

NEW ZEALAND DOTTEREL: SOUTH ISLAND HISTORICAL NOTES AND SOUTHLAND COASTAL RECORDS

By MAIDA BARLOW

ABSTRACT

Historical records of South Island breeding of NZ Dotterel (*Charadrius obscurus*) are discussed. The latest discovered South Island breeding record was 1881. No record of South Island coastal breeding was found. Numbers of birds wintering on the Southland coast declined substantially and rapidly from 1972 to 1992. The cause of decline is believed to be a decline in the Stewart Island breeding population. Colour-banded adults had allegiance to a specific wintering ground. Food items of birds at Stewart Island included 10-20 mm juvenile flounders.

The current decline of NZ Dotterel in southern New Zealand (Dowding & Murphy, this issue) places a value on previously unpublished records, which are presented here. At the same time it is appropriate to comment on some previously published statements.

SOUTH ISLAND COASTAL BREEDING

Fleming (1982) summarised early NZ Dotterel records. In September c.1840, Earl collected a specimen in breeding plumage at Waikouaiti. It was sent to the British Museum and is illustrated in Gray (1844/45). Buller (1872) had the species "dispersed along the whole of our shores." Oliver (1930) gave no specific information on South Island breeding locations.

Southland

There is no record of coastal breeding on mainland Southland. George Moffett, whom I accompanied on many local field trips in the late 1940s and 1950s, had since c.1890 known of NZ Dotterel about the Southland coast, especially Awarua Bay, but knew of no breeding closer than Stewart Island. My mother, Olga Sansom, believed that, if the species bred anywhere on the Southland coast, it would be along the Tiwai Peninsula and/or the sand-dunes of Fortrose Peninsula, habitat with some similarities to the known breeding habitat at Mason Bay, Stewart Island. In the early 1950s my mother, Mrs Nan Smith (then Miss Dalrymple), Rex Royds and Arthur Hamilton made several trips in the breeding season, searching the 34 km stretch of peninsulas and sand-dunes between Tiwai Point and Fortrose (Figure 1). They found breeding Banded Dotterels (*Charadrius bicinctus*) but no NZ Dotterels and were satisfied that they did not breed there. Much of this area was searched without success four times between 1967 and 1969, twice when I camped on the spit with my family for several days and twice by OSNZ parties which camped there for two and three days. In 1970-71 an aluminium smelter was constructed on Tiwai Point, roading was extended

