SIZE, AGE STRUCTURE AND MORPHOMETRICS OF THE SHORE PLOVER POPULATION ON SOUTH EAST ISLAND

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ABSTRACT

The previous distribution of the Shore Plover (*Thinornis novaeseelandiae*) and the possible reasons for its decline are outlined. The species is now confined to one small population on South East Island (Rangatira) in the Chatham Islands. In January and February 1993, we captured and banded or re-banded about 95% of this population and determined its age structure. Excluding juveniles of the 1992-93 season, 55% of the population is aged 6 years or less, 31% is aged between 7 and 12 years, and 14% is aged 13 years or more. The oldest bird currently alive is 18 years old. Estimates of population size and productivity for the season are compared with previous (mostly unpublished) records.

Morphometric data are presented; there are small but significant differences in total head length, bill and tarsus between adult males and females, and in weight, wing and mid-toe between adults and 1-year-olds. In January, primary moult was more advanced in 1-year-olds than in adults.

INTRODUCTION

The Shore Plover (*Thinornis novaeseelandiae*) is a wading bird endemic to New Zealand, at present confined to a single wild population of about 130 birds. It is classified as endangered (Bell 1986) and sometimes included in the genus *Charadrius* (e.g. Sibley & Monroe 1990). There is little reliable information on the previous distribution of the species but in the early-mid 19th century it was probably widely distributed around the coast of the South Island. It was also reported from the North Island (e.g. Hutton 1869, Buller 1882) but those records, and the suggestion that the species bred in the South Island and wintered in the north (Hutton 1901), have been questioned by Sibson (1982). It seems possible that some records (in both North and South Islands) resulted from mis-identification of Turnstones (*Arenaria interpres*) (Sibson 1982, Davis 1987). The last reliable mainland New Zealand record was at Waikawa River, Otago, in or before 1872 (Potts 1874), after which the only definite records are from the Chatham Island group. The species was found on Mangere and Pitt Island in 1871 (Travers & Travers 1873), but disappeared from both after cats (*Felis catus*) were introduced (Fleming 1939). There are apparently no sight records from Chatham Island, but sub-fossil remains are present (Checklist Committee 1990). It is generally assumed that cats and/or Norway rats (*Rattus norvegicus*) were responsible for the decline of the Shore Plover (Davis 1987), as the species disappeared from the New Zealand mainland before ship rats (*R. rattus*) or mustelids were widespread. With the exception of a few vagrants to other islands in the Chathams group (particularly Pitt Island), the Shore Plover has apparently been confined to South East Island (Rangatira) since the 1880s or early 1890s. Hundreds of birds were removed from this population by commercial

collectors between 1890 and 1910 (D.V. Merton & B.D. Bell, *Endemic birds of the Chatham Islands,* unpubl. MS, NZ Wildlife Service).

The first detailed description of Shore Plover behaviour and habitat was that of Fleming (1939), who visited South East Island in December 1937. He found 52 pairs and estimated that there were 70 pairs in total. At that time the island was grazed and some pairs were nesting on pasture in the central part of the island (C.A. Fleming, Sketch Maps of South East Island, NZ Wildlife Service file 33/5/59). They were similarly recorded from grassy slopes near the summit in 1954 (Dawson 1955). The last sheep were removed in 1961 (Bell 1974) and the number of breeding pairs fell as pasture became overgrown (Flack 1976). Since then, Shore Plovers have bred only on coastal rock platforms and on the Clears, an open, exposed area of low, sparse vegetation at the southern end of the island. The NZ Wildlife Service began surveys in the late 1960s (Flack 1976) and colour banding in 1970. Since the late 1970s, there have been regular surveys and juveniles have been banded in most years, so that currently much of the population is individually colour banded. A detailed study of the species was undertaken by Davis (1987), who described breeding biology, habitat use, and productivity in relation to environmental factors.

Because Shore Plover exist in one small, vulnerable population, accurate and regular monitoring is important. Analysis of banding records and recent sightings suggested that some birds were carrying duplicated combinations and that others had lost colour bands, so that many sightings were no longer reliable. In the 1991-92 season, the Department of Conservation (DoC) began a project to restore the banding programme to order. As part of this project we visited South East Island in January and February 1993 to band or re-band as many Shore Plover as possible. We took the opportunity to describe the age structure of the population accurately from recaptures, and to collect morphometric and moult data.

