

Movements of Caspian Terns (*Sterna caspia*) from a colony near Invercargill, New Zealand, and some notes on their behaviour

MAIDA BARLOW

11 Salier Crescent, Mt. Stuart 7000, Tasmania, Australia

ABSTRACT

Caspian Terns (*Sterna caspia*) from an isolated colony in southern New Zealand were studied for 30 years. Aims of the study were to identify the birds' wintering grounds and to discover the whereabouts of birds during immaturity, by tracing movements of known-aged birds. Adults moved to several wintering grounds up to 1150 km to the northeast. Some birds were locally nomadic in winter, but little distance nomadism was identified in adults. In some families, one parent left the colony up to three weeks before the rest of the family. Juveniles left their natal colony when aged 7-9 weeks, and each was accompanied by one parent until aged 8-9 months. Typically, parents took turns at accompanying a juvenile, in stints of ca. 1-3 days, but two siblings wintered 360 km apart, each accompanied by a parent. Birds on outward passage moved in stages in flocks of 2-4 birds. Families lingered at staging areas for 2-26 days. A 49-54 day old juvenile moved 195 km in five days. Mortality was high in juveniles which moved further than ca. 900 km. Seventy seven percent of juveniles remained sedentary at their wintering ground to age 9 months, and 30% stayed on at the same location through their second winter. Immature birds remained sedentary, were locally nomadic or wandered far inland. Some returned to the colony and stayed briefly, but those which had wandered tended to remain at one site for weeks or months before moving on. Juveniles begged only from their parents. Flight skills and some feeding behaviour of known-aged juveniles are described, as are some behaviours at staging areas.

KEYWORDS: Caspian Tern, *Sterna caspia*, movement, behaviour, Invercargill

INTRODUCTION

The Caspian Tern (*Sterna caspia*) is a species of almost cosmopolitan distribution, which breeds highly selectively across temperate zones of Eurasia, Africa and North America, and in Australia and New Zealand (Cramp 1985, Turbott 1990). It is primarily a colonial breeder (Ludwig 1965, Soikkeli 1973, Falla *et al.* 1979), but some birds breed as solitary pairs (Cramp 1985) and as single pairs in colonies of other Laridae, particularly gulls (Pierce 1984).

Movements of Caspian Terns from the Baltic, Black Sea and US Great Lakes are well documented (Ludwig 1965, Cramp 1985), but not those of the southern hemisphere populations. In Canterbury, New Zealand, Pierce (1984) found that isolated pairs and family parties which bred inland, converged after breeding on coastal and inland river deltas and at coastal lagoons and lakes; and that all far-inland birds departed, apparently to the east coast for autumn and winter, but single birds occasionally visited inland lakes in winter.

This paper examines the movements from 1964 to 1995 of breeders and their offspring from a colony near Invercargill, New Zealand (Figure 1). During this period the colony usually numbered 60-80 pairs, with an exceptional decline to 27 pairs in 1992. The site is believed to be at the southern limit of latitude for colonial breeding by the species. The closest established colonies known were 800 km to the north-east, at Nelson and Farewell Spit (Figure 1), but in the past colonies have occurred in the South Island at Washdyke Lagoon, Rakaia, Wairau Bar and Farewell Spit (Oliver 1955).

After breeding, all but 1-3 birds left the estuary. Adults returned in spring and the colony re-established.

COLONY SITE

New River Estuary (4144 ha) is formed by the Oreti and Waihopai Rivers. The city of Invercargill lies at its head, and the estuary is commonly called the Invercargill Estuary. The Caspian Terns bred at 46°30'S, 168°19'E, on either or both of two shellbanks which were separated at mid to low tide by 600 m of tidal channels and mud-flat. When gales coincided with high tides, partial or total colony washouts occurred; this happened in most years. There is anecdotal evidence that a colony of Caspian Terns has been present on this estuary since at least the 1890s (G. I. Moffat (186?-1959), pers. comm. 1951). Oliver's "...most southern breeding colony (is) in Bluff Harbour" (Oliver 1955) refers to the Invercargill Estuary colony. Bluff Harbour is 4 km from the estuary at their closest shores, and has held only one or two isolated pairs of Caspian Terns since the 1950s.

The Caspian Tern is primarily a species of shallow coastal waters (Challies 1985), and there is little of this habitat south and west of Invercargill. Occasional summer sightings at Riverton and Tuatapere (Figure 1) suggested that one or two isolated pairs may breed there, and a sighting of a metal-banded bird at Tuatapere on 15 September 1991 indicated that some of these may be Invercargill bred birds. Fiordland, to the west, contains no suitable habitat, and no Caspian Terns are recorded from that area (Bull *et al.* 1985).

METHODS

Site visits

Each breeding season (August-January) 1964-1993, I visited the colony several times to band chicks, except in 1975 when no visits were made, and in 1982 and 1991 when chicks were banded by Roger Sutton and Gary Morgan respectively. In the 1992 and 1993 seasons I visited almost daily, to obtain breeding data. Each winter 1976-1993, the site was visited at least once, when numbers of Caspian Terns were recorded. Each year 1988-1994, two to five visits were made between mid-August and late September to observe and record colony re-establishment.

