40	103	68	68	93	76	20	321
Black stilt and hybrids	Winter count		32	27	25	21	14	21	25	10	14	21	2	
	Summer count	1	1	1	3	0	3	1	11	1	6	3	1	
	Population estimate		33	27	25	24	15	22	30	15	17	23	2	68

3.3 NEW ZEALAND BREEDING WADERS

Counts and population estimates for each New Zealand breeding wader species are summarised in Table 3.

3.3.1 Pied oystercatcher (*Haematopus ostralegus finschi*)

In winter, between 62 338 and 102 001 pied oystercatchers (*Haematopus ostralegus finschi*) were counted (Table 3; Fig. 2). The average winter count, 83 450, is a little higher than the 83 017 recorded by Sagar et al. (1999), and comparison of specific sites shows an estimated 14% increase overall. Based on winter counts, the most important harbours are Manukau Harbour, the Firth of Thames and Kaipara Harbour (Table 4; Fig. 2). These are the same sites as reported by Sagar et al. (1999), but each had higher average counts in this study. At other important sites (Farewell Spit, Golden Bay, Tasman Bay and the Estuary of the Heathcote and Avon Rivers/Ihutai), however, numbers have declined or stabilised (Table 4), and there has been no definite overall increase during the period of this study (Fig. 3).

Summer counts were typically much lower than winter counts, with between 10 132 and 24 926 birds counted (21% of the winter total) (Fig. 4). The summer population consisted mainly of non-breeding birds. The degree of change in numbers between seasons varied along the country (Table 4). The biggest differences were in the harbours from the Auckland isthmus to Whangarei (17%), and the smallest differences were in the Canterbury and Otago regions (38%). In the Southland region, the seasonal trend was reversed, with more birds (363%) being counted at coastal sites in summer than in winter.

TABLE 4. TEN-YEAR AVERAGES OF PIED OYSTERCATCHER (*Haematopus ostralegus finschi*) COUNTS.
Data are presented for New Zealand sites where more than 2000 birds on average were counted in winter between 1995 and 2003, or that had comparative data in Sagar et al. (1999) and other counts mentioned in the text. Winter counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM = standard error.

SITE	SUMMER 1994–2003			WINTER 1995–2003			WINTER 1983–1994		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Manukau Harbour	4296	514	10	29334	1938	10	25707*	3501	11
Firth of Thames	3555	767	10	17834	2174	10	12618*	3414	11
Kaipara Harbour	2950	706	10	17794	2302	10	13554*	3910	9
Farewell Spit	1632	253	10	5855	1410	10	7443*	1363	11
Estuary of the Heathcote and Avon Rivers/Ihutai	175	80	8	3284	202	6	3006	646	11
Kawhia Harbour	461	353	9	2485	281	9			
Tasman Bay	751	80	10	1747	388	8	2304*	518	11
Golden Bay	571	202	10	1513	111	8	3052*	1393	8
Whangarei Harbour	218	57	10	1362	229	9			
Canterbury region	1210	202	8	4190	250	6			
Otago region	1154		1	1989	713	1			
Southland region	3409	335	2	939	587	2			

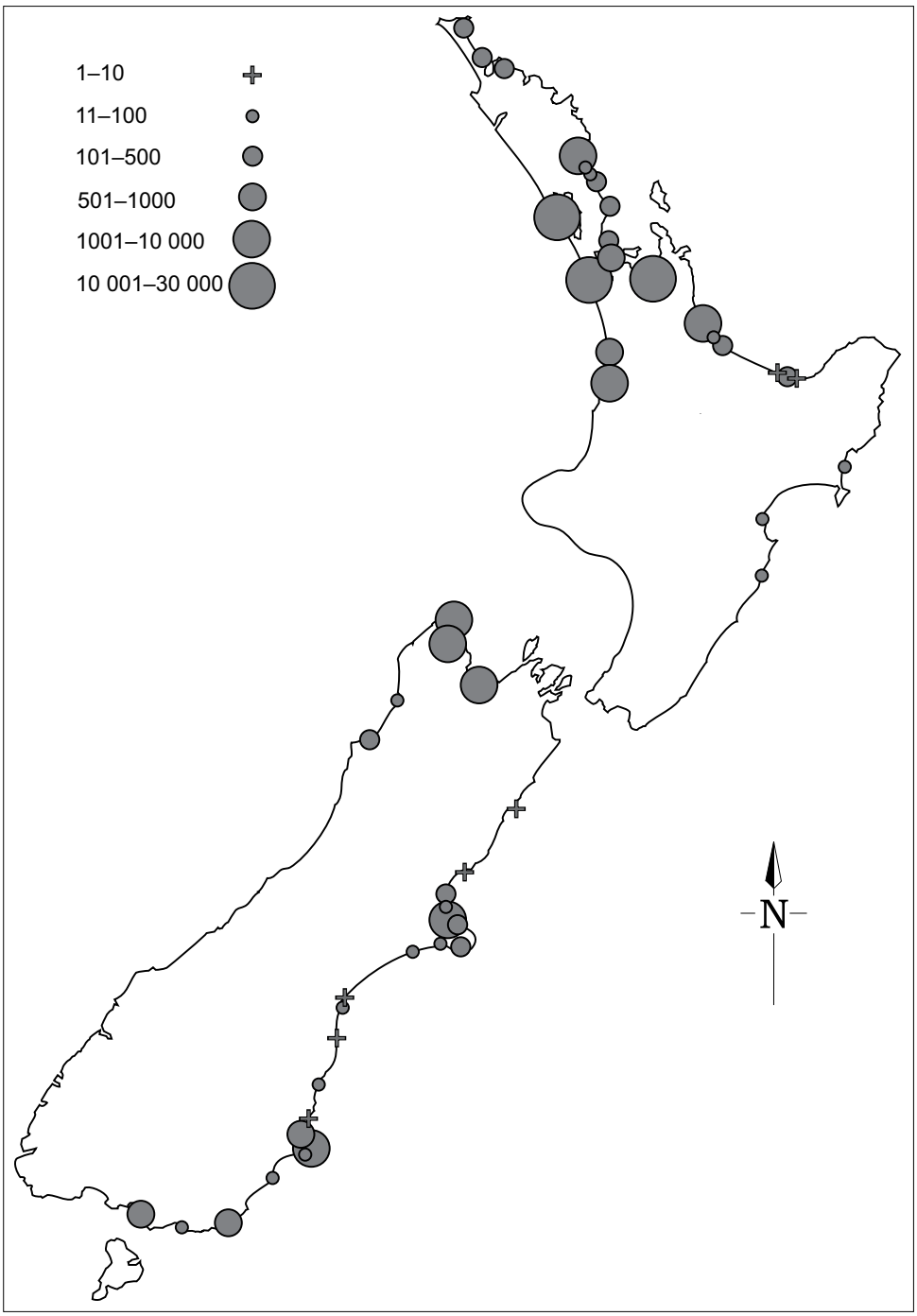


Figure 2. The distribution and abundance of pied oystercatchers (*Haematopus ostralegus finschi*) in New Zealand during winter between 1995 and 2003. Only sites with at least one bird, on average, are shown.

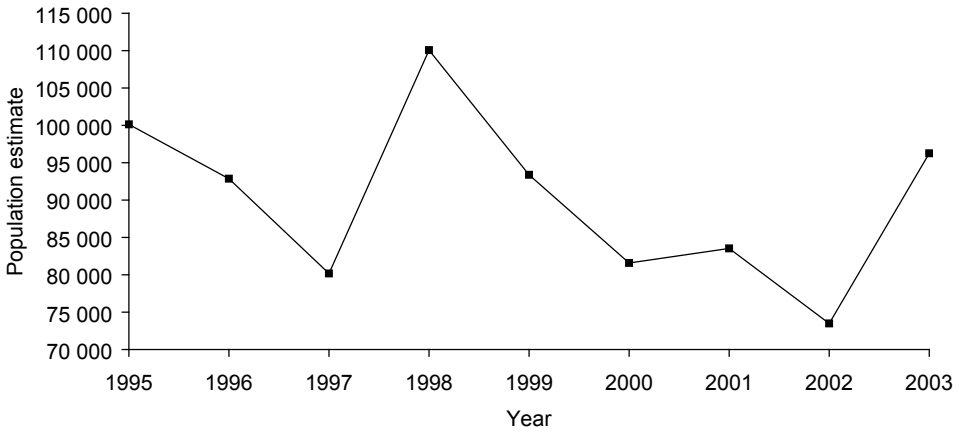


Figure 3. Population estimates for the pied oystercatcher (*Haematopus ostralegus finschi*) in New Zealand during winter between 1995 and 2003.

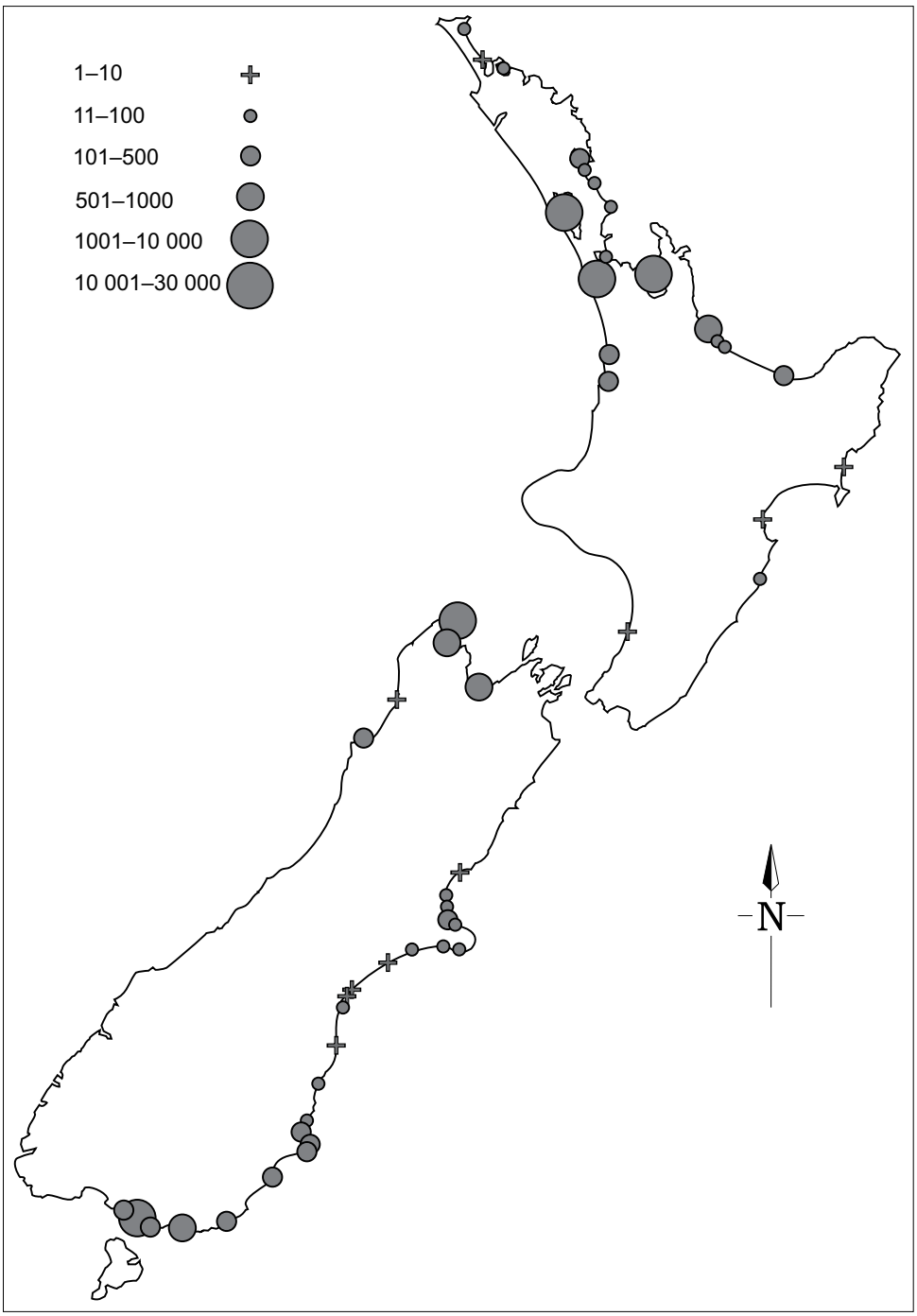


Figure 4. The distribution and abundance of pied oystercatchers (*Haematopus ostralegus finschi*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.3.2 Pied stilt (*Himantopus himantopus leucocephalus*)

The winter counts of pied stilts (*Himantopus himantopus leucocephalus*) ranged from 8892 to 21 648 birds (Table 3; Fig. 5). The average total count of 16 010 birds is a little lower than that of the previous decade (Sagar et al. 1999), but numbers at most significant sites increased by 22% overall (Table 5). The low counts at Farewell Spit and Golden Bay, even in winter (Table 5), seem remarkable given the high numbers of other species at these sites. Many pied stilts live inland and are essentially sedentary, particularly in the northern North Island. Therefore, they may not be well monitored by these counts, as the numbers frequenting the coast may depend on whether rainfall or drought are affecting feeding habitats inland (Veitch 1999).

Over summer, 2383–5956 birds (average 4382) remained at the count sites (Fig. 6). Across all sites, this is about 30% of the winter population. There were, however, marked local differences between sites in the proportions recorded (Table 5). Counts of southern populations (Lake Ellesmere (Te Waihora), and the Otago and Southland regions) were actually higher (167%) over the summer, whereas in the harbours of the Auckland isthmus, summer counts were substantially lower (15%) than winter counts.

TABLE 5. TEN-YEAR AVERAGES OF PIED STILT (*Himantopus himantopus leucocephalus*) COUNTS.
Data are presented for New Zealand sites where more than 300 birds on average were counted in winter between 1995 and 2003, or that had comparative data in Sagar et al. (1999) and other counts mentioned in the text. Winter counts are compared with those from the previous decade (Sagar et al. 1999); * = $P < 0.05$. *n* = the number of counts from which the average was calculated, SEM = standard error.

SITE	SUMMER 1994–2003			WINTER 1995–2003			WINTER 1983–1994		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Manukau Harbour	681	79	10	3981	376	9	3348*	256	11
Firth of Thames	611	111	10	3908	376	9	3452*	347	11
Kaipara Harbour	404	47	10	3591	401	9	2651*	304	10
Parengarenga Harbour	37	37	3	1078	217	3	688	55	8
Ahuriri Estuary	178	63	8	853	183	8	605*	99	11
Lake Ellesmere (Te Waihora)	1202	272	8	683	157	6	548*	66	11
Whangarei Harbour	119	38	10	422	72	9	418	55	9
Tauranga Harbour	32	8	6	357	90	6	441	69	11
Golden Bay	1	1	8	71	7	8			
Farewell Spit	6	2	10	29	7	9			
Otago region	484	0	1	300	52	2			
Southland region	276	91	2	194	76	2			

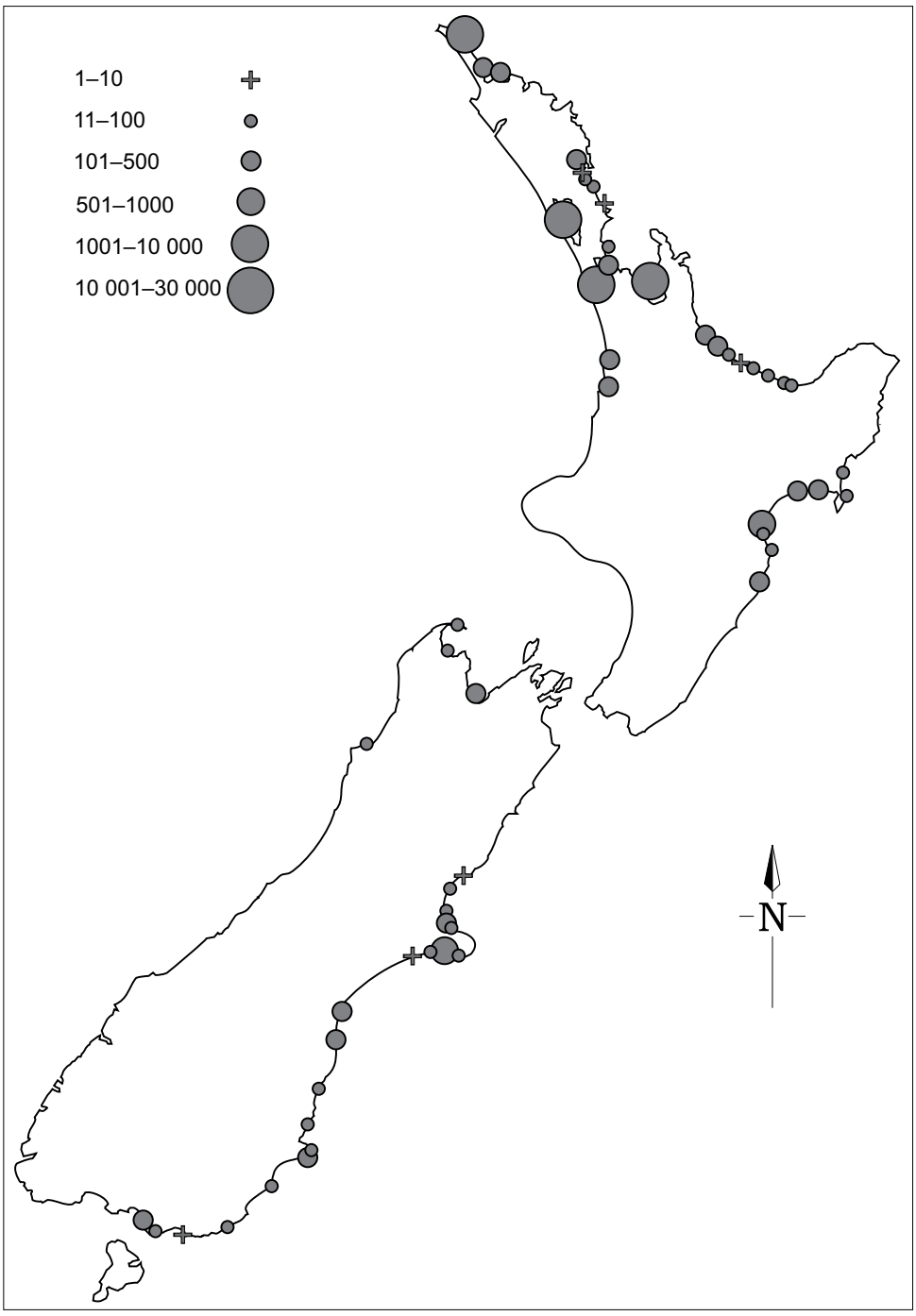


Figure 5. The distribution and abundance of pied stilts (*Himantopus himantopus leucocephalus*) in New Zealand during winter between 1994 and 2003. Only sites with more than one bird, on average, are shown.

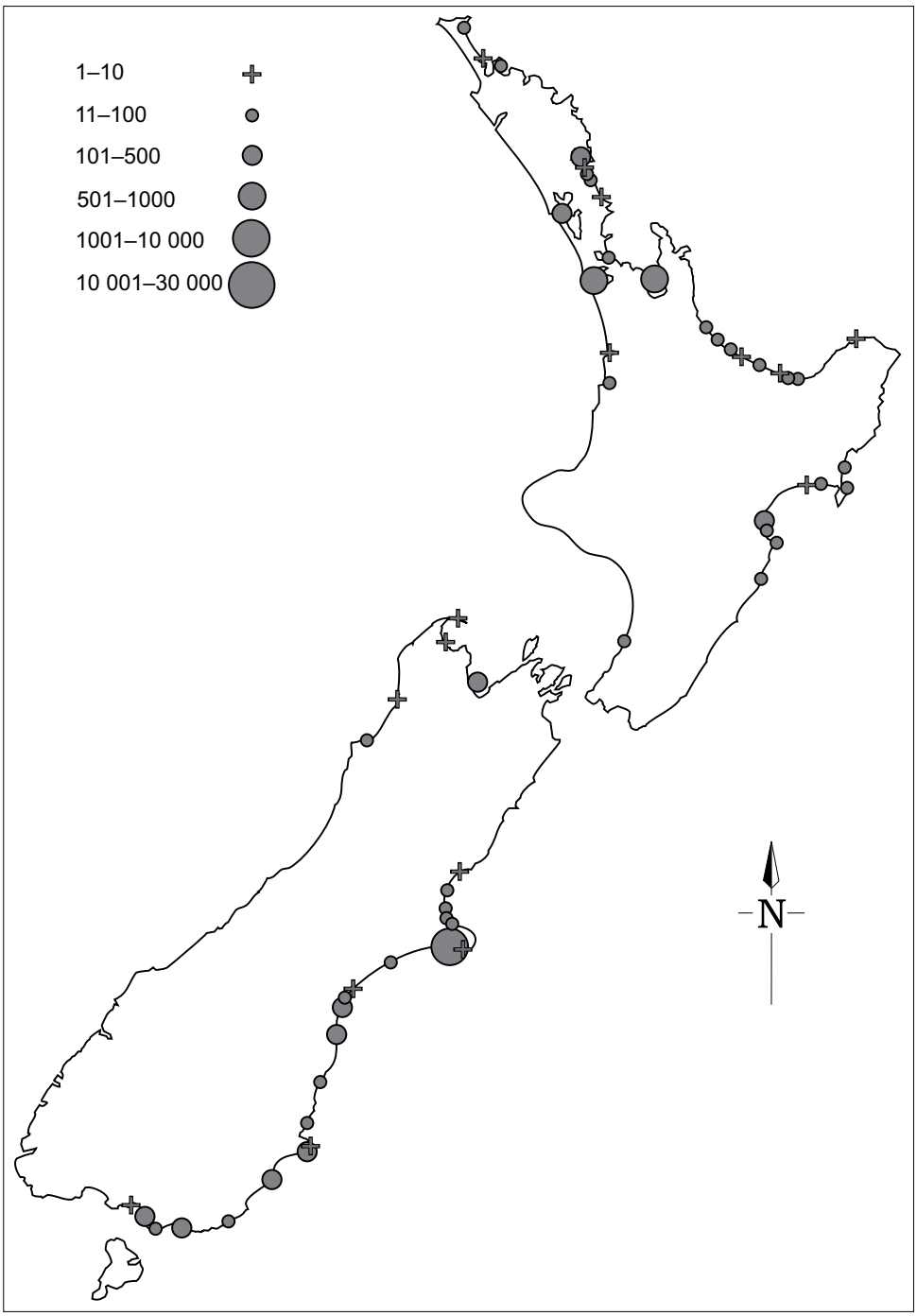


Figure 6. The distribution and abundance of pied stilts (*Himantopus himantopus leucocephalus*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.3.3 Banded dotterel (*Charadrius bicinctus bicinctus*)

Total counts for banded dotterels (*Charadrius bicinctus bicinctus*) ranged from 2759 to 6296 (average 4546) in winter (Table 3; Fig. 7). Numbers have declined substantially since the previous decade (Sagar et al. 1999). A comparison of numbers counted at the same sites during the two periods indicated a decline of 16% between 1984–1994 and 1994–2003 (Table 6). There was some local variation, however, with counts increasing at Lake Ellesmere (Te Waihora) (38%) and Kaipara Harbour (39%) (Table 6). The local declines seem to have been particularly large at Ohiwa Harbour (45%), Farewell Spit (27%) and Parengarenga Harbour (83%) (Table 6). There was also a tendency for overall numbers to have decreased during the count period (Fig. 8).