STUDY AREA & METHODS

South East Island lies 2.1 km to the south-east of Pitt Island in the Chatham Islands, at 44°21′ S 176°10′ E. It is about 220 ha in area; descriptions of topography, vegetation, and Shore Plover distribution on the island are given by Fleming (1939) and Davis (1987). We visited South East Island from 4 January to 4 February (JED) and from 4 February to 2 March 1993 (ESK); we also had available the results of a survey by ESK and S. Phillipson in November 1992. Shore Plover pairings were recorded in early January and from November survey sightings; by late February, some birds were less territorial and identifying pairings was more difficult.

Birds were captured on noose-mats. These are a modification by JED of the technique used by Page *et al.* (1983) to catch Snowy Plovers (*Charadrius alexandrinus nivosus*), and have been used to capture NZ Dotterels (*C. obscurus*) since 1991. Each mat consists of a strip of plastic mesh (mesh size c. 45 mm) approximately 700 mm long x 90 mm wide, to which monofilament nylon nooses (loop diameter 40-45 mm) are attached. Details of how nooses are tied have been filed with the Banding Office, Department of Conservation, Wellington. Mats are pegged, tied, or weighted down. Birds

are walked over them and become caught by the feet (usually around the tarsus). All birds captured were given a size C metal band on the left tibia and two coloured plastic butt bands (ID = 4 mm, made of UV-stable Darvic PVC) on each tarsus. Butt ends of plastic bands were spot-welded using a small butane-powered soldering iron.

In January and early February, morphometric and moult data were collected by JED. Birds were weighed to the nearest gram with a 100 g Pesola balance. Wing (flattened but not straightened) and tail measurements were to the nearest millimetre; wing measurements were excluded from analysis if the outer primaries were in active moult. Tarsus, total head length (THL, measured from the tip of the bill to the back of the head), exposed culmen (bill) and mid-toe & claw (MTC) were recorded to the nearest 0.1 mm using Vernier calipers. Means of measurements were compared using Students *t*-test, sex ratios were tested using a χ^2 test, and correlations were tested by computing the correlation coefficient *r* (Sokal & Rohlf 1981). Probability <0.05 was considered significant. Moult of primary and secondary feathers was scored by standard techniques (Ginn & Melville 1983).

RESULTS

Population size and productivity

Excluding two chicks not known to have fledged, we captured or recaptured 125 birds. We also saw six others, giving an estimated population of 131. These consisted of 41 pairs, 24 apparently unpaired birds (see below), and 25 fledged juveniles. Productivity in the 1992-93 season was therefore 0.61 chicks fledged per pair. In Table 1, these figures are compared with previous records.

Band status and age structure

The band status of the 125 birds captured is shown in Table 2. Excluding juveniles of the season, at the start of our study there were 95 previously banded birds, of which only 21 were colour banded, retained all their bands, and were not potential duplicates.

Figure 1 shows the age structure of the population. Most birds had been banded as juveniles and were therefore of known age; birds banded as adults or 1-year-olds are shown separately as birds of minimum age. We captured 10 known 1-year-old birds and two thought to be 1-year-olds (from the advanced state of their primary moult - see below); none of the 12 appeared to be paired. The 24 unpaired birds were 9 males and 15 females; this was not significantly different from an even sex ratio ($\chi^2 = 1.5$, d.f. = 1, P = 0.22). Of the 16 unpaired birds of known age, 13 were either 1 or 2 years old.