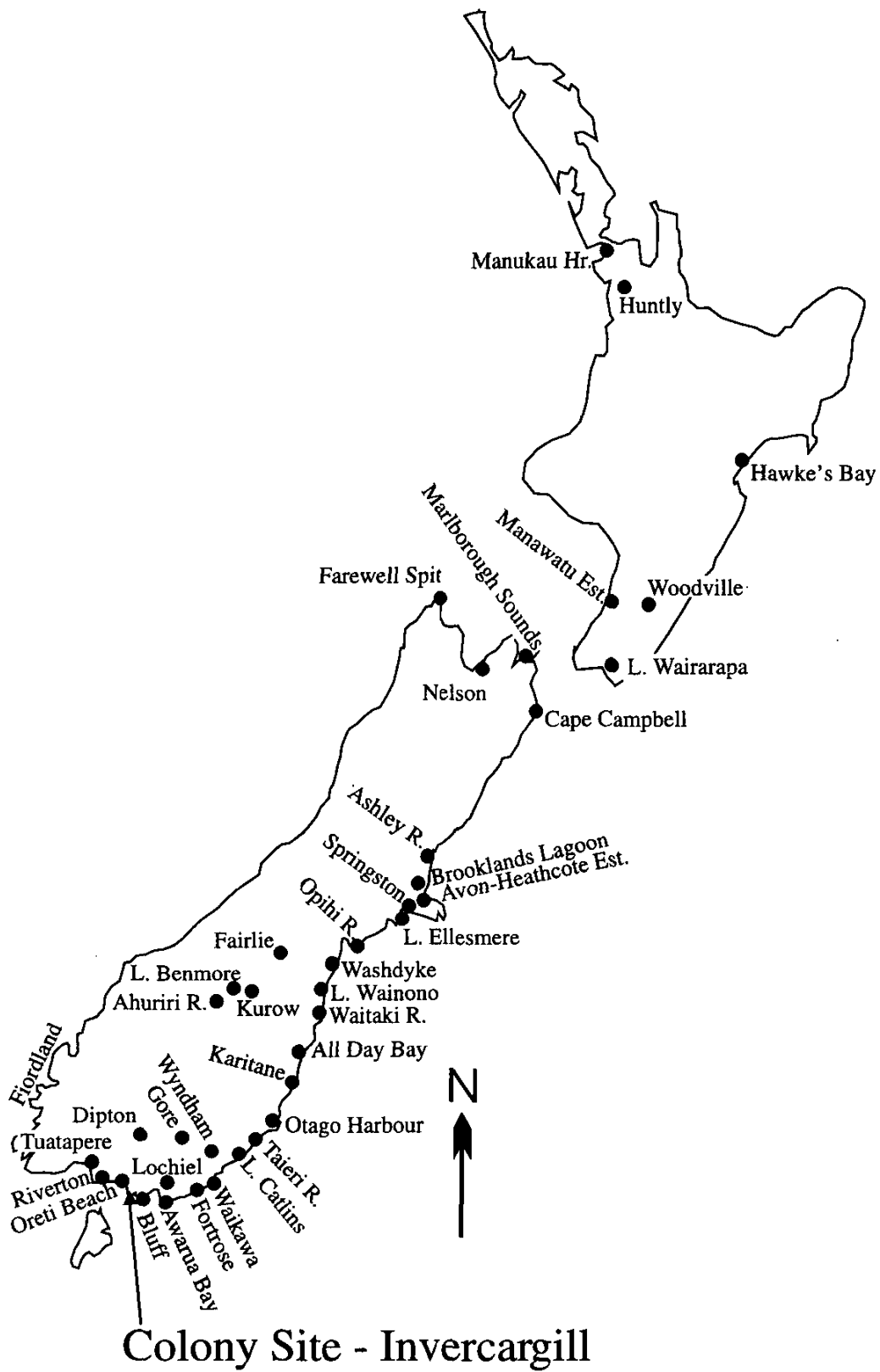


FIGURE 1 – Location of places referred to in the text.

Banding

Chicks

Metal bands were applied when chicks were aged 2+ days; unique colour codes were applied to 36 chicks (12 each year 1991-1993); and from 1987 to 1993 year-codes were applied to 153 chicks. Colour-bands were applied when the chicks were recaptured at age ca. 10 days, when the tarsi were long enough to accommodate two bands. A total of 1285 chicks was banded, 1096 of these with metal only.

Adults

In 1987-1989, 26 breeding adults were captured, some in drop-traps and others with a monofilament line nest snare (Zwickel & Bendall 1967) modified to capture birds around the feet (Cuthbert 1988) and further modified to overcome a problem with birds which flew after snaring. Sixteen of the adults captured had been metal-banded at the colony as chicks, so were of known age, and colour year-codes were applied. Because the metal band could be on either leg, mirror-codes (e.g. BW-M, M-BW) were allocated for each year, and it happened that 11 of the 16 were uniquely-banded, either because they were of different ages or because birds of the same age had been metal-banded on different legs. The 10 adults which carried no band when captured were banded with a single code, as a cohort of breeding adults of unknown age at the time of banding.

Recoveries

The 204 birds which provided the data base for this study were recovered as follows:

- (1) Banded birds found dead or which subsequently died, reported to the New Zealand National Banding Scheme (NZNBS) and identified by band number (n = 31).
- (2) Sightings of colour-banded birds, made by the writer or by experienced observers using telescopes, and reported to NZNBS or to the writer (n = 150 birds). Many of these birds were sighted more than once.
- (3) Sightings of metal-banded and unbanded adults which when sighted were with a begging colour-banded Invercargill-bred juvenile, and reported as above (n = 23). Begging behaviour is described later in this paper.

In 1988, after consulting McKenzie (1972), Pierce (1984), Bull *et al.* (1985), and Classified Summarised Notes in *Notornis*, and obtaining anecdotal evidence of Caspian Tern sightings from various sources, I explored all coastal wetlands and river mouths between Invercargill Estuary and Ashley River mouth, except the Southland waterways, which I knew well, and some sections of Otago Harbour and Lake Ellesmere (Figure 1). From these sources, and from my knowledge of Caspian Tern behaviour at the colony, I formed a concept of possible staging areas and wintering sites along this 500 km coastal strip, and planned a route which it was feasible for me to survey periodically. Between 1989 and 1994, I made 14

three-day autumn/winter surveys of the route and recorded the numbers of Caspian Terns present, their identity and behaviour. Sites always visited were Lake Catlins, Washdyke and Brooklands Lagoons, Bromley Sewage Ponds, and mouths and/or estuaries of the Karitane, Ashburton, Rakaia and Avon-Heathcote Rivers. Sites sometimes visited (numbers of visits) were: Fortrose (12), Haldane (12), Waikawa (12) and Papatowai (4) Estuaries; Tahakopa (4), Taieri (7), Waitaki (8), Opihi (8), Rangitata (4) and Ashley (9) River mouths; coastal routes Taieri Mouth to Waldronville (7) and Waianakarua River to Oamaru (5); parts of Otago Harbour (7) and Lake Ellesmere (8); Purakanui (4), Waikouaiti (4) and Lake Ki-Wainono (8). Southland coastal wetlands were checked frequently for banded birds. At Fortrose Estuary I camped for one or two nights most years 1988/1994 during January/February while birds were on passage. In 1992/1994 I spent 19 days at Lake Catlins, on visits of 1-3 days in all months of the year except May, July and September, when I observed and recorded behaviour and local movements of identified families and other birds of known age.

OSNZ members were advised of the study and asked to look for and report banded birds, through requests to regional representatives, notices and interim reports in *OSNZ News*, and by talks to some regional groups.

Experienced observers visited inland lakes and rivers less frequently than coastal areas, and terns seen inland were seldom seen roosting, and were, therefore, unlikely to be identifiable from bands. Conversely, some birds which died inland were reported by landowners and fishermen, whereas coastal activities seldom led to the reporting of dead Caspian Terns, despite the greater human population on the coast.