During summer, 161 to 1371 (average 613) birds remained at the count sites (Table 3; Fig. 9). Seasonal counts showed interesting regional variations around the country (Table 6). The Southland region stood out by having a higher population (231%) at coastal sites during the summer than winter. Generally, however, there was a substantial decrease in numbers during summer, with less than 5% of the winter totals remaining at most sites from Farewell Spit northward. Intermediate numbers remained in the Canterbury (30%) and Hawke's Bay (32%) regions. Those sites at which a larger proportion of birds were counted in summer tended to be close to important inland breeding sites.

TABLE 6. TEN-YEAR AVERAGES OF BANDED DOTTEREL (*Charadrius bicinctus bicinctus*) COUNTS.
Data are presented for New Zealand sites where more than 100 birds on average were counted in winter between 1995 and 2003, or that had comparative data in Sagar et al. (1999) and other counts mentioned in the text. Winter counts are compared with those from the previous decade (Sagar et al. 1999); * = $P < 0.05$. n = the number of counts from which the average was calculated, SEM = standard error.

SITE	SUMMER 1994–2003			WINTER 1995–2003			WINTER 1983–1994		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Lake Ellesmere (Te Waihora)	322	80	8	1225	273	6	887	684	11
Farewell Spit	41	9	10	756	42	9	1030*	311	11
Kaipara Harbour	20	6	10	636	71	9	459	324	9
Manukau Harbour	7	3	10	540	73	9	642	220	11
Kawhia Harbour	1	1	9	331	49	9	347	150	11
Tauranga Harbour	43	40	6	289	95	6	334	276	11
Whangarei Harbour	19	3	10	272	43	9	290	176	11
Ohiwa Harbour	1	1	6	222	45	6	404*	134	11
Parengarenga Harbour	0	0	3	148	7	3	881*	343	8
Aotea Harbour	1	0	9	122	42	9			
Porangahau Estuary	16	2	7	114	14	8			
Firth of Thames	1	1	10	87	20	9			
Hawke's Bay region	39	8	7	121	12	8			
Canterbury region	421	75	8	1412	292	6			
Southland region	450	320	2	195	10	2			

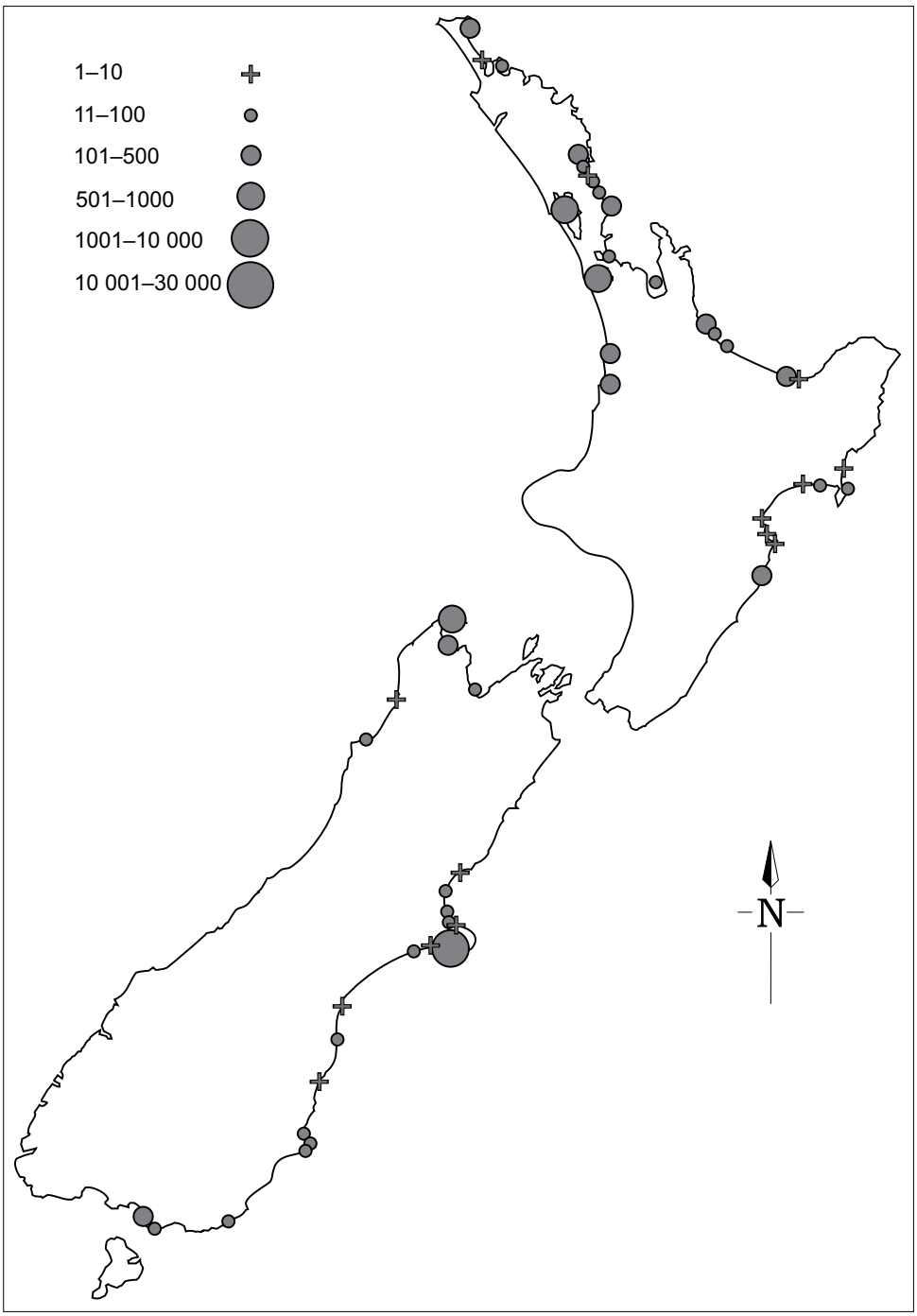


Figure 7. The distribution and abundance of banded dotterels (*Charadrius bicinctus bicinctus*) in New Zealand during winter between 1995 and 2003. Only sites with more than one bird, on average, are shown.

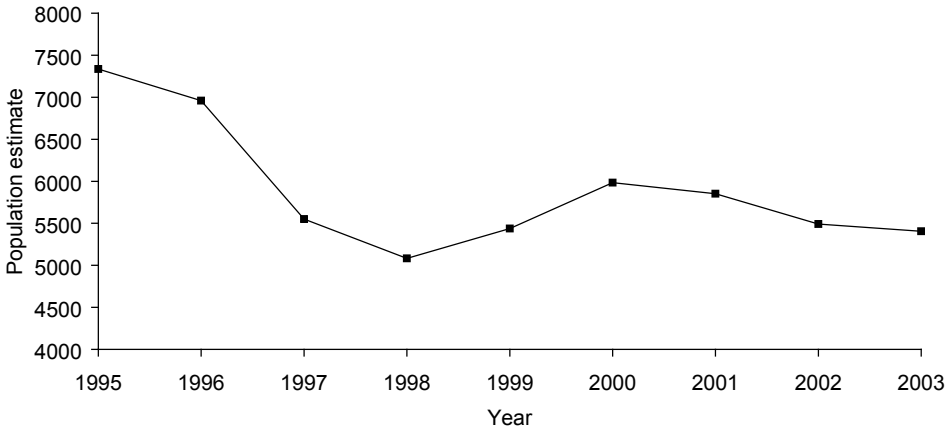


Figure 8. Population estimates for the banded dotterel (*Charadrius bicinctus bicinctus*) in New Zealand during winter between 1995 and 2003.

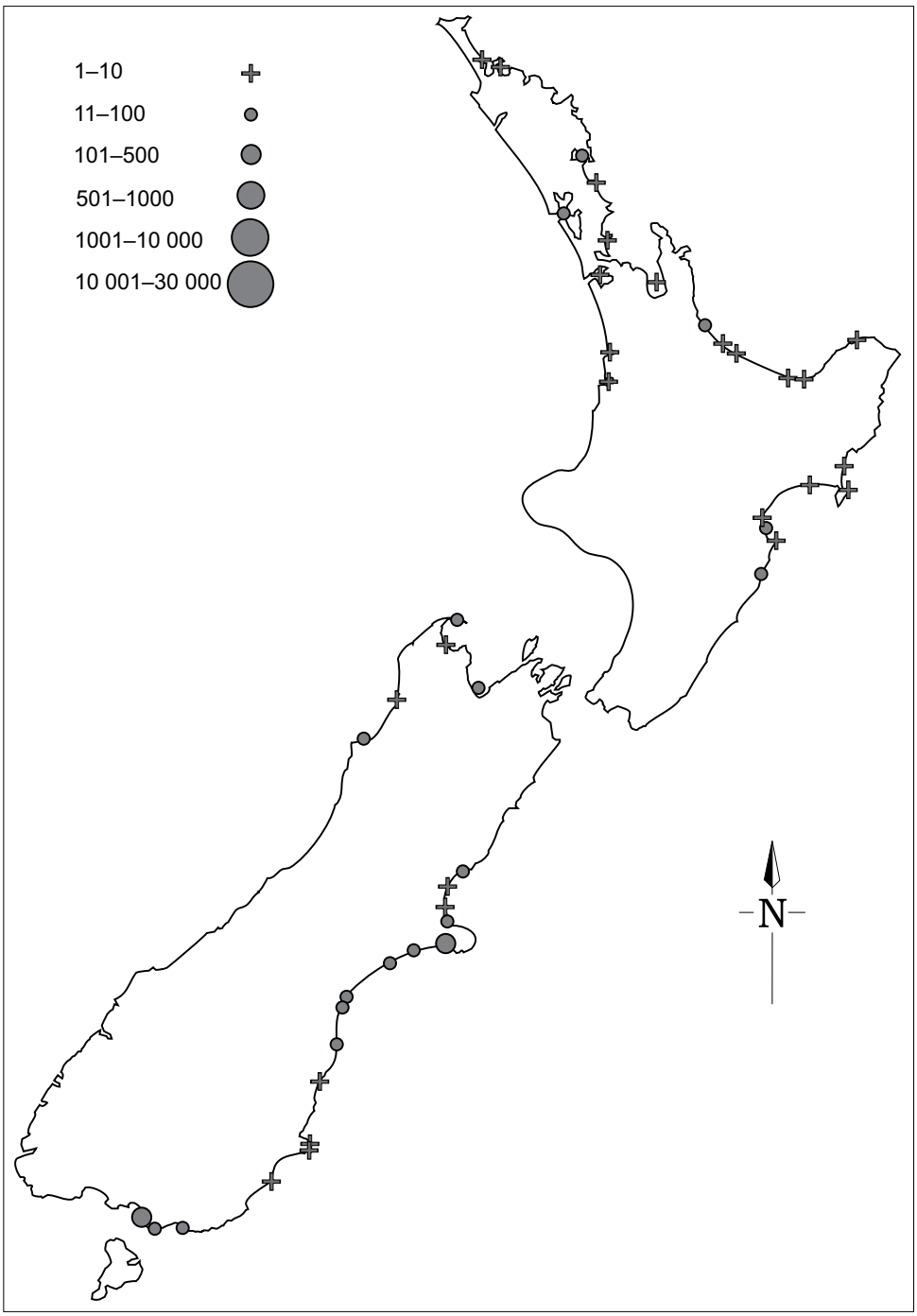


Figure 9. The distribution and abundance of banded dotterels (*Charadrius bicinctus bicinctus*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.3.4 Wrybill (*Anarhynchus frontalis*)

At their winter peak, numbers of wrybills (*Anarhynchus frontalis*) varied from 3459 to 5732 (average 4481) (Table 3; Fig. 10). This considerably exceeds the numbers that were counted in the previous decade (Sagar et al. 1999), and comparison of counts from the same sites suggests a 30% increase. As in previous counts, most wrybills (84%) are found at just two sites, Manukau Harbour and the Firth of Thames, but the pattern of distribution has changed. While the number of birds occurring in the Firth of Thames has remained stable (unlike the general population trend), there has been an increase in the number occurring at Manukau Harbour (Table 7; Fig. 11), continuing the trend noted by Veitch & Habraken (1999). Since 2000, there have been more wrybills at Manukau Harbour than the Firth of Thames (Fig. 11). Numbers on the Waitemata Harbour have increased, but it is possible that it is being used, in part, as a roosting site for birds from Manukau Harbour (Riegen & Dowding 2003). Smaller populations appear to have declined at Whangarei Harbour but increased at Kaipara Harbour. Few other sites were used in winter, but some isolated sites such as the Muriwai Lagoons, Porangahau Estuary and Tasman Bay are consistently used by small numbers of wrybills, while stragglers at other sites are rare.

In summer, only about 5% of the winter totals remained; between 57 and 459 (average 177) birds were found (Table 3), mostly at the main wintering sites (Table 7). At Lake Ellesmere (Te Waihora), however, the summer population increased beyond the winter total (Table 7).

TABLE 7. TEN-YEAR AVERAGES OF WRYBILL (*Anarhynchus frontalis*) COUNTS.

Data are presented for New Zealand sites where more than 30 birds on average were counted in winter between 1995 and 2003, or that had comparative data in Sagar et al. (1999) and other counts mentioned in the text. Winter counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM=standard error.

SITE	SUMMER 1994–2003			WINTER 1995–2003			WINTER 1983–1994		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Firth of Thames	54	10	10	2072	171	9	1958	201	11
Manukau Harbour	17	2	10	1925	239	9	1171*	53	11
Parengarenga Harbour	0	0	2	192	40	3	137	20	7
Kaipara Harbour	43	21	10	157	18	9	115*	20	11
Waitemata Harbour	0	0	4	131	96	4	14*	3	6
Whangarei Harbour	6	5	10	81	15	9	136*	27	11
Porangahau Estuary	3	3	7	68	18	8	56	5	9
Muriwai Lagoons	1	1	5	38	8	5			
Tasman Bay	0	0	8	37	5	8	13*	5	6
Houhora Harbour	0	0	2	15	10	3	34*	10	6
Lake Ellesmere (Te Waihora)	39	17	8	1	1	6			

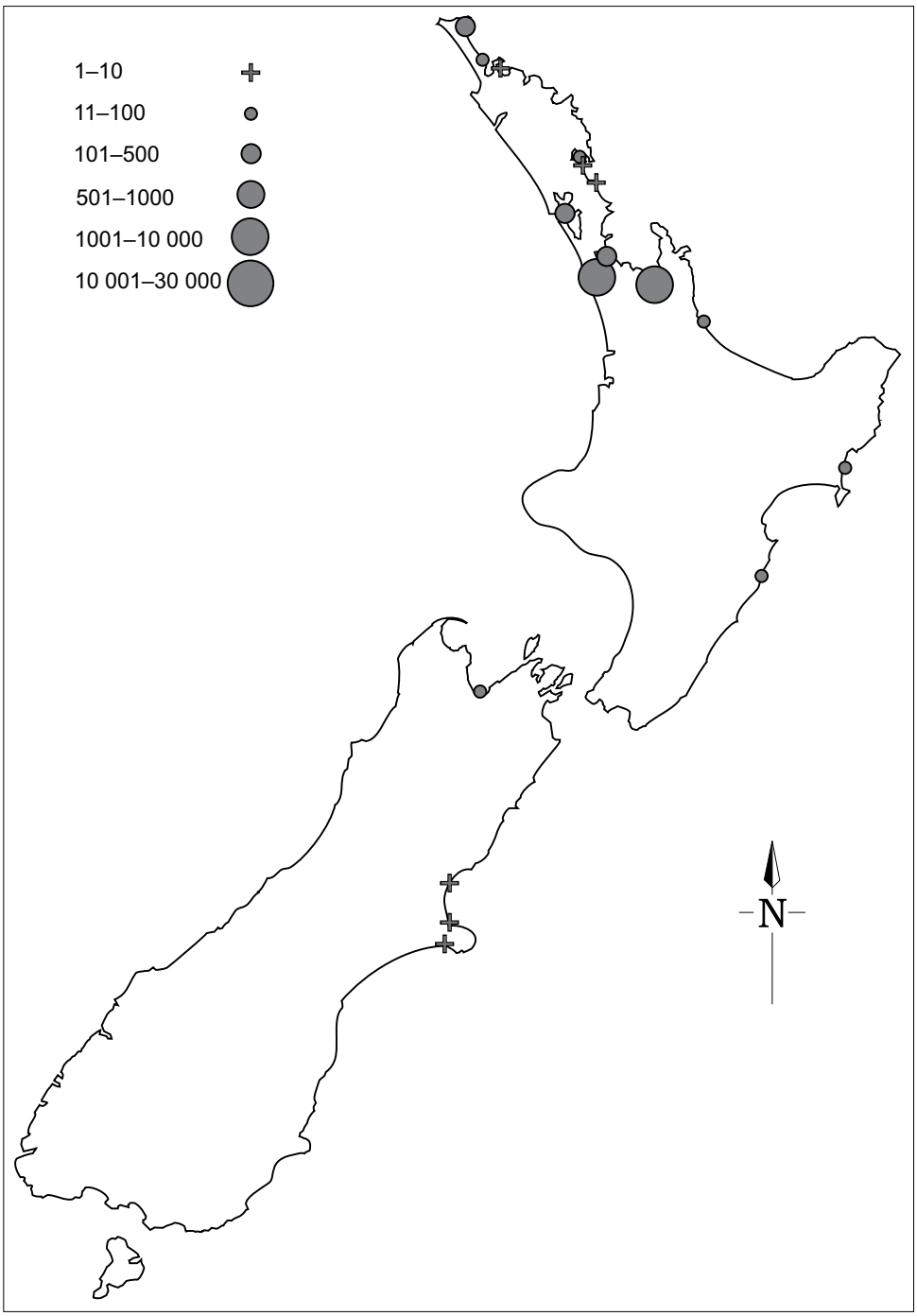


Figure 10. The distribution and abundance of wrybills (*Anarhynchus frontalis*) in New Zealand during winter between 1995 and 2003. Only sites with more than one bird, on average, are shown.

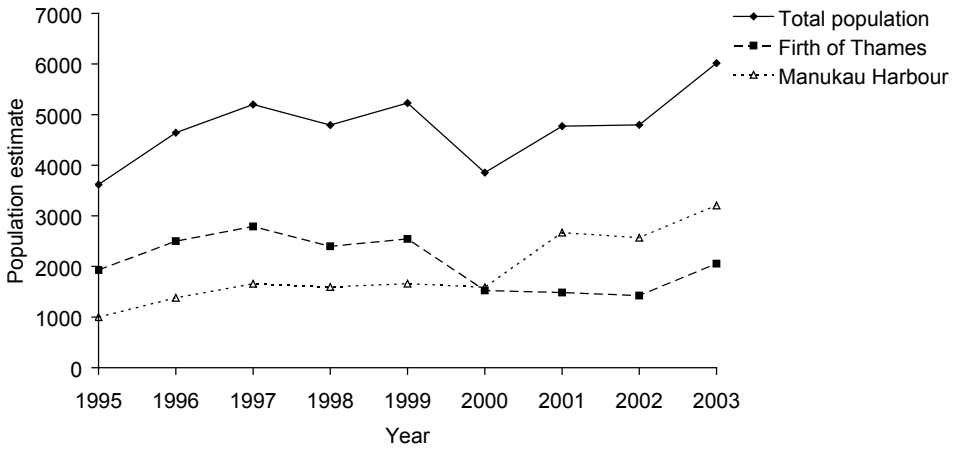


Figure 11. Population estimates for the wrybill (*Anarhynchus frontalis*) in New Zealand during winter between 1995 and 2003. Overall population estimates and counts for the Firth of Thames and Manukau Harbour are shown.

3.3.5 Variable oystercatcher (*Haematopus unicolor*)

Winter counts of variable oystercatchers (*Haematopus unicolor*) averaged 1328 birds (Table 3; Fig. 12). Summer counts were only a little lower, averaging 1009 birds, suggesting that seasonal movements are quite local. The total population estimate is similar to that from 1984–1994, but the comparison of specific sites shows that there has been a 42% increase overall (Table 8). This continues the trend reported by Sagar et al. (1999). At physically larger sites such as Tasman Bay and Ohiwa Harbour, numbers have increased further, whereas at many of the more important smaller sites, numbers have remained at similar levels or even declined (Table 8). Further investigation has suggested, however, that the populations at these smaller sites may have also increased but then spread into adjacent sites. For instance, near Waipu there are now substantial additional populations at Whangarei Harbour and Ruakaka Estuary. There are also further large populations that were not identified by Sagar et al. (1999), which may have increased in the intervening period (Table 8).

TABLE 8. TEN-YEAR AVERAGES OF VARIABLE OYSTERCATCHER (*Haematopus unicolor*) COUNTS.
Data are presented for New Zealand sites where more than 50 birds on average were counted in winter between 1995 and 2003, or that had comparative data in Sagar et al. (1999) and other counts mentioned in the text. Winter counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM=standard error.

