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Birds of the Snares Islands, New Zealand

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Abstract Bird records from the Snares Islands between Dec 1982 and Oct 2000 are summarised. Population estimates and distributions are given for the 29 breeding species. Bird species recorded breeding on the Snares Is for the first time since 1982 were southern black-browed albatross (*Diomedea melanophrys*), Chatham Island albatross (*D. eremita*), mallard (*Anas platyrhynchos*), southern black-backed gull (*Larus dominicanus*), fantail (*Rhipidura fuliginosa*), and starling (*Sturnus vulgaris*). Fantails are now abundant on the Snares Is. Published work on the breeding chronology and breeding success of 8 intensively studied species is summarised, and new information on breeding ecology is presented for all breeding species. Sightings of 70 non-breeding and vagrant species are summarised; 34 of these were new records from the Snares Is since 1980. The total bird list for the Snares Is is now 99 species, with a further 8 species reported from boats offshore.

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INTRODUCTION

The Snares Islands (48°01' S 166°36' E) are a small island group lying 105 km SSW of Stewart I., New Zealand (Fig. 1; Plate 1A). The 2 largest islands (North East I., 280 ha and Broughton I., 48 ha) have forested interiors (almost entirely *Olearia lyalli*) surrounded by tussock grasslands above steep granite cliffs (Fleming *et al.* 1953; Fineran 1964). Most of the islands are cliff-bound (Plate 2A), but 4 major catchments draining to the east coast of North East I. (NEI) open into enclosed bays surrounded by more gentle slopes (Fig 2; Plate 2B) including the location of the biological station on Station Point (Plate 1B). The vegetation is more diverse on the sheltered east coast, with more *Brachyglottis stewartiae* in the canopy, a fringe of *Hebe elliptica*, and ground cover species including the ferns *Polystichum vestitum*, *Asplenium obtusatum*, and *Blechnum durum*, the large leaved punui (*Stilbocarpa robusta*) and the mat-forming herbs *Callitriche antarctica* and *Crassula moschata* (Fineran 1964, 1969). The smaller islets around NEI are mainly bare granite, usually with a cap of *Poa astonii* tussock. However, the largest islet (Alert Stack, 5 ha) has a mixture of *P. tennantiana* and *P. astonii* tussock grassland, similar to the tussock grasslands on NEI and Broughton I. The outlying Western Chain islets (Plate 1A, 8 ha) 4 km southwest of NEI are largely devoid of vegetation, but Tahi and Toru Islets have small caps of *P. astonii* (Miskelly 1984).

No introduced mammals have ever become established on the Snares Is, and the only adventive plant species now present are annual grass (*Poa annua*) and chickweed (*Stellaria media*), which are minor components of the vegetation around Boat Harbour and

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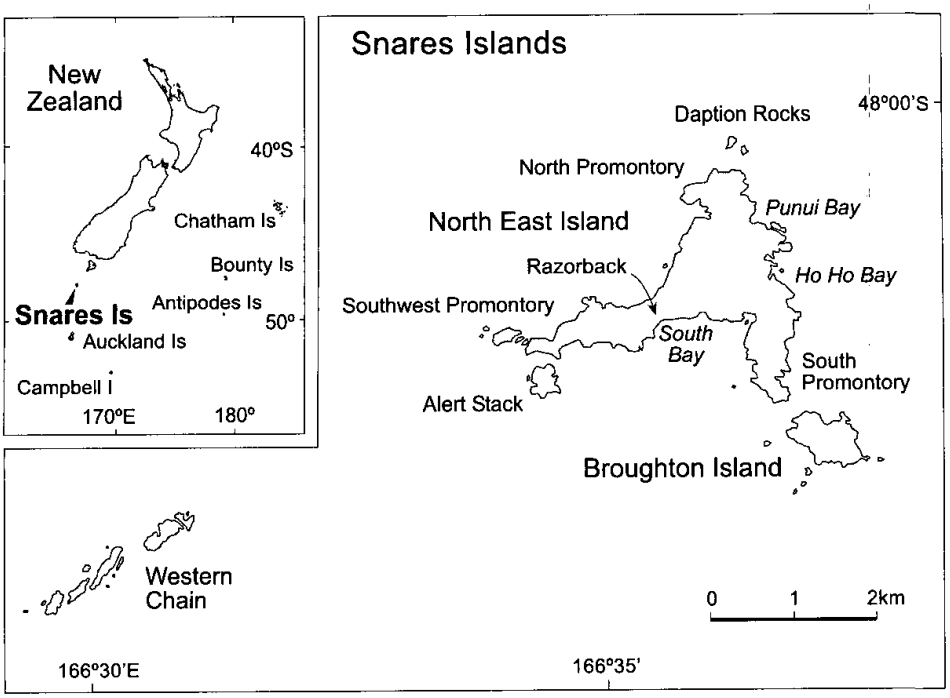

Fig. 1 Locality map for the Snares Islands, showing place names mentioned in the text.

Ho Ho Bay (Department of Conservation 1998). The Department of Conservation administers the Snares Is as a Nature Reserve, with access by permit only.

Bird records from the Snares Is have predominantly accumulated over 5 phases of the islands' history:

1. During the period 1888-1927 scientists, naturalists and collectors made brief visits to the Snares Is aboard government steamers servicing the castaway depot (e.g., Reischek 1889; Chapman 1890; Ogilvie-Grant 1905; Guthrie-Smith 1936). Also during this period, a brief visit was made by the Philosophical Society of Canterbury's Expedition to the Sub-Antarctic Islands (Waite 1909).

2. Two expeditions stayed on NEI in 1947-48. The New Zealand Government/American Museum of Natural History-sponsored Snares Island Expedition was ashore 24 Nov-6 Dec 1947 and made extensive observations of most bird species (summarised in Fleming 1948, 1950a, b; Stead 1948; Wilson 1959). L.E. Richdale and W.M.C. Denham studied courtship and early incubation behaviour of southern Buller's albatross (*Diomedea bulleri bulleri*) 9 Jan-26 Feb 1948 (Richdale 1949a, b), and Richdale (1948) also produced a popular account of their visit.

3. The University of Canterbury constructed a biological station on Station Point in Jan-Feb 1961, and ran a series of expeditions to the islands through to 1976-77. The station was occupied for parts of 9 summer seasons over this period, including a 13-month stay by Don and Carol Horning Dec 1971 - Jan 1973. Warham (1967) produced a comprehensive account of the birds of the Snares Is following his visit in Jan-Feb 1967, and this was updated by Warham & Keeley (1969), Horning & Horning (1974), and Sagar (1977a). Detailed studies on 9 bird species were undertaken during these expeditions: Snares Island snipe (*Coenocorypha aucklandica huegeli*) (Anderson 1968), Snares crested penguin (*Eudyptes robustus*) (Stonehouse 1971; Warham 1974, 1975), southern Buller's albatross (Richdale & Warham 1973; Warham 1982; Warham & Bennington 1983; West & Imber 1986), Snares Island tomtit (*Petroica macrocephala dannefaerdi*) (Best 1975), mottled petrel (*Pterodroma inexpectata*) (Warham *et al.* 1977), Antarctic tern (*Sterna vittata*) (Sagar 1978), Snares Islands fernbird (*Bowdleria punctata caudata*) (Best 1979), Snares cape pigeon (*Daption*

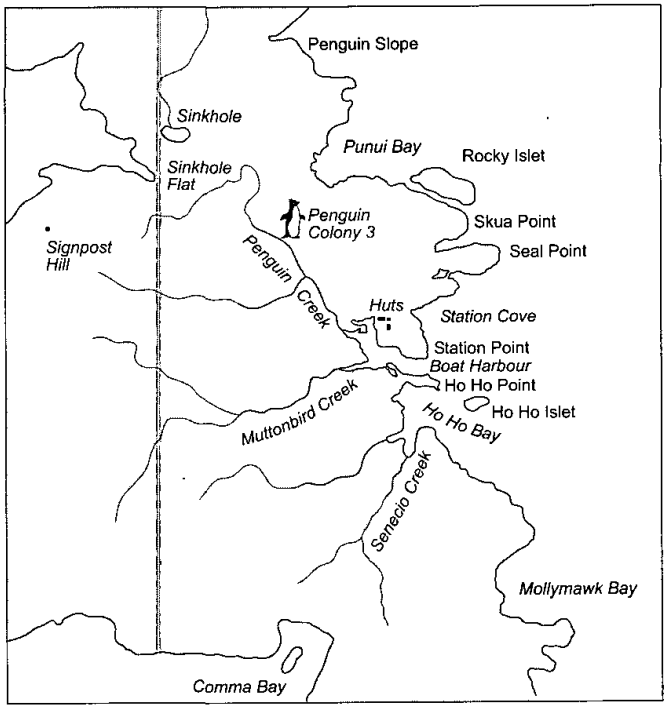

Fig. 2 Detail of the central east coast of North East I., Snares Is, showing place names mentioned in the text.

capense australe) (Sagar 1979) and sooty shearwater (*Puffinus griseus*) (Warham & Wilson 1982; Warham *et al.* 1982; Sagar & Horning 1998).

4. Following concern at the mooring of fishing boats at the rodent-free Snares Islands Nature Reserve, the Department of Lands & Survey (and subsequently the Department of Conservation) funded University of Canterbury expeditions to the Snares Is to monitor fishing boat activity each summer from 1982-83 to Dec 1987. Bird research undertaken during this time included projects on redpoll (*Carduelis flammea*) (Fennell & Sagar 1985), Snares cape pigeon (Sagar 1986; Sagar *et al.* 1996), Snares Island snipe (Miskelly 1987, 1989, 1990a, b, c, 1999a, b), southern Buller's albatross (Warham & Fitzsimons 1987), Snares Island tomtit (McLean & Miskelly 1988; Miskelly 1990b), Antarctic tern (Sagar & Sagar 1989), and Snares crested penguin (Lamey 1990; Proffitt & McLean 1991).

5. A study investigating the impacts of fisheries bycatch on southern Buller's albatross commenced in 1992 and has involved 2-3 visits to NEI each year to date (Sagar & Warham 1993, 1998; Sagar *et al.* 1994, 1998, 1999, 2000; Sagar & Weimerskirch 1996; Stahl *et al.* 1998; James & Stahl 2000; Stahl & Sagar 2000a, b). Other bird research projects undertaken during these visits have included investigating foraging ecology of Snares Island tomtits (McLean *et al.* 1994) and sooty shearwaters (Weimerskirch & Sagar 1996; Weimerskirch 1998). An Otago University research programme on population ecology of sooty shearwaters (titi) that commenced in 1996 is also ongoing (de Cruz *et al.* 1997; Hamilton, de Cruz *et al.* 1997; Hamilton, Moller *et al.* 1997; Hamilton *et al.* 1998; Lyver *et al.* 1998, 1999; Hamilton in press). A census of breeding Snares crested penguins on NEI was undertaken in Oct 2000; the results of this will be reported elsewhere.

The markedly different avifauna of the Western Chain islets has been a focus for researchers since the landing by Robert Falla on 4 Dec 1947 (Stead 1948). Birds recorded during visits to the Western Chain between 1972 and 1995 were reported by Fleming & Baker (1973), Sagar (1977b), Miskelly (1984, 1997) and Clark (1996). These islets are the only known nesting sites for Salvin's albatross (*Diomedea salvini*), southern black-browed albatross (*D. melanophrys*) and fulmar prion (*Pachyptila crassirostris*) within the Snares archipelago, and the crested penguins there breed 6 weeks later than they do on NEI and Broughton I. (Miskelly 1997). The first researchers to stay overnight on the Western Chain did so on Toru Islet 30 Sep-6 Oct and 9-18 Nov 1995, and confirmed breeding by a Chatham Island albatross (*D. eremita*) (Clark 1996).

This paper reports on bird observations made during 39 visits to the Snares Is between Dec 1982 and Oct 2000. The authors were present on the Snares Is 2 Dec 1982 - 20 Feb 1983 (CMM), 3-26 Jan 1984 (PMS), 2-26 Feb 1984 (CMM), 26 Nov 1984 -16 Feb 1985 (CMM), 22 Sep-1 Oct 1985 (CMM), 2-21 Nov 1985 (CMM, PMS), 1 Dec 1985 - 10 Mar 1986 (CMM), 3 Dec 1985 - 10 Mar 1986 (AJDT), 22 Oct 1986 - 20 Feb 1987 (CMM), 22 Oct-16 Nov 1986 (PMS), 16 Nov 1986-20 Feb 1987 (AJDT), 7 Nov-8 Dec 1987 (CMM, PMS), 3-17 Mar 1992 (PMS & AJDT), 30 Jul-1 Aug 1992 (CMM), 1-22 Mar 1993 (PMS), 22-28 Jul 1994 (PMS), 23 Feb-17 Mar 1995 (PMS), 20 Jul-2 Aug 1995 (PMS), 1-19 Mar 1996 (PMS), 1-20 Mar 1997 (PMS), 17-27 Jul 1997 (PMS), 24 Feb-13 Mar 1998 (PMS), 27 Jul-5 Aug 1998 (PMS), 18 Nov-21 Dec 1998 (RPS), 10 Jan-8 Feb 1999 (RPS), 24 Feb-20 Mar 1999 (PMS), 25 Mar-12 May 1999 (RPS), 4-11 Jul 1999 (PMS), 22 Dec 1999 - 3 Feb 2000 (RPS), 23 Feb-14 Mar 2000 (PMS) , 31 Mar-5 May 2000 (RPS) and 4-24 Oct 2000 (AJDT). In addition, notes for 1981-84 were provided by crayfisherman Murray Schofield, for 30 Nov 1983 - 26 Feb 1984 by Gillian Eller, for 1-22 Mar 1994 by Janice Molloy, for 18-27 May 1996 and 20-31 Jul 2000 by Jean-Claude Stahl, and for 23-30 Jul 1996 by Jean-Claude Stahl and Peter Reese. Additional records by the Otago University Titi research team provided by RPS cover the periods 21 Nov-16 Dec 1996, 15 Jan-1 Feb 1997, 3 Apr-20 May 1997, 17 Dec 1997 - 5 Feb 1998 and 8 Apr-13 May 1998.

Summaries of breeding distribution, breeding chronology and population size are provided for each of the 29 breeding species, and notes are provided on 70 non-breeding visitors and vagrant species recorded from the Snares (including some previously unpublished records from the 1970s).

SYSTEMATIC ACCOUNT

The following list includes all species seen or found ashore, over land or visible from the shore on the Snares Is. Unconfirmed, and/or doubtful records are listed in Appendix 1. Species recorded only from boats within 15 km of the islands are listed in Appendix 2. Taxonomy and nomenclature follows Turbott (1990) except for albatrosses, where we follow Onley & Bartle (1999) for species names, and diving petrels, where we follow Kinsky (1970) and Marchant & Higgins (1990). Specimens held in the Museum of New Zealand Te Papa Tongarewa collection are given as MNZ.

Hoary-headed grebe (*Poliocephalus poliocephalus*)
A hoary-headed grebe in Boat Harbour on 11 Feb 1975 was the first recorded from New Zealand (Best 1976).

Wandering albatross (*Diomedea exulans*)
A wandering albatross was seen off Seal Point on 27 Oct 1986, and another was seen there on 2 May 1997 (latter M. Renner pers. comm.). Wandering albatrosses were seen from boats within 10 km of the Snares Is on 15 Jan 1984 (1) and 10 Feb 1984 (2). All these birds were presumed to be of the forms of *D. exulans* breeding on the Auckland and Antipodes Is (see Appendix 2 for snowy albatross *D. chionoptera*).

Wilson (1959) reported that a "pair of wandering albatrosses were seen flying over the land as if thinking of breeding" in Dec 1947, and Warham (1967) reported that wandering albatrosses were seen out at sea less frequently than royal albatrosses.

Southern royal albatross (*Diomedea epomophora*)
Single southern royal albatross were seen off Station Point on 6 Dec 1985, off North Promontory on 30 Oct 1986, off Seal Point on 1 Nov 1986 and off South Promontory on 25 Nov 1986. One was seen from Toru Islet, Western Chain on 29 Dec 1984 (Miskelly 1997). Southern royal albatrosses were frequently seen around boats near the Snares Is, e.g., 6 on 7 Dec 1982, 5 on 26 Jan 1983, 1 (banded) on 9 Feb 1983, 1 on 26 Nov 1984, 6 on 10 Feb 1984, 2 on 8 Jan 1985, 1 on 10 Feb 1987, *c.*10 on 7 Nov 1987, 2 on 1 Aug 1992, 2 on 2 Feb 1993 (1 of which had been colour-marked as an incubating adult on Campbell I. on 22-30 Jan 1993) and 1 on 26 Jun 1998 (latter 2 records AJDT pers. obs.). Southern royal albatrosses breed only on Campbell I. and the Auckland Is (Turbott 1990).

Northern royal albatross (*Diomedea sanfordi*)
Northern royal albatrosses were frequently seen close offshore (on at least 28 occasions 1982-87), but paid no attention to fishing boats. Many sightings were of 2-4 birds consorting (and sometimes displaying) together, often within metres of the shore. Northern royal albatrosses breed only on the Chatham Is and at Taiaroa Head, Otago Peninsula (Turbott 1990).

Southern black-browed albatross (*Diomedea melanophrys*)
Southern black-browed albatrosses were first recorded from the Snares Is on 12 Feb 1984, when 3 adults (including a pair) were seen on Toru Islet in the Western Chain (Miskelly 1984). Six adults were ashore there on 15 Dec 1984, including 1 bird incubating an egg at the site where a pair was seen the previous season. Six adults were also seen on 29 Dec 1984 (Plate 3A), including both members of the breeding pair, still with an egg. The same nest site contained a young chick on 19 Jan 1986; no adults were in attendance, but 3 others were captured and banded at a site 30 m from the nest (Miskelly 1997). One adult was seen ashore on Toru Islet from a boat close offshore on 10 Feb 1987. One pair (no egg) and 3 unpaired birds were present in Oct-Nov 1995 (Clark 1996).

Assuming that the 1986 chick hatched in early Jan, the breeding chronology matches that given for this species at other breeding localities by Marchant & Higgins (1990). Elsewhere in the New Zealand region this species breeds on Bollons I. in the Antipodes Is (115 pairs in 1995; Tennyson *et al.* 1998) and among the large colonies of northern black-browed albatrosses (*D. impavida*) on Campbell I. (24 nests in 1992; Moore *et al.* 1997).

An adult southern black-browed albatross was seen off Skua Point on 8 Dec 1986, and 1 flew around Mollymawk Bay on 22 Jul 2000 (J.-C. Stahl, pers. comm.). Unidentified black-browed albatrosses (either *D. melanophrys* or *D. impavida* – see Appendix 2) were seen near the Snares Is on 10 Feb 1984 (1 subadult south of the Western Chain), 19 Jan 1986 (1 adult, 1 immature between NEI and the Western Chain), 7 Nov 1987 (2 adults, 2 immatures to northwest), 15 Nov 1987 (1 adult off Seal Point) and 8 Dec 1987 (1 adult off Southwest Promontory).

Shy albatross (*Diomedea cauta*)
The only records of shy albatrosses ashore on the Snares Is are from Toru Islet. One was ashore on 12 Feb 1984 (Miskelly 1984) and another in Nov 1995 (Clark 1996). Two were seen in flight over Rima Islet on 11 Feb 1984 (Miskelly 1984), and 1 flew at *c.*300 m a.s.l. over the tip of Southwest Promontory on 18 Nov 1987. Shy albatrosses were common scavenging around fishing boats in summer, although vastly out-numbered by Salvin's and southern Buller's albatrosses. The maximum number noted at a time was 10 on 26 Jan 1983. Four were seen just north of the Snares Is on 26 Jun 1998 (AJDT pers. obs.). The main breeding colonies of shy albatrosses are in the Auckland Is, 170 km south of the Snares Is (Tennyson *et al.* 1998).

Salvin's albatross (*Diomedea salvini*)
Within the Snares Is, Salvin's albatrosses breed only on Toru and Rima Islets in the Western Chain. Sagar (1977b) reported 135 chicks and 9 eggs on Rima Islet on 9 Nov 1976, from which Robertson & van Tets (1982) deduced a mean hatching date of the end of Oct. Miskelly (1984) counted 150 chicks on Rima Islet and 435 chicks on Toru Islet in Feb 1984, and suggested that the total population was fewer than 650 pairs. Clark (1996) reported 1021 nests with eggs on Toru on 5 Oct 1995, and 189 nests with either an egg or a chick on Rima on 8 Nov, which was the mean hatch date (i.e. a week later than in 1976). Assuming an incubation length of 72 days (Robertson & van Tets 1982), the mean lay date would have been 28 Aug. Hatching on Toru was estimated to occur 29 Oct-19 Nov. Only about 507 chicks were still alive (from 1021 eggs) by mid Nov (Clark 1996). Thus the total breeding population may not have changed much since1983-84.

Salvin's albatrosses have never been found ashore on NEI or Broughton I., but 1 flew over the cape pigeon study colony on North Promontory on 24 Jan 1986. Salvin's albatrosses were occasionally seen offshore from NEI, particularly in Nov when southern Buller's albatrosses were all but absent from the Snares Is (e.g., 1 off Seal Point on 30 Sep 1985 and 38 there on 6 Nov 1985, a loose flock off Daption Rocks on 4 Nov 1985, and 10 off North Promontory on 10 Nov 1986). During summer, Salvin's albatrosses were the second commonest albatross around fishing boats near the Snares

Is, e.g., *c.*200 south of Broughton I. on 7 Dec 1982.

Elsewhere, Salvin's albatrosses breed on the Bounty Is (30,750 pairs; Taylor 2000) and Crozet Is (4 pairs; Jouventin 1990).

