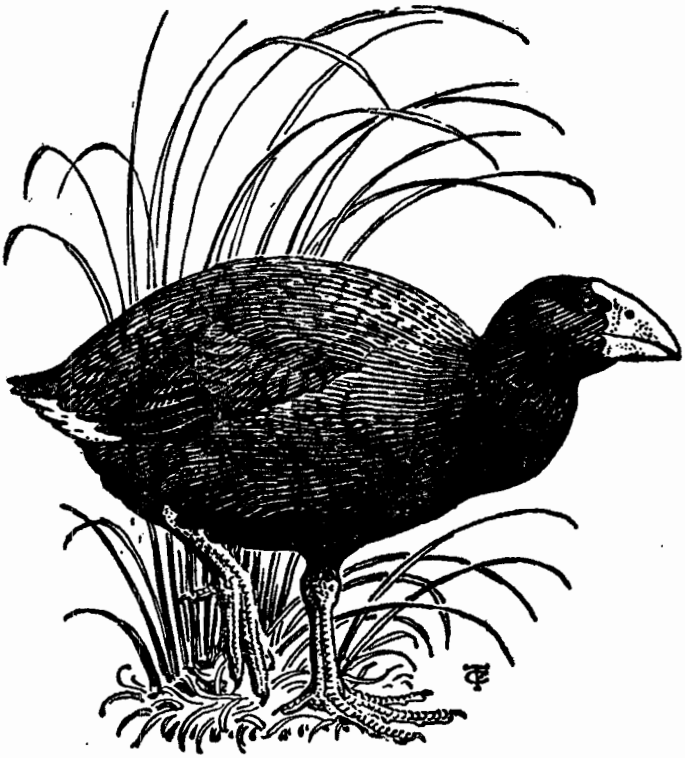
NOTORNIS

Journal of the Ornithological Society of New Zealand



Volume 19 Part 3 September 1972

OFFICERS 1971 - 72

President — Mr. F. C. KINSKY, Dominion Museum, Private Bag, Wellington

Vice-President — Mr. B. D. BELL, Wildlife Branch, Dept. of Internal Affairs, Private Bag, Wellington

Editor — Mr. E. W. DAWSON, P.O. Box 8009, Wellington

Assistant Editor — Mr. A. BLACKBURN, 10 Score Road, Gisborne

Treasurer — Mr. H. W. M. HOGG, P.O. Box 3011, Dunedin

Secretary — Mr. B. A. ELLIS, 44 Braithwaite Street, Wellington, 5

Members of Council:

Mr. A. BLACKBURN, 10 Score Road, Gisborne

Dr. P. C. BULL, 131 Waterloo Road, Lower Hutt

Dr. R. A. FALLA, 41 Kotari Road, Days Bay, Wellington

Mrs. J. B. HAMEL, 42 Ann Street, Roslyn, Dunedin

Mr. N. B. MACKENZIE, Pakowai, Napier R.D. 3

Mr. D. V. MERTON, Wildlife Branch, Dept. of Internal Affairs, Private Bag, Wellington

Mr. R. R. SUTTON, Lorneville Post Office, Invercargill

Conveners and Organisers:

Beach Patrol: Mr. M. J. IMBER, Wildlife Branch, Dept. of Internal Affairs, Wellington

Card Committee: Mr. B. D. BELL, Wildlife Branch, Dept. of Internal Affairs, Wellington

Librarian (and enquiries for back numbers): Mrs. H. R. McKENZIE P.O. Box 45, Clevedon

Nest Records: Mr. D. E. CROCKETT, 21 McMillan Ave., Kamo, Whangarei

Recording (including material for classified summarised notes): Mr. A. T. EDGAR, Inlet Road, Kerikeri

SUBSCRIPTIONS AND MEMBERSHIP

Annual Subscription: Ordinary membership, $4; Endowment membership, $5; Husband/wife membership, $6; Life membership, $80 (age over 30); Student membership (under age 21), 25% rebate off ordinary rate; overseas subscriptions, 50 cents extra.

Subscriptions are payable on a calendar year basis at the time of application for membership and on receipt of invoice each January. Prompt payment of subscription will ensure continued receipt of *Notornis.*

Applications for membership, changes of address and letters of resignation should be sent to the Hon. Treasurer.

[Registered with POHQ, Wellington, as a magazine]

CONTENTS

M. BARLOW The establishment, dispersal and distribution of the Spur-winged Plover in New Zealand 201

M. L. BARLOW, P. M. MULLER & R. R. SUTTON Breeding data on the Spur-winged Plover in Southland, New Zealand 212

C. M. VOOREN Seasonal abundance and behaviour of sea birds in the Bay of Plenty, New Zealand 250

B. REID North Island Brown Kiwi: *Apteryx australis mantelli.* Measurements and weights of a young chick 261

P. C. BULL & P. D. GAZE Bird distribution mapping scheme. Report for 1971 267

Short Notes

J. & M. McFADZIEN Pied and Black Fantails 271

S. M. REED Mongolian Dotterel at Mangere 271

R. H. MICHIE Eagles in Northland 272

P. E. ROBERTS Sighting of Black-capped Petrels at sea off the New Zealand west coast 273

S.M. REED Report on Great Barrier Island, January 1972 274

B. REID Kiwi egg laid at Wellington Zoo 276

Letters

J. M. CUNNINGHAM Service to the Society 278

J. R. JACKSON Sight recoveries of Red-billed Gulls 278

J. M. CUNNINGHAM Constitutional procedure at the A.G.M. 280

Reviews

R. J. SCARLET The Swans, by Peter Scott and the Wildfowl Trust 281

Some Recent literature 283

From the Editor's Desk 285

About our authors 287

Regional Representatives 288

The Society and its officers ..... inside front cover

Instructions for authors ..... inside back cover

Printed by TE RAU PRESS LTD., Gisborne

INSTRUCTIONS FOR AUTHORS

INTENDING CONTRIBUTORS ARE ASKED TO REFER TO NOTORNIS 19 (1): 102-104, APRIL 1972, FOR FULL DETAILS CONCERNING THE PREPARATION OF MANUSCRIPTS SUBMITTED FOR PUBLICATION. Study these carefully and prepare your manuscript accordingly. Unless these requirements, briefly stated below, are followed, manuscripts will be returned without further consideration.

GENERAL — Let at least two other people read your manuscript before sending it in and heed their comments. Check that all editorial requirements have been met and that all pages, tables and figures have been included; wrap and pack securely (especially photographs) and send to: The Editor, *Notornis*, P.O. Box 8009, Wellington.

FORM — *Two copies required,* typed, double-spaced with wide margins, on heavy-weight paper.

ABSTRACT — Provide up to 150 words for any paper exceeding 1000 words.

UNITS, CONVENTIONS — Use metric conversions for all measurements. Follow N.Z. Government Printing Office Style Book for other conventions.

NOMENCLATURE — Follow the OSNZ Annotated Checklist (1970) unless otherwise explained. Give scientific and common names (spelt with initial capitals) at first mention.

ILLUSTRATIONS — Plan for legible reduction to 7" x 4" (18 mm x 10 mm) or 3½" x 4" (8.5 mm x 10 mm). Photographs must be on glossy paper with strong contrast.

TABLES — Type *cleanly* on electric typewriter (whenever possible) with new carbon ribbon on heavy paper. Indicate position of each in the text.

ACKNOWLEDGEMENTS — Make certain that anyone who is acknowledged as having " critically " read the manuscript has indeed done so.

REFERENCES — These *are* important. Check titles, dates, and pagination carefully and spell out in full, following examples given in issues of *Notornis* from March 1972 onwards. In text, cite as " Blackburn (1972) said . . ." or " . . . according to some observers (Kear & Burton 1971)."

ADDRESS — Full postal address of author to be given at end of paper.

PROOFS — Supplied only on request or at Editor's discretion. *They must be returned without delay.*

REPRINTS — Authors will get 25 free reprints (other than of Short Notes, etc.). *Additional reprints may be ordered at cost directly from the printers, Te Rau Press Ltd, P.O. Box 195, Gisborne,* after notification of acceptance of the manuscript.

CONTRIBUTIONS WILL BE ASSUMED TO BE READY FOR PUBLICATION AS RECEIVED. TYPESCRIPTS AND ILLUSTRATIONS NOT IN THE PROPER FORM WILL BE RETURNED TO THE AUTHOR.

Book reviews, short notes, and news items are especially welcome.

NOTORNIS

is the journal of the Ornithological Society of New Zealand (Inc.)

Editor: E. W. Dawson,
P.O. Box 8009,
WELLINGTON.

VOLUME 19 PART 3 SEPTEMBER, 1972

THE ESTABLISHMENT, DISPERSAL AND DISTRIBUTION OF THE SPUR-WINGED PLOVER IN NEW ZEALAND

By MAIDA BARLOW

ABSTRACT

The Spur-winged Plover *(Lobibyx novaehollandiae)* is an Australian species, self-introduced to New Zealand in 1932 and now established as a breeding species in Southland and parts of Otago. Its establishment and present distribution are outlined. The method of spread in five different localities is demonstrated. Local movement is described.

ARRIVAL AND EARLY ESTABLISHMENT

In 1946 the late Very Rev. C. J. Tocker reported the early establishment of the Spur-winged Plover in New Zealand to the Southland Acclimatisation Society in the following words:

> " Some twelve years ago one of the Borstal farm managers, Mr John Bell, told me of a pair of strange birds which had settled on the Borstal farm a couple of years earlier. They had lived, but some of the chicks had been lost. There were then five birds. I went over with my binoculars on two occasions and managed on the second to stalk up close to the birds, which are very furtive and difficult to approach, and get a good steady view. I had no difficulty in identifying them as the Australian Spur-winged Plover, *Lobivanellus lobatus.* I have watched the colony with interest ever since. I should say there are now from thirty to fifty birds. To my personal knowledge several have been shot in the last two shooting seasons, not wantonly, though there is always a danger of that, but through genuine mistake. The birds' area is now extended south as far as Awarua Plains, and west as far as Taramoa. I have little doubt that as they increase they will extend their territory . . . The bird, I am sure, ought to be given protection." (Dept. of Internal Affairs File).

This report was forwarded to the Department of Internal Affairs in May 1946 and the species was given full protection in September 1946.

Mr. Tocker's report fixes the date of the first arrival as approximately 1932 (two birds). In 1934 there were five birds. By 1946 there were 30 to 50 spreading to Awarua Plains and Taramoa (areas within a six-mile radius of Invercargill).

By 1951 the numbers had increased to approximately 100, extending in range to the mouth of the Waimatuku River and the Oreti River near Oporo, both within ten miles of Invercargill (Sansom 1951). Numbers increased steadily in the Invercargill area until the 1960s. Since 1965 numbers in this area have remained fairly stable.

Between 26 September and 5 October 1971 a count was made of all birds within a 10-mile (16 km) radius of the Invercargill Post Office. I am grateful to Mr R. R. Sutton for helping with this work. In September/October birds are breeding and on territory, and there was no danger of counting any bird more than once, even though the count could not be made in one day. No chicks or juveniles were included. The total was 827. At a conservative estimate this would be two-thirds of the actual number. The approximate 1971 population within a 10-mile radius of Invercargill is therefore 1240 birds.

METHOD OF SPREAD

From 1965 to 1970 the Spur-winged Plover was the subject of a study by a group of Southland ornithologists. The main purpose was to collect breeding data, and a paper on this aspect of the study appears in this issue (Barlow, Muller & Sutton 1972). At the same time the banding programme which was essential to the study provided some information on movement and distribution. The use of colour combinations allowed sight recognition of individuals.

Breeding adults banded totalled 119. The adults remained in the same area year by year. Fledged young birds remained with the parents until they were 8 to 10 months old. They then did one of three things:

1. Remained and bred in the vicinity of their natal area, occupying an area left vacant by death of an "old" bird.
2. Moved to a nearby area and remained and bred there.
3. Left the area.

TABLE 1 — DISPERSAL OF FLEDGED YOUNG

No. in sample	Sightings, second or subsequent year		No data
	Natal area	2-3 miles from natal area	
70	14	12	44

The dispersal of a sample of 70 fledged young, all of which had the same chances of being re-sighted, is shown shown in Table 1.

In the study area the species numbers remained fairly stable. It is therefore safe to assume that the area held its optimum breeding population. At the same time, land usage within the area caused modification of habitat, sometimes to the birds' advantage, sometimes not. While some habitat was lost to housing, industrial development, and regrowth of vegetation, new habitat was provided by the clearing of scrub-covered land previously unsuitable for the species.

The species spread throughout the country by two methods:

1. The " ink-blot " spread: birds bred at the perimeters of an established breeding area and this became a continuing process where the habitat was suitable.
2. Birds arrived in a previously unpopulated area, remained and bred. From this nucleus a further ink-blot spread developed.

The banding programme provided some evidence of " ink-blot " spread into newly-created habitat within an area which held a stable population. It is considered that it is the juveniles in category 3 above (" Left the area ") which move out to populate new areas, although there is no evidence to prove this theory. To date the greatest known distance covered by a banded bird from Southland is 12 miles (19.3 km). The Australian long-distance record (Liddy 1969) is 91 miles (145.6 km).

HABITAT

Spur-winged Plovers prefer wet swampy ground with short cover. Scattered rushes and sedges provide a broken pattern background both to the incubating bird and to the chicks. Areas of dense rushes are not used. The birds will use pasture with short cover of up to approximately five inches, cultivated paddocks, grain-crop or hay stubble, new turnip crops and areas left fallow after turnip or choumoellier crops have been eaten down. When birds are found in such areas a further search will usually reveal a nearby wet area with rough cover. Other places used are stony or sandy river-verges and riverbeds, gravel pits, estuaries, and sometimes coastal beaches. In Central Otago birds may be found in overgrown tailings left after gold-dredging, or in other dry stony places with sparse grass cover. In most cases there is water nearby (river, stream or irrigation race) but not always. One pair had a nest at least half a mile from the nearest water. A further requirement appears to be wide uninterrupted visibility. It is unusual to find birds in narrow gullies or valleys with restricted outlook. They will sometimes use undulating slopes. They can be found at high altitudes, where other conditions are suitable (e.g. Caroline 1530′ (465.9 m), Wilkin Valley 2000′ (609.6 m), Mid-Nevis Valley 2200′ (670.6 m)). In summary, the area of choice is wet, rough, with short cover, flat, and has a wide outlook.

COLONISATION IN CERTAIN LOCALITIES

Colonisation and present status in five areas are now described.

Makarora Catchment:

An Internal Affairs Department Field Officer found 2 adults and 3 chicks on 10 November 1952; on 10 March 1953 he saw 3 birds; and on 15 February 1955, 5 birds. On 9 September 1963, Mrs Pennycook of Makarora Station told Mr H. R. McKenzie that up to 9 birds were often on the wet flats below the homestead. In October 1966 Mr Peter Child found 21 birds along 9 miles of river-bed, mostly in pairs. Mr Alan Wright was Internal Affairs Department Field Officer at Haast in 1966, 1967 and 1968. His counts in the Makarora area, covering about 2 miles of road, are as follows: 11 January 1967, 14 (11+3); 17 January 1967, 17 (4+8+2+1+2); 31 May 1967, 28 (2+10+7+9); 11 June 1967, 60 (54+2+4); 22 June 1967, 84 (3+36+4+5+2+34); 28 June 1967, 93 (1+3+3+46+29+11); 2 July 1967, 21; 22 July 1967, 15; 18 August 1967, 49 (45+4). Mr Wright (pers. comm.) said, " Birds were observed in 1966 and 1968 but no details taken. Breeding also took place in 1966, 1967 and 1968, but I would not like to say how many." Mr Child (pers. comm.) found 36+ in one flock on 2 June 1968, and on 23 May 1970, 47+, including 39 at the river delta.

Lillburn Valley:

Mr Bruce Campbell farmed at Lillburn Valley from 1935 until 1971. His farm was bounded by the Lillburn River at its junction with the Waiau River. In 1970 Mr Campbell told me; " Up to 1963 there were only a few Spur-winged Plovers about. They appeared to increase about this time, and since 1963 numbers have been fairly stable, the usual flock size at the river being 15 to 20, and a regular population of pairs about. An exceptional flock of about 50 just below the Lillburn River mouth was counted in 1965. The birds move off from the paddocks in the summer and return again about May."

Lower Clutha and Lake Tuakitoto:

The first record from Lake Tuakitoto was in October 1962, from Mrs L. E. Walker; Mr B. D. Bell saw 4 there in November 1964; Mr H. R. McKenzie recorded about 8 on 5 November 1965; and Mr W. T. Poppelwell noted 9 on 16 March 1968. Mr Bill Jones, farmer of Stirling, told me in June 1969: " Spur-wings first appeared here about 5 years ago. They are getting thick now; always some down by the river and the lake." In a letter dated 5 May 1971, Mrs Jones says: " There are 5 pairs on our farm just now, and we all say there is definitely an increase since 1969."

Upper Clutha River Valley:

Establishment and spread in the Clutha River valley between Island Block and Roxburgh is demonstrated by the following records:

" 1957-63 None seen, although area visited frequently, and lived

in for periods of some weeks at a time during these years." (O. Sansom); July 1964 Millers Flat 3 (D. Kelly); 30 July 1965, Mr A. J. Hodgkin, farmer of Moa Flat, in letter to Mrs J. Hamel: ". . . my first sighting of Spur-winged Plovers, 4 of which flew over the farm from south to north today"; 26 September 1965, Roxburgh East 2 (Richard Gray). There are no further records until 24 March 1967 when I found 13 at Island Block. Subsequent increase in the valley is demonstrated by the further sightings, all by the author unless otherwise acknowledged: 23 April 1967, 15 (9+2+2+2); 5 August 1967, 2+2; 18 November 1967, 1; 24 December 1967, 20, at least 2 of which were juveniles; 12 September 1968, 14 birds, 4 nests; 12 June 1969, 30 (Island Block) +3; 30 August 1969 13 birds, 3 nests; 19 April 1970, 17 (Dumbarton) (C. E. Barlow); 22 March 1971, 8 (M. M. Davis); 20 April 1971, 56 (+1+11 (Dumbarton) +5+2+29 (Island Block) +6).

On 12 September 1968, a drive from Clydevale through Tuapeka Mouth and Beaumont to Roxburgh revealed birds breeding in 7 places. These were nests or broods sighted from the car, and would not be the total population. It is apparent that the valleys formed by the rivers have provided a highway for the dispersal of birds in the region.

Lawrence:

Here the species is at an early stage of colonisation. March 1962: " Heard calling over the town of Lawrence. Reported reliably by a man who apparently knows these birds well in Australia and Tasmania." (R. Nilssen); 28 October 1967, 2 adults (M.L.B.); 26 December 1967, 3 adults, all in moult; 13 September 1968, 2 birds, 1 nest; 6 April 1969, 4 birds; 30 August 1969, 2 birds, 1 nest; 11 May 1970, 3 birds; 21 March 1971, 2 adults, 1 juvenile; 30 August 1971, 3 breeding pairs with nests. The sighting of three moulting adults in December 1967 indicates that these birds did not breed successfully that year. Had they done so the offspring would still have been with the adults (Barlow, Muller & Sutton 1972). But in 1968 the first nest was found and there is evidence of breeding in subsequent years.

Discussion:

The colonisation pattern is demonstrated in the examples cited. Density is influenced by availability of suitable habitat.

A note about flying habits is relevant. From my home in Invercargill I sometimes hear Spur-wings at night, calling from a height as they fly over. This also happens in the daytime, and birds have been seen in twos, threes, fours and singly, flying high and in a direct line. This differs from the flight patterns of birds on their home ground. Breeding birds, once established in an area, remain there or in the close vicinity all the year round.

The composition of the large flocks is not fully known. These flocks occur most often in the autumn, but may be found at any time of the year. The autumn flocks probably include some juveniles of the year. In late autumn the juveniles of neighbouring families mingle, forming small flocks. Adults are also found in these flocks. In the study area where most of the population was banded flocks of up to 15 were seen and the flock composition known. It may be significant that since 1965 no large flocks have been found in the study area, where population numbers are stable and breeding density is probably at optimum levels. Flocks of more than 100 have been seen within ten miles of the study area. The large flocks probably contain numbers of non-breeding birds.

LOCAL MOVEMENT

The local movements of eight breeding birds over three years is shown in Fig. 1. For reasons of clarity only 6 to 8 sightings of each bird are plotted. In fact there were many more, in some cases hundreds, of sightings of the birds in the same locality over the years. The land surrounding the area shown in Fig. 1 was under close scrutiny throughout the years of the study, and had these birds moved further afield they would probably have been sighted at one time or another. The adult birds could always be found in the breeding area during the 9 to 10 months occupied by the breeding period and post-fledging period of dependence of the brood. In the remaining two to three months they could often be seen in their usual haunts; if not immediately found, a vigilant search would usually be successful.

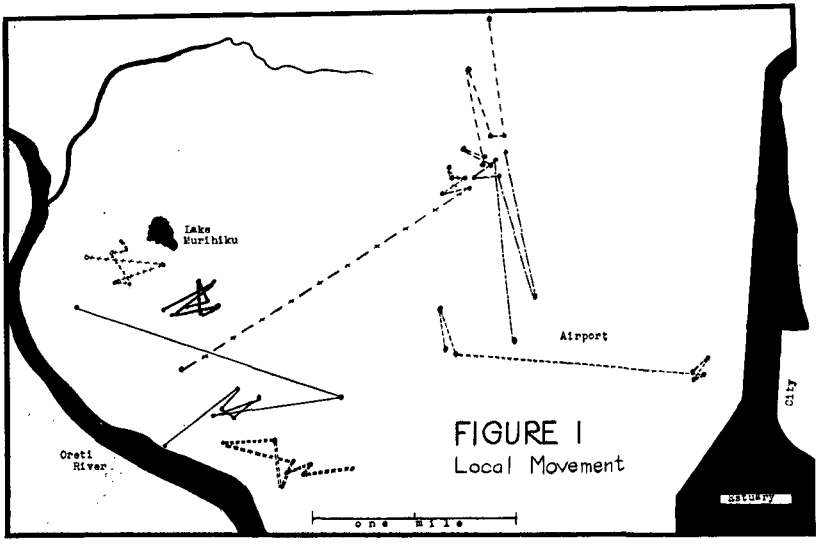


FIGURE 1: Local movement of 8 breeding Spur-winged Plovers over 3 years.

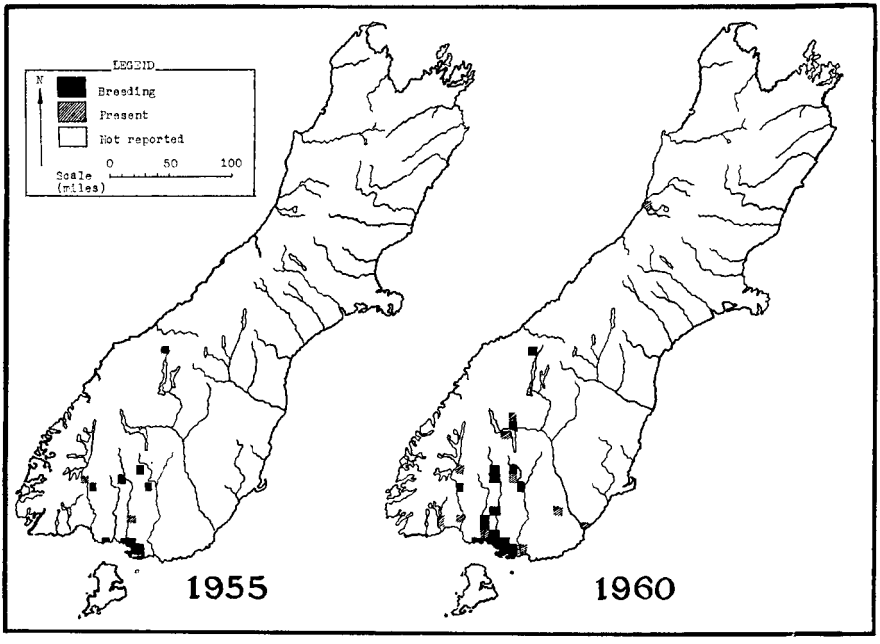


FIGURE 2A: Distribution and status of the Spur-winged Plover at 5 year intervals; 1955, 1960.

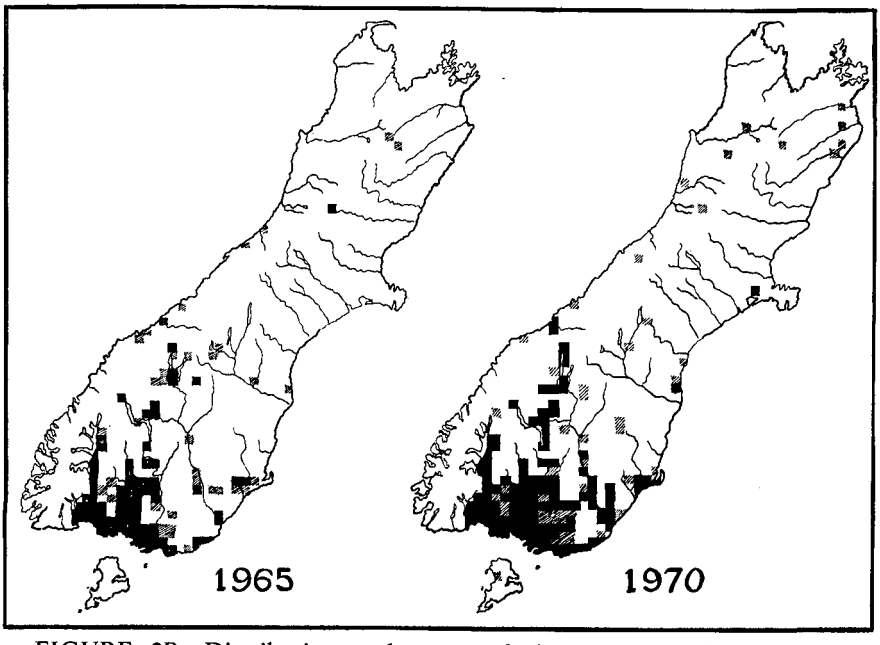


FIGURE 2B: Distribution and status of the Spur-winged Plover at 5 year intervals; 1965, 1970.