Departure of birds from the colony and from staging posts was judged to have occurred when birds, previously present, were not seen on subsequent searches of the area.

Definition of terms

Breeding season: First adults arrived at the colony site in mid-August and most years the last birds left in late January or February. In this paper the season is represented by the year when breeding began: e.g. '1991' = 1991/1992 season.

Birds: Chicks fledged at ca. 35 days; most juveniles were independent by August/September when aged ca. 9 months; birds reached maturity and first bred at 3-5 years. In this paper 'juveniles' are birds aged 5 weeks to 9 months; those whose hatch-date was unknown were classed as immatures in September. Immatures are aged 10 months to 35 months. 'Adults' are aged 3 years and older. A 'family' is an adult with a begging juvenile. Begging is as described in Cramp (1985).

Nomadism: Wandering, when not related to movement to or from wintering grounds.

Adult sedentariness: Criteria adopted were a minimum of three sightings at one non-colony location in one year, at least one month having elapsed between first and last sightings.

'**Inland**' was defined as 30 km in a straight line from the nearest coast.

RESULTS AND DISCUSSION

Return to the colony

Adults

The first returning adults arrived in mid-August and by early September in most years there were 10-12 birds. Numbers increased in groups of 2 - ca. 10 (occasionally ca. 20) to mid-October and in some years to as late as the first week in November. An influx of 30 birds on the night of 1-2 November 1993 was unusual. Some new arrivals had white crown-streaks (remnants of winter plumage), but most had entirely black crowns of full breeding plumage. For up to four weeks the terns spent much time in pre-breeding activities on the mudflats, mostly in pairs and widely separated from other pairs. Loose groups of possibly unpaired birds were also seen. Later arrivals were almost certainly paired on arrival because within one or two days they made nest scrapes and laid eggs.

In the northern hemisphere, flocks on spring migration contained 2-7 birds, although single migrants sometimes occurred (Cramp 1985). Bergman (1953) saw birds arrive at the Baltic in April (early arrivals) in pairs, and Josefik (1969), cited in Staav (1979), saw transmigrants in spring flying in pairs in Poland. However, Staav (1979) considered it probable that the Baltic terns generally paired on the breeding grounds, because first-time breeders and older adults showed strong fidelity to the natal colony and former site of breeding; had pairs formed while wintering or on migration (when birds from different colonies mingled) one of the birds would have been forced to follow the other to a new colony, which would have resulted in long dispersal and weak site tenacity. Invercargill birds which wintered more than ca. 450 km from the colony (the majority) mingled with non-colony birds in autumn and winter, and had the opportunity to form pairs with non-colony birds. However, natal site fidelity and colony site tenacity were strong (Barlow, unpubl. data), factors which suggest that most pairings of Invercargill birds occurred at the breeding grounds.

Immatures

Each year 1988-1994, 1-3 colony-bred birds aged 11-12 months arrived at the same time as adults and stayed 2-10 days. Most (4 of 5 whose behaviour was recorded) were seen begging and each had probably accompanied a parent back to the colony. Five uniquely-marked first-year birds which returned were:

(1) H27278 BM-R, hatched ca. 10 December 1991 and one of the first three chicks to hatch that year, was back on 9 November 1992 but not seen again until 27 November 1994 when it returned and bred, the only 3-year-old to return that year.

(2) H27313 YM-Y, was the third chick to hatch in 1992. It was 465 km NE at Avon-Heathcote Estuary on 9 February 1993, was back at the colony, begging, on 29 October 1993 aged 11 months, but was not seen again until 27 February 1995 when it was back at the Avon-Heathcote.

(3) H27380 WB-M, the second chick to hatch in 1993, was seen 195 km ENE at Karitane from 12 February 1994 to 19 February 1994, and was back at the

colony on 27 November 1994 but was not seen there again.

(4) H27320 GM-G hatched eight days after the first chicks in 1992, was still at the colony with its 20-year-old parent, H18766 M-WY, on 7 January 1993, but both had left by 16 January 1993. M-WY wintered 490 km NE at Ashley River mouth (4 sightings 10 May 1993 - 13 August 1993) and was back at the colony by 29 October 1993. GM-G was found dead at the colony on 7 November 1993, the stage of decomposition indicating death about 23 October 1993. It is unlikely that GM-G spent its first winter with parent M-WY, because it was not seen at Ashley River mouth on four sightings of M-WY.

(5) H27393 GY-M hatched 7 days after the first chick in 1993, was begging at the colony on 7 December 1994 when aged 12 months, was not there on 4 December 1994 and had left by 14 December 1994.

Only two first-year birds were found in the Invercargill region in autumn/winters of 1988-1994; these were a 7-month old year-coded bird, -RM, on 15 June 1988 three km from the colony site, and H27301, aged 6 months 20 days, found freshly dead on 6 August 1992 on Oreti Beach, 8 km from the colony site. Year-coded R-WM, aged 10 months, begging on 8 September 1991 five km from the colony site, had probably wintered elsewhere and returned, because no R-WM (an easily-seen combination) was sighted in the region in autumn/winter 1991.

The return of first-year birds was not fully understood. I am not aware of any study of extreme juvenile dependence and/or parental tolerance thresholds in birds. Caspian Terns offer opportunities for investigation of both subjects.

Four immatures aged 21 to 26 months arrived at the colony on various dates in November and January 1989 to 1993, and stayed 3-9 weeks. These were nomads which moved independently of adults, and stayed longer than the first-year birds. Similarly, in the Baltic a few two-year olds visited colonies, arriving later in summer than other birds (Cramp 1985). Nomadism in immatures is discussed later in this paper.

Isolated breeders

Some isolated breeders with fledged juveniles joined birds at the colony for a time. In years when it was thought that all chicks had been banded, a puzzling feature was the presence late in the breeding season of occasional unbanded juveniles. These were at first assumed to be birds which had been missed during banding, but in 1992, when all colony nests and eggs were marked and every chick known to have been banded, proof was obtained of an isolated breeder bringing its juvenile to the colony site. On 7 January 1993, when most chicks had fledged and some families had left, an unbanded fledged chick appeared at the colony, begging from a 5-year-old year-coded colony-bred bird. One of that cohort had been seen on 12 November 1992, nesting in isolation 13 km SE at Awarua Bay, and the adult newcomer was possibly that bird. Only one of that cohort bred at the colony in 1992 and it was still there when the newcomers appeared. They remained until 16 January 1993 but had left by 24 January 1993, therefore stayed ca. 10 days. If this family came from Awarua Bay, their use of the Invercargill Estuary

was possibly related to food and/or 'companionship' rather than as a staging post, because the estuary is north-west of Awarua Bay and all autumn migratory movement was east and north-east. Pierce (1984) found that solitary pairs and family parties from inland Canterbury also converged at coastal sites after breeding.