Chatham Island albatross (*Diomedea eremita*)
At the Snares Is, Chatham Island albatrosses have been seen ashore on both Western Chain islets that support Salvin's albatross colonies. Two were on Rima Islet on 11 Feb 1984, and they were seen on Toru Islet on 26 Jan 1983 (1), 12 Feb 1984 (2), 15 Dec 1984 (3), 29 Dec 1984 (7; Plate 3B) and 19 Jan 1986 (1) (Miskelly 1984, 1997). All birds seen were adults, but none was associated with a chick. A Chatham Island albatross was found incubating on Toru in early Oct 1995, but this egg had failed by 14 Nov, although 5 separate birds were still present (Clark 1996). Birds appearing intermediate in appearance between *D. eremita* and *D. salvini* seen southwest of the Western Chain on 10 Feb 1984 and on Toru Islet on 29 Dec 1984 were discussed by Miskelly (1984, 1997). M. Schofield (pers. comm.) reported occasionally seeing Chatham Island albatrosses near the Snares Is during 1981-84.

The only known breeding site for Chatham Island albatrosses is on The Pyramid in the Chatham Is (Marchant & Higgins 1990).

Southern Buller's albatross (*Diomedea bulleri bulleri*)
At the Snares Is, southern Buller's albatrosses breed on NEI, Broughton I., Alert Stack, the Daption Rocks, Rocky Islet and Toru Islet (Miskelly 1984; Sagar *et al.* 1999). The number of breeding pairs has increased markedly during the past 30 years, from an estimated 4664 pairs in 1969 (Warham & Bennington 1983), to 8460 pairs in 1992 (Sagar *et al.* 1994), and 8877 pairs in 1997 (Sagar *et al.* 1999). The number of breeding pairs appears to have been relatively stable on Broughton I. since at least 1985, with counts of 559 occupied nests in Feb 1985, and 539 and 518 in Mar 1992 and 1997 respectively. In contrast, numbers of breeding pairs estimated on NEI have increased – 4664 in 1969, 7459 in 1992, and 7936 in 1997. A total of 328 occupied nests was counted on Alert Stack in Feb 1985, as against estimates of 443 and 423 in 1992 and 1997, respectively. The only other known breeding site for this taxon is the Solander Islands (2625 occupied nests in 1996; Sagar *et al.* 1999).

Southern Buller's albatrosses were absent from the Snares Is between breeding seasons. Early arrivals were 1 off Skua Point on 20 Nov 1987 and 1 circling cliffs in Punui Bay on 22 Nov 1987. The earliest birds seen in breeding colonies were 1 on 4 Dec 1982 and 1 on 6 Dec 1971. Birds were then observed ashore consistently from mid-Dec, after which numbers increased rapidly, with males returning, on average, 7 days earlier than females (Sagar & Warham 1998). The laying period extended from late Dec to late Feb, with the peak in the third week of Jan. Incubation averaged 69 days and hatching occurred from mid-Mar to early May. The chicks were brooded for 18-30 days and the average nestling period was 167 days, with fledglings departing from late Aug to early Oct (Sagar & Warham 1998). Exceptionally late fledglings were single birds seen ashore on 30 Oct 1986 and 3 Nov 1985.

During the breeding season, birds from the Snares Is foraged widely in Australasian waters (Sagar & Weimerskirch 1996; Stahl & Sagar 2000a). During incubation, birds made trips to the Tasman Sea, as far as the west coast of Tasmania, or east coast of the South Island. Short trips east of the Snares Is were made during the brood stage and then the birds alternated between trips to the east coast of the South Island and east of the Snares Is. From Jun, 1 female foraged off the west coast of the South Island. Most birds disperse outside Australasian waters during the non-breeding season (Stahl *et al.* 1998). Breeding birds frequently associate with fishing vessels and fisheries discards occurred in 92% of foods fed to chicks (James & Stahl 2000). Other common food items were salps, squid, and crustaceans.

Southern Buller's albatrosses are long-lived: the oldest banded bird disappeared when aged at least 53 years (Sagar & Warham 1993). The annual survival rate of breeding birds during 1992-1997 was 0.955 (Sagar *et al.* 2000), and so with annual breeding the average bird has 17 breeding attempts in its lifetime.

Reischek (1889) reported "Grey-headed albatrosses (*Diomedea chlororhyncha*)" nesting on the cliffs during his visit in Jan 1888. These were probably adult southern Buller's albatrosses, as Reischek did not record seeing any Buller's albatrosses, which are invariably present in Jan. Grey-headed albatrosses (*D. chrysostoma*) have not otherwise been reported ashore on the Snares Is (see Appendix 2).

Light-mantled sooty albatross (*Phoebetria palpebrata*)
Two light-mantled sooty albatrosses were seen over Skua Point on 30 Dec 1982. Singles were seen over Station Point on 24 Jan 1983, 1, 10, and 27 Dec 1986, Punui Bay on 6 Jan 1984, Signpost Hill on 13 Jan 1984 (G. Eller, pers. comm.), Broughton I. on 28 Dec 1984, North Promontory on 10 Nov 1986, Mollymawk Bay on 3 Mar 1997, off Seal Point on 26 Apr 1997 (M. Renner pers. comm.) and offshore on 20 Apr 1999. A light-mantled sooty albatross was also seen over Toru Islet on 29 Dec 1984 (Miskelly 1997), and the only record at sea near the islands was 1 between NEI and the Western Chain on this date. Single birds were previously reported by Warham (1967), Horning (1976) and Sagar (1977a). The light-mantled sooty albatross is a circumpolar species that breeds on the Auckland, Campbell, and Antipodes Is within the New Zealand region (Turbott 1990).

Sooty shearwater (*Puffinus griseus*)
The sooty shearwater is the most abundant species at the Snares Is, breeding on all vegetated islands including

Tahi and Toru Islets. An estimated 2,750,000 burrow-holding pairs were present during the period 1969 to 1971 (Warham & Wilson 1982). However, there were about 37% fewer sooty shearwater burrows during the period 1996-2000 (P. Scofield & C. Hunter, unpubl. data). Sooty shearwaters breed at many sites throughout New Zealand, southeast Australia, Chile, and the Falkland Islands (Turbott 1990).

The annual cycle of sooty shearwaters at the Snares Is was described by Warham *et al.* (1982). From mid-May to mid-Sep sooty shearwaters are absent from the Snares Is. The majority of the birds return during late Sep, the earliest birds being 3 seen off the Western Chain on 13 Sep 1985 (K. Schofield, pers. comm.). There is a pre-laying exodus from late Oct to mid-Nov, although the number seen in flight over the island at dusk did not noticeably decline until 5 Nov 1986 and 7 Nov 1987. Laying is synchronous, with about 67% of eggs laid between 20 and 24 Nov. Many eggs are laid on the surface and the dates that these were first seen were 19 Nov 1969 and 17 Nov 1972 (Warham *et al.* 1982), and 17 Nov 1986, 21 Nov 1985 and 22 Nov 1987. Incubation occupies about 53 days and about 67% of eggs hatch between 11 and 16 Jan. Earliest chicks were recorded on 2 Jan 1987, 5 Jan 1985, 10 Jan 1986 and 11 Jan 1983. In 1972, chick-rearing continued until about the third week of Apr, by which time most adults had departed. Most chicks departed in the last week of Apr and first week of May.

During chick-rearing, parent sooty shearwaters from the Snares Is apparently rely on productive distant waters, perhaps as far away as 1150 km, to build up their body reserves and to feed their chick (Weimerskirch 1998). These long foraging trips last, on average, about 11 days (Weimerskirch 1998) and during such foraging trips the maximum depths attained when feeding ranged from 2 m to 67 m (mean 38.7 m; Weimerskirch & Sagar 1996).

At the Snares Is, banding of adults (i.e. when at least 4 years old) began in 1967 and the oldest banded birds were 2 banded in 1970 and recaptured alive in Jan 2000, when 34+ years old. Five hundred chicks were banded and weighed during Apr-May 1972. Subsequent recaptures showed that the mass of sooty shearwater chicks immediately before fledging influenced their chance of survival (Sagar & Horning 1998); heavier fledglings having a higher recapture rate as adults than lighter fledglings.

Several partial albino sooty shearwaters were seen, including a white-headed bird seen regularly near the Western Chain in 1985-86 (K. Schofield, pers. comm.). The University of Otago titi research team banded a full albino chick on 28 Apr 2000 and regularly saw partial albino adults at the take-off sites in the morning.

Subantarctic little shearwater (*Puffinus assimilis elegans*)

A subantarctic little shearwater was seen off Seal Point on 5 Mar 1986. Possible little shearwaters were seen off Seal Point/Station Point on 11 Apr 1997 (M. Renner, pers. comm.) and in Apr 1999 (J. Haselmayer, pers. comm.), and another possible sighting was 3 km north on 17 Mar 1992. These birds were most likely vagrants from the large population on the Antipodes Is (Imber 1983).

Southern diving petrel (*Pelecanoides urinatrix chathamensis*)

Diving petrels bred widely on NEI, and were also noted breeding on Broughton I. (small chick 20 Dec 1983), Alert Stack (20 Dec 1976; PMS), North Daption Rock (21 Dec 1976; PMS), and probably on Toru Islet, where 1 was seen entering a burrow on 14 Nov 1995 (Clark 1996). Elsewhere, remains of skua-killed birds were found on Tahi and Rua Islets, and breeding was suspected on Tahi Islet (Fleming & Baker 1973; Miskelly 1984). At the Snares Is the species is confined to nesting in soil burrows.

Diving petrels were the second most common bird species breeding on the Snares Is. Two population estimates on NEI were made based on burrow counts. In Feb 1987, AJDT surveyed diving petrel-sized burrows in 126 5 × 5 m plots in 6 different habitat types and measured burrow occupancy rate in 100 diving petrel-sized holes near Station Point by "fencing" them with sticks during part of the chick rearing period (12-18 Jan 1987). During 26 Dec 1999 - 7 Jan 2000, 154 10 × 10 m plots in 11 different habitat types were surveyed by RPS, Darren Scott, and Andrea Booth, primarily to determine sooty shearwater burrow density. The position of 60 of these plots was determined using a randomisation technique similar to that described by Warham & Wilson (1982). The other 94 plots were made at 100-pace intervals along 3 transects that ran across the whole island along (1) north-south, (2) east-west and (3) northwest-southeast axes. Burrows of <7 cm diameter were assumed to belong to diving petrels. Direct comparison between the 2 surveys is problematic as no suitable vegetation map was available and the different vegetation types defined in the 2 surveys were not directly comparable (Table 1). For an estimate, we assumed that both surveys sampled the various vegetation types at a frequency similar to the abundance of that vegetation. We found that the difference between the total mean burrow density in 1987 (0.076 ± 0.011 burrows m^{-2}) and 1999-2000 (0.111 ± 0.019 burrows m^{-2}) surveys was not significant (z = 2.326, P = 0.113, 2-tailed z-test), and so combined the two. The combined mean density of the 2 samples was 0.095 ± 0.012 burrows m^{-2} (n = 280, area sampled = 1.855 ha). Given a total vegetated area of 238.08 ha for NEI (Warham & Wilson 1982), we estimated that there were 226,941 ± 28,079 diving petrel-sized burrows there.

Breeding diving petrels generally return to their burrow each night during chick rearing (Richdale 1943). A burrow was therefore considered occupied if a fence was knocked down 5-7 times during 12-18 Jan 1987.

Table 1 Two estimates of diving petrel (*Pelecanoides urinatrix chathamensis)* burrow densities in different habitats on North East I., The Snares, giving mean number of burrows m^{-2} and standard error ($SE_{\bar{x}}$).

Habitat type	1987 Mean	1987 $SE_{\bar{x}}$	1987 *n*	1999-2000 Mean	1999-2000 $SE_{\bar{x}}$	1999-2000 *n*
Bare peat under *Olearia*	0.020	0.007	30	0.056	0.009	44
Shallow soil under *Olearia*				0.075	0.036	12
Penguin-affected areas under *Olearia*				0.273	0.176	12
Dense ground cover under *Brachyglottis/Olearia*	0.023	0.006	21			
Fern under *Olearia*				0.101	0.021	7
Poa under *Olearia*				0.159	0.046	30
Brachyglottis/Olearia <50m from stream	0.064	0.022	18			
Brachyglottis				0.153	0.069	3
Shallow soil on steep slopes and seepages				0.222	0.130	11
Hebe	0.056	0.017	10			
Dry *Hebe*				0.121	0.074	8
Wet *Hebe*				0.030	0.011	7
Poa astonii	0.252	0.044	20	0.051	0.014	7
Poa tennantiana	0.062	0.022	27	0.043	0.012	13
Mean	0.076	0.011	(126)	0.111	0.019	(154)

Two burrows were eliminated from the sample as they were apparently occupied by sooty shearwaters. Forty-seven burrows had the fences knocked down 5-7 times during this period and were considered occupied (48% occupancy of all those burrows sampled). A breeding study in 1986-87 found that by 12 Jan, 53% (8/15) of nests had failed. Richdale (1943) found that diving petrels abandoned the colony for the season shortly after breeding failure, and so the number of breeding pairs based on occupancy on 12-18 Jan could under-estimate the number that had attempted to breed by half. Thus we estimate the breeding population on NEI to be similar to the number of diving petrel-sized holes, i.e. 227,000 pairs.

A significant population of diving petrels probably breeds on Broughton I., given the total vegetated area there (30.4 ha) and the similarity of the vegetation types there to those on NEI. Using the mean density of nests on NEI, we estimate that 29,000 pairs (227,000 × 0.128) could breed on Broughton I. Thus, in total, the Snares Is may have a breeding population of about 250,000 pairs of diving petrels. Diving petrel nests were also found in unoccupied sooty shearwater burrows or burrows that began within sooty shearwater entrance tunnels. A 10 × 10 m sample plot that was excavated on NEI in Dec 1996 to establish sooty shearwater density (Hamilton, de Cruz *et al.* 1997) found 6 diving petrel chicks, although no diving petrel-sized burrows were visible on the surface. It is not known how often diving petrels use sooty shearwater burrow entrances but this finding indicates that we could have under-estimated the population.

Diving petrels are absent from the Snares Is during part of the non-breeding period. Horning & Horning (1974) found that they were absent from the islands from 23 Apr until 27 Aug 1972. We found that numbers ashore decreased dramatically in late Apr 1999 and 2000 but that some birds were still coming ashore until at least 12 May 1999. The laying and incubation period has not been studied at the Snares Is, but diving petrels were abundant ashore during Oct 2000 and freshly laid eggs were found on 15 Oct (1, G. McAllister pers. comm.) and 3 on 22 Oct; 2 of these are now in MNZ. Of 15 nests studied by AJDT in 1986-87, 10 eggs hatched 27 Nov-19 Dec 1986 ($\bar{x}$ = 7 Dec ± 6.1 days) and 5 eggs failed to hatch. Using an incubation period of 53.5 days (Marchant & Higgins 1990), laying occurred during Oct, probably peaking in mid Oct. Seven of the 10 chicks that hatched in 1986-87 fledged, although their growth was stunted. Their fledging weight was 79 ± 9 g (66-91 g), which is considerably lower than mean breeding adult weight (123.6 g), at which diving petrels normally fledge (Marchant & Higgins 1990). This poor condition was reflected in the very poor breeding success of diving petrels that season. Massive mortality of chicks and fledglings was noted during Jan 1987. The first dead chicks were seen on the surface on 9 Jan 1987, and large numbers were seen from 22 Jan, with about 230 dead seen on 22-25 Jan alone, mainly in and near the Sinkhole, and floating in the sea off the east coast.

In 1987, 9 chicks were brooded for 11.8 ± 2.0 days (9-15 days; brooding not always continuous during these periods) and the nestling period was 48.7 ± 3.5 days (44-55 days, *n* = 7), with these fledglings departing 19-25 Jan. The earliest fledglings seen were on 12 Jan 1987. Fledged young were first seen in early Feb 1967 (Warham 1967). In 1986, fledglings were noted from early to late Feb, with a chick found with down on most of its body on 16 Feb. In 1987, the latest fledgling was noted on 16 Feb. In 1992, a freshly dead fledgling was found on 9 Mar, a live fledgling with wisps of down remaining on its back was caught on 10 Mar, a freshly dead fledgling was found on 11 Mar and a live chick with down on its back was seen on 14 Mar. In 1986-87, the relatively early

fledging dates, the low fledging weights, and the huge chick mortality observed suggest that the breeding season was atypical.

Weights and measurements of Snares Is adults were presented in Marchant & Higgins (1990). Measurements of 22 Snares Is eggs were: 38.1 ± 2.1 mm (31.8-42.3 mm) × 30.2 ± 0.8 mm (29.0-31.9 mm); mean weight of 18 eggs during 19-29 Nov 1986 was 17.5 ± 2.0 g (15.5-21.4 g).

We occasionally noted diving petrels offshore between Nov and Mar, and they were often seen in large numbers from vessels near the islands. Despite being absent from land during much of the non-breeding period, in early Jun 1981 diving petrels were plentiful up to 3 km offshore (Robertson *et al.* 1981) and 1 was seen just offshore on 26 Jun 1998 (AJDT, pers. obs.).

Grey petrel (*Procellaria cinerea*)
Single grey petrels were seen offshore from Seal Point on 10, 18, and 22 Apr 1997 (M. Renner, pers. comm.). Within the New Zealand region, grey petrels are known to breed on Antipodes Island and on islets off Campbell Island (Turbott 1990).

White-chinned petrel (*Procellaria aequinoctialis*)
Single white-chinned petrels were seen off Seal Point on 30 Apr, 6 and 17 May 1997 (M. Renner, pers. comm.), and 1 was seen on 10 May 1999 (J. Haselmayer, pers. comm.). A few white-chinned petrels were regularly seen behind fishing boats working near the Snares Is: 2 on 26 Jan 1983 and 10 Feb 1987, singles on 7 Dec 1982, 9 Feb 1983, 10 Feb 1984, 9 Feb 1985 and 2 Feb 1993 (latter AJDT pers. obs.). The closest that the similar Westland petrel (*P. westlandica*) has been seen to the Snares Is was 1 at 37 km north-north-east on 22 Sep 1985, and 5 together 40 km north on 25 Nov 1985. White-chinned petrels breed on islands in the Auckland, Antipodes, and Campbell Island groups within the New Zealand region (Turbott 1990).

Snares cape pigeon (*Daption capense australe*)
At the Snares Is, cape pigeons breed on NEI, Broughton I., the Daption Rocks, Alert Stack, and the Western Chain; the total population was estimated to be 7385 breeding pairs in 1984 (Fig. 3). Nests were on ledges or under rocks and in caves or cliff faces adjacent to the sea (Sagar 1979; Miskelly 1984; Sagar *et al.* 1996). Elsewhere, this taxon breeds on the Bounty, Antipodes, Auckland, Campbell, and Chatham Is (Sagar *et al.* 1996).

The 1-egg clutch was laid during 4-18 Nov and the incubation period averaged 45 days (Sagar *et al.* 1996). Eggs hatched 20 Dec (1986) - 4 Jan and young fledged 5-24 Feb, with an average fledging period of 50 days (Sagar 1979; Sagar *et al.* 1996). The nesting colonies were apparently abandoned immediately after breeding (Mar), but large flocks were present off NEI from Mar to Oct e.g., 3500-4000 off North Promontory on 27 Jul 1994, 13,700 off Mollymawk Bay on 28 Jul 2000 (J.-C. Stahl, pers. comm.), 5000 off Ho Ho Bay on 29 Sep 1985, and *c.* 8000 off the east coast of South Promontory on 16 Oct 2000. Pairs re-occupied nest sites as early as Jun and Jul (Robertson *et al.* 1981; Sagar *et al.* 1996). A breeding adult colour-marked at the North Promontory study colony was reported following a fishing trawler in Foveaux Strait on 17 Jan 1986, and another was seen off Broughton I. on 3 Feb. 1986 (K. Schofield, pers. comm.).

Annual survival was 0.939 for breeding males and 0.844 for breeding females; the oldest banded bird recorded was a female that was recaptured incubating 26 years and 5 months after it was first banded (Sagar *et al.* 1996).

An unusual record was an apparently healthy bird found several hundred metres inland under the forest in the Penguin Creek catchment on 23 Oct 2000. A pale-backed nominate *D. c. capense* was seen among a large flock of Snares cape pigeons in Ho Ho Bay on 2 Dec 1982.

Antarctic fulmar (*Fulmarus glacialoides*)
Three fulmars were seen en route to the Snares Is on 22 Sep 1985, and another on 22 Oct 1986. K. Schofield (pers. comm.) reported 3-4 around his fishing boat near the Western Chain each day in Sep 1985. A fulmar was seen off North Promontory on 28 Dec 1985, and they were regularly seen offshore during 19 Nov-10 Dec 1986 (max. 2 at a time). There were also 4 sightings during 27 Oct-8 Dec 1987, and 1 was off Rocky Islet on 6 Oct 2000. Antarctic fulmars breed around the coast of Antarctica and on adjacent islands, but are frequently recorded in New Zealand waters in winter (Turbott 1990).