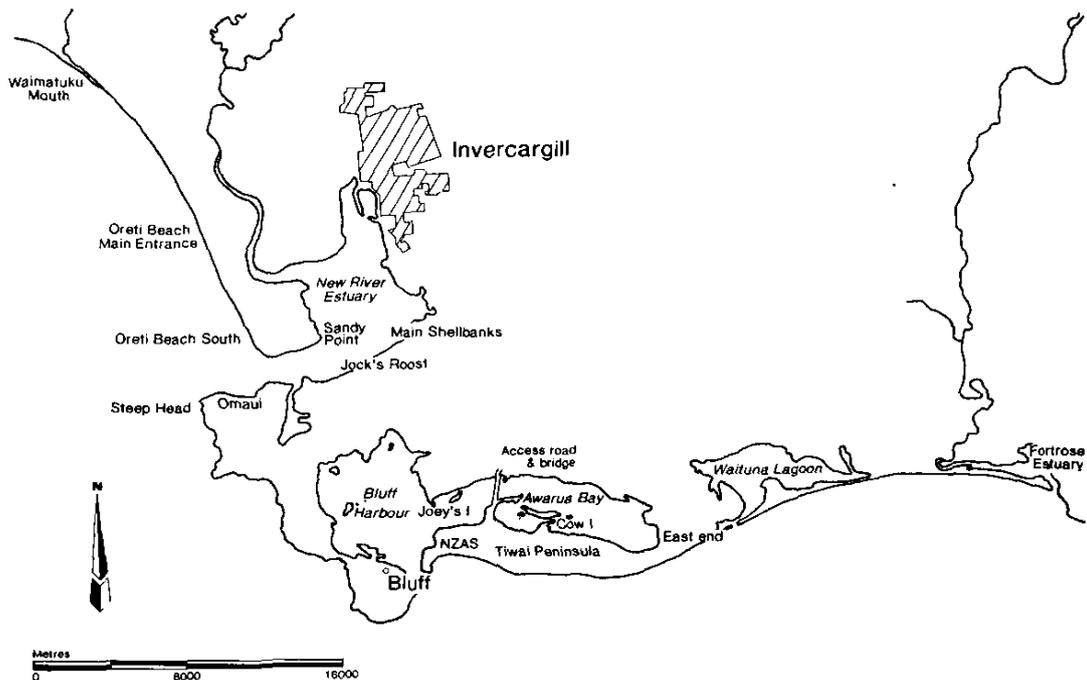


FIGURE 1 — Part of Southland coast, showing localities mentioned in the text

and upgraded and a bridge was built across the neck of Awarua Bay (Figure 1). The peninsula, including the Cow Island area favoured by wintering NZ Dotterels, became more accessible and, after 1971, was visited many times. NZ Dotterels were not found breeding.

Conclusion

Earl's September c.1840 specimen, in itself not evidence of breeding, appears to be the only record in the literature upon which the supposed *coastal* breeding in the South Island has been based. None of the several records on the Southland coast in breeding months have been related to breeding activity. On 14.10.73, I saw a single bird in full breeding plumage on Oreti Beach. It was assumed to be en route to the Stewart Island breeding grounds. On 1.10.55, R.M. Royds saw 10 birds at Waituna Lagoon, of which Edgar (1969:97) wrote: "Even this comparatively late date is not evidence of breeding. . .". On many visits to Waituna by Southland OSNZ members after 1976 the species was recorded only once, a single bird on 22.1.87.

I have therefore no evidence of coastal breeding anywhere in the South Island.

SOUTH ISLAND INLAND BREEDING

Buller (1873) recorded specimens and sightings from "far up in the Southern Alps"; "at nearly 7000 feet"; and "in the Spencer ranges. . . at . . . fully 8000 feet". He quoted Potts's description of nest, eggs and young at the "summit of Dog range in the Ashburton district" and mentioned the "good series of eggs in Canterbury Museum." Later editions gave no new information on breeding. Baker (1932) quoted a 7-page account by surveyor (later Under-Secretary of Lands) T.N. Brodrick. Writing in 1881 from his

camp in the Makarora Valley near Wanaka, Brodrick described several bird species, but principally kakapo and kiwi, their habitats and behaviour. Of NZ Dotterel he wrote: "Above the bush are to be found the . . . mountain plover or dottrel. It is about twice the size of the common dotterel and has more colour on the breast. It makes its nest in coarse grass and its eggs are a great delicacy". Marples (1946) gave the species as then breeding in North, South and Stewart Islands. His list was based on Oliver (1930), modified after reference to post-1930 publications, and information and suggestions from ornithologists. Marples mentioned possible "errors and inconsistencies which may have arisen owing to arbitrary decisions in certain obscure cases which I have made myself." His South Island breeding statement is probably such an error, based on caution at that time of scanty records.

McKenzie & Heather (1985) were openly cautious: "...possibly a small breeding population still exists in the northern highlands of the South Island." This suggestion, based on the small numbers regularly at Farewell Spit, has become less plausible since recent sightings there of Stewart Island-banded birds (Dowding & Murphy, this issue.)

Fleming (1982), quoting Stead (1927), said that by 1927 it had almost disappeared from Canterbury.

I have found no published record of South Island breeding later than Brodrick's 1881 nest and egg description.

Conclusion

Hard facts are few. Early observers seem to have regarded their inland breeding as too commonplace for detailed comment, and so we are left guessing.

RUAPUKE AND STEWART ISLANDS

Hugh Wilson visited Ruapuke in August 1983 and stated (letter to John Dowding 1.8.91): "The only dotterels seen were Banded Dotterels."