SITE	SUMMER 1994–2003			WINTER 1995–2003			WINTER 1983–1994		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Tasman Bay	282	33	10	261	51	8	80*	19	11
Ohiwa Harbour	68	22	6	179	36	6	82*	41	11
Houhora Harbour	24	15	2	123	50	3			
Waipu Cove	97	11	10	112	23	9	126	32	11
Parengarenga Harbour	36	12	2	108	42	3			
Mangawhai Harbour	85	17	6	89	13	6	100	23	5
Farewell Spit	49	8	10	89	12	9	60*	17	11
Ruakaka Estuary	57	10	10	88	19	9			
Tauranga Harbour	83	36	6	68	8	6	74	19	11
Estuary of the Heathcote and Avon Rivers/Ihutai	23	4	8	65	9	6			
Whangarei Harbour	56	18	10	63	11	9			
South Otago	61	0	1	63	0	1			
Golden Bay	53	12	10	59	8	8			
Omaha	46	9	3	55	0	1			
Karamea Estuary	39	0	1	55	0	1			
Rangaunu Harbour	15	9	2	54	12	3			
Oraka Beach/Mahia Peninsula	28	37	2	52	6	3			
Little Waihi Estuary	32	13	6	28	9	6	60*	30	11

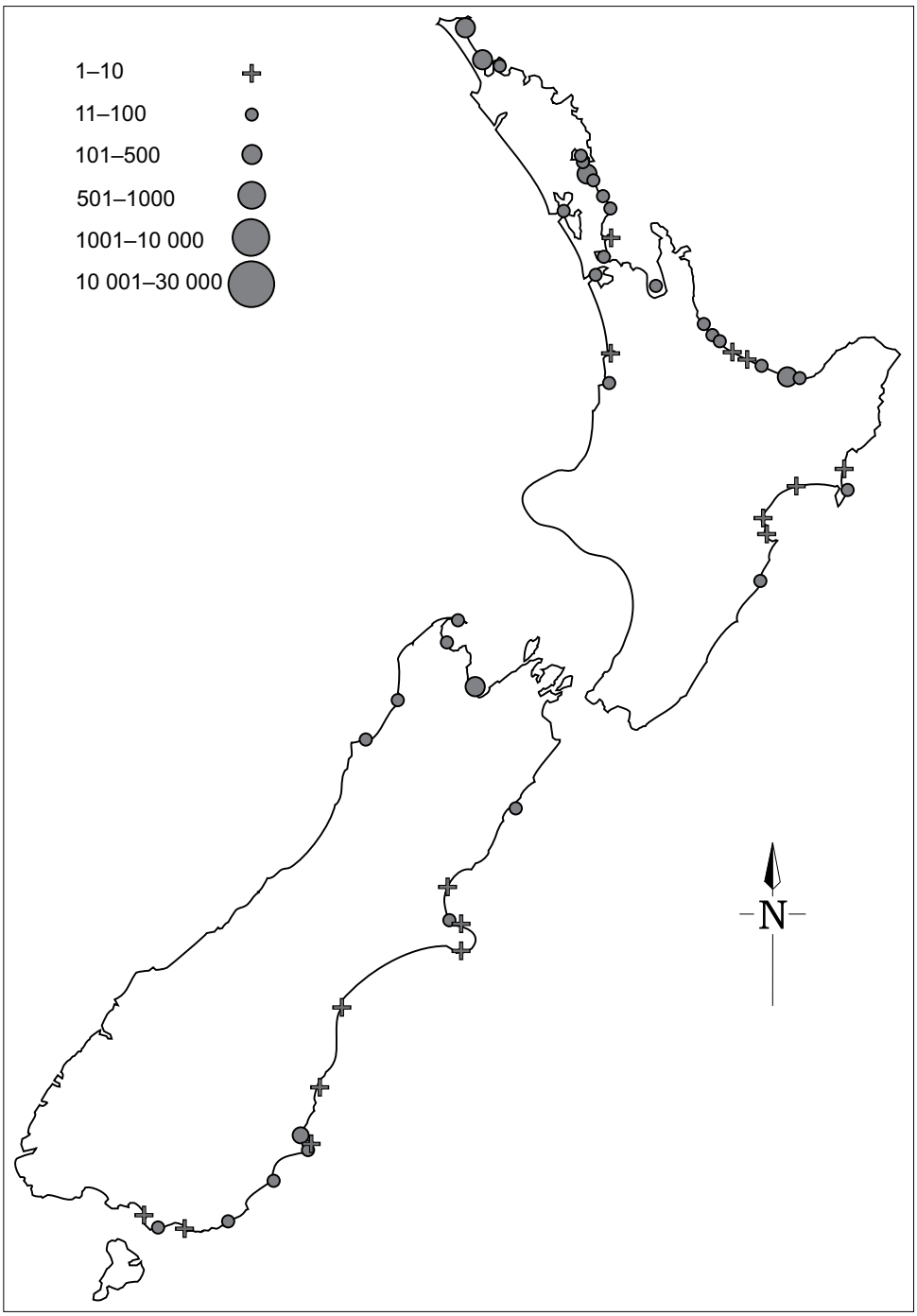


Figure 12. The distribution and abundance of variable oystercatchers (*Haematopus unicolor*) in New Zealand during winter between 1995 and 2003. Only sites with more than one bird, on average, are shown.

3.3.6 Spur-winged plover (*Vanellus miles novaehollandiae*)

Counts of spur-winged plovers (*Vanellus miles novaehollandiae*) were higher in winter, when 571–2216 birds were counted; however, the decrease during summer was not large, with 492–802 individuals counted (Table 3). This suggests that populations were largely resident, with little movement to the coast. This species tends to use inland habitats even after breeding and, as noted by Sagar et al. (1999), is not well monitored by these counts.

The spread of spur-winged plovers following their initial colonisation of New Zealand in 1932 (Heather & Robertson 2000) has continued. There are now significant populations occurring further north than was recorded up to 1994 (Table 9), including the Firth of Thames, Manukau Harbour and Kaipara Harbour.

TABLE 9. TEN-YEAR AVERAGES OF SPUR-WINGED PLOVER (*Vanellus miles novaehollandiae*) COUNTS.
Data are presented for New Zealand sites where more than 100 birds on average were counted in winter between 1995 and 2003, or that had comparative data in Sagar et al. (1999) and other counts mentioned in the text. Winter counts are compared with those from the previous decade (Sagar et al. 1999); * = $P < 0.05$. *n* = the number of counts from which the average was calculated, SEM = standard error.

SITE	SUMMER 1994–2003			WINTER 1995–2003			WINTER 1983–1994		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Firth of Thames	121	20	10	229	20	9			
Manukau Harbour	120	20	10	187	39	9			
Whakaki Lagoon	9	9	5	150	98	5	135	42	5
Kaipara Harbour	84	16	10	131	28	9			
Whangarei Harbour	22	7	10	32	7	9			
Porangahau Estuary	9	4	7	29	1	8	54*	30	11

3.3.7 New Zealand dotterel (*Charadrius obscurus*)

New Zealand dotterels (*Charadrius obscurus*) have two disjunct populations that are now known to be taxonomically distinct (Dowding 1994) and quite different ecologically (Dowding & Murphy 2001). While the two forms were not differentiated in these counts, banding records have shown that some southern New Zealand dotterels (*C. o. obscurus*) reach as far north as Farewell Spit, while northern New Zealand dotterels (*C. o. aquilonius*) have only been recorded in the North Island (Dowding & Moore 2004). It has been assumed here that South Island records refer to the southern taxon and North Island records to the northern taxon.

Between 228 and 433 (average 318) northern New Zealand dotterels were counted annually each winter between 1994 and 2004 (Table 3; Fig. 13); summer counts were a little lower, ranging from 128 to 279 (average 227) (Table 3). No counts were returned from some of the important sites that were identified by Sagar et al. (1999), but comparable counts from specific sites in 1984–1994 showed that overall numbers have increased by 10%, although this increase has not been uniform across all sites (Table 10). Populations at Mangawhai and Kaipara Harbours have increased, while those at Tauranga and Ohiwa Harbours appear to have declined. An overall increase is further suggested by significant winter counts at sites that were not listed by Sagar et al. (1999).

Southern New Zealand dotterels now breed only on Stewart Island/Rakiura. One of their regular wintering flocks is at Awarua Bay in Southland (Dowding & Moore 2004), where an average of 24 birds was counted in two seasons, 1996 and 1997 (Table 3; Fig. 13). These winter counts are similar to the average counts from the previous decade (Table 10). In summer, two birds were found at Awarua Bay in November 1996 and eight birds were found in February 1996, although the latter may have included the start of the post-breeding flock. Away from Southland, there was a single bird at Wainono Lagoon (Lake Ki-Wainono) in November 1994 and single birds at Farewell Spit during each count from November 2001 to June 2003.

TABLE 10. TEN-YEAR AVERAGES OF NEW ZEALAND DOTTEREL (*Charadrius obscurus*) COUNTS.
Data are presented for New Zealand sites where more than 20 birds on average were counted in winter between 1995 and 2003, or that had comparative data in Sagar et al. (1999) and other counts mentioned in the text. Winter counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM=standard error.

SITE	SUMMER 1994–2003			WINTER 1995–2003			WINTER 1983–1994		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Mangawhai Harbour	60	12	6	73	15	6	38*	4	11
Kaipara Harbour	35	4	9	64	10	9	32*	2	9
Omaha	14	3	3	36	0	1	32	2	11
Waipu Cove	29	5	9	30	5	9			
Manukau Harbour	27	3	9	30	3	9			
Firth of Thames	16	2	9	29	15	9			
Ohiwa Harbour	10	2	6	28	4	6	51*	8	11
Houhora Harbour	28	4	2	24	24	3			
Awarua Bay	5	3	2	24	4	2			
Rangaunu Harbour	9	9	2	23	23	3	33	4	5
Parengarenga Harbour	1	1	2	23	6	3			
Whangarei Harbour	10	6	9	22	4	9			
Tauranga Harbour	15	7	6	13	4	6	29*	4	11
Ruakaka Estuary	7	1	10	11	4	10			

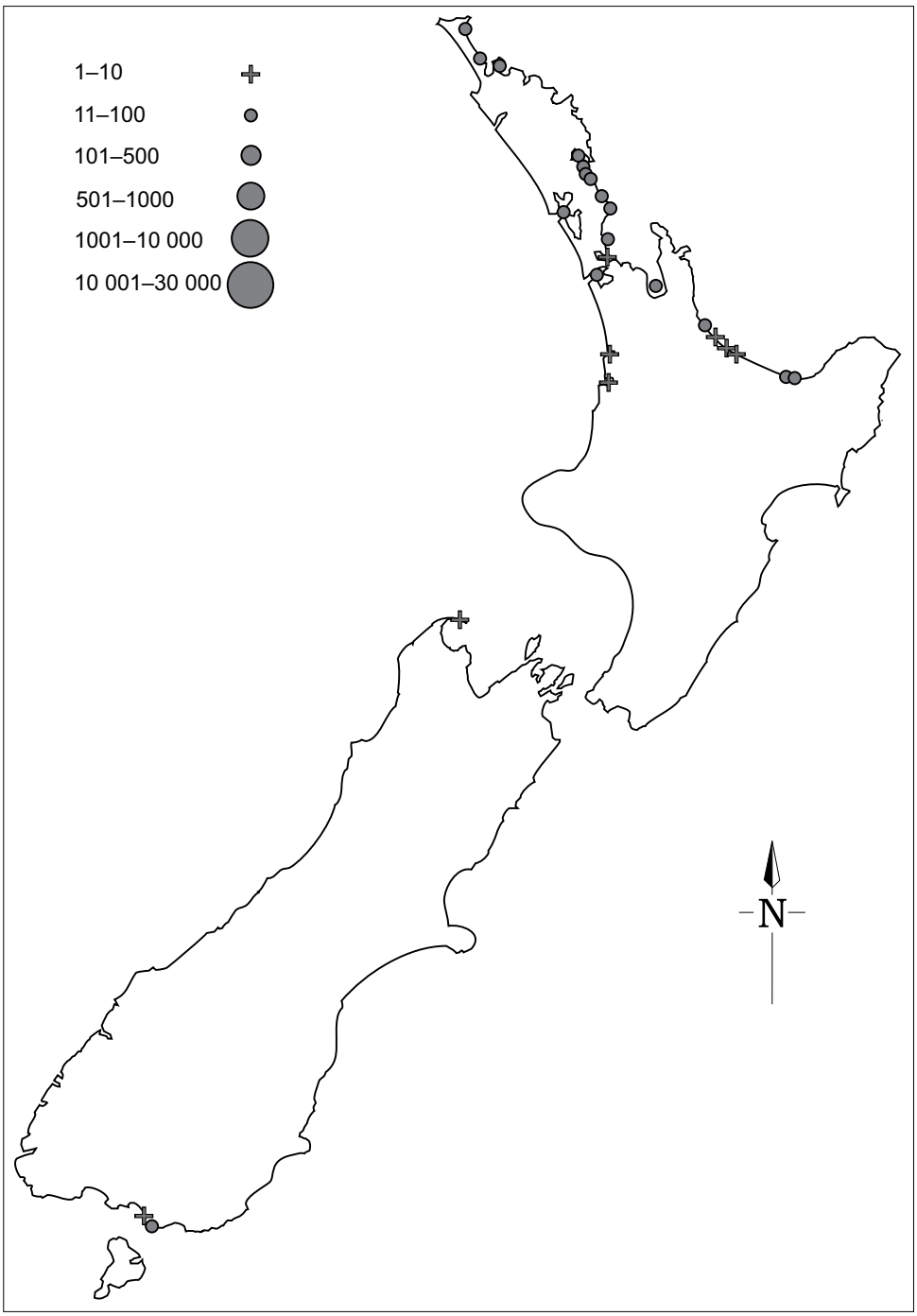


Figure 13. The distribution and abundance of New Zealand dotterels (*Charadrius obscurus*) in New Zealand during winter between 1995 and 2003. Only sites with more than one bird, on average, are shown.

3.3.8 Black-fronted dotterel (*Charadrius melanops*)

Between 0 and 214 (average 60) black-fronted dotterels (*Charadrius melanops*) were counted in winter, and 1–17 (average 8) were counted in summer (Table 3). Few of the important sites identified by Sagar et al. (1999) were monitored during 1994–2003; consequently, it is hard to assess changes. However, there appears to have been a large increase of 195% (Table 11). This is mostly due to increased numbers at Ahuriri Estuary, where average counts have risen substantially. At the other two sites that were surveyed again—Washdyke Lagoon and Matata Lagoon—there were declines in the average numbers counted. In addition, up to four birds have been recorded in summer at Manukau Harbour since 2000 and eight birds were seen there in winter 2003. Black-fronted dotterels are primarily freshwater, wetland birds, and only a very small proportion of their total population (which is estimated at 17 000 individuals; Heather & Robertson 2000) was counted.

TABLE 11. TEN-YEAR AVERAGES OF BLACK-FRONTED DOTTEREL (*Charadrius melanops*) COUNTS.
Data are presented for New Zealand sites where more than 1 bird on average was counted in winter between 1995 and 2003, or that had comparative data in Sagar et al. (1999) and other counts mentioned in the text. Winter counts are compared with those from the previous decade (Sagar et al. 1999); * = $P < 0.05$. *n* = the number of counts from which the average was calculated, SEM = standard error.

SITE	SUMMER 1994–2003			WINTER 1995–2003			WINTER 1983–1994		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Ahuriri Estuary	7	2	8	61	25	8	9*	5	11
Washdyke Lagoon	1	1	4	3	2	6	8*	4	8
Matata Lagoon	0	0	6	1	0	6	5	0	1
Manukau Harbour	1	1	10	1	0	9			

3.3.9 Black stilt (*Himantopus novaezelandiae*) and hybrids

There has been long-term confusion about the classification of black stilts (*Himantopus novaezelandiae*) and their hybrids with pied stilts. However, the identity of intermediate-plumaged ('smudgy') birds was clarified by Pierce (1984), who described and illustrated both hybrids and maturing black stilts. Therefore, count results had two categories: 'black stilt' and 'black stilt/hybrid'. In spite of this, different regions tended to use one or the other to tally their birds. Since observers in different regions were probably not consistent with their allocations, I have combined both counts for the purpose of these analyses, even though this means that detail has been obscured.

Annual winter counts varied from 10 to 32 birds, with an average of 21 (Table 3; Fig. 14). This reflects an overall increase from the average of 15 that can be calculated for the 1984–1994 period if counters were categorising birds in a similar way each time. In summer, the numbers of birds remaining at the wintering sites were much lower, with birds being seen most consistently in Canterbury (Table 12), where all individuals were classified as 'black stilt/ hybrid' rather than 'black stilt'.

TABLE 12. TEN-YEAR AVERAGES OF BLACK STILT (*Himantopus novaezelandiae*) COUNTS.

Data are presented for New Zealand sites where more than one bird on average was counted in winter between 1994 and 2003. *n* = the number of counts from which the average was calculated, SEM = standard error.

SITE	SUMMER 1994–2003			WINTER 1995–2003		
	COUNT	SEM	*n*	COUNT	SEM	*n*
Kawhia Harbour	0	0	9	7	1	9
Manukau Harbour	0	0	10	6	1	9
Canterbury region	2	1	8	3	0	6
Kaipara Harbour	1	0	10	1	0	9
Bay of Plenty region	0	0	6	1	0	6

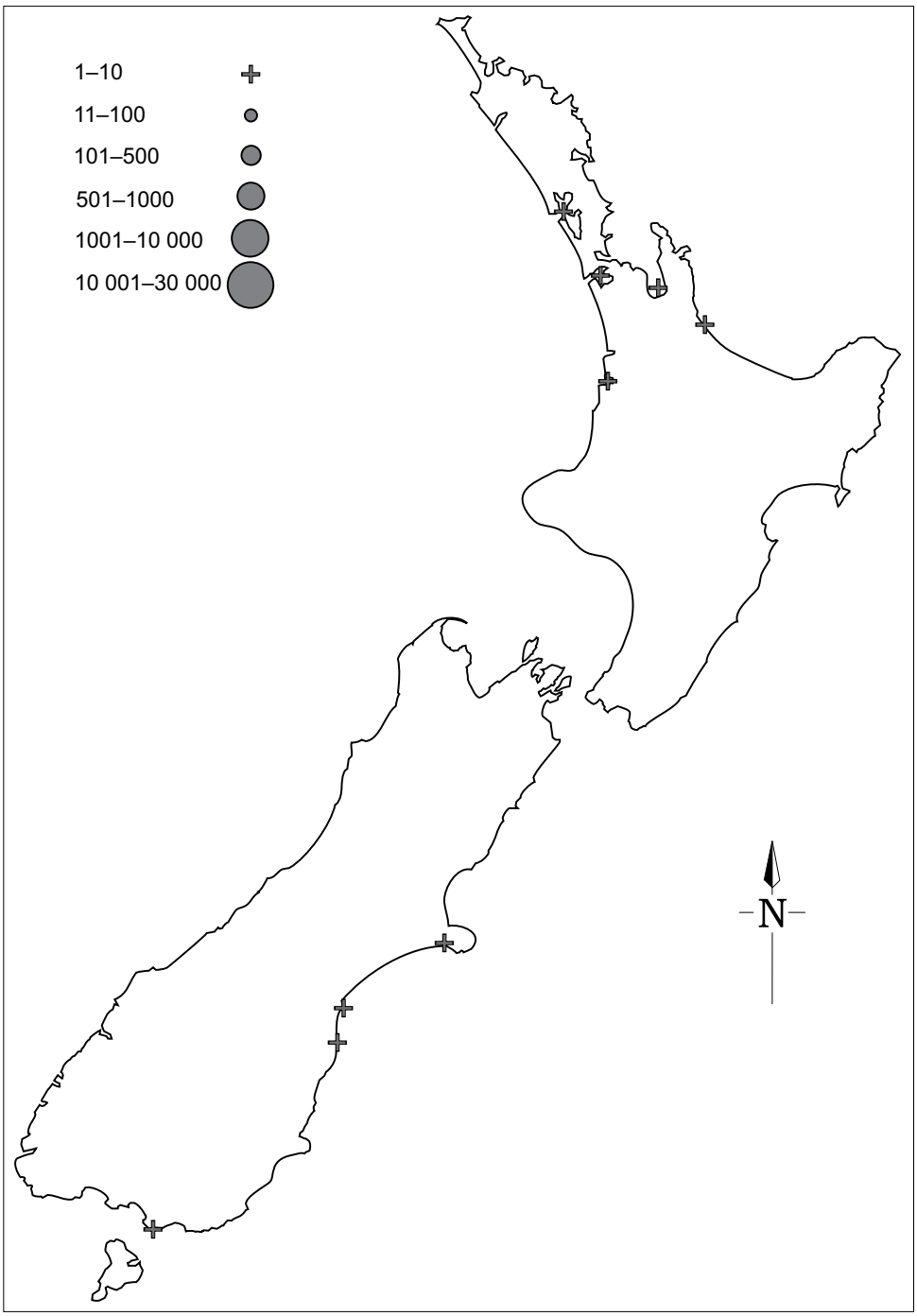


Figure 14. The distribution and abundance of black stilts (*Himantopus novaezelandiae*) and hybrids in New Zealand during winter between 1995 and 2003. Only sites with more than one bird, on average, are shown.

TABLE 13. SUMMARY OF COUNTS AND POPULATION ESTIMATES OF ARCTIC MIGRANTS IN NEW ZEALAND BETWEEN NOVEMBER 1994 AND JUNE 2003.
Population estimates were derived from the summer counts and cover only those sites from which at least one count was returned (SEM = standard error of the mean). Population estimates for 1983–1994 are from Sagar et al. (1999).

SPECIES	MEASURE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	MEAN	SEM	ESTIMATE 1983–1994
Eastern bar-tailed godwit	Winter count		5807	8073	10051	7734	11604	8510	8658	4426	5796	7851	747	
	Summer count	100938	82492	87274	79618	83563	80083	73813	65867	59528	60652	77383	4046	
	Population estimate	105560	104296	97552	94053	98912	94609	97760	92062	85271	83001	95308	2297	101698
Lesser knot	Winter count		4691	2704	5568	1426	1643	1010	3829	3932	2313	3013	525	
	Summer count	61985	66513	45569	38323	45379	30561	29965	35027	27281	38671	41927	4203	
	Population estimate	63340	68582	47551	47639	54540	39707	39176	45141	37528	49032	49224	3253	58637
Turnstone	Winter count		495	117	158	430	44	241	176	193	165	224	49	
	Summer count	2844	2409	2066	1614	1664	1338	959	1469	1445	1323	1713	179	
	Population estimate	3302	2618	2198	2605	2643	2319	2015	2525	2501	2314	2504	110	5069
Pacific golden plover	Winter count		0	1	1	0	0	4	0	0	2	1	0	
	Summer count	223	73	97	158	234	141	141	125	209	157	156	17	
	Population estimate	231	156	112	207	319	201	233	229	301	229	222	19	649
Red-necked stint	Winter count		14	29	54	8	18	32	3	9	41	23	6	
	Summer count	92	53	135	113	69	100	152	145	137	96	109	10	
	Population estimate	120	137	138	146	180	131	184	184	169	136	153	8	175
Whimbrel	Winter count		18	0	8	0	1	4	11	5	9	6	2	
	Summer count	152	106	36	47	66	45	72	75	54	51	70	11	
	Population estimate	152	114	39	64	83	68	100	103	82	74	88	10	117
Curlew sandpiper	Winter count		20	0	1	0	0	2	1	4	6	4	2	
	Summer count	63	49	49	24	5	20	14	24	21	8	28	6	
	Population estimate	64	63	50	33	27	30	24	34	31	18	37	5	86
Sharp-tailed sandpiper	Winter count		0	0	12	0	0	0	0	0	0	1	1	
	Summer count	34	10	16	12	9	8	9	37	24	17	18	3	
	Population estimate	35	17	18	18	20	15	16	45	31	25	24	3	81
Eastern curlew	Winter count		24	3	3	1	2	1	1	3	3	5	2	
	Summer count	17	25	28	18	15	16	12	21	11	19	18	2	
	Population estimate	20	31	30	26	25	24	22	31	21	27	26	1	34
Pectoral sandpiper	Winter count		0	0	0	0	0	0	0	0	0	0	0	
	Summer count	5	0	5	1	5	3	3	16	8	8	5	1	
	Population estimate	5	6	6	2	11	4	4	18	9	10	8	1	

3.4 ARCTIC MIGRANTS

Counts and population estimates for each Arctic migrant species are summarised in Table 13.

3.4.1 Eastern bar-tailed godwit (*Limosa lapponica baueri*)

In summer, between 59 528 and 100 938 eastern bar-tailed godwits (*Limosa lapponica baueri*) were counted (Table 13; Fig. 15), making them the most common of the Arctic migrant waders in New Zealand. This wide range in count totals between years is due largely to a lack of counts from some important sites in some years. Including estimates for the uncounted sites gives a total population estimate of 83 001–105 560 birds (Table 13). Average numbers at specific sites in 1984–1994 (Sagar et al. 1999) and 1994–2003 were very similar (Table 14), with a small increase of 9% overall. There was, however, a tendency for the population estimates to decline throughout the period 1993–2003 (Fig. 16).

In winter, numbers of eastern bar-tailed godwits decreased to between 4426 and 11 604 birds (Table 13), about 9% of the summer totals. This proportion was fairly consistent across all sites (Table 14; Fig. 17).

TABLE 14. TEN-YEAR AVERAGES OF EASTERN BAR-TAILED GODWIT (*Limosa lapponica baueri*) COUNTS.
Data are presented for New Zealand sites where more than 2000 birds on average were counted in summer between 1994 and 2003. Summer counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM=standard error.