LOCALITY REPORTS

The distribution and status of the species at five year intervals from 1955 to 1970 is indicated in Figs. 2A and 2B, based on material from the OSNZ Recording Scheme, and on reports made to me and since lodged with the Scheme.

Most of the following locality reports are the first recorded sightings in the area. Later sightings, where included, give an indication of increase in the particular area. The Letter B indicates evidence of breeding, either nest or chicks having been seen. The number is the number of fledged birds; chick numbers are not included. Bracketted names are those of the people who supplied the information and initials indicate that the reporter's name has previously been listed. Records marked with an asterisk are considered to be vagrant birds. In the years prior to 1951 Spur-winged Plovers, usually single birds, appeared as vagrants in different parts of the country (Oliver 1955).

1951 Five Rivers 2B (I. Drummond).

1952 Makarora 2B (Field Officer); Waiau River just below Manapouri 4 (W. Macdonald).

1954 Manapouri airstrip 5 (Field Officer).

1955 Redcliffs 2B (B. Ellis); Lumsden (M. F. Soper); Colac Bay 2B (Mrs Stick).

1956 Waiwera 4 (O. Sansom); 10 miles south of Te Anau 2 (Mrs Nan Smith); One Tree Point (OS); Colac Bay 6B (Mrs Stick); Pahia 4 (W. Molloy); Thornbury B (R. M. Royds); Lower Mataura River (S. L. Lobb); Lake east end (L. Young); *Lake Ryan Cobden West Coast Acclimatisation Society Game Farm: 3 stayed two seasons (1956/57).

1957 Mossburn (M. Small); Lake Hayes 3 (MFS); Lake Hawkins Invercargill 43 (G. I. Moffett); Gummies Bush 2 (A. Thomson); Winton 8 B (H. Smith); Scott's Gap 4B (Mrs Gay); Dunearn/ Aparima: Many birds in this area B (N. F. Sansom).

1958 Queenstown 2B (MFS); Inchclutha (I. McLaren); *Matata, Bay of Plenty 1 (R. T. Adams).

1959 Gorge Road 8 (SLL).

1960 Gorge Road 21 (SLL); Remarkables Station, Queenstown (Jardine).

1961 Routeburn Station c.12 (R. H. Bryant); Mt Aspiring Station 2 (P. Child); Te Anau 17 (B. D. Heather).

1962 Mararoa Station 6 (BDH); Matukituki River (PC); Remarkables Station, Queenstown B (Jardine); Lower Shotover 2 (Hansen); Lindis Valley, 12 miles above Tarras "said to be first seen" (PC); Heriot B (Mrs L. E. Walker); Lawrence 1 calling (R. Nilssen); Lake Tuakitoto (LEW); Tokoiti (J. Hamel); Outram 2; Ahuriri 2 (B. D. Bell); Ohau 2 (BDB); Hakataramea 8 (BDB).

1963 Te Anau B (MFS); Oreti Valley above Mossburn c.40 (W. T. Poppelwell); " Very common throughout open country of Southland. Common Te Anau district and Waiau Valley west to Fiordland bush edge. Main centre of population still Invercargill airport region. Densest population in coastal strip near Invercargill. Inland are scattered, especially alongside riverbeds, but by no means entirely " (BDH); Queenstown 4 breeding pairs (MFS); Routeburn Station c.12 (RHB); Lindis Valley Geordie Hill Station 2B (PC); Pomahaka 1 (RN); Haast 7, Arawhata 2 and Hunter (several) Riverbeds (Graham Adams told PC first seen here 1963); 2 miles south of Franz Joseph Glacier c.12, moved on (D. Panckhurst); Upper Waitaha Valley 4 in May, not present November (A. B. Munden); Kokatahi 2, moved on (M. Wallace); Lake Sumner B (K. Rowe); St. Helen's Station, headwaters of Wairau, reported present (KR).

1964 *Southland:* Otautau 28 (MLB); Balfour 7 (P. Ryan); McNab 4 (WTP); Eglington Valley 2 (Parks Board Instructor).
Otago: Increasing slowly and in small numbers in Otago; breeding; none in Alexandra basin so far (PC); Waipahi 2 (LEW); Momona 3 (LEW); Hindon 2 (D. Kelly); Taieri Mouth 2 (WTP); Outram 5B (H. W. M. Hogg and G. Grant); Toko Mouth 5 (DK); Millers Flat 3 (DK); Lake Wanaka 60+ 26/7/64 (PC); Shovel Flat, upper West Matukituki Valley 2 (PC); Phoebe's Creek, Lower Matukituki 2 (PC); " Not in Oamaru District " (A. Nuttall).
Westland: Kokatahi 5 (E. W. Crack).

1965 *Southland:* Waimatuku 46 (MLB); Riversdale/Lumsden 50+ Many in small flocks (RN).
Otago: Tapanui a few (MFS); Moa Flat 4 flew over (AJH); Roxburgh East 2 (R. Gray); Alexandra 2 (PC); North Taieri 2 arrived mid-July, B 12 August 1965 (D. Ross); Remarkables Station, Queenstown 10/12 (Jardine);Queenstown/Arrowtown 20+ pairs (excluding Jardine's) (MFS); Fairlight 20 (GG); Lower Shotover 2B (Hensen); Ewings Flat, Wanaka 1 August 1965, 50-60 (PC); Ewings Flat, Wanaka May 1965 96 (H. Tanfield); Clutha River: " Not reliably reported further down river than Tarras. No new areas noted 1965 " (PC); (Note: except Alexandra 10 December 1965).
Canterbury: Studholme 2 (H. R. McKenzie).
Marlborough: Rainbow Station, St. Arnaud, upper reaches of Wairau River 2 (J. Cowie).

1966 *Otago:* Waipahi 4 (WTP); Lowburn Ferry, Cromwell 2 (OS); Naseby-Kyeburn Road 8 (WTP); 12 June 1966, Matukituki River Mouth 38 + 40 (PC).
Canterbury: Washdyke Lagoon, Timaru 5/6 (moved on) (B. R. Keeley).
Marlborough: Near Seddon 2 (OS).
Westland: Poerua 2 (R. A. Webber).

1967 Mason Bay, Stewart Island 2 (MLB).
Otago: "Becoming more plentiful and widespread" (WTP); Hooper's Inlet 1B (WTP); Otanemomo 1 (WTP); Owaka 1 (WTP); Wakatipu area: Rees Valley 25 in 8 miles; Dart Valley 20 in 11 miles; great increase in last three years (PC); Upper Manukerikia 11 + 3 B (PC).
Haast: Autumn, c. 60 (AW).
Canterbury: 3 miles up Tekapo River from confluence of Pukaki and Tekapo Rivers 2 (R. Hosken); Lake Ellesmere 12 (G. A. Tunnicliffe).
Marlborough: Ure River 1 (J. Taylor).
Manawatu: *Lake Horowhenua 1 (E. B. Jones); *Hokio Beach 2 (EBJ).

1968 *Otago:* Fruitlands 2 (WTP); Lower Lindis, Cluden-Clutha 7 in 12 miles (PC); Lake Howden 2 (D. A. Lawrie); Henley c. 20 (JAC).
Canterbury: Otaio River 5 (R. J. Pierce); Lake Wainono 6 (RJP); Lake Tekapo 2 (RJP).
Westland: *Barrytown (T. Hartley-Smith).
Marlborough: Blenheim 1 (JAC).

1969 *Otago:* Kokonga, Central Otago 4B (T. J. Taylor).
Mid-Nevis Valley 6B (PC).
Westland: Franz Joseph 4 (PC).
Canterbury: Lake Wainono 4 (RJP); Lake Ellesmere B (M. M. Davis); Lake Tekapo 2 (RJP).
Marlborough: Near Murchison 1 (F. C. Kinsky).
Nelson: Near Warwick Junction 2 (S. C. Sparrow).
Wellington: *Waimeha Lagoon, Waikanae (R. B. Sibson).

1970 *Otago:* Matukituki River Mouth 80+ (30 January 1970) (PC); Howe 5 (WTP); Wilkin Valley 2000′ a.s.l. 2 (PC).
Canterbury: Harihari 2 (JRJ); Lake Wainono 2-8 present throughout year; breeding suspected (RJP).
Marlborough: Ure River 1 (JC).

1971 Fox Glacier 4 (MLB).
Stewart Island: Horseshoe Bay 2; Lonneker's Bay 2 (OS).

DISCUSSION

It is considered that the 1932 arrivals in Southland were a pair which by chance found themselves in a vacant niche where breeding conditions were ideal. These birds formed the nucleus of the present population. Some wind-assisted Spur-winged Plovers have probably reached Southland since 1932. Vagrants of other Australian species have done so, and there is no reason to doubt that further Spur-winged Plovers have also arrived. Any such birds would soon find others of their species and would swell the numbers to a small extent.

It is possible that the 1952 birds in the Makarora area were wind-blown from the west. Had they originated from the Southland stock they would have by-passed many suitable breeding areas en route, and it seems more reasonable to suppose that they were wind-blown vagrants.

The main cause of population increase however is considered to be the high rate of natural increase in the optimum breeding areas (Barlow, Muller & Sutton 1972).

The Southland/Otago colonisation continues. More distant areas where breeding is occurring are Lakes Wainono and Ellesmere in Canterbury, and there is good reason to believe that in the ensuing years birds in these areas will increase and disperse in the pattern described.

ACKNOWLEDGEMENTS

I am indebted to Peter Muller and Roger Sutton for their permission to use material from the manuscript of our paper published in this issue of *Notornis* (Barlow, Muller & Sutton 1972). Mr A. T. Edgar's careful records from the OSNZ Recording Scheme were an essential reference. Reports from many people have contributed to the pattern of distribution, and these are acknowledged with thanks.

LITERATURE CITED

BARLOW, M. L.; MULLER, P. M.; SUTTON, R. R. 1972. Breeding data on the Spur-winged Plover in Southland, New Zealand. Notornis 19(3): 212-249, figs 1-14, tables 1-13.

DEPARTMENT OF INTERNAL AFFAIRS FILE. Spur-winged Plover, Department of Internal Affairs File 46/62/15.

LIDDY, J. 1969. A summary of Spur-winged Plover banding in Tasmania. The Australian Bird Bander 7(1): 12-14.

OLIVER, W. R. B. 1955. New Zealand birds. 2nd ed. Pp. 1-661, text illus., 12 unnumb. col. pls. Wellington: A. H. & A. W. Reed.

OSNZ. Recording Scheme, Ornithological Society of N.Z., Inc. Unpublished reports.

SANSOM, O. 1951. Spur-winged Plover in New Zealand. Notornis 4(6): 138-139.

Mrs C. E. Barlow,
152 Lewis Street,
Invercargill

BREEDING DATA ON THE SPUR-WINGED PLOVER IN SOUTHLAND, NEW ZEALAND

By MAIDA L. BARLOW, PETER M. MULLER, ROGER R. SUTTON

ABSTRACT

A population of Spur-winged Plover *(Lobibyx novaehollandiae)* in Southland was studied from 1965 to 1969. Nest areas and nest building are described and breeding territories discussed. Average clutch size was 3.74. Clutch size was not affected by rainfall. Incubation was shared between male and female by day. Laying began in June and ended in November, with peak laying occurring in August. Re-nesting occurred after nest or brood loss. There was one record of double brood. Incubation period was 30 to 31 days. Excessive incubation, laying pattern and hatching pattern are discussed. Hatch success in fully incubated nests was 73.99%; 50% of unhatched eggs contained early dead embryos; 49.83% of nests produced live chicks. Causes of nest loss are discussed. Chick mortality in the first fourteen days was high. 17.45% of chicks were known to fledge, but the true survival rate was probably of the order of 25%. Mean hatch weight was 20.5 grams. Chick growth rate is demonstrated. Fledging age was 7 to 8 weeks. Post-fledging dependence is discussed. Fledged juveniles remained with parents until 7 to 8 months old. The breeding cycle occupied the successful breeders for 11 months. Females could breed when one year old; males could breed in their second year, and may have done so when one year old. There was evidence that some pairs did not effectively part until the death of one of the pair. One bird was still breeding at 9 years 11 months, another at 8 years.

CONTENTS

1. Introduction
2. Material and methods
   - 2.1 Nest records
   - 2.2 Banding
   - 2.3 Trapping methods
   - 2.4 Rainfall data
   - 2.5 Sex determination

NOTORNIS 19: 212-249 (1972)

3. Results
- 3.1 Nest areas
- 3.2 Copulation — egglaying time relationship
- 3.3 Nestbuilding — egglaying time relationship
- 3.4 Nestbuilding
- 3.5 Breeding territories
- 3.6 Clutch size
- 3.7 Behaviour of incubating birds
- 3.8 Egg dimensions
- 3.9 Dates of laying
- 3.10 Re-nesting
- 3.11 Breeding condition
- 3.12 Incubation period
- 3.13 Laying pattern compared with hatching pattern
- 3.14 Double brood
- 3.15 Hatching
- 3.16 Nest success and causes of nest loss
- 3.17 Chick survival
- 3.18 Hatch weights and chick growth rate
- 3.19 Fledging age
- 3.20 Post-fledging dependence
- 3.21 Breeding age
- 3.22 Pair bond
- 3.23 Longevity

4. Summary of results

5. Acknowledgements

6. Literature cited

1. INTRODUCTION

The establishment of the Spur-winged Plover *Lobibyx novaehollandiae* as a wind-blown migrant from Australia has been described by Barlow (1972). In 1964 a group of Southland members of the Ornithological Society of New Zealand decided that a concentrated study of the species would make the best use of the limited number of active field workers in the area. The study began in the 1965 breeding season and continued through to 1969 with some follow-up observations in 1970 and 1971. In 1968 there was an opportunity to co-operate with the National Film Unit in providing suitable material for a film of the species (Fig. 1). Recently some sequences were shown in the feature "The New Settlers," one of the new series of natural history television films produced by the National Film Unit, making its debut on Central Television on 2 July 1972.

The topic was to be looked at from three aspects:

1. Population study: distribution and movement.
2. Breeding data.
3. Behaviour study.

This paper collates the data gathered under section 2.

The plan called for an intensive study of the 8000-acre (3237.49 hectares) area shown in Fig. 2, one-third of the area to be covered by each of the three field workers. We had hoped to produce population and nesting density figures for each area and so fix the rate of increase of the species in it, but because we could not be certain that we had found every nest we had to abandon this part of the plan. Nevertheless some deductions on the rate of increase are possible from the statistics which follow.

A wary bird, the Spur-winged Plover cannot be approached successfully on foot except on the rare occasions on which it nests or feeds near cover. Thus we were limited to working from vehicles. Since most of the area was too wet to be negotiated with ordinary vehicles during the breeding season, we were confined to nests within sight of roads. As a result of this limitation, even though the study block was reasonably well roaded, observations were gradually extended beyond the initial study area in order to enlarge the sample, but most observations were made in the original area or in the areas immediately adjacent to it. A few nests in other areas which could be visited regularly were included in some of the statistics.

FIGURE 1: In 1968 the study team co-operated with the National Film Unit in obtaining material for a film of the species. (Left to right: Peter Muller, Lionel Lobb, Grant Foster (Film Unit), Roger Sutton, Dr R. A. Falla, Maida Barlow, Dale Pomeroy (Film Unit)).

Photo: National Film Unit

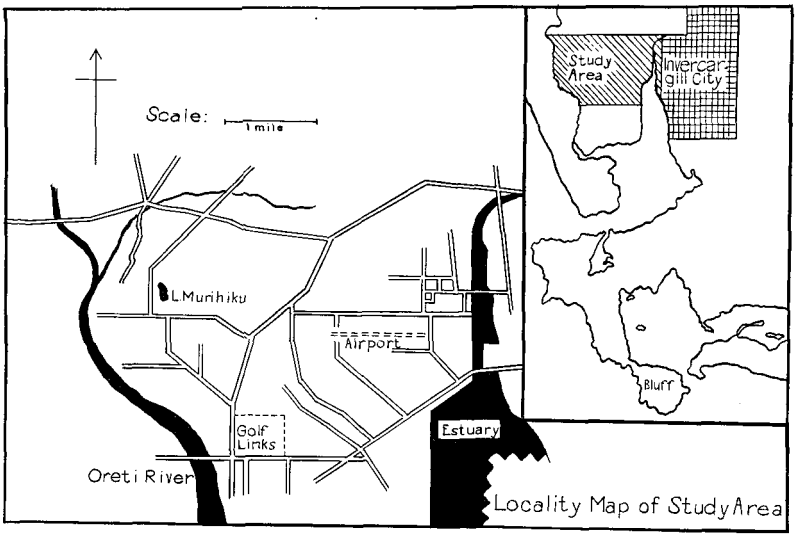


FIGURE 2: Locality map of study area.

2. MATERIAL AND METHODS

2.1 *Nest Records:*

Breeding data were recorded on nest record sheets under the following headings: Nest number; locality, description of breeding territory; distance from wet area; date found; number of eggs; date hatched; clutch size; number of eggs hatched; data on unhatched eggs; notes on chick mortality; number of chicks reared to fledging; weather during rearing period; notes (stock movement, etc.).

2.2 *Banding:*

Individual colour banding was used. After five years' wear some bands were largely devoid of colour but others stood up well and a few looked, from a distance, as good as when they were first applied. Because the monel bands soon darkened in colour and became difficult to see on a muddy leg, we had our remaining stocks electroplated and this overcame the problem. Some colours were more successful than others. We used black bands but had to discard them (the mud problem again) and we found green difficult to pick up at a distance. White, yellow, orange and blue were the most successful colours. Chicks younger than fourteen days were usually too small to retain the E band. Two weeks was therefore the minimum age adopted for chick banding. Two-week-old chicks retained the bands and did not appear to be handicapped. One band was monel,

the others being aluminium and lighter than the monel band. Many one- to three-day-old chicks were handled and weighed. Various methods of temporarily marking these young chicks — essential if we were to obtain data on chick growth — were considered and discarded. Most carried a risk of maiming the chick if it was not recovered, of modifying its activities or of increasing its vulnerability to predators. In 1967 a satisfactory method of marking young chicks was evolved. It consisted simply of making up small bands in a variety of colours from thin strips of rubber. These were easily applied to the chick's leg, with the use of expanding circlip pliers. Even if the chick was not subsequently re-caught there was no danger of restriction or injury to the bird. A different colour was used for each chick in a brood and the colour recorded with the chick's weight and age. When the brood was picked up again later each chick was identifiable, the rubber band was removed, the chicks weighed and the permanent metal bands applied. The occasion did not arise when there was confusion between broods. Broods did not mingle until many weeks, usually months, after fledging. Chick finding was usually preceded by adult finding and these adults were usually colour banded and therefore identifiable.

FIGURE 3: Individual colour combinations were a key factor in the study. This two-week-old chick has the combinations White over Aluminium (left), White (right).

Photo: R. R. Sutton

2.3 *Trapping methods:*

Lionel Lobb provided the tools for bird-catching. He first constructed drop-traps which were used to trap adults at their nests, and later a form of clap-trap for catching adults after the chicks had hatched. No one who has seen these traps can doubt the ingenuity and painstaking workmanship of the designer and builder. The bait for the clap-trap was the clutch of chicks in a small wire cage. As long as the chicks were only a few days old one or both adults would return to them, perhaps settling down by the cage in an attempt to brood them. The trap could then be tripped and one or both birds caught. Adult birds would rarely return to chicks older than a week, and the likelihood of their return dropped markedly after the first few days. In all trapping operations we tried to put the bird's welfare before our own interest, and to cause as little disturbance as possible.

Frequent discussions were necessary during the course of the study, both to report results and to modify plans in the light of experience. These get-togethers also were valuable in boosting flagging morale, for if one member of the team had just about given up in despair another had invariably had an encouraging success. None of us acting alone could have obtained the results we were able to achieve as a team. Each member made regular observations on his or her section of the block, but could also call for assistance from the others if daily (and sometimes thrice daily) visits were needed to a nest site, or if a day-long nest vigil was to be attempted.

2.4 *Rainfall data:*

Rainfall information was examined, particularly in attempting to make correlations with clutch size (see Section 3.6). Table 1 (compiled from Meteorological Service records — see "Literature Cited") shows rainfall for the five years of the study. It will be seen that during the peak breeding months of July to October there were three seasons of near average rainfall, one which was wetter than average, and one which was extremely dry.

2.5 *Sex determination:*

No reliable guide to sex difference, either in the field or in the hand, was discovered. Sex determination in the field was by observation of previously banded birds in copulation.

Laven (1940), as quoted by Little (1967), records that in a population of Ringed Plovers *(Charadrius hiaticula)* studied, he never observed reversed positions in copulation by male and female. Little (1967) records similar findings in a population of Wattled Plovers *(Afribyx senegallus)*. In many of the banded pairs of Spur-winged Plovers copulation was seen a number of times. With each pair it was always the same bird which mounted the other. It is assumed that with the Spur-winged Plover reversed positions in copulation occur rarely, if at all.

TABLE 1

TOTAL RAINFALL IN INCHES
INVERCARGILL AIRPORT : 1ft A.S.L.
(N.Z. Meteorological Service)

	1965	1966	1967	1968	1969	Mean
Jan	4.27	3.19	1.90	3.47	4.46	3.56
Feb	5.41	3.46	2.33	3.69	1.47	3.81
Mar	2.05	1.26	2.36	4.72	5.00	4.26
Apr	4.24	5.29	5.88	4.61	4.37	3.76
May	4.39	2.81	4.99	3.17	3.12	3.70
Jun	7.93	5.28	1.98	3.22	4.67	3.85
Jul	2.98	2.42	1.98	3.78	2.01	2.76
Aug	1.88	1.19	4.03	1.18	2.57	3.04
Sep	3.00	1.05	2.22	5.17	2.32	3.26
Oct	4.88	1.65	3.55	4.27	5.40	3.37
Nov	2.70	3.90	4.46	3.75	1.45	3.57
Dec	5.01	2.96	4.48	1.98	5.23	3.62
Totals	48.74	34.46	40.18	42.99	42.34	42.56

Average annual rainfall : 42.56

TOTAL RAINFALL

	1965	1966	1967	1968	1969	Mean
Jul/Oct	12.74	6.31	11.78	14.40	12.30	12.43

Both sexes have spurs protruding from the carpometacarpus, close to the carpal joint (see Fig. 7). Length and shape of spurs varied and consideration was given to the possibility that this variation could be related to sex difference. The spurs of twenty-two breeding adults were measured. Of these eight were known fmales and five

were known males. Six other birds were from three breeding pairs and therefore of opposite sex, and the remaining three were birds of unknown sex. The age of the birds was not considered. Length, width and thickness of each spur were measured, using vernier calipers. Two birds (males) were measured on two different occasions, and showed variations in measurements, as could be expected considering the deciduous nature of the keratinised epithelium of the spur. These measurements were:

Bird	Date	Left Spur	Right Spur
No. 224	7/9/68	18.7 x 5.7 x 3.4	17.5 x 5.8 x 2.9 mm
	30/9/70	17.7 x 5.5 x 2.9	18.1 x 5.5 x 2.8 mm
No. 265	5/10/68	15.4 x 5.4 x 3.1	15.3 x 5.6 x 2.9 mm
	1/11/70	15.2 x 5.7 x 3.2	14.5 x 5.9 x 2.9 mm

TABLE 2

SPUR MEASUREMENTS

Size of sample	Length	Width	Thickness
16			
FEMALES			
Minimum	13.4	4.9	2.9
Maximum	19.3	6.2	3.4
Mean	15.9	5.3	2.9
Median	15.0	5.3	2.9
14			
MALES			
Minimum	13.7	4.4	2.0
Maximum	18.9	5.7	3.4
Mean	15.8	5.5	2.9
Median	15.4	5.6	2.9

In two of the three pairs of unknown sex there was a marked difference in spur lengths and first indications were that this may be a reliable method of determining sex. However, in another pair the lengths (14.8 mm and 15.3 mm in one bird and 14.2 mm and 14.2 mm in the other) were very similar.

While the male measurements were usually the larger, there were two examples where the females' spurs were considerably longer than the males (19.3 mm and 19.1 mm compared with the male's 13.7 mm and 13.7 mm; and 19.1 mm and 18.1 mm compared with the male's 15.4 mm and 15.3 mm). In the small sample measured, these two females have influenced the mean figures. For this reason the median figures in Table 2 demonstrate the findings rather better than do the mean. The results were inconclusive.

3. RESULTS

3.1 *Nest areas:*

Farm animals (sheep, cattle, horses and pigs) and regular human movement influenced the choice of nesting area. Nest records strongly indicated that the birds preferred a nesting area wheree there were no animals. In only 31 of 222 nests where the full early history of the nest was known did nesting start in an area accessible to farm animals. On 29 of these 31 occasions only a very few animals (maximum 13, minimum 1) were on or had access to the chosen nesting area. A sample of 126 paddocks in the study block had a total acreage of 2110 acres (853.9 hectares). Maximum paddock size was 47 acres (19 ha), minimum 2½ acres (1.01 ha), and average paddock size 16.7 acres (6.7 ha). No nests were recorded on the Otatara Golf Links which are contained in the study area. Suitable nest sites were available here but human movement was considerable. No nests were recorded on the Invercargill airfield during the study period, but there was one earlier report of a nest on the uneven edge of the sealed runway. Pedestrian movement on the airfield is small but regular movement by vehicles, especially aircraft, is considerable. Regular vehicle movement did not appear to be a limiting factor in nest site selection in other parts of the study area. Closely mown grass with no surface irregularities was the probable reason for no nesting on the airfield.