We believe that in most cases, values for minimum age birds are the same as (or very close to) their real ages. (See Discussion - most birds that escaped banding in their natal season were banded within one or two years.) If the population is divided into three broad age classes and minimum age birds are included, the age structure of the population can be summarised as in Table 3. There is no significant difference from an even sex ratio in any of the three age classes. (For old birds $\chi^2 = 2.57$, d.f. = 1, P = 0.1)

TABLE 1 — Records of Shore Plover population size and productivity on South East Island, 1937 — 1993

date	observer and source	pairs	non-breeding birds	total adults	productivity (fledglings/pr)	total autumn population*
Dec 1937	Fleming (1939)	52-70				
Nov 1961	B.D. Bell (quoted in Flack 1976)	min. 47				
summer 1968	B.D. Bell (CSN 19: 49)			*c.* 100		
1968-70	D.V. Merton (quoted in Flack 1976)			77-90		
Mar 1972	Phillips (1977)					82
Feb 1973	Merton & Bell (unpubl. MS, NZ Wildlife Service)					81
1972-75	Flack (1976)	33-40		68-82		
Jan 1981	J.&B. Seddon (CSN 29: 62)					145
Nov-Dec 1981	T.G. Lovegrove (CSN 29: 62)			101		
Jan 1982	D. Crouchley (Wildlife Service file 33/5/59)	40	26	106		
1982	Hayman *et al.* (1986)	*c.* 40				140
Oct-Dec 1982	A. Munn (Wildlife Service file 33/5/59)	*c.* 35		*c.* 113		
Nov-Dec 1983	A. Munn (Wildlife Service file 33/5/59)	40	10	90		
1984-85	A. Davis (Shore Plover Recovery Plan)	44	37	125	0.89	
1985-86	A. Davis (DoC file 2/10/10/3)	44	28	116	0.64	
autumn 1986	Species log, South East Island				0.47	
1986-87	A. Davis (Shore Plover Recovery Plan)	43	32	118	0.58	
Feb 1987	A. Hemmings (unpubl. report, Auckland University)			104		129
1987-88	A. Davis (DoC file 2/10/10/3)	43	min. 24	min. 110	0.49	
Oct 1987	Species log, South East Island			*c.* 114		
Feb 1988	P. Cromarty (DoC file 2/10/17/1)					126
1988-89	A. Davis (DoC file 2/10/10/3)	39	42	120	0.62	
Nov 1989	A. Grant (Species log, South East Island)			114		
autumn 1990	Dilks & O'Donnell (1993)					118
Oct-Nov 1990	Anon (DoC file BIR 016)	43	9	95		
Apr 1991	G. Murman (DoC file BIR 016)					82
1991-92	B. Bell & R. Nilsson (unpubl. report, DoC Canterbury)	43			min. 0.33	105
Nov 1992	E. Kennedy & S. Phillipson (DoC file BIR 016)			103		
Jan-Feb 1993	this study	41	24	106	0.61	131

*includes fledged young of the year

TABLE 2 — Band status of 125 Shore Plovers captured in January and February 1993. Two birds banded as pulli and not known to have fledged are excluded.

Band status	Number of birds (%)
Unbanded fledged juveniles of 1992-93 season	25 (20.0)
Previously unbanded adults/one-year-olds	5 (4.0)
Previously metal-banded adults/one-year-olds	6 (4.8)
Metal listed but no colour combination recorded	2 (1.6)
Birds banded but no record of when or where	6 (4.8)
Birds carrying wrong colour combination for metal number	5 (4.0)
One or more colour bands lost	20 (16.0)
Birds carrying potential duplicate combinations	35 (28.0)
Carrying complete, correct combinations and not potential duplicates	21 (16.8)