SITE	WINTER 1995–2003			SUMMER 1994–2003			SUMMER 1983–1993		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Kaipara Harbour	1208	229	9	16 883	941	10	10 381*	1068	9
Manukau Harbour	2050	327	9	16 859	1674	10	15 534	1246	11
Farewell Spit	1676	941	8	11 402	1690	10	13 557*	796	11
Firth of Thames	763	114	9	7979	784	10	6479*	806	11
Tauranga Harbour	421	73	6	4859	421	6	5105	252	11
Ohiwa Harbour	360	61	6	4017	353	6	3952	166	11
Tasman Bay	329	100	8	3880	487	8			
Kawhia Harbour	280	63	9	3850	435	9	3693	265	11
Parengarenga Harbour	449	249	2	3568	2216	3	3717	480	9
Rangaunu Harbour	97	97	2	3750	250	3	3975	879	6
Whangarei Harbour	307	29	9	3043	374	10	3224	495	10
Houhora Harbour	250	250	2	2567	1723	3			

Figure 15. The distribution and abundance of eastern bar-tailed godwits (*Limosa lapponica baueri*) in New Zealand, during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

Figure 16. Population estimates for the eastern bar-tailed godwit (*Limosa lapponica baueri*) in New Zealand during summer between 1994 and 2003.

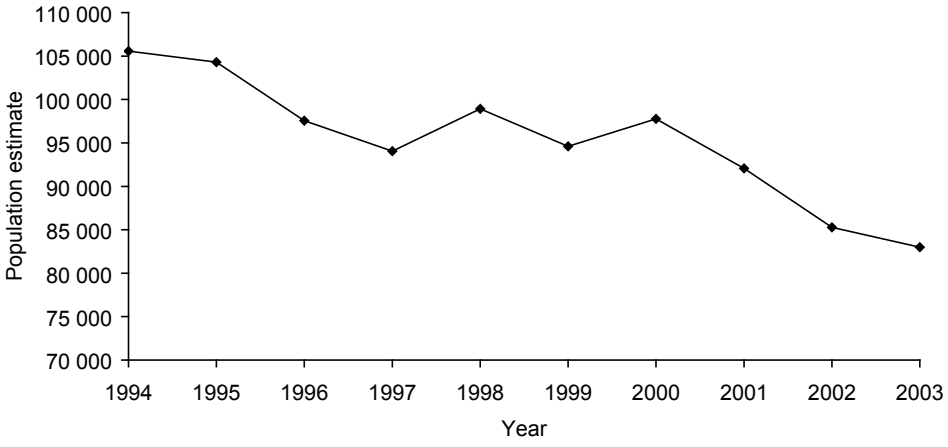
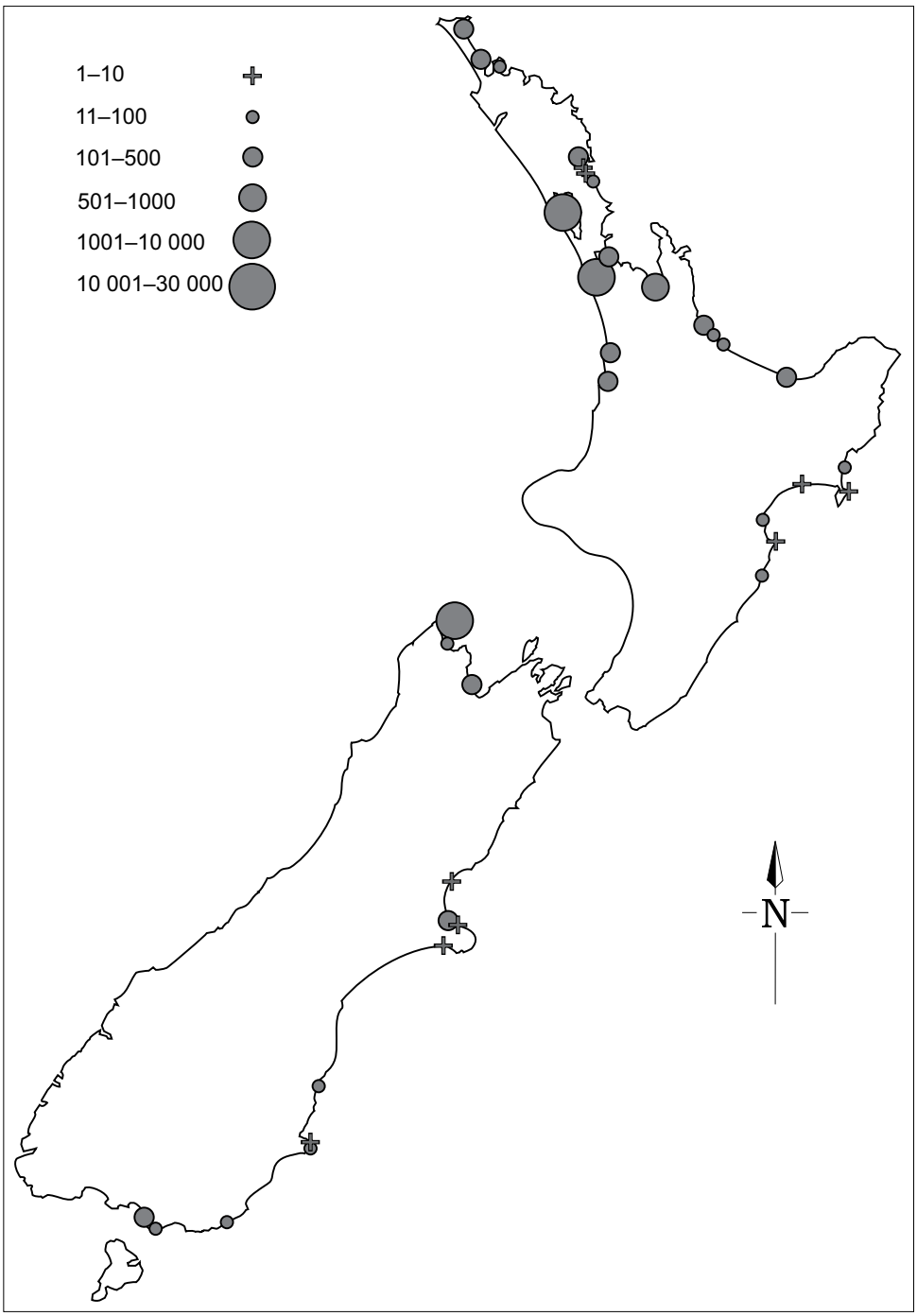


Figure 17. The distribution and abundance of eastern bar-tailed godwits (*Limosa lapponica baueri*) in New Zealand, during winter between 1995 and 2003. Only sites with more than one bird, on average, are shown.



3.4.2 Lesser knot (*Calidris canutus*)

Lesser knots (*Calidris canutus*) were the second most common Arctic migrant in New Zealand, with 27 281–66 513 (average 41 927) individuals being counted in summer, mostly concentrated at a small number of sites (Table 13; Fig. 18). Comparison of average numbers at specific sites with counts from the previous 10 years shows that there has been an overall decline of 14%. There has also been a further decline throughout this study (Table 13; Fig. 19). However, changes were markedly different between sites (Table 15). For example, numbers declined significantly at Manukau Harbour (22%), Whangarei Harbour (21%) and Farewell Spit (47%), but increased at Kaipara Harbour (30%) and the Firth of Thames (37%).

Over winter, the numbers of lesser knots fell to between 1010 and 5568 (average 3013). The numbers counted in winter in New Zealand varied from 3% to 15% (average 6%) of the summer population (Table 13), but they were not evenly spread (Fig. 20). The proportion of the summer flock remaining at Manukau Harbour over winter was very high (20% on average); in contrast, only 2%–6% remained elsewhere in New Zealand (Table 15). This means that 56%–94% (average 78%) of the total winter population of lesser knots in New Zealand was found at Manukau Harbour, and when the lower counts were recorded there, the national total was also low. The importance of Manukau Harbour for overwintering lesser knots may have increased, as an average of 60% of the winter flock was present there in the decade before this study (Sagar et al. 1999). However, this difference is not a result of an increase in the numbers of birds at Manukau Harbour, as the average counts there for both winter and summer were actually lower in this study.

TABLE 15. TEN-YEAR AVERAGES OF LESSER KNOT (*Calidris canutus*) COUNTS.

Data are presented for New Zealand sites where more than 1000 birds on average were counted in summer between 1994 and 2003. Summer counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM=standard error.

SITE	WINTER 1994–2003			SUMMER 1995–2003			SUMMER 1983–1993		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Manukau Harbour	2339	489	9	12 522	1658	10	16 083*	1349	11
Kaipara Harbour	60	20	9	10 186	1030	10	7846*	1660	9
Farewell Spit	264	54	8	8220	1282	10	15 538*	1193	11
Firth of Thames	201	95	9	5259	650	10	3848*	271	11
Rangaunu Harbour	0	0	2	4067	1832	3	1839	334	6
Parengarenga Harbour	47	23	2	3200	1616	3	4897	1224	10
Whangarei Harbour	33	17	9	1988	221	10	2528*	367	10
Houhora Harbour	0	0	2	1200	611	3	1876	276	6
Waitemata Harbour	0	0	4	1036	724	4			

Figure 18. The distribution and abundance of lesser knots (*Calidris canutus*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

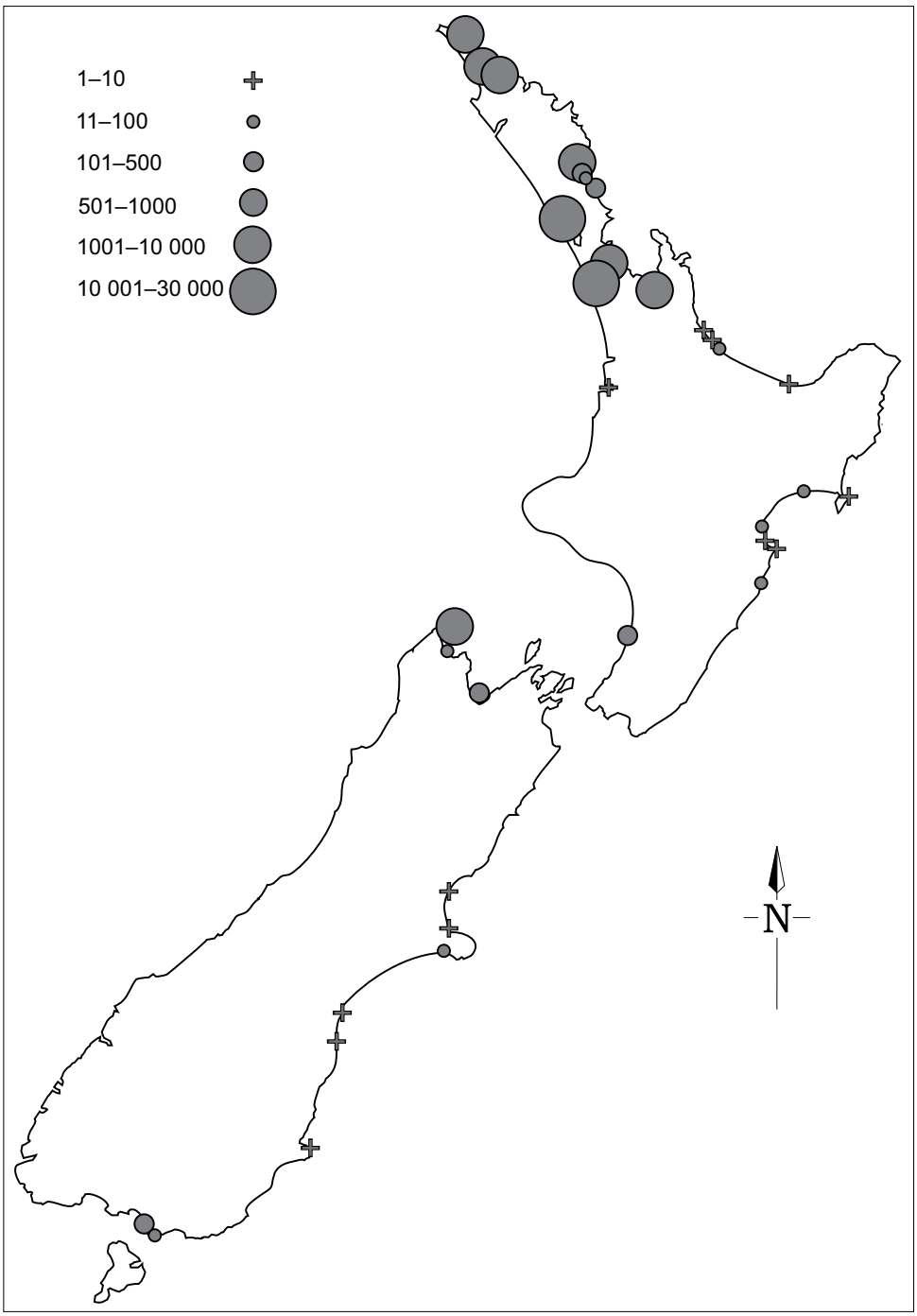


Figure 19. Population estimates for the lesser knot (*Calidris canutus*) in New Zealand during summer between 1994 and 2003.

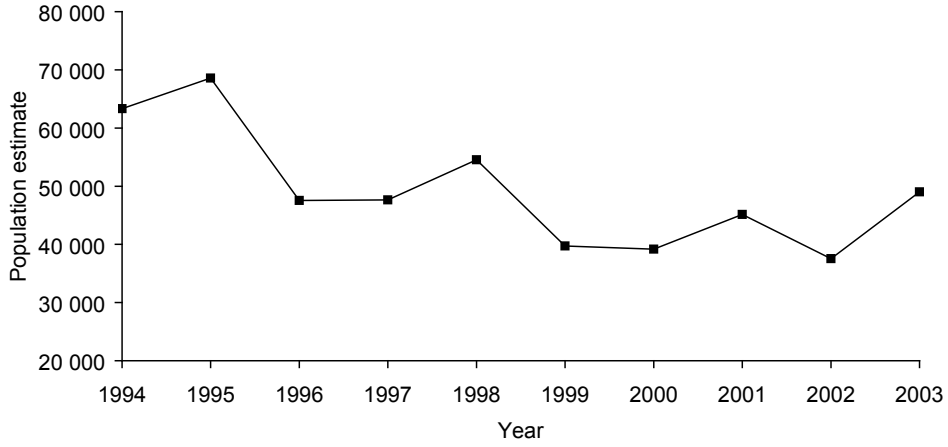
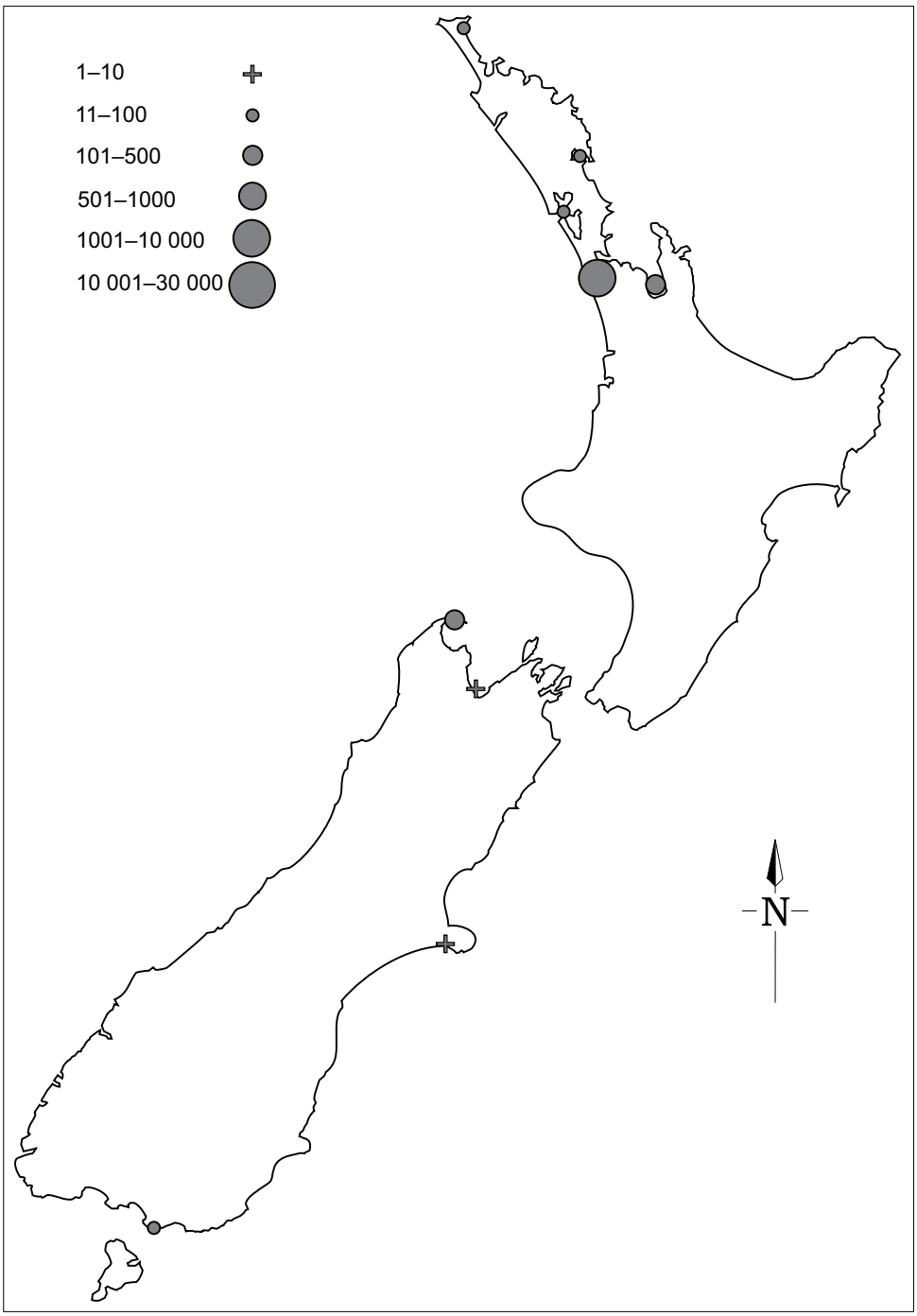


Figure 20. The distribution and abundance of lesser knots (*Calidris canutus*) in New Zealand during winter between 1994 and 2003. Only sites with more than one bird, on average, are shown.



3.4.3 Turnstone (*Arenaria interpres*)

During the period of this study, 959–2844 turnstones (*Arenaria interpres*) were counted in summer (Table 13; Fig. 21). Compared to the previous decade (Sagar et al. 1999), overall counts seem to be well down. However, some very important sites (e.g. Southland region and Parengarenga Harbour) were not counted often. Comparison of those sites that were monitored during both decades indicates a 46% decline in the numbers occurring in New Zealand (Table 16). In addition, there appears to have been a trend of slowly decreasing numbers during 1994–2003 (Fig. 22). Although the low numbers of counts for sites from the Southland and Far North regions do not enable an accurate analysis of changes there, all of the sites showed this trend.

In winter, numbers declined to 44–495 (Table 13; Fig. 23). As noted by Sagar et al. (1999), the number of overwintering turnstones, as a proportion of the numbers present during the previous summer, varied markedly between years. The extremes were 35% in 1998 and 3% in 1999, but the average was 9%. Regionally, the greatest differences were seen at Farewell Spit (16%), which seems to be a favoured site, and the Invercargill Estuary (1%), which is not (Table 16). Unfortunately, few counts were available for Southland, but figures from Sagar et al. (1999) also suggested that there were real regional differences in the seasonal use of sites.

TABLE 16. TEN-YEAR AVERAGES OF TURNSTONE (*Arenaria interpres*) COUNTS.

Data are presented for New Zealand sites where more than 50 birds on average were counted in summer between 1994 and 2003. Summer counts are compared with those from the previous decade (Sagar et al. 1999); * = $P < 0.05$. n = the number of counts from which the average was calculated, SEM = standard error.

SITE	WINTER 1995–2003			SUMMER 1994–2003			SUMMER 1983–1993		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Farewell Spit	88	11	8	564	61	10	846*	106	11
Kaipara Harbour	47	12	9	401	58	10	423	67	9
Manukau Harbour	30	6	9	278	41	10	427*	62	11
Rangaunu Harbour	7	7	2	281	177	3	256	67	6
Invercargill Estuary	2	2	2	265	101	2	574	79	10
Parengarenga Harbour	18	11	2	167	84	3	915*	164	8
Awarua Bay	5	5	2	137	97	2	203	50	11
Tasman Bay	12	4	8	119	31	8	252*	39	11
Houhora Harbour	3	3	2	74	52	3			
Tauranga Harbour	5	3	6	63	22	6	250*	21	11
Firth of Thames	2	2	9	31	4	10	106*	16	11
Fortrose Estuary	0	0	1	19	18	3	75*	12	10

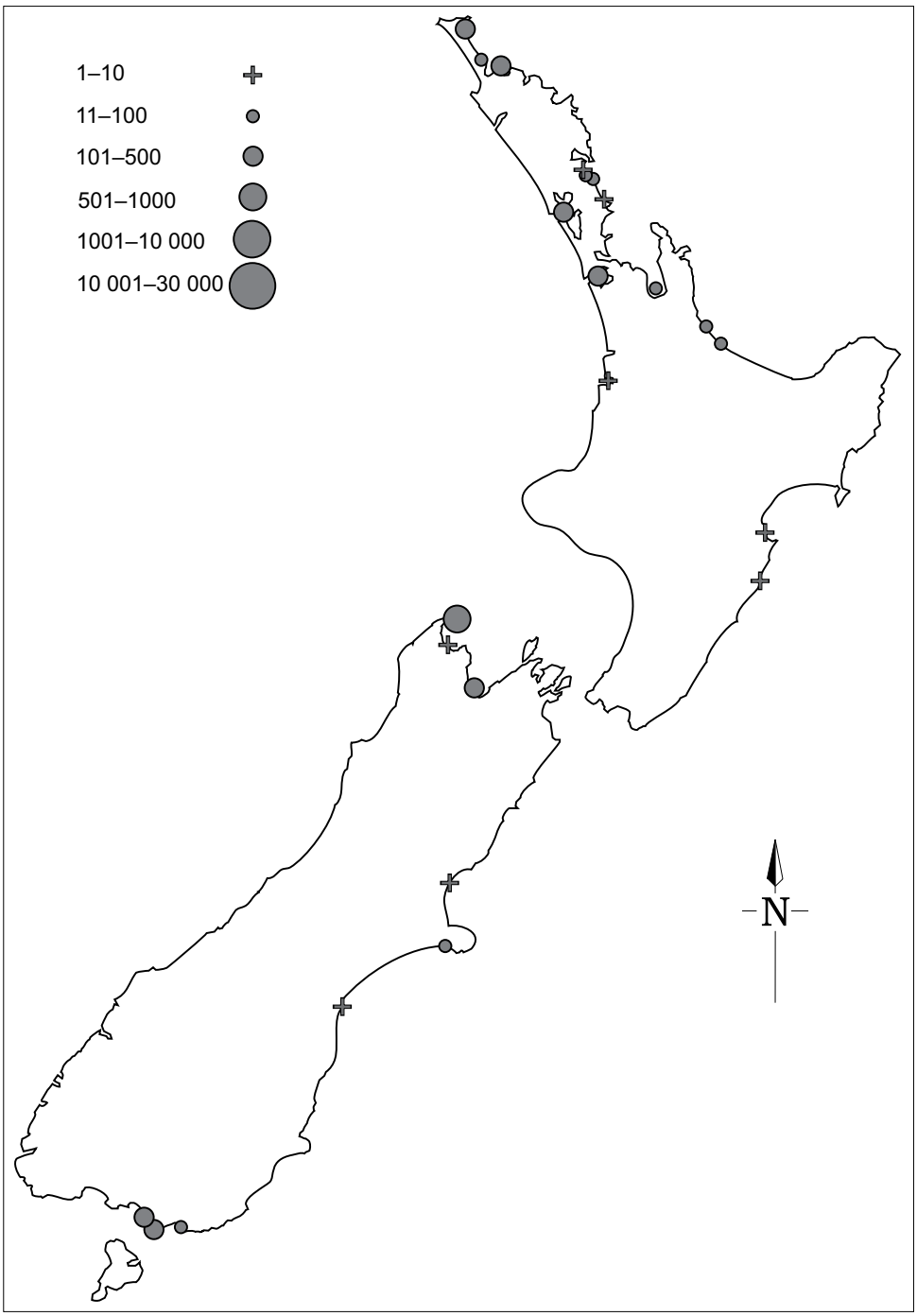


Figure 21. The distribution and abundance of turnstones (*Arenaria interpres*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