I made four visits to the island on 10-12.11.87, 10-11.2.88, 10-11.9.88 and 5-7.10.88. On three of these visits I went round the whole island shore on foot, covered much of the grazed pasture and searched all dunes. In September 1988 I searched the dunes and eastern beaches. I saw no NZ Dotterels. Ruapuke is a staging post for migrating Banded Dotterels (Pierce, in prep.) and may be also for NZ Dotterels.

Guthrie-Smith (1914) described breeding habitat and behaviour at Mason Bay, Stewart Island. My grandmother, Mary Jensen, who was observant of Stewart Island's natural history, spent much time at Mason Bay, especially between about 1930 and 1945. In those years NZ Dotterels were commonly found along the 3 km stretch of beach from Martins Creek to beyond Duck Creek. This section of the 14 km-long beach was backed by a succession of gradually steepening sand-dunes, where the NZ Dotterels bred. They were not found further north towards Mason Head, where the dunes rose steeply from the beach. My uncle Norman Jensen recently confirmed these locations. He spent much time at Mason Bay in 1929-33, knew the species well, and recalled them as being "common in the sandhills and on that part

of the beach." George Leask (1899-1974) ran sheep in the Mason Bay area and spent many months there each year during his adult life. In 1968 Olga Sansom recorded in a notebook that, when riding after sheep, George Leask found NZ Dotterel nests between the big sandhills and the beach on flat places between dunes. The nests were more often further back than nearer the beach. He had also found nests up Stony Creek, which is north of Duck Creek.

Indications of decline

Fleming (1982) believed that total NZ population numbers had "improved slightly, or at worst remained stable, during the past two decades", but for Stewart Island Fleming would have known only of the May 1955 count of over 218, the only published Stewart Island flock (McKenzie & Traill 1956). Certainly the published records indicated that numbers of wintering birds on the Southland coast were falling (see Table 2), but in 1982 both the origin and the status of these birds were unproved. Their numbers could not with assurance be regarded as indicators of the state of the Stewart Island population.

In 1952 or 1953, I was on Paterson Inlet with R.H. Traill and G.I. Moffett. A flock of c.320 NZ Dotterels passed overhead close to the launch, flying east to west between the Neck and the head of the inlet, a 15 km route then commonly used by the species. I was not at the time aware of the significance of the flock size. It was Mr Moffett who had us independently count and recount the birds as they approached, passed over and flew beyond us. He impressed me by saying "Don't forget that number. It's important." Nevertheless I did not write it down. I mentioned it to Ross McKenzie when I first met him in South Auckland in 1954. He visited Stewart Island in May 1955, went up Paterson Inlet with Mr Traill in his launch and saw the flock of 218+ recorded in McKenzie & Traill (1956). Having no written record or firm date, I have not previously reported the earlier sighting. Now, with further evidence of decline of the species (Dowding & Murphy, this issue) I place it tentatively on record, together with the following previously unpublished Stewart Island sightings from my diaries:

1952 or 1953	Paterson Inlet: c.320 (MB, G.I. Moffett, R.H. Traill)
26.1.65	Mudflat Island, Freshwater River mudflats: 28 (MB, O. Sansom, R.H. Traill)
Aug/Sept. 1965	Mudflat Island: 50+ (O. Sansom)
5-9.1.67	Mason Bay, Duck Creek to Martins Creek: max. 18 (MB, O. Sansom)
19.8.68	Freshwater River mudflats: 52+ (C.E. Barlow)
10-14.12.77	Freshwater River mudflats: max.5 (MB, G.G. Allen, R.R. Sutton, S.L. Lobb)

BANDING ATTEMPTS

On 1.4.85, R.R. Sutton and I clap-trapped three birds at Awarua Bay and colour-banded them W/RM. Table 1 gives their measurements.

TABLE 1 — Measurements (mm)

Bill length	28	30	30
Bill depth at widest point	9	10	10.5
Tarsus length	38	39	40
Mid-toe and claw length	28	30	32
Wing length	160	165	170
Tail length	67	65	83
Weight (g)	168	170	176

Measured with Vernier calipers and a rule; weighed in a bag with a Salter 200 g spring balance.