Departure

Order of departure was: December/January - failed breeders; some successful early breeders with 7-8 week old juveniles; some single parents. January - 8-9 week old juveniles with remaining parents. February - 6-8 week old juveniles from late renests with parents.

Failed breeders

Until early December, egg loss or nest desertion was usually followed by renesting (Barlow, unpubl. data). Birds which did not renest left soon after loss or desertion. For example, all eggs and small chicks were washed out on 26 December 1987 and on 1 January 88 only 23 large chicks and juveniles and ca. 40 adults remained; on 16 December 1989, two days after nests of 80 pairs had been washed out only ca. 70 birds remained; in 1987 and 1989 each of two adults, which deserted their nests after being trapped or snared, had left two days later; occasionally a late breeder whose eggs were still unhatched in mid-January, by which time many families had left, deserted the nest and departed.

Successful breeders and offspring

On leaving, each juvenile was accompanied by at least one parent. Families left singly or in small flocks which seldom contained more than 4 birds.

(1) Early breeders: Some of the first juveniles left ca. 2 weeks after fledging. Before birds were uniquely-banded, early-hatched chicks were identifiable as a group because first nests were usually on the crest of the shellbank, escaping washouts, and juveniles from those nests were larger and more advanced than those from later nests.

(2) Parents which left without offspring: In some families where only one chick survived, one parent left about and sometimes before the time the juvenile fledged at ca. 5 weeks. For example: (a) In 1992 two pairs, each of which included a uniquely-banded bird, each produced one live chick. These chicks were seen frequently, each with either or both of its parents, until they were aged ca. 4 weeks, after which neither banded parent was seen on the estuary that season and was judged to have left. One of these chicks was uniquely-banded and had been seen several times with the remaining parent until it fledged. The other chick was year-coded and probably fledged, because few chicks which survived to four weeks died before fledging (Barlow, unpubl. data).

(b) During severe storms the waters of the estuary and contributory rivers were turbid. Some adults dip-fed along the backwaters, flying slowly 0.25 m to 0.5 m above the water with bills at right angles to the surface, periodically hovering briefly and dropping to dip their bills into the water, sometimes capturing small

TABLE 1 - Ages at which fledged juvenile Caspian Terns were present at, and/or had left their natal site at Invercargill Estuary, New Zealand, in 1993 and 1994

Bird	Date present	Age (days)	Date not present	Age (days)
H27314 WM-Y	4 Jan 93	49	7 Jan 93	52
H27315 BM/G	"	49	"	52
H27310 YM/B	"	54	"	57
H27312 BM/Y	7 Jan 93	54	16 Jan 93	63
H27319 RM-G	"	52	"	61
H27316 RM-Y	"	52	"	61
H27320 GM-G	"	49	"	58
H27313 YM-Y	16 Jan 93	63	24 Jan 93	71
H27325 WM-G	"	57	"	65
H27392 WR-M	26 Jan 94	63		
H27384 R-BM	"	62		
H27380 WB-M			26 Jan 94	67
H27379 R-RM			"	66
H27356 BY-M			"	63
H27393 GY-M			"	62
H27390 RB-M			"	62
H27389 GR-M			"	62
H27386 YR-M			"	62
H27394 R-YM			"	59

Mean age present (days) 54.9 ± 5.5 ; (49-63); n = 11

Mean age not present (days): 61.3 ± 4.8 ; (52-71); n = 17

#Year-coded birds

M-RY				
7 birds	16 Jan 93	54-43		
M-RY				
12 birds			16 Jan 93	61-54
M-RY				
2 birds	24 Jan 93	42		
M-RY				
7 birds			24 Jan 93	62-51
YG-M				
7 birds	26 Jan 94	53-41		
YG-M				
17 birds			26 Jan 94	64-53

see text

prey (flounders and worms were seen), then continuing their search. At high tide all congregated on the few available roosts. Counts taken in these conditions in 1992 and 1993, when the colony was visited almost daily, showed a gradual reduction in adult numbers after the juveniles began to fledge.

Mean survival to fledging was ca. 1.2 chicks per pair in 1992 and ca. 0.8 in 1993 (Barlow & Dowding, unpubl. data), and juveniles never outnumbered adults even after some adults had left. It appeared that no parent left early in families where two juveniles fledged.

(3) 8-9 week old juveniles with parent(s): Most families from successful initial breeding left before mid-January. Those from early renests left later, but most had gone by the end of January.

(4) 6-8 week old juveniles with parent(s) from late renests left early in February, and rarely remained beyond the second week in February.

Siblings

Some siblings left at different times, each with one parent. In 1992, each of two pairs of uniquely-coded siblings was occasionally seen together with one or both parents, but after age ca. 4 weeks all four juveniles were usually widely separated, each accompanied by one parent. In one of these families the older juvenile was not seen on the estuary after 4 January 1993, although its sibling remained until 16 January 1993, being fed by a parent. Each was seen subsequently at different locations, and so these siblings left at different times.

Time of departure

This appeared to be influenced *inter alia* by the age of the juvenile, the developmental skills which it had attained, local weather conditions and summer to autumn seasonal change.

Juvenile age

Most juveniles left when aged 7-8 weeks, some not until 9 weeks (Table 1). Year-coded birds are excluded from calculations of means in Table 1, because ages of individual year-coded birds, present or absent, were not known.

Most uniquely-coded birds were older than year-coded birds because unique codes were applied to chicks from early nests. Exact dates when birds departed were not known because identification checks of fledged birds were not made daily. Therefore, in Table 1 the ages of birds when last seen at the colony are less than their ages on leaving, while the ages of birds not seen exceed their ages on leaving. Ages of individual year-coded birds could not be determined from sightings. Therefore, Table 1 shows possible ages of those birds which had departed and those that remained on the given dates. The two birds banded M-RY present on 24 January 1993 (Table 1) had not fledged on 16 January, and so are not included in the counts for that date.

Juvenile skills

At eight weeks of age juveniles captured small prey (e.g. worms and 3 cm flounders *Rhombosolea* sp.) while wading at the water's edge, or by dip-feeding from low flight above the tide-edge. They plunge-dived 5-10 m offshore from heights of 5-6 m, but none was seen to capture prey when plunge-diving. All were still fed by the parent(s).