Southern giant petrel (*Macronectes giganteus*)
An adult dark morph southern giant petrel was seen among 20 northern giant petrels off Station Cove on 24 Jan 1983. Other dark morph birds were seen off Comma Bay on 24 Sep 1985, off Station Point on 19 Nov 1985, 5 Jan 1986, 20 Jan 1987, 14 Mar 1992 and 22 Oct 2000, off North Promontory on 2 Jan 1986, over Boat Harbour on 10 Jan 1986 and off South Promontory on 14 Jan 1987. All these birds were adults and hence had much paler heads, necks and underparts than adult northern giant petrels (*M. halli*). A white morph southern giant petrel was seen around the coast of NEI on 3 occasions during 21-26 Nov 1986, and 3-4 white morph birds were seen together off Seal Point on 23 and 27 Apr 2000. White morph southern giant petrels were seen offshore almost daily in Apr-May 1997, with 12 together once among 2 flocks each of up to 100 giant petrels of both species roosting on the sea east of NEI (M. Renner, pers. comm.). On 20 and 21 Nov 1987 a very tame adult dark morph southern giant petrel was present in Boat Harbour and was hand-fed canned fish. Horning & Horning (1974) described and photographed a northern giant petrel exhibiting similar behaviour at the same site. A very pale (but not white) southern giant petrel was present around Station Point in Jan 2000, and was

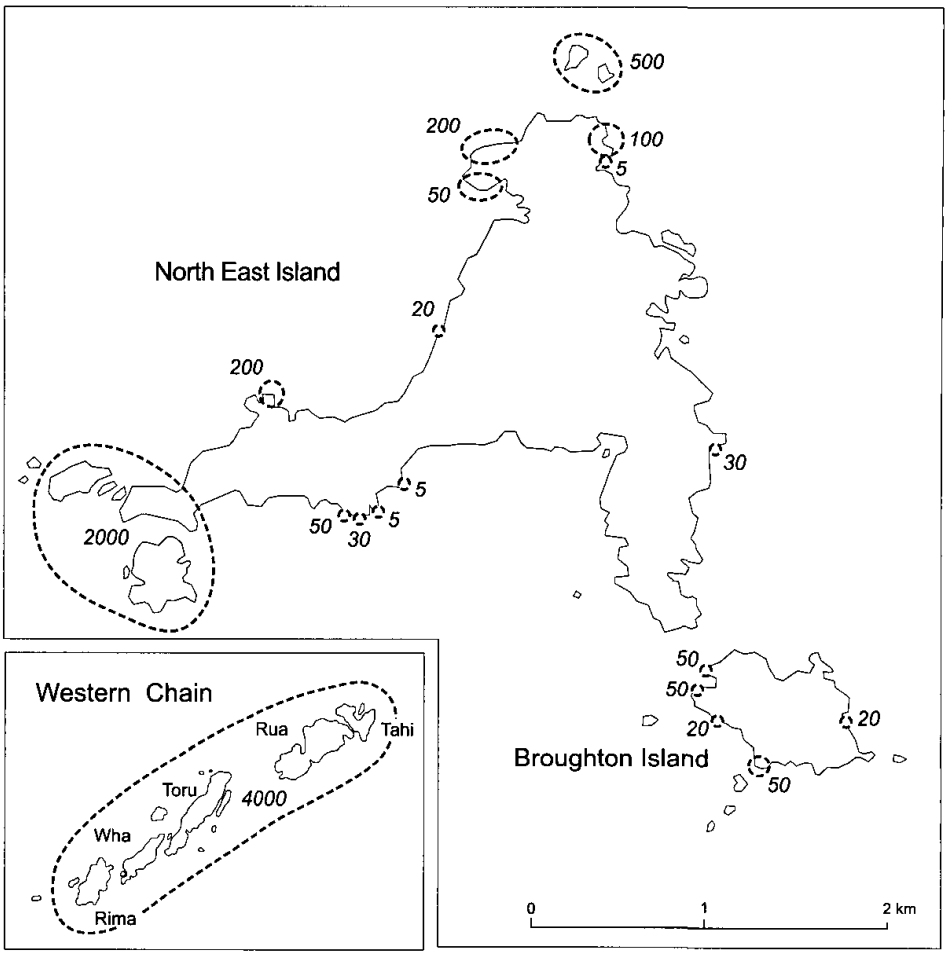

Fig. 3 Breeding distribution of Snares cape pigeons (*Daption capense australe*) at the Snares Is in 1984-85, showing estimated number of breeding pairs at each site.

attacked by a sealion in Boat Harbour on 3 Jan. White morph southern giant petrels were previously reported from the Snares Is by Chapman (1890), Ogilvie-Grant (1905), Wilson (1907), Horning & Horning (1974), and Sagar (1977a). Some of the early records are probably based on a specimen collected by Sir P.A. Buckley, Colonial Secretary, that remains in the Natural History Museum, Tring (BMNH 1893.12.4.2; J. Cooper, pers. comm.).

The closest breeding site for southern giant petrels to the Snares Is is on Macquarie I. (Turbott 1990).

Northern giant petrel (*Macronectes halli*)

Northern giant petrels do not breed on the Snares Is, but were occasionally seen roosting in flocks on windswept tussock saddles on South Promontory (18, 8 Jan 1983; 10, 25 Nov 1986; 9, 11 Mar 1997) and on Broughton I. (12, 17 Dec 1984; 20, 11 Feb 1985; 15+, 14 Jan 1987; 8, 6 Dec 1987). Warham (1967) reported 30 roosting on the South Promontory saddle on 2 Feb 1967. Twice (6 Jan 1983, 11 Jan 1985), northern giant petrels were found in Snares crested penguin colonies well inland. The 1983 bird (on North Promontory) had been banded as an adult on Ocean I., Auckland Is on 8 Dec 1972.

Giant petrels (mainly of this species) gathered around the shoreline at penguin landing sites in Jan-Feb to prey and scavenge on departing Snares crested penguin chicks. Maximum counts recorded in Station Cove were 20 (24 Jan 1983), 6 (Jan 1984), 15 (19 Jan 1986), 10 (14 Jan 1987), 10 (4 Mar 1995), and 12 (Jan 2000). These numbers were well below those recorded in the 1960s and 1970s: 124 on 2 Feb 1967 (Warham 1967) and 32 in Jan 1977 (Sagar 1977a).

Single northern giant petrels could be seen almost daily patrolling the inshore waters around the Snares, but they were generally wary of fishing boats. Within the New Zealand subantarctic, northern giant petrels breed on the Auckland, Antipodes, and Campbell Is, and also on the Chatham Is and Macquarie I. (Turbott 1990).

Fairy prion (*Pachyptila turtur*)

Fairy prions breed widely around the coast of NEI (Fig. 4) and they have also been recorded ashore in crevices on South Daption Rock (breeding 30 Nov 1976, PMS), Rocky Islet (incubating adults 10 Dec 1976, PMS; 3 eggs 3 Dec 1984), Alert Stack (nesting adults 20 Dec 1976, PMS), and Broughton I. (present 25 Feb 1984 and 17 Mar 1992). Elsewhere, skua-killed fairy prions have been found on Rua Islet (Miskelly 1984), Toru Islet (Miskelly 1997), and 2 on 19 Jan 1986) and North Daption Rock (8 Feb 1977, PMS). They probably breed on some of the other small stacks around the main islands but are thought not to nest on the Western Chain (Miskelly 1984). On the Snares Is, almost all fairy prions nested

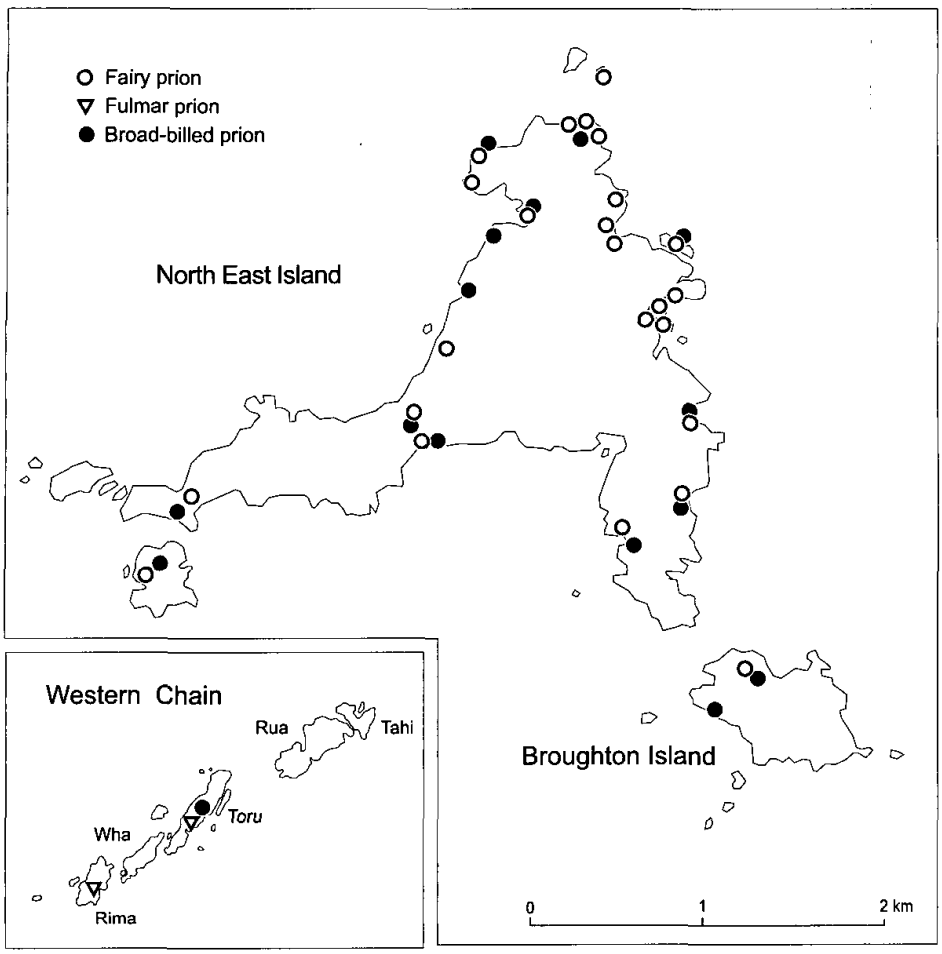

Fig. 4 Breeding distribution of prions (*Pachyptila* spp.) at the Snares Is. Records were based on eggs, chicks, or adults in rock crevices during the day:

in rocky sites, but 4 occupied burrows were found in soil in Station Cove and Punui Bay in Feb-Mar 1986. Warham (1967) stated that the species did not appear very numerous, but a rough population estimate by AJDT suggested that 3500 pairs bred on NEI and that hundreds of pairs could nest on Broughton I., making a total of about 4000 pairs at the Snares Is. These estimates were based on a coastal survey of prions in 1985-86 and 1986-87, a visit to Broughton I. on 17 Mar 1992 and the nesting density in an intensively surveyed coastal strip between the northern side of Boat Harbour and the base of Seal Point. AJDT estimated that 52 pairs were nesting within this area and that this was 1.5 % of the coast of NEI. The population appeared to be fairly evenly distributed around the coastal fringe of NEI. Three records of fairy prions away from the coast, all in the Penguin Creek catchment, were unusual: a dead adult found on 5 Dec 1985 and live fledglings found on 8 and 14 Feb 1987.

Fairy prions came ashore at the Snares Is throughout most of the year but their attendance onshore in the non-breeding period was sporadic. Horning & Horning (1974) thought that the species probably stayed in the Snares Is area throughout the year, but they did not specifically identify prions that they saw flying about the Snares. We found failed or non-breeders to be abundant ashore from late Feb to 9 Mar 1986 and the species was abundant ashore 4-16 Mar 1992. Fairy prions were not found ashore in mid-late Apr 1999 or 2000 but birds were present again in early May. Prions heard calling on Station Point in the second half of May 1996 (J.-C. Stahl, pers. comm.) would have been this species, as this was then the only prion that nested in that area. Fairy prions were ashore on and near Station Point 20-31 Jul in 1992, 1994, 1996, and 2000 (J. Molloy, P. Reese, J.-C. Stahl, pers. comm.) and on North Promontory on 26 Sep 1985, and were common ashore at several sites in Oct 2000.

A study of the breeding biology of fairy prions was carried out on Station and Seal Points, North Promontory and a cave near the Sinkhole by AJDT in 1985-86 and 1986-87. Laying occurred in early Nov, with the earliest eggs being laid between 4 and 9 Nov in 1985. In 1986, 14 eggs were laid by 10 Nov, 14 eggs were laid 10-13 Nov and 1 egg was laid on 16 Nov. Incubation averaged 47.0 ± 1.8 days (45-50 days, n = 7) in 1986, and peak hatching occurred on 22 Dec 1984 (6 eggs and 6 guarded chicks) and ranged from 20-30 Dec in 1985 and 18-31 Dec in 1986. Incubation shifts were normally 3-6 days. In 1986, hatching success was 59.6% (28/47). Chicks were normally brooded for a few days after hatching. Fledglings departed from 2-14 Feb 1986 (peak 8 Feb) and between 1-4 and 20+ Feb 1987 (mean for 23 nests 11-12 Feb ± 8.3 days). In 1986-87, the nestling period was 48.2 ± 1.9 days (46-51 days, n = 15). Fledging success was 78.6% (22/28) in 1986-87. The

latest chick found (on 20 Feb 1987), was well feathered but some down remained.

Weights and measurements of adult fairy prions from the Snares Is were presented in Marchant & Higgins (1990). Measurements of 60 Snares Is eggs in 1985-87 were: 45.8 ± 1.6 mm (42.6-50.0 mm) × 33.5 ± 1.1 mm (30.0-36.2 mm); mean weight of 31 eggs at pipping was 23.8 ± 2.0 g (19.3-27.7 g).

A fairy prion chick weighing 60.6 g was found being brooded by an adult cape pigeon in a cape pigeon's nest on the North Promontory on 6 Jan 1987. The cape pigeon's egg was abandoned and the chick was successfully raised and fledged, weighing 129 g 1 day before it left on the night of 13-14 Feb, 38 days later (in 1987 mean weight of 17 fairy prion fledglings was 126.5 ± 9.5 g). Both adults of the cape pigeon pair were often found ashore by day with the prion chick, whereas cape pigeons rearing their own chicks typically visited nests only briefly during feeding (Sagar *et al.* 1996). We suggest that the birds remained ashore because the smaller feed sizes required by the prion chick failed to provide the stimulus needed for the much larger cape pigeons to continue foraging.

The oldest banded fairy prion recorded on the Snares Is was over 15 years old when recovered on 20 Oct 2000 at the site where it was banded as a breeder on 27 Dec 1985. Band recoveries indicated that 16 (16%) of adults alive in the study sites on Station Point and at the base of Seal Point in 1986-87 were still alive in Oct 2000.

Flocks of several hundred prions were occasionally seen at sea off the coast of the Snares Is between Dec and Mar. The largest flock seen was about 1000 birds within 2 km of the eastern coastline of NEI on 10 Mar 1986. Although most prions seen at sea were not identified to species, most birds observed closely off the east coast of NEI were thought to be fairy prions.

Fulmar prion (*Pachytila crassirostris crassirostris*)
Within the Snares Is, fulmar prions are known to breed only on Toru and Rima Islets in the Western Chain (Fig. 4), with an estimated population of 400-600 pairs (Miskelly 1984). However, this may be an overestimate, as on 3 visits to Toru Islet in Dec 1984 and Jan 1986 only 2-6 eggs or chicks were noted during brief searches of rock tumbles. Hatching occurred in mid Dec (2 eggs and 2 small chicks noted on 15 Dec 1984; Miskelly 1997), about a week earlier than fairy prions on NEI. Laying occurred around mid Nov in 1995 (Clark 1996) which was about 2 weeks later than expected (assuming an incubation period of 47 days as for fairy prion; Marchant & Higgins 1990 and this study).

Fulmar prion remains were found in skua middens on Rua and Toru Islets (Miskelly 1984, 1997) and 4 skulls were found in skua middens on Skua Point in 1985-86.

Small flocks of fulmar prions (<100 at a time) were common around the islets of the Western Chain, but they were not identified among the larger flocks (presumably of fairy prions) further offshore.

Elsewhere this taxon breeds on the Bounty, Auckland, and Heard Is (Turbott 1990).

Salvin's prion (*Pachyptila salvini*)
A Salvin's prion skull was found in a skua midden on Skua Point on 18 Dec 1985 (now MNZ 26545). Salvin's prions breed on islands in the southern Indian Ocean, and regularly reach New Zealand seas in winter (Turbott 1990).

Broad-billed Prion (*Pachyptila vittata*)
Broad-billed prions bred widely around the coast of NEI (Fig. 4) and were also recorded nesting or present in crevices on Broughton I. (landing at dusk 25 Feb 1984), Toru Islet (2 chicks, 15 Dec 1984; 1 old egg, 2 dead chicks, 19 Jan 1986; Miskelly 1997), Rocky Islet (Horning & Horning 1974; Sagar 1977a; 1 chick, 3 Dec 1984) and on Alert Stack (1 in crevice 9 Feb 1985). On the Snares Is, broad-billed prions are known to nest only in rocky sites. A population estimate by AJDT was based on a coastal search for prions in 1985-86 and 1986-87. The largest concentration of this species was found in South Bay, where 350 birds were seen or heard on the ground and in the air on 28 Feb 1986, and where about 60 chicks were seen during a brief search on 19 Nov 1986. These numbers suggested that hundreds of pairs nested in South Bay. Similar numbers of broad-billed prions were also seen in flight above all other rock piles at the bases of cliffs on the western side of the island. Unfortunately several of these sites were inaccessible, and so breeding could not be proven. However, the numbers seen in flight indicate that 2000-5000 pairs of this species bred on NEI. Although skua-killed broad-billed prions were found on Rima Islet on 21 Nov 1976 and Tahi Islet on 19 Feb 1984, they are not known to breed there (Miskelly 1984, 1997). Remains were also found on South Daption Rock on 30 Nov 1976 (PMS). Unusual site records were 1 under a hut on Station Point on 21 Dec 1982, and a pair in Oct 2000 nesting in a cave on Station Point that had been frequently examined since the 1960s.

At the Snares Is, broad-billed prions came ashore throughout most of the year. As with fairy prions, Horning & Horning (1974) thought that the species probably stayed in the Snares Is area throughout the year, but they did not specifically identify prions that they saw flying about the islands. The species commonly came ashore during Feb 1986 and they were found ashore in Mar 1992 and 1999, in late Apr 1999 (6 attracted to lights at Punui Bay), in early Jun 1981 (Robertson *et al.* 1981), on 26 Jul 1994 and 31 Jul 1992.

The breeding biology of broad-billed prions was studied by AJDT and PMS in 1986-87 in caves on North Promontory and in a small rock pile near the Sinkhole. The laying period has not been studied at the Snares Is, but the species was found incubating at the Razorback and on North Promontory between 22 Sep and 1 Oct 1985. There are only 2 records of incubation shifts: a

female incubated for 5-7 days and her mate incubated for 6 days in Oct 2000. In 1986, hatching peaked around 22 Oct 1986, when 2 eggs (1 starred, 1 pipped) and 3 small chicks were found; the 2 eggs had hatched by 24 Oct. In 2000 the hatching period was similar, with an unguarded chick estimated to be 1 day old on 18 Oct when at least 7 other birds were incubating, 4 birds were incubating on 22 Oct, and a second chick hatched on about 23 Oct. Using an incubation period of 45-50 days for other prion species (Marchant & Higgins 1990), peak laying was probably in early Sep. Adults were recorded ashore by day with chicks up to 8 days old, and 2 nestling periods were 58-59 and 60-61 days. Seventeen fledglings departed between 12 Dec 1986 and 13-15 Jan 1987. Two chicks on Toru Islet fledged between 15 and 29 Dec 1984 (Miskelly 1997).

Weights and measurements of adults from the Snares Is were presented in Marchant & Higgins (1990). Fourteen eggs measured 50.4 ± 1.7 mm (48.1-53.9 mm) × 36.9 ± 0.7 mm (35.7-38.3 mm). The mean weight for 3 eggs at the end of incubation was 34.2 g (range 33.5-35 g).

The oldest broad-billed prion recorded on the Snares Is was over 14 years old when recovered on 7 Oct 2000 at the site where it was banded as a breeder on 26 Oct 1986.

Only 1 broad-billed prion has been identified offshore from the coast of the Snares Is during the day (off Seal Point on 6 Oct 2000), but they were commonly seen in 1s, 2s, or small flocks from vessels offshore. However, this species was occasionally seen coming ashore during the day and often came ashore up to 2-3 h before dusk, so that considerable numbers could be seen in the air over breeding sites.

The earliest record of this species at the Snares Is appears to be of skua-killed birds found in 1947 (Fleming 1948). Oliver (1955) reported that the species bred on the Snares Is, but Warham (1967) noted that live birds of this species had never been observed at the group. Broad-billed prions breed in spring and were not found nesting near Station Point, where most people visit, until Oct 2000. They were not confirmed as breeding on the Snares Islands until 1976 (Sagar 1977a).

Blue petrel (*Halobaena caerulea*)

Six weathered blue petrel skulls were found in skua middens on Skua Point in Jan and Feb 1986, Mar 1992, and Oct 2000, and on Seal Point in Jan and Dec 1986 (one of the latter is now MNZ 26636; the Oct 2000 specimen is also in MNZ). Blue petrels breed in the southern Atlantic and Indian Oceans and (in small numbers) on stacks off Macquarie I., but regularly occur in New Zealand seas in winter (Turbott 1990).

Mottled petrel (*Pterodroma inexpectata*)

Mottled petrels bred widely around the coastal fringe of NEI and Broughton I. (Warham *et al.* 1977). They have been found breeding on Toru Islet (100+ pairs; Miskelly 1984), on Alert Stack (incubating on 20 Dec 1976; PMS), on North Daption Rock (incubating on 21 Dec 1976; PMS), and are thought to breed on Rocky Islet (Warham *et al.* 1977). Mottled petrels may breed on Tahi Islet, where skua-killed birds were found in 1984, and on a stack off Toru Islet (Miskelly 1984). Skua-killed birds were also found on Rua Islet in 1984 (Miskelly 1984). On the Snares Is nesting mottled petrels were confined almost exclusively to shallow soil and rocky areas in coastal tussock and under *Hebe elliptica*. They are apparently excluded from areas of deeper soil by competition with the larger and more aggressive sooty shearwater for burrow space. Warham *et al.* (1977) estimated the Snares Is population of mottled petrels to be tens of thousands of birds, but it has never been surveyed. They considered that the Snares Is were the most important and best-protected breeding place remaining for the species. Recent work on Whenua Hou (Codfish Island) indicates that 300,000-400,000 pairs may breed there (M. Imber, pers. comm.), perhaps an order of magnitude greater than the Snares population.