The three banded birds were seen again at the bay on 30.4.85 and 17.6.85 and one on 13.8.85. None was seen on Stewart Island. One W/RM wintered on Awarua Bay in 1986, 1987, 1988 and 1989, indicating strong site allegiance in winter.

Not until 29.1.89, when Stewart Island-banded birds (Dowding & Murphy, this issue) were first seen at Awarua Bay, was proof obtained that Awarua Bay winterers come from Stewart Island.

BEHAVIOUR AT AWARUA BAY WINTERING GROUNDS

Distribution: The favoured area was 5 x 1 km of tidal mudflat on the southern shore of the bay. Few other waders used this area, most preferring the bay's other major mudflats 6-8 km to the east at the head of the bay. The NZ Dotterel fed singly or in loose associations of three or four, widely and unevenly distributed over the 5 x 1 km area. They used five high tide roosts, separated by wide stretches of water and channels. Factors which may have influenced the species' preference for this area over the other major wader feeding site in the bay were that

1. It had several alternative roost sites and feeding grounds,
2. Few other wading birds were there, and
3. It was comparatively sheltered from the region's frequent high winds and harsh weather.

Flocking: From their December/January arrival until about June/July, the birds seldom formed a true flock but at high tide gathered in loose, often bickering groups, usually distributed over several of the roosts. Singles, or 2 or 3 birds sometimes flew between roosts. By June/July the birds tended to form more cohesive flocks in the air and on the ground, but singles and groups of 2 or 3 still broke away from the main group or were found widely apart from it.

Observations: There were practical difficulties in counting the birds at Awarua Bay. Roosts and feeding grounds were widely separated. Some intervening channels could not be forded even at low tide. Islands and peninsulas impeded wide views. The number of observers at any one time was small. These, and the birds' behaviour, meant that only by repeated visits could total numbers in any one season be assessed. Observations of banded birds since 1989 have shown that, whereas some individuals were

always found in the bay in any one winter, others were found only sometimes. Therefore counts made on any one day may not be the season's total.

FOOD

Many times I have watched the species taking small mudcrabs (*Helice crassa*) on the Awarua Bay mudflats. On 10.12.77 at Paterson Inlet, Stewart Island, R.R. Sutton (pers. comm.) watched five NZ Dotterels at close quarters by telescope. They were eating small (10-20 mm) flounders (*Rhombosolea* sp.) from shallow pools left on the mudflat by the receding tide.

SOUTHLAND COASTAL RECORDS

Table 2 shows numbers recorded from 1952 to 1992 at Southland coastal sites. Band combinations and breeding plumage colour intensity (on decreasing scale +++ to 0) where known are shown, as are previous publication references. Sightings were mine except where otherwise stated. Other contributors to the records, shown by initials in Table 2, were C.E. Barlow, W.J. Cooper, C. & J. Dainty, M.M. Davis, J.E. Dowding, R.A. Falla, B.D. Heather, A. Hocken, M. & H. Jukes, P. & T. McClelland, K. & J.V. Morrison, P. & W. Muller, B. O'Cain, R.M. Royds, O. Sansom, R.B. Sibson, N. Smith, J.H. Sorensen and R.R. Sutton.

Interpretation of data in Table 2 must allow for the fact that only on the Oreti Beach sections was data collected at regular intervals, and then for only part of the 40-year period. The numbers and regularity of visits varied at different sites in different years. Before 1964 visits to all sites were infrequent, but since 1964 OSNZ members have visited many scores of times without recording the species. Table 2 includes few nil returns, except those at the major wintering site at Awarua Bay's Cow Island. Except for Cow Island in 1985-1992 and Oreti Beach, all sites were visited more often (minimum 4 per year) in the season for transequatorial migrant waders, September to April, than in other months.

The sites

Oreti Beach: Monthly foot patrols of 15 km between the main entrance and Waimatuku Mouth were made 1964-1983 by R.R. Sutton and the writer. Only one NZ Dotterel was seen.