Flight skills were recorded on 16 January 1993 in wind gusting to 35 knots (64 km/hr) (NZ Meteorological Service), when nine juveniles ranging from 6 to 9 weeks old were observed at the estuary. All except one bird flew competently at low altitude (ca. 4 m). In stronger winds on other days juveniles aged 7-9 weeks did not fly by choice, but when disturbed flew low for 20-30 m to another roost.

Local weather conditions

Families left in the clear weather that came with high pressure systems, and in clearing weather as a low pressure system of short duration passed on. However, when a stormy low pressure system of several days' duration passed on, families remained for 1-3 further days, possibly to feed, following reduced prey-capture associated with water turbidity during storms. Pierce (1980) found that turbid water prevented Caspian Terns from seeing their prey.

Seasonal change

Successful late breeders began their migratory journey when their juveniles were two weeks younger than the departure age of juveniles from early nests, suggesting that seasonal change was the proximate cause of their departure.

Adult moult may also have been a factor which influenced departure time. Moult of the black crown of breeding plumage was well advanced in successful adults by the time they departed.

Effects of weather systems and coastal configuration

Outward movement was strongly advantaged by the flow of weather systems, in combination with the coastal configuration. The east coast of the South Island follows a north-easterly line from the south (Figure 1) and the first 500 km of the birds' outward migratory flyway followed this coastline. Weather systems usually approached from the west and south-west and moved away to the north and east. Outward movement from the colony was predominantly to the north and east. Generally, migrants select directional winds favourable for their destination, and wind speeds within their flight capabilities (Bellrose 1967).

Recoveries of Swedish birds soon after fledging indicated initial movement in various directions to traditional feeding grounds up to 100 km from the colony, and dispersal persisted for one month before the onset of southward migration (Cramp 1985). That Invercargill families typically remained on the natal estuary for 2-3 weeks after the juveniles fledged indicated that the estuary satisfied their requirements until the onset of migration, and they had no need to disperse. The estuary appeared to provide food for all age-groups. It had shores, pools and tide-lines where juveniles practised developmental behaviour including identification, capture and retention of prey. It provided extensive space at mid- to low tide, when individual families spent much time in isolation from others, and restricted space at high tide, when behaviour was more gregarious. Compared with most other *Sterna*, Caspian Terns are not highly gregarious outside the breeding season, except when roosting (Cramp 1985).

Begging behaviour

Observations of uniquely-banded birds showed that juveniles begged only from their parents. Five times I saw juveniles sidle up to other birds (4 adults, 1 immature), lower their heads in submission, but not assume the full soliciting posture of begging behaviour. On each occasion the other bird turned its head towards

TABLE 2 - Caspian Terns which bred at Invercargill Estuary before and after being reported seen at another location in autumn/winter

Bird	Breeding at colony - selected dates	Reported seen		Distance (km) From colony
		Date	Location	
H18633 RG-M	25 Nov 87	19 Jan 88	Avon-Heathcote Est	465
“	24 Nov 88			
“	29 Dec 90	24 Mar 91	Avon-Heathcote Est	465
“		29 Jul 91	Manukau Harbour	1170
“	9 Nov 91	20 Jun 92	Manukau Harbour	1170
H27149 M-WG	27 Nov 88	27 Jul 89	Avon-Heathcote Est	465
“	11 Nov 89	31 May 90	Avon-Heathcote Est	465
H25877 GB-M	8 Dec 89	29 Jul 90	Lake Ellesmere	430
“	26 Oct 90			
H18766 M-WY	7 Jan 93	#30 Jun 93	Ashley River mouth	490
“	29 Oct 93	#15 Feb 94	Otago Harbour	190
“	14 Dec 94			

Presumed to be this bird; see text

the juvenile, snapped its bill, and the juvenile walked away. This behaviour could not be confused with begging, which typically persisted for 10-30 seconds and was accompanied by high-pitched whining calls. Juveniles to age ca. 5 months frequently repeated this behaviour for periods of up to ten minutes. The parent sometimes shuffled or flew away from a persistently begging juvenile, but did not repulse it. After age ca. 5 months juveniles begged less than formerly, but at age 7 to 8 months, during June/July, some resumed persistent begging, possibly because of feeding difficulties in winter. By August/ September most juveniles were independent, but four of five 11- to 12-month-olds which returned to the colony were seen begging. Exceptionally late begging was observed in two birds aged 16 months and 18 months, and one aged 25 months whined and mewed, but did not beg, as it stood beside an adult.

Movement after leaving the colony

Regional presence in winter

No Caspian Tern was found at the colony site on 24 winter (May-July) visits 1976-1993. Between March and early August in most years small numbers (1-6) were occasionally seen on other sectors of the estuary, on lower reaches of its contributing rivers, or on nearby Oreti Beach. Two juveniles, one immature aged 29 months, and three adults were recovered dead or observed in the Invercargill region between May and early August 1980-1992, indicating that the few birds in this area in winter were usually adults and dependent juveniles. The only bird recovered in winter south and west of the Invercargill region was a juvenile found injured and subsequently destroyed at Tuatapere on 4 June 1988. (New Zealand National Banding Service, A. Wright, observer.) It was six months old and was probably accompanied by an adult.

Distant movement - adults

Return movements were proved by four uniquely-banded adults, seen away from the colony in autumn/winter and found breeding at the colony in the preceding and following seasons (Table 2).

H18766 M-WY was banded with a code which had previously been used in the North Island and was issued to me in error by NZNBS. A letter from NZNBS dated 15 December 1994 authorised its inclusion in Table 2, with the qualification that the sightings (which were in the South Island) were presumed to be of the Invercargill bird. In the years of this study 11 adults were uniquely colour-banded for long enough to prove that they bred at the colony before and after they wintered elsewhere. Consequently birds recorded in Table 2 represent 36% of possible recoveries.

Most adults undertook return movements, because with rare exceptions all left the region after breeding, many were recovered or sighted at staging and wintering grounds, and return to the colony was proved by adult trapping and sightings in successive years. However, there is insufficient evidence to conclude that the birds followed a true migration pattern to and from the same destinations each year. More sightings of uniquely-marked birds will be needed before such a firm conclusion can be drawn.

Juvenile and family movement

Juveniles moved in stages to the wintering grounds, and until the end of its first winter each was accompanied by one parent. Observations of four families which included marked birds indicated that parents took turns to accompany the juvenile, in stints of several days' duration. In these families the 'absent' parent was in the area, but some may have been locally nomadic. Three juveniles were sole survivors of their broods and sibling status of the fourth was not known. The families were

(1) Juvenile H27390 RB-M, and parents BW-M and an unbanded bird, at Lake Catlins: RB-M was with its unbanded parent on 27 January 1994 and 7 April 1994 and with BW-M on 11 and 12 February 1994 and 6 April 1994. On 18 and 19 February 1994 and 25 February 1994 BW-M was alone and did not join other mixed-age conspecifics on the lake; RB-M was not found. On 7 April 1994 RB-M was with its unbanded parent, and BW-M was alone on an arm of the lake 6 km distant. In many hours of observation no interchange of parents was seen and the whole family was never seen together.