The type of land used for nesting is shown in Table 3 (see also Fig. 4).

With one exception nests were in an open position which provided the incubating bird with an uninterrupted view in all directions. The exception was placed between two small tussocks *(Poa triodioides)*. Nests were usually placed where some roughness of ground or vegetation provided camouflage. Patches of dead *Carex cominata,* dead thistles and tufts of dead pasture grasses were favourite nest sites. Nests were frequently placed on small raised mounds,

TABLE 3

TYPE OF NEST AREA

Type	Total	%
Good pasture	78	25.32
Rough pasture	129	41.88
Old turnip and choumoellier	44	14.29
Old grain stubble	12	3.90
Gravel pits	5	1.62
Young grain crop	6	1.95
Reclaimed land	2	.65
Rough cultivated land	32	10.39
Total	308	100.00

NOTE : The total of 308 includes 15 nests which were of value for nest area selection purposes only and from which no other data were obtained.

especially in areas where the ground was generally wet. Nests in good pasture were more conspicuous but here too full use was made of any surface irregularities. The practice of mowing rushes *(Juncus polyanthemos)* which often grow in damp pasture in the area helped to create additional suitable nesting areas. The birds quickly occupied such areas soon after rush mowing, using the cut off rush crown as a nest site.

The distance of nests from wet areas is recorded in Table 4. A wet area near the nest site provided newly hatched chicks with a suitable feeding area. Nevertheless it is not considered to be an essential factor. Even very young chicks showed considerable mobility. A single chick from nest M/2/67 travelled half a mile from the nest within three days of hatching. Three nest sites on dry stony ground in Central Otago in 1969 were at least quarter of a mile from the nearest water, which was an irrigation race.

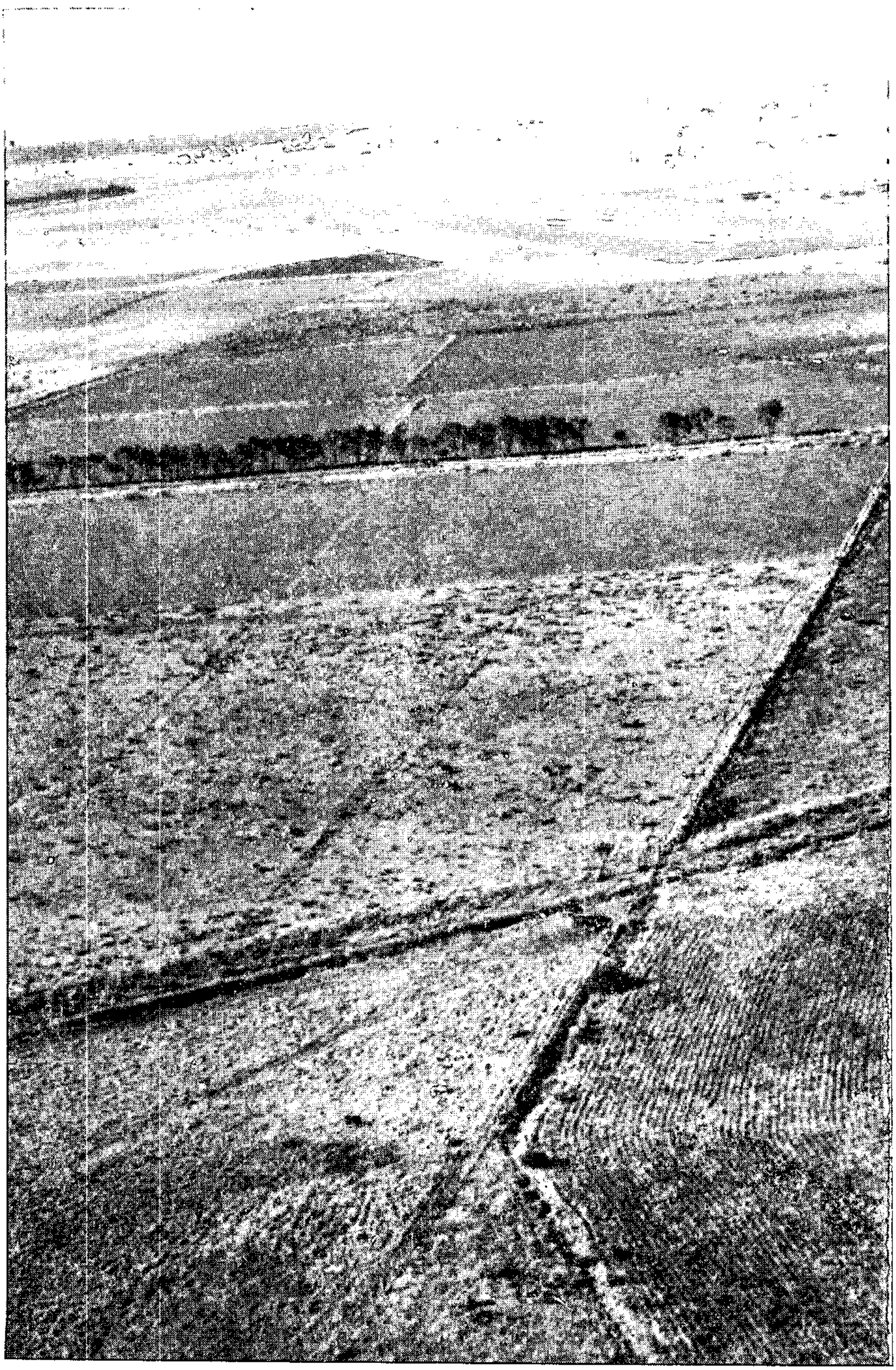


FIGURE 4: Typical Spur-winged Plover habitat. Rough pasture and old crop ground in the foreground and developed pasture beyond. In the right background are the buildings of the Invercargill Airport and beyond them the city.

TABLE 4

NEST DISTANCE FROM WET AREA

Yards	1965	1966	1967	1968	1969	All Years	%
0 - 10	20	19	28	31	27	127	40.58
11 - 20	3	3	5	8	2	21	6.82
21 - 50	13	11	16	12	11	63	20.46
Over 50	14	9	10	20	8	61	19.80
Not wet	5	9	18	2	4	38	12.34
Totals	55	51	77	73	52	308	100.00

3.2 *Copulation-egglaying time relationship:*

Copulation was observed in different pairs as follows:

14, 13 and 9 days before first egg laid
8 and 7 „ „ „ „ „
8 „ „ „ „ „
7 „ „ „ „ „
4 „ „ „ „ „
2 „ „ „ „ „
1 day after first egg laid, but before incubation started. (The only record of copulation after egg-laying, except following a lost nest.)

3.3 *Nestbuilding-egglaying time relationship:*

Nestbuilding was observed in different pairs as follows:

12 days before first egg laid
9 „ „ „ „ „
7 „ „ „ „ „
5 „ „ „ „ „

3.4 *Nest building:*

The birds adopted a typical attitude when shaping the nest. They leaned forward on bent legs with tail tilted well upwards and breast pressed into the nest cup. This was done with a shuffling circular movement. Both male and female shared nest building. Most nests were lined with dead grass, thistle stalks, dead carex leaves, carex roots or some other similar naterial found near the nest site. Nests on sites such as old turnip ground where no such material was available remained unlined throughout incubation. Two exceptions were nests S/40/68 and B/6/69, which were lined with

material not available near the nest site, the first with pieces of bark and other residue from a pine plantation some 250 yards (220 m) away, and the second with small twigs and pine needles which were unlikely to have been collected closer than 25 yards (22 m) from the nest. Birds were never seen carrying nesting material but it is apparent that this probably happened in these instances. The usual procedure was that both birds would toss nesting material towards the nest from any direction within about a six foot (1.8 m) radius of the nest. This material was then gathered and placed in the nest by either of the pair while sitting or standing on the nest site. Nest building continued in some cases during the first week of the incubation period. Trial nests, in which eggs were never laid, were sometimes found. These were usually close to the final nest site.

Nest sanitation was of a high order. Droppings in or near the nest were found only at the few nests which the birds themselves had destroyed. Eggshells were removed in sequence as each egg hatched, and were frequently found jettisonned in water at varying distances from the nest.

3.5 *Breeding territories:*

The size of apparent breeding territories was considered, but this matter appears to be extremely complex and is not fully understood. Distances between nests were usually considerable, but exceptions were recorded, the best examples being nests S/13/66 and S/14/66 which were only 22 yards (20 m) apart and were both being incubated at the same time. Fig. 5 shows the areas within

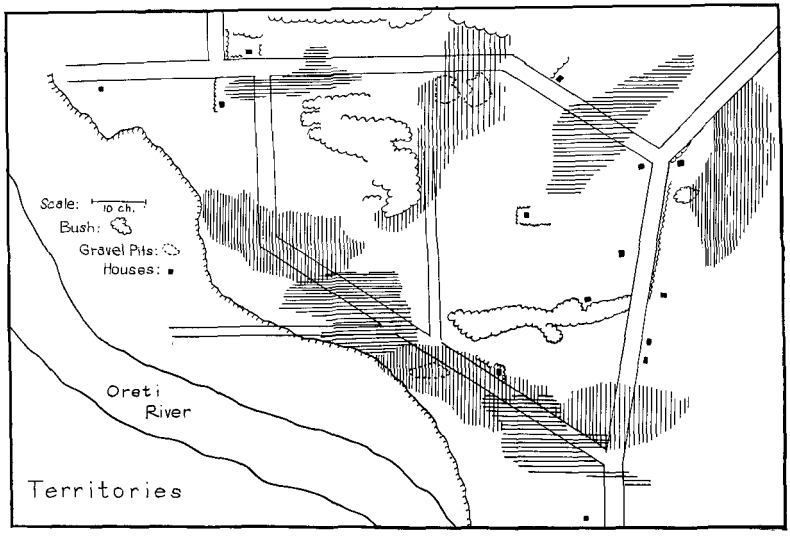


FIGURE 5: Areas, pairs and territory of Spur-winged Plovers.

which nine marked pairs of birds were always found, and outside which they were never found, during the months from June to November. Areas varied from 21 to 48 acres (8.4 to 19.4 ha). The average size was 36 acres (14.5 ha). Some territories appeared to overlap slightly. There were gaps of 100 acres (40.47 ha) or more between some territories, but this was largely due to other factors involved in nest area selection. Aggressive behaviour between birds of neighbouring territories was never observed.

3.6 *Clutch size:*

The 206 clutches listed in Table 5 were certainly complete because they were watched regularly during the laying period or they contained four eggs which, with two exceptions, was the maximum number recorded for any clutch. The only five-egg clutch had one abnormally small egg (42.1 x 31.1 mm) which did not hatch. A nest found in 1967 was unusual in containing six eggs and in having three adult birds in attendance; these eggs, perhaps laid by more than one female, are excluded from Table 5.

TABLE 5

CLUTCH SIZE

Year	1 egg	2 eggs	3 eggs	4 eggs	5 eggs	Mean
1965	(2)	(7)	13 (7)	24		3.65
1966	(1)	1 (4)	5 (15)	32		3.81
1967	1 (2)	2 (13)	8 (23)	34		3.66
1968	(5)	1 (11)	5 (14)	37		3.83
1969	1 (2)	1 (6)	5 (6)	35	1	3.79
All years	2 (12)	5 (41)	36 (65)	162	1	3.74

NOTE : Figures in brackets represent clutches discarded because? incomplete (see text).

Some other clutches, with less than four eggs, are shown in brackets in Table 5. They were found after laying had finished and an egg or two could have been lost before the nest was found. It is unlikely, however, that eggs were lost from all these clutches so the figures in Table 5 for the mean number of eggs per clutch are probably a little too high.

In Tasmania, Thomas (1969) found mean clutch sizes of 3.57, 3.47 and 3.62 over three years, and stated that these values " slightly underestimate true clutch size because eggs may have been lost before some nests were found." No importance can be attached

to the small differences between the New Zealand and Tasmanian figures because different criteria were used in defining a full clutch.

The nests in Table 5 are not all first clutches. Some are known to be re-layings, and others may be re-layings. Size difference between first and subsequent clutches is not considered significant, see Table 6.

TABLE 6 CLUTCH SIZES

1ST AND 2ND LAYING

Size of Sample : 10

1st Clutch	2nd Clutch
2	3
3	3
3	2
2	2
4	4
3	3
2	4
4	4
4	4
4	4

In Southland the clutch size seemed unaffected by rainfall during the breeding season. Although 1966 was a very dry season with only 6.31 inches (160.27 mm) of rain between July and October (see Table 1) and 1968 a wet one (14.40 in; 365.76 mm) the mean clutch size was almost identical in the two years, 3.81 and 3.83 (see Table 5).

3.7 *Behaviour of incubating birds:*

The behaviour of incubating birds was studied by occasional day-long observation of a few well placed nests. These nests, belonging to banded birds of known sex, were in places free from disturbance by passers by, and they could be watched from a parked vehicle distant enough for changeover of vehicle to have no effect on the birds. The results are shown in Fig. 6.

Vigils 1 and 2 show the same nest at different stages of incubation. In Vigil 3 the near monopoly of incubation by the female seems unusual. With many other pairs, observed less intensively, the female seemed to be the off duty bird as frequently as the male (Fig. 7).

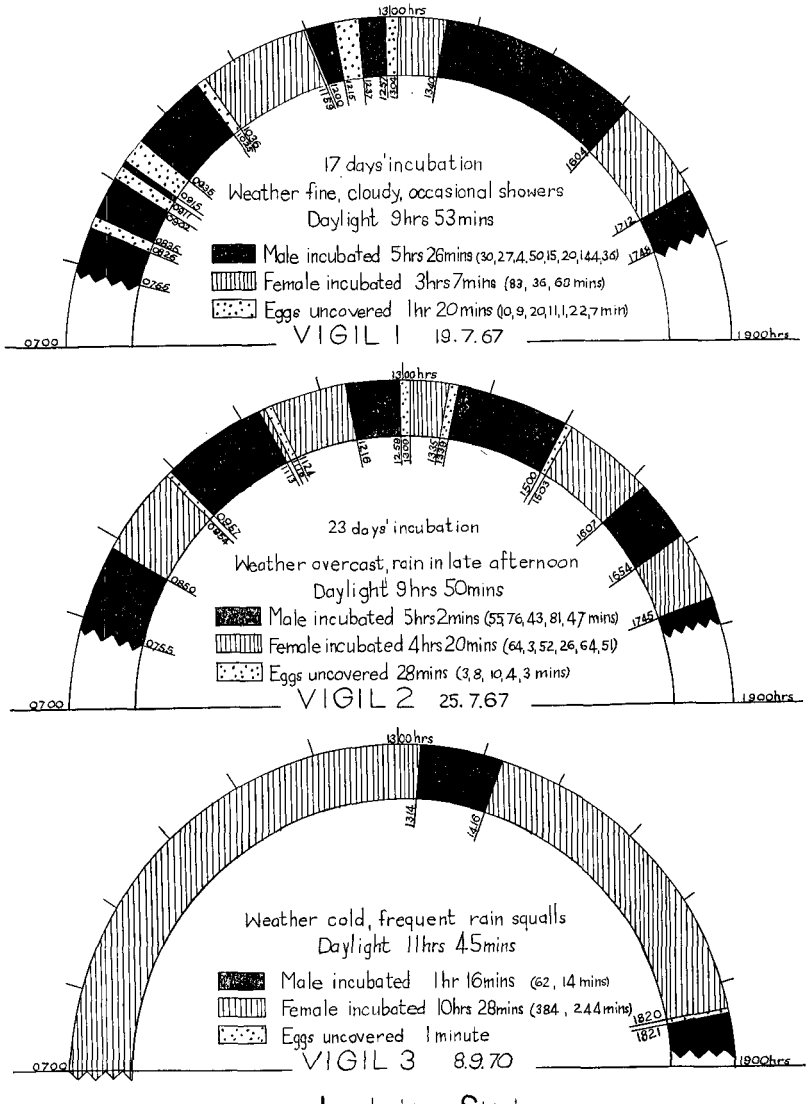


FIGURE 6: Incubation stints.

Nests were watched before nightfall on nine occasions, and each time the male took over just before dark. Moreover, early on frosty mornings incubating birds had frost on their backs indicating that they had been sitting for some considerable time (cf. also Fig. 14).

On the few occasions when the sex of the bird was known, it was always the male. These observations suggest that although incubation is shared between the sexes by day the male may incubate all night.

On several occasions birds were seen using the bill to turn their eggs, and sometimes the toes may have been used too. Numbered eggs changed position from one visit to another and the small egg in the five-egg clutch was in a different position in the nest on three out of four visits. These observations conflict with those of Thomas (1969) who wrote " the eggs normally assume a fixed position in the nest."

The problem of shading eggs from excessive heat observed in African Plovers by Hall (1964) and Little (1967) does not arise in Southland.

FIGURE 7: Adult Spur-winged Plover about to settle on nest. Note how the spurs protrude when the bird is in this attitude.
Photo: R. R. Sutton

3.8 *Egg dimensions:*

Sixty eggs were measured in millimetres with vernier calipers:

	Length (mm)	*Width* (mm)
Maximum	54.8	37.6
Minimum	45.7	33.0
Mean	49.4 ± 2.0	35.3 ± 1.0

The abnormally small egg mentioned above measured 42.1 mm x 31.1 mm and was not included in the calculations.

3.9 *Dates of laying:*

The number of clutches started each week in the five years 1965-69 is shown in Fig. 8. In all cases laying date was known either by field observation or by back-calculating from hatching date. Lack of observer efficiency in nest-finding in 1965 is a variable which may be reflected in the figures.

Peak laying occurs in August.

Some nests in Fig. 6 are known to be re-layings, and others may be re-layings. These undoubtedly cause the second surge of laying in most years.

3.10 *Re-nesting:*

Re-nesting following nest or brood loss often occurred. Proof was obtained on 24 occasions. Of these cases, 5 are excluded from the sample as the time lapses between sightings were such that interim nesting attempts may have been made. Of the remaining 19, 3 were cases of re-nesting after brood loss and the other 16 after nest loss. All time-lapses quoted are absolute maximum periods.

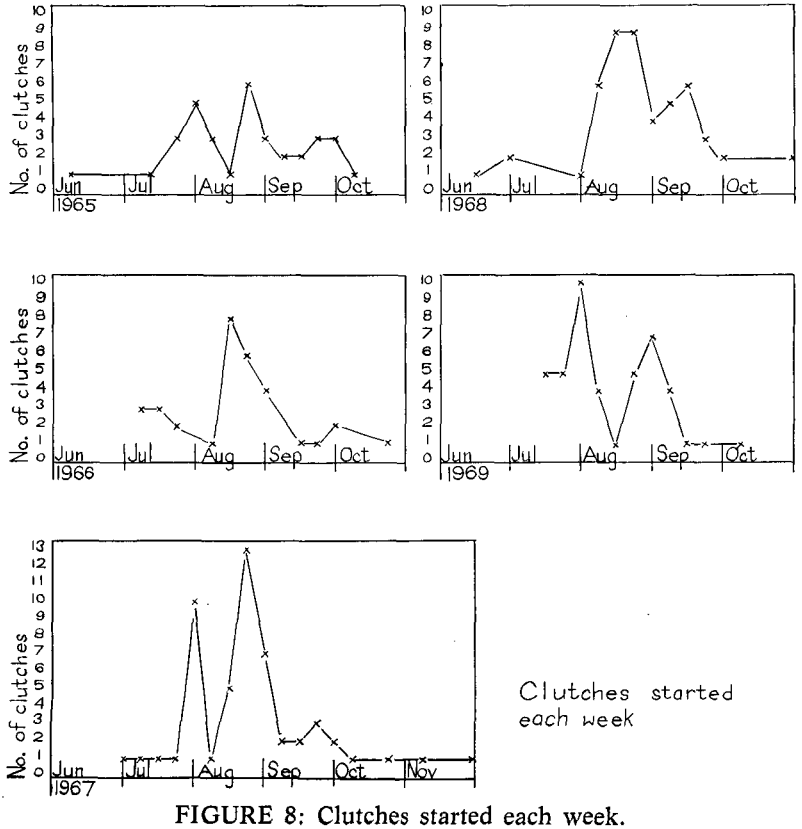


FIGURE 8: Clutches started each week.

After nest loss: In 16 cases, time lapse between loss of nest and start of second clutch ranged from 6 days to 28 days, mean period being 16 days, median 13, and mode 10 days. The mode occurred 4 times out of the 16.

After brood loss: Time lapses until start of second clutch were 19, 21 and 21 days.

In two cases at least three nesting attempts were made. The first of these produced a nest in which close interest was maintained for seven weeks but no eggs laid, a second nest with a 3-egg clutch (deserted), and a third nest with a 3-egg clutch (ploughed in). The second example produced three 3-egg clutches, the first predated, the second deserted, and with the third the eggs disappeared.

Location of subsequent nests in relation to the first varied from 20 yards to 800 yards.

Loose eggs lying about the study area were found once only, in association with a 4-egg nest which eventually hatched.

3.11 *Discussion of " breeding condition ":*

Consideration must be given to the " breeding " condition of the birds. The longer time lapse in cases of re-nesting after brood loss supports the supposition that gonad regression would be more advanced in these birds than in birds re-nesting after nest loss at an early stage of incubation. Evidence on this point is scanty, again because of the difficulty in finding nests before the clutch was complete. In the cases of lost first nests there could of course be no back-checking from hatch date. Factors other than gonad regression undoubtedly influenced the time lapse; e.g. in one instance there was a time lapse of 19 days when the first nest had been under incubation for only 4 days (i.e. 4 days since clutch completion). The male was a 2-year-old bird, banded as a chick, constantly seen since then, known to be in its first breeding season, and never a very " tolerant " bird. Inexperience could have been a factor here. In cases of nest loss due to farming activity the finding of a suitable new nesting area was probably an important factor.

3.12 *Incubation period:*

It has been impossible to determine exactly when incubation begins. Some birds would sit on the nest from the time of the laying of the second egg in a 4-egg clutch, but whether the bird was actually incubating was not known. Some birds with an incomplete clutch would leave the nest unattended throughout the day, except for an occasional visit to " look at " the egg(s). The laying time of the last egg in the clutch has been regarded as the starting time of incubation.

From 1967 attempts were made to number eggs in order of laying, using a felt-tipped pen. The aim was to assess incubation period, and to compare laying order with hatching order. Finding nests before incubation had started was difficult, but with increased

TABLE 7 INCUBATION PERIOD

Nest No.	Found	Number of eggs	Notes	Hatched	Incubation period
M.4/65	14/8/65	4			30-31 days
B.5/65	19/8/65	4			31-32 days
S.26/65	18/9/65	3	4th egg laid say 18/9/65	completed evening 19/10/65	Not less than 31 days
B.4/68	7/8/66	1	2 eggs hatched on 8/9/66		
	10/8/66	3rd egg laid between 0830 -1315 hr	1 egg hatched between 1600 hr 9/9/66 and 1100 hr 10/9/66		31 days from laying of 3rd egg
B.10/66	23/8/66	1			
	26/8/66	1645 hr 3			
	27/8/66	0730 hr 4	Frosty, cold; bird in adjoining paddock; did not go to nest.		
		0930 hr	Sunny, cold; bird not on nest.		
			28/8/66 0830 hr) 1050 hr) 1530 hr) bird incubating		
			26/9/66 1130 hr 2 hatched	1815 hr 3 hatched	
			27/9/66 0800 hr 3 hatched	1315 hr 4 hatched	29-30 days
B.9/67	Latest time laid:		Earliest time hatched:		
	Egg No 1 : 0800 hr 19/8/67		0800 hr 19/9/67 = Minimum 31 d after laying		
	Egg No 2 : 0800 hr 19/8/67		1500 hr 19/9/67 = " 31 d 7 hr " "		
	But a further egg was laid after these two, therefore incubation may not have begun until say, 20/8/67, which would reduce incubation time approximately 30 days				
B.11/67	Egg 1 laid before 1000 hr 19/8/67		Hatched between 1800 22/9 - 0925 23/9		
	" 2 " " 1430 hr 21/8/67		" " 0800 - 1215 22/9/67		
	" 3 " after 1430 hr 21/8/67		" " 0800 - 1215 22/9/67		
	No 1 hatched 34 + days after laying				
	No 2 " 32 + " " "				
	No 3 " 30½ " " "				30½ days
B.14/67	Egg 1 laid before 20/8/67		Hatched before 1800 hr 19/9/67) At least		
	" 2 " " 20/8/67		" 0800-1530 hr 19/9/67) 30 days		
	" 3 Earliest		Latest		
	Laid 1200 hr 20/8/67		1500 hr 21/8/67		
	Hatch 0600 hr 20/9/67		0700 hr 20/9/67		
	Therefore maximum incubation period Egg 3 - 30 days 19 hours				
	minimum " " " 3 - 29 days 15 hours				
S.1/69	Egg 4 Laid before 1430 hrs 12/7/69				
	Hatched and chick just dry 1145 hrs 12/8/69				
	Incubation period 30 days 21¾ hrs.				

SUMMARY : Minimum proved incubation period was 29 days 15 hrs.
Usual incubation period 30/31 days.

understanding of the birds' behaviour some results were obtained. Disturbance of the birds in the egg-laying or early incubation period would often be followed by desertion of the nest. On two occasions disturbed birds were seen trampling nests with their feet and using both feet and bill in breaking (and eating) the eggs. Eggs were marked only up to the end of August, so that any pair which " lost "

its nest as a result of this interference would have time to renest successfully in the same season. Egg-marking was carried out with circumspection, when the birds were well away from the nest. This could mean a long vigil, as often as three times per day over a period of several days. This section of the study could not have been accomplished without close team-work. The sample is small, but definite data were obtained.