Oreti Beach South: Sightings were made along a 2 km stretch of beach approximately 37 km on a direct line across Foveaux Strait from Mt Anglem, Stewart Island. This section of beach is somewhat sheltered from prevailing south-westerly winds by Steep Head and other Omaui headlands (Figure 1). In 1984-1989 it supported discrete but increasing clumps of marram grass (*Ammophila arenaria*), much wood and marine flotsam and jetsam, and 8-12 breeding pairs of Banded Dotterel. Between January 1985 and December 1988, 56 visits were made at monthly intervals and sometimes more often to collect data on Banded Dotterels. This area was reached from the nearest vehicle access by walking 2 km of comparatively unsheltered and unlittered beach. No NZ Dotterel was seen on this bare section. The sightings predated Stewart Island banding. Although bird identities were not known, sightings (Table 2) suggest that in 1985 and again in 1986 2-4 wintering birds stayed on the littered sheltered section of beach most of the time. Apart from

TABLE 2 — NZ Dotterels counted on mainland Southland coast 1952-1992.
 * = previously recorded in classified summarised notes (*Notornis* — various). Abbreviations — see text.

Date	No. Seen	by	Notes	Date	No. Seen	by	Notes
ORETI BEACH				WAITUNA LAGOON			
*22.03.56	5	BDH, RMR		01.10.55	10	RMR	Edgar 1969:97
14.10.73	1		+++	22.01.87	1		
ORETI BEACH SOUTH				FORTROSE ESTUARY			
07.05.85	4			*10.02.89	1		0 immature
03.06.85	3			AWARUA BAY-COW ISLAND ENVIRONS			
10.06.85	0			*13.07.52	3	RMR	Joey's Island
30.07.85	4			*12.06.54	2	NS, RMR	Joey's Island
*28.08.85	4			*22.01.55	8	RMR, OS, NS	Joey's Island
*09.01.86	1			04.11.67	0	OSNZ Party	
11.05.86	3			23.12.68*	0		
26.06.86	0			23.01.69	51	OSNZ Party	Muller 1969:130
19.07.86	2			*06.05.69	17	RRS	
07.08.86	4		2+++ , 20	22.03.70	14		
10.06.87	3			*02.05.70	32	RRS	
INVERCARGILL ESTUARY				*14.06.70	39	RRS	
Sandy Point				25.06.72	34		
*04.02.52	677	JHS	0	02.07.72	51		
10.01.87	6	CEB		*27.06.76	28	M&HJ	
Main Shellbanks				13.12.76	1		Tiwai Spit
* .03.56	4	BDH, RMR		*27.12.77	5	RRS	
11.04.64	1			26.12.79	0		
02.01.69	3	P&WM	Muller 1969:135	*29.03.80	24		
18.01.69	1	RBS	Immature Muller 1969:135	19.04.80	0		
*27.03.70	7	PM		01.06.80	0		
*07.02.71	3			27.06.80	0		
03.02.74	1			03.01.81	0		
13.12.76	1			*16.02.81	1	K&JVM	
10.01.87	3	PM		26.12.81	0		
Jock's Roost				20.08.83	0		
21.01.69	1	RAF	Muller 1969:135	*04.03.84	15	M&HJ	
16.02.69	7	P&WM	Muller 1969:135	24.06.84	15		3++, 5+, 70
07.02.71	4		2+, 20	*22.07.84	18	WJC	
*20.01.86	3		3+++	*25.07.84	28	JVM	
30.01.86	0			*12.08.84	6	WJC	
16.02.92	2	PM		*16.02.85	1	RRS	near bridge
AWARUA BAY EAST				*17.03.85	21	WJC et.al.	
.01.63	2	OSNZ Party	Muller 1969:130	21.03.85	24		
25.02.68	1			*01.04.85	30		3 trapped/banded W/RM
28.07.68	10	RRS		05.04.85	27		
19.01.69	2	MHD	Muller 1969:135	14.04.85	27	WJC	
22.02.75	20			30.04.85	29		3xW/RM
01.03.75	15			06.05.85	0		shooting season
01.02.76	6			17.06.85	33		3xW/RM
06.02.76	3			29.06.85	32	RRS	
14.02.76	11			02.07.85	0		
19.03.77	7			*08.07.85	21		2++
09.01.78	1			*19.07.85	28	K&JVM	
15.03.80	1		0	*13.08.85	29		20++, 7+, 20, 1xW/RM
07.02.81	1			03.01.86	0		
11.07.92	1		+++ on paddock with B. Dott.	10.01.86	0		
21.07.92	1		+++ " " "	*19.01.86	13		1xW/RM
				01.02.86	27	WJC	
				*03.02.86	22		W/RM
				08.02.86	2	OSNZ Party	