(2) At Fortrose on 20-21 January 1993 there were three Caspian Terns: a juvenile, a metal-banded adult and adult -WM. In 20 hours of observation -WM and the juvenile were always together except when -WM was foraging. The metal-banded adult was always alone, 2-3 km from the family and out of their line of vision when the birds were on the ground. It fed upstream, whereas the family fed on the estuary. The status of the metal-banded bird was unknown, but its behaviour was similar to that of the off-duty BW-M at Catlins, described earlier.

(3) At Karitane on 25 and 26 January 1994 juvenile H27377 WG-M was begging from an unbanded adult, and from an adult banded M- on 11 February 1994 and 19 February 1994.

(4) At Karitane on 11 February 1994 juvenile H27380 WB-M begged from an unbanded adult, and on 19 February 1994 from an adult banded -M.

Observations of another family suggested that interaction may occur between separated parents. At Washdyke Lagoon on 12 February 1994 there were three Caspian Terns: juvenile YG-M begging from an unbanded adult, and an adult banded -M which roosted 80-150 m from the family and fed alone. The metal-banded bird appeared alert to the family's movements, turning its head to the side and looking up when they flew. At 10:51 -M was ca. 120 m from the family, when both adults suddenly flew almost simultaneously, soared in the high straight ascent of high-flight (Cramp 1985), then made overtaking passing movements over land 1-3 km west of the lagoon. The juvenile remained on the ground, whining. At 10:54 the adults disengaged, the unbanded adult returned to the juvenile, and -M flew out over the sea, but returned at 11:01 and pitched ca. 130 m from the family, as before. On 18 February 1994 from 15:15 to 18:15 YG-M and the unbanded adult were together but no other Caspian Tern was seen on the lagoon. High-flight is a courtship display. Near the end of the breeding season some adults which have lost young show some resurgence of low- and high-flights (Cramp 1985). The high-flight of the birds at Washdyke Lagoon may have been a reinforcement of bonding between parents, but the status of the banded adult was not known.

Parenting in stints

Accompanying the juvenile in stints may be adaptive behaviour which has physical benefits for the parents, yet ensures that the juvenile's needs are met. Until a juvenile was ca. 4 months old, 'accompanying' it entailed absolute vigilance by the parent, except in the short periods when the parent foraged. It observed all the juvenile's ground-based activities, and sometimes intervened; for example, by stepping up with lowered head in threat posture ('foreward posture', Cramp 1985), when the juvenile appeared about to swallow a piece of wood (observed in three different families). When the juvenile foraged and practised plunge-diving, the parent watched from shore and sometimes flew above or near the juvenile. When the family roosted in isolation, with tucked bills, the adult's eye opened when there was any nearby or overhead bird movement or call. At high tide roosts, where there was frequent bickering among conspecifics, parent and juvenile stayed close together; the loose flock possibly provided some protection from intruders, but it increased risk to the juvenile from attack by conspecifics.

The parent was therefore continually alert and did not relax. That the degree of vigilance entailed sustained physical tension was suggested by the accompanying parent's alert stance, visual awareness, and frequent anticipation of or instant reaction to perceived or actual threat. This behaviour contrasted markedly with that of off-duty parents, which roosted motionless for many hours. By leaving, the off-duty parent could recoup its condition.

Juveniles appeared to expend much energy in sustained periods of begging. When the parent did not respond with food the juvenile eventually desisted. It could not then turn to solicit the second parent, and presumably expend more energy, because only one parent was present.

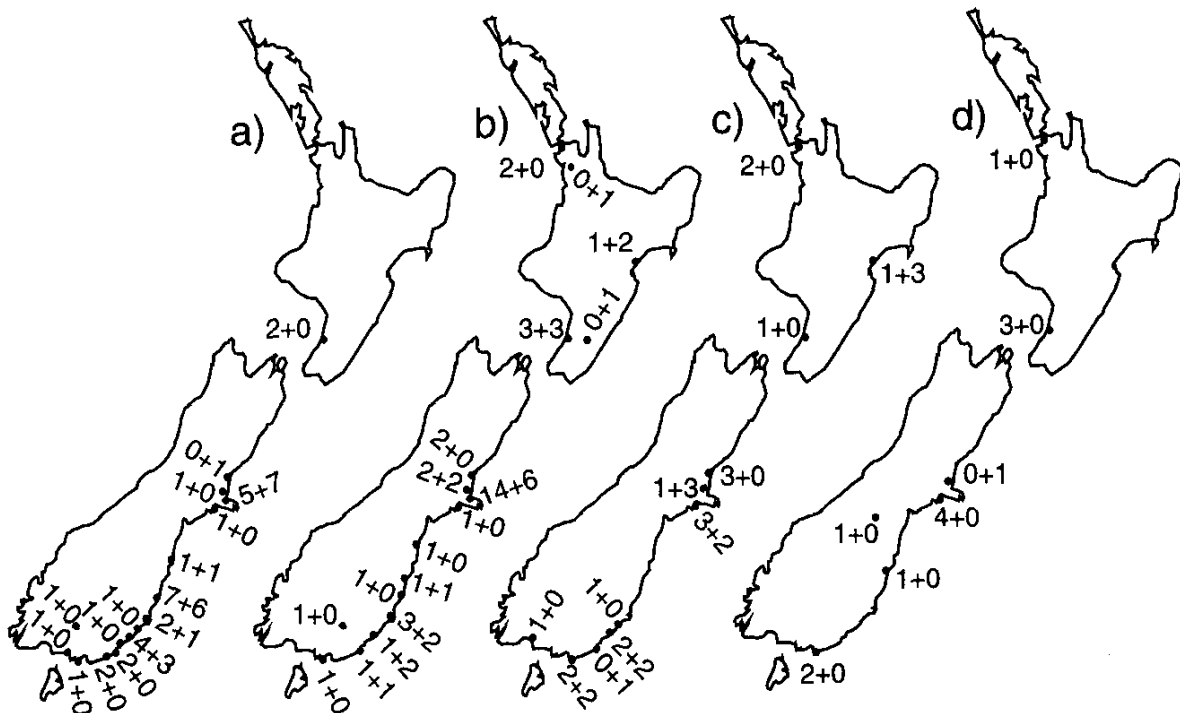


FIGURE 2 – Movement of adult and juvenile Caspian Terns from Invercargill estuary 1970-1994. Adult numbers are given first and juvenile numbers are after the + symbol. (a) December - February ; (b) March - May; (c) June - August; (d) September - November.