Mottled petrels have not been reported from the Snares Is between mid-Jun and mid-Oct (Warham *et al.* 1977). During the non-breeding season, the species migrates to the North Pacific Ocean, with failed and non-breeders flying north as early as Feb and Mar (Marant & Higgins 1990). In 1972, the earliest mottled petrels were heard calling on 24 Oct and a burrow was found cleaned out a few days later (Horning & Horning 1974). In 2000, calling was not heard by 23 Oct, but 2 mottled petrels were found ashore that night and at least 1 of these birds remained ashore the next day. About 25 singles were seen at sea between the Snares Is and Stewart I. on 24 Oct 2000. There is thought to be a pre-laying exodus of 9-16+ days (Warham *et al.* 1977). In the 1969-70 and 1970-71 seasons, laying was recorded from 7 Dec to 2-10 Jan, with a peak about 19 Dec; $^2/_3$ of eggs were laid 15-22 Dec. Incubation lasted *c.*50.5 days, and peak hatching occurred *c.*7 Feb. Hatching extended from 31 Jan to *c.*21 Feb, but $^2/_3$ of chicks hatched 4-11 Feb. Chicks were brooded for up to 2 days and the nestling period was considered to be 90-105 days. Fledglings departed from early May to 8 Jun (Warham *et al.* 1977). The species was heard calling overhead until mid-Apr (Horning & Horning 1974). Mottled petrels called in the air at night frequently between Nov and Mar, and could be attracted to the ground using "war-whoops" (Tennyson & Taylor 1990).

Mottled petrels were not commonly seen offshore during daylight, but about 300 were seen off North Promontory at 0700 h NZST on 16 Jan 1986. Warham *et al.* (1977) stated that they never saw this species from the island by day, and they are rarely seen close to land throughout their range (Marchant & Higgins 1990). Warham *et al.* (1977) reported that they were quite plentiful >19 km northwest of the Snares Is on 4 Dec 1969 and were present >50 km south of the islands on 2 Jan 1967. More recent observations show that, given

suitable weather conditions, mottled petrels were common close to the islands. On calm days none would be seen, but when winds exceeded 15 knots, mottled petrels were common 1-15 km south of the Western Chain, e.g., 20-30 on 26 Jan 1983 and 50+ on 9 Feb 1983.

Grey-faced petrel (*Pterodroma macroptera*)
A grey-faced petrel was seen offshore from Seal Point on 6 May 1997 (M. Renner, pers. comm.). One was seen 15 km north of the Snares Is on 22 Sep 1985. Grey-faced petrels breed on many islands and headlands around northern North Island (Turbott 1990).

White-headed petrel (*Pterodroma lessonii*)
A white-headed petrel was seen offshore on 20 Apr 1999 (J. Haselmayer, pers. comm.). A gadfly petrel heard calling in flight at night north of Station Cove by CMM on 10 Jan 1987 was probably a white-headed petrel.

Single white-headed petrels were seen south of the Western Chain on 9 Feb 1983 and south of Broughton I. on 8 Jan 1985. Two were seen 13-15 km north of NEI on 17 Mar 1992. These birds were probably from the large breeding populations on the Auckland or Antipodes Is (Turbott 1990).

New Zealand white-faced storm petrel (*Pelagodroma marina maoriana*)
A white-faced storm petrel was caught at night under *Olearia* forest near Penguin Colony 3 on 28 Nov 1986 (weight 44 g, culmen 15.2 mm, tarsus 42.0 mm, wing 158 mm, tail 61 mm to centre feather, 73 to outer feather). This bird was probably a vagrant from the muttonbird islands off southwest Stewart I., although a few white-faced storm petrels breed on the Auckland Is (Turbott 1990).

Black-bellied storm petrel (*Fregetta tropica*)
Remains of 2 skua-killed black-bellied storm petrels were found on Skua Point in Jan and Feb 1987, and in Punui Bay in Mar 1996 (all specimens held in MNZ). Black-bellied storm petrels were seen from fishing boats near the Western Chain on 9 Feb 1983 (6), 15 Jan 1984 (1), and 10 Feb 1987 (1), and 3 were 8-13 km north on 17 Mar 1992. Within the New Zealand region, black-bellied storm petrels breed on the Auckland and Antipodes Is (Turbott 1990).

King penguin (*Aptenodytes patagonicus*)
A king penguin was seen swimming in Ho Ho Bay on 26 Jan 1983. It came ashore to moult on Station Point 29 Jan-19 Feb 1983 (Plate 3C). A specimen collected on the Snares Is by H.H. Travers was reported by Wilson (1907; plate VIII, fig. 4) and is in the Natural History Museum, Tring (BMNH 1897.3.12.1; J. Cooper, pers. comm.). The nearest breeding colony of king penguins is on Macquarie I. (Turbott 1990).

Yellow-eyed penguin (*Megadyptes antipodes*)
A juvenile yellow-eyed penguin seen among Snares crested penguins on Penguin Slope on 2 Dec 1998 was the first recorded from the Snares Is. Yellow-eyed penguins have 2 genetically distinct populations: 1 in Otago, Southland and Stewart I. to the north of the Snares Is, and the other on Campbell and Auckland Is to the south (Triggs & Darby 1988). The provenance of the Snares Is bird is not known.

Gentoo penguin (*Pygoscelis papua*)
A gentoo penguin ashore on Station Point 27-28 Dec 1985 (Plate 3D) is the only record from the Snares Is. The nearest breeding colony is on Macquarie I. (Turbott 1990).

Blue penguin (*Eudyptula minor*)
Blue penguins were recorded from the Snares Is during most visits between 1982 and 1987. Two were seen in 1983-84: 1 was offshore from Broughton I. on 9 Feb 1984, and a fresh head was found on Toru Islet on 12 Feb 1984 (Miskelly 1984). At least 1 blue penguin was present in 1984-85: in Boat Harbour on 2 Dec 1984, off Seal Point on 30 Jan 1985 and off South Promontory on 11 Feb 1985. There was an influx in 1985-86, with at least 5 birds present: 1 long dead on Ho Ho Point on 8 Nov 1985, 1 in Mollymawk Bay and another off Broughton I. on 19 Jan 1986, 1 in Boat Harbour on 30 Jan, 10 and 12 Feb 1986, 1 injured ashore in Ho Ho Bay on 7 Feb, 1 off Seal Point on 15 Feb, 1 dying on Muttonbird Creek beach on 18 Feb, and 1 alive and 1 dead at the base of Seal Point on 23 Feb 1986. At least 2 blue penguins were present in 1986-87: 1 was seen in Boat Harbour on 25-27 Dec 1986, 6 and 11 Jan and 18 Feb 1987, and 1 dead for about 5 days was on Muttonbird Creek beach on 12 Jan 1987. On 27 Dec 1986 a blue penguin rushed erratically about Boat Harbour after being disturbed by a cruising New Zealand sealion (*Phocarctos hookeri*).

Single blue penguins were seen in Mollymawk Bay on 4 and 12 Mar 1996, and a healthy bird was ashore on Penguin Slope on 5 Mar 1997. A single juvenile was in Boat Harbour on 5 Feb 1998 (T. de Cruz, pers. comm.) and again on 4 Feb 1999. At least 2 blue penguins were present between 28 Feb and 5 Mar 2000. A recently moulted bird was found freshly dead near the mouth of Muttonbird Creek on 5 Mar 2000. The remains of a blue penguin were found in a sealion regurgitation on Ho Ho Point on 15 Apr 2000.

Single blue penguins were previously reported from NEI by Warham & Keeley (1969), Horning & Horning (1974) and Sagar (1977a), while Horning (1976) reported 2 seen in Ho Ho Bay on 8 Feb 1975. A specimen was collected by C.H. Hay on 14 Jan 1970 (MNZ 15518). Horning & Horning (1974) speculated that there may have been a pair of blue penguins breeding near the hut. The Snares Is are at the southern limit for blue penguins, which are known to breed as far south as Stewart I. (Turbott 1990).

Rockhopper penguin (*Eudyptes chrysocome*)
Two forms of rockhopper penguin have been recorded at the Snares Is: the eastern rockhopper penguin (*E. c. filholi*), which breeds in large numbers on the Antipodes, Auckland, and Campbell Is in the New Zealand subantarctic, and the western rockhopper penguin (*E. c. chrysocome*), a vagrant from Cape Horn and the South Atlantic (Tennyson & Miskelly 1989).

Eastern rockhopper penguins were regularly sighted in small numbers on the Snares Is, with up to 5 birds recorded moulting there most seasons. Most were recorded among Snares crested penguins at the main penguin landing points on the east coast of NEI, but single birds were recorded in Snares crested penguin colonies away from the coast on 27 Dec 1982 (an immature) and 4 Jan 1983 (an adult).

Moulting eastern rockhopper penguins were recorded from mid Jan to mid Mar, with minimum numbers of 4 in 1983, 5 in 1984, 2 in 1985, 4 in 1986, 3 in 1987 and 1993, 2 in 1995 and 1996, 4 in 1997, 0 in 1998 and 1 in 1999. Equal numbers of adults and immatures were seen. Larger numbers of eastern rockhopper penguins were seen in Dec (before the moult) in some years: 3 adults, 5 immatures in 1985; 4 adults, 7 immatures in 1986; 4 adults, 8 immatures in 1999. The earliest sightings were birds seen on 10 Dec 1985 and 6 Dec 1986.

Waite (1909) claimed that "numerous examples of C. [*Catarractes*] *chrysocome* were found breeding at the Snares", although Ogilvie-Grant (1905) was emphatic that they did not breed on either the Snares or Bounty Is. Of 2 eggs formerly catalogued as rockhopper penguin eggs from the Snares Is in the MNZ collection, MNZ 7195 (73.7 × 49.3 mm) is labelled "Snares Isle 3-10-[18]95 Crested Penguin J. Bollons", and MNZ 7687 (57.2 × 46.5 mm) is labelled "Doubtful Cape Pigeon? Western Reef Snares Oct [19]06. J. Bollons". MNZ 7195 falls within the size range of typical Snares crested penguin "B" eggs (Warham 1974). MNZ 7687 appears to be a penguin egg, but is too small for typical eggs of either Snares crested penguin or rockhopper penguin (measurements in Marchant & Higgins 1990). Given the lack of corroborative evidence, it is more plausible that this is a dwarf egg of a Snares crested penguin. Both eggs have now been re-registered as Snares crested penguin eggs.

A western rockhopper penguin was found among Snares crested penguins on Ho Ho Point on 20 Dec 1985. It defended a nest site there from 26 Oct 1986 to 14 Jan 1987. A different bird was in Station Cove on 17 Nov 1986 (Tennyson & Miskelly 1989). Western rockhopper penguins were seen subsequently in Boat Harbour 5-9 Mar 1993 (Medway 2000), 1 freshly moulted on Penguin Slope on 2 Mar 1994 (J. Molloy, pers. comm.) and another the same on 3 Mar 1995, 1 freshly moulted in a Snares crested penguin colony near Muttonbird Creek on 2 Mar 1995, 1 in premoult condition in Boat Harbour on 12 Mar 1996, 2 in Ho Ho Bay on 10 Mar 1997 (1 just completed moult, 1 in premoult condition), 1 just completed moult in Boat Harbour on 25 Feb 1998, and another the same on 1 Mar 1999 and 25 Feb 2000. A maximum of 2 western rockhopper penguins was seen each season. As no immature birds were seen, it is possible that all the sightings from 1985 to 1999 were of the same 2 individuals. These remain the only records of this taxon from the New Zealand region.

Macaroni/royal penguin (*Eudyptes chrysolophus*)
A juvenile female royal penguin (*E. c. schlegeli*) in poor condition that came ashore in Station Cove on 19 Feb 1986 (Plate 4A) was found dead on 25 Feb (MNZ 23555). An adult royal penguin was photographed by Janice Molloy on Penguin Slope on 2 Mar 1994 (Plate 4B).

Single macaroni penguins (*E. c. chrysolophus*) were found in Station Cove on 10 Jan 1969 (Warham & Keeley 1969), in Jan 1970 (Warham 1971, 1972) and 30 Nov 1974 (Horning 1976). The subspecific identification of the first 2 birds was disputed by Falla *et al.* (1970, 1971). The third bird (an adult male) was collected (MNZ 18645). None was seen during 1982-2000.

Royal penguins breed only on Macquarie I.. The nearest breeding colony of macaroni penguins is on Heard I. in the southern Indian Ocean (Turbott 1990).

Fiordland crested penguin (*Eudyptes pachyrhynchus*)
Fiordland crested penguins were the most frequently seen penguins other than the locally breeding Snares crested penguins. Up to 30 immature Fiordland crested penguins moulted on the Snares Is each year, but numbers were probably underestimated as these penguins often moulted solitarily under vegetation away from the main penguin landing sites. Fiordland crested penguins breed earlier than other crested penguins in the New Zealand region (Marchant & Higgins 1990), and this was reflected in the relatively early moult of immature Fiordland crested penguins on the Snares Is. Birds in premoult fat were recorded before the end of Dec in most years, with the earliest on 14 Dec 1985. Minimum numbers recorded in Jan-Feb were 7 in 1983, 30 (including 4 on Broughton I.) in 1984, 22 in 1985, 16 in 1986, 8 in 1987, 8 in 1999 and 10 in 2000. The maximum count on 1 day was 17 on 6 Feb 1984, when all 9 penguin landing sites from Penguin Slope to South Promontory (Fig. 5) were checked. A few Fiordland crested penguins were still completing their moult in Mar, with a late bird recorded on 10 Mar 1997 (a yearling banded as a chick by Martin Abel at Jackson Head, South Westland, 14 Nov 1995).

A few Fiordland crested penguins were found ashore before the moult. Single immatures were seen on Ho Ho Point on 8 Nov 1985 and 17 Nov 1986, in Station Cove on 1-2 Nov 1986, 5 Nov 1986 (a different bird), 26 Nov 1986 and 3 and 7 Nov 1987, and on Penguin Slope on 6 Dec 1986.

Only 3 adult Fiordland crested penguins were seen

Fig. 5 Distribution of breeding colonies and landing sites for Snares crested penguins (*Eudyptes robustus*) in 1984-85. Locations of some closely spaced colonies are approximate only. Compare with fig. 9 in Warham (1974).

on the Snares Is. One, with badly injured feet, climbed out of Boat Harbour on 31 Jan 1986. The only adult recorded moulting (in premoult fat on Station Point, 4 Mar 1986) was also injured. The only healthy adult Fiordland crested penguin seen was among the Station Cove penguins on 2 Nov 1986. It had moved inland to a small Snares crested penguin colony above the base of Seal Point by 4 Nov. On 5 Nov 1986 this bird (presumed female) was displaying with an adult male Snares crested penguin at an empty nest in this colony.

The numbers of Fiordland crested penguins moulting on the Snares Is in the 1980s was comparable to those in 1969, when Warham & Keeley (1969) recorded 20 ashore. The species breeds on islands and headlands from South Westland to southern Stewart Island, including Solander I. (Turbott 1990).

Snares crested penguin (*Eudyptes robustus*)

The endemic Snares crested penguin (Plate 4C) breeds only on NEI and Broughton I. and on Toru and Rima Islets in the Western Chain (Fig. 5). Breeding penguins on NEI and Broughton I. landed at 12 sites along the east coasts of the islands and walked up to 900 m from the landing sites to colonies (Fig. 5). Most colonies were under *Olearia* or *Brachyglottis* forest or among *Hebe* shrubland, but a few (especially in Sinkhole Flat and on South Promontory) were on bare rock and mud. On Toru and Rima Islets, the penguins landed at 1-2 sites on each islet and nested in scattered aggregations under boulders and in crevices among Salvin's albatross colonies (Miskelly 1984).

Fledgling counts were undertaken at most colonies on NEI in Dec-Jan from 1982-83 to 1986-87, but 1985-86 was the only year when it was possible to estimate breeding success, and so calculate the number of breeding pairs. In Sep 1985, 375 pairs at 2 colonies laid eggs (typically 2 per pair; Warham 1974). No pairs reared twins, and 275 chicks fledged from these 2 colonies in Jan 1986. This 73.3% breeding success rate meant that each fledgling represented 1.36 breeding pairs. About 14,000 chicks fledged from 126 colonies on NEI in 1985-86 (mean 110 per colony, range 3-640), giving an estimated population of 19,000 breeding pairs.

The number of pre-fledging chicks on NEI varied from *c.*10,200 to *c.*18,800 over the 5 years (Table 2). Assuming that productivity on Broughton I. and the Western Chain varied in a similar way, and that *c.*5% of chicks died after the counts, it is likely that 11,300 to 22,000 chicks fledged each year from 1982-83 to 1986-87 (mean 18,000). We estimated that about 23,300 breeding pairs were present in late 1985. Clark (1996) reported a count of 231 pairs on eggs on Toru Islet in Nov 1995, compared to an estimate of 300-400 chicks there on 12 Feb 1984 (Miskelly 1984).

The breeding chronology of Snares crested penguins on NEI was well documented by Warham (1974); any variation that we found is noted. The timing of breeding on Broughton I. was essentially the same as for NEI,

Table 2 Estimated number of Snares crested penguin (*Eudyptes robustus*) chicks alive 1-2 weeks before fledging between 1982-83 and 1986-87. Numbers in parentheses are estimates based on part counts or (for Broughton I. and the Western Chain) assuming that productivity varied in a similar way to that on North East I. The only direct estimate for the Western Chain was in 1983-84. Chick mortality post-census was estimated for a few colonies on North East I. in 1985-86 (10%) and 1986-87 (0.2%).

	North East I.	Broughton I.	Western Chain	Total
1982-83	10,200	(1400)	(290)	11,900
1983-84	(16,100)	2500	(500)	19,100
1984-85	18,800	3800	(610)	23,200
1985-86	15,400	(3100)	(500)	19,000
1986-87	17,600	(3600)	(570)	21,800

but breeding was much later on the Western Chain (see below). On NEI, breeders returned from late Aug and eggs were laid 19 Sep-20 Oct (peak for 1st egg of 2-egg clutch, 28 Sep in 1972). Laying interval was 4.45 ± 0.92 days (44 nests) in 1972 and 4.34 ± 0.28 days (22 nests, range 4-5 days) in 1985. Incubation period (estimated from laying date of 2nd, larger, egg) was 33.3 ± 1.36 days (29 nests, 31-37 days) in 1972 and 33.5 ± 1.46 days (17 nests, 31.5-37 days) in 1985. The hatching interval for 11 nests in 1985 was 0.7 ± 0.6 days (0-2 days). Eggs hatched between 23 Oct (1985, 2000) and 12 Nov, and chicks departed between 1 Jan (1987) and 8 Feb (peak 17-21 Jan). Breeding adults were absent from the island from mid Feb and returned to moult at their nest sites from mid Mar through to early May (exceptionally 30 May) before vacating the island again. Unusually, an adult was ashore in Station Cove on 26 Jul 2000 (J.-C. Stahl, pers. comm.).

Peak hatching on Toru Islet occurred soon after 15 Dec in 1984 (Miskelly 1997), indicating that peak laying was about mid Nov, about 6 weeks later than on NEI. Laying had started before 9 Nov in 1995 and was almost complete by 17 Nov (Clark 1996).

Despite considerable effort made to locate fledged twins, instances of the successful fledging of both young are rare (see Lamey 1990). In 1984-85, 6 fully-grown chick pairs were seen to be fed (each by a single adult) in each of 6 separate colonies. In 1985-86, 29 sets of twins were found towards the end of the guard stage (chicks >2 weeks old), but no successful fledging of twins was proven. In 1986-87, 19 of 1049 broods (1.8%) contained twins 10-15 days old, 2 broods of twins were still alive when >30 days old, and 1 brood of twins fledged. Young in this latter brood weighed 2.3 kg and 2.6 kg on 12 Jan (cf. mean of 2.6 kg for single chicks; Warham 1974). Both chicks had fledged by 18 Jan, but it was not possible to determine whether both chicks had been reared by their biological parents throughout the post-guard stage.

Minimum survival rates of banded fledglings during their first year varied greatly: 4.9% of 82, 1983; 39.1% of 199, 1984; 6.7% of 282, 1985; 10.6% of 292, 1986. Survival in year 1 averaged 15%, followed by a mean of 57% for the next 2 years, although band-loss may have contributed to low apparent survival rates. Presumed minimum age of first breeding is 6 years (Warham 1974). Adult survival rates are unknown, but a male banded as an adult in Nov 1968 was still breeding in 1986-87 at 22+ years old. The oldest banded bird still alive in Oct 2000 was a male banded as an adult in 1985-86. The only other banded birds found alive (as breeders) in Oct 2000 were 2 banded as chicks in 1984-85 and 1985-86.

Three "isabelline" chicks with pale fawn dorsal plumage were found in the same colony in upper Muttonbird Creek: 1 in 1982-83 and 2 in 1985-86. These are the first recorded instances of isabellinism in Snares crested penguins, but the state is known in at least 7 other penguin species (Marchant & Higgins 1990; Everitt 2000). Another partial albino chick with white patches on its head was also in the Muttonbird Creek colony in 1982-83. The same colony was checked on 24 Sep 1985 (when all breeding adults were present at nest sites) but no aberrant birds were seen. Two partial albino adults breeding in Oct 2000 had mainly white posterior dorsal plumage with normal head and upper body plumage. Three partially melanistic birds with breast bands similar to *Spheniscus* penguins were seen in 1985-86 and 1986-87 (see also Warham 1974). Typical eye colour in Snares crested penguins is red-brown (Warham 1974), but we saw 4 birds with pale yellow irides (similar to *Megadyptes*) and 1 with pale brown irides.

Feeding flocks of Snares crested penguins were often encountered within 3 km of the islands (see Fenwick 1978), including the Western Chain. Few were seen en route to or from Stewart I.: 1st penguins seen 24 km out from the Snares Is on 2 Feb 1984; 1 at 80 km out on 30 Nov 1985; singles and pairs from 30 km out on 7 Nov 1987; 5 at 12 km north on 18 Jan 1993 (latter AJDT pers. obs.).

Erect-crested penguin (*Eudyptes sclateri*)

The number of erect-crested penguins moulting on the Snares Is in Jan-Feb varied markedly between years: 4, 1983; 35, 1984; 16, 1985; 5, 1986; 6, 1987. From 1992 to 2000, 0-3 erect-crested penguins were recorded, but

as these visits were mainly in Mar, it is likely that some birds had already completed their moult and left. Of the 21 erect-crested penguins seen on 15 Feb 1984, 13 were on Penguin Slope.