TABLE 2 — Cont'd

Date	No Seen	by	Notes	Date	No Seen	by	Notes
AWARUA BAY							
- COW ISLAND ENVIRONS (cont'd)							
10.02.86	1			06.04.90	1		
*06.03.86	29		W/RM	09.04.90	1		
*21.04.86	29		W/RM	01.05.90	0		
19.07.86	28	K&JVM		29.05.90	0		
10.01.87	1			10.06.90	8	C&JD	
17.03.87	24		W/RM	28.06.90	11		1+++ , 2++ , 4+ , 40
21.04.87	24		W/RM	07.07.90	23	MB, JED	RYW/M, RYB/M, BWY/M
25.07.87	19	KM		29.01.91	0		
*15.02.88	19		W/RM	13.02.91	11	JED	
30.04.88	14		W/RM	11.04.91	14		RYW/M, RYB/M
13.08.88	0	PMcC		23.05.91	13		RYW/M, RYB/M
*29.01.89	12		3++ , 2+ , 30, RYB/M BWY/M				Gammy-leg
11.03.89	9		RYB/M	04.07.91	0		
19.03.89	5		RYB/M	30.07.91	13		RYW/M, RYB/M, 2+++ , 4++ , 2+ , 30
23.04.89	1	B O'C		07.03.92	0		
05.05.89	0			02.04.92	11	JED	
06.05.89	0	B O'C	shooting season	19.04.92	5		RY/M, Gammy-leg
*12.05.89	20		RYB/M, BWR/M, W/RM 10+4+3+1+1+1	10.06.92	13	DoC Party	RY/M, OBW/M, OBY/M, Gammy-leg
*30.06.89	20			12.06.92	5		Gammy-leg
31.07.89	23		RYB/M 0, BWR/M 0 W/RM +++ , 5+++ , 5+ , 90	11.07.92	12	P&TMcC	
.03.90	4	AH		04.09.92	6		2+++ , 1+ , 30

Awarua Bay's Cow Island area, this is the only site where any Southland coastal wintering birds have been known to remain for several months. In 1989, gales and big tides uprooted the marram, eroded the foredunes and cleared the beach of its accumulated debris. Breeding Banded Dotterels left. Since 1988, Lloyd Esler (pers. comm.) has walked this section of beach approximately fortnightly but has seen no NZ Dotterel. Factors which influenced the birds to stay in 1985 and 1986 were unknown but may have included the comparative shelter from the headland, and low shelter and possible amphipod and/or isopod food species (Lloyd Esler, pers. comm.) associated with beach debris. However, these conditions also applied in 1987-89 when there was only one sighting of 3 birds, which did not stay. Awarua Bay's Cow Island area is more sheltered than Oreti Beach. Its only beach debris is a periodic accumulation of storm-torn *Zostera* sp., and the food species of its mudflats (unstudied) would differ from those of Oreti Beach, which is a sandy open surf beach.

Sandy Point: The 4.2.52 record from J.H. Sorensen, recorded as "Oreti", was probably Daffodil Bay, Sandy Point (N. Smith, pers. comm.). Sandy Point is in the estuary of the Oreti River (Invercargill Estuary).

Awarua Bay East: OSNZ members visited this site frequently. Records of small flocks in 1975 and 1976, which apparently stayed for at least 7 and 14 days respectively, were unusual for this site. Cow Island was not visited at the same time.