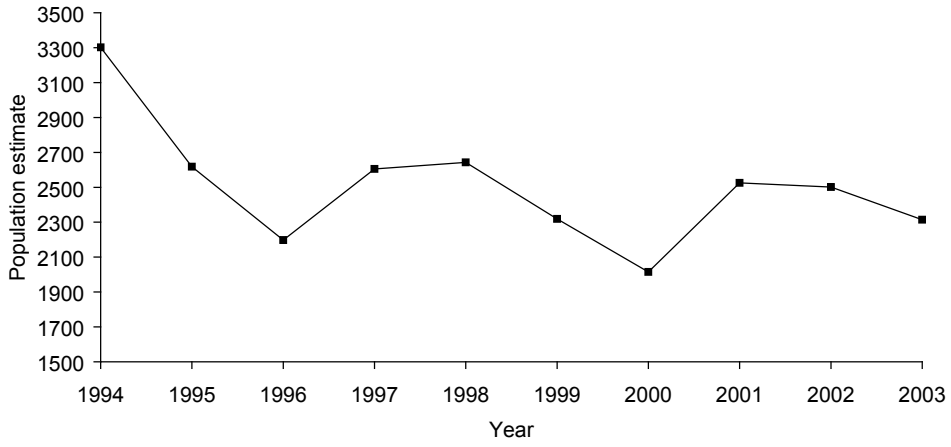
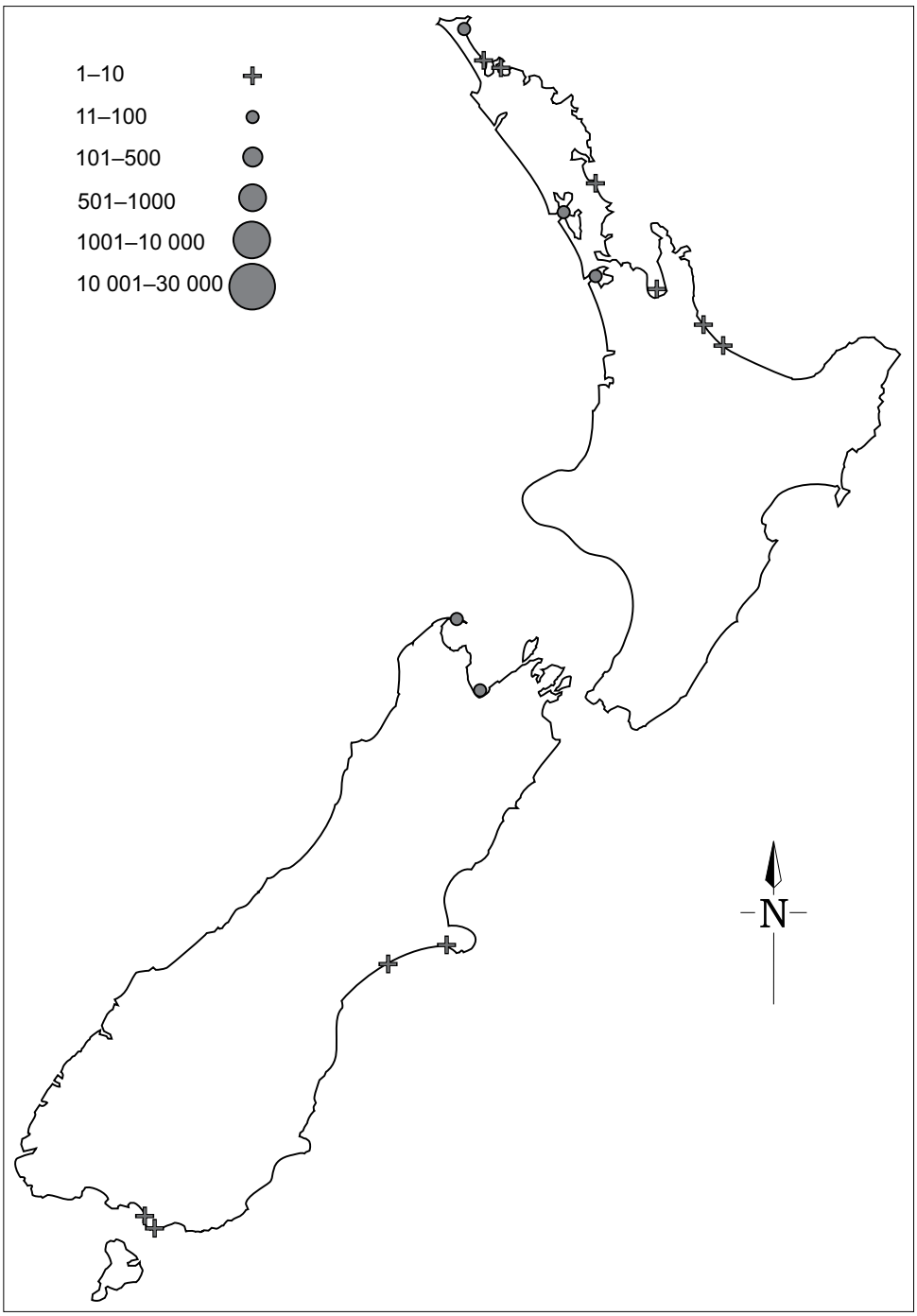


Figure 22. Population estimates for the turnstone (*Arenaria interpres*) in New Zealand during summer between 1994 and 2003.

Figure 23. The distribution and abundance of turnstones (*Arenaria interpres*) in New Zealand during winter between 1995 and 2003. Only sites with more than one bird, on average, are shown.



3.4.4 Pacific golden plover (*Pluvialis fulva*)

Pacific golden plovers (*Pluvialis fulva*) were widespread, with 73–234 (average 156) birds counted in summer (Table 13; Fig. 24). However, very few of them (0.5%) overwinter in New Zealand, with a maximum of four birds being counted in any one year (Table 13). The most important sites appeared to be Kaipara Harbour, Lake Ellesmere (Te Waihora), Parengarenga Habour, Farewell Spit and Kaituna Cut/Maketu Estuary. Pacific golden plovers are difficult to count and were probably often missed at some sites. Rather than using regular high-tide roosts, Pacific golden plovers will often move onto paddocks, especially when recently ploughed, and can be difficult to locate. They are also wary and may quickly leave a roost when disturbed. Three sites (Parengarenga Harbour, Whangarei Harbour and Manukau Harbour) tended to have larger flocks, but birds were not found during half or more of the counts. If these zero counts were disregarded, these sites would be among the top five locations for this species.

Between 1994 and 2003, numbers in this study were considerably lower than were recorded in the previous decade (Sagar et al. 1999). Not only was there poorer coverage of sites, but at the sites for which there were comparative data, numbers had halved (50%) overall (Table 17). This decline may have been exaggerated by the comparative shortage of good counts in this study; however, it is strongly indicated by a fall in numbers at almost every site. Only at Lake Ellesmere (Te Waihora) and Kaipara Harbour were similar numbers recorded as during the previous decade.

TABLE 17. TEN-YEAR AVERAGES OF PACIFIC GOLDEN PLOVER (*Pluvialis fulva*) COUNTS.
Data are presented for New Zealand sites where more than 10 birds on average were counted in summer between 1994 and 2003. Summer counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM=standard error.

SITE	WINTER 1994–2003			SUMMER 1995–2003			SUMMER 1983–1994		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Kaipara Harbour	0	0	9	44	10	10	49	9	9
Lake Ellesmere (Te Waihora)	0	0	6	36	8	8	39	13	11
Parengarenga Harbour	0	0	2	29	29	3	75	27	8
Farewell Spit	0	0	3	21	9	3	15	3	11
Kaituna Cut/Maketu Estuary	0	0	6	17	5	6	27*	5	11
Whangarei Harbour	1	0	9	14	5	10			
Manukau Harbour	0	0	9	12	5	10	47*	7	11
Manawatu Estuary	0	0	1	12	0	1	32	2	11
Ahuriri Estuary	0	0	8	11	3	8	23*	5	11
Ohiwa Harbour	0	0	6	8	3	6	10	2	11
Awarua Bay	0	0	2	8	7	3	18	6	10
Wairoa Estuary	0	0	5	6	6	5	17*	5	11
Firth of Thames	0	0	9	4	2	9	32*	14	11
Invercargill Estuary	0	0	2	0	0	3	34*	11	9

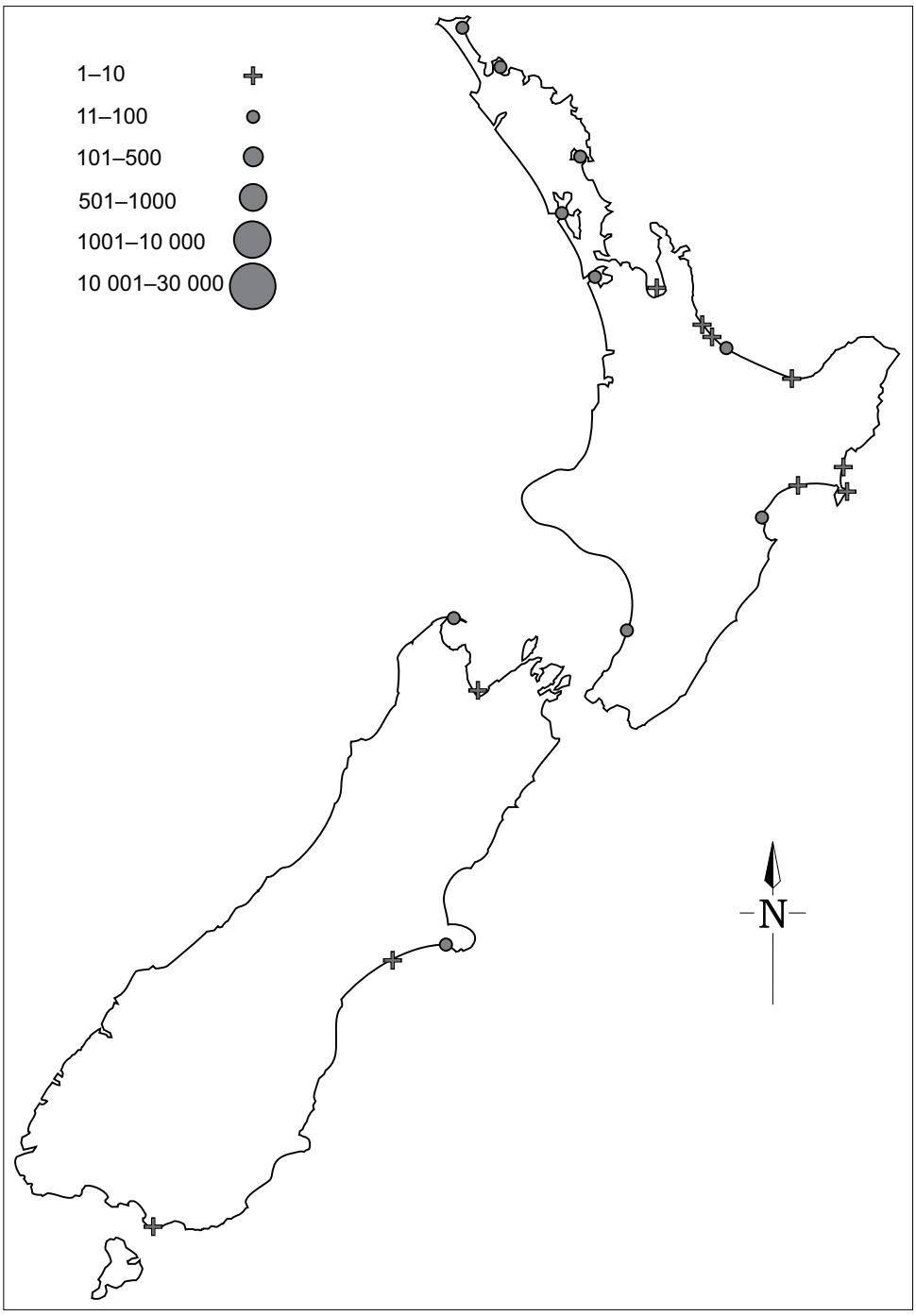


Figure 24. The distribution and abundance of Pacific golden plovers (*Pluvialis fulva*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.4.5 Red-necked stint (*Calidris ruficollis*)

The most common of the smaller sandpipers was the red-necked stint (*Calidris ruficollis*), with 53–152 birds counted in summer (Fig. 25) and 3–54 birds (5% of the summer population) overwintering at the same sites (Table 13). Most red-necked stints (69%) were found at just two sites, Lake Ellesmere (Te Waihora) and Awarua Bay. Occasionally, at some sites, more birds were counted in winter than in summer; however, it is unclear whether this reflects movement or birds being missed in counts.

Although fewer red-necked stints were counted than in the previous decade (Sagar et al. 1999), average numbers at specific sites were very similar (+1%), with some sites a little higher and some a little lower (Table 18). The only well-counted site where numbers fell significantly was the Firth of Thames.

TABLE 18. TEN-YEAR AVERAGES OF RED-NECKED STINT (*Calidris ruficollis*) COUNTS.

Data are presented for New Zealand sites where more than 5 birds on average were counted in summer between 1994 and 2003, or that had comparative data in Sagar et al. (1999). Summer counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM=standard error.

SITE	WINTER 1995–2003			SUMMER 1994–2003			SUMMER 1983–1993		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Lake Ellesmere (Te Waihora)	18	3	8	78	8	8	68*	8	11
Awarua Bay	11	11	2	28	9	3	27	6	11
Manukau Harbour	4	1	10	16	3	10	16	3	11
Kaipara Harbour	0	0	10	10	2	10	5*	1	9
Porangahau Estuary	3	1	7	8	1	7	7	2	8
Farewell Spit	1	1	3	8	4	3	15	2	11
Firth of Thames	1	0	10	2	1	10	5*	2	11
Parengarenga Harbour	2	2	2	0	0	3	6*	3	8

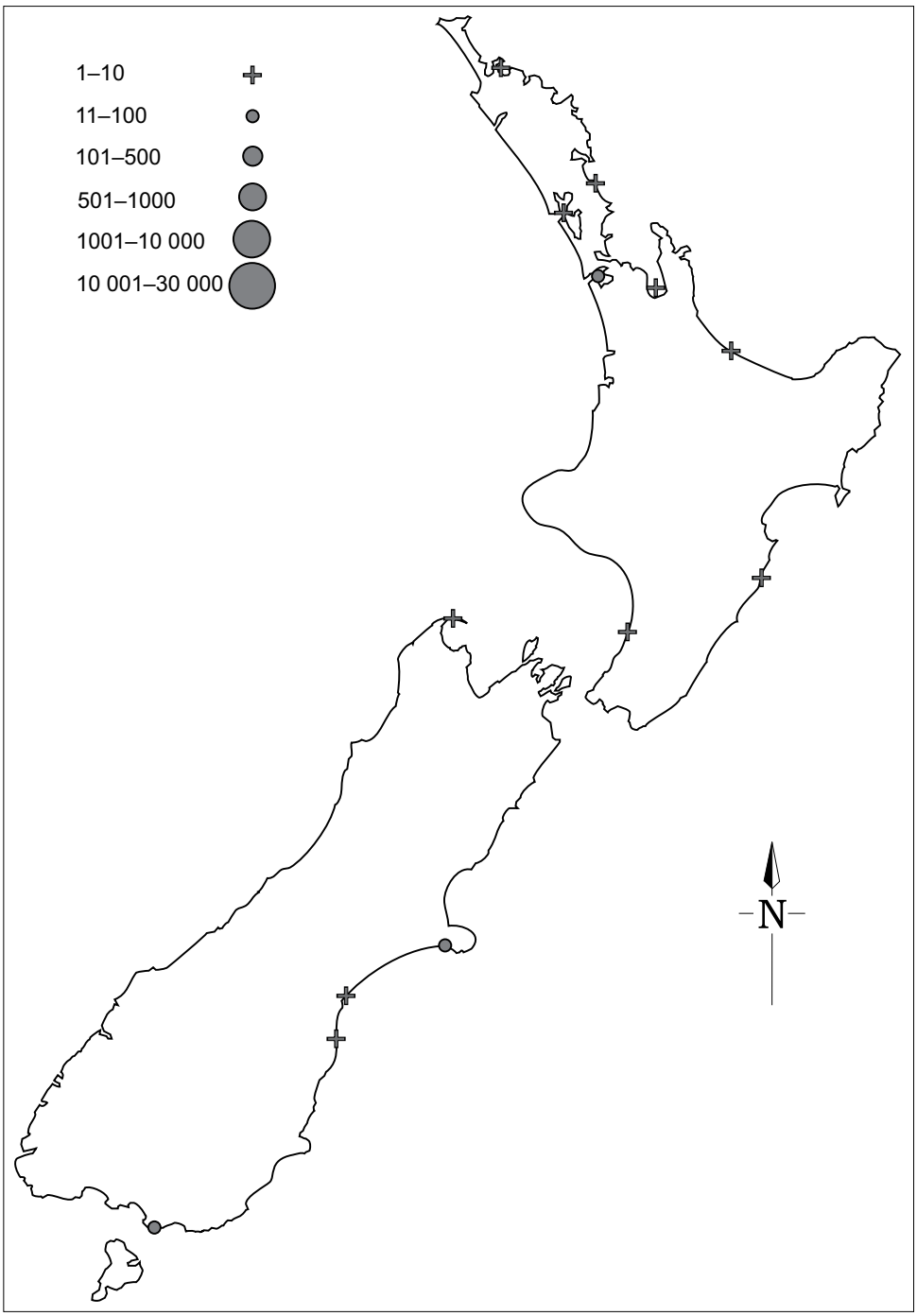


Figure 25. The distribution and abundance of red-necked stints (*Calidris ruficollis*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.4.6 Whimbrel (*Numenius phaeopus*)

In summer, 36–152 (average 70) whimbrels (*Numenius phaeopus*) were counted (Fig. 26); 0–18 birds (about 6% of the summer population overall) remained during winter (Table 13). Numbers at specific sites with comparative data have declined by 23% since 1984–1994. However, there were few counts from Parengarenga Harbour and Farewell Spit, which typically hold larger populations (Table 19).

TABLE 19. TEN-YEAR AVERAGES OF WHIMBREL (*Numenius phaeopus*) COUNTS.

Data are presented for New Zealand sites where more than 1 bird on average was counted in summer between 1994 and 2003, or that had comparative data in Sagar et al. (1999). Summer counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM=standard error.

SITE	WINTER 1995–2003			SUMMER 1994–2003			SUMMER 1983–1993		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Farewell Spit	1	0	3	16	7	3	15	2	11
Firth of Thames	1	0	9	16	2	10	19*	4	11
Kaipara Harbour	0	0	9	15	4	10	16	1	9
Whangarei Harbour	1	1	9	14	5	10			
Parengarenga Harbour	0	0	2	13	7	3	26	6	8
Manukau Harbour	1	1	9	5	3	10	6	2	11
Kawhia Harbour	1	0	9	6	1	9			
Oraka Beach/Mahia Peninsula	0	0	5	6	2	5			
Kaituna Cut/Maketu Estuary	0	0	6	3	1	6	3	1	11
Ohiwa Harbour	0	0	6	1	1	6	3*	1	11
Rangaunu Harbour	2	2	3	5	5	2			
Orowaiti Lagoon	2	0	1	0	0	0			

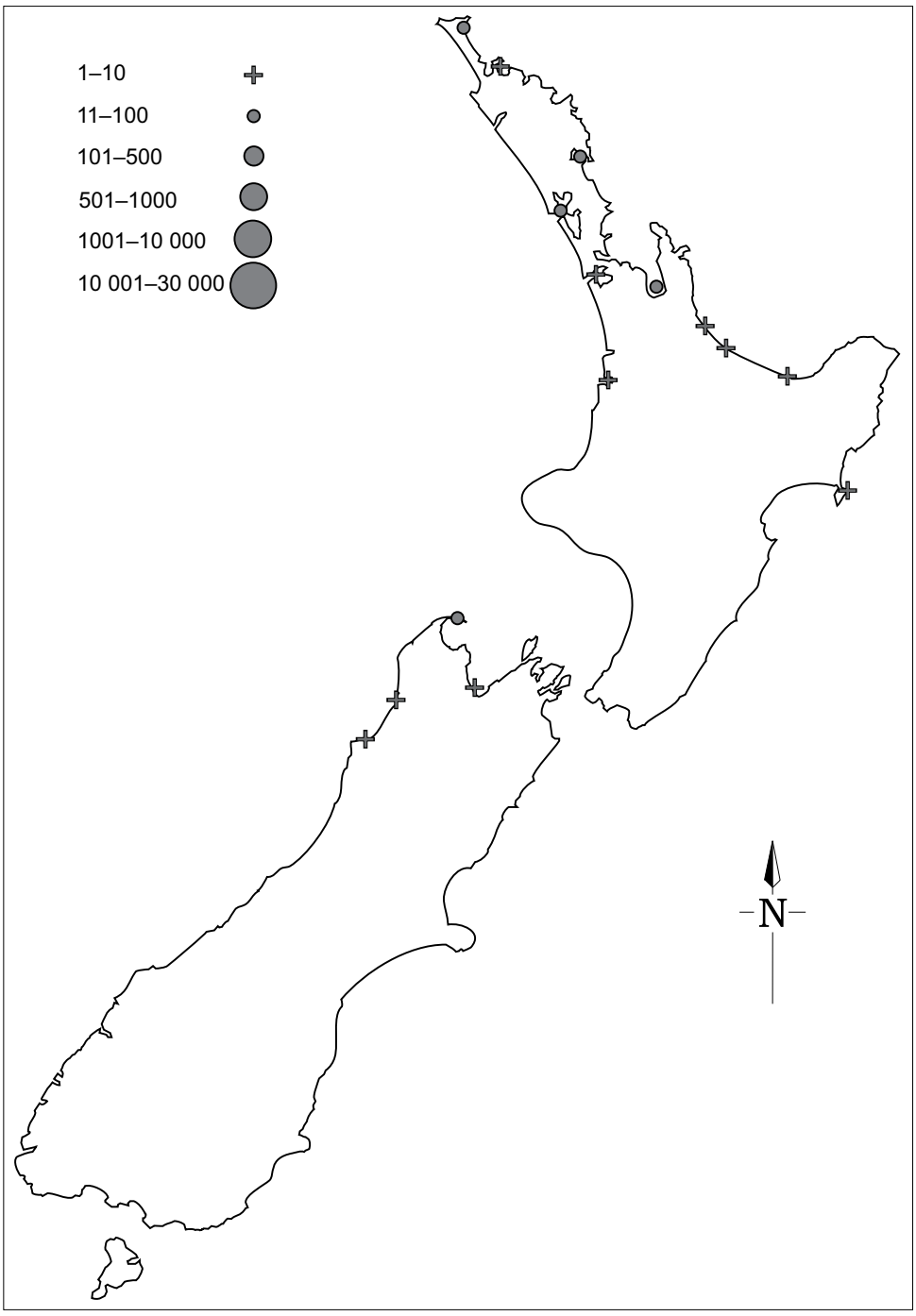


Figure 26. The distribution and abundance of whimbrels (*Numenius phaeopus*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.4.7 Curlew sandpiper (*Calidris ferruginea*)

Between 5 and 63 curlew sandpipers (*Calidris ferruginea*) were counted each summer (Fig. 27), and 0–20 (12%) remained over winter (Table 13). Results from sites with comparative data indicated a 49% decline in numbers between 1983–1994 and 1994–2003, with the greatest decline at the Firth of Thames (74%). The only site where numbers increased was Manukau Harbour, which has become the second most important site after Lake Ellesmere (Te Waihora) (Table 20), even though birds were not sufficiently common here in 1984–1994 to be listed by Sagar et al. (1999). Lake Ellesmere (Te Waihora) and Manukau Harbour were the only sites that consistently supported curlew sandpipers; single counts of 30 birds in the Firth of Thames in 1994, 22 at Parengarenga Harbour in 1995 and six at Wairoa Estuary in 1998 have contributed markedly or entirely to the higher average counts at these sites.