Sibling movement

Two 1992 siblings wintered at different locations, each with one parent. The older sibling, H27310 YM-B, left the colony between 4 January 1993 and 7 January 1993 and was 105 km E at Lake Catlins on 26 February 1993, begging from an unbanded adult. Other sightings, all at Catlins, were on 25 February 1994 when, aged 16 months, it occasionally begged unsuccessfully from an adult banded -M, and 7 April 1994 and 4 January 1995 when it was alone. Its sibling, H27313 YM-Y, was still at the colony on 16 January 1993, was never seen at Lake Catlins, was 465 km NE at the Avon Heathcote Estuary on 9 February 1993, was back at the colony, begging unsuccessfully on 29 October 1993, but was not seen on or after 30 October 93 and had presumably left.

Independent movement by successful parents is known in other Caspian Tern populations. Juveniles on migration in the USA were accompanied by only one adult (Ludwig 1965). Recoveries of Swedish birds soon after fledging indicated dispersal usually in family parties comprising single parents and 1-2 young, and in Poland late summer and autumn flocks were typically of 2-3 (62% of observations) comprising family parties of 1 adult with 1-2 offspring, though both adults were present in 25% of observations (Cramp 1985).

Locations

Figure 2 depicts numbers of individual birds, not numbers of sightings. Many birds were seen several times at the same location in a year, and some adults in

several years. Birds at the colony during the breeding season are not shown. Uneven observer distribution tends to exaggerate sectors of the route. Year-coded birds are included, but may be under-represented because only the maximum numbers seen together at one time are depicted; those seen at the same site in different years are depicted only once. Conversely, year-coded birds which changed location within a time-period may be shown more than once; dates of sightings show that this could have occurred with 2 adults and 2 juveniles between Washdyke Lagoon, Lake Ellesmere, Avon-Heathcote Estuary and Brooklands Lagoon.

Figure 2a shows the outward route taken by families, off-duty parents and failed breeders, except that in Southland two adults found dead up rivers 17 km and 38 km from the colony on 12 December 1971 and 5 January 1972 may have been breeders foraging away from the colony. No Invercargill bird was identified at the Opihi River mouth, although several metal-banded birds, which had not been banded in Canterbury, have been seen there (Pierce 1984). These were probably Invercargill colony birds, because no other Caspian Terns were banded south of Canterbury, and none of those banded north of Canterbury has been recovered south of Christchurch (R. Cossee pers. comm.). Avon-Heathcote Estuary is an important non-breeding site for the Invercargill breeding population (Crossland 1993). The two birds seen in Manawatu were 5-year olds, seen several times after 16 January 1993 and 7 February 1993; the dates, and the fact that no accompanying juveniles were recorded, suggest that they were failed breeders.

In autumn in most years one family remained at Waikawa, 1-3 families at Catlins, and 1-3 possibly lingered for a time in Otago Harbour (Figure 2b). One family staged at Karitane until 20 March 1991, but this was atypical, because in most years staging families had passed through Karitane by the end of February, and none wintered there. The Avon-Heathcote Estuary supported many families, and adults without juveniles, which were probably failed breeders and off-duty parents. At the Avon-Heathcote Estuary, monthly average Caspian Tern numbers 1987-1990 rose from 40 in December to peak at 100+ in March, and fell to 30 in May (Crossland 1993). Families reached the Manawatu Estuary in late March/April. The earliest recovery of a juvenile at Hawke's Bay was on 26 March, and a juvenile was found dead at Huntly on 8 May 1971. The earliest adult arrivals at Manukau Harbour, on 18 May 1992, 13 May 1993 and 19 May 1995, were possibly failed breeders, because no begging juvenile was reported.

Few families were found wintering south of Lake Ellesmere, despite disproportional emphasis on birds in the south, which was closely monitored in all seasons 1987-1994 (Figure 2c). Invercargill Estuary sometimes contained one family, Waikawa Estuary one family, and Lake Catlins 1-3 families. Also, 1-3 nomads of unknown age occurred at these sites in winter, and single birds were occasionally seen flying inland along rivers. At Otago Harbour, 1-3 birds were sometimes seen in June/July, and four seen 40 km inland at Clydevale in June 1988 were considered to be unusual (Hocken & Baker 1991). One adult wintered at Karitane during May to August 1991. Sightings and recoveries (Figure 2c) indicate that many of these birds would have been from the Invercargill colony. Some

TABLE 3 - Distances travelled from Invercargill Estuary, dates recovered, and dates where known of presence at and/or absence from the colony site, of juvenile known-aged Caspian Tern

Recovery site	Distance (km) from colony	Bird		Date recovered	Age when recovered (days)	Date at colony	Date not at colony
Lake Catlins	105	H27390	RB-M	27 Jan 94	63		26 Jan 94
Otago Harbour	190	H27379	R-RM	15 Feb 94	80		26 Jan 94
Karitane Estuary	195		R-WM	28 Feb 91	76		
"	195		R-WM	28 Feb 91	76		
"	195	H27279	YM-R	31 Jan 92	54	26 Jan 92	
"	195	H27283	BM-W	29 Feb 92	54		
"	195		BM-B	29 Feb 92	48		
"	195	H27377	WG-M	25 Jan 94	66		
"	195	H27380	WB-M	11 Feb 94	83		26 Jan 94
Washdyke Lagoon	320		YG-M	12 Feb 94	82		
Avon-Heathcote Est.	465		-RM	19 Jan 88	61		
"	465		-BM	24 Jan 89	65		
"	465		R-WM	26 Feb 91	74		
"	465	H27287	WM-B	9 Apr 92	87		
"	465	H27313	YM-Y	9 Feb 93	87	16 Jan 93	24 Jan 93
"	465		M-RY	9 Feb 93	85		24 Jan 93
"	465		YG-M	6 Feb 94	76		
"	465		YG-M	6 Feb 94	76		
Brooklands Lagoon	480	H27389	GR-M	22 Feb 94	89		26 Jan 94
Manawatu Estuary	865		R-WM	31 Mar 91	107		
"	865	H27288	WM-R	17 Apr 92	101		26 Jan 92
Woodville	900	#H24953		3 May 70	168		
Ngaruro R, Hawkes Bay	1015	#H27392	WR-M	26 Mar 94	122	26 Jan 94	
Waitangi E, Hawkes Bay	1030	H27325	WM-G	22 May 93	191	16 Jan 93	24 Jan 93
L Kimihia, Huntly	1130	#H18724		8 May 71	161		