Erect-crested penguins were found at all the main penguin landing sites, including Broughton I. (4, 25 Feb 1984; 3, 11 Feb 1985), Rima Islet (1, 11 Feb 1984), and Toru Islet (1, 19 Jan 1986). Erect-crested penguins were rarely found away from the coastal rocks, but 2 moulting immatures were found in Snares crested penguin colonies on 21 and 29 Jan 1987. Erect-crested penguins were recorded ashore before the moult in 1985 (3, 9-29 Dec); 1986-87 (4 adults, 10 immatures 4 Dec - 5 Jan); 1987 (1 adult, 1 immature 30 Nov - 3 Dec); 1998 (1 adult, 2 Dec); moulting birds were noted from 14 Jan onwards. While most moulting erect-crested penguins seen were immature, adults were noted on 19 Jan 1986 (Toru Islet), 26 Feb 1986 (Station Point), and 8 Feb 1987 (base of Seal Point).

Previous counts of moulting erect-crested penguins on NEI were 2 in 1967 (Warham 1967) and 15 in 1969 (Warham & Keeley 1969). Large populations of erect-crested penguins breed on the Antipodes and Bounty Is (Marchant & Higgins 1990).

Australasian gannet (*Morus serrator*)
Single gannets were seen off the north and east coasts of NEI on 9 days between 14 Nov 1985 and 6 Feb 1986, on 5 days during 21 Nov-30 Dec 1986 and on 4 Dec 1987, 6 Dec 1998, and 25 Feb 1999. One was offshore from Broughton I. on 26 Feb 1984, and another was off Toru Islet on 19 Jan 1986 (Miskelly 1997). All were adults. Gannets were reported previously by Horning & Horning (1974) and Sagar (1977a). The nearest gannet colony to the Snares Is is on Little Solander I. in Foveaux Strait (Cooper *et al.* 1986).

Black shag (*Phalacrocorax carbo*)
Single black shags were seen in Boat Harbour on 27 Jul 1998 and on South Promontory on 17 Oct 2000. The only other records were of >60 immatures present around the Snares Is in 1976-77 (Sagar 1977a).

Pied shag (*Phalacrocorax varius*)
Two pied shags were seen in 1961 (Warham 1967), at least 3 were present in 1973 (Horning & Horning 1974), and 2 were seen in Jun 1981 (Robertson *et al.* 1981). None was seen during 1982-2000.

Little shag (*Phalacrocorax melanoleucos*)
At least 3 little shags were present in 1982-83, 4 in 1983-84, and 1 in 1984-85. They were usually seen roosting on the eastern side of NEI, particularly near Ho Ho Point, and all were of the pied phase. Little shags were seen in 1968-69 (2; Warham & Keeley 1969), 1974-75 (2; Horning 1976), and 1976-77 (at least 7; Sagar 1977a). Warham (1967) reported a nest apparently of this species first seen in 1961 and still present in 1967.

Auckland Island shag (*Leucocarbo colensoi*)
A juvenile Auckland Island shag first seen in Boat Harbour on 24 Jul 1994 had gained full adult plumage by Mar 1996 (Plate 4D). This bird was seen on 14 visits and was still present in Oct 2000, often associating with Snares crested penguins on Ho Ho Point, where it defended a nest site in a penguin colony. When penguins were present the shag walked to and from the colony with the penguins, but when there no penguins the shag flew to and from its nest site.

Spotted shag (*Stictocarbo punctatus*)
A spotted shag was collected on the Snares Is on 7 Jan 1902 (Ogilvie-Grant 1905) The skin is BMNH 1905.2.2.31 (J. Cooper, pers. comm.).

White-faced heron (*Ardea novaehollandiae*)
A white-faced heron was seen in Ho Ho Bay on 13 Sep 1982 (M. Schofield, pers. comm.), 2 were present between Ho Ho Bay and Skua Point 1-22 Feb 1984, and 1 in a penguin colony above the Sinkhole 11-23 Jan 1985. Single white-faced herons were also seen around Boat Harbour and Ho Ho Bay on 22-23 Sep 1985, 4-5 Mar 1992, 5 Mar 1996 and in Apr-May 1997. A dead white-faced heron found beside a penguin colony in Penguin Creek on 10 Oct 2000 is held at MNZ. Previous records were 2 in Feb-Mar 1972 and 1 dead on 27 Oct 1972 (Horning & Horning 1974), and 1 in Ho Ho Bay on 22 Feb 1975 (Horning 1976).

White heron (*Egretta alba*)
A single white heron was seen in Boat Harbour on 24 Apr 1973 (Horning & Horning 1974). None was seen during 1982-2000.

Cattle egret (*Bubulcus ibis*)
The remains of a cattle egret were found in a fern clump on Station Point on 14 Jan 1986 (now MNZ 25653). The skeleton of another was found near Penguin Colony 3 on 28 Jul 1994. Two cattle egrets were foraging among roosting penguins at Ho Ho Bay and Station Cove 22-28 Apr 1997 (Medway 2000), and 1 was present in penguin colonies 14-17 Apr 2000. A single humerus found in a skua midden on Skua Point on 6 Oct 2000 (MNZ unregistered) may have come from this latter bird.

Canada goose (*Branta canadensis*)
A Canada goose on NEI 16-27 Nov 1987 was first seen in Boat Harbour being harassed by red-billed gulls (*Larus novaehollandiae*), Antarctic terns, skuas, and New Zealand sealions. On several occasions it was seen feeding on *Callitriche antarctica* on Skua Point. When disturbed on 23 Nov it settled on the sea off Seal Point among a flock of cape pigeons.

Chestnut-breasted shelduck (*Tadorna tadornoides*)
A female chestnut-breasted shelduck was seen regularly around Station Cove and Ho Ho Bay 27 Nov-22 Dec

1984. This bird was very approachable (Plate 4E), and was observed eating *Callitriche antarctica* on 7 and 9 Dec 1984. It was part of a New Zealand-wide influx of chestnut-breasted shelducks from Australia in 1983-85, which included records from Auckland and Campbell Is (Heather 1987).

Australian wood duck (*Chenonetta jubata*)
A male Australian wood duck first seen near Boat Harbour on 9 Dec 1982 was seen on 3 more times to 10 Feb 1983. Although the bird was not seen in 1983-84, 2 fresh wood duck feathers were found in the lining of a fernbird nest on Skua Point in Feb 1984. What is presumed to have been the same bird was seen 7 times between 11 Dec 1984 and 6 Feb 1985. It was caught at the base of Skua Point at night on 13 Nov 1985 (Plate 5 A, B; weight 1045 g), and was seen on 9 further days through to 7 Mar 1986, mainly at Sinkhole Flat. The wood duck was often seen in company with a mallard hen (e.g., 10 Feb 1983, 2 and 21 Jan 1985, 3 and 6 Feb 1985, 14 Nov 1985) but was always very wary. This was only the 4th record of the species from New Zealand (Turbott 1990).

Mallard (*Anas platyrhynchos*); **grey duck** (*A. superciliosa*)
A small, mixed population of mallards and grey ducks is resident on NEI. Mallards were first reported from the Snares Is in 1968-69, when 1 hybrid was seen (Warham & Keeley 1969). Horning & Horning (1974) reported 2 male mallards on 26 Apr 1973, and Robertson *et al.* (1981) reported 18 mallards in early Jun 1981. We found a skua-killed hybrid in 1982-83, but did not confirm breeding by mallards until 1984-85, when 2 different broods accompanied by females mallards were seen. Three further mallard broods were seen in 1985-86, and 2 in 1986-87.

Both species were encountered most frequently in swampy areas on Sinkhole Flat and the upper reaches of Penguin Creek, but they were wary and difficult to approach. Other locations where ducks were seen included Skua Point, Seal Point, Boat Harbour, Muttonbird Creek, South Promontory, and Punui Bay. The largest flocks seen (other than ducklings) were 9 grey ducks on 23 Jan 1985 and 8 Mar 1999, 9 mallards on 7 Nov 1987, 9 (both species) on 4 Mar 1992, and 13 unidentified ducks on 19 Mar 1993, all at Sinkhole Flat. The proportion of mallards seen changed little from the 1980s (45% of 65 sightings) to the 1990s (53% of 95 sightings). Based on the number of nests and broods seen (minimum of 4 in 1982-83 and 1986-87), we suggest that no more than 10 pairs of ducks were present, about 50% of each species. Of the 13 nests and broods seen in the 1980s, 7 were accompanied by female mallard and 6 by grey ducks. The 2 nests found (both grey ducks) contained 5 eggs (hatched 2 Jan 1983) and 8 eggs (20 Nov 1986). Brood sizes were 1, 1, 3, 4, 4, 5, and 8 (mallard) and 2, 4, 7, and 8 (grey duck). Ducklings were seen between 6 Nov and 8 Mar (mallard) and 22 Oct and 10 Jan (grey duck).

Observations in Oct 2000 indicate a dramatic decline in relative abundance of grey ducks at the Snares Islands after the 1990s. There were 24 sightings of adult mallards (max. 3 together) and none of grey ducks. A 10-egg mallard nest was found on 12 Oct, and a dead recently hatched duckling (species unknown) was found on 19 Oct 2000 (MNZ unregistered).

Earlier records indicate the presence of grey ducks only. Stead (1948) reported finding 4 grey duck nests, of which 3 nests contained 7, 10, and 9+ eggs (latter clutch apparently not complete). Horning & Horning (1974) estimated that 30-40 grey ducks were present, including 11 in Sinkhole Flat in Jul 1973, and 8 ducks with about 25 ducklings in Muttonbird Creek on 27 Dec 1972. The largest brood seen was 11 ducklings on 19 Dec 1972.

Grey teal (*Anas gracilis*)
Two grey teal seen in Boat Harbour on 20 Nov 1987, and 1 on 21 and 24 Nov 1987 are the only records of this widespread Australasian species from the Snares Is.

Australasian shoveler (*Anas rhynchotis*)
A male shoveler seen in flight over Station Cove on 17 May 1997 (M. Renner, pers. comm.) was the first recorded from the Snares Is.

White-eyed duck (*Aythya australis*)
A female white-eyed duck seen on 4 occasions in Ho Ho Bay in Aug and Sep 1981 (M. Schofield, pers. comm.) was 1 of only 4 records of this Australian species in New Zealand since 1895 (Turbott 1990).

Australasian harrier (*Circus approximans*)
Single harriers were seen over Ho Ho Bay on 9 Dec 1982, 8 Jan 1983 and 24 Jul 1994, and over Penguin Creek on 24 Sep 1985. A freshly dead Snares Island snipe on Station Point on 22 Sep 1985 may have been killed and consumed by the harrier seen 2 days later. Single harriers were seen over the centre of NEI on 17 and 23 Nov 1987 and 7-22 Oct 2000, and 1 was hunting over the coastline and forest on 24 Apr and 6 May 1999. Single harriers were also reported by Warham (1967), Horning & Horning (1974), and Horning (1976).

Pied oystercatcher (*Haematopus ostralegus finschi*)
A juvenile pied oystercatcher was seen on a North Promontory clifftop on 13 Feb 1986. Two pied oystercatchers that flew over Station Point on 9 Dec 1986 separated after being chased by a skua. An oystercatcher was also heard calling as it flew over Station Point on 9 Feb 1987. No oystercatchers of any species had previously been reported from any of the New Zealand subantarctic island groups (Turbott 1990).

Spur-winged plover (*Vanellus miles*)
A spur-winged plover was seen around Station Point on 19 May 1997 (K. Squires, pers. comm.).

Table 3 Results of transect counts of territorial male Snares Is snipe (*Coenocorypha aucklandica huegeli*) call rates through the 3 main habitat types on North East I. in Feb 1983. Observed densities were corrected to an estimated density using a coefficient of detectability of 3.56 (see text). Total breeding population estimates were based on the combined areas of different vegetation types calculated for both North East and Broughton Is. L_1 and L_2 give lower and upper 95% confidence limits respectively.

Habitat type	Area (ha)	Observed density (males ha^{-1})	Estimated density (males ha^{-1})	Estimated breeding population (pairs)	L_1	L_2
Olearia forest with dense ground cover	89	0.28	1.00	89	55	123
Olearia forest over bare peat	78	0.06	0.21	16	0	32
Poa tussock grassland	86	0.72	2.56	220	197	243
Total	253	-	-	325	252	398

Turnstone (*Arenaria interpres*)
A turnstone flew past Seal Point on 15 Jan 1984, 2 were seen between Skua Point and Ho Ho Bay on 4 and 6 Nov 1985, and a 3rd with more black on the breast was first seen on 15 Nov. All 3 were seen together on Ho Ho Islet on 18 Nov, and 1 was at the South Promontory penguin landing on 14 Dec. The last record was of 1 heard on 25 Dec 1985. While turnstones have not been recorded from the Snares Is previously, they regularly visit the Auckland Is farther south (Turbott 1990).

Snares Island snipe (*Coenocorypha aucklandica huegeli*)
The endemic Snares Island snipe (Plate 5C) was abundant on NEI and Broughton I., and also occurred on Alert Stack (recorded on 20 Dec 1976 by PMS and 9 Feb 1985 by CMM). An estimate of the population density of snipe in the 3 main habitats on NEI (*Olearia* forest with dense ground cover, *Olearia* forest over bare peat, and tussock grassland) was attempted in Feb 1983. Transects recording call rates of territorial males in these 3 habitats were compared with transects through the snipe study area north of Station Point, where the density of colour-banded territorial males was known to be 2.56 ha^{-1} (Miskelly 1999b). Transects through the study area produced observed densities for territorial males of 0.72 ha^{-1}, allowing the calculation of a coefficient of detectability (Colquhoun 1940) of 3.56. Using this value to correct densities recorded during transects elsewhere, the breeding population of snipe on NEI and Broughton I. was estimated at 325 pairs (Table 3). The density of territorial male snipe in the study area over 6 seasons varied from of 2.56 ha^{-1} in 1982-83 to a peak of 3.79 ha^{-1} in 1986-87 (Miskelly 1999b) (mean, 3.24 ha^{-1}). Assuming that variation in population density of snipe in the study area reflected changes in the entire population, the breeding population of snipe on the Snares Is in 1982-87 probably fluctuated between 325 and 480 pairs (mean, 413 pairs).

Snipe were all but absent from the barren interior of the *Olearia* forest on NEI (Table 3). The highest densities under forest were found in the study area (between Station Point and Punui Bay) and on Ho Ho Point, where the diverse ground cover included *Polystichum vestitum* fern, *Poa tennantiana* tussock, and mats of *Callitriche antarctica*. The 1983 transect results revealed that the density of snipe in the *Poa* grasslands beyond the *Olearia* canopy were similar to those in the study area (Table 3).

Snares Island snipe bred from Nov to May (Miskelly 1999a). The 2-egg clutches were laid 4 Nov-19 Feb, but a small downy chick seen on 4 May 1972 (Horning & Horning 1974) must have hatched from a clutch laid in early Apr (Miskelly 1999a). Incubation took 22 days and chicks did not become independent until about 65 days old (Miskelly 1990a), and so a chick from an egg laid on 19 Feb would not reach independence until mid May. If the chick seen on 4 May survived, it would have become independent in early Jul. During the 1985-86 and 1986-87 seasons, 82% of 39 pairs bred, 78% of 63 eggs hatched, and 48% of 50 chicks fledged, resulting in an overall breeding success of 0.6 fledglings $pair^{-1}$ (Miskelly 1990a).

During 1982-87, the mean annual survival rate for adult Snares Island snipe was 83% (Miskelly 1999b), including the higher mortality after the severe 1982-83 El Niño event (Miskelly 1990b). As 57 colour-banded snipe were known to be present in the study area in Dec 1987, it was anticipated that about 27 of these would still be alive in Dec 1991, and that snipe could potentially live for well over 20 years. However, the minimum number of colour-banded snipe known to be alive in 1992 (when visits recommenced) was only 21, suggesting that the mean annual survival rate had been only 78% for the intervening 4 years. Annual survival rates from 1991 to 1998 (when 5 colour-banded snipe were known to be alive) averaged 81%, but only 1 colour-banded snipe has been seen since. The longest-lived Snares Island snipe known up until 1987 was a male banded as an adult (i.e. at least 1 year old) by Peter Wright on 24 Nov 1969 and last seen on 3 Feb 1983 at the age of 14+ years. The longest-lived bird of the 93 adult snipe individually colour-banded in the study area during 1982-87 was a female banded as an adult on 27 Dec 1984 and last seen on 18 Dec 1998 at the age of 15+ years. The oldest known-age snipe was banded as a chick *c.*40 days old on 12 Feb 1986, and last seen 12 years later on 9 Apr 1998. The only colour-banded snipe known to be alive in Oct 2000 was banded as an adult on 23 Nov 1987, and was thus at least 14 years old when last seen.

Japanese snipe(*Gallinago hardwickii*)
A single Japanese snipe was seen on Skua and Seal Points on 12-14 Nov 1985. On 13 Nov it was probing in a sward of *Crassula moschata* on Seal Point. There are no previous records of Japanese snipe from New Zealand's subantarctic islands (Turbott 1990; Miskelly 2000), but there are probable sightings from Macquarie I. even farther south (Warham 1969).

Sharp-tailed sandpiper (*Calidris acuminata*)
A sharp-tailed sandpiper was in Station Cove on 8 and 9 Nov 1986. Previous sightings of single birds were reported by Warham & Keeley (1969) and Sagar (1977a).

Bar-tailed godwit (*Limosa lapponica*)
Six bar-tailed godwits reached NEI in Oct 1985, but 3 were already dead by the time they were discovered on 3 and 11 Nov 1985. Three live godwits were seen regularly between Skua Point and Station Cove 5-14 Nov 1985, 2 until 11 Dec (1 was found skua-killed on 16 Nov), and the remaining female was last seen on 23 Dec 1985. The 3 live godwits were caught at night on 13 and 14 Nov 1985. All 6 (including the 3 found dead) were birds of the year. Measurements indicated that there were 3 males and 3 females; weights of the 3 live birds were 209 g (both males) and 229 g (female). Initially, the godwits were seen mostly roosting and feeding on exposed mats of *Crassula moschata* and *Callitriche antarctica* around the coastal margin, but the last survivor was seen under the canopy *c.*100 metres from the coastal margin on 16 and 23 Dec 1985. Another bar-tailed godwit was present 22 Oct-5 Dec 1986, when it was seen regularly around Boat Harbour and Station Cove, and also under the forest on 14 Nov and 3 Dec 1986. A second godwit was found dead on Station Point on 26 Oct 1986. Buckingham & Willemse (1988) reported a bar-tailed godwit in Boat Harbour on 20 Oct 1987, and 3 godwits (1 male, 2 females; MNZ unreg.) were found dead (2 skua-killed) 6-17 Oct 2000. The only previous record was 1 present from 28 Oct 1972 - 13 Jan 1973 (Horning & Horning 1974).

Tattler sp. (*Tringa brevipes* or *T. incana*)
A tattler (most likely *T. brevipes*) seen on 9 Dec 1968 was reported by Warham & Keeley (1969). No tattlers were seen between 1982 and 2000.

Greenshank (*Tringa nebularia*)
A greenshank seen 20 Nov-13 Dec 1968 (Warham & Keeley 1969) remains the only record from the Snares Is.

Brown skua (*Catharacta skua lonnbergi*)
Brown skuas were the only predatory birds resident on the Snares Is. Breeding territories were spaced regularly around clifftops and headlands (Fig. 6) and were defended vigorously against both conspecifics and human intruders. In Dec 1984, the breeding population (including those on outlying islets) consisted of 68 pairs, 13 trios, 2 groups of 4, and 1 group of 5. Non-breeding "clubs" were seen regularly on Skua Point (max. 91 individuals, 6 Nov 1985) and northwest Broughton I. (max. 30, 29 Dec 1984). A club of 30-36 skuas was present on a clifftop south of Signpost Hill in Feb 1983, on 24 Feb 1986, 13 Mar 1992, and 2 Mar 2000. As this club was not seen before Feb, it might have been comprised of breeders following breakdown of territoriality at the end of the breeding season, or decreased territorial aggression may have permitted nonbreeders from the main club on Skua Point to roost there. The total population was estimated to be at least 310 adults.

Skuas were present on the Snares Is throughout 1972 but about half the population was thought to have left the islands during May-Sep (Horning & Horning 1974). Laying and incubation were mostly complete before we arrived, and so the limited information on clutch size was based on late clutches at a late stage of incubation. Ten clutches were found in Dec 1984 (4, 1 egg; 6, 2 eggs; mean 1.6 eggs clutch^{-1}; 73.6 ± 2.0 mm (68.6-76.3 mm) × 53.4 ± 1.2 mm (51.2-56.4 mm); n = 16). At the same time, there were 30 broods of young chicks (17, 1 chick; 13, 2 chicks; mean 1.4 chicks successful brood^{-1}). Hatching was recorded between 1 Nov (1987) and 25 Dec (1986). Assuming a mean incubation length of 30 days (Higgins & Davies 1996), eggs were laid 2 Oct-22 Nov. Horning & Horning (1974) recorded the earliest egg on 3 Oct 1972. In 2000, assuming a laying interval of 2-3 days (Higgins & Davies 1996), 6 first eggs were laid between 3-5 and 18 Oct, and 4 other nests had 1st eggs laid before 21 Oct. The earliest fledging recorded was on 30 Dec 1985. Nine pairs and 1 trio between Station Point and Skua Point fledged 14 chicks in 1986-87 (6, 1 chick; 4, 2 chicks; 1.4 chicks breeding group^{-1}). Richdale (1948) reported that all fledglings left by the end of Feb, but we noted 2-3 fledglings still ashore on 4-8 Mar 1992, and in 1998 and 1999 the last fledgling left in the 2nd week of Apr (see below). Most non-breeding skuas left the island in winter, e.g., 85 skuas in the club on Skua Pt on 31 Mar 2000 had dwindled to 7 by 1 May 2000.