Relatively few birds (0%–8%) overwintered at most sites (Table 20). Manukau Harbour was the prime site for curlew sandpipers over winter, with 33% of the summer flock remaining there. In 1995, more birds overwintered at Manukau Harbour than were present there in summer. It is possible that the extra birds moved across from the Firth of Thames, where 30 had been counted in summer, but none had remained in winter.

TABLE 20. TEN-YEAR AVERAGES OF CURLEW SANDPIPER (*Calidris ferruginea*) COUNTS.

Data are presented for New Zealand sites where more than 1 bird on average was counted in summer between 1994 and 2003, or that had comparative data in Sagar et al. (1999). Summer counts are compared with those from the previous decade (Sagar et al. 1999); *=$P<0.05$. n=the number of counts from which the average was calculated, SEM=standard error.

SITE	WINTER 1995–2003			SUMMER 1994–2003			SUMMER 1983–1993		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Lake Ellesmere (Te Waihora)	1	1	6	13	3	8	30*	5	11
Manukau Harbour	3	2	9	9	1	10			
Parengarenga Harbour	0	0	2	7	7	3	14	5	9
Firth of Thames	0	0	9	4	3	10	15*	3	11
Wairoa Estuary	0	0	3	3	4	2			
Awarua Bay	0	0	2	1	1	3	10*	3	11
Farewell Spit	0	0	3	1	1	10	3*	1	11

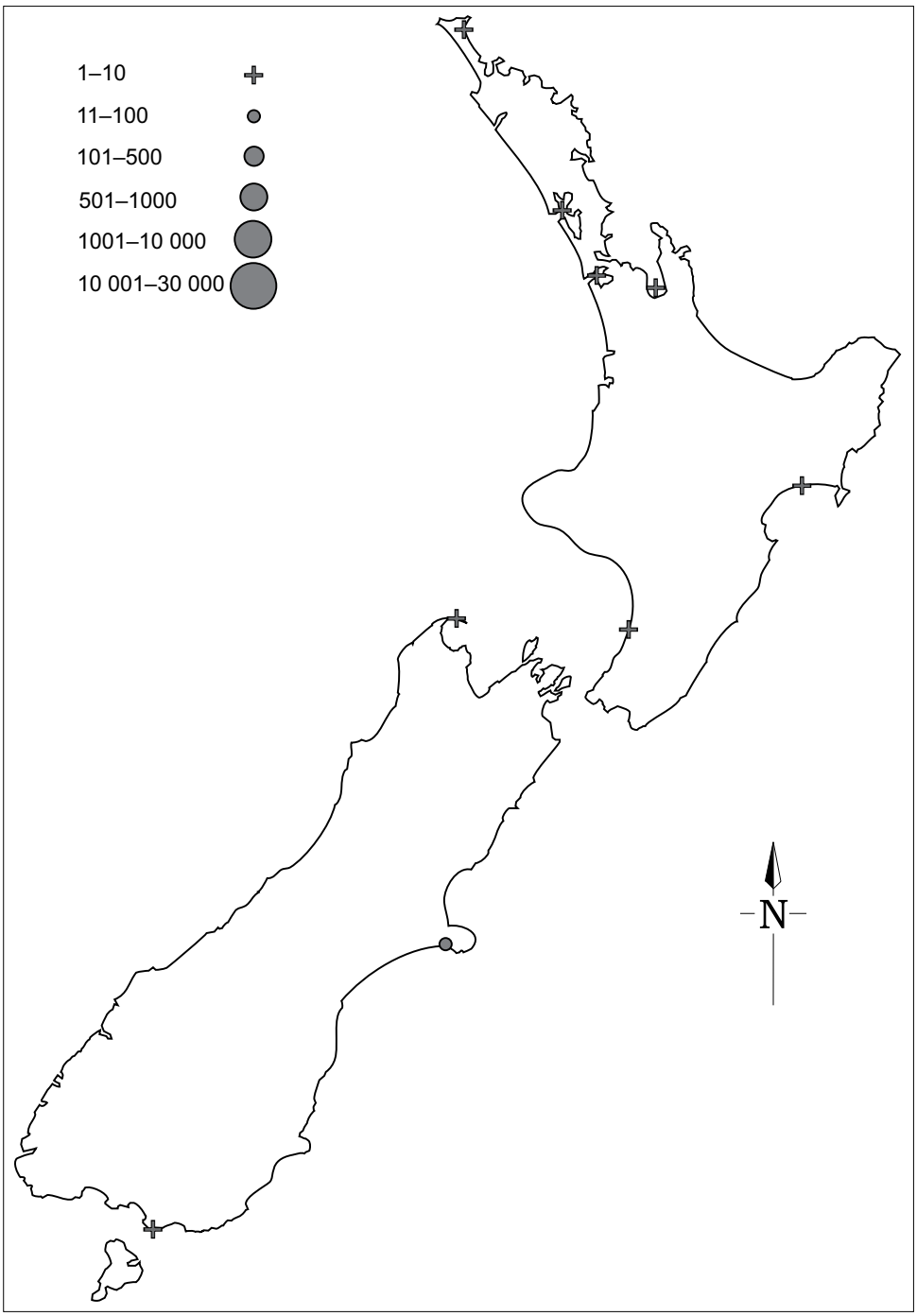


Figure 27. The distribution and abundance of curlew sandpipers (*Calidris ferruginea*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.4.8 Sharp-tailed sandpiper (*Calidris acuminata*)

Between 8 and 37 sharp-tailed sandpipers (*Calidris acuminata*) were counted each summer (Table 13; Fig. 28). Comparisons of average counts with those reported at important sites by Sagar et al. (1999) indicate a decline of 71% in the numbers occurring in New Zealand (Table 21). Even the maximum count recorded during 1994–2003 was below the mean for the previous 10 years. Peak counts of 34 and 37 in 1994 and 2001, respectively, were followed by declines; in the remaining years, up to 17 birds were recorded.

Sharp-tailed sandpipers seldom overwinter in New Zealand. Only one case was recorded: a flock of 12 birds at Parengarenga Harbour in 1997 (Table 13). Similarly, in most years Sagar et al. (1999) found that no birds overwintered, but in a single year (1992) 9 of the 15 birds they listed during summer were recorded.

TABLE 21. TEN-YEAR AVERAGES OF SHARP-TAILED SANDPIPER (*Calidris acuminata*) COUNTS.

Data are presented for New Zealand sites where more than 1 bird on average was counted in summer between 1994 and 2003, or that had comparative data in Sagar et al. (1999). Summer counts are compared with those from the previous decade (Sagar et al. 1999); * = $P < 0.05$. *n* = the number of counts from which the average was calculated, SEM = standard error.

SITE	SUMMER 1994–2003			SUMMER 1983–1993		
	COUNT	SEM	*n*	COUNT	SEM	*n*
Manukau Harbour	5	1	10	9*	2	11
Lake Ellesmere (Te Waihora)	5	2	8	11*	4	11
Wainono Lagoon (Lake Ki-Wainono)	3	1	8			
Farewell Spit	3	1	10			
Firth of Thames	3	1	10	13*	4	11
Kaipara Harbour	2	1	10			
Parengarenga Harbour	2	2	3			
Manawatu Estuary	2	0	1			
Kaituna Cut/Maketu Estuary	0	0	6	5*	1	11

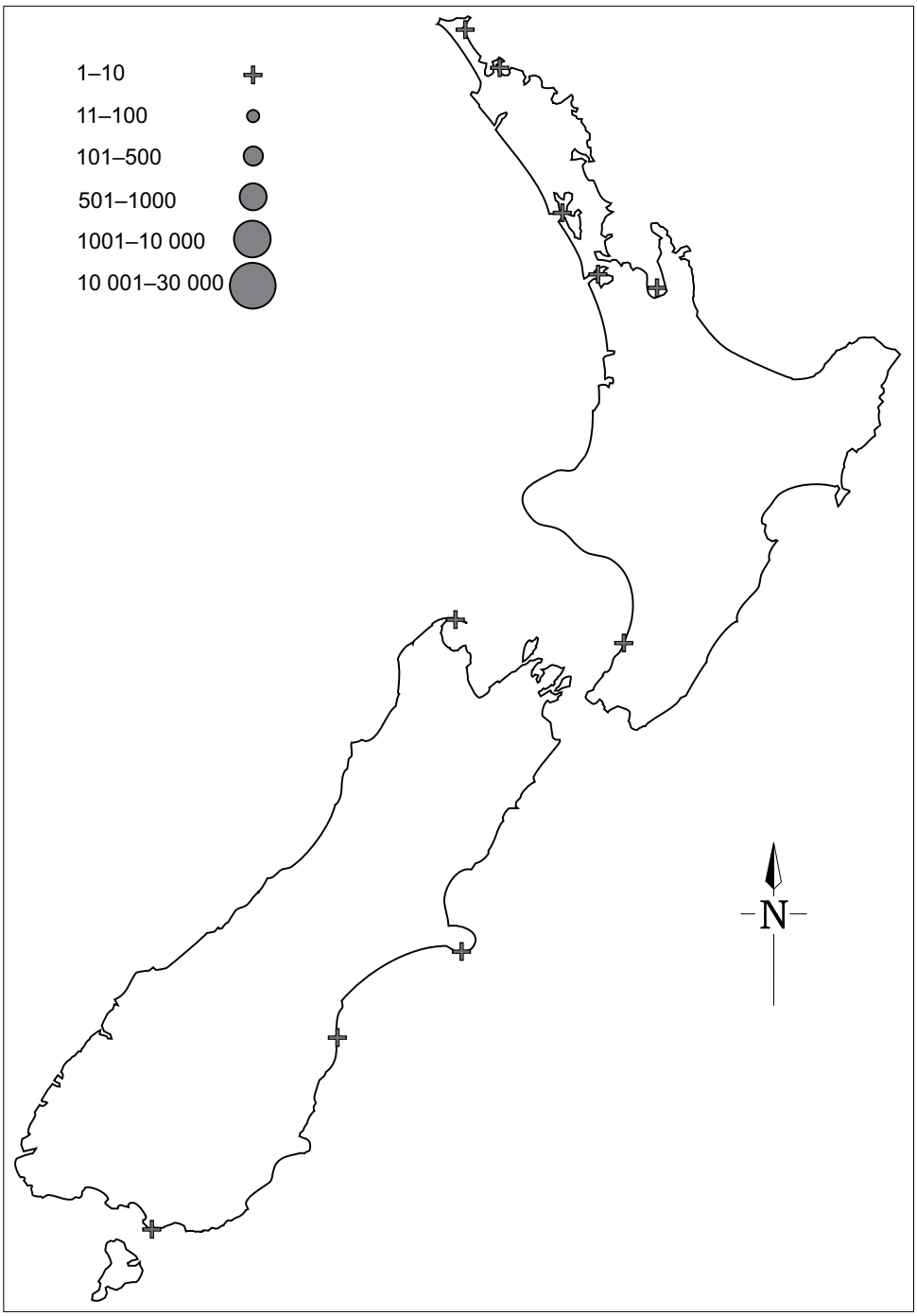


Figure 28. The distribution and abundance of sharp-tailed sandpipers (*Calidris acuminata*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.4.9 Eastern curlew (*Numenius madagascariensis*)

Between 11 and 28 (average 18) curlews (*Numenius madagascariensis*) were counted in summer (Fig. 29), and 1–24 in winter (Table 13). Comparison of specific sites suggests that there has been an 11% decline since 1983–1994 (Table 22). However, numbers seem to have remained more or less constant throughout the 1994–2003 period (Table 13), suggesting that the decline in numbers reaching New Zealand (Sagar et al. 1999) may have ended. The longer series of counts from the Firth of Thames and Manukau Harbour between 1960 and 2003 shows that there has been little overall change in total number at these sites, but a steady local decline at the Firth of Thames and a corresponding increase at Manukau Harbour (Veitch & Habraken 1999). There may be a continuing local trend of increase at Manukau Harbour at the expense of the Firth of Thames, but the combined average count for the last 5 years of this survey period (mean = 6, SEM = 1) is only half that recorded during the first 5 years (mean = 13, SEM = 3; $t = 4.7$, df = 4, $P < 0.01$). The proportion of the population that overwintered (23%) was quite large compared with other Arctic migrants. Sagar et al. (1999) and Veitch & Habraken (1999) also found a high proportion of birds overwintering (25% and 27%, respectively). Presumably, many of the curlews in New Zealand have not yet reached breeding age. In 1995, more birds were counted in winter ($n = 25$) than in the previous summer ($n = 17$) (Table 13).

TABLE 22. TEN-YEAR AVERAGES OF EASTERN CURLEW (*Numenius madagascariensis*) COUNTS.
Data are presented for New Zealand sites where at least 1 bird on average was counted in summer between 1994 and 2003, or that had comparative data in Sagar et al. (1999). Summer counts are compared with those from the previous decade (Sagar et al. 1999); * = $P < 0.05$. n = the number of counts from which the average was calculated, SEM = standard error.

SITE	WINTER 1995–2003			SUMMER 1994–2003			SUMMER 1983–1993		
	COUNT	SEM	*n*	COUNT	SEM	*n*	COUNT	SEM	*n*
Farewell Spit	1	0	3	8	3	3	8	1	11
Manukau Harbour	1	1	9	6	1	10	9*	1	11
Invercargill Estuary	1	1	2	3	1	3			
Firth of Thames	1	0	9	3	1	10	4*	1	11
Kaipara Harbour	1	1	9	3	0	10			
Parengarenga Harbour	0	0	2	3	3	3	2	0	8
Mouth of the Ashley River/ Rakahuri	0	0	6	2	0	8	1	0	10
Whangarei Harbour	0	0	9	0	0	10	1	1	11
Manawatu Estuary	0	0	0	1	0	1			
Orowaiti Lagoon	0	0	0	1	0	1			

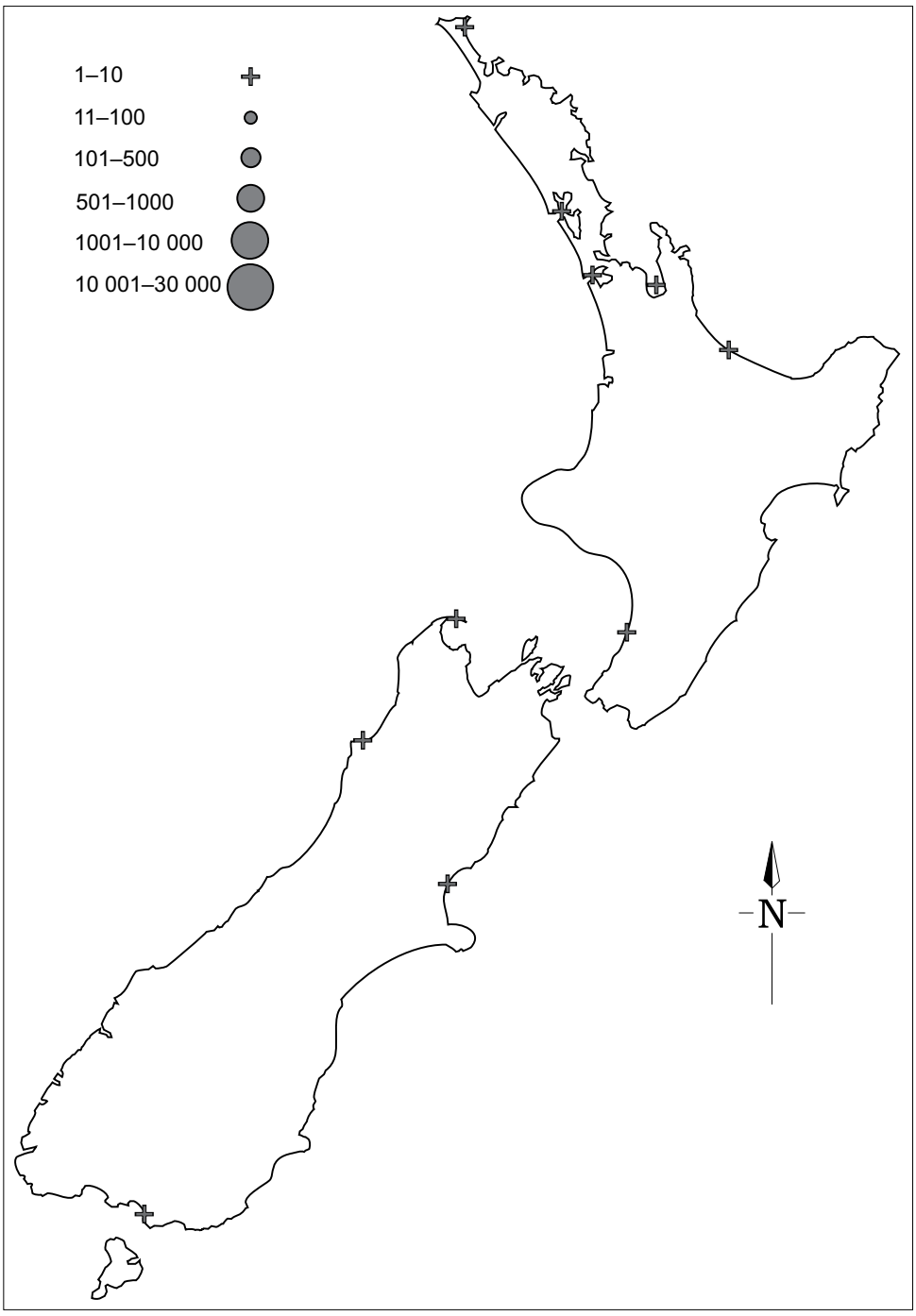


Figure 29. The distribution and abundance of eastern curlews (*Numenius madagascariensis*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.4.10 Pectoral sandpiper (*Calidris melanotos*)

Pectoral sandpipers (*Calidris melanotos*) were not common, but were recorded in all years but one. Up to 16 birds were recorded in summer counts (Fig. 30), but none were recorded in winter (Table 13). The main sites were Lake Ellesmere (Te Waihora) (average 3), Ahuriri Estuary (1), and Manukau Harbour (1). The overall numbers (average 5) were slightly higher than those from the previous decade (average 4; Sagar et al. 1999).

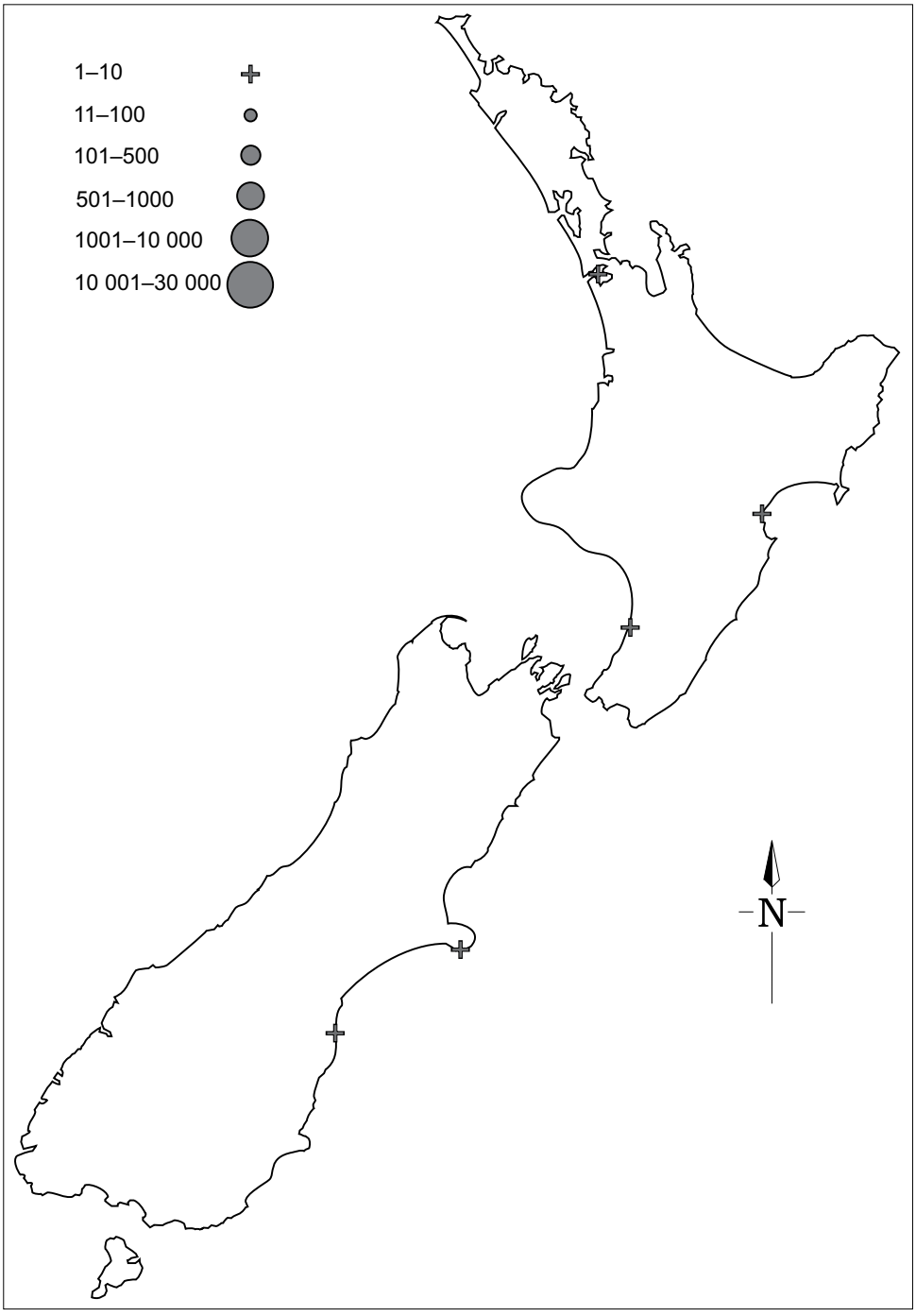


Figure 30. The distribution and abundance of pectoral sandpipers (*Calidris melanotus*) in New Zealand during summer between 1994 and 2003. Only sites with more than one bird, on average, are shown.