Using criteria as detailed, the incubation period for the species in Southland is thirty to thirty-one days.

There were two instances of excessive incubation of 50 days, and one each of 55, 56, 57, 59 and 62 days. All eggs contained early dead embryos. This evidence suggests that the fact that eggs are not viable is not a reason for desertion.

Renesting following excessive incubation was not observed.

3.13 *Laying pattern compared with hatching pattern:*

Variable hatch weights and size of chicks was a noticeable feature. Most broods would contain at least one weakling. Spread of the clutch was known to extend over several days. Start of incubation was unproven. There was variation in the time birds began to cover the eggs.

The hatching process was variable. In some cases a 4-clutch would hatch in a few hours from first to fourth chick (minimum recorded six hours); in others hatching would extend over a longer period (maximum recorded thirty-six hours — actual interval between emergence of first and last chick).

An attempt was made to determine whether laying order and possible incubation time had an effect on hatching order and hatch weights. Results were difficult to obtain for several reasons: the difficulty of nest-finding at the pre-egg stage; interference at egg-laying stage appeared to promote desertion and possibly increased the chance of predation; interference at hatching time had to be minimal, as more than one visit to a hatching brood could result in the adults moving off with the chicks and deserting the unhatched or partially hatched eggs.

The following results were obtained:

Nest B.11/67: 3-egg: Nos. 2 & 3 hatched before No. 1.
No. 1 hatched 34+ days after laying.
2 hatched 32+ days after laying.
3 hatched 30½ days after laying.
No. 1 chick (first egg laid, last to hatch) was the weakling.

Nest B.14/67: 3-egg: 1st and 2nd laid eggs hatched first.
3rd egg hatched last.
3rd chick (last to hatch, last egg laid) was the weakling.

Nest S.3/67: 4th egg only marked in each case, and in each case
Nest S.36/67: this was the last to hatch.

Results are inconclusive.

Although the actual hatching may be near to simultaneous, the progress of the hatch can vary.

Nest B.16/68: A 4-egg nest, discovered incubating 1 September 1968. Hatch details:

Oct. 1 3 p.m. 1 pipped; 1 starred; 2 entire.
2 2 p.m. No progress.
3 4.30 p.m. 1 pipped+++; 2 pipped++; 1 entire.
4 1.30 p.m. 1 chick 1 foot from nest
1 chick dry in nest
1 chick damp in nest
1 egg entire.

The fourth egg contained an early dead embryo.

3.14 *Double brood:*

In 1967 a banded pair produced two broods. The second clutch was laid at the time when the single surviving chick of the first brood fledged. This juvenile remained under the protection of the non-incubating adult until the second clutch hatched, when the first juvenile (then aged 11 weeks) disappeared. One juvenile was reared to fledging stage from the second brood.

In 1966 this pair had two nests, a 4- and a probable 3-clutch, both of which were lost, presumably to predators. The female was not banded at this time, and it can only be assumed that she was the same bird (see later notes on Pair-bond in Section 3.22).

In 1968 the pair bred again, a single brood from which one juvenile was reared to fledging age at least.

3.15 *Hatching:*

Earliest known hatch-date in each year
2/7/65 2/8/66 26/7/67 12/7/68 9/8/69.
Latest known hatch-date in each year
7/11/65 29/10/66 24/12/67 28/11/68 1/11/69.
Hatch success is shown in Table 8.

TABLE 8

HATCH SUCCESS

Year	Total fully incubated nests	Total eggs	Eggs hatched	% hatch
1965	28	94	71	75.53
1966	21	75	60	80.00
1967	34	109	83	76.15
1968	42	143	94	65.73
1969	33	121	93	76.86
All years	158	542	401	73.99

Where possible eggs which failed to hatch were examined. Criteria used were those adopted by the Imperical Chemical Industries Game Research Station (see " Literature Cited ").

Of 141 eggs which failed to hatch, 15 (10.64%) were infertile. When the total number of eggs (542) is considered, the infertility figure is 2.76%.

3.16 *Nest success and causes of nest loss:*

A successful nest is defined as one which, after the full incubation period, produced live chicks.

TABLE 9

UNMATCHED EGGS

	1965	1966	1967	1968	1969	All years	%
Infertile	2	3	4	1	5	15	10.64
Early dead embryo	11	8	10	27	15	71	50.35
Dead in shell	3	1	4	8	0	16	11.35
Cracked	4	3	1	3	3	14	9.93
Missing or unknown	3	0	7	10	5	25	17 73
Totals	23	15	26	49	28	141	100 00

TABLE 10

NEST SUCCESS

Year	Total nests	Successful	% success
1965	55	25	45.45
1966	45	20	44.44
1967	73	33	45.21
1968	70	35	50.00
1969	50	33	66.00
All years	293	146	49.83

Uniformity: When considering the figures shown in Table 10, the question of uniformity of observer efficiency must also be examined. The amount of observer time expended in each of the five years is considered to have been uniform with the exception of 1969, when less time was spent in the field. The possibility of failure to find

unsuccessful nests could be reflected in the higher than usual nest success percentage shown for 1969. This is unlikely, as the lesser amount of observer time is compensated for by the fact that experience gained in the previous years made it possible to obtain a similar result with less expenditure of observation time. Any unevenness in data collection is more likely to have occurred in 1965 when observation techniques were being developed.

The causes of loss in the 30 cases recorded as "Unknown" in Table 11 will be covered by one of the other causes listed in that table, and probably in a similar ratio to the figures shown.

TABLE 11

CAUSES OF NEST LOSS

Cause	Number lost	%
Land usage	25	17.01
Farm animals	27	18.37
Predation	12	8.16
Poor hatchability	12	8.16
Egg disappearance	20	13.61
Human interference	9	6.12
Bird interference	9	6.12
Flooding	3	2.04
Unknown	30	20.41
Total	147	100.00

Land usage and farm animals: These are major factors in nest loss (35.38% of total). "Land usage" includes such activities as cultivation, fertilizer spreading, bulldozing and ditch excavation. Where farm animals were moved into a nesting area the nest and eggs were frequently trampled and destroyed. Animals responsible were sheep (25 times), cattle (once) and horses (once). Concentrations of non-breeding sheep in particular had a habit of congregating around the incubating bird and eventually trampling the nest. Only 2 nests were known to survive in the presence of a concentration of sheep. Cattle appeared equally inquisitive but were much less prone to trampling the nest. This was well demonstrated with Nest S/25/67, where dairy cows spent considerable time nosing the incubating bird but did not trample the nest. A cow calved within 20 yards of the ultimately successful Nest S/10/68.

In the presence of farm animals 22 nests were successful: sheep 9, cattle 9, horses 3 and pigs 1. These figures indicate a higher rate of nest success in the presence of farm animals than is really the case. In all but 6 of the 22 cases animals were present in very small numbers. In 4 of these 6 cases the stocking rate was low in relation to paddock size, with stock numbers ranging from 188 to 120 in paddocks ranging from 47 acres (19 ha) to 33 acres (13.3 ha) in area. The other two held 36 and 22 animals on 9 acres (3.6 ha) and 5½ acres (2.2 ha) respectively. Further, nests were frequently situated in a rough semi-grazeable part of the area which animals were less inclined to frequent.

In the presence of farm animals (sheep 15, cattle 11 and horses 5), 31 nests were built. These figures would indicate that the birds preferred the company of sheep, cattle and horses in that order, but in fact this was not the case. Sheep were the predominant animal in the area, cattle were present in moderate numbers and horses were few. The chances of birds nesting in the presence of sheep were therefore much greater.

Cultivation and the movement of farm animals suited the species' breeding habits, and influenced both the choice of nesting area and the overall breeding success. In the study area it was normal farm management to have almost all the sheep and cattle concentrated in a small area, being fed on turnips, hay and choumoellier during the winter period from mid-May to mid-August. Most the paddocks were unoccupied by farm animals during this period, thus providing early nesting birds with a wide choice of nesting areas. In mid-August, sheep were moved from winter feeding quarters on to kept pasture in the unoccupied paddocks. Grazed-off turnip and choumoellier ground was then left vacant until mid-October when drier weather permitted cultivation of this ground. As can be seen from Fig. 8, this mid-August animal movement clashed to some extent with peak nesting. The vacant turnip and choumoellier ground was used to some extent for re-nesting, and sufficient time was usually available for full incubation to be completed before cultivation began. By comparison, South Island Pied Oystercatchers *(Haematopus ostralegus finschi)*, which also nest on farm land in Southland, are generally less successful. This species, which starts egg-laying in early September, commonly nests on old turnip and choumoellier ground. Although little information is available, observations suggest that the rate of nest loss with Pied Oystercatchers is much greater than with Spur-winged Plovers, because the generally later nesting period clashes with cultivation.

Predation: The 12 losses are likely to be conservative and can probably be supplemented by a number of the 20 cases listed under "Egg disappearance." Predators were not definitely identified. The main suspects were Pukeko *(Porphyrio melanotus)*, rats *(Rattus norvegicus)* and stoats *(Mustela erminea)*. The predatory habits of the last-named are consistent with egg disappearance. Hedgehogs *(Erinaceus*

europaeus) were present in the area but were disregarded as predators for two reasons: (a) the complete disappearance of eggs from the nest is inconsistent with the hedgehog's method of attack. It usually eats eggs on the spot and makes a mess of the nest in the process. This was not observed. (b) Hedgehogs do not come out of hibernation in Southland until late August, by which time the nesting season is well advanced.

Poor Hatchability: These 12 nests were the subject of excessive incubation. The reasons for poor hatchability are unknown.

Interference: Destruction of nest and eggs by the birds themselves is covered under "Bird interference." The 9 cases of "Human interference" were largely inadvertent. Nest trapping was responsible for some, and other activities such as fence construction near the nest site for the remainder.

Flooding: The 3 instances occurred in July 1968, when unusually high rainfall was recorded (3.78 inches; 96 mm) (see Table 1). Average July rainfall is 2.76 inches (70 mm). Because of the uniform monthly rainfall damaging fluctuations in water levels were rare. Many nests were situated in very wet areas.

Unknown: Each year some nests were deserted early in the incubation period for causes which this study has not uncovered. The eggs in many such nests were found to contain early dead embryos. It is tempting to hypothesize that the birds were by some means aware that the eggs were not viable, and that this could have been a reason for desertion, but this is disproved by the evidence of excessive incubation previously documented.

3.17 *Chick survival:*

Despite the genuine and regular attempts made to follow the fortunes of all broods hatched, the "No data" figures in Table 12 show that many chicks were not found. The figures show the high mortality rate within the first fourteen days (90 from a total of 401 = 22.44%). In addition many, and probably most, of the 169 chicks in the "No data" column must have died. The true mortality rate in the first fourteen days is probably nearer 55%.

Of the 142 known to have survived the first fourteen days it will be seen that 70 are known to have fledged. This represents 17.45% of the chicks hatched, and 49.3% of the chicks known to have survived the first fourteen days. The "No further data" figure of 64 will include a large number of birds which did fledge. The true survival rate is probably nearer 25% of chicks hatched.

While the chicks were under a week old the adults spent a considerable time brooding them, particularly if temperatures were low. Chicks would still be brooded at times when they were two weeks old. During this early period the adults were assiduous and vociferous in driving off predators, particularly Harriers *(Circus approximans)*. These two activities of brooding and Harrier-chasing

were of great assistance to us in locating young broods. As chicks grew behaviour patterns changed. The adults would often be hundreds of yards apart, and sometimes one would fly off altogether for a time. Adult behaviour would become more secretive, the birds tending to skulk low in the rushes and sedges. The chicks would crouch flat and immobile without the constant warning calls uttered by the adults when the chicks were younger. Harrier-chasing was less apparent. Chicks older than four or five weeks would often run before crouching. The combination of all these factors meant that finding of chicks older than fourteen days was not simple (Fig. 9). It is our belief that many of the birds which survived to fourteen days, but were not subsequently found, did in fact survive to fledging stage. This belief is supported by the fact that many of the 70 birds known to fledge were not seen from the time of banding until many weeks, sometimes months, and in two cases years later.

Broods from nests where the number hatched was known are listed in Table 12. It does not include all chicks banded.

3.18 *Hatch weights and chick growth rate:*

While some birds were more tolerant of approach and interference than others, the general pattern was that adults and young would move from the brooding area after interference and would be difficult to re-locate. Even without interference it often happened

FIGURE 9: Camouflage of unfledged chicks in relatively sparse escape cover was a factor in chick survival.

Photo: R. R. Sutton

TABLE 12

CHICK SURVIVAL

Year	No. hatched	Succumbed at less than 14 days	Survived to 14 days	No data	Of those surviving to 14 days: Known to fledge	Known to succumb	further data
1965	71	7	43	21	13	3	37
1966	60	8	18	34	8	2	8
1967	83	31	19	33	11	0	8
1968	94	25	31	38	18	1	12
1969	93	19	31	43	20	2	9
All years	401	90	142	169	70	8	64

that the birds moved from the original nesting/brooding area when the chicks were about two weeks old. There was frequently a further move when the young were about five to six weeks old. These moves were probaly dictated by the need for more cover as the chicks grew, although food needs may have been a factor. Thus, a brood would soon be moved from a nesting area with little more cover than cattle hoof-marks and one-inch high growth. But a similar area with an adjacent patch of *Carex sp.* and some patches of rushes may have been adequate habitat for a brood right through to fledging at eight weeks. Unsuitability of surrounding terrain was not a hindrance to movement. Broods were known to cross roads, ditches, gravel pits, heavily stocked paddocks, sizeable streams of running water, and even a fair-sized river (Waihopai River). (On 18/10/64 H. W. M. Hogg (1964) saw a 2-4 day old chick swim forty feet across the strongly flowing Taieri River and struggle up a sloping rock retaining wall six feet high.)

The following factors appeared to influence a move to a different area:

1. Stock movement.
2. Land usage.
3. Disturbance after a certain age — often two to three weeks, sometimes earlier; but some birds were more tolerant of disturbance than others.
4. When chicks five to six weeks old; better protective cover; more, possibly different, food.
5. Weather: the drying up of wet areas could cause the birds to move to the nearest suitable wet area.

TABLE 13

CHICK GROWTH RATE

Hatch wt (g)	1 day	2	14	15	16	17	18	19	21	24	34	35	44	52
20)			72											
22)			44											
20)												195		
20)											150			
20)		17†												
18)		16†												
18)	13†													
20)	19	20†												
20)	20	20†												
18)	19	†												
24)		24												
24)														
20)						56								
18)						†<								
22)						78								
22)						†<								
18)			52											
22)			56											
20)			60											
20)				49										
21)				59										
?)				45										
19)			64											
23)			77											
24)					65									
22)					58									
24)					64									
18)								73						
20)								80						
22							83							
22)					80									
24)					†<									
23)			51											
21)			49											
20									74					
20													218	
20)				48										225
20)			†<											
18			62											
?)					34					58				
?)										45				
?)										55				

KEY : † Died < Before

Hatch weights: 75 new-hatched chicks were weighed. " New-hatched " means chicks known to be less than twenty-four hours old.

Size of sample:	75
Minimum weight:	14 grams
Maximum weight:	26 grams
Mean weight:	20.5 grams.

Growth rate: While attempts were made to recapture rubber-banded chicks at fourteen days and thus standardise results, this was in fact achieved with only 10 birds. Other birds were recovered when older. The results are set out in Table 13 and Fig. 10.

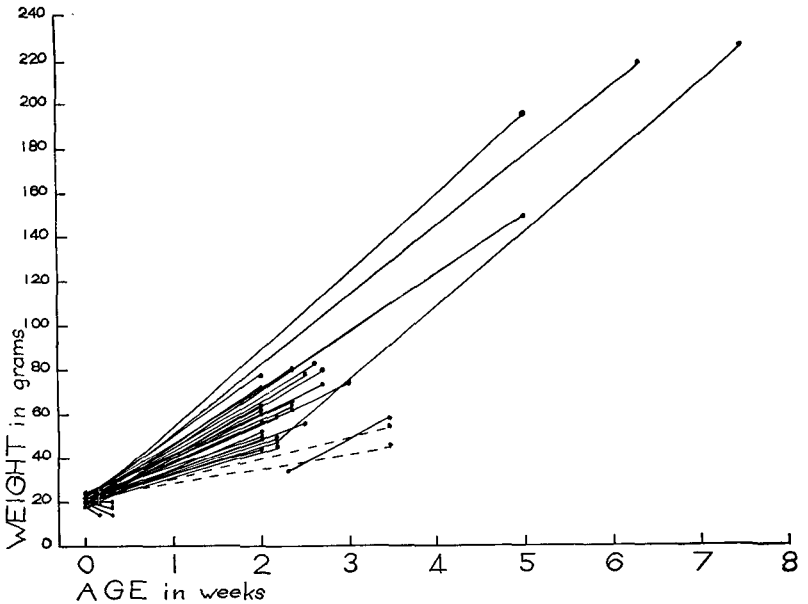


FIGURE 10: Chick growth rates.

The sample is too small to allow any firm conclusions to be drawn, but several points are raised by the figures. They reflect the variability in growth rate, which was observed in many more instances than those in which weights were obtained. Extremes of growth rate were not found to be caused by difference in habitat or apparent food supply. The usual pattern was to find variation within the brood. This is demonstrated in Table 13 where birds of the same brood are bracketed. It will be seen that while it was usual for chicks with the higher hatch-weight to make the greater growth-rate, this did not invariably happen.

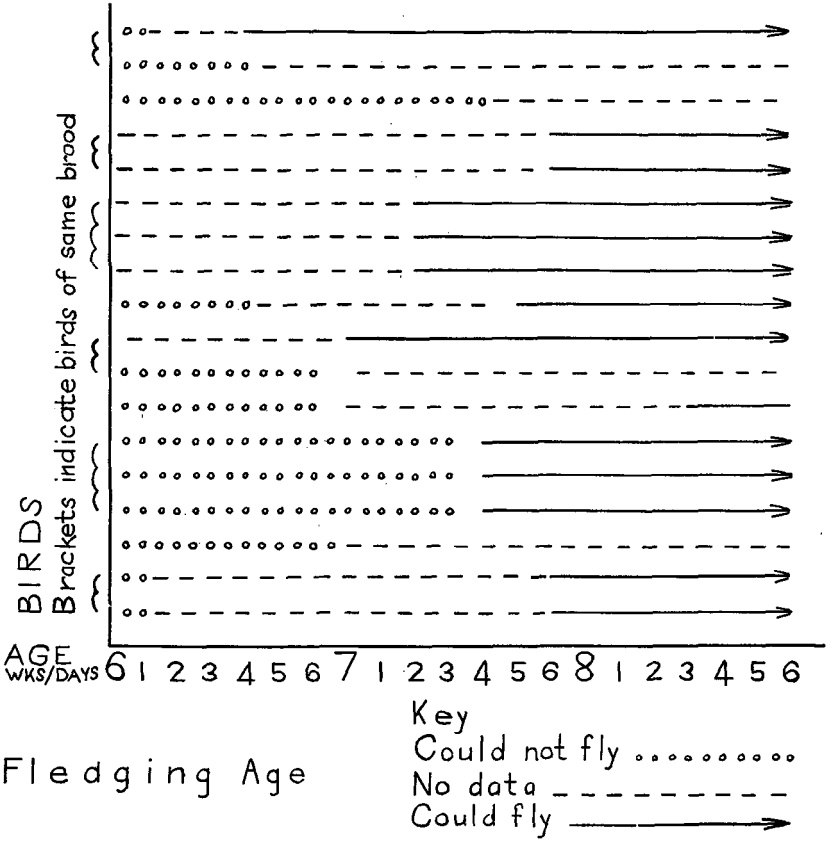


FIGURE 11: Fledging age.

Adult weights: Only 4 adult birds have been weighed. Two breeding males weighed 375 g and 400 g. A breeding pair (sex unknown) weighed 375 g and 390 g.

3.19 *Fledging age:*

Most birds could fly by the eighth week (Fig. 11). A field note on early flight reads: " Low floating flight, most gliding, with some wing-beats. One bird, when walking and feeding, flew a few feet over an obstructing log; when disturbed flew about 25 yards, rising to about 12 feet." No birds were seen in obvious practice flights, wing-beating or wing-exercise. Young birds would stretch a wing almost horizontally when preening, but so would adults.

3.20 *Post-fledging dependence:*

The species is nidifugous and the young often moved from the nest within an hour of hatching. Chicks less than 24 hours old were seen feeding, and when picked up had mud adhering to their bills.

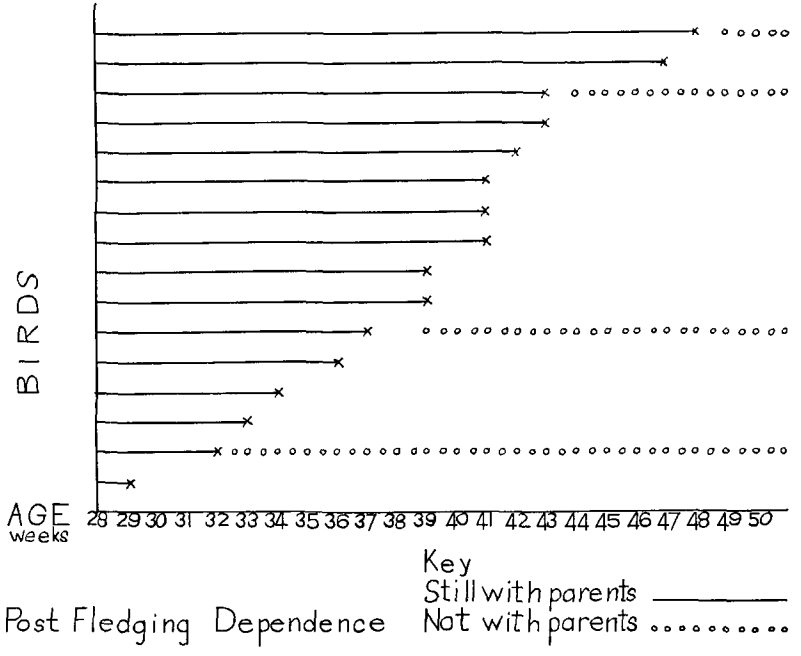


FIGURE 12: Post-fledging dependence.

Nevertheless they appeared to be closely dependent upon the parents for many months (Fig. 12). It was not until the fledglings were seven to eight months old that they began to mingle with other birds. Even at that age they were usually found with one or both parents. The parental behaviour was still protective with at least one adult on guard and alert and warning calls by the parent eliciting response from the young. The following extracts from field notes describe the position:

" 19/5/69; Family groups still mostly together, but juveniles briefly moving off and back again. Some communal flocking, but adults tending to remain on, or soon return to, usual territories."

" 9/6/69: Much haphazard group-forming and breaking-up, although many family groups still firmly together."

"2/7/70: Families together part of the time, juveniles moving away at times; parties of restless juveniles together. They settle and relax when with adults. Some adults copulating."

In Fig. 12, " Not with parents " means that the juvenile was never again seen with the parents, although the parents were seen frequently thereafter.

In summary, it is seen that the breeding cycle occupied the successful breeders for the greater part of the year. With some closely observed pairs the new season's breeding began within a week or two of the departure of the previous season's young.

3.2 *Breeding age:*

Breeding age is established by the following evidence from the field notes:

1. E23457 banded as chick approximately two weeks old 31 October 1964. Nest-trapped 18 October 1966 at its second nest for the season; first nest found 28 August 1966 and subsequently deserted. Rebanded with combination A.O/R (E61331). A female as seen in copulation (4 observations).
   Therefore a female can breed in its second year.
2. E61405 (O.A.) banded as a chick approximately two weeks old on 8 August 1965.
   1966: 12 sightings; twice with small flock, 3 times alone, 7 times with unbanded bird. Behaviour as pair, but copulation not seen, and frequency and intervals of sightings satisfied observer that these birds did not breed successfully in 1966. However the possibility of an unsuccessful nest for a short time cannot be dismissed.
   1967: Many sightings, same area, with unbanded bird.
   25 June 1967, seen in copulation; this bird the male; seen similarly several times 1967 and 1968. 27 July 1967, with nest, 3 eggs.
   Therefore a male can breed in its second year.
3. E61436 (-.W/A) banded as a two-week-old chick 24 October 1965.
   1 November 1966: One of a breeding pair, with two chicks; clap-trapped and bands examined; incubation of its eggs must have started at least 1 October 1966.
   7 June 1971: A female as seen in copulation.
   Therefore it is possible for a female to breed at the end of its first year.
4. E61561 (A/B.R/B) hatched c. 7 September 1966, banded 22 September 1966. Seen (a male) copulating with unbanded bird on 30 July 1967 at age of approximately 10 months. Copulation preceded by nest-building activities, but no nest eventuated at this site.
   Therefore a male will attempt copulation at approximately 10 months.

3.22 *Pair bond:*

By the end of 1966 seven breeding pairs had been banded, in 1967 twelve further pairs, and in 1968 eight more pairs. No further data were obtained from 9 of these 27 pairs. The subsequent history of the remaining 18 pairs is indicated in Fig. 13.