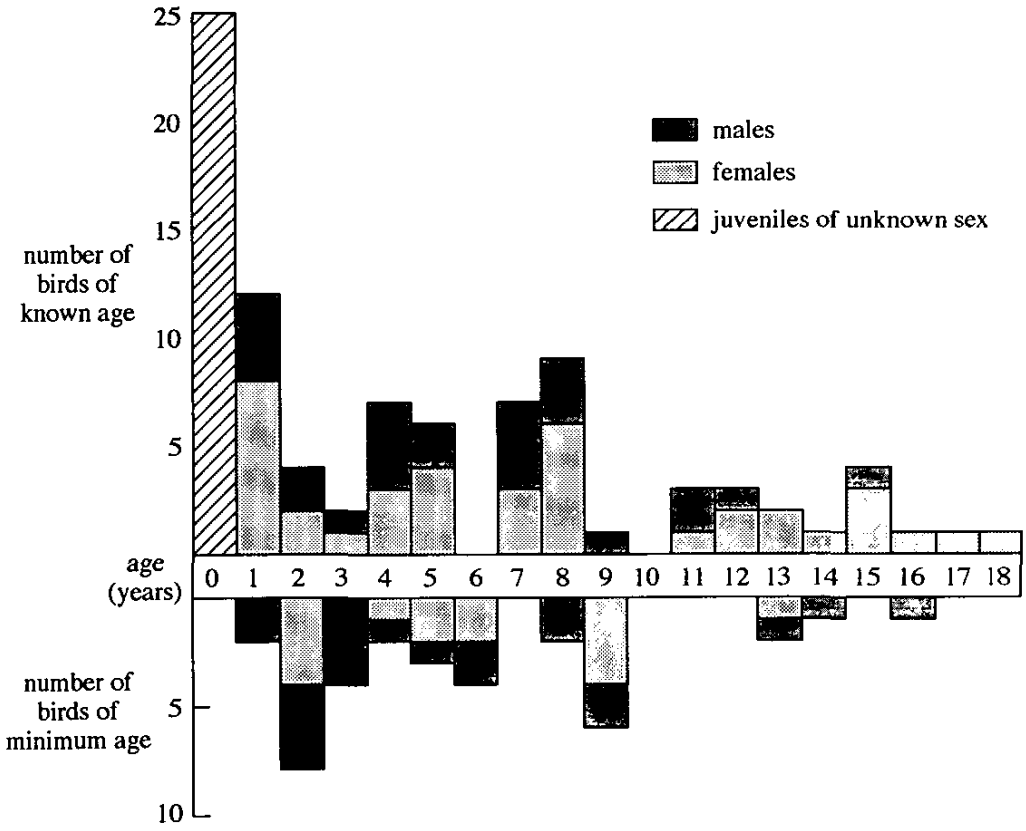

FIGURE 1 — Age structure of the Shore Plover population on South East Island, January-February 1993

TABLE 3 — Summary of the age structure of the Shore Plover population, including birds of minimum age and excluding juveniles of the 1992-93 season

Age class (years)	Males	Females	Total (%)
Young (1 - 6)	27	27	54 (55)
Middle (7 - 12)	15	16	31 (31)
Old (13-18)	4	10	14 (14)
Totals	46	53	99

Morphometrics

Measurements and weights of adult Shore Plovers (2 years and older) are shown in Table 4. There are statistically significant (but small) differences between males and females in THL, bill, and tarsus.

There are also significant differences between adults and 1-year-olds in weight, wing and MTC (Table 5). The difference in tarsus was on the borderline of significance, and differences in tail, THL, and bill were not significant.

Chicks can fly before reaching 1-year-old or adult weight; 16 fledged (but dependent) chicks caught between 10 Jan and 2 Feb averaged 44.1 g (SD = 4.81, range = 34-53).

TABLE 4 — Comparison of measurements and weights of adult male and female Shore Plovers

Measurement	Sex	Mean (SD)	Range	n	P
WING	M	122.9 (2.1)	118 - 127	36	0.56
	F	122.7 (2.5)	118 - 127	35	
TAIL	M	60.1 (2.5)	53 - 64	36	0.65
	F	60.3 (2.2)	56 - 65	35	
THL	M	49.5 (1.07)	48.0 - 52.1	36	0.0008
	F	48.7 (0.83)	46.7 - 50.6)	35	
BILL	M	23.6 (0.94)	22.0 - 26.4	36	0.003
	F	23.0 (0.78)	21.2 - 24.2	35	
TARSUS	M	24.9 (0.61)	23.6 - 25.8	36	0.014
	F	24.5 (0.59)	23.2 - 25.5	35	
MTC	M	23.9 (0.53)	22.8 - 25.0	36	0.32
	F	23.7 (0.60)	22.1 - 25.0	35	
WEIGHT	M	61.8 (3.1)	56 - 69	35	0.46
	F	61.2 (3.4)	56 - 69	36	

TABLE 5 — Differences in measurements and weights of adult and 1-year-old Shore Plovers