3.5 RARE WADERS

Nineteen other species of waders and one hybrid taxon were recorded during counts. For each of these, totals for the decade were less than 25 birds (Table 23). Since the count methodology clearly emphasised the common species of wader, rare species will often have been missed, especially when they were difficult to identify.

TABLE 23. NUMBERS OF RARE WADERS COUNTED IN NEW ZEALAND BETWEEN NOVEMBER 1994 AND JUNE 2003.

SPECIES	MEASURE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	TOTAL
American golden plover*	Winter count		0	0	0	0	0	0	0	0	0	0
	Summer count	0	0	0	0	0	0	0	0	0	1	1
Black-tailed godwit	Winter count		1	1	0	0	0	0	2	0	2	6
	Summer count	0	2	0	1	0	2	0	1	1	1	8
Broad-billed sandpiper	Winter count		0	0	0	0	0	1	0	0	0	1
	Summer count	1	0	0	0	0	1	1	0	1	0	4
Dunlin	Winter count		0	0	0	0	0	0	0	0	0	0
	Summer count	1	0	0	0	0	0	0	0	0	0	1
Great knot	Winter count		1	0	0	0	0	0	0	0	0	1
	Summer count	0	0	0	0	0	0	0	0	0	0	0
Grey plover	Winter count		0	1	0	0	0	0	0	0	0	1
	Summer count	0	1	0	0	0	0	0	1	4	0	6
Grey-tailed tattler	Winter count		0	1	0	1	0	0	0	0	0	2
	Summer count	3	1	4	0	4	1	0	3	2	3	21
Hudsonian godwit	Winter count		0	0	0	0	0	0	0	0	0	0
	Summer count	0	0	0	0	0	0	0	1	0	0	1
Large sand dotterel	Winter count		0	0	0	0	0	0	0	0	0	0
	Summer count	1	0	0	1	1	1	0	1	0	0	5
Least sandpiper*	Winter count		0	0	0	0	0	0	0	0	0	0
	Summer count	0	0	0	0	0	0	0	1	0	0	1
Little whimbrel	Winter count		0	0	0	0	0	0	0	0	0	0
	Summer count	0	0	0	0	0	0	0	2	0	1	3
Marsh sandpiper	Winter count		3	0	0	0	0	4	1	0	0	8
	Summer count	1	2	0	0	4	0	4	0	0	1	12
Mongolian dotterel	Winter count		0	0	0	0	0	0	0	0	2	2
	Summer count	1	2	0	2	2	2	1	1	0	1	12
Oystercatcher hybrid	Winter count		0	0	0	0	0	0	0	0	7	7
	Summer count	0	0	0	0	0	0	0	0	0	0	0
Red-necked phalarope	Winter count		0	0	0	0	0	0	0	0	0	0
	Summer count	0	0	0	0	0	0	1	0	0	0	1
Ruff	Winter count		0	0	0	0	0	0	0	0	1	1
	Summer count	0	0	0	0	0	0	0	0	0	0	0
Sanderling	Winter count		1	0	0	0	0	0	0	0	0	1
	Summer count	0	3	0	0	0	1	2	0	0	0	6
Shore plover	Winter count		0	0	0	0	0	0	0	0	0	0
	Summer count	0	0	1	0	0	0	0	0	0	0	1
Terek sandpiper	Winter count		0	0	2	0	0	0	0	0	0	2
	Summer count	0	0	3	1	1	2	2	1	2	1	13
Wandering tattler	Winter count		0	0	0	0	0	0	0	0	0	0
	Summer count	0	0	0	0	0	0	0	0	0	1	1

* Unconfirmed identification.

Several species of rare waders, such as marsh sandpipers (*Tringa stagnatilis*), appeared to be relatively common in winter. It is likely that great knots (*Calidris tenuirostris*) and black-tailed godwits (*Limosa limosa melanuroides*) were more easily found in the smaller winter flocks.

Although the majority of rare waders were Arctic migrants, two New Zealand breeding taxa were also recorded in low numbers. A shore plover (*Thinornis novaeseelandiae*) was seen at Waipu in November 1996, which probably originated from an unsuccessful attempt to re-establish the species in the Hauraki Gulf (Dowding & Murphy 2001). In addition, seven hybrid oystercatchers (*Haematopus ostralegus* x *unicolor*) were recorded from the mouth of the Ashley River/Rakahuri in June 2003. This reflects the small amount of interbreeding between variable and pied oystercatchers that has been recorded there in recent years (Andrew Crossland, OSNZ pers. comm.).

3.6 NEW ZEALAND COUNTS IN A FLYWAY CONTEXT

Recent population estimates for the East Asian Flyway and Australia in 1993 (Watkins 1993) and 2005 (Bamford et al. 2008) can be used to give an indication of how the counts from New Zealand reflect the wider context (Table 24). Comparing the average counts in New Zealand for 1983–1993 and 1994–2003 with the differences between single counts in 1994 and 2003 shows a broad agreement in terms of increases and decreases, but there is up to 50% variation in the amount of change indicated (Table 24). This result may be due to real differences in the datasets being compared, but may also be a consequence of the technique used: the difference between two points in fluctuating datasets is unlikely to provide a good representation of trends.

TABLE 24. POPULATION ESTIMATES AND TRENDS FOR THE WHOLE EAST ASIAN FLYWAY, AUSTRALIA AND NEW ZEALAND.

To make values comparable, the change in New Zealand has been recalculated using totals from all sites counted in both summer 1994 and summer 2003 (winter 1995 and winter 2003 for banded dotterel). The difference between counts is given as a percentage of the initial count. In addition, the percentage change between 10-year averages for 1983–1994 and 1994–2003 are given. Data for the East Asian Flyway and Australia are from Watkins (1993) and Bamford et al. (2008).

SPECIES	FLYWAY			AUSTRALIA			NEW ZEALAND			% CHANGE
	1993	2005	% CHANGE	1993	2005	% CHANGE	1994	2003	% CHANGE	1983–1994 TO 1994–2003
Banded dotterel*	50 000	50 000	0	30 000	N/A	N/A	7335	5406	–26	–16
Pacific golden plover	90 000	100 000–1 000 000	N/A	9000	N/A	N/A	231	229	–1	–50
Turnstone	28 000	35 000	+25	14 000	20 000	+43	3302	2314	–30	–46
Lesser knot	255 000	220 000	–14	153 000	135 000	–12	63 340	49 032	–23	–14
Curlew sandpiper	250 000	180 000	–28	188 000	118 000	–37	64	18	–72	–49
Sharp-tailed sandpiper	166 000	160 000	–4	166 000	140 000	–16	35	25	–29	–71
Red-necked stint	471 000	325 000	–31	353 000	270 000	–24	120	136	+13	+1
Eastern curlew	21 000	40 000	+90	19 000	28 000	+47	20	27	+35	–11
Whimbrel	40 000	100 000	+150	10 000	N/A	N/A	152	74	–51	–23
Bar-tailed godwit	330 000	325 000	–2	165 000	185 000	+12	105 560	83 001	–21	+9

* Banded dotterel population was assessed from winter counts, unlike other species.

Comparing the change in counts between 1994 and 2003 in New Zealand with those from Australia and the flyway in 1993 and 2005 probably does give a very general picture of population trends, however. There seem to be general declines in populations from all of the count units of lesser knots, curlew sandpipers and sharp-tailed sandpipers, suggesting that declines recorded in New Zealand reflect wider scale impacts. Bar-tailed godwit numbers may be approximately stable overall, as counts show either small increases or decreases. More interestingly, trends in New Zealand differ from those elsewhere for some species. Red-necked stints appear to have increased in New Zealand but declined elsewhere, while turnstones have declined in New Zealand despite numbers counted elsewhere having increased. Eastern curlews have also declined in New Zealand but not elsewhere (the suggestion of an increase between 1994 and 2003 is the result of unusually low counts returned in 1994). Also of interest is the apparently stable flyway population of banded dotterel, given the declines observed in New Zealand.

The ratio of first-year birds to older birds in canon net catches in Australia is also available for some species. In some cases, there are indications of a fairly simple relationship between the proportions of first-year birds and the numbers counted on census in New Zealand. Considering just the data from the Firth of Thames, Kaipara Harbour and Manukau Harbour, the only occasions when there was a rise in counts of curlew sandpipers (1999 and 2001) and red-necked stints (1998–2000 and 2001) were when more than 20% of birds captured in Australia were first-year birds (Minton 2003). However, similar percentages of young curlew sandpipers in Australian catches in 1997/8 and red-necked stints in 1995/6 did not lead to increased counts in those years (Fig. 31). There was a more definite signal for the turnstones, with increases following high proportions of first-year birds in Australia in 1997/8 and 1999/2000 (Minton 2003), probably because these birds are more abundant; however, the increase was delayed until winter, suggesting that the migration of these young birds was later than that of adults and fell between the census periods (Fig. 32). The drop off in numbers was also rapid, suggesting that frequent productive breeding seasons are needed to maintain good population numbers for these three species at least.

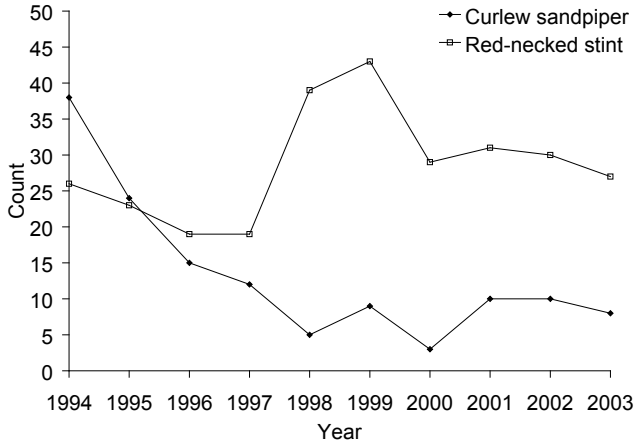


Figure 31. Counts of curlew sandpipers (*Calidris ferruginea*) and red-necked stints (*C. ruficollis*) from the Firth of Thames, and Kaipara and Manukau Harbours, New Zealand, during summer from 1994 to 2003.

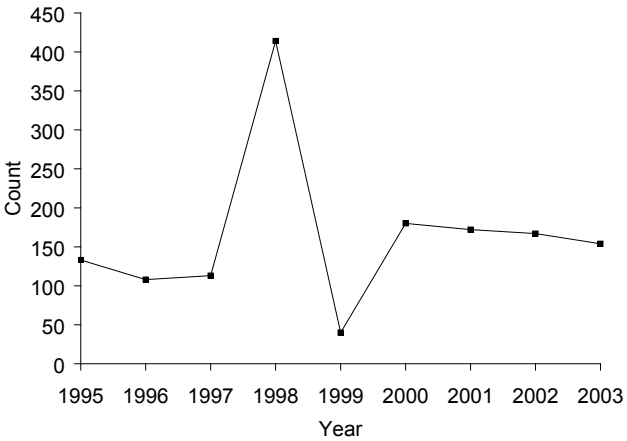


Figure 32. Counts of turnstones (*Arenaria interpres*) from Farewell Spit (1995 missing, replaced with mean), and Kaipara and Manukau Harbours, New Zealand, during winter from 1995 to 2003.

4. Discussion

4.1 POPULATION TRENDS

4.1.1 New Zealand breeding species

Many species of indigenous waders move to coastal sites after the breeding season and thus can be monitored well by these high-tide counts. This method is least effective for spur-winged plovers, which are largely terrestrial, and black-fronted dotterels, which prefer freshwater wetlands. While both these species appear to have increased, only a small proportion of their populations was available to be counted. Similarly, black stilt counts can be problematic, not only because more than 85% of individuals overwinter inland (Dowding & Moore 2004), but also due to the identification problems posed by immature plumages and hybrids.

Numbers of pied oystercatchers have increased steadily and spectacularly since 1940. Originally, they bred on braided riverbeds in the South Island; however, this habitat has become widely degraded by the spread of woody weeds (Dowding & Murphy 2001) and numbers have declined on Mackenzie Country riverbeds since the 1960s (Maloney 1999). They have, however, adapted to breeding on farmland (Baker 1973) and this is now an important breeding habitat. There was a lower rate of increase during 1994–2003 than during the previous decade (Sagar et al. 1999), suggesting that numbers may be stabilising. Pied oystercatchers have begun to colonise North Island sites in the Wairarapa and Hawke's Bay (Heather & Robertson 2000), however, and this foothold may be the prelude to further expansion of their breeding range.

The number of pied stilts appears to have increased by about 20% since the previous decade. Comparing 10-year means from Manukau Harbour and the Firth of Thames (Veitch & Habraken 1999) indicates that this change is within the range of previously recorded fluctuations but reflects a real increase in population size rather than the result of birds moving toward the coast in drier weather (Veitch 1999). A long-term banding study identified several sub-populations with different patterns of migration (Dowding & Moore 2004) and, based on changes at particular sites, these seem to have shown different trends. The stable populations at Ahuriri Estuary, Tauranga Harbour and Whangarei Harbour may reflect local birds breeding on the coast and inland. Parengarenga Harbour also has a locally resident population that may have increased. The numbers of pied stilts overwintering in the harbours of the Auckland isthmus have also increased, but they are a mixture of locally breeding birds and migrants from mid-Canterbury to Southland.

Wrybill numbers also appear to have increased by almost 30% over most of the sites tabulated by Sagar et al. (1999), with the population now averaging almost 4500 birds. Since the 1970s, numbers on the Firth of Thames and Manukau Harbour have averaged about 3770 birds (Veitch & Habraken 1999), suggesting a long-term average total population of about 4500 birds (Riegen & Dowding 2003). The lower numbers recorded in the mid-1980s by Sagar et al. (1999) may partly be the result of flooding on the breeding sites, as recorded by Hughey (1985) during the 1982 and 1983 breeding seasons. Whilst breeding,

wrybills are also vulnerable to predation and probably loss of breeding habitat due to weed infestation (Riegen & Dowding 2003). Given these pressures, the constancy of the population size seems remarkable, and is perhaps due in part to the management of their breeding habitats in the Mackenzie Country by the Department of Conservation.

Numbers of northern New Zealand dotterels and, particularly, variable oystercatchers seem to have increased, continuing the trend reported by Sagar et al. (1999). Both species tend to favour the smaller harbours and estuaries along the northeastern North Island, and there are also large numbers of variable oystercatchers in the Nelson region. These increases appear to be the result not only of increasing numbers at some of the larger sites, but also of range expansion. Near the smaller estuaries that were identified by Sagar et al. (1999) as holding large numbers of variable oystercatchers, there now seem to be adjacent sites where large populations have developed in the last 10 years. This pattern is less obvious for New Zealand dotterels, as some sites had fewer birds; however, there are now significant numbers at sites that were not listed by Sagar et al. (1999). There has also been range expansion into Hawke's Bay and Taranaki (Heather & Robertson 2000). Predators have been controlled and human disturbance reduced at key sites on northern North Island beaches and harbours since the mid-1980s (Wills et al. 2003). This may explain the increase noted here, as about 20% of breeding pairs of northern New Zealand dotterels now occur at protected sites (Dowding & Murphy 2001; Wills et al. 2003). Since many pairs of variable oystercatchers are also encompassed by this protection, as they occupy similar habitats to northern New Zealand dotterels, it is tempting to also attribute the continuing increase in their numbers to this management. However, Crossland (2001) pointed out that numbers of this species seem to have increased a little earlier at some sites and in some places that are remote from the areas where protection was carried out.

By 1992, predation by cats (*Felis catus*) had reduced the population of southern New Zealand dotterels to about 60 birds (Dowding & Murphy 2001). However, since 1995, control of cats on Stewart Island/Rakiura has markedly improved adult survival and breeding success of the dotterels. Demographically, the southern form is quite different from the northern form, being more productive with a higher population turnover, which has resulted in a rapid increase in numbers since management began (Dowding & Murphy 2001). The total population was over 200 birds in 2004 (Dowding & Moore 2004). Since the two counts from Southland in this study were carried out very early in the recovery phase and no counts were made on Stewart Island/Rakiura, this population change is poorly documented here.

The one species of endemic wader that has clearly declined in numbers during the period of these counts is the banded dotterel. Several distinct sub-populations with different migratory behaviours have been identified from a large-scale banding study (Pierce 1999), but not all of these were well monitored by these counts. Most of the populations that breed between inland Canterbury and Southland migrate to southeastern Australia after breeding (Pierce 1999), and so are not covered by these counts. Some of these birds may overwinter at Lake Ellesmere (Te Waihora), where numbers went against the general trend, increasing by 38% in winter. Counts made at North Island sites in this study largely monitored banded dotterels breeding in the central North Island and Marlborough.

Two-thirds of the birds counted on Farewell Spit came from Marlborough and the West Coast (Pierce 1999). Most of these populations have declined since the previous decade. At present, a commonly used population estimate for banded dotterel is 50 000 birds, 20 000 of which overwinter in New Zealand and the remainder in Australia (e.g. Pierce 1999; Heather & Robertson 2000; Barter 2002). This total was based on counts from Australia, unpublished data from breeding sites and the proportions of colour-banded birds seen at non-breeding sites (Dowding & Moore 2004). Based on this study, however, substantially lower estimates of 5083–7335 were derived between 1995 and 2004. These estimates are not complete, as some moderately important overwintering sites (e.g. Whangapoua Harbour, Lake Grassmere/Kapara Te Hau and Lake Wairarapa; Dowding & Moore 2004) were not counted and some birds overwinter *in situ* in spite of harsh conditions (Pierce 1999; Sagar et al. 1999). However, even given this, it is difficult to justify a figure of 20 000 from the counts considered here.

For the banded dotterel, the overall picture is one of decline, as the population seems to have been very much higher in the 1940s, with counts of 1000+ and 2000 at Waitakaruru on the Firth of Thames, 3000 at Ohiwa Harbour, and 500–1000 at Mangere on the Manukau Harbour (Fleming & Stidolph 1951). Furthermore, they must have declined quickly, as average census counts at Manukau Harbour (337) and the Firth of Thames (44) were much lower during the 1960s (Veitch & Habraken 1999) than counts during the 1940s (Fleming & Stidolph 1951). More recent counts from these sites suggest that there was a slow, fluctuating recovery that peaked during the 1980s, followed by a decline (Veitch & Habraken 1999). The results from this study suggest that this decline is ongoing.

4.1.2 Arctic migrants

Situated at the extreme end of the East Asian Flyway, New Zealand receives an important proportion of the populations of only three species of long-distance migrants—eastern bar-tailed godwit, lesser knot and turnstone. The most common of these is the bar-tailed godwit. The Alaskan subspecies of bar-tailed godwit (*Limosa lapponica baueri*) that overwinters here has a population estimated at 170 000 birds (Barter 2002); at least 95 000 (56%) of these spent the non-breeding season in New Zealand during this study. Numbers have remained fairly constant at Manukau Harbour and the Firth of Thames since 1960 (Veitch & Habraken 1999), suggesting a stable population. Although there has been a steady decline in population size during the decade covered by these counts, the figures still fall within the range shown by Sagar et al. (1999) for the previous decade, and the overall population estimate is only a little less (Table 13).

There are thought to be c. 220 000 lesser knots (*Calidris canutus rogersi* and *C. c. piersmai*) visiting Australia and New Zealand each year (Barter 2002). Based on the estimate derived from these data, the almost 50 000 birds in New Zealand represent 23% of the total population. Generally, the lesser knots wintering in New Zealand and southern and eastern Australia have been regarded as belonging to the subspecies *rogersi*, while those in northwestern Australia are *piersmai*, but it has been suggested that both subspecies occur in New Zealand (Tomkovich & Riegen 2000). Overall, there seems to have been a fluctuating tendency for decline during the 10 years of this study. However, local trends in lesser knot populations are considerably different, with fairly large increases and decreases

in numbers at different sites between the two 10-year periods (Table 15). This pattern has also persisted over the longer term, with a large and fairly steady decline in numbers counted at Farewell Spit, and a smaller decline at the Firth of Thames since 1960, both of which were balanced by an increase at Manukau Harbour over the same period (Veitch & Habraken 1999; Schukard 2002). This study suggests that between 1994 and 2003 the numbers of birds at the Firth of Thames and Kaipara Harbour have started to increase again, while there have been declines at Farewell Spit and Manukau Harbour. This shows that lesser knots are far more dynamic spatially than any other species of wader in New Zealand and are thus best monitored by a nationwide count.

Turnstones are one of the less common long-distance migrants, with a flyway population of 35 000 birds (Bamford et al. 2008). The New Zealand population of 2500 birds comprises about 8% of this total. In the previous decade, Sagar et al. (1999) suggested that 18% of the population migrated to New Zealand; in the decade of this study, the Australian estimate rose as the New Zealand one decreased (Table 24). Considering data from both sets of counts, the New Zealand turnstone population has been in almost continual decline since 1983. Since the 1960s, the numbers of turnstones at the Firth of Thames and Manukau Harbour increased to reach a peak in the 1980s and then they began to decline again (Veitch & Habraken 1999). At these sites, the numbers counted during this study were close to those from 40 years earlier.

The other species of Arctic migrants in New Zealand are much less common and make up only a very small proportion of the flyway populations. Of these species, only red-necked stints and pectoral sandpipers appear to have occurred in similar numbers to the previous decade. The apparent decline in whimbrel and eastern curlew numbers is small, but Pacific golden plover and curlew sandpiper counts have more or less halved, while counts of sharp-tailed sandpipers are down by more than two-thirds.

4.2 SITE USE DURING THE NON-BREEDING SEASON

4.2.1 New Zealand breeders

While winter counts of New Zealand breeders generally exceeded summer counts, the reverse was true for banded dotterels and pied oystercatchers from the Southland region, and for pied stilts from Lake Ellesmere (Te Waihora) south to Southland. Extensive banding projects with banded dotterels (Pierce 1999) and pied stilts (Dowding & Moore 2004) in New Zealand showed that both species were divided into sub-populations that had different migratory behaviours and that utilised different wintering sites. The pied oystercatchers monitored by these counts showed similar differences between sites in the way their counts changed seasonally, suggesting that they may also have a structured population; for example, most of the birds from Southland seem to migrate away from the region in winter.

For these species, the higher numbers of birds counted in summer at southern sites will have consisted partly of relatively sedentary coastal and lowland breeders, and perhaps failed breeders from inland sites. In addition, pre-breeding age banded dotterels, pied stilts and presumably pied oystercatchers migrate

toward the breeding areas (Sagar et al. 1999; Dowding & Moore 2004), which may explain the higher numbers at nearby sites. There was also an increase in wrybills during summer at Lake Ellesmere (Te Waihora) (Table 7). Since about half of the young birds return south in spring (Davies 1997), some of these are likely to have been young birds that had not yet established a breeding territory. Similarly, banded dotterel numbers were relatively high during summer in the Hawke's Bay and Canterbury regions, suggesting that young birds may also be congregating on the coast near these important inland breeding sites.

4.2.2 Arctic migrants

Provided they are able to build up sufficient energy reserves, adult Arctic migrants are expected to return to their breeding sites in the austral autumn. The majority of the populations that remain during the austral winter are usually composed of young birds that have not reached breeding age. Even the apparently higher proportion of adult lesser knots in winter may simply reflect difficulties in aging some birds (Battley 1999). If the relative quality of the sites is the same in winter as it is in summer, a similar proportion of the summer flocks of Arctic migrants might be expected to remain over winter at each site. This was true for bar-tailed godwits, with the proportion of the summer flock counted during winter varying little between most sites. In contrast, lesser knots showed a quite different pattern, with only a very small proportion of the summer flock (2%–6%) remaining at most sites except Manukau Harbour (17%), which equated to an average of 78% of the national population in winter. Turnstones appeared to be intermediate, with about 10% of the summer totals remaining at most sites, but fewer in the Southland region and, perhaps, more at Farewell Spit.