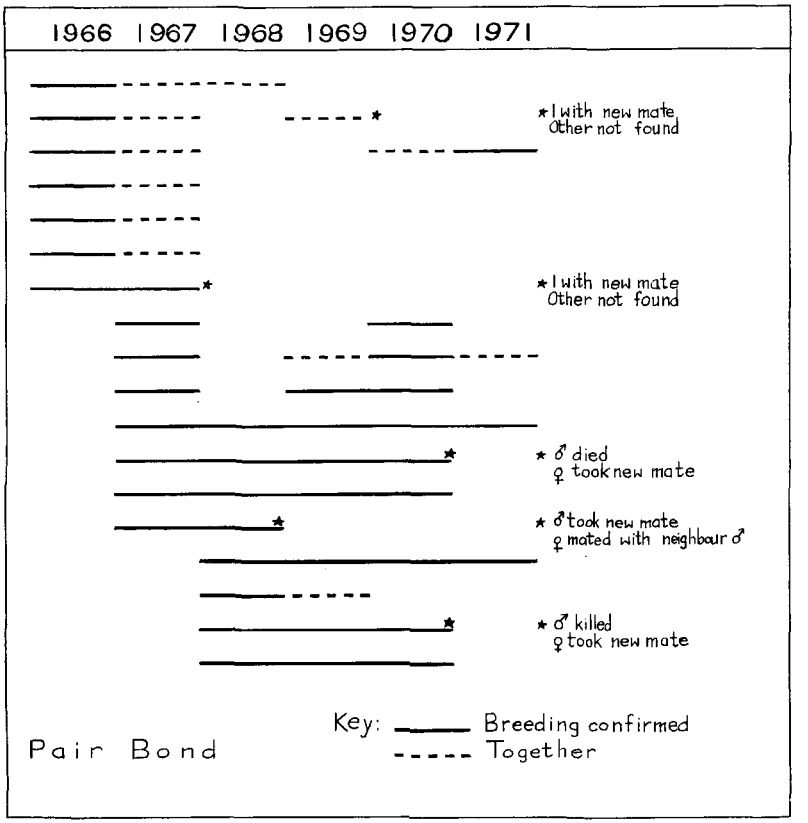


FIGURE 13: Pair bond.

Of the five cases of change of mate, only one was the result of a known "divorce." In this case the female mated with a neighbouring male for a season, the male taking a new (unbanded) mate. The female bred successfully with the neighbour male for the season then disappeared. This (neighbour) male bred with an unbanded bird in 1967 and again in 1969 and 1970. It is not known if this was a frank exchange of mates for a season.

In three other cases of change of mate, the "old" mate was not seen again. It must be assumed that some if not all of these birds died, and the change of mate was due to death of the previous mate.

The two remaining cases occurred in 1970, and we were able to discover the circumstances.

The first of these pairs had been together for at least four years (this was in fact the pair concerned with the double-brood). They bred in 1970, but when the chicks were two days old it was noted that the male looked bunched and unwell. He was not seen again alive, and the dessicated corpse was found after a close search of the area a month later. In the meantime the chicks disappeared (apparently died), and the female took a new mate. 15 days after she was last sighted with the original mate and the chicks, she was seen in a "new" (to her) area adjoining her usual territory, with a new mate; 6 days later their nest with a single egg was found.

The second pair had been together for at least three years. In 1970 they nested in rough ground across a road from the wet area where they usually raised their brood. After hatching, they were apparently shepherding the brood across the road when the male was hit by a car and killed. By simple good luck, one of the study team was driving along the same road shortly afterwards and found the dead but still warm bird, with the agitated female and brood in the grass on the road verge. Two days later the female was seen with the brood in the wet paddock. Twelve days later again (14 days after the death of the male) there was no sign of the brood, and the female was seen near the boundary of her usual territory copulating with a " new " male. (We cannot resist commenting on the promptness with which these two females acquired new mates, after their known long and continual association with the previous mates. They did not " sweat and whine about their condition," but got on with the business of living; perhaps just another example of the adaptability of the species !) It is also interesting that both these episodes occurred at the height of the breeding season, in a part of the study block where most birds were banded and breeding areas closely adhered to. " Strange " birds were seldom seen in this area over the years. The question of where the new mates came from can only be speculated upon. One, certainly, was a stiff, unusual-looking bird, recognisable by his peculiar stance, and had not been seen in the area before.

3.23 *Longevity:*

Between 1959 and 1965 113 chicks were banded with single aluminium bands (Kinsky 1960-62) (C. J. R. Robertson pers. comm.). The 1959 birds were the first of the species to be banded in New Zealand. All were banded in Southland. Between 1966 and 1968 14 other unfledged birds were banded in Otago and Southland. In the course of the present study 388 birds have been banded. Of these 269 were unfledged chicks and 119 were adults.

Some of the unfledged chicks were of known hatch-date and therefore of known age. As fledging age is approximately eight weeks, age of all birds banded as chicks is known to within eight weeks.

Of 119 adults banded, three were birds which had previously been banded as chicks.

Therefore, 396 birds of known age to within eight weeks have been banded to date. Two birds give particular information on longevity: *1.* No. 5813 banded as a chick on 9 November 1961 by R. R. Sutton; nest-trapped 13 September 1967 as a breeding adult, and was found to be a male as seen in copulation 27 June 1971. The latest sighting was as a breeding bird on 10 October 1971, aged 9 years 11 months; and, *2.* No. 4101 banded as a chick on 16 October 1960 by Mrs Olga Sansom, nest-trapped 19 October 1968 as a breeding adult, sex unknown, aged eight years old.

The passage of time should provide more conclusive evidence of the longevity of the species.

4. SUMMARY OF RESULTS

Nest areas were generally where there were no farm animals or human interference; nests were in open positions, with some roughness of ground or vegetation for camouflage, where the incubating birds had an uninterrupted view in all directions.

Copulation and egglaying times varied from 14 days to 2 days before and one day after the first egg. Nest building was noted up to 12 days before the first egg. Average clutch size was 3.74. The clutch size was not affected by rainfall.

FIGURE 14: Rigorous weather was no barrier to successful breeding. Snow falls and frosts up to 11 degrees Celsius did not disrupt nesting.

Photo: R. R. Sutton

Incubation was shared between the male and the female by day. Laying was from June to November with the peak in August. Re-nesting occurred after nest or brood loss. One record of double brood was made. Incubation period was from 30 to 31 days.

Hatching success was 73.9%. In unhatched eggs 50% contained embryos. Live chicks were produced from 49.8% of the nests. Chick mortality in the first 14 days was high, the true survival rate probably being about 25%. The mean hatch weight was 20.5 g. The fledging age was 7 to 8 weeks. Fledged juveniles remained with their parents until 7 or 8 months old.

The breeding cycle occupied the birds for 11 months of the year. Females can breed at one year old and males in their second year. Some evidence was found of pair bonds lasting until death of one partner. Longevity reached to nearly 10 years.

5. ACKNOWLEDGEMENTS

Many people have contributed in different ways to this study. We are indebted to: Mr B. D. Heather, who helped to outline the study plan; Mr S. L. Lobb, whose ingenuity in devising and constructing the bird-traps was a key factor in the study; Mr R. Boud for field work in the early stages; Mr J. Mackintosh, who devised the technique of converting aluminium bands to colour bands, and supervised this work; Miss M. M. Davis, Messrs A. Blackburn and H. R. McKenzie, Drs R. A. Falla, C. A. Fleming, R. F. Smith, M. F. Soper and K. Wodzicki, who encouraged and assisted in various ways; Mr C. J. R. Robertson and other staff of the Banding Office, Wildlife Division, Department of Internal Affairs; The Royal Society of New Zealand, for a grant from the Hutton Fund; Dr P. C. Bull and Mr F. C. Kinsky, who read a late draft of this paper and made constructive suggestions; local farmers, airport and Borstal Farm authorities for their co-operation; finally to our families, for interest and support, for listening to Spur-wing talk for years, and for not fussing about the petrol bills!

6. LITERATURE CITED

BARLOW, M. 1972. The establishment, dispersal and distribution of the Spur-winged Plover in New Zealand. Notornis 19(3): 201-211, figs 1-2, table 1.

HOGG, H. W. M. 1964. Unpublished reports *in* Recording Scheme, Ornithological Society of N.Z., Inc.

IMPERIAL CHEMICAL INDUSTRIES. Hatching game birds' eggs. ICI Research Station Advisory Booklet No. 11 (issued as — Hatching game birds' eggs under broodies. Booklet 11*a:* 1-16, illus. Rev. ed. 1964 [first publ. 1936] *and* Hatching game birds' eggs in incubators. Booklet 11*b:* 1-27, illus. Rev. ed. 1964 [first publ. 1961]). Fordingbridge, Hampshire: Eley Game Advisory Service [formerly ICI Game Services].

KINSKY, F. C. 1960. 10th Annual Report of the Banding Committee, Ornithological Society of New Zealand, Inc., for the year ending 31st March 1960. Pp. 1-42, 1 fig., tables A-B. Wellington: Dominion Museum.

——— 1961. 11th Annual Report of the Banding Committee, Ornithological Society of New Zealand, Inc., for the year ending 31st March 1961. Pp. 1-37, 1 fig., tables A-B. Wellington: Dominion Museum.

——— 1962. 12th Annual Report of the Banding Committee, Ornithological Society of New Zealand, Inc., for the year ending 31st March 1962. Pp. 1-36, tables A-B. Wellington: Dominion Museum.

LAVEN, H. 1940. Beitrage zur Biologie des Sandregenpfeifers. Journal fur Ornithologie 88: 193-287.

LITTLE, J. deV. 1967. Some aspects of the behaviour of the Wattled Plover *Afribyx senegallus* (Linnaeus). Ostrich 38: 260-

N.Z. METEOROLOGICAL SERVICE 1965-1969. Rainfall observations *in* N.Z. Meteorological Service Miscellaneous Publication 107, monthly climatological tables extracted from the N.Z. Gazette (later *in* Meteorological Observations for 1965 and for 1966, N.Z. Met. Serv. Misc. Pub. 109 (1965), 109 (1966); subsequently issued separately as Rainfall Observations for 1967, for 1968, and for 1969, N.Z. Met. Serv. Misc. Pub. 110 (1967), 110 (1968), 110 (1969)).

OSNZ 1970. Annotated checklist of the birds of New Zealand including the birds of the Ross Dependency. (The Checklist Committee, F. C. Kinsky, Convener), Ornithological Society of N.Z., Inc. Pp. 1-96, maps 1-4. Wellington, *&c.:* A. H. & A. W. Reed.

THOMAS, D. G. 1969. Breeding biology of the Australian Spur-winged Plover. Emu 69(2): 81-102, figs.

THOMSON, A. L. (ed.) 1964. A new dictionary of birds. Pp. 1-928, illus. London: Nelson.

Mrs C. E. Barlow,
152 Lewis Street,
Invercargill

Mr Peter M. Muller,
10 Eden Street,
Invercargill

Mr Roger R. Sutton,
P.O. Lorneville,
Invercargill

SEASONAL ABUNDANCE AND BEHAVIOUR OF SEA BIRDS IN THE BAY OF PLENTY, NEW ZEALAND

By C. M. VOOREN
Fisheries Research Division, P.O. Box 19062, Wellington

ABSTRACT

The seasonal patterns of the abundance of petrels and other birds at sea in the western Bay of Plenty, as observed in 1968 and 1969, are described and correlated with the existing data on breeding places and seasons. Inferences on seasonal migrations and on the feeding range of several species are drawn, and flocking and feeding behaviour are described.

INTRODUCTION

During a fisheries research programme from May 1968 to October 1969 I spent a few days at sea in almost every month aboard the research vessel *Ikatere* of the New Zealand Marine Department. The area traversed was off the east coast of the Coromandel Peninsula and in the western and central parts of the Bay of Plenty, mainly between Slipper Island and Plate Island, from about 5 miles off the mainland to the edge of the continental shelf (indicated by the 100-fathom isobath in Fig. 1). This area is the study area.

On a typical research cruise the vessel would leave Auckland in the morning and travel during daytime through Hauraki Gulf and Colville Channel to the vicinity of Slipper Island. After 4 or 5 days in the study area the vessel would return to Hauraki Gulf overnight. In my fisheries work I spent about 6 daylight hours on deck each day, during which I could observe sea birds more or less continuously. A pair of 10 x 50 binoculars was used in the observations, and the species were identified according to the descriptions by Oliver (1955), Moreland (1957), and Falla, Sibson & Turbott (1966). Some identifications were verified by examining specimens in the Dominion Museum, Wellington. For each cruise the abundance of the species as observed during at least one of the days in the study area was indicated according to the following scale:

0 = absent.
1 = scarce: 1-10 birds.
2 = common: 10-100 birds.
3 = very abundant: more than 100 birds.

By October 1968 I had become familiar with most species that occurred regularly in the study area, and the data collected between October 1968 and October 1969 are summarised in Fig. 2.

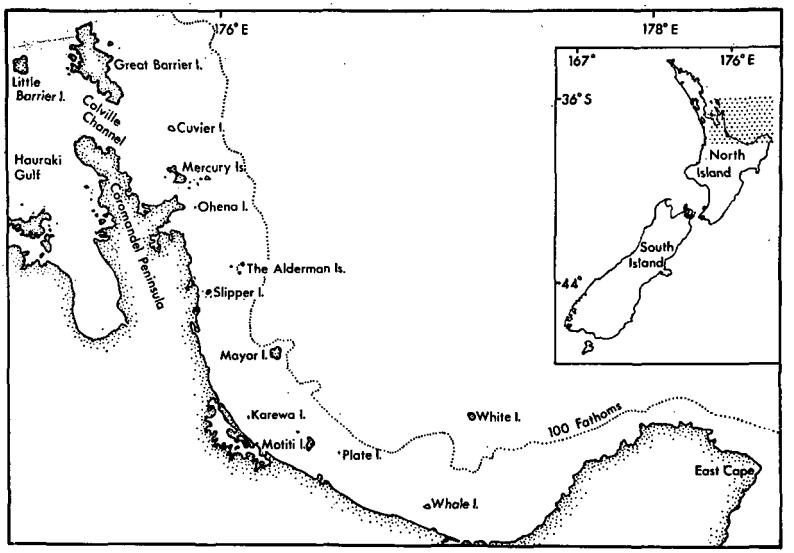


FIGURE 1: Localities mentioned in the text.

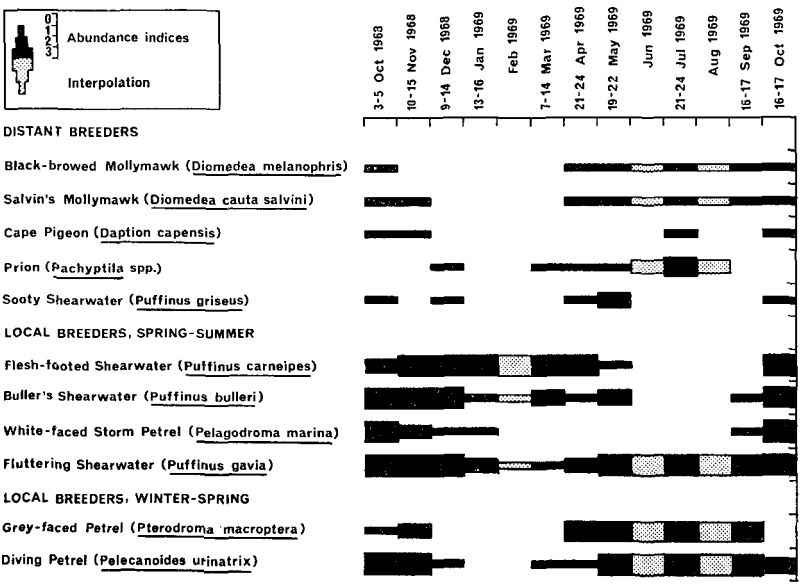


FIGURE 2: Monthly abundance indices of species in the study area. No observations were made in February, June and August 1969.

These data are discussed in detail below, with some occasional observations on abundance east of the study area and in Hauraki Gulf and Colville Channel.

" Petrels " indicates Procellariiformes in general. " In shore " indicates the waters less than 2 miles from the nearest shore, " off shore " the waters between 2 miles from the nearest shore and the 100-fathom isobath, and " far off shore " the waters outside the 100-fathom isobath. The seasons denote the following months: spring, September-November; summer, December-February; autumn, March-May; winter, June-August. The terms " unemployed birds " and " successful parents " are used as defined by Richdale (1963). One species that breeds in small numbers in summer in or near the study area is nevertheless listed as " distant breeder " because it was commonly seen in the study area only in autumn; the birds then seen were probably migrants from distant breeding grounds further south.

During the above period I was not able to distinguish in the field between the Royal Albatross, *Diomedea epomophora* Lesson, and the white adult form of the Wandering Albatross, *Diomedea exulans* Linnaeus, and between the Fluttering Shearwater, *Puffinus gavia* (Forster), and the Little Shearwater, *Puffinus assimilis* Gould. According to Falla (1934), the Little Shearwater is not common at any season in the study area and does not form flocks in coastal waters, and the Fluttering Shearwater is a very common breeder and is often seen in large flocks. It can therefore be safely assumed that the present data on feeding flocks and on large seasonal variations in the abundance of shearwaters of this type refer to the Fluttering Shearwater. Although many albatross sightings were of the easily recognisable dark phase of the Wandering Albatross, the two albatross species are treated together. No attempts were made to identify prions, *Pachyptila* spp., to the species level, so that they are dealt with as a group.

1. SEA BIRDS OTHER THAN PETRELS

1.1 At all times of the year a few Southern Black-backed Gulls, *Larus dominicanus* Lichtenstein, could be seen each day, attracted by the vessel and often following it for a while, but this species never occurred in large numbers off shore. This is in agreement with the description by Oliver (1955) of this bird as basically a shoreline species.

1.2 There are several breeding colonies of the Red-billed Gull, *Larus novaehollandiae scopulinus* Forster, inside and to the east of the study area (Gurr & Kinsky 1965). This species was, however, never abundant off shore, except in July 1969 off Motiti Island, where during 2 days several flocks containing up to 500 birds each were seen. Although the birds seem to stay close to their breeding colonies in summer, large off-shore concentrations may be a feature of the central Bay of Plenty in winter.

1.3 The White-fronted Tern, *Sterna striata* (Gmelin), was never observed far from shore. Flocks of the species were seen only in November-December 1968 and September 1969 near Motiti Island and Plate Island, which probably indicated the presence of breeding colonies in the area. The large flocks that were frequently seen in Hauraki Gulf are not a regular feature of the study area, so that the species does not seem to breed there in great numbers.

1.4 The Australian Gannet, *Sula bassana serrator* Gray, was usually common in Hauraki Gulf and Colville Channel and also east of the study area, but was seen within the study area only in small numbers on a few occasions. The birds of the nearby colony at White Island (Oliver 1955) apparently do not range much into the central and western Bay of Plenty.

2. PETRELS, DISTANT BREEDERS

2.1 Wandering Albatross, *Diomedea exulans* Linnaeus, and/or Royal Albatross, *Diomedea epomophora* Lesson, and Giant Petrel, *Macronectes giganteus* Gmelin:

These species were regularly seen all year round, but never in large numbers. The present data do not confirm the observation by Norris (1965) that in spring these birds leave the coastal waters to the east of the North Island.

2.2 Black-browed Mollymawk, *Diomedea melanophris* Temminck, Salvin's Mollymawk, *Diomedea cauta salvini* (Rothschild), and Cape Pigeon, *Daption capensis* (Linnaeus).

All three species were absent from the study area in summer and early autumn (December 1968-March 1969); at other times of the year they were regularly seen in small numbers, Salvin's Mollymawk being the least abundant species. In Cook Strait these species are also far less numerous in summer than at other times of the year (J. A. Bartle, pers. comm.), and Norris (1965) noted that Cape Pigeons disappeared from the Tasman Sea and the east coast of New Zealand during the first 2 weeks of November. The three species breed in summer on islands in latitudes south of New Zealand (Oliver 1955). Apparently the immature section of the populations also migrates in spring to more southern latitudes, if not to the parental breeding grounds.

2.3 Sooty Shearwater, *Puffinus griseus* (Gmelin):

The species breeds in small numbers on The Aldermen Islands, Whale Island, and White Island. " . . . the number of burrows of this species on any of the islands would not be more than a dozen " (Falla 1934: 251). The birds seen occasionally from October 1968 to April 1969 probably belonged to these small populations, and the increase in numbers that occurred in May 1969 is to be seen as a symptom of the massive northward migration from the Stewart Island

area and further south that takes place along the coasts of New Zealand in April-May (Richdale 1963). Apparently the Bay of Plenty lies outside the main path of the migration, or at its fringe, for even in May the species was not really abundant in the study area.

3. PETRELS, LOCAL SPRING-SUMMER BREEDERS

Of the local spring-summer breeders mentioned below, three species (Nos. 3.2-3.4) are transequatorial migrants (Falla 1934). The common feature of these three species was their complete absence in winter (see July 1969 in Fig. 2), but apart from this, there were important differences in their seasonal pattern of abundance at sea.

3.1 Prions, *Pachyptila* spp.:

During most of the year prions were seen only occasionally, but large flocks of up to several hundreds of birds were common in winter (July 1969). The Fairy Prion, *Pachyptila turtur* (Kuhl), breeds at the Poor Knights Islands, about 100 miles NW of the study area, and possibly at islands in the outer Hauraki Gulf (OSNZ Annotated Checklist 1970). The birds seen in summer and autumn may well belong to the populations on these islands. The Fairy Prion " appears to have a non-migratory regime merely dispersing over the Southern and Indian Oceans after breeding " (Serventy, Serventy & Warham 1971: 112). The large numbers of prions seen in winter may therefore include Fairy Prions from the Poor Knights Islands as well as migrants from more distant areas belonging to this and other species.

3.2 Flesh-footed Shearwater, *Puffinus carneipes hullianus* Mathews:

The main breeding station in the Bay of Plenty is Karewa Island (Oliver 1955). The birds begin to come ashore there in September (Falla 1934). Initially they stay ashore most of the time and go without food (R. A. Falla, pers. comm.). This would account for their absence at sea in September 1969. From October 1968 until the end of April 1969 they were very abundant at sea, but by May they had almost disappeared. This species simply appears to arrive *en masse* at the beginning of the breeding season and to depart equally abruptly at the end of it.

3.3 Buller's Shearwater, *Puffinus bulleri* Salvin:

The sole breeding station is north of the study area, at the Poor Knights Islands (Falla 1934); suppositions about breeding at other islands have never been confirmed (R. A. Falla pers. comm.). Buller's Shearwater was absent from the Bay of Plenty in mid-winter. The data indicate that these birds appear in moderate numbers in September (possibly August, but no observations were made in that month), and are very common from October to December. Most of the young hatch in the latter half of December (Falla 1934); therefore there should be much breeding activity in January. However, numbers declined considerably in January 1969; in the following autumn the birds became somewhat more common in the study area.

The unemployed Sooty Shearwaters migrate away from the breeding grounds much earlier than the successful parents do (Richdale 1963), and the decrease in numbers of Buller's Shearwater at sea in January suggests that a similar phenomenon may occur in this species. The subsequent increase in numbers in March-May would then be due to the appearance of the young-of-the-year; according to Falla (1934), the fledglings leave the nest in March.

3.4 White-faced Storm Petrel, *Pelagodroma marina* (Latham):

Near the study area this species breeds at the Mercury Islands; inside it, it breeds at The Aldermen Islands and possibly Mayor Island (Oliver 1955). The present data confirm the statement by Falla (1934) that the birds are very common at sea during daytime in October-November; they often occurred in large loose concentrations of several hundreds of individuals. Richdale (1965: 56) stated that in general " . . . Storm Petrels spend their daylight hours a long way from the breeding grounds," but this does not seem to apply to the earlier part of the breeding season in the Bay of Plenty. The eggs are laid during the last 10 days of October (Falla 1934). Many birds are therefore brooding the eggs in November, which accounts for the decrease in numbers at sea from October to November 1968. According to Falla (1934), hatching takes place towards the end of November, and I can confirm his statement that from then on the birds appear only in inshore waters after sunset. During that part of the breeding season the daytime activities (probably including feeding) seem to take place well off shore, outside the 100-fathom isobath.

In northern New Zealand the fledglings leave the nest in late February and early March (Oliver 1955). The present data suggest that the young birds leave the burrows after dark and make immediately for far off-shore waters, for no birds at all were seen within the 100-fathom isobath in March 1969 during daytime. The birds are absent from the breeding grounds from late March until the middle of August (Falla 1934), and no birds were seen at sea in those months during the study period.

At about 10 p.m. on 13 November 1968 three White-faced Storm Petrels were attracted by the ship's lights close to Slipper Island and were captured. This suggests that the species may breed on Slipper Island or the islets nearby, the captured specimens possibly having been on their way to breeding places on these islands.

3.5 Fluttering Shearwater, *Puffinus gavia gavia* (Forster):

Falla (1934) states that this species is the most common breeding petrel in northern New Zealand. In the Bay of Plenty it has been found breeding on The Aldermen Islands, Slipper Island, Plate Island, and Whale Island. Birds were present in the study area at all times of the year, as was also concluded by Imber & Crockett (1970) from data on beach wrecks. The present data show also marked seasonal variations in the abundance at sea.

The breeding period ends in late January, the young leaving the nest during the last 10 days of that month (Falla 1934). During the cruise of 13-16 January 1969 the breeding birds should still have been present in the study area. The numbers seen at sea at that time were nevertheless very low, compared with the vast numbers seen earlier in the breeding season. This may indicate a movement away from the area by the unemployed birds on their suspected migration to the eastern coast of Australia (Imber & Crockett 1970). The proportion of unemployed birds in breeding populations of shearwaters is quite high, e.g., about two-thirds in the population of the Sooty Shearwater (Richdale 1963). Movements of this component of a population should therefore have a noticeable effect on the abundance of the birds in a given area.

Fluttering Shearwaters remained scarce in the study area from January 1969 until the end of April 1969. Observations in the Hauraki Gulf and in Colville Channel at the same time gave the impression that peak numbers were reached there during these months. This suggests that after the possible migration across the Tasman Sea by the unemployed birds in summer, there is a northward movement from the Bay of Plenty towards Hauraki Gulf in early autumn. By May 1969 the birds have apparently returned again to the Bay of Plenty, although they were not present in such vast numbers as in October-December 1968. This may indicate that only last season's successful parents returned, the unemployed birds remaining elsewhere.