Measurement	Age	Mean(SD)	Range	n	P
WING	Adult	122.8 (2.3)	118 - 127	71	0.0001
	1-year-old	118.9 (1.3)	117 - 121	7	
MTC	Adult	23.8 (0.56)	22.1 - 25.0	71	0.0011
	1-year-old	23.1 (0.57)	22.3 - 23.9	8	
TARSUS	Adult	24.7 (0.62)	23.2 - 25.8	71	0.05
	1-year-old	24.2 (0.74)	23.1 - 25.3	8	
WEIGHT	Adult	61.5 (3.2)	56 - 69	71	0.0001
	1-year-old	56.8 (1.7)	54 - 59	9	

Moult data

Primary moult in the Shore Plover is descendant. Figure 2 shows primary moult scores of 61 birds (52 adults and nine known 1-year-olds) in active primary moult. From 7 to 11 January inclusive, only 4 of 15 adults captured were in active primary moult. In the period 31 January to 3 February, all 13 adults captured were in active primary moult. Excluding eight birds which had just begun primary moult (P1 dropped or in pin), most moulting birds had two or three primaries active at a time; of 53 birds, six (11%) had one primary active, 24 (45%) had two, 19 (36%) had three, three (6%) had four and one (2%) had five. Eight birds (all captured after 22 January) were in active primary and secondary moult. A plot of primary *vs* secondary moult scores of these birds (not shown, $r = 0.79$ $P = 0.019$) suggests that on average secondary moult begins at a primary moult score of 23.

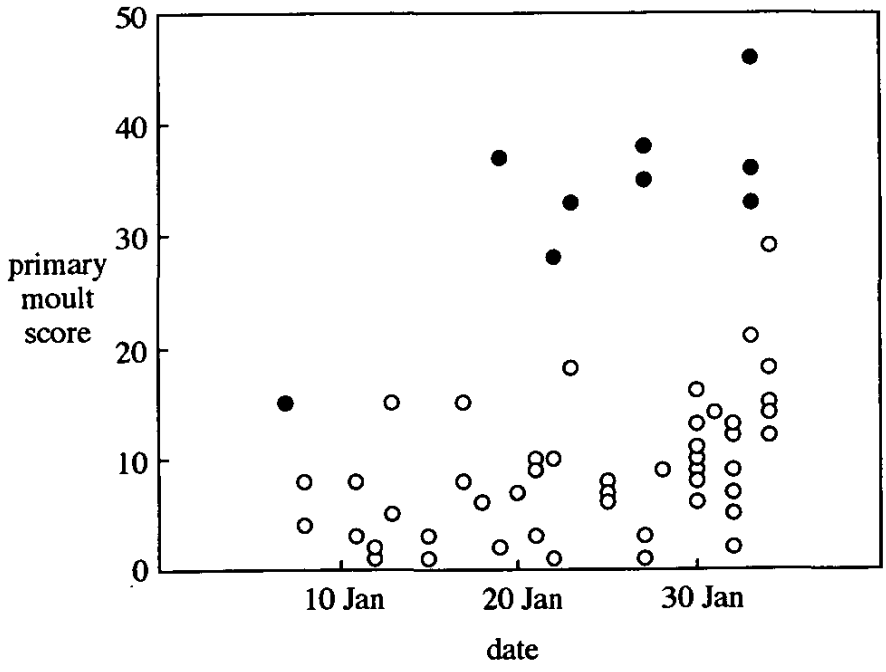

FIGURE 2 — Primary moult scores of Shore Plover in active primary moult in January and early Februrary 1993. Closed circles (●) are known 1-year-old birds.

DISCUSSION

Population size and distribution

During the past 10 years, the Shore Plover population appears to have been stable at 39-44 breeding pairs, and an autumn total of about 120-130 birds. We estimated productivity for the 1992-93 season at 0.61 chicks fledged per pair. Our estimates of number of pairs, total population and productivity are typical of the values (Table 1) found in the period 1984-1989 (A. Davis 1988, Shore Plover Recovery Plan *and* DoC file 2/10/10/3), when monitoring was most intensive. Numbers of pairs, total adults, and total autumn population recorded have fluctuated during the past 30 years; some of this fluctuation is undoubtedly real, but there has also been variation in survey effort. In some seasons, the presence of metal-only or unbanded juveniles and unpaired birds (both highly mobile) has made accurate counts more difficult (A. Davis, DoC file 2/10/10/3).