Regional differences in the seasonal use of some sites by lesser knots and probably also turnstones suggested local movements within New Zealand. Presumably this reflects changes in food supply, perhaps exacerbated by the winter climate. Given the predominance of pre-breeding birds in the flocks remaining over the southern winter, the favoured sites are disproportionately important for the recruitment of breeding adults. An example of this is the premier importance of Manukau Harbour for lesser knots.

4.3 CHANGING SITE USE

Among the trends and fluctuations in this dataset there seems to have been a consistent shift in importance between the Firth of Thames and Manukau Harbour for several species. For example, traditionally, the Firth of Thames has been the main wintering site for wrybills, but Veitch & Habraken (1999) noted a difference in trends between counts at the two sites, with numbers apparently beginning to converge since the 1980s. This trend has continued, resulting in more birds being counted at Manukau Harbour than at the Firth of Thames since June 2000. Similarly, there were consistently more lesser knots on the Firth of Thames until the late 1970s (Veitch & Habraken 1999), following which the number of birds declined on the Firth of Thames and increased at Manukau Harbour. This trend may be reversing now, with an increase in numbers on the Firth of Thames and a decrease at Manukau Harbour between the 1983–1994 and 1994–2003 periods. Manukau Harbour has also become increasingly important

as an overwintering site for lesser knots and birds may congregate there from throughout New Zealand.

Numbers of less common species at these two sites have also been affected. Counts of Pacific golden plovers have declined during the two count periods to c. 25% and 13% of their previous totals at Manukau Harbour and the Firth of Thames, respectively. When the same data were used by Veitch & Habraken (1999) to compare the 1980s with the 1990s, there was an even larger contrast. Observations throughout the year over the time period covered by these studies showed that the large number of zero counts at Manukau Harbour were a result of birds not being found, whereas the once important roosts on the southern shores of the Firth of Thames have been abandoned (Tony Habraken, OSNZ, pers. comm.). The only well-known and well-counted site where numbers of red-necked stints have declined was the Firth of Thames; numbers at Manukau Harbour remained stable. While the number of curlew sandpipers has halved nationally since 1983–1993, the number at the Firth of Thames has declined by 75%; Manukau Harbour was the only site where numbers increased, making it the second most important site in the country, even though this species was rarely seen there before 1992 (Veitch & Habraken 1999). The number of eastern curlews visiting New Zealand, including the Firth of Thames, has decreased recently; however, the population at Manukau Harbour has risen and perhaps now stabilised (Veitch & Habraken 1999).

While the Firth of Thames and Manakau Harbour are the best monitored sites, there may also have been long-term changes elsewhere. Between 1983 and 2001, numbers of pied oystercatchers declined at Golden Bay and Tasman Bay, but increased at Farewell Spit (Schukard 2002). Between the 1983–1994 and 1994–2003 periods, all three sites had statistically significant declines, unlike the Firth of Thames, Kaipara Harbour and Manukau Harbour, where the number of pied oystercatchers increased. Numbers of lesser knots declined even more substantially at Farewell Spit than anywhere else during this study, following on from a long period of decline there (Schukard 2002).

These changes in counts of particular species at specific sites that do not reflect the wider trend might reflect impacts from local habitat change. It has been shown that black-tailed godwits in England maintain a fairly constant population size at good non-breeding sites, where birds have a higher prey intake, better survival and earlier arrival on the breeding grounds, whereas the population varies greatly at poorer sites (Gill et al. 2001). Where populations have generally declined, it could be argued that proportional changes in counts may reflect differences in habitat quality. This may be the case for the increased proportion of lesser knots using Manukau Harbour in winter, which may simply highlight the premium importance of that site for this declining species. Wrybills, on the other hand, have clearly maintained a constant population, and if their numbers reflect site quality, then there must have been habitat changes underlying the shift of the main population from the Firth of Thames to Manukau Harbour. Also convincing are the counts of curlew sandpipers and eastern curlews, which show quite different trends at Manukau Harbour and the Firth of Thames than seen across the country as a whole. There has been speculation that the increasing area of mangroves (*Avecinnia marina*) on the Firth of Thames may have been responsible for this shift (e.g. Riegen & Dowding 2003), but there have been

many changes to the habitats at both sites (Veitch & Habraken 1999) that could have impacted on the habitat quality for wading birds.

In at least some of these cases, birds do actually seem to have shifted sites, suggesting changes in habitat quality have occurred rather than preferential declines of these species at poorer sites. Species such as the wrybill and lesser knot, which depend on a very small number of sites nationally, are clearly vulnerable to changes at their wintering sites.

4.4 ARCTIC MIGRANTS, NEW ZEALAND AND THE EAST ASIAN FLYWAY

Unfortunately, the decline in so many wader populations in New Zealand is not unexpected. There appears to be a widespread trend for declining wader populations, particularly for long-distance migrants. Of 207 populations worldwide for which trends are known, 92 (44%) have decreased and only 27 (13%) have increased (Zöckler et al. 2003). Although these declines are almost universal, the causes of them are hard to pin down, with many different reasons being suggested in different studies (Zöckler et al. 2003). It may be fair to characterise these causes as being related to either climate change or varied human pressures on specific habitats along the flyway. It has been suggested that climate change may be having a long-term impact on ruff (*Philomachus pugnax*), but it is a difficult phenomenon to prove (Zöckler 2002).

Breeding success may affect the numbers of at least some wader species. When species sharing the same breeding areas show similar trends in the proportions of yearling birds in their flocks but different trends from those nesting elsewhere, it may be fair to suspect that factors such as predation pressure and weather conditions operating on the breeding sites are important (Minton 2003). However, there are wider concerns too.

Recent research indicates that the links on a flyway are tight and interdependent, with the birds operating near the limits of their capabilities. To make the prodigious flights necessary to link the sites they use through the year, migratory waders reorganise their whole body. For instance, in lesser knots the wing and heart muscle masses increase along with fat and protein reserves, while non-essential organs such as the gut, kidneys and leg muscles reduce in size (Battley et al. 2000). In spite of this, wind assistance may still be required for lesser knots to carry out their migration within their energy budgets (Piersma et al. 1991), which must place these birds under extreme selective pressure to meet the demands of preparation for and recovery from migration on top of breeding and moulting.

Better non-breeding sites, where there is enhanced prey uptake and survival, allow the earlier departure of migrating black-tailed godwits, which, in turn, has been shown to influence breeding site quality and productivity (Gunnarsson et al. 2005). Early arrival at staging sites before the food is depleted is expected to be advantageous (Drent et al. 2003; Schekkerman et al. 2003), and food failure at staging sites can be critical. This has been shown for lesser knots (*Calidris canutus rufa*) staging at Delaware Bay, where catastrophic food failure due to overharvesting of horseshoe crabs (*Limulus polyphemus*) had critical

impacts, leading to loss of body condition followed by dramatically reduced productivity, recruitment and adult survival, and a loss of 50% of the wintering population between 2000 and 2002 (Baker et al. 2004; Morrison 2006). However, more subtle effects will also cause population declines. Commercial dredging of shellfish in the Dutch Wadden Sea led to annual declines of 2.6% in the settlement of young cockles and an 11.3% annual decline in food quality (flesh to shell ratio) for lesser knots (*Calidris canutus islandica*), reducing their survival. A third to a half of the entire population of this subspecies winters or stages in the Dutch Wadden Sea and the decline observed there was sufficient to account for the 25% decline recorded throughout northwestern Europe between 1997–8 and 2002–3 (van Gils et al. 2006). European oystercatchers (*Haematopus ostalegus*) are also sensitive to the amount of food available in winter, so that shellfishing leads to reduced body condition and survival (Stillman et al. 2003; Atkinson et al. 2005; Verhulst et al. 2004); a concurrent decline in breeding success was also observed, but the link between this and shellfishing was not tested (Verhulst et al. 2004). Many birds were dying when only a fraction of the available food was consumed, as dominance relationships led to the exclusion of some birds from preferred feeding sites (Stillman et al. 2003).

For bar-tailed godwits (*Limosa lapponica taymyrensis*), many key parameters that are probably related to breeding success, and short- and long-term survival seem to be already determined when they arrive at their spring staging site on the Dutch Wadden Sea. These characteristics appear to be signalled by the intensity of their breeding plumage; however, the fact that plumage colour for individual birds does not seem to vary much between seasons (Drent et al. 2003) suggests that the quality of individuals is determined early in life. Right from their first capture, the body condition index of lesser knots (*Calidris canutus islandica*) captured at a staging site in Iceland was higher in birds that were recaptured in subsequent years than in birds that were not, and this was particularly marked during seasons that had harsh weather with low temperatures or late snow cover (Morrison 2006). This also suggests that bird quality is a lifetime, rather than a seasonal, attribute.

There may be a genetic component to the survival and lifetime productivity of individual birds, but the quality of the habitats they occupy as they mature must also be an important factor in population dynamics. A population of semipalmated sandpipers that was monitored during the last stages of a decline from abundance to extinction actually showed increased breeding success—enough for the population to increase, all things being equal. Unfortunately, the return rates of the adults to the breeding grounds fell, fewer young returned to breed and those that did return bred only once before disappearing. These factors indicate a decline in bird quality and the high breeding success indicates that it happened away from the breeding grounds. Semipalmated sandpipers stage at Delaware Bay and may have been affected by the same food failure that impacted on the lesser knots there; however, the decline in this species has been occurring for at least 50 years and few birds remained by the time this event took place (Jehl 2007). Similarly, a long-term decline in the number of curlew sandpipers overwintering in Victoria, Australia, seems to be a consequence of reduced adult survival rather than breeding failure or the mortality of young birds prior to completing their first migration (Rogers & Gosbell 2006).

It is likely that different species will have evolved different strategies for negotiating the flyway, but that impacts in one place will be quickly felt along the flyway, making it difficult to unravel local effects without making direct measurements. Although speculative, it seems that the quality of non-breeding sites in New Zealand, for example, could have a large influence on the lifetime productivity of birds maturing here as well as affecting the year-to-year survival and productivity of adults. The habitat quality of wintering sites used by sub-adult New Zealand breeding waders may have similar effects, so changes to these habitats (e.g. Veitch & Habraken 1999) must be of concern.

Declines in the numbers of Arctic migrants reaching New Zealand are not, however, necessarily matched by declines elsewhere. For example, although numbers of Pacific golden plovers have fallen severely in New Zealand, in Hawaii this species appears to have benefited from urbanisation and numbers seem to have increased. Thus it is possible that the decline of this species in Australia and New Zealand may be due to 'short stopping' in places like Hawaii (Johnson 2003), where improving conditions allow birds to overwinter closer to their breeding sites. Similarly, one could also speculate that more turnstones and eastern curlews stop over in Australia than formerly, as the populations there appear to have increased while they have declined in New Zealand. Given the indications that young turnstones move from Australia to New Zealand after the main period of migration, there may be less incentive to leave Australia when conditions are more favourable there. This highlights the need to consider the wider context when interpreting these counts.

5. Acknowledgements

This work owes everything to all those people who go out on wader censuses, remarkably often it seems, in the extremes of sun, wind, rain and even snow, to complete these counts. I am also grateful to the regional organisers, in particular Adrian Riegen, who has collated the data, checked it and made it available. I have been particularly dependent on Adrian and Phil Battley for feedback and comments throughout this work, Gillian Vaughan for technical help, David Lawrie for encouragement throughout, and Paul Sagar for reviewing a draft of this report. This research was funded by the Department of Conservation (Science Investigation No. 3599).

6. References

Anon. 2001: Colour flagging protocol for migratory shorebirds in the East Asian–Australasian Flyway. Environment Australia, Canberra. 19 p.

Atkinson, P.W.; Clark, N.A.; Dodd, S.G.; Moss, D. 2005: Changes in fisheries practices and oystercatcher survival and body mass in a marginal cockle fishery. *Ardea 93*: 199–212.

Baker, A.J. 1973: Distribution and numbers of New Zealand oystercatchers. *Notornis 20*: 128–144.

Baker, A.J.; González, P.M.; Piersma, T.; Nile, L.J.; do Nascimento, I.S.; Atkinson, P.W.; Clark, N.A.; Minton, C.T.D.; Peck, M.K.; Aarts, G. 2004: Rapid population decline in red knots: fitness consequences of decreased fuelling rates and late arrival in Delaware Bay. *Proceedings of the Royal Society of London B 271*: 875–882.

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

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. 104 p.

Battley, P.F. 1999: Seasonal mass changes of lesser knots (*Calidris canutus*) in New Zealand. *Notornis 46*: 143–153.

Battley, P.F.; Piersma, T.; Dietz, M.W.; Tang, S.; Dekinga, A.; Spaans, B.; Hulsman, K. 2000: Empirical evidence for differential organ reductions during trans-oceanic bird flight. *Proceedings of the Royal Society of London B 267*: 191–195.

Crossland, A.C. 2001: Long-term changes in numbers of variable oystercatchers (*Haematopus unicolor*) at two wintering sites in Canterbury, South Island, New Zealand. *The Stilt 40*: 2–6.

Davies, S.J. 1997: Population structure, morphometrics, moult, migration, and wintering of the Wrybill (*Anarhynchus frontalis*). *Notornis 44*: 1–14.

Dowding, J.E. 1994: Morphometrics and ecology of the New Zealand Dotterel (*Charadrius obscurus*) with a description of a new subspecies. *Notornis 41*: 221–223.

Dowding, J.E.; Chamberlin, S.P. 1991: Annual movement patterns and breeding-site fidelity of the New Zealand Dotterel (*Charadrius obscurus*). *Notornis 38*: 89–102.

Dowding, J.E.; Moore, S.J. 2004: Habitat networks of the indigenous shorebirds in New Zealand. *OSNZ Contract Report Series No. 1.* Ornithological Society of New Zealand, Wellington. 99 p.

Dowding, J.E.; Murphy, E.C. 2001: The impact of predation by introduced mammals on endemic shorebirds in New Zealand: a conservation perspective. *Biological Conservation 99*: 47–64.

Drent, R.; Both, C.; Green, M.; Madsen, J.; Piersma, P. 2003: Pay-offs and penalties of competing migratory schedules. *Oikos 103*: 274–292.

Fleming, C.A.; Stidolph, R.H.D. 1951: Banded Dotterel inquiry: 2nd interim report. *Notornis 4*: 62.

Gill, J.A.; Norris, K.; Potts, P.M.; Gunnarsson, T.G.; Atkinson, P.W.; Sutherland, W.J. 2001: The buffer effect and large-scale population regulation in migratory birds. *Nature 412*: 436–438.

Gill, R.E.; Piersma, T.; Hufford, G.; Servranckx, R.; Riegen, A. 2005: Crossing the ultimate barrier: evidence for an 11,000 km long non-stop flight from Alaska to New Zealand and Eastern Australia by bar-tailed godwits. *Condor 107*: 1–20.

Gunnarsson, T.G.; Gill, J.A.; Newton, J.; Potts, P.M.; Sutherland, W.J. 2005: Seasonal matching of habitat quality and fitness in a migratory bird. *Proceedings of the Royal Society B 272*: 2319–2323.

Heather, B.D.; Robertson, H.A. 2000: The field guide to the birds of New Zealand, revised edition. Viking, Auckland. 440 p.

Hughey, K.F.D. 1985: The relationship between riverbed flooding and non-breeding wrybills on northern feeding grounds in summer. *Notornis 32*: 42–50.

Jehl, J.R. 2007: Disappearance of breeding semipalmated sandpipers from Churchill, Manitoba: more than a local phenomenon. *The Condor 109*: 351–360.

Johnson, O.W. 2003: Pacific and American golden-plovers: reflections on conservation needs. *Wader Study Group Bulletin 100*: 10–13.

Kaps, M.; Lamberson, W.R. 2004: Biostatistics for animal science. CABI Publishing, Oxfordshire, UK, and Cambridge, Massachussetts, USA. 464 p.

Maloney, R.F. 1999: Bird populations in nine braided rivers of the upper Waitaki Basin, South Island, New Zealand: changes after 30 years. *Notornis 46*: 243–256.

Milton, D. 2003: Threatened shorebird species of the East Asian-Australasian Flyway: significance for Australian wader study groups. *Wader Study Group Bulletin 100*: 105–110.

Minton, C. 2003: The importance of long-term monitoring of reproduction rates in waders. *Wader Study Group Bulletin 100*: 178–182.

Morrison, R.I.G. 2006: Body transformations, condition, and survival in Red Knots *Calidris canutus* travelling to breed at Alert, Ellesmere Island, Canada. *Ardea 94*: 607–618.

Pierce, R.J. 1984: Plumage, morphology and hybridisation of New Zealand stilts *Himantopus* spp. *Notornis 31*: 106–130.

Pierce, R.J. 1999: Regional patterns of migration in the Banded Dotterel (*Charadrius bicinctus bicinctus*). *Notornis 46*: 101–122.

Piersma, T.; Drent, R.; Wiersma, P. 1991: Temperate versus tropical wintering in the world's northernmost breeder, the knot: metabolic scope and resource levels restrict subspecific options. *Acta XX Congressus Interationalis Ornithologici*: 761–772.

Riegen, A.C. 1999: Movements of banded Arctic waders to and from New Zealand. *Notornis 46*: 123–142.

Riegen, A.C.; Dowding, J.E. 2003: The wrybill *Anarhynchus frontalis*: a brief review of status, threats and work in progress. *Wader Study Group Bulletin 100*: 20–24.

Rogers, K.G.; Gosbell, K. 2006: Demographic models for red-necked stint and curlew sandpiper in Victoria. *The Stilt 50*: 205–214.

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

Schekkerman, H.; Tulp, I.; Ens, B. 2003: Conservation of long-distance migratory wader populations: reproductive consequences of events occurring in distant sites. *Wader Study Group Bulletin 100*: 151–156.

Schukard, R. 2002: Wader distribution at Farewell Spit, Golden Bay and Tasman Bay. *Occasional Publication No. 54*. Nelson/Marlborough Conservancy, Department of Conservation, Nelson. 40 p.

Stillman, R.A.; West, A.D.; Goss-Custard, J.D.; Caldow, R.W.G.; McGrorty, S.; Dit Durrell, S.E.A.L.; Yates, M.G.; Atkinson, P.W.; Clark, N.A.; Bell, M.C.; Dare, P.J.; Mander, N. 2003: An individual behaviour-based model can predict shorebird mortality using routinely collected shellfishery data. *Journal of Applied Ecology 40*: 1090–1101.

Tomkovich, P.S.; Riegen, A.C. 2000: Mixing of red knot populations in Australasia: some thoughts. *The Stilt 37*: 25–27.

Underhill, L.G.; Prŷs-Jones, R.P. 1994: Index numbers for waterbird populations. I. Review and methodology. *Journal of Applied Ecology 31*: 463–480.

van Gils, J.A.; Piersma, T.; Dekinga, A.; Spaans, B.; Kraan, C. 2006: Shellfish dredging pushes a flexible predator out of a marine protected area. *Public Library of Science Biology 4*: e376.

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

Veitch, C.R.; Habraken, A.M. 1999: Waders of the Manukau Harbour and Firth of Thames. *Notornis 46*: 45–70.

Verhulst, S.; Oosterbeek, K.; Rutten, A.L.; Ens, B.J. 2004: Shellfish fishery severely reduces condition and survival of oystercatchers despite creation of large marine protected areas. *Ecology and Society 9*: 17. www.ecologyandsociety.org/vol9/iss1/art17/

Watkins, D. 1993: A national plan for shorebird conservation in Australia. Australian Wader Study Group, Royal Australasian Ornithologists Union and World Wide Fund for Nature. RAOU Report No. 90. Melbourne, Australia.

Wills, D.E.; Murray, J.; Powlesland, R.G. 2003: Impact of management on the breeding success of the northern New Zealand dotterel (*Charadrius obscurus aquilonius*) on Matakana Island, Bay of Plenty. *Notornis 50*: 1–10.

Zöckler, C. 2002: Declining ruff *Philomachus pugnax* populations: a response to global warming? *Wader Study Group Bulletin 97*: 19–29.

Zöckler, C.; Delany, S.; Hagemeijer, W. 2003: Wader populations are declining—how will we elucidate the reasons? *Wader Study Group Bulletin 100*: 202–211.

Appendix 1

COMMON AND SCIENTIFIC NAMES OF THE WADERS COUNTED IN NEW ZEALAND BETWEEN 1994 AND 2003

COMMON NAME	SCIENTIFIC NAME
Pied oystercatcher	*Haematopus ostralegus finschi*
Variable oystercatcher	*Haematopus unicolor*
Hybrid oystercatcher	*Haematopus ostralegus* x *unicolor*
Pied stilt	*Himantopus himantopus leucocephalus*
Black stilt	*Himantopus novaezelandiae*
Hybrid stilt	*Himantopus novaezelandiae x leucocephalus*
Northern New Zealand dotterel	*Charadrius obscurus aquilonius*
Southern New Zealand dotterel	*Charadrius obscurus obscurus*
Banded dotterel	*Charadrius bicinctus bicinctus*
Black-fronted dotterel	*Charadrius melanops*
Large sand dotterel	*Charadrius leschenaultii*
Mongolian dotterel	*Charadrius mongolus*
Shore plover	*Thinornis novaeseelandiae*
Wrybill	*Anarhynchus frontalis*
Pacific golden plover	*Pluvialis fulva*
American golden plover	*Pluvialis dominicana*
Grey plover	*Pluvialis squatarola*
Spur-winged plover	*Vanellus miles novaehollandiae*
Turnstone	*Arenaria interpres*
Lesser knot	*Calidris canutus*
Great knot	*Calidris tenuirostris*
Sanderling	*Calidris alba*
Dunlin	*Calidris alpina*
Curlew sandpiper	*Calidris ferruginea*
Sharp-tailed sandpiper	*Calidris acuminata*
Pectoral sandpiper	*Calidris melanotos*
Red-necked stint	*Calidris ruficollis*
Least sandpiper	*Calidris minutilla*
Broad-billed sandpiper	*Limicola falcinellus*
Ruff	*Philomachus pugnax*
Eastern curlew	*Numenius madagascariensis*
Whimbrel	*Numenius phaeopus*
Little whimbrel	*Numenius minutus*
Eastern bar-tailed godwit	*Limosa lapponica baueri*
Black-tailed godwit	*Limosa limosa melanuroides*
Hudsonian godwit	*Limosa haemastica*
Wandering tattler	*Tringa incana*
Grey-tailed tattler	*Tringa brevipes*
Marsh sandpiper	*Tringa stagnatilis*
Terek sandpiper	*Tringa terek*
Red-necked phalarope	*Phalaropus lobatus*

DOC Research & Development Series

DOC Research & Development Series *is a published record of scientific research carried out, or advice given, by Department of Conservation staff or external contractors funded by DOC. It comprises reports and short communications that are peer-reviewed.*

Individual contributions to the series are first released on the departmental website in pdf form. Hardcopy is printed, bound, and distributed at regular intervals. Titles are also listed in the DOC Science Publishing catalogue on the website, refer www.doc.govt.nz under Publications*, then* Science & technical.

New Zealand Government