Awarua Bay's Cow Island and environs: Since 1970, when the building of the bridge across the neck of Awarua Bay substantially altered its environs,

NZ Dotterel have not been seen at Joey's Island (1952-1955 sightings). Joey's Island is 3 km from Cow Island, which was seldom visited before 1969. 1971-1983 visits to Cow Island were more frequent but sporadic. Identification of high tide roosts began in 1984. Many 1985-1986 visits centred on trapping attempts rather than bird counts. From 1989, more frequent visits have been made and results passed on to John Dowding for inclusion in his Stewart Island-based study. In 1992, the Department of Conservation assumed the Cow Island data-collection role.

Rarity at minor sites

Table 2 does not truly demonstrate how rare and sporadic the NZ Dotterel is at minor sites because it records presence and not absence. Being unusual, any sightings of NZ Dotterel at all sites except Awarua Bay's Cow Island would be reported. OSNZ members' visits to and knowledge of the various sites meant that NZ Dotterel, if there, would seldom have been overlooked except in the extensive areas of Invercargill Estuary's main shellbanks, and at Cow Island for reasons previously stated.

Movement

Most birds seen at sites other than Cow Island stayed for short periods of up to several days. Exceptions were those at Oreti Beach South in 1985 and 1986. No banded bird has been seen at the minor sites. Indications are that the minor sites were staging areas for birds in passage.



FIGURE 1 — Presence of NZ Dotterel on Southland coast, based on number of sightings, not number of birds, from 1952 to 1992. Wintering sites were seldom checked in May.

Seasonal movement to and away from the mainland Southland coast is demonstrated in Figure 2. The skew caused by irregularity of visits is somewhat compensated for in Figure 2 by the numbers of visits over a long time frame.

The low May figure should be disregarded because observers seldom visited the sites, apart from Oreti Beach, during the May duck-hunting season.

The January/February and July peaks in Figure 2, which include many occasions when a few birds visited minor sites but did not stay (Table 2), indicate peak passage movement.

Bird numbers

Largest flock sizes on Southland coast each year that flocks were seen, 1969-1992, were

1969	51	1985	33
1970	39	1986	29
1972	51	1987	24
1975	20	1988	19
1976	28	1989	23
1977	7	1990	23
1980	24	1991	14
1984	28	1992	13

The figures show a substantial and rapid decline 1972-1992.

The aluminium smelter

The construction in 1970/71 of the aluminium smelter (New Zealand Aluminium Smelters Ltd), its access road, and the bridge across the neck of Awarua Bay brought major change to the western end of Tiwai peninsula. What effects, if any, these changes had on the mudflats favoured by the NZ Dotterel are not known.

Access is easier than formerly. Even so, non-ornithological visitors were few up to 1992: up to 10 at times in the duck-hunting season and occasional walkers and trail-bike riders.

Apart from low-tide trail-bike access, vehicle access to the mudflat area is only through the smelter plant, where a rigid security system excludes all but bona fide visitors.

Predators seen were stoats (3 sightings); weasel (1 sighting); dogs, few and only with sportsmen in the shooting season and occasionally with walkers. Rats and cats were not seen but probably there. NZAS operates strict rodent and other animal controls within the plant boundary. On more than one occasion feral cats have been eradicated from the plant and its surrounds (K.J. Duke, NZAS Specialist Environmental Officer, pers. comm.).

Effluent: No people live on site at NZAS or on Tiwai peninsula. NZAS employs c.1150 people and has operated continuously since 1971. Sewage effluent is biologically treated to a high degree and is discharged to the western end of Awarua Bay west of the bridge. Cooling, washing, flushing and surface waters are discharged similarly from three points. The waters of Awarua Bay are classified SB and monitored annually by the Southland Regional Council. There have been no instances of non-compliance with the

baseline SB water quality parameters (I.K. Welsh, Water Quality Officer, Southland Regional Council, pers. comm.). Gaseous effluent is discharged continuously from the smelter's 137 m-high stack.

Other species: Apart from NZ Dotterel, no decline was apparent in the numbers of birds or bird species which used Awarua Bay.

Cause of decline

There was no apparent evidence that the smelter and associated works have contributed to the decline in mainland Southland's coastal wintering numbers. The only known factor is the decline of the species at its source on Stewart Island.

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MAIDA BARLOW, 38 Filleul Street, Invercargill