Since the late 1960s, Shore Plovers have been confined to coastal rock platforms and the Clears on South East Island. There is concern that continuing re-growth of vegetation and expansion of the fur seal (*Arctocephalus forsteri*) colony may be reducing the amount and quality of breeding and feeding habitat further, particularly in the southern part of the island (A. Davis 1988, Shore Plover Recovery Plan).

Age structure

At the start of our study, only 22% of the banded birds in the population would have provided reliable information from sightings. Our study, based on metal band numbers of recaptured birds, provides an accurate age structure for the Shore Plover population. There are very few (or no) birds known to be 2-3, 6, or 9-10 years old. Banding records show that these correspond to years when there was little or no banding effort. These three gaps in known ages correspond well to three groups of minimum age birds, because most birds that escaped banding as juveniles in those years were banded in the following year (or within two years in the case of 2-3 and 9-10 year olds). The minimum ages shown for them are therefore, in most cases, the real ages or within one year of them.

Although Shore Plover numbers are apparently stable (Table 1), it is important to know whether the population is ageing, as this could signal low recruitment and give early warning of a possible decline. We found no cause for concern in the age structure of the population in 1993. Although a precise comparison is difficult, the age structure of the population in February 1993 appears broadly similar to that found in February 1986 by Davis (1987). The Shore Plovers on South East Island can undoubtedly reach a considerable age. In 1990, Dilks & ODonnell (1993) recaptured a bird aged 20 years minimum, the oldest bird caught in 1993 was aged 18, and the oldest in 1986 was 17 years minimum (Davis 1987). These are not isolated cases; 14% of the adult/1-year-old population in 1993 was 13 years or older. Our study shows, however, that a high proportion of younger birds was also present; even when juveniles of the season are excluded, more than half the population in 1993 was aged 6 years or less (Table 3). In addition, there was no significant bias in sex ratio in any of the three age classes.

The lack of a significant sex bias among unpaired birds that we found is consistent with the suggestion (Davis 1987) that the number of breeding pairs is limited by availability of breeding habitat, and not by a lack of potential mates. Our observation that no known 1-year-old birds were paired also agrees with the finding that Shore Plovers do not breed until 2 years of age or more (A. Davis 1988, Shore Plover Recovery Plan).

Morphometrics and moult

Fleming (1939) measured seven Shore Plovers of each sex and found males to average slightly larger (but did not analyse the results statistically); Davis (1987) measured 24 birds and described the sexes as similar in size. We found significant but small differences in adult THL, bill and tarsus, with males larger in each case. Other New Zealand plovers show a similar slight sexual size dimorphism. Male NZ Dotterels also average significantly larger than females in THL and tarsus (Dowding, in prep.) and Hay (1984) found that male Wrybills (*Anarhynchus frontalis*) were significantly larger in all measurements except wing length. In all three species the differences are small and there is considerable overlap, so predicting sex in any of them by measurements alone is not completely reliable.

We also found some differences between adults and 1-year-olds; the latter may be lighter in weight because they are immature (i.e. not fully grown) or because they are excluded from the best feeding areas by breeding birds. The average weight of fledged dependent juveniles in our study (44.1 g) is consistent with the average fledging weight of 37 g given by Davis (1987).

More data is needed before the timing and duration of primary moult can be described completely, but it is clear that early in primary moult, 1-year-old birds are more advanced than adults. This is not surprising; among waders, immature or non-breeding birds generally begin moult before breeding adults (Ginn & Melville 1983). The difference may prove useful in ageing Shore Plovers that escape banding in their natal season and are caught the following season.

CONCLUSION

With two Black Robin (*Petroica traversi*) populations established in the Chatham Islands group, the Shore Plover is now the single most vulnerable bird species on South East Island. With a total wild population of about 130 in one location, it is undoubtedly one of the rarest shorebirds in the world (Hayman *et al.* 1986) and must be considered seriously endangered. Historical evidence suggests that the species is particularly susceptible to introduced mammalian predators; although numbers have been roughly constant for some years and the age structure of the population gives no cause for concern, a rat or cat (or possibly weka *Gallirallus australis*) irruption could easily result in the rapid extinction of the species in the wild. The need to establish a second wild Shore Plover population therefore remains extremely urgent.

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