Although Falla (1934) and Oliver (1955) reported burrowing and courtship behaviour ashore as starting in September, the birds may begin to come ashore shortly after their return to the breeding area in May. Blackburn (1970: 298) saw " small numbers " coming ashore at Little Ohena Island (a small islet off Ohena Island) in June 1970.

The migration into Hauraki Gulf in early autumn may be connected with the annual moult of the adults, which starts in January and may continue until June (Falla 1934). Flight power is much reduced in this species during moult (R. A. Falla, pers. comm.). It is perhaps advantageous for the adults to spend the major part of the moulting period in an area such as Hauraki Gulf, which offers much shelter in the form of bays and islands in comparison with the Bay of Plenty, which is much more open and exposed.

4. PETRELS, LOCAL WINTER-SPRING BREEDERS

4.1 Grey-faced Petrel, *Pterodroma macroptera gouldi* (Hutton):

This species breeds on most islands off northern New Zealand (Falla 1934). The main breeding stations in the study area are The Aldermen Islands, Mayor Island, and Whale Island (Oliver 1955). From April to September 1969 the species was commonly seen at sea towards the evening near islands. The vessel was often stationed near Slipper Island in the late afternoon. From about 1½ hours before sunset onwards the waters nearby were occupied by a large

diffuse aggregation of birds, all on the wing and moving very fast; at any moment up to about 500 birds could be seen by scanning the whole horizon. On such occasions the birds did not form well-defined flocks moving in a co-ordinated way like, for instance, the Fluttering Shearwater. The only structure that was observed commonly was groups of two or three birds moving at great speed, one or two birds closely following another individual. If this were just a symptom of gregariousness, the groups could be expected to be larger, but since usually only small numbers of birds are involved, this behaviour probably reflects intraspecific communication at a higher level, such as courtship.

The young hatch in late August and September (Falla 1934). Large concentrations of birds near the nesting grounds in the late afternoon were not seen after September (both in 1968 and 1969). This indicates that the behaviour of the birds may change after the hatching of the young. Possibly the daylight hours are from then on more fully spent in gathering food for the nestling in off-shore waters, so that the birds arrive near the breeding grounds only after dark. A departure of unemployed birds may also be involved here.

During daytime the species was never seen close to land, but was occasionally observed over deep water near the edge of the continental shelf. In November 1968, for instance, a loose group of about 100 birds was seen at about 5 p.m. 3 miles east of The Aldermen Islands. In March and September 1969 many birds were also seen between noon and 3 p.m. 5 miles north of Plate Island. This suggests that when at sea the birds spend the daylight hours mostly over the deeper off-shore waters, but not as far from the breeding grounds as was, for instance, assumed by Oliver (1955: 163), who stated: " Probably . . . its feeding ground is some hundreds of miles from its breeding place." During research cruises in March 1970 and June 1971 I found the species to be common throughout the day at the western side of East Cape, where the continental shelf is very narrow, so that deep water is close to the shore.

4.2 Diving Petrel, *Pelecanoides urinatrix* (Gmelin):

In the study area this species has been found breeding at The Aldermen Islands, Karewa Island, Slipper Island and nearby islets, and Plate Island. Diving Petrels are common during most of the year, except that " . . . from January to March . . . they are rarely seen at sea in coastal waters " (Falla 1934: 246). The present data show a similar absence from December 1968 to April 1969, so that during much of summer and in early autumn the species seems to be absent from the more off-shore waters also. During that time of the year the annual moult of the adults takes place (Falla 1934, Thoresen 1969). In the Diving Petrel this is a drastic occurrence, the remiges and rectrices being moulted all at once (Watson 1968). R. A. Falla, in a paper read at the August 1969 Conference of the

New Zealand Marine Sciences Society, has suggested that during the moult the adults may remain for long periods in their burrows. If this were so, the question still remains of where the young-of-the-year go after they leave the nests in December, as stated by Falla (1934). A possible explanation is that during the period in question this small bird is still present at sea near the breeding grounds, probably as close to shore as usual, but making itself inconspicuous by not forming large groups and by living mostly on the water like the Blue Penguin, *Eudyptula minor* (Forster). This species is a very common breeder in the study area, judging from massive beach strandings mentioned by Oliver (1955), from the large number of penguin footprints observed on the beaches of Whale Island in December 1968, and from the frequency with which penguin calls were heard from islands at night during most of the study period. Yet penguins were only very rarely seen at sea.

5. PETRELS, OCCASIONAL VISITORS

5.1 Black Petrel, *Procellaria parkinsoni* Gray:

Of the several breeding places of this species, Little Barrier Island is the nearest to the study area (Oliver 1955). One specimen was seen in March 1969 during daytime, between Mayor Island and Motiti Island. Many Flesh-footed Shearwaters were around at the time. Since the Black Petrel has not often been identified at sea (OSNZ Annotated Checklist 1970), I give here the field notes made on the occasion: " Flight swooping and soaring, very high and fast compared with that of Flesh-footed Shearwater. Seems somewhat smaller than Flesh-footed Shearwater. Bird completely dark brown-black. Bill dark, upper mandible dark bluish grey, shiny." The absence of this species from beach wrecks in the Bay of Plenty in 1967 (Imber & Boeson 1969) suggests that it does not regularly occur in the area.

5.2 White-headed Petrel, *Pterodroma lessoni* (Garnot):

Two specimens were seen in July 1969 near the Mercury Islands, associating with an " evening flock " of Grey-faced Petrels. The White-headed Petrel is regularly cast ashore on New Zealand beaches in winter (Oliver 1955, Imber & Boeson 1969).

FLOCKING AND FEEDING

Throughout spring and summer, when Fluttering Shearwater and Buller's Shearwater were common, these species were often seen feeding together at the sea surface in large mixed flocks. Close to the shores of Motiti Island and Plate Island White-fronted Terns and Red-billed Gulls often formed part of such flocks as well, so that at that time of the year these four species may in some areas exploit the same sources of food. Fluttering Shearwater and Red-billed Gull also fed together in the central Bay of Plenty in flocks

in winter. As Belopol'skii (1961) pointed out, this type of occurrence does not necessarily indicate a high degree of competition between species for food. Where a certain kind of prey acceptable to several species is highly abundant, mixed feeding flocks may occur, whereas only the highly specialised species (stenobiotic *sensu* Belopol'skii) will pursue it where it is scarcer.

Sladden (*in* Oliver 1955: 129) and Norris (1965) said that the Flesh-footed Shearwater also often associates with the Fluttering Shearwater and Buller's Shearwater, but in the Bay of Plenty I have never seen this bird associating with any other bird species. Large flocks of several hundreds of Flesh-footed Shearwater were observed in November 1968. It was not clear whether or not these birds were feeding, but their presence was not related to discharged ship's offal. At other times of the year discharged offal usually attracted a large number of these birds, but apart from this the birds seemed to move in a solitary manner and occurred diffusely all over the area, many single birds showing up all around whenever one scanned the horizon.

The Sooty Shearwater occurred sometimes with Buller's Shearwater in flocks during autumn, but this association was not seen at other times of the year.

When prions were common in the study area during winter, they were mostly seen in feeding flocks, not associating with other bird species.

ACKNOWLEDGEMENTS

I am grateful to Dr R. A. Falla and Mr J. A. Bartle for their encouragement throughout the investigation and for their useful criticisms of the manuscript. I would also like to thank Mr F. C. Kinsky for his advice in matters of species identification.

LITERATURE CITED

BELOPOL'SKII, L. O. 1961. Ecology of sea colony birds of the Barents Sea. Pp. 1-346, text-figs 1-135, tables 1-92, pls I-XVI. Jerusalem: Israel Program for Scientific Translations Ltd. (Translated by R. Ettinger and C. Salzmann from: Ekologiya morskikh kolonial'nykh ptits Barentsova Morya (1957). Pp. 1-458, text-figs 1-135, pls I-XVI. Moscow: Akademiya Nauk SSSR, Karel'skii filial.)

BLACKBURN, A. 1970. Birds of Little Ohena Island. Notornis 17(4): 297-299.

FALLA, R. A. 1934. The distribution and breeding habits of petrels in northern New Zealand. Records of the Auckland Institute and Museum 1(5): 245-259, pls 54-56, 1 map.

FALLA, R. A.; SIBSON, R. B.; TURBOTT, E. G. 1966. A field guide to the birds of New Zealand and outlying islands. Pp. 1-254, text illus., pls 1-18. London: Collins.

GURR, L.; KINSKY, F. C. 1965. The distribution of breeding colonies and status of the Red-billed Gull in New Zealand and its outlying islands. Notornis 12(4): 223-240, 1 fig., 1 table.

IMBER, M. J.; BOESON, B. W. 1969. Seabirds found dead in New Zealand in 1964. Notornis 16(1): 50-56, fig. 1, tables 1-5.

IMBER, M. J.; CROCKETT, D. E. 1970. Sea birds found dead in New Zealand in 1968. Notornis 17(3): 223-230, tables 1-4.

OLIVER, W. R. B. 1955. New Zealand birds. 2nd ed. Pp. 1-661, text illus., 12 unnumb. col. pls. Wellington: A. H. & A. W. Reed.

OSNZ 1970. Annotated checklist of the birds of New Zealand including the birds of the Ross Dependency. (The Checklist Committee, F. C. Kinsky, Convener), Ornithological Society of N.Z., Inc. Pp. 1-96, maps 1-4. Wellington, *&c.*: A. H. & A. W. Reed.

MORELAND, J. 1957. A guide to the larger oceanic birds (albatrosses and Giant Petrel) of New Zealand waters. Tuatara VI(3): 99-107, pls I-II.

NORRIS, A. Y. 1965. Observations of seabirds in the Tasman Sea and in New Zealand waters in October and November, 1962. Notornis 12(2): 80-105, 1 map, table I.

RICHDALE, L. E. 1963. Biology of the Sooty Shearwater *Puffinus griseus*. Proceedings of the Zoological Society of London 141(1): 1-117, text-figs 1-4, tables 1-45, pls 1-2.

——— 1965. Biology of the birds of Whero Island, New Zealand, with special reference to the Diving Petrel and the White-faced Storm Petrel. Transactions of the Zoological Society of London 31(1): 1-86, text-fig. 1, tables 1-43, pls I-III.

SERVENTY, D. L.; SERVENTY, V.; WARHAM, J. 1971. The handbook of Australian sea-birds. Pp. 1-254, figs 1-127, col. pls 128-142. Sydney, *&c.*: A. H. & A. W. Reed.

THORESON, A. C. 1969. Observations on the breeding behaviour of the Diving Petrel *Pelecanoides u. urinatrix* (Gmelin). Notornis 16(4): 241-260, figs 1-18, tables 1-3.

WATSON, G. E. 1968. Synchronous wing and tail molt in Diving Petrels. Condor 70(2): 182-183.

Mr C. M. Vooren,
Fisheries Research Division,
N.Z. Marine Department,
P.O. Box 19062,
Wellington

NORTH ISLAND BROWN KIWI: *Apteryx australis mantelli*

MEASUREMENTS AND WEIGHTS OF A YOUNG CHICK

By BRIAN REID

Wildlife Service, Department of Internal Affairs, Wellington

INTRODUCTION

At Kupe, Taranaki, on 26 October 1971 a dog exposed a nest and killed the incubating male bird. The contents of the nest, an emerging, half-hatched chick which the dog's owner removed from its shell, and a fertile egg, were placed in a heated cupboard. Within 18 hours the chick had died from internal haemorrhaging — and the embryo did not develop further. The adult, chick and egg were sent to the Wildlife Service and prepared as study specimens.

The egg measured 129.0 x 81.8 mm, contained a half-grown feathered embryo and weighed 430.7 g (shell 23.1 g; contents 407.6 g). When fresh, an egg with these dimensions would probably weight about 485 - 490 g (Reid 1971*a*).

THE DAY-OLD CHICK

The chick had a pink bill with an exposed length of 40.2 mm, and its vibrissae were only slightly longer than the other facial feathers. While the distal third of the claws were horn-colour, the proximal two-thirds were black; and the feet and toes were pinkish-grey. The yolk-sac was fully enclosed and, at death, the chick weighed 318.6 g — or about 65% of the calculated fresh weight of its sibling egg. The feathers, except for being proportionately smaller, were indistinguishable from those of the adult. Measurements and weights of the incubating adult and chick are given in Table 1.

Excluding the yolk-sac, the chick weighed 205.5 g or 12.1% of the weight of the incubating male. The skin (including wings) formed 30.3%, the carcass (head, neck, trunk, thighs, legs and feet) 50.1% and the viscera 19.7% of the chick's weight.

Compared with the adult, the hind limbs of the chick were disproportionately long (Table 1B) but they were poorly fleshed (Table 1A) and formed a smaller part of the bird's weight. Relative to their respective trunk lengths, the hind limbs of the chick were 15% longer than the hind limbs of the adult; but, relative to their respective trunk (including head and neck) weights the hind limbs of the chick were about 40% lighter than those of the adult.

Yolk sac:

The 318.6 g total weight of the chick included a 1.2 g yolk-sac containing 111.9 g of yolk. The yolk-sac from this chick is compared in Table 2 with those present in chicks of other species and shows

that the yolk reserve in the kiwi, per unit of body weight, is two-and-a-half times as great as that of the domestic chick, three times as great as that of the Adelie Penguin and five times as great as that of the Antarctic Skua.

The ages are not known of the other kiwi chicks included in this table. One (with a 54 g yolk-sac) was killed while foraging outside its burrow and is thought to be at least six days old. The other, whose vertebral column, pelvis and long bones were about 18% longer than those of the one-day chick, is estimated to be about three weeks old.

Adelie Penguin chicks, which hatch with an average food reserve of 1.8 g yolk per 10 g of body weight, may sometimes survive if not fed until the fifth day following hatching (Reid & Bailey 1966). A kiwi chick hatching with a food reserve of 5.5 g of yolk per 10 g of body weight should be able to withstand a more prolonged fasting period and undergo considerable weight loss without ill effect. Young kiwis totally denied food and water would probably die from water privation long before they depleted their yolk (and fat) reserves.

Data in Table 3 show that yolk from both the one-day-old and the (estimated) three weeks old chicks had a similar water content which was considerably below that of yolk from a fresh egg (Reid 1971 *b*). This suggests that proportionately more water than solids are withdrawn from the yolk, either during development, or within the first few hours following hatching. The 111.9 g of yolk in the day-old chick had the same dry weight, and may therefore have about the same nutritive value, as 126.3 g of yolk from a fresh egg.

The yolk-sac opened into the intestine at a point midway between the gizzard and the paired caeca. In the three-week old chick the tube of the 1.2 cm long connecting stalk was still continuous with the intestine.

Fat reserve:

The chick (excluding yolk-sac) weighed 205.5 g. It had a lean weight of 162.0 g and carried 43.5 g of fat. Approximately 70% of the fat was subcutaneous and only six percent visceral. Of the latter; 1.15 g was on the gizzard and 1.45 g was distributed throughout the other internal organs. The distribution of fat in the day-old and three-weeks-old chick is shown in Table 4.

DISCUSSION

In the day-old chick the legs were lightly fleshed and the proximal third of the three metatarsals (which fuse together and with the tarsals to form the tarsometatarsus) were still separate — and Robson's (1958) observations on kiwis hatched in captivity showed they were unable to stand until their fourth day, and did not leave the nest to feed until their sixth day. Turbott & Wightman (1959) observed a nest in the wild and believed that the chick did

not venture out until about 10 days after hatching, but T. R. Hartree (pers. comm.) stated that a chick hatched by the Hawke's Bay Wildlife Trust on 14 December 1971 first left its burrow on the fifth night following hatching.

There is a considerable reduction from the hatching weight during this fasting period. Robson and Hartree each took a few weights at irregular intervals and their data, along with that for the day old chick are summarised in Table 5. Both used kitchen scales and the weights obtained should be regarded as only approximate. Furthermore, the minimum weights they recorded are probably heavier than the minimums reached by the chicks, as it is improbable that any weighings coincided with the minimum weight. The weight of the one-day-old chick (excluding yolk-sac) was about 42% of the weight of the sibling egg, and this agrees closely with the data of Robson and of Hartree. Weights taken by the latter show the nine-day-old chick weighed 39% of the weight of the fresh egg.

It is doubtful whether the chick of any other species hatches with such an abundant food reserve. The lean weight of the one-day-old chick represented only 50.8% of its total weight; and for every 10 g of lean body weight this chick carried 9.6 g (6.9 g yolk; 2.7 g fat) of food reserves. Utilisation of the yolk-sac alone would account for a decrease in the hatching weight by about 35%, but a considerably greater loss in weight (perhaps approaching half the hatching weight) could probably be tolerated as the fat reserves represented about 27% of the chick's lean weight.

It seems fairly certain that the fasting and associated weight loss noted in chicks reared in captivity is also characteristic of wild-reared birds. Seven young kiwis found outside their burrows (and therefore thought to be at least five or six days old) all weighed less than the one-day-old chick. Their weights were — 185.8, 236, 251, 263.5, 281, 283.5 and 300 g. The 281 g chick contained a 54 g yolk-sac and the 263.5 g chick had a 14.1 g yolk-sac. Two chicks, one weighing 251 g, the other 300 g, were both carrying plenty of fat (F. C. Kinsky, pers. comm.). Robson stated that his chicks did not regain their hatching weight until they were four weeks old; but Hartree reported that his chick, which weighed 140 g at the age of ten days, weighed 240 g (about two-thirds the weight of the fresh egg and therefore, approximately the hatching weight) when it was only 16 days old.

In 55 days the weight of the chick hatched by the Hawke's Bay Wildlife Trust increased from its minimum of 140 to 565 g — a gain of 425 g or 7.7 g a day. A young chick at Mt Bruce, suffering several injuries including a blind weeping eye that required daily treatment over several weeks, also gained at a mean rate of 7.7 g a day over a period of 57 days. This chick weighed 185.8 g when it arrived on 20 April 1971 and 625.3 g on 17 June 1971, a gain of 439.5 g.

Table 1 COMPARISON, INCUBATING MALE AND DAY OLD CHICK

A. WEIGHTS	Adult		Chick		Chick as %
	grams	%	grams	%	of Adult
Feathers	115.2	6.8	12.9	6.3	11.2
Skin (incl. fat and wings)	321.1	18.9	49.4	24.0	15.4
Feathers and skin	436.3	25.7	62.3	30.3	14.3
Head, Neck, Trunk	363.7	21.4	47.0	22.9	12.9
Legs, Thighs	518.0	30.5	42.3	20.6	8.2
Feet	74.5	4.4	13.5	6.6	18.1
Legs, Thighs, Feet	592.5	34.9	55.8	27.2	9.4
Viscera and fluids	306.7	18.0	40.4	19.7	13.2
TOTAL	1699.2	100.0	205.5	100.0	12.1

B. BONE MEASUREMENTS	Adult (mm)	Chick (mm)	Chick as % of Adult
Bill, exposed length	96.8	40.2	41.5
Vertebrae, cervical & thoracic	244.0	96.0	39.3
Rib, fifth	58.0	23.5	40.5
Ilium	108.0	43.0	39.8
Femur	91.8	41.2	44.9
Tibiotarsus	128.7	58.4	45.4
Metatarsus	66.8	34.4	51.5
Digit and claw, third	57.4	32.0	55.7

C. VISCERA, WEIGHTS and MEASUREMENTS	Adult	Chick	Chick as % of Adult
Gizzard, fat free and clean (g)	18.7	2.975	15.9
Heart, fat free and clean (g)	15.7	0.780	5.0
Liver, " " " " (g)	46.7	3.850	8.2
Oesophagus (cm)	23.5	8.8	37.4
Proventriculus (cm)	4.0	1.4	35.0
Intestines (cm)	136.0	35.5	26.1
Caecum I (cm)	18.0	6.6	36.7
Caecum II (cm)	19.0	7.1	37.4
Rectum (cm)	11.5	5.5	47.8

Table 2 YOLK-SAC AND CHICK WEIGHT

Species	Total Weight (g)	Yolk Sac (g)	True Weight (g)	Yolk sac as % of True Wt.
Hen	36.0	6.5	29.5	22.0
Skua	68.6	6.8	61.8	11.0
Penguin	86.3	13.1	73.2	18.0
Kiwi, 1 day	318.6	113.1	205.5	55.0
Kiwi, 6 days	281.0	54.0	227.0	24.0
Kiwi, 3 weeks	263.5	14.1	249.4	6.0

1 Romanoff 1960; 2 Reid 1966; 3 Reid and Bailey 1966.

Table 3 WEIGHT OF YOLK IN KIWI EGG AND CHICKS

Source	Wet Weight	Dry Weight	Percent Solids	Fresh Equivalent
Fresh Egg	251.4	142.5	56.7	251.4
Chick, 1 day	111.9	71.6	64.0	126.3
Chick, 3 weeks	14.1	9.1	64.5	16.0

Table 4 WEIGHT AND DISTRIBUTION OF FAT IN KIWI CHICKS

Part of Body	Day Old Chick			Three Week Chick		
	Lean	Fat	Total	Lean	Fat	Total
Skin and Wings	31.7	30.6	62.3	-	-	67.7
Head and Bill	11.0	0	11.0	12.5	0	12.5
Trunk and Neck	28.3	7.7	36.0	36.9	7.4	44.3
Legs and Thighs	39.7	2.6	42.3	57.1	2.0	59.1
Feet	13.5	0	13.5	15.1	0	15.1
Viscera etc.	37.8	2.6	40.4	48.1	2.6	50.7
TOTALS	162.0	43.5	205.5	-	-	249.4

Table 5 WEIGHTS OF KIWI EGGS AND CHICKS

	Egg Weight (g)	Chick Weight		Days After Hatching	Hatching Wt. as % Egg Wt.	Lowest Wt. as % of	
		At Hatching	Lowest Weight			Egg Weight	Hatching Weight
I	290	180	115	-	62	40	64
I	370	240	170	14	65	46	71
II	355	-	140	9	-	39	-
III	485*	319	205	-	65	42a	64a
III	485*	319	162	--	-	33b	51b

I Robson, II Hartree, III Reid: * Estimated Weight of Sibling Egg
a = Weight of Chick excluding 113 g. yolk-sac
b = Weight of Chick excluding 113 g. yolk-sac and 43.5 g. of fat.

ACKNOWLEDGEMENTS

I thank Messrs Ken Francis and T. R. Hartree of the Hawke's Bay Wildlife Trust for supplying details about their recently hatched chick; and Dr G. R. Williams for comments on the text.

LITERATURE CITED

REID, B. E. 1966. The growth and development of the South Polar Skua *(Catharacta maccormicki)*. Notornis 13(2): 71-89, 7 figs, 6 tables, pls II-III.

——— 1971a. The weight of the Kiwi and its egg. Notornis 18(4): 245-249, tables 1-5.

——— 1971b. Composition of a Kiwi egg. Notornis 18(4): 250-252, tables 1-4.

———; BAILEY, C. 1966. The value of the yolk reserve in Adelie Penguin chicks. Records of the Dominion Museum 5(19): 185-193, 1 fig., tables 1-7.

ROBSON, F. D. n.d. [1958]. Kiwis in captivity. Some observations on the famous flightless birds of New Zealand as told to Robert Gibbings by F. D. Robson. 3rd ed. Bulletin of the Hawkes Bay Art Gallery and Museum [Napier]. Pp. 1-8, 1 fig.

ROMANOFF, A. L. 1960. The avian embryo, structural and functional development. Pp. xvi + 1-1305, 426 figs. New York: Macmillan.

TURBOTT, E. G.; WIGHTMAN, G. C. 1954. A breeding record of the Kiwi in North Auckland. Notornis 6(1): 150-152.

Mr B. E. Reid,
Wildlife Service,
Department of Internal Affairs,
Wellington

BIRD DISTRIBUTION MAPPING SCHEME

Last year's report (*Notornis* 18: 207-210) summarised progress from the completion of the feasibility trial in 1969 (*Notornis* 17: 231-235) until 30 March 1971. The present report, the third in the series, is limited to the eight months 1 May to 31 December 1971 so that future reports can cover a full calendar year.

As at 31 December 1971, a total of 4224 lists of species had been received and these covered 61% of the 1600 North Island squares (only 29% in April 1971) and 33% of the 2000 South Island ones (19% in April 1971). The lists were contributed by 278 observers. As in previous reports, the accompanying maps (Figs 1 and 2) serve two purposes: first, to show the scheme's progress towards the objective of a species list from every square in New Zealand and, second, to illustrate the distribution of some selected species as revealed by lists received to date. Figs 1 and 2 show all the squares from which lists had been received up to June 1972; some cards belonging to next year's report are included to give a more up-to-date indication of which squares still have to be covered.

A marked improvement in coverage was achieved in almost all parts of New Zealand during 1971-72. The improvement in the Wellington district, formerly poorly covered considering the several ornithologists who live there, is especially pleasing (as at 13 March 1972, lists were available from 152 of the 155 squares in the Wellington district — a 98% coverage, thanks largely to the energetic work of Dr J. A. Fowler). The North Island is now reasonably well covered except for some difficult country in the centre (Taranaki across to East Cape). A great deal of work still remains in the South Island where ornithologists are not only fewer and less evenly distributed, but have more squares to cover, many of them difficult to reach. The need for detailed information on the distribution of birds, particularly the rarer native species, has become urgent following recent proposals for changes in the commercial use of large areas of forest in the South Island; this provides a further opportunity for the Ornithological Society and government departments to cooperate in securing information of mutual interest.