Most skuas on NEI and Broughton I. preyed on the resident petrel species. Of 3752 midden remains from the whole of NEI in Jan-Feb 1986 (AJDT, pers. obs), 45.4% were diving petrel, 21.3% mottled petrel, 13.8% broad-billed prion, 8.3% sooty shearwater, and 8.1% fairy prion. The composition of prey deposits varied considerably between locations. For example, middens on the northeast coast contained mainly diving petrels, while mottled petrels were the most common prey elsewhere, apart from in South Bay, where broad-billed prions were most common. Middens between Signpost Hill and Razorback had a higher percentage of sooty shearwaters than those elsewhere on the island. Skua diet also differed seasonally, probably according to the availability of prey. For example, eggs and chicks of

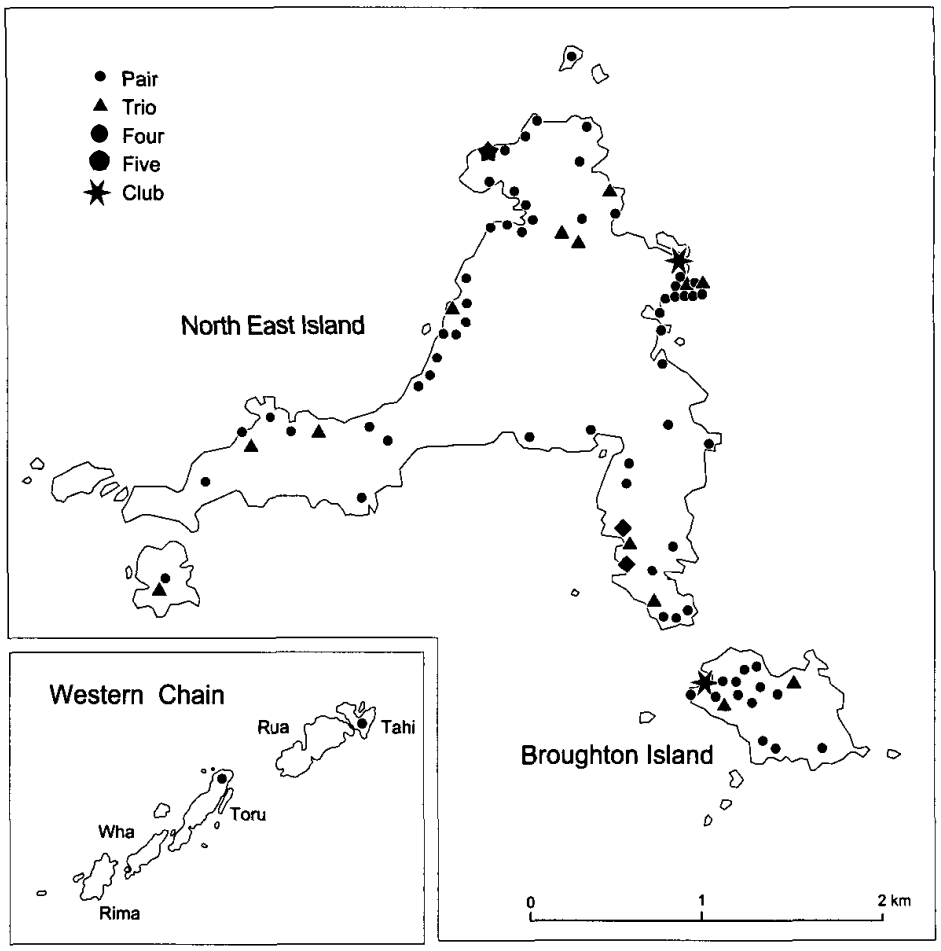

Fig. 6 Breeding territories and club sites for brown skuas (*Catharacta skua lonnbergi*) on the Snares Is in Dec 1984. Territories of 6 pairs and 2 trios on Seal Point not shown accurately.

Snares crested penguins and chicks of southern Buller's albatrosses were commonly found in middens in Oct-Nov. Large numbers of surface-laid sooty shearwater eggs were consumed in Nov-Dec. Unusual diet items on NEI included seal regurgitations, and: red-billed gull (12 records); mallard and grey ducks, hybrid ducks, and ducklings (8); eastern bar-tailed godwit (8); blue petrel (6); goose barnacles (5 masses); fulmar prion (4); cape pigeon (3); black-bellied storm petrel (3); Antarctic tern (3); seal remains (3); rock pigeon (2); blackbird (2); Salvin's prion (1); Snares Island snipe (1); skua chick (1); mottled petrel egg (1); and a *Mecodema* beetle. On Broughton I, 143 prey remains found on 17 Mar 1992 (AJDT pers. obs) included mottled petrels (35%), diving petrels (28%), goose barnacle masses (17%), sooty shearwaters (7%), fairy prions (6%), eggs (4%), and smaller numbers of penguins and a broad-billed prion. On the Western Chain, the prey species recorded were diving petrel, mottled petrel, fulmar prion, fairy prion, broad-billed prion, a sooty shearwater, a Salvin's mollymawk chick, a blue penguin, and fish (Miskelly 1984, 1997; Clark 1996; AJDT, pers. obs.).

In Nov 1998 a pair of skuas that nested in a small clearing in *Olearia* forest at the head of Punui Bay exhibited an interesting feeding method. In the early evening (before dark) they stalked and caught early-arriving sooty shearwaters immediately after they landed, before they had recovered from the fall through the canopy. Of 7 birds killed in this manner over 9 days, at least 5 were females with eggs in their oviducts; the other 2 were too completely eaten to sex. This behaviour ceased when the number of surface-laid eggs (see Warham *et al.* 1982) was high enough for the skuas to concentrate on, after which they appeared to eat them exclusively until the supply dwindled again. In 1998 and 1999 this pair's chick was the last fledgling observed to leave the island, in the second week of Apr.

Skuas were rarely seen more than 1 km from shore, but 1 was 12 km north on 3 Dec 1985. Two previously-banded skuas were recovered; 1 bred on Station Point in 1982-83 and 1983-84, and the other (which had an injured wing) was caught near Sinkhole on 7 Nov 1985. Both had been banded as chicks on NEI in Dec 1969, and so were 14 and 16 years old, respectively, when last seen.

Southern black-backed gull (*Larus dominicanus*)
Two adult southern black-backed gulls were seen over Station Point on 7 Jan 1986, and at least 1 was seen regularly between Ho Ho Bay and Skua Point until 9 Mar 1986. In addition, an immature black-backed gull was seen between 27 Feb-6 Mar 1986. Single adults were seen on 6 days during 22 Oct 1986 - 12 Jan 1987, with 2 on 11 Dec 1986. One adult was seen off South and Southwest Promontories on 3 days between 16 Nov and 6 Dec 1987.

Southern black-backed gulls apparently started breeding on the Snares Is between 1987 and 1992. A

Table 4 Measurements of red-billed gulls (*Larus novaehollandiae*) caught on North East I. in Nov 1987. Birds sexed by cloacal examination during incubation; measurements of 7 unsexed birds not included. All measurements in mm.

		Exposed culmen	Total culmen	Depth at gonys	Width at gonys	Tarsus	Mid toe & claw	Wing	Tail
Male	Min.	28.1	46.0	9.6	4.0	43.8	39.5	264	108
n = 18	Max.	33.7	53.4	11.1	5.6	49.6	42.7	296	123
	Mean	31.4	50.6	10.4	4.9	47.4	41.2	280.7	114.7
	s	1.5	2.1	0.5	0.4	1.6	1.2	8.2	3.5
Female	Min.	28.9	45.1	9.2	4.2	44.5	39.4	274	109
n = 5	Max.	31.8	49.0	10.3	4.9	46.2	40.9	281	114
	Mean	30.2	47.2	9.8	4.7	45.0	39.9	277.8	111.0
	s	1.1	1.7	0.4	0.3	0.7	0.6	2.9	1.9

pair with a fledgling was seen in Mar 1992 (first seen in Ho Ho Bay on 4 Mar 1992), 1 adult was seen on South Promontory on 14 Mar 1993, and a bird of the year was in Station Cove on 9 Mar 1996. Sightings in Mar 1997 included an adult on Broughton I. on 2 Mar, a 2nd-year bird in Comma Bay and an adult on South Promontory on 11 Mar, 2 young of the year in Ho Ho Bay on 15 Mar, and 2 adults and a 2nd-year bird in Mollymawk Bay on 16 Mar. Two adults were seen in Jul 1997, 3 adults and 1 juvenile were in Mollymawk Bay on 1 Mar 1998, and single adults were seen there on 2, 5, and 12 Mar 1998 and 3 Aug 1998. Larger numbers of southern black-backed gulls were present on the Snares Is in 1999, records including 1 adult and 2 juveniles at Seal Point on 25 Feb, 2 adults and 1 juvenile in Mollymawk Bay on 1 Mar, 3 adults, a 2-year-old and a juvenile off Ho Ho Bay on 21 Mar, 10 (including at least 4 subadults) in Punui Bay on 5 Jul, and 2 1st-year birds in Ho Ho Bay on 6 Jul. None was seen during Dec 1999 - Jan 2000, but at least 2 adults and 1 juvenile were present 24 Feb-12 Mar 2000, and an adult plus a 1st-year bird, a 2nd-year bird and a 3rd-year bird were seen on 8 Apr 2000. There were widespread sightings in Oct 2000 (minimum 4 adults, 1 immature, but probably more birds of both age classes).

Previous records of southern black-backed gulls from the Snares Is include an estimate of fewer than 12 present in 1947-48 (Fleming 1948; Richdale 1948), and 2 present in Jan-Feb 1969 (Warham & Keeley 1969).

Red-billed gull (*Larus novaehollandiae scopulinus*)
Red-billed gulls bred singly and in colonies of up to 30 pairs around the coasts of NEI and Broughton I. (Fig. 7), often in association with nesting Antarctic terns. The total breeding population in Dec 1984 was 160 pairs, not including Rima Islet, where Miskelly (1984) saw 1 chick on 11 Feb 1984; other fledglings seen there may also have been reared locally. The largest flocks recorded were 267 roosting in Mollymawk Bay on 1 Mar 1999, 275 there on 25 Feb 2000, and *c*.400 feeding off Seal Point on 9 Mar 2000. Breeding details were recorded by PMS in 1976-77, and CMM measured a further 50 eggs from 33 clutches in Dec 1984. Incubation time for 26 eggs was 22-28 days (mean 24.7 days), allowing laying dates to be estimated for those eggs laid before mid Nov 1976. The first eggs in 40 clutches were laid 20 Oct-20 Dec, with 95% of clutches being started 29 Oct-5 Dec (mean 13 Nov). Clutch size for 80 nests for the 2 seasons combined averaged 1.8 eggs (19, 1 egg; 25, 2 eggs; 3, 3 eggs: 54.5 ± 2.1 mm (49.4-60.7 mm) × 37.7 ± 1.2 mm (35.0-42.0 mm); n = 136 eggs). Fresh weights were 41.4 ± 3.0 g (33.0-48.5 g; n = 49). In 1976-77, hatching occurred 14 Nov-1 Jan.

Thirty adult red-billed gulls were captured and measured on the nights of 19 and 21 Nov 1987 (Table 4). One of the males caught on 19 Nov was 19 years old (banded as a chick, NEI, 13 Dec 1968).

Red-billed gulls on the Snares Is fed mainly on euphausiids captured close offshore (Fenwick 1978). However, these gulls often attended Snares crested penguin colonies to feed on spilt regurgitations. Unusual food items noted included a snipe chick on 6 Feb 1984, a large leech (*Ornithobdella edentula*) from a penguin colony on 27 Nov 1987, and congealing blood from a shark-attacked sealion on 4 Mar 1986.

Black-billed gull (*Larus bulleri*)
A freshly dead adult black-billed gull was found on the shores of Boat Harbour on 5 Nov 1985. An immature seen in Boat Harbour on 9 Nov 1986 was found dead there on 19 Nov, and 1 adult was seen among red-billed gulls on South Promontory on 17 Dec 1986. Two black-billed gulls were reported by Warham & Keeley (1969).

Black-fronted tern (*Sterna albostriata*)
A juvenile black-fronted tern roosted with Antarctic terns in Ho Ho Bay on 27 Feb 1998. Guthrie-Smith (1936) reported "a few black-fronted Tern (*Sterna albistriata*)" as well as a single "swallow tailed Tern (*Sterna vittata*)" during a visit on 26 Mar 1927. As this was the first time that he had seen Antarctic terns, it is possible that he misinterpreted plumage variability in that species.

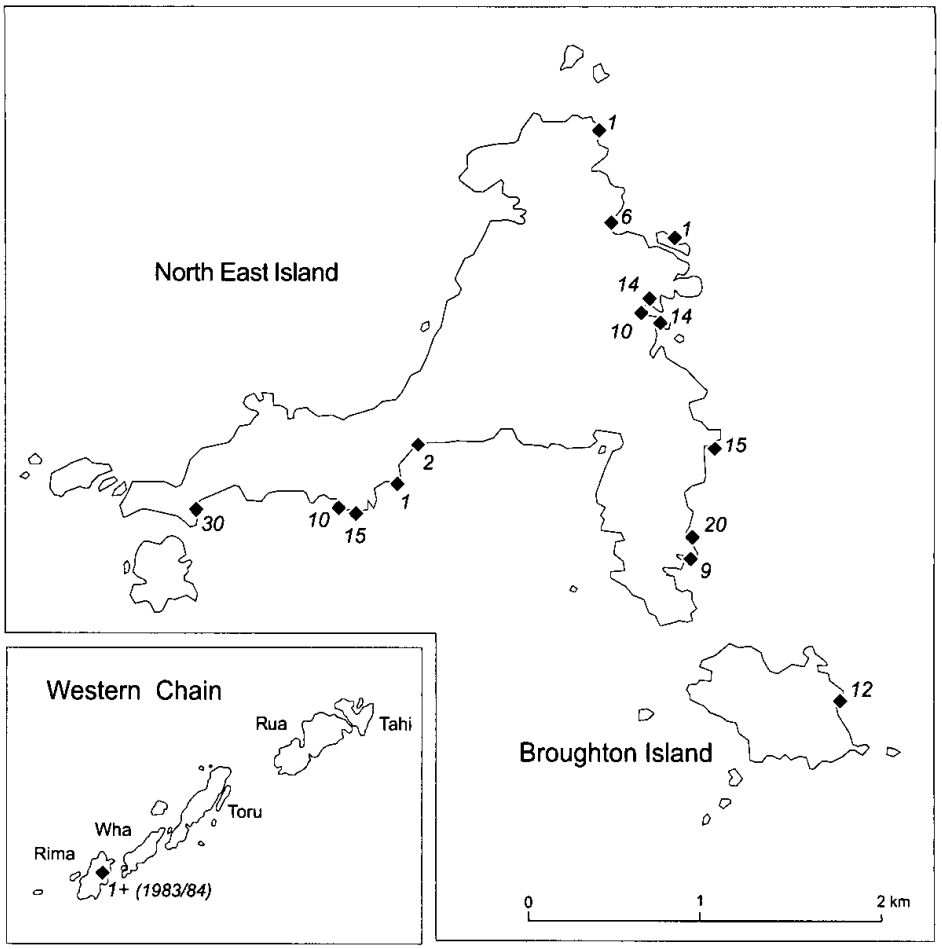

Fig. 7 Breeding distribution of red-billed gulls (*Larus novaehollandiae scopulinus*) at the Snares Is in Dec 1984, showing the number of nests counted at each site.

White-fronted tern (*Sterna striata*)
Three white-fronted terns roosted among red-billed gulls at the base of Seal Point at night on 2 Mar 1986. Up to 4 roosted with Antarctic terns in Ho Ho Bay on 6 days during 9-20 Mar 1993, and 1-2 were there 19 Apr-5 May 2000. A white-fronted tern was foraging with Antarctic terns off the Western Chain on 19 Feb 1984 (Miskelly 1984).

Antarctic tern (*Sterna vittata bethunei*)
Surveys of Antarctic terns at the Snares Is during Jan 1984 and Dec 1984 - Jan 1985 indicated that the total breeding population was about 70 pairs (PMS, CMM unpubl. data). Most Antarctic terns at the Snares Is bred on NEI, with the largest concentrations on the eastern side of the South Promontory and south side of the Southwest Promontory. From late Jan, fewer pairs defended breeding sites and numbers at communal roosts increased through Feb and Mar (max. count 101 birds in Mar 1992). Numbers at the Snares Is declined during Apr (max. count 44) and few were present during Jul and early Aug (max. count 28). Elsewhere this taxon breeds around southern Stewart Island and on the Antipodes, Bounty, Auckland, Campbell, and Macquarie Is (Turbott 1990).

On the Snares Is, Antarctic terns generally bred in small colonies on steep slopes or cliffs adjacent to the sea (Sagar 1978). The laying period extended from about mid Sep to the end of Dec, rarely extending into Feb and Mar. The 1-2 egg clutches were incubated for 24-25 days, and fledging took 27-32 days (Sagar 1978). Hatching success was 93%, 75% of chicks fledged, and so breeding success was 69%. After breeding, adult Antarctic terns moulted into non-breeding plumage so that by the end of Mar most adults were in pale plumage; they assumed breeding plumage from Jul.

Banding showed that the minimum age of 1st breeding was 3 years. The oldest known bird was banded as a breeding adult in Jan 1984 and was 18+ years old when last seen in Mar 1999.

Antarctic terns appeared to feed close inshore as they were seen only within 1 km of the Snares Is when approaching from the north, but fed up to 3 km south of the Western Chain. A 1-year-old dye-marked in Boat Harbour on 6 Nov 1985 was seen feeding between Southwest Promontory and the Western Chain a few days later (K. Schofield, pers. comm.). At the Snares Is, Antarctic terns fed mostly on fish and crustaceans and their feeding ability was reduced in strong winds (Sagar & Sagar 1989).

Arctic tern (*Sterna paradisaea*)
An adult arctic tern in eclipse plumage roosted among Antarctic terns on Ho Ho Islet on 14 Nov 1987, and it was joined by an immature bird there on 15 Nov. Compared to Antarctic terns, the arctic terns were

Table 5 Standard measurements of 5 species of passerines caught on the Snares Is in 1984-87. $x \pm$ SD, (range), *n*.

		Weight (g)	Culmen (mm)	Tarsus (mm)	Wing (mm)
Snares Is fernbird	Adult,?sex	36.6 ± 4.3	14.8 ± 0.7	22.6 ± 2.2	68.5 ± 3.0
		(30.5-40.4)	(13.8-15.8)	(19.1-25.7)	(65-72)
		6	6	6	6
Snares I. tomtit	Adult male	19.2 ± 1.0	13.0 ± 0.6	25.1 ± 1.0	82.2 ± 1.5
		(18.3-20.1)	(12.0-13.6)	(23.9-26.6)	(80-84)
		5	6	6	6
	Adult female	21.1 ± 1.8	12.5 ± 1.0	24.3 ± 1.4	79.8 ± 1.3
		(21.0-23.0)	(11.6-14.0)	(22.8-26.4)	(79-82)
		5	5	5	5
	Juvenile, ?sex	18.0 ± 1.5	-	25.4	80
		(16.2-19.8)	-	(25.2-25.6)	-
		4	-	2	1
Silvereye	Adult, ?sex	12.1 ± 1.1	10.7 ± 0.8	16.2 ± 1.2	61.4 ± 1.9
		(10.1-16.5)	(8.6-11.8)	(14.4-18.0)	(58-66)
		32	14	14	28
Redpoll	Adult male	13.3 ± 0.7	9.5 ± 0.3	15.9 ± 0.8	69.6 ± 1.8
		(12.0-14.0)	(9.0-9.8)	(14.9-17.2)	(66-71)
		10	10	10	10
	Adult female	12.5 ± 0.9	9.6 ± 0.7	15.0 ± 0.9	67.6 ± 2.1
		(11.0-14.0)	(8.4-10.6)	(13.1-16.2)	(64-71)
		15	15	15	15
	Juvenile, ?sex	11.8 ± 0.8	9.3 ± 0.5	15.6 ± 0.7	68.8 ± 2.1
		(10.5-13.5)	(8.3-10.3)	(14.1-16.6)	(65-74)
		20	17	17	17

smaller, with shorter legs and shorter, finer black bills. The darker primaries of the arctic terns were apparent both at roost and from the underside of the extended wing. The adult also had a grey belly and breast (unlike the white belly of non-breeding Antarctic terns), but this was not as dark as the underparts of Antarctic terns in breeding plumage. Earlier unconfirmed sightings were made on 19 Dec 1982, 24 Dec 1982 (2), and 2 Jan 1983.

Rock pigeon (*Columba livia*)
A banded racing pigeon found in a skua midden on 7 Dec 1984 came from a loft in Palmerston North and had been released at Invercargill on 3 Nov 1984 (E. Pain in lit. to CMM, 28 Mar 1985). Ironically, the only previous record of a racing pigeon from the Snares Is (10 Dec 1976 - 3 Jan 1977) was also of a Palmerston North bird, released at Invercargill on 9 Dec 1976 (Sagar 1977a).

A third racing pigeon (with a Hamilton Bird Club band) was found long dead under the main hut on Station Point in Dec 1999.

Red-crowned parakeet (*Cyanoramphus novaezelandiae*)
Three red-crowned parakeets were seen occasionally around Station Cove 31 Dec 1974 - 21 Feb 1975 (Horning 1976). None was seen between 1982 and 2000. Red-crowned parakeets are abundant on islands off southern Stewart Island, which are visible from the Snares Is on a clear day.

Oriental cuckoo (*Cuculus saturatus*)
An oriental cuckoo seen perched and in flight over Boat Harbour on 10 Dec 1986 was a new record for the Snares Is, and 1 of only about 20 records from New Zealand (Turbott 1990).

Shining cuckoo (*Chrysococcyx lucidus*)
A shining cuckoo was heard from Station Point on 7 Dec 1985, and 3 were found dead in the vicinity of Station Cove on 9, 17, and 31 Dec 1985. A shining cuckoo was seen and heard between Station Point and Ho Ho Bay on 4 days 20-31 Oct 1987 (Buckingham & Willemse 1988). R. Guse (pers. comm.) heard 1 on 27 Jan 1997, and 1 was heard from Station Point on 8 and 22 Oct 2000. Sagar (1977a) reported 1 found dead on 12 Nov 1976.

Long-tailed cuckoo (*Eudynamys taitensis*)
A long-tailed cuckoo was seen north of Station Point on 14 Jan 1986. One was seen and heard frequently between Penguin Creek and Senecio Creek 17-27 Dec 1986, and approached within 10 m in response to playback of taped calls on 23 Dec. Sagar (1977a) reported 1 present 29 Nov-10 Dec 1976.

Morepork (*Ninox novaeseelandiae*)
A morepork was heard in Station Cove on the night of 7 Nov 1986, and 1 was seen at night near Skua Point on 30 Nov 1987. P. Reese (pers. comm.) photographed 1 on Station Point on 27 Jul 1996. There are no previous records of moreporks from the Snares Is or any other subantarctic island group (Turbott 1990).

Spine-tailed swift (*Hirundapus caudacutus*)
Spine-tailed swifts were seen during 4 expeditions between Jan 1983 and Dec 1986. Swifts were seen on 6 days between Station Cove and Mollymawk Bay during 2 Jan-9 Feb 1983, with 2 on each of 7 and 9 Jan and 9 Feb. One was over Broughton I. on 20 Dec 1983 (G. Eller, pers. comm.), and 3 were above Muttonbird Creek on 16 Dec 1984 and over the base of South Promontory on 17 Dec 1984. Two were over Signpost Hill on 21 Nov 1986 and over Penguin Colony 3 on 14 Dec 1986, with the last sighting being of 1 over Boat Harbour on 15 Dec 1986. Spine-tailed swifts had not been reported from the Snares Is before 1983.

Skylark (*Alauda arvensis*)
A skylark was seen south of Signpost Hill on 8 Feb 1984, and 2 were on Skua Point on 27 and 31 Oct 1986. Two birds on the west coast were seen on 3 occasions in Apr 1999. Three skylarks were seen on North Promontory 7-13 Oct 2000. Previous reports were 3 seen on 14 Feb and 14 Apr 1972 (Horning & Horning 1974) and 1 on Station Point on 23 Dec 1974 (Horning 1976).

Welcome swallow (*Hirundo tahitica neoxena*)
A swallow seen around Ho Ho Bay on 2-3 Dec 1982 had been present since 18 Nov (M. Schofield, pers. comm.). Twelve mummified corpses of swallows were extracted from a horizontal rock crevice beside Boat Harbour on 12 Nov 1985. One swallow was seen over Ho Ho Point on 12 and 15 Oct 1986 (Buckingham & Willemse 1988). Several were present in Apr-May 1998 (T. de Cruz, pers. comm.), 2 during 14-20 Apr 1999, 5 on 6 May 1999, at least 19 on 7 May 1999 and 35 on 9 Apr 2000, with at least 5 still present on 5 May. These birds also roosted in the rock crevices beside Boat Harbour. The only previous record was of 2 swallows over Razorback in Jun 1981 (Robertson *et al.* 1981).

Australian tree martin (*Hirundo nigricans*)
Two tree martins were seen over Boat Harbour on 4 Feb 1984 and at Punui Bay on 9 and 12 Feb 1984. M. Schofield (pers. comm.) reported 2 present during Aug-Oct 1982, and 2 were seen on 18-20 Feb 1969 (Warham & Keeley 1969).

Dunnock (*Prunella modularis*)
Single dunnocks were seen or heard on 26 Sep 1985, 8-17 Jan 1986, 17 Feb 1987 and 12 Oct-25 Nov 1987 (latter seen initially by Buckingham and Willemse and included in their 1988 report). One was heard on 24-28 Jul 1994, and 1 or 2 were on Station Point 14-26 Apr 2000. Previous reports were 1 seen by Stead (1948) and singles on 19 Nov-21 Dec 1968 (Warham & Keeley 1969).

Blackbird (*Turdus merula*)
Blackbirds were abundant throughout the *Olearia* and *Brachyglottis* forest on the Snares Is. Their wary nature and tendency to flush noisily from nests when approached resulted in over 70 nests being found. Most nests were in the crowns of *Polystichum* or *Asplenium* fern clumps within 1.5 m of the ground. Other nest sites included among *Hebe elliptica* branches, among root masses of wind-thrown *Olearia* trees, and 6 m above ground in an *Olearia* canopy. Clutch size in 62 active nests found with complete clutches or broods was 1 (1 clutch), 2 (11), 3 (27), 4 (21), and 5 (2) eggs (mean, 3.2 eggs). Breeding extended over at least 5 months, with eggs being recorded from 22 Oct (1986; 2 eggs being incubated) to 18 Jan (1986; 1 chick and 1 pipping egg). Two nests were found on Broughton I. on 28 Dec 1984, and 1 blackbird was seen on Alert Stack on 9 Feb 1985. Based on active nests found in Nov and Dec in 1985-87, breeding density north of Station Point was estimated to be c. 2.3 pairs ha^{-1}. Blackbird population density was evidently lower in the interior of the *Olearia* forest on NEI (where there is little vegetation on the forest floor), and the total population on NEI and Broughton I. was estimated to be 220 pairs.

Song thrush (*Turdus philomelos*)
Song thrushes had a resident breeding population on the Snares Is, although they were about an order of magnitude scarcer than blackbirds. Most nests found were old or deserted, and only 7 active nests were found (2, 3 eggs; 5, 4 eggs; mean, 3.7 eggs). Eggs were recorded from 25 Oct (1986) to 9 Dec (1986), and fledglings were noted between 2 Dec (1987) and 12 Feb (1984). Song thrushes were most conspicuous in Oct and early Nov, when the density of singing males allowed an estimate of 20-30 pairs, most being along the eastern side of NEI. A song thrush was seen on Alert Stack on 9 Feb 1985, 2 were on Broughton I. on 17 Mar 1992, and a fledgling was on Toru Islet on 12 Feb 1984 (Miskelly 1984).

At least 3 unusually marked song thrushes were seen on Ho Ho Point over 2 seasons. A thrush with pale grey upperparts and unmarked underparts was seen on 5 and 7 Jan 1986, and a "flavistic" thrush with pale yellow-brown upperparts, pale spots on the breast, a yellowish bill, dark eyes, and pink legs was seen on 10 Jan 1986. A 2nd flavistic bird with similar markings but with pink eyes was caught there (by hand) on 5 Dec 1986. This bird was blind, but survived until at least 26 Jan 1987.

Snares Islands fernbird (*Bowdleria punctata caudata*)
The endemic Snares Islands fernbird (Plate 5D) was the most abundant landbird on the Snares Is. Fernbirds were found in all vegetated habitats on NEI, Broughton I. and Alert Stack, and 1 was seen on Rocky Islet on 10 Dec 1976 (PMS). Based on the density of nests found in the snipe study area, fernbird density was estimated at 8 pairs ha^{-1}. Incidental observations in other habitats indicated that fernbird densities were similar throughout NEI and Broughton I. This density was similar to Richdale's (1948) estimate of 4 pairs $acre^{-1}$ (10 pairs ha^{-1}), equivalent to a total population of *c.*1500 pairs.

Breeding occurred from Oct to Mar. A fledgling seen on 6 Nov 1985 must have come from an egg laid before 2 Oct (incubation period = 15-19 days, fledging period = 20-21 days; Heather & Robertson 1996). Two chicks with their primaries still in sheath on 7 Mar 1996 are presumed to have come from eggs laid after 5 Feb. Nests were typically sited in fern or tussock clumps (Stead 1948; Best 1975), but 1 with eggs on 24 Nov 1986 was inside a hollow *Olearia* trunk, in a site typical of Snares Island tomtit (McLean & Miskelly 1988). Clutch size averaged 2.45 (11 x 2 eggs, 9 x 3 eggs) and brood size averaged 2.07 (13, 2 chicks; 1, 3 chicks). In the early 1970s, hatching success was 54% (79 eggs), and fledging success was 60%, giving a total breeding success (young fledged/eggs laid) of 32% (Best 1975).

Measurements of 6 adult Snares Islands fernbirds of unknown sex are given in Table 5.

Grey warbler (*Gerygone igata*)
Single grey warblers were seen at Station Point on 23 Feb 1984 (G. Eller, pers. comm.), at the base of Skua Point on 29 and 30 Sep 1985, and south of Muttonbird Creek on 12 Feb 1987. Another was present during both Mar 1994 (J. Molloy, pers. comm.) and Jul 1994. Grey warblers were singing regularly on Station Point and south of Senecio Creek in Mar and Apr 1999 (at least 2 birds present). Up to 15 were estimated to be present during Jul-Oct 1973 (Horning & Horning 1974).

South Island fantail (*Rhipidura fuliginosa fuliginosa*)
Fantails apparently colonised the Snares Is between 1977 and 1981. The only records before 1977 were of a pied bird present during Mar-Sep 1973 (Horning & Horning 1974) and 1 on Southwest Promontory on 29 Jan 1975 (Horning 1976), although Buller (1905) reported a black fantail specimen from the Snares Is. Robertson *et al.* (1981) reported that fantails were present in Jun 1981, and we found a large population in Dec 1982 (e.g., loose flock of 40+ birds seen on 15 Feb 1983). All birds seen since 1982 have been of the pied phase. Broods of up to 4 fledglings were seen each year from 1982 on, but the first nests were not found until Nov 1987 (4-egg nest on 17 Nov, another with recently hatched chicks on 25 Nov, both found by Ian McLean). Fledglings were noted between 24 Oct (1986) and 20 Dec (1982). All birds handled appeared to be typical South Island fantails based on tail feather markings. Weights of 2 adults were 7.5 and 9.7 g, respectively; 3 juveniles weighed 7.0 , 7.0 , and 7.5 g. Fantails are now the 3rd commonest passerine on the Snares Is, with an estimated population of 300 pairs on NEI and Broughton I.

Snares Island tomtit (*Petroica macrocephala dannefaerdi*)
The endemic Snares Island tomtit (Plate 5E) occurred throughout *Olearia* and *Brachyglottis* forest and *Hebe elliptica* shrubland on NEI and Broughton I., and they were also present on Alert Stack and both Daption Rocks (McLean & Miskelly 1988; PMS pers. obs.). Breeding density within the forest was estimated at 2.7 pairs ha^{-1}, giving a conservative estimate of the total breeding population of 500 pairs (McLean & Miskelly 1988), as a few pairs appeared to have territories entirely within the *Poa* tussock grasslands where densities were not estimated. Similar densities within the forest were also estimated by Stead (1948; territories 60-100 yards across equates to 1.3-3.6 pairs ha^{-1}) and Richdale (1948; "a little more than one pair per acre" equates to >2.5 pairs ha^{-1}).

Breeding occurred Oct-Jan; clutch size averaged 2.8 (5, 2 eggs; 25, 3 eggs) and brood size averaged 2.5 chicks near fledging (1, 1 chick; 9, 2 chicks; 13, 3 chicks; McLean & Miskelly 1988) which would mean that 85% of 68 eggs hatched and 96% of 24 pairs fledged at least 1 chick in late 1987. In comparison, Best (1975) recorded that 87% of 54 eggs hatched, and 64% of 47 chicks fledged in 1974. Only a single brood was raised $pair^{-1}$ $year^{-1}$.

Measurements of adult and fledgling Snares Island tomtits are given in Table 5.

Silvereye (*Zosterops lateralis*)
Silvereyes were common on the Snares Is, but were encountered mainly in belts of *Hebe elliptica* shrubland along the east coast of NEI and on Broughton I. Numbers were estimated at 100-200 pairs. Nine nests were found between 1982 and 1987; accessible active nests had clutch or brood sizes of 2 (n=3) or 3 (n=1). Most nests were in *Hebe* up to 3 m above the ground, but 1 was in *Polystichum* at 1.5 m, 1 was in *Olearia* at 3.5 m, and 1 was in *Brachyglottis* at 5 m above ground. Breeding was recorded from Oct (fledglings on 25 Nov 1986) to Feb (chicks in a nest on 10 Feb 1986). Measurements of unsexed adult silvereyes caught by mist-netting in Jan 1984, Nov 1986, and Feb 1987 are summarised in Table 5.

Tui (*Prosthemadera novaeseelandiae*)
An immature tui seen by Bernard Stonehouse in 1961 (Warham 1967) remains the only record from the Snares Is.

Yellowhammer (*Emberiza citrinella*)
Yellowhammers were irregular vagrants to the Snares Is, and were recorded during only 5 visits between 1982 and 2000. The dried remains of an adult male were found in the Castaway Depot on Station Point in Dec 1982, and a male was seen on Ho Ho Point on 5 and 8 Nov 1985. A male and a female were seen frequently between Station Cove and Ho Ho Bay in Nov 1986, with the female being seen 29 Oct-18 Nov, the male between 1-22 Nov, and both together on 8 days 4-18 Nov 1986. A female was seen on 8 Nov 1987, and also on 29 and 30 Apr 1999, and an immature male was seen on Station Point on 2 and 7 May 1999.

Yellowhammers were previously reported by Warham & Keeley (1969: 1 dead male) and Sagar (1977a: 2).

Chaffinch (*Fringilla coelebs*)
Chaffinches were generally wary and inconspicuous on the Snares Is, but males were noted as singing strongly during Oct and Nov visits in 1985-87. Singing males were distributed throughout the *Olearia* forest, with an estimate of 20-30 for NEI. No nests were found, but fledglings were noted in Jan-Feb 1983 and Jan 1987. Chaffinches have been recorded as present on the Snares Is since 1948 (Fleming 1948; Stead 1948; Warham 1967), but the only previous breeding record was a deserted nest found in Dec 1976 (Sagar 1977a).

Greenfinch (*Carduelis chloris*)
Greenfinches were recorded as vagrants on most visits to the Snares Is in the 1980s, with small flocks apparently resident around Station Point in late 1986 and 1987. Minimum numbers were: 2 males 9-19 Dec 1982, 1 female on 19 Dec 1984 and 13-14 Nov 1985, 2 males and 1 female 6 Nov-29 Dec 1986, 2 males and 5 females 17 Oct-29 Nov 1987, 1 on 8-9 Dec 1998, 2+ Mar-May 1999 and 2 on 2 Jan 2000. Almost all sightings were along the coastal fringe between Skua Point and Boat Harbour, particularly on Station Point and in Station Cove. Dead female greenfinches were found in Station Cove on 14 Nov 1987 and near Penguin Colony 3 on 26 Nov 1987. Two male greenfinches caught by mist-netting on 22 Nov 1986 weighed 25.5 and 30.7 g.

Greenfinches were reported previously on the Snares Is by Warham & Keeley (1969: 3), Horning & Horning (1974: individuals and small flocks) and Sagar (1977a: 3).

Goldfinch (*Carduelis carduelis*)
Small numbers of goldfinches were recorded during every visit to the Snares Is from 1982 to 1987, with a larger influx in Oct-Nov 1987. Sightings were mainly on Station Point, but a surprising number were recorded at the Razorback, Southwest Promontory and Penguin Slope given how infrequently these sites were visited. Sightings up to Feb 1987 included: Razorback (2 on 4 Dec 1982, 1 on 8 Feb 1984, 3 on 5 Dec 1984), Station Point (2 on 27 Dec 1983, 1 on 16 Dec 1984, 2 on 22 Dec 1984, up to 4 on 11-28 Dec 1985, up to 3 on 22 Oct-27 Nov 1986) and Penguin Slope (1 on 30 Oct 1986). Sightings in Oct-Nov 1987 included 2 at the mouth of Muttonbird Creek and a flock at Penguin Slope on 17 Oct, 2 on Station Point 20-23 Oct (when 1 was found dead), 7 over the western cliffs on 27 Oct (all Oct records in Buckingham & Willemse 1988), 8+ at Mollymawk Bay on 16 Nov, *c.*30 on the north face of Southwest Promontory on 18 Nov, and 3 on Station Point on 23 Nov 1987. One was on Station Point on 7 May 1998 (T. de Cruz, pers. comm.), 1 on 8-9 Dec 1998, and 2 on 2 Jan 2000.

Goldfinches were reported previously on the Snares Is by Ogilvie-Grant (1905), Fleming (1948), Stead (1948), Warham & Keeley (1969: up to 5), Horning & Horning (1974: up to 15) and Sagar (1977a: up to 6).

Redpoll (*Carduelis flammea*)
Small numbers of redpolls occurred throughout the Snares Is, but were encountered mainly in areas of *Hebe elliptica* and *Poa* along the east coast of NEI. Flocks of up to 10 birds were seen feeding on *Poa annua* seedheads from Feb. The total population was estimated to be <100 pairs. The earliest fledglings were seen in mid Dec. Three nests in *Hebe* on Station Point contained chicks on 9 Dec 1985, and 16 Jan and 23 Feb 1986.

The colour of the poll of birds from the Snares Is was less variable in comparison to birds from Campbell I. and 2 South Island locations; only 2 colour classes being noted in either sex (Fennell & Sagar 1985). Measurements of birds mist-netted in Jan 1984, Nov 1986 and Feb 1987 are summarised in Table 5.

House sparrow (*Passer domesticus*)
House sparrows were recorded as vagrants on most visits in the 1980s, although up to 5 were resident in 1986-87, and 4 in Nov 1987. A female was present in Dec 1982, 1 was seen on 13 Dec 1983 (G. Eller, pers. comm.), a male was on Station Point on 22 Sep 1985, 2 males were there on 9 Nov 1985, and another was in Station Cove on 23 Feb 1986. Three male and 2 female house sparrows were feeding on *Poa annua* in Station Cove on 26 and 27 Oct 1986, and all 5 were alive until at least 7 Dec 1986. Numbers declined over the next 2 months, but there were still 2 males until at least 6 Jan 1987 (1 until at least 22 Jan) and 2 females until at least 6 Feb 1987 (the last sighting). All sightings were between Station Cove and Boat Harbour. Two males and 2 females were seen during 12-25 Nov 1987, with single pairs seen 10 Nov-5 Dec 1987. A female was prospecting for a nest site in the Castaway Depot on Station Point on 12 Nov 1987.

House sparrows were recorded during only 2 visits in the 1990s: a female with a fledgling barely able to fly was on Ho Ho Point on 1 Mar 1999 (both were seen again on 10 Mar), and 1 female present on Station Point during 26-30 Apr 1999. Warham (1967) reported that house sparrows had "evidently nested under the iron roof of the old castaway hut" and that up to 3 were present in 1967. House sparrows were also reported by Fleming (1948), Horning & Horning (1974: 2 males) and Sagar (1977a: up to 14).

Starling (*Sturnus vulgaris*)
Starlings probably have a small, resident population on the Snares Is, but the birds are extremely wary and are rarely seen near Station Point. It is assumed that starlings nest in holes in cliff-faces given the frequency with which they were seen at remote cliff sites. Starlings were recorded on only 2-8 occasions each year from 1982-83 to 1986-87, with maximum flock sizes of 8, 18, 9, 4, and 4 respectively. Half the sightings were at Skua Point,

but other locations included Broughton I. (1 on 9 Feb 1984, 9 on 11 Feb 1985, 8 on 17 Mar 1992), North Promontory, Southwest Promontory, South Promontory and Sinkhole. The only evidence of breeding was a family group with 2 recent fledglings at the base of Skua Point on 30 Dec 1986. Fewer starlings were seen from 1993 to 2000, with 0-2 recorded on each visit. Starlings were noted as being present by Fleming (1948) and Stead (1948), and as being rare by Warham (1967).

DISCUSSION

Avian biogeography of the Snares Islands

Knowledge of the avifauna of the Snares Is has increased considerably since the last comprehensive account was published (Warham 1967). In the intervening 33 years, a further 62 species have been recorded from the islands, and a further 8 species are known to have bred there. However, the only well-established new breeding species is the fantail (Table 6).

Typically, the Snares Is are considered to be part of New Zealand's subantarctic islands (Holdaway *et al.* in press), but their avifauna differs significantly from those of the more southerly (and larger) Antipodes, Auckland, and Campbell Islands. The Snares Is are notable as the southern limit for fernbird and fantail, but many other species are absent while occurring on islands both to the north and the south. The depauperate landbird fauna of the Snares Is probably results from the small size of the archipelago and, particularly, the low floral diversity (Fineran 1964, 1969). The absence of tui and bellbird (present on the Auckland Is) probably reflects the absence of nectar- and berry-producing trees and shrubs. It is more difficult to explain the absence of pipit, parakeets, rails, and teal, as the Snares Is have habitat that appears at least comparable with that occupied by other southern populations of these taxa.

The diverse seabird fauna of the Snares Is shows strong biogeographical links with the Stewart I., Solander and Fiordland regions immediately to the north. Particularly noteworthy are the shared presence of southern Buller's albatross, broad-billed prion, southern diving petrel, and mottled petrel, the superabundance of sooty shearwaters, and the close relationship between Fiordland crested and Snares crested penguins (Warham 1974). There are also similarities with the seabird fauna of the Chatham Islands, which share broad-billed prion, southern diving petrel, and 2 closely related taxa of albatross (northern Buller's albatross *D. bulleri* unnamed subsp. and Chatham Island albatross). With the exception of sooty shearwaters, all these taxa are absent from the island groups to the south. The barely vegetated islets of the Western Chain have an avifauna very similar to that of the barren Bounty Is 940 km to the east, sharing Salvin's albatross, cape pigeon, fulmar prion, and a species of crested penguin (Robertson & van Tets 1982). Seabirds characteristic of the more southern island groups but absent as breeding species from the Snares Is include royal albatross, wandering albatrosses, light-mantled sooty albatross, white-chinned petrel, grey petrel, Antarctic prion, subantarctic diving petrel (*P. urinatrix exsul*), white-headed petrel, black-bellied storm petrel, and rockhopper penguin. The only breeding species that the Snares Is shares with islands to the south but not to the north is the southern black-browed albatross, which is a very recent colonist.

Table 6 Estimated breeding populations for the 29 bird species known to breed on the Snares Is. See systematic accounts for methods used to estimate population size for each species.