While the improvement in the number of squares covered by bird lists is encouraging, there is no room for complacency. A report recently prepared by Dr J. A. Fowler lists the species so far recorded from each of the 155 squares inthe Wellington district. The number of species noted per square varied from 5 to 50 with a mean of 20. Even allowing that the number of species recorded reflects the diversity of the habitat as well as the thoroughness of the survey, it is certain that many squares contain far more species than have yet been recorded from them. Clearly, many more lists are needed even from squares already marked as "covered"; areas of native forest, often

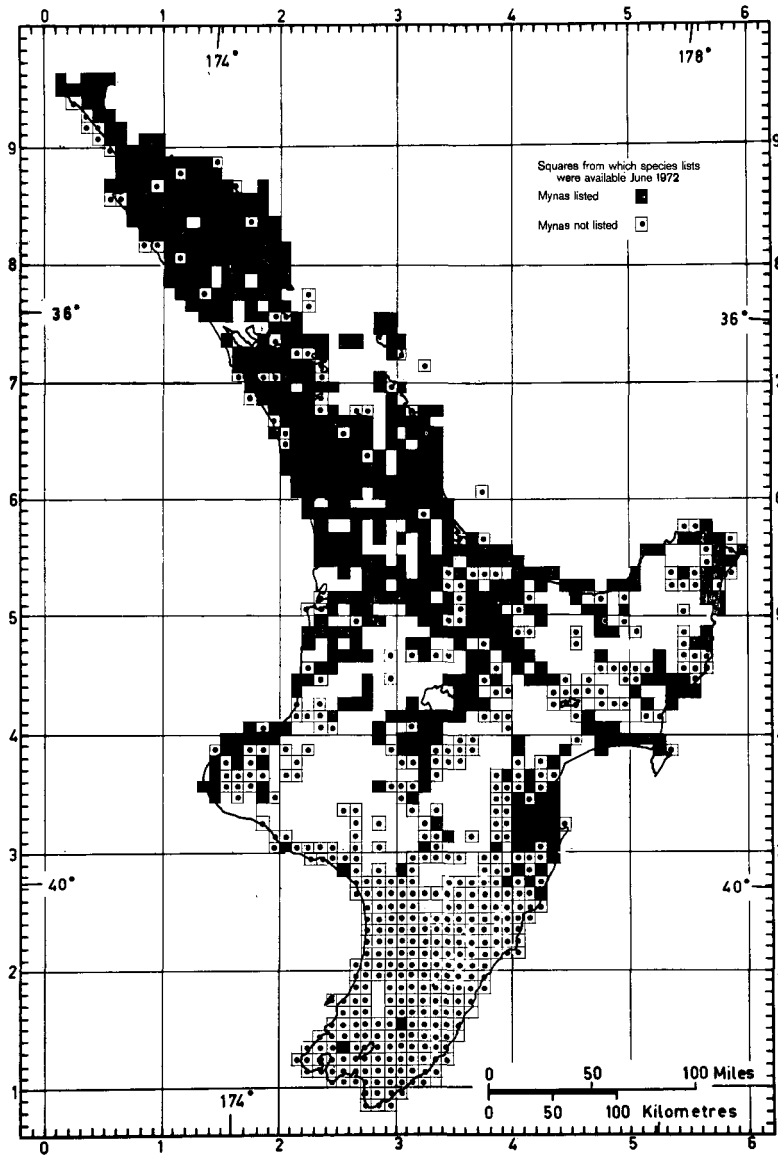


FIGURE 1: Distribution of Mynas *(Acridotheres tristis)* in the North Island. Squares from which species lists are available are either shaded black (Mynas present) or have a central black dot (Mynas not listed); the remaining areas (white) are those from which species lists are not yet available. (Only two cards record Mynas in the South Island; see text.)

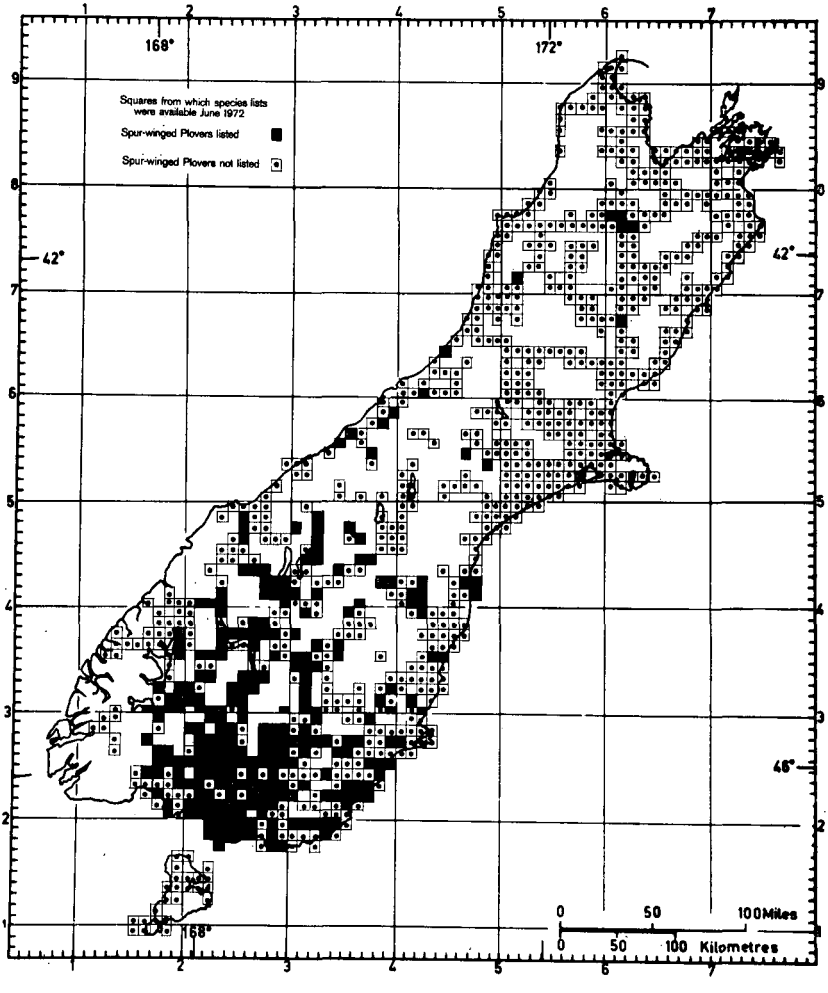


FIGURE 2: Distribution of Spur-winged Plovers *(Lobibyx novaehollandiae)* in the South Island. Presence, seeming absence and 'no data' are indicated as in Fig 1. (Only one card reports a Spur-winged Plover in the North Island.)

less easily reached than roadside farmland, require particular attention.

Electronic data processing facilities are necessary before all the detailed information collected by the mapping scheme can be properly used. The value of the data is appreciated by government departments concerned with wildlife and, hopefully, some assistance will be forthcoming from the Government Computer Centre. Although negotiations to this end are in progress, they advance only slowly. In the meantime, the recording office has begun the task of transcribing data from the old cyclostyled forms, used in 1969-70, to the new printed cards; having only one type of card will greatly facilitate filing and storage of data.

This year's report differs from previous ones in that the maps show the distribution of two species of birds: the Myna *(Acridotheres tristis)* in the North Island (Fig 1) and the Spur-winged Plover *(Lobibyx novaehollandiae)* in the South Island (Fig 2). To avoid confusion the maps exclude two records of Mynas from the South Island (one bird at East Taieri on 10/9/70 and three near Rakaia on 20/12/71), and one of a Spur-winged Plover in the North Island (a single bird resident at Waikanae, square N.2517). Mynas (Fig 1) are numerous and widely distributed in many districts north of Latitude 40°S, and especially so near townships and cultivated areas; they are rare in native forests except where roads and picinc spots provide openings. The reason for the virtual absence of Mynas in the southern quarter of the North Island, even in intensively cultivated areas, is not understood. The climate of, say, Manawatu can hardly be too cold for a bird that can flourish around Taupo and survive at Waiouru. The status of the Spur-winged Plover in New Zealand is described by other authors elsewhere in this issue. Any discrepancy between that detailed account and the distribution shown in Fig 2 probably results from the fact that Fig 2 contains only records supported by cards held by the Bird Mapping Scheme; records of Spur-winged Plovers, available from other sources, are excluded.

The authors wish to thank the many people who have contributed to the Mapping Scheme during the past year. Mr C. J. R. Robertson of the Wildlife Service (Department of Internal Affairs) provided information on computer services, the Cartographic Section of DSIR prepared Figs 1 and 2, Regional Representatives distributed and checked cards, and a great many people contributed skill, time and money in compiling birds lists from places out of town.

Dr P. C. Bull,

Mr P. D. Gaze,
Ecology Division,
DSIR,
P.O. Box 30-466,
Lower Hutt.

SHORT NOTES

PIED AND BLACK FANTAILS

Inspired by John L. Craig's article (1972), and with a clear personal recollection of the Black Fantail well known in the South Island, we decided to make a count in the course of a nine-day tour through the North Island in May 1972. Our route took us from Hawkes Bay through the Manawatu Gorge, Wanganui, New Plymouth, Waitomo and Taupo and we counted 81 positive sightings of fantails — all pied.

This seems to confirm that Black Fantails are rare in the North Island but it doesn't prove that there aren't any.

REFERENCE

CRAIG, J. L. 1972. Investigation of the mechanism maintaining polymorphism in the New Zealand Fantail, *Rhipidura fuliginosa* (Sparrman). *Notornis* 19 (1): 42-54, 6 tables.

JOHN and MARY McFADZIEN

P.O. Box 157,
Havelock North

★

MONGOLIAN DOTTEREL AT MANGERE

On 16 April 1972, Mrs H. Hagen and I observed an unusual dotterel at Mangere pools. There were about 30 Wrybill in the vicinity but none very close to the dotterel which was feeding in the mud and running short distances in typical dotterel manner. We separated, Mrs Hagen making a detour round the bird in order to drive it closer to me; it soon became apparent that it was unable to fly although it could run fast and swim well. After some manoeuvring we managed to catch it; no injuries were apparent. Measurements of bill, wing and tarsus were taken, also notes on plumage. Outstanding features were its large black eye, longish legs and faint, broad, smudgy breast band. Comparison later with skins in the Auckland Museum proved it to be a Mongolian Dotterel *(Charadrius mongolus)*. Another visit to the same area was made a week later but the dotterel had disappeared.

SYLVIA M. REED

4 Mamaku Street,
Meadowbank,
Auckland 5.

EAGLES IN NORTHLAND

On Saturday, 25 March 1972, Mr Leon Kernot of Kaitaia was travelling by car, with a friend from Australia, up the Ninety Mile Beach. About half a mile south of Hukatere Hill they came upon a large bird of prey just finishing a meal of sea gull which it had apparently killed. The bird did not rise until approached to within some thirty or forty feet and, hence, they had a good view of it. The bird was at least two or three times as large as a Harrier, very dark brown on the back, paler on the under body, and the legs were clothed with feathers right down to the feet. The wing-span was estimated to be about six feet, and before being disturbed on the beach the bird stood very erect.

About two weeks later, on 10 April, Mr Ron Hopkins, a crayfisherman and skipper of the boat *Wainoni*, saw what was apparently the same bird on the Cape Maria Van Diemen island off the mainland, the distance from the first sighting being about 40 to 50 miles. The details supplied by Mr Hopkins (including a report in the *Northland Age* that: " The bird appeared to have a six foot wing span and to be light brown on part of its plumage with a dirty yellow front and feathered legs ") were much the same as those given by Mr Kernot and would suggest that the bird could possibly be the Wedge-tailed Eagle of Australia, judging by the coloured figure given in the 8th edition of Leach's " Australian Bird Book " (Leach 1944: fig. 158 (opp. p. 29)). These are not the first sightings of strange birds of prey since another was observed by several people around Kaitaia a little over a year ago and seemed to answer the description of a Peregrine although I did not see it myself. Both of the recent eagle sightings were reported in the local paper and Press Association messages have also appeared in other papers (e.g. *The Evening Post* in Wellington).

REFERENCES

EVENING POST, 1972. Australian eagle in NZ ? The Evening Post [Wellington], 30 March 1972: 1.

LEACH, J. 1944. An Australian bird book. 8th ed. (rev. and ed. by C. Barrett). Pp. 1-200, illus. Melbourne: Whitcombe & Tombs Ltd.

NORTHLAND AGE, 1972*a*. Big bird may have been eagle. Northland Age, 41 (48), 28 March 1972: 1.

NORTHLAND AGE, 1972*b*. " Eagle " on island off Cape Maria. Northland Age 41 (51), 11 April 1972: 1.

R. H. MICHIE

45 South Road,
Kaitaia

SIGHTING OF BLACK-CAPPED PETRELS AT SEA OFF THE NEW ZEALAND WEST COAST

Single Black-capped Petrels *(Pterodroma externa cervicalis)* were observed on 20 February 1972 from 1145 to 1400 hours (N.Z.S.T.) between 16 and 20 miles (25 and 35 km) off the coast between Piha and Muriwai Beach, on the west coast of the North Island. The birds (or bird) were seen on several occasions during this period and came close enough to the vessel (m.v. *Ikatere,* the Fisheries Research Division's 63-ft trawler) to allow positive identification. The petrel was distinctive enough for other members of the crew to recognise and point out to me. The weather at the time was fine with a glassy sea, and generally calm weather with light winds from an easterly quarter had prevailed over the previous week.

Black-capped Petrels, which breed on the Kermadec Islands and are regularly seen north of New Zealand, have not been observed at sea in New Zealand coastal waters, though they must sometimes occur close to New Zealand, because damaged specimens have been recorded from Rotorua after a severe tropical storm in April 1968 (Kinsky 1971) and near Hamilton by Reed (1972) after strong northerly winds during October 1971. These previous records have been associated with strong winds, but the present sighting was made during a period of settled weather, and it is possible that Black-capped Petrels occur more regularly on oceanic waters off the New Zealand northern coasts than indicated by storm-wrecked specimens.

Details of the sightings were:

Date	Time	Position Latitude S	Position Longitude E	Sea surface temperature °C	Other Birds
20/2/72	1145-1200	36° 58′	174° 03′	20.3	Black-winged Petrels, **Pterodroma** spp.
	1300-1330	36° 52′	174° 02′	20.3	Grey-faced Petrels, **Pterodroma** spp.
	1400	36° 48′	174° 03′	20.3	Black-winged Petrels Buller's Shearwaters Fluttering Shearwaters Flesh-footed Shearwaters

LITERATURE CITED

KINSKY, F. C. 1971. Recent occurrences of rare petrels in New Zealand. Notornis 18 (3): 215-216.

REED, S. 1972. Black-capped Petrel in the Waikato. Notornis 19 (1): 91.

P. E. ROBERTS

Fisheries Research Division,
Marine Department,
327 Willis Street,
Wellington

REPORT ON GREAT BARRIER ISLAND, JANUARY 1972

A group of seven members of the OSNZ and one visitor spent from 25 until 30 January 1972 camping on Great Barrier Island for the purpose of covering as much of it as possible for the Mapping Scheme. The island breaks into nine squares and original plans allowed one week there, but unfortunately cyclone " Carlotta " intervened so that crossing had to be postponed by three days. However, by working consistently throughout, eight squares were covered reasonably thoroughly.

As is well known, Great Barrier Island is the stronghold of the Brown Duck and considerable flocks of these were seen, up to 200 on one occasion, more particularly at dawn and dusk when they are active. They occur mainly in the swamps on the eastern side of the island between Whangapoua and Medlands Beach, but odd ones are seen almost anywhere on the island from time to time.

The Black Petrel breeds on the slopes of Mount Hobson (highest point 2,038 ft (621 m)) and probably on other peaks of lesser height. It is more plentiful here than on Little Barrier, and the population was estimated at about 300 - 400. This is considerably more than the 50 pairs stated by Bartle (1967) but he has since said (pers. comm.) that he wishes to revise his estimate more in line with ours. The night of 26 January was spent on top of Mt Hobson. The first Cook's Petrel was heard calling at 8.25 p.m.; although these were seen and heard in flight, none was found on the ground and we surmised their burrows, if any, must be situated lower, as on Little Barrier Island. Just after 8.30 p.m., Black Petrels were heard clacking in their burrows and then seen flying in. The clacking was at times positively deafening, but in spite of it sounding so close, it was no easy matter to track it down to a particular burrow. Those on the surface became silent on being approached. Four burrows were located with birds in them, one with a 3-day chick, three on eggs. The bird with chick bore a band which we later discovered was put on by J. A. Bartle in December 1966 when the bird was found in a burrow in the sameplace, very close to the summit. Eight new birds were banded that night, two of them in one burrow with egg, so presumably a pair. The clacking noise continued until just after dawn, whereas the calling of Cook's Petrel faded away soon after mid-night. The Black Petrel also has a two-note call which was heard from the burrow and also from one bird while being handled. Another sound heard from them resembled a cooing noise. Four of the banded birds were weighed and their bills and wings measured:—

	Weight	Bill Length	Wing Length	
K 2114	675 g	41 mm	345 mm	
K 2120	625	41	370	
K 2121	900	40	353	} presumed
K 2122	780	44	365	} pair

It is interesting to note that the heaviest bird was by no means the largest.

The Mt Hobson area is now State Forest property and the bush is being allowed to regenerate naturally. There are practically no large trees, except for one or two Kauris, possibly 50-60 years old, because the early settlers first cut out all timber and the later firewood trade took a heavy toll. Forestry management includes measures to keep down the goat population and at present no exotics are being planted. Regeneration appears good, and there are several species endemic to Great Barrier; e.g. *Leptospermum sinclairi, Coprosma dodonaefolia* and *Olearia allomi.* The forest is podocarp and mixed broadleaf, and contains many berry-bearing and nectar-producing trees, including seven species of Rata (*Metrosideros* spp.). Nevertheless, tuis and pigeons are by no means plentiful, and bellbirds were neither seen nor heard. It is possible that many trees are as yet too young to produce large crops of berries. Rats are plentiful and robbed the party of food at night.

A large part of the island consists of second growth Manuka *(Leptospermum scoparium)* and Kanuka *(Leptospermum ericoides)* which is periodically burned off. The commonest species is easily the Kingfisher and the general impression is of a paucity of bird life, particularly in the bush areas.

Besides those already mentioned, the following species were noted: Gannet; Black Shag; Pied Shag; Little Shag; White-faced Heron; Reef Heron; Bittern: Black Swan; Mallard; Grey Duck; Harrier; Californian Quail; Pheasant; Banded Rail; Pukeko; Variable Oystercatcher; Banded Dotterel; N.Z. Dotterel; Wrybill; Godwit; Pied Stilt; Black-backed Gull; Red-billed Gull; Caspian Tern; White-fronted Tern; N.Z. Pigeon; Kaka; parakeets (heard only); Shining Cuckoo; Morepork; Skylark; Pipit; Grey Warbler; Fantail; Song Thrush; Blackbird; Silvereye; Tui; Yellowhammer; Chaffinch; Greenfinch; Goldfinch; House Sparrow; Starling; Myna; White-backed Magpie [for scientific names consult OSNZ Annotated Checklist, 1970].

In the northernmost area, a local resident reported Kokako as being extremely rare. In this part, the bush is in poor condition, overrun with goats and pigs, hence little or no regeneration, the dominant species being Kohekohe *(Dysoxylum spectabile)* and Nikau *(Rhopalostylis sapida)*, with very little Tawa *(Beilschmiedia tawa)*. There were also local reports of Fernbird, and Riflemen were seen by two other members visiting the island a week previously. The Welcome Swallow has not apparently reached the island yet. A rather surprising omission is the Dunnock; perhaps further observations will reveal it as present.

Thanks are due to those who took part with me in this project being: D. White, S. Chamberlin, R. Thomas, M. Delamore, P. Miller, L. Claydon (visitor), Mrs W. Mitchell. All worked hard and willingly for the five days which could hardly be described as a holiday, especially for three of the party who, in turn, went down with some kind of 2-day stomach ' bug.'

Seabirds seen on the crossings have purposely been omitted from this report.

We are indebted to the N.Z. Forest Service who provided a camp site, some of our transport, and were most co-operative.

LITERATURE CITED

BARTLE, J. A. 1967. Records of Cook's Petrels and Black Petrels from Great Barrier Island. Notornis 14 (1): 26-27.

SYLVIA M. REED

4 Mamaku Street,
Meadowbank,
Auckland, 5.

★

KIWI EGGS LAID AT WELLINGTON ZOO

A blind female North Island Brown Kiwi *(Apteryx australis mantelli)* of unknown age arrived at Wellington Zoo in 1960. In mid-1969 she was shifted to an enclosure measuring 32 by 21 feet (670 sq. ft; 62.5 sq. m) and, since then, has laid eight eggs — the first in November 1969 and the eighth on 15 November 1971. These eggs were irregularly spaced, the intervals between them being 92, 207, 57, 26, 67, 99 and 188 days respectively.

The bird maintains good health, but she is exceptionally small. She weighed 1701 g six days after laying a 374 g egg in 1970; and a series of five weights taken during 1971 and early 1972, which ranged from 1612 to 1719 (mean 1665) g, show her to be about two-thirds the weight of wild females in good condition. Measurements and fresh weights are known for six eggs and these weights average about 22% of her mean body weight (Table 1). The mean weight of 363.5 g for this series of eggs is about 8 g or 2.2% heavier than the mean weight obtained from the calculation $.565ab^2$ (Reid 1971: 246) which, it seems, may understate the weight of fresh kiwi eggs.

When the female laid in February 1970 she was alone in the enclosure — the male had been shifted to a neighbouring pen some time earlier. The other seven eggs, which were laid while she had a male companion, were also infertile.

The egg laid on 15 November 1971 had an internal volume of 342.5 ml. Its fresh weight of 374.7 g decreased by 36.1 g to 338.6 g after 31 days of incubation. This egg was deep-frozen and the shell, albumen and yolk separated. The shell, which weighed 22.3 g, had a volume of 10.5 ml. The albumen weighed 95.1 g and the yolk 221.2 g or 62.8% of the weight of the contents at the time of laying. Romanoff & Romanoff (1949) have shown that during the early period of weight-loss in stored eggs the albumen, as well as losing water by evaporation through the shell, also loses it by diffusion to the yolk which, as a consequence, increases in size. To be meaningful, comparisons of the contents of eggs which differ widely in age should be based on the dry weights of these contents. In a fresh egg, described elsewhere (Reid 1971), yolk comprised 61.1% and albumen 38.9% by weight of the contents. Data in Table 2 compare this egg with the one laid at Wellington Zoo and show that,

while the contents of the latter egg include proportionately more yolk, this yolk contains fewer solids — and that on a dry weight basis the yolk content of both eggs is almost identical.

In the eggs of other species of birds the yolk comprises from 13.2 to 44.6% of the contents (Romanoff & Romanoff 1949) but in two eggs of the North Island Kiwi the yolk represented between 61 and 62% by weight of their contents when fresh. The large quantity of yolk in the kiwi egg permits this species to meet the demands of an exceptionally long incubation period (74 to 84 days) and still hatch with ample food reserves to nourish it during its first five or more days of life when it is confined to the nesting burrow.

I thank Nubar Dakessian for providing weights of fresh eggs and other information.

Table 1 MEASUREMENTS AND FRESH WEIGHTS OF EGGS : WELLINGTON ZOO

Date Laid	Measurements (mm)	Shell Weight	Total Weight	Egg Wt. as % of Mean Body Wt.
10.11.69	112.2 x 75.3	21.7	360.0	21.6
10. 2.70	119.6 x 69.4	19.7	374.0	22.5
5. 9.70	121.0 x 71.7	21.7	354.6	21.3
1.11.70	111.5 x 78.1	23.2	368.0	22.1
27.11.70	110.4 x 73.9	20.6	352.5	21.2
15.11.71	116.5 x 75.0	22.3	374.7	22.3
Mean	115.2 x 73.9	21.5	363.5	21.8

Table 2 YOLK CONTENT OF A FRESH EGG FROM A WILD BIRD, AND OF A 31-DAY OLD EGG LAID AT WELLINGTON ZOO.

Egg	Weight of		Yolk			
	Fresh Contents (g)	Yolk (g)	As a % of Contents	Dry Weight (g)	Dry Wt. as % of Wet Wt.	Dry Wt. as % of Contents
Wild	411.7	251.4	61.1	142.5	56.7	34.6
Zoo	352.4	221.2	62.8	122.7	55.5	34.8

LITERATURE CITED

REID, B. 1971. The weight of the Kiwi and its egg. Notornis 18 (4): 245-249, tables 1-5.

ROMANOFF, A. L.; ROMANOFF, A. J. 1949. The avian egg. Pp. xii + 1-918, 42 figs. New York: Wiley; London: Chapman Hall.

BRIAN REID

Wildlife Service,
Department of Internal Affairs,
Wellington

LETTERS

The Editor,
Sir,

SERVICE TO THE SOCIETY

A quarter of a century ago it was my pleasure, as Secretary-Treasurer, to acknowledge year after year a donation to the Society's funds from Miss B. McDougall. Although lists of donations received regrettably did not appear in *Notornis* from volumes 8 to 14 inclusive, I believe her generosity continued and recent years have shown she is still a regular contributor of increasing amounts. What devotion she has shown over the years to the welfare of the Society!

Another example is that of Dr R. A. Falla who is I think the only member who has served continuously on the Council since the foundation of the Society. I am sure all members will join me in congratulating these two members whose records of service stand unsurpassed in their respective fields.

J. M. CUNNINGHAM

Wellington
27 July 1972

★

The Editor,
Sir,

Mills, J. A. 1971. The reliability of sight recoveries of banded Red-billed Gulls. The Australian Bird Bander 9 (4): 83-84 (Department of Internal Affairs, Wildlife Publication No. 131)

The review by J.M.C. of this paper was most interesting and we can agree on the importance of checking the work. In some instances simple book-keeping checks are adequate, appropriate to dead material but often needs-be, other checks are required for live birds. This paper is one such check. More generally the accuracy of the data will determine the precision of the deductions.

My experiences may be relevant.

During the six years 1959-64 I recovered by sight more than 1700 Red-billed Gulls, and made six definite mistakes among the birds sighted, one of a bird handled, and one of a band found squashed into the road. The first six mistakes were of three types; simple numerical slips (Hartree, 1952: 5-10) such as inversion of the order of two digits; secondly the repetition of a digit probably often when it has been difficult to obtain a view of the whole number; and thirdly anticipation. Bands of two diameters, "E" diameter and "H" diameter were used on Red-billed Gulls. All E bands were pre-fixed with E and most H bands with H. Some H bands had only a number. Now these bands could be recognised apart at a glance; further often those of different years of the same size could be recognised, so

usually it was only necessary to read the final three or four digits of the five figure number. The first one or two digits could be guessed, perhaps hardly consciously.

However, lack of this anticipation was one of the striking confirmations of the accuracy of my work. A gull from a remote banding station was recognised by the reading of the first two digits of its number and no impossible combinations were read.

Also for some years colour-banding was used to distinguish the colony where the gull had been banded. Certainly the initial digits of birds from all colonies were read correctly.

Another test of accuracy was the reading of both numbers of gulls with two numbered bands on and of the number of Black-billed Gulls *(Larus bulleri)* colour-banded to distinguish the individual. Among the latter there was disagreement because of loss of colour bands and the bad-fading of many colours, as was experienced with gulls coloured banded to indicate the colony.

Further tests are possible. The recoveries of different hundreds of one year's gull chicks from one colony would be expected to be distributed binomially. This was found for several years; for other years when the recoveries did not have a binomial pattern there is good independent evidence suggesting that the pattern based on sight recoveries was showing a real effect.

It may be of interest to explain the mistake made with the squashed band. The gull was sighted, alive and well with the number that had been thought to be on the squashed band. The squashed band was on hand so it could be examined again.

Certainly there can be little doubt about the band number of gulls that were seen repeatedly in one locality. For the others little hangs on a single recovery; deductions should be made from several instances of similar recoveries.

It may be of interest to examine the alternatives of colour banding, of extensive re-trapping, or of making deductions from recoveries of banded gulls found dead.

Colour banding of Black-billed Gulls has already been discussed. Also birds with several bands on one leg are especially liable to be lame with that leg. I consider two bands on one leg as undesirable. And no colour-banding scheme could be used to identify the thousands of gulls that were banded each year.

Retrapping causes great disturbance of the birds. Many birds quickly learn to recognise the trap and become much more shy. Only the stupid and the very bold are frequently retrapped; the results are grossly non-random. Even my sight recoveries of gulls were non-random with too many male gulls and too many first-year gulls being identified. Also most traps are not light and mobile; overseas these traps are usually at research stations and are permanent structures.

If only recoveries from dead birds are used then most of the interest and detail that can be learnt from banded birds is lost. Also the recovering of banded birds is the work of a banding project and surely it is most undesirable that this be passed to the general public. The expense of obtaining these recoveries remains even though it is now spread over many heads.

Now, how is the worth of a technique, method or theory judged? First it is judged by an internal criticism of the results and secondly by checking independently the more extreme deductions, easily accessible to checking.

These criteria will apply to results obtained by sight recoveries of banded birds.

An original "aim" of our Society was "the study of living birds in their natural state." I believe a careful and intense programme of obtaining a wealth of sight recoveries of banded birds is one of the best policies in such a study. "Best" in that it is relatively simple, easy, and of low cost; and skilfully carried out with minimum disturbance to the birds observed.

REFERENCES

EDGAR, A. T.; HEATHER, B.D.; ROBERTSON, C. J. R. (n.d.) Bird study in New Zealand.

HARTREE, D.R. 1952. Numerical analysis. Oxford: Clarendon Press.

J. R. JACKSON

103 Linwood Avenue,
Christchurch, 1.
21 July 1972

★

The Editor,

Sir,

CONSTITUTIONAL PROCEDURE AT THE AGM

In the report of the Annual General Meeting for 1972 (*Notornis* 19 (2): 176) concerning the "matter of joining CoEnCo" Dr R. A. Falla is reported as saying "this was the place for members to instruct Council . . ."

Unfortunately this is not so. The 1953 Constitution of the Society provided for the Council to manage the affairs of the Society "subject to the direction of the Society in general meeting." Members will recall that in 1968 and again in 1970 I fought tooth and nail against certain proposed alterations to the constitution, including the dropping of this desirable provision, in the new and unsatisfactory constitution which was finally adopted in Christchurch in 1971 in my absence.

Members will now realise that they have surrendered control of their own society to the ruling council as their only practical recourse (if they should wish it) is to unseat its members, one third at a time, over three years. Let us hope that the council will in fact, continue to act as a "benevolent dictatorship."

J. M. CUNNINGHAM

Wellington
27 July 1972

REVIEWS

Peter Scott and the Wildfowl Trust. *The Swans.* Michael Joseph, London 1972. £4.20 (in England).

This is a beautiful and exciting book, of 242 pages, with a frontispiece reproducing four Bewick's Swans in flight from an oil painting by Peter Scott, 48 monochrome plates and very many line drawings by a variety of artists. The contents cover practically every aspect of the lives of the swans of the world, although with some species there are as yet unanswered questions. Peter Scott contributes the introduction, Hugh Boyd deals with Classification. He follows that of Delacour and Mayr, and is thus on the side of the " lumpers." He provides a useful key to recognition of the eight species and subspecies recognised. M. A. Ogilvie discusses Distribution, numbers and migration, Myrfyn Owen and Janet Kear write on Food and feeding habits, Janet Kear on Reproduction and family life, and J. V. Beer and M. A. Ogilvie deal with Mortality, including a section on parasites. This is followed by a chapter on the Swan in mythology and art by Mary Evans and Andrew Dawnay. The latter then discusses Exploitation and Geoffrey Mathews concludes with a chapter on Conservation, ending it with a plea for " universal rational birth control . . . without it all conservation efforts will be in vain." There are nine statistical appendices, a Bibliography with 350 entries and a good index.

So much for a summary of the book's contents. I said it was " a beautiful and exciting book." It is very well written and beautifully produced, a book that is a joy to own. The excitement comes from learning more of what has happened and is happening at Slimbridge and the two other areas controlled by the Wildfowl Trust, and to learn that a Japanese farmer and his sons had, by winter feeding and protection, at Suiibara, near Niigata, increased the population of Whooper and Eastern Bewick's Swans from 15 birds in 1955 to over 1,000 in 1970, in a lake of about 400 yards in diameter, bounded by rice paddies on one side, and an industrial area on the other. At Slimbridge, from November 1948, when the first Bewick's Swan " dropped in " the total built up to a maximum of 411 for any one day — and a season total of 626, during the winter of 1970-71. Each Bewick's Swan has a different colour pattern on the bill, and every Slimbridge bird was given a name. By the 1970-71 winter, 1,315 birds had been named, and two girls, Mary Evans and Dafila Scott, who must possess phenomenal visual memories, could recognise every bird.

This is a book that should be on the shelf of everyone, Scientific ornithologist or plain bird lover (not mutually exclusive terms, of course) who delights in watching Swans.

R. J. SCARLET

This is a beautiful book on a beautiful subject. The true swans of the world, six full species and two strong subspecies — or if you so wish, eight species of which five belong to the northern hemisphere and three to the southern — here come into their own in a scientific publication which at the same times does justice to their distinctive grace and eloquently pleads for their conservation.

From time immemorial swans have attracted the notice of *Homo sapiens,* hunter and artist. Not only have they often helped to feed and clothe him right down to today, but they have appealed to his aesthetic sense and often inspired his art and literature (*v.* chap. 7).

Since the establishment of the Wildfowl Trust new fields of research have been revealed and much has been learnt about the life and habits of many species of wildfowl which on their migrations make a mockery of national boundaries fixed by man; and the work of the Slimbridge team must have been given a felicitous fillip by the exciting information which resulted from the meticulous study of the wild Bewick's Swans which, bringing the new generation with them, return winter after winter from their arctic breeding grounds.

An introduction by Peter Scott is followed by a series of essays on various aspects of the ecology of the genus *Cygnus.* All are written by scientists who know and love their subject. For the biologist who is concerned with wildfowl problems in other lands, these essays, which are backed by maps and tables, will be of inestimable value. New Zealand is not neglected. Our native *Cygnus sumnerensis* became extinct not so long ago, a victim of the hunger of the so-called ' noble savage.' But studies of the introduced and flourishing Australian Black Swan have provided useful comparative and corroborative material.

There is, in fact, in this meaty volume much to make New Zealand ornithologists pause and ponder. Are we accepting our responsibilities towards the conservation of the world's threatened species of waterfowl ? With our temperate climate, generous rainfall and abundance of relatively clean and unpolluted water, is it not time to consider a more liberal policy ? Do we not need some sort of ' wildfowl trust ' on a much more ambitious scale than anything we have at present; firstly to further the study of our declining species — alas, it is not difficult to list them — with a view to their re-establishment, if possible, in strength; secondly to consider the release in New Zealand of fine species from other lands, of course after careful study and with due regard for their ecological needs ? Would not the great lagoons of Southland, the avian vacuum of Manapouri or perhaps Buller's Lake Puponga look a little brighter and better if Black-necked and/or Coscoroba Swans were rearing their families upon them ? These are two handsome South Americans which belong to roughly the same latitude as New Zealand. Neither species would be likely to pose a threat to those two particularly sacred cows of New Zealand, the sheep and the trout. Is it not worth considering that New Zealand might become a ' bank ' for selected species ?

If the ordinary man and his children can see and learn to appreciate big birds such as swans, there is a fair chance that they may then be led on to understand the need for protecting smaller and less conspicuous animal species, which are equally beautiful or precious. The first appeal must be to the eye.

This timely and well-documented volume is graphically illustrated with photographs and sketches both serious and gay. Many of the line drawings are indeed exquisite. Peter Scott and his team of devoted biologists and artists are to be congratulated and thanked. All who read — and they will be many — will surely be strengthened in their resolve to try to save some of the world's fine creatures before it is too late. Here we have more ammunition for the armoury of the enlightened conservationist.

R. B. SIBSON

SOME RECENT LITERATURE

BECK, J. R.; BROWN, D. W. 1971. The breeding biology of the Black-bellied Storm-petrel **Fregetta tropica.** Ibis 113 (1): 73-90, illus.

BRAXTON, D. 1971. Macquarie Island. Sea Frontiers. Magazine of the International Oceanographic Foundation 17 (4): 224-229, illus.

BUCKLEY, P. A.; WURSTER, C. F. 1970. White-faced Storm Petrels **Pelagodroma marina** in the North Atlantic. Bulletin of the British Ornithologists' Club 90 (2): 35-38.

CAYET, O. 1972. Faune aviaire des atolls. Pp. 119-136, pls 34-43 (Chapitre X) **in:** Le monde vivant des atolls Polynesie francaise Tuamotu-Gambier. Publications de la Societe des Oceanistes No. 28: 1-148, pls. 1-43 [introduction to birds of the Tuamotu group].

COWLES, G. S. 1970. The original description by H. O. Forbes of the extinct New Zealand Musk Duck **Biziura delautouri.** Bulletin of the British Ornithologists' Club 90(6): 166-168.

DARBY, M. M. 1970. Natural history of the Bounty Islands. Animals (London) 13 (4): 171-177, illus., map. [account of landing on Bounty Is, 12 January 1968, from **Magga Dan**].

ELLIOTT, H. F. I. 1970. Outlook for bird conservation. Bird Study 17: 81-94.

FALLA, R. A. 1972. Mammals, birds and habitat. New Zealand Wildlife 36: 2-5.

FARNER, D. S.; KING, J. R. (eds) 1971. Avian biology, Vol. 1. Pp. xx + 1-386, illus. New York: Academic Press. [reviewed by Allan Keast in Science 175 (4027): 1233, 17 March 1972].

FERGUSON-LEES, I. J. 1969. Studies of less familiar birds. 155. Little Stint. British Birds 62 (9): 382, illus. (after p. 368).

FOWLER, J. A. 1972. A bird-watching holiday on Stewart Island. Forest & Bird No. 84 (May 1972): 15-18, 2 figs.

FOWLER, J. A. 1972. Birds of the off-shore islands. Forest & Bird No. 84 (May 1972): 26-27, 2 figs.

FRANCIS, K. E. 1971. The New Zealand Kiwi. 20 pp. (unnumbered), illus. Christchurch: Whitcombe & Tombs Ltd.

HALD-MORTENSEN, P. 1970. [Lesser Redpoll **Carduelis flammea cabaret** (Muller), as a breeding bird in Denmark]. Dansk ornithologisk Forenings Tidsskrift 64: 163-193 (in Danish with English summary) [" A careful and stimulating account of . . . . breeding biology "].

HARRISON, C. J. O.; WALKER, C. A. 1970. The extinct Musk Duck **(Biziura)** of New Zealand: a re-appraisal of **B. delautouri.** Bulletin of the British Ornithologists' Club 90(1): 6-10, pl. I.

KEAR, J.; BURTON, P. J. K. 1971. The food and feeding of the Blue Duck **Hymenolaimus.** Ibis 113(4): 483-493, pls 18-20, table 1.

KINSKY, F. C. 1972. Paired ovaries consistently present in Kiwis (Aves, Apterygiformes). Search 3 (4): 140, fig. 1.

KOOYMAN, G. L. et al. 1971. Diving behaviour of the Emperor Penguin **Aptenodytes forsteri.** Auk 88(4): 775-795, figs 1-8, tables 1-6.

MERTON, D. V. 1972. Cuvier — an island restored. Forest & Bird No. 84 (May 1972): 7-9, 3 figs.

ROBERTSON, C. J. R. 1972. Royal Albatross colony at Taiaroa Head expanding and flourishing. Forest & Bird No. 84 (May 1972): 3-6, 3 figs. [also in — Wildlife 1971, a review].

ROBINSON, F. N. 1971. How to record bird song. Electronics Australia, March 1971: 12-15, 4 figs.

SHAUGHNESSY, P. D. 1971. Frequency of the white phase of the Southern Giant Petrel, **Macronectes giganteus** (Gmelin). Australian Journal of Zoology 19: 77-83.

SOPER, M. F. 1970. Native birds. (Nature in New Zealand series). Pp. 1-63, illus. Wellington, **&c.:** A. H. & A. W. Reed.

SPELLERBERG, I. F. 1971. Aspects of McCormick Skua breeding biology. Ibis 113 (3): 357-363, fig. 1, tables 1-4.

SPELLERBERG, I. F. 1971. Arrival and departure of birds at McMurdo Sound, Antarctica. Emu 71(4): 167-171, text-fig. 1, table I.

STIDOLPH, R. H. D. 1971. The birds around us. From a diary of bird observations in New Zealand over a period of 50 years 1921-1971. Pp. 1-140, figs 1-8, pls 1-4, 7 line drawings (as chapter heads). Masterton: Hedley's Bookshop Ltd.

STONEHOUSE, B. 1971. The Snares Islands Penguin **Eudyptes robustus.** Ibis 113 (1): 1-7, fig. 1, pls 1-2, tables 1-4.

TAYLOR, R. H.; FLUX, J. E. C. 1971. Review of Annotated checklist of the birds of New ZZealand. The Checklist Committee (F. C. Kinsky, Convener), Ornithological Society of New Zealand, Inc. A. H. & A. W. Reed, Wellington, 1970. Proceedings of the N.Z. Ecological Society 18: 80-82.

THOMAS, D. G.; DARTNALL, A. J. 1971. Ecological aspects of the feeding behaviour of two calidritine sandpipers wintering in southeastern Tasmania. Emu 71: 20-26. [Curlew Sandpiper, **Calidris ferruginea** and Red-necked Stint, **C. ruficollis**].

WARHAM, J. 1971. Body temperatures of petrels. Condor 73(2): 214-219.

WARHAM, J. 1972. Breeding seasons and sexual dimorphism in Rockhopper Penguins. Auk 89 (1): 86-105, figs 1-6, tables 1-6.

WELLER, M. W.; DERKSEN, D. V. 1972. Use of time-lapse photography to study nesting activities of birds. Auk 89 (1): 196-200, figs 1-2. [with special reference to the incubation behaviour of Adelie Penguins at Hallett Station].

WODZICKI, K. 1972. The Tokelau Islands (Men and introduced animals in an atoll ecosystem). South Pacific Bulletin 22 (1): 37-41, illus.

WOOD, R. C. 1971. Population dynamics of breeding South Polar skuas of unknown age. Auk 88(4): 805-814, tables 1-9.

YEATES, G. W. 1971. Diurnal activity in the Adelie Penguin **(Pygoscelis adeliae) at** Cape Royds, Antarctica. Journal of Natural History 5 (1): 103-112, figs 1-9.

YUDIN, K.A. 1970. A guide to the tubenoses (Procellariiformes) of the Antarctic and Subantarctic. Pp. 202-257, figs 1-35 **in** ANDRIYASHEV, P. A. & USHAKOV, P. V. (eds) Studies of marine fauna VI (XIV). Biological results of the Soviet Antarctic Expedition (1954-1958), Vol. 4 (translated from Kratkiy opredelitel' trubkononykh ptits (Procellariiformes) Antarktiki i Subantarktiki. Issledovaniya fauny morei VI (XIV). Resul'taty biologisheskikh issledovanii Sovetskoi antarkticheskoi ekspeditsii (1955-1958), 4: 200-254 (1968) by Israel Program for Scientific Translations, Jerusalem).

FROM THE EDITOR'S DESK

AN EDITORIAL HOBBY HORSE

Several times during the past few weeks administrators and " men-in-the-street " not directly involved in Science have expressed their misgivings to me about scientists and the " environmental bandwagon " as it has come to be called. There has been much discussion of late as to whether churchmen should pronounce on what the politicians say are political issues and, indeed, whether some politicians, themselves, should speak about matters falling within another's portfolio. As ornithologists, we fall between the two camps. Some of us are professional scientists, therefore we must preserve our objectivity. But we may be only " amateurs " in ornithology, perhaps only marginally qualified. Are we entitled to speak out on environmental issues involving birds simply because we wear the white laboratory coat of the scientist ? The question is not easy to answer, especially when it comes from those little able to distinguish between the man and his apparel. Perhaps we have to make it abundantly clear whether we are talking with our coats on or off. Objectivity is not, however, the prerogative of the scientist and we must all take care that emotion does not blind us to facts and sound propositions.

BioScience, February 1972, the journal of the American Institute of Biological Sciences, carries a timely editorial, " Scientists and the Environmental Bandwagon," in which this theme is developed. All thinking laymen and scientists involved in environmental work, alike, who make up, in fact, the bulk of the OSNZ, should read this, and, also, a similar message concerning " The responsibility of the professional ecologist in the preservation of natural areas " appearing in the *Ohio Journal of Science,* January 1972. Copies of both these papers are available from the OSNZ's library. Let me quote the concluding paragraph of the *BioScience* editorial:

" Our fragile earth is in serious danger. We need level heads, prepared minds, careful and meticulous analyses and sound scientific programs and solutions. Objectivity must be exercised by both environmentalists and their critics. All scientists who have abandoned objectivity must become scientists again. Careful laboratory and field work must replace blind guesses and wild extrapolation. We need scientific leadership that will win the confidence of laymen and people in government."

References: BEHNKE, J. A. 1972. Scientists and the environmental bandwagon. *BioScience* 22 (2). 73; STANSBERY, D. H. 1972. The responsibility of the professional ecologist in the preservation of natural areas. *The Ohio Journal of Science* 72 (1): 1-3.

ISLANDS OF THE GULF

New Zealand ornithologists undoubtedly regard the islands of the Hauraki Gulf as some of the most important of native bird habitats. Across my desk came recently a wonderful packet of pamphlets issued by the Hauraki Gulf Maritime Park Board which watches over most of the islands of the Gulf extending from the Poor Knights in the north to the Alderman Islands in the south-east and including such well-known and well-loved places as Rangitoto and Kawau. A series of booklets deals with each island in turn, its geography, history and unique features including Maori legends and even a history of wartime coastal defence establishments. Professor John Morton has written on the coastal biology of several islands in his own inimitable style. Members of the OSNZ will find these papers of great interest. Those responsible for their appearance must be commended for their enterprise, setting a fine example for other regions. As the Hauraki Gulf Maritime Park Board Act 1967 states, the Board is committed to " Administer and control the park in such a manner as to ensure to the public the maximum and proper use and enjoyment of the park consistent with the preservation of its natural features and the protection and well-being of its flora and fauna." These pamphlets are evidence of the Board's good intent. An informative newsletter is being issued three times a year and it, together with the other publications, may be obtained from the Information Officer, Hauraki Gulf Maritime Park Board, Department of Lands & Survey, P.O. Box 5249, Auckland.

ABOUT OUR AUTHORS

MAIDA BARLOW visited Whero Island, as a child, while Dr L. E. Richdale was working there. His advice to " study a single species and study it thoroughly " was not forgotten. Later she had the benefit of training and encouragement from Mr H. R. McKenzie. Other *Notornis* publications include notes or papers on Stewart Island Shags, Black-tailed Godwit, Gull-billed Tern, Broad-billed Roller and Dusky Moorhen. She is a past Council member and Regional Representative of the OSNZ.

PETER MULLER'S field work began with the Spur-winged Plover study, and his ornithological interests now cover a wide field. He is the author of " Wind and Water," the report of the January 1969 field study course in Southland. He is editor of *The Southland Times.*

ROGER SUTTON is senior field officer for the Southland Acclimatisation Society. His work for conservation has had some noteworthy effects. A wide knowledge of Southland's wildlife and his experience as a field worker have also been of benefit to a number of scientific investigations. Previous *Notornis* publications include those on Sanderlings, Whimbrels, food-passing by Harriers, and homing instinct in Pukeko. He is a Council member of the OSNZ and Regional Representative for Southland.

CAREL VOOREN was born in Rotterdam, Netherlands, 14 November 1941. He graduated in zoology at the State University of Utrecht in 1968, and his graduate studies included a project on the breeding biology of the House Sparrow. Since May 1968 he has worked as a scientific officer with the Fisheries Research Division of the Marine Department in Wellington. His principal research interest is the fisheries biology of the Tarakihi, *Cheilodactylus macropterus,* with particular emphasis on population dynamics. Field work takes him regularly to sea all round the New Zealand region. He says: " A reasonable number of breeding studies ashore has been made on sea birds, but few ornithologists get the chance to observe the birds regularly at sea where they spend, after all, most of their lives. I, therefore, decided to use my spare time at sea for studying this largely unknown aspect of sea bird biology, and the present paper is the first result of this."

BRIAN REID was born in 1930. After leaving school in 1947 he worked with the National Forest Survey until 1952 when he entered Canterbury University College. On obtaining his B.Sc. degree, he was employed for three years as Fishery Officer (mainly on trawlers and seine boats) in Auckland before transferring to the Antarctic Division of DSIR in 1958. He wintered-over at Cape Hallett during 1959 and made two subsequent visits to Antarctica where he studied penguins, skuas and seals. Since 1963 he has been with the Department of Internal Affairs studying Takahe, Kakapo and Kiwi.

REGIONAL REPRESENTATIVES

FAR NORTH & NORTHLAND: A. T. Edgar, Inlet Road, Kerikeri
AUCKLAND: Mrs. S. Reed, 4 Mamaku Street, Auckland 5
SOUTH AUCKLAND: H. R. McKenzie, P.O. Box 45, Clevedon
WAIKATO: D. Wilkins, 630 Grey Street, Hamilton (Provisional)
BAY OF PLENTY: R. M. Weston, 250 River Road, Kawerau
VOLCANIC PLATEAU: R. W. Jackson, 9 Kenrick Road, Rotorua
GISBORNE/WAIROA: A. Blackburn, 10 Score Road, Gisborne
TARANAKI: D. G. Medway, P.O. Box 476, New Plymouth
MANAWATU: Dr I. G. Andrew, 6 Eton Place, Palmerston North
HAWKES BAY: N. B. Mackenzie, Pakowhai, Napier, R.D. 3
WAIRARAPA: B. W. Boeson, P.O. Box 30, Carterton
WANGANUI: Michael O'Shea, 29 London Street, Wanganui
WELLINGTON: M. C. Falkiner, 118 Miromiro Road, Normandale, Lower Hutt
NELSON: F. H. Boyce, 19 Marybank Road, Nelson
MARLBOROUGH: J. A. Cowie, P.O. Box 59, Kaikoura
CANTERBURY: J. R. Jackson, 103 Linwood Avenue, Christchurch
WEST COAST: Vacant
OTAGO: Mrs. J. B. Hamel, 42 Ann Street, Roslyn, Dunedin
SOUTHLAND: R. R. Sutton, P.O., Lorneville, Invercargill

———★———

LITERATURE AVAILABLE

From all bookshops:

Annotated checklist of the birds of New Zealand. (OSNZ) $4.95
A field guide to the birds of New Zealand, by R. A. Falla, R. B. Sibson and E. G. Turbott, 2nd rev. ed. $5.00

From B. D. Heather, 10 Jocelyn Crescent, Pinehaven, Upper Hutt:

A biology of birds, by B. D. Heather. $1.33

From B. A. Ellis, 44 Braithwaite Street, Wellington 5:

Field guide to the waders, by H. T. Condon & A. R. McGill. 75c

The following are available from Mrs. H. R. McKenzie, P.O. Box 45, Clevedon:

Back numbers of Notornis at 75c (Vols 2-13) and $1 per part (Vols 14-19). Complete sets available.
OSNZ Library catalogue, 70 pp. 50c

Banding reports, Nos 8-14, 50c each.
Nos 1-7 are incorporated in early issues of Notornis.
Kermadec Expedition, 1964, by A. T. Edgar. 45c