Species	Est. pop. size (pairs)	Year
Southern black-browed albatross	1	1984-86
Salvin's albatross	1210	1995-96
Chatham Island albatross	1	1995-96
Southern Buller's albatross	8882	1997
Sooty shearwater	2,750,000	1969-72
Southern diving petrel	250,000	1987 & 1999-2000
Snares cape pigeon	7,500	1984
Fairy prion	4,000	1985-87
Fulmar prion	400-600	1984
Broad-billed prion	2,000-5,000	1985-87
Mottled petrel	10,000+	1968-70
Snares crested penguin	23,300	1985-86
Mallard	5	1982-87
Grey duck	5	1982-87
Snares Island snipe	325-480	1982-87
Brown skua	84	1984
Southern black-backed gull	0-2	1992-2000
Red-billed gull	160	1984
Antarctic tern	70	1984
Blackbird	220	1985-87
Song thrush	20-30	1985-87
Snares Islands fernbird	1,500	1985-87
South Island fantail	300	1985-87
Snares Island tomtit	500	1987
Silvereye	100-200	1985-87
Chaffinch	20-30	1985-87
Redpoll	<100	1985-87
House sparrow	0-1	1999
Starling	<10	1985-87

Given the apparent pristine state of the Snares Is, there are a number of seabirds that are surprisingly absent. It is possible that lack of suitable foraging areas has prevented establishment of yellow-eyed penguins and *Leucocarbo* shags, but there appears to be no logical explanation for the absence of breeding populations of royal albatrosses, northern giant petrel, white-faced storm petrel, or grey-backed storm petrel. The complete absence of breeding storm petrels on the islands is particularly remarkable.

Vagrants and recent colonists

The extraordinary list of vagrant species reported here from the Snares Is probably results from a combination of factors, including serendipity. The islands' location

close to Stewart I., downwind from Australia and only 170 km north of the Auckland Is has facilitated the arrival of vagrants from several sources (see below) and the small size of the islands meant there was a high likelihood of vagrants being seen once they arrived. The most diverse habitats on the Snares Is are located close to the biological station on Station Point on the more sheltered, eastern side of NEI. Many vagrants were probably seen almost as soon as they arrived. The large amount of time spent on the Snares Is by experienced ornithologists over the past 3 decades has also been a major factor in the 3-fold increase in the species list for the islands since 1967.

Previous authors have speculated on the likely provenance of vagrant bird species on the Snares Is (Warham & Keeley 1969; Horning & Horning 1974; Sagar 1977a). With the larger data set now available, it is apparent that birds reach the Snares Is from many sources. For the 46 vagrant or recently colonised species of almost unequivocal provenance, 17 (37%) came from mainland New Zealand, 8 (17%) from Australia, 7 (15%) were holarctic migrants that regularly reach both Australia and New Zealand, 3 (7%) each were from the southern Indian Ocean and Antarctica, 2 (4%) each were from the Auckland and Antipodes Is, and 1 (2%) each were from the Chatham Is, Campbell I., Macquarie I., and the south Atlantic. This is consistent with the findings of Holdaway *et al.* (in press) who, in a detailed analysis of avian biogeography of the New Zealand region, found links between the avifaunas of the subantarctic islands and the New Zealand mainland, Australia, South America, and Antarctica. Most vagrant species arrived at times expected from their known migration times, e.g., holarctic waders mainly occurred in Oct-Dec, cattle egrets in Apr, vagrant penguins mainly during their moult in late summer, and cuckoos and swifts during the summer.

Changes in population size and breeding success

The Snares Is appear to be one of the terrestrial ecosystems least disturbed by humans on the planet. The original vegetation cover remains intact, there are no introduced mammalian predators or browsers, and evidence of human presence is limited currently to 2 introduced plant species, 6-7 introduced bird species (all self-colonised from the New Zealand mainland), a cluster of small huts, and a short length of boardwalk. However, it is sobering to consider that the avifauna of the Snares Is is presumed to have increased from 17 to 29 breeding species in the last 200 years, and that most of this increase results from human influences. The few breeding bird populations that have been surveyed more than once also indicate the dynamic nature of the Snares Is ecosystem.

The most thoroughly censused Snares Is bird population is that of the southern Buller's albatross, which had a mean annual increase in breeding pairs of 3.4% between 1969 and 1992 and 1.6% between 1992 and 1997 (Sagar *et al.* 1999). The population increase may result from improved foraging efficiency as a consequence of scavenging behind fishing boats (Sagar *et al.* 1999; James & Stahl 2000) although, ironically, many southern Buller's albatrosses are drowned on long-line hooks (Murray *et al.* 1993). It is unclear whether varying estimates for the breeding population of Salvin's albatrosses on the Western Chain (650 pairs in Feb 1984, Miskelly 1984; 1210 pairs in Oct-Nov 1995, Clark 1996) indicate a population increase or result from a consistently high rate of egg failure.

The dramatic crash in the legendary sooty shearwater population on the Snares Is between 1972 and 1996 (P. Scofield & C. Hunter, unpubl. data) is disturbing, but not surprising given the known magnitude of sooty shearwater mortality from by-catch in drift-nets in the North Pacific during their non-breeding season (de Grange *et al.* 1993). If this decline continues, there are likely to be impacts on the terrestrial ecosystem of the Snares Is through reductions in nutrient input from the marine environment, and reduced burrowing, trampling of vegetation, and harvesting of vegetation for nest linings (Fineran 1964).

Annual production of Snares crested penguin chicks on NEI increased from 5000 in 1968-69 (Warham 1974) to 18,800 in 1984-85. Unfortunately it is not possible to determine whether increased chick production resulted from a higher breeding population, increased breeding success, or a combination of these factors, as 1985-86 was the only season when the total number of breeding pairs was estimated. During the 1980s, chick production in 1982-83 was 40% lower than the mean for the subsequent 4 years (Table 2). Miskelly (1990b) described possible impacts of the severe 1982-83 El Niño event on Snares Island snipe and Snares Island tomtit. It is possible that the low chick output of Snares crested penguins that year was also a consequence of the effects of this major climatic event on either or both foraging conditions for adults and exposure of chicks to cold, wet, and windy conditions. Post-fledging survival of the 1982-83 chicks was also the lowest recorded over 4 years. There is some evidence that mortality of post-guard stage chicks varied greatly between years (Table 2 caption). Reischek (1889) referred to "thousands rotting among the black sand" in Jan 1888. Warham (1974) also discussed the 10-fold difference between Stead's (1948) estimate of 5000 penguins on Penguin Slope and Warham's own estimate of fewer than 500 there 20 years later. The magnitude and underlying causes of population fluctuations in Snares crested penguins are poorly understood.

The only Snares Is landbird that has been intensively studied over several years also exhibited surprising variability in population density and breeding success (Miskelly 1990b, 1999b). Population densities of Snares Island snipe in the study area varied by 113% over 6 years, being lowest in the breeding season immediately

after the 1982-83 El Niño event. The low population in 1983-84 was caused by a combination of low breeding success in 1982-83 and higher than normal adult mortality rates during the 1983 winter (Miskelly 1990b).

The most recent records of ducks on the Snares Islands indicate that grey ducks may be on the verge of extinction there, having been displaced by the ubiquitous mallard.

Future research and survey opportunities

Perhaps the most intriguing mystery among Snares Is birds is the reason for the 6 week difference in the timing of breeding by crested penguins on the Western Chain compared to NEI and Broughton I. Miskelly (1997) reported a small, but statistically significant, difference in bill length of both sexes between the 2 populations, but concluded that it was not possible to separate birds between the populations because of extensive overlap in this measurement. It is possible that the crested penguins of the Western Chain are a cryptic species, as the huge difference in breeding chronology is likely to restrict gene flow between the 2 populations, even though they are <10 km apart. This could be investigated by comparing rates of gene flow between colonies on NEI, between NEI and Broughton I., and between NEI and the Western Chain (see Miskelly 1997). It would also be invaluable to obtain a series of benchmark counts of breeding pairs of Snares crested penguins (in Oct) and breeding success (chick counts in late Dec) to allow better interpretation of causes of variation in the number of fledglings produced. The first such count was undertaken on NEI in Oct 2000.

The robust population estimates now available for many bird species on the Snares Is provide baselines for future monitoring. Recently discovered population changes in albatrosses and shearwaters at the Snares Is indicate that on-going monitoring and research into the causes of these changes will be crucial to conservation and management of these special islands. Population estimates of southern Buller's albatrosses and sooty shearwaters should be repeated at regular intervals and related to known changes in fishing methods and their impacts on these 2 species. This is particularly important for sooty shearwaters given the apparently massive decline in the Snares Is population over the past 30 years. An attempt should be made to estimate the importance of this decline on the vegetation and other bird species.

Efforts should be made to monitor colonisation of the Snares Is by new breeding species, particularly southern black-browed albatrosses and Chatham Island albatrosses on Toru Islet. Establishment of Chatham Island albatrosses at this site is of particular interest as this species is otherwise confined as a breeding species to The Pyramid in the Chatham Islands. The Chatham Island albatross has also been seen ashore on Albatross Island in Bass Strait (photograph with incorrect caption in Lindsey 1986, p. 26) and so its breeding range may be expanding under population pressure at The Pyramid..

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Appendix 1: Suspense list

Fluttering shearwater (*Puffinus gavia*)

A male specimen in the American Museum of Natural History (527760), previously in the Rothschild collection, is labelled "Snares Isl." in Dannefaerd's handwriting (Murphy 1952). As with the Hutton's shearwater specimen (AMNH 527761 – see below), there is doubt about the validity of the collecting location (Murphy 1952). The lack of observations of fluttering shearwaters at or near the Snares Is since then suggest that the specimen was probably mislabelled.

Hutton's shearwater (*Puffinus huttoni*)

A female specimen in the American Museum of Natural History (527761) and previously in the Mathews and Rothschild collections, is labelled "Snares Isl." in Dannefaerd's handwriting (Murphy 1952). This is the holotype of Hutton's shearwater (Mathews 1912). Mathews stated that the holotype was a male, but the specimen now labelled as the holotype is labelled as a female (Hartert 1926; T. Chesser, pers. comm. to AJDT). There has been longstanding doubt about the validity of the collecting location: Mathews (1912) stated that *P. huttoni* was "breeding" on the Snares Is, but Murphy (1952) suggested that the holotype might have been shot in waters close to the Snares Is or may have been mislabelled. We have 1 sighting and 3 other possible sightings of Hutton's shearwaters east of Stewart I. on 3 Mar 1992 (AJDT pers. obs.) which show that this species occurs further south than previously realised (Marchant & Higgins 1990) and gives some weight to the possibility that the holotype was taken at sea near to the Snares Is (Murphy 1952).

There is confusion about how many specimens labelled from the Snares Is actually existed, and who collected them. The earliest documentation that we have found of *P. gavia/huttoni* at the Snares Is is correspondence from Dannefaerd to Rothschild, held at Tring (J. Cooper pers. comm. to AJDT), which lists 2 "Puffinus Gavia

Snares Isl" sent to Rothschild on 16 May 1895. The next references are Godman (1907-08) and Waite (1909), who state that Henry Travers collected a fluttering shearwater there. However, these references were before Mathews (1912) described Hutton's shearwater as a distinct from *P. gavia*. Mathews received what was to become the holotype *P. huttoni* from Rothschild, because Hartert (1926) stated that Rothschild received the holotype *P. huttoni* "from Dannefaerd, given in exchange to Mathews". Hence, it seems likely that one of Dannefaerd's "Puffinus Gavia" became the *P. huttoni* holotype. The Mathews collection was later sold back to Rothschild and, later again, most of Rothschild's collection was sold to the American Museum of Natural History (Fleming 1982: 4). From the detailed description given by Godman (1907-08; especially the relatively dark throat and neck and the lateral undertail coverts "edged with smokey-brown along the outer webs"), it appears that the 'Travers' specimen was also a Hutton's shearwater. Godman (1907-08) noted also that this bird was a female (as is the holotype of *P. huttoni)* in the Rothschild collection. It seems likely that the bird referred to by Godman and the Mathews' holotype are the same individual, as assumed by Clark & Fleming (1948), and that Mathews mistakenly wrote the wrong sex in his type description. This theory is supported by the fact that Hartert (1926) referred to only single Hutton's and fluttering shearwater specimens from the Snares Is in the Rothschild collection, and that no *P. gavia/huttoni* specimen from the Snares Is bearing Travers' name could be located in the American Museum of Natural History (T. Chesser, pers. comm. to AJDT). Mathews (1912) apparently had examined specimens that he identified as both male and female *P. huttoni*, so it may be that he had in his possession both the Dannefaerd birds. As both Travers and Dannefaerd were field collectors and dealers, either one could have collected the birds or bought them from sailors (e.g., Warham & Bell 1979) and possibly on-sold them to one another. However, it seems that Dannefaerd was the person who sent the specimens to Rothschild after having attached his own labels. Serventy (1939), followed by Clark & Fleming (1948), assumed that the specimen referred to by Godman was different to the two discussed by Hartert, so that in total they believed that there were three *P. gavia/huttoni* specimens from the Snares Is. Given that only two *P. gavia/huttoni* specimens from the Snares Is can now be located (AMNH 527760 and 527761), we believe that all records are likely to refer to these specimens. However, to clarify further how many specimens existed, research is needed into how Dannefaerd obtained the specimens and how Travers' name came to be associated with a specimen.

The origin of the date of collection for the holotype of *P. huttoni* of Jan 1890, given by Clark & Fleming (1948) and Oliver (1955), is a mystery. It is not mentioned in earlier publications that we have found and is not on the specimen's label. Until this date is corroborated from another source, we believe that it should be discounted. Most dated subantarctic New Zealand bird specimens with Travers and Dannefaerd labels are from 1894 (AJDT, unpubl. data) and that is thought to be the only year in which Henry Travers personally collected in this region (Warham & Bell 1979).

Auckland Island teal (*Anas aucklandica*)
Hector (1896) reported that "Dr Collins, who shot specimens of [Auckland Island teal] in the Auckland Is, was certain that he saw the same flightless duck in a small permanent pool on the top of the Snares Island, which would be a new locality".

Pipit (*Anthus novaeseelandiae*)
Chapman (1890) reported the presence of "ground-larks (*Anthus novae-zealandiae*)" following his visit on 8 Jan 1890. Waite (1909) also reported that members of the Philosophical Institute of Canterbury Expedition saw a pipit on the Snares Is in Nov 1907. No specimens are known to have been collected, and there have been no subsequent records.

Bellbird (*Anthornis melanura*)
Reischek (1889) reported that when he landed on 22 Jan 1888 he observed "three strangers" (i.e. bird species that he had not seen before) including "a bell-bird, which was rare and shy", and later described it as being "darker in plumage than on the mainland". Three members of the 1976-77 expedition heard a possible bellbird on 29 Nov 1976, but the bird was not seen.

Dusky woodswallow (*Artamus cyanopterus*)
Two wood swallows (probably dusky woodswallows) hawking insects over Ho Ho Bay 10-13 Oct 1983 were reported by M. Schofield (pers. comm.). Dusky woodswallows have not otherwise been reported from New Zealand.

Appendix 2: Species seen only from boats within 15 km of the Snares Islands

Seabirds were recorded from boats in the vicinity of the Snares Is on 7 Dec 1982, 26 Jan 1983, 9 Feb 1983 (all CMM), 15 Jan 1984 (GJE), 2 and 10 Feb 1984, 26 Nov 1984, 29 Dec 1984, 8 Jan 1985, 9, 11, and 16 Feb 1985, 22 Sep 1985 (all CMM), 3 Dec 1985 (AJDT), 19 Jan 1986 (CMM, AJDT), 22 Oct 1986, 10 Feb 1987 (both CMM), 3 and 17 Mar 1992 (both AJDT), 1 Aug 1992 (CMM), 18 Jan and 2 Feb 1993, 26 Jun 1998 (all AJDT), 8 May 1999 and 3 Feb 2000 (both RPS). See main text for information on sightings at sea for those species also recorded on or adjacent to the islands.

Snowy albatross (*Diomedea chionoptera*)
An adult snowy albatross was seen south of the Western Chain on 26 Jan 1983.

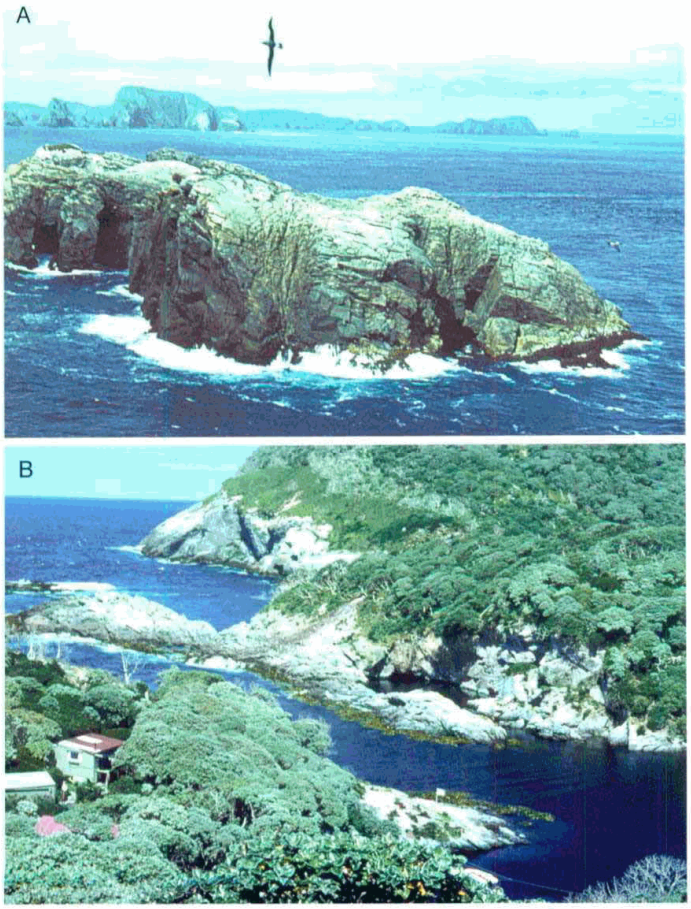

Plate 1 (A, B) A, The Snares Is from the north end of Toru Islet, Western Chain. Rua and Tahi Islets in the foreground, North East (left) and Broughton Is in the distance. Dec 1984. **B,** Station Point and Boat Harbour, with Ho Ho Point and Ho Ho Bay in the background. Feb 1984 (compare with fig. 9 in Falla 1948 and plate XXV in Warham 1967). Photographs: C. Miskelly.

Plate 2 (A, B) **A,** The north side of Southwest Promontory viewed from near Signpost Hill, with the Western Chain in the background, Dec 1984. **B,** Ho Ho Bay and Ho Ho Point from near Senecio Creek, with Station Cove and Seal Point in the background. Note F.V. *Sea Emerald* moored in Ho Ho Bay, Sep 1985. Photographs: C. Miskelly.

Plate 4 (A-E) A, Royal penguin (*Eudyptes chrysolophus schlegeli*), Station Cove, Feb 1986. **B,** Royal penguin (*E. chrysolophus schlegeli*), Penguin Slope, Mar 1994. **C,** Snares crested penguins (*Eudyptes robustus*) with chicks, Station Point, Nov 1985. **D,** Auckland Island shag (*Leucocarbo colensoi*), Ho Ho Point, Mar 1997. **E,** Female chestnut-breasted shelduck (*Tadorna tadornoides*), Station Cove, Dec 1984. Photographs: **A, C, E,** C. Miskelly; **B,** J. Molloy; **D,** P. Sagar.

Plate 3 (A-D) **A,** A pair of southern black-browed albatrosses (*Diomedea melanophrys*) on Toru Islet, Dec 1984. Salvin's albatrosses (*Diomedea salvini*) in background. **B,** Chatham Island albatross (*Diomedea eremita*) (left) and Salvin's albatross (*Diomedea salvini*) (right), Toru Islet, Dec 1984. **C,** King penguin (*Aptenodytes patagonicus*), Station Point, Feb 1983. **D,** Gentoo penguin (*Pygoscelis papua*), Station Point, Dec 1985. Photographs: C. Miskelly.

Plate 5 (A-E) A, B, Male Australian wood duck (*Chenonetta jubata*), Nov 1985. **C,** Snares Island snipe (*Coenocorypha aucklandica huegeli*), Jan 1985. **D,** Snares Islands fernbird (*Bowdleria punctata caudata*), Dec 1987. **E,** Snares Island tomtit (*Petroica macrocephala dannefaerdi*), Nov 1985. Photographs: **A, B, E,** P. & J. Sagar; **C, D,** C. Miskelly.

Northern black-browed albatross (*Diomedea impavida*)
An adult northern black-browed albatross was seen south of Broughton I. on 7 Dec 1982, and a subadult was 2 km north of Daption Rocks on 22 Sep 1985. At least 2 of 10 black-browed albatrosses in a mixed group feeding behind a tourist vessel on 3 Feb 2000 were of this species. Most other sightings did not distinguish between *D. melanophrys* and *D. impavida* (see under former in main text).

Grey-headed albatross (*Diomedea chrysostoma*)
No grey-headed albatrosses were seen during summer visits to the Snares Is. One adult and 2 juveniles were 10-15 km northeast of the islands on 1 Aug 1992.

Yellow-nosed albatross (*Diomedea chlororhynchus*)
An adult yellow-nosed albatross of the white-headed (Indian Ocean) form was seen south of the Western Chain on 8 Jan 1985.

Short-tailed shearwater (*Puffinus tenuirostris*)
A short-tailed shearwater scavenged behind a fishing boat off the Western Chain on 22 Dec 1985 (K. Schofield, pers. comm.).

Antarctic petrel (*Thalassoica antarctica*)
An Antarctic petrel scavenged behind a fishing boat near the Western Chain on 10 Sep 1985 (K. Schofield, pers. comm.). Note that Antarctic fulmars were constantly present around the Snares Is at this time (K. Schofield, pers. comm.).

Soft-plumaged petrel (*Pterodroma mollis*)
Martin Renner saw a soft-plumaged petrel just north of the Snares Is on 20 May 1997 (Medway 2000).

Grey-backed storm petrel (*Oceanites nereis*)
A grey-backed storm petrel was seen off the Western Chain on 15 Jan 1984. Another was northeast of NEI on 26 Nov 1984, and 1-2 were 2 km south of Broughton I. on 19 Jan 1986. Forbes (1893) stated that grey-backed storm petrels were found "on the Snares". No details were provided, and they have not been reported ashore on the Snares Is by other workers.

Editor's Note

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