Recovered dead or injured and later died

Invercargill families wintered in the Christchurch area, but many birds which had been at the Avon-Heathcote Estuary in autumn had moved by June and were not found; monthly average Caspian Tern numbers from June to August 1987-1990 were 10 birds (Crossland 1993). No Invercargill families wintered at the Manawatu Estuary. At Hawke's Bay, one family wintered each year 1984, 1988 and 1993, and may have included the same parent(s). Bird H18633 RG-M, at Manukau Harbour on 29 July 1991 and 20 June 1992, was colour-banded in 1987 and returned to breed at the colony each year until the 1991 season. On 19 January 1988 and 24 March 1991 it was at the Avon-Heathcote Estuary, possibly en route to Manukau, where it was last seen on 6 July 1992, then aged 22 y 8 months.

The single juvenile in Figure 2d was a 'well-decayed' dead bird found on North Brighton beach on 15 September 1991, and had probably died in winter. A dead bird at Kurow on 20 October 1972, aged 3 y 10 m, and a 3-year old at Washdyke Lagoon on 10 November 1990 were possibly still immature, although the Washdyke bird may have been en route to the colony for its first breeding. The birds at Lake

TABLE 4 - Numbers of adult and juvenile Caspian Terns from a colony near Invercargill, New Zealand, found staging at Fortrose and Karitane Estuaries in January/March

Fortrose Estuary			#Karitane Estuary			#Karitane Estuary		
Date	Adult	Juv	Date	Adult	Juv	Date	Adult	Juv
10 Jan 76	2	0	28 Feb 91	7	2	28 Jan 93	5	2
10 Feb 86	3	0	18 Mar 91	6	2	1 Feb 93	3	0
11 Feb 86	3	0	20 Mar 91	5	1	3 Feb 93	3	1
30 Jan 87	2	0	31 Jan 92	2	1	11 Feb 93	4	1
31 Jan 87	2	0	7 Feb 92	2	2	9 Mar 93	3	1
10 Feb 89	4	1	##			22 Jan 94	1	1
11 Feb 89	4	1	29 Feb 92	4	3	25 Jan 94	1	1
17 Feb 92	5	1	15 Jan 93	2	0	26 Jan 94	1	1
20 Jan 93	2	1	16 Jan 93	5	3	11 Feb 94	7	2
21 Jan 93	2	1	22 Jan 93	1	0	19 Feb 94	5	2
25 Jan 95	1	0	24 Jan 93	3	2			
26 Jan 95	2	0	26 Jan 93	3	2			

Data Source: Derek Onley (pers. comm.) except for those collected on 28 Feb 1991, 11 Feb 1994 and 19 Feb 1994.

Numbers varied, to a maximum of 11 birds, between 7 Feb 1992 and 29 Feb 1992 (D. Onley, pers. comm.).

Ellesmere were 5- and 6-year olds which, on 5 December 1992 (two birds) and 9 October 1993 (three birds), were seen at a newly forming colony. No Invercargill adult was identified at the Avon-Heathcote Estuary in spring, despite an increase in monthly averages of birds during 1987-1990 from 15 birds in September to 30 birds in November (Crossland 1993). At the Manawatu Estuary, three year-coded adults aged 4 and 5 years were last seen on 20 October 1991 and 24 October 1992, and birds with the same codes returned in January, February and March 1992 and 1993. At Manukau Harbour on 3 October 1993 a bird aged 3 y 9 m was possibly still immature.

No bird was certainly identified on return migration, possibly because, as with Baltic birds (Cramp 1985), adults on spring migration travelled faster and roosted less than when accompanying offspring in autumn.

Distances travelled by families

Ages in Table 3 are maximums because birds may have arrived earlier than the date recovered, and the age quoted for year-coded birds (unnumbered in Table 3) is that of the oldest in the cohort.

Best time, age and movement data were obtained from H27279 YM-R, which moved 195 km in 5 days, aged 7 w 0 d - 7 w 5 days. Other birds moved 465 km NE, to the Avon-Heathcote Estuary, in 1-3 weeks, since most juveniles left at age 8-9 weeks and several reached the Avon-Heathcote Estuary by age 9-11 weeks. Manawatu Estuary, 865 km NE, was reached 6-7 weeks after leaving Invercargill. WR-M was recovered 1015 km NE at Hawke's Bay, at most 8 w 3 d after leaving.

The travelling time of YM-R approximated that of Polish birds, which travelled 40-50 km per day on early autumn movement (Cramp 1985). A further indication

TABLE 5 - Time spent at staging areas by juvenile Caspian Terns of known age, from a colony near Invercargill, New Zealand

Bird		Age on arrival (days)	Location	Date first seen	Date last seen	Time spent (days)
R-WM		ca.84	Karitane Estuary	28 Feb 91	20 Mar 91	21
R-WM		ca.84	"	28 Feb 91	18 Mar 91	19
H27279	YM-R	54	"	31 Jan 92	7 Feb 92	8
H27377	WG-M	65	"	25 Jan 94	19 Feb 94	26
H27380	WB-M	84	"	11 Feb 94	19 Feb 94	9
	YG-M	ca.77	Washdyke Lagoon	12 Feb 94	18 Feb 94	7
	BM-B	ca.140	Avon-Heathcote E	11 Apr 92	12 Apr 92	2
H27288	WM-R	102	Manawatu Estuary	17 Apr 92	3 May 92	17
H27325	WM-G	184	Waitangi Estuary Hawke's Bay	22 May 93	13 Jun 93	23

Mean time spent (days): 14.5 ± 8 (2-26); $n = 9$

that some birds moved ca. 40 km per day was that some, including adults unhampered by juveniles, staged at Fortrose, 38 km from the colony site.

Distances up to 480 km, covered by families with juveniles aged 8-12 weeks, did not relate to the age of the juvenile, either between years or within the same year. For example, 195 km distant at Karitane, where all families were known to stage because none over-wintered, juvenile ages in different years ranged from 6 w 6 d to 11 w 6 days; and in 1994 two birds in their tenth week had moved 105 km and 195 km, two in their eleventh week moved 465 km and three in their twelfth week moved 190 km, 195 km and 320 km.

Juveniles were capable of covering distances of up to 200 km 1-2 weeks before the usual departure age of 8-9 weeks. The youngest bird found away from the colony, BM-B (Table 3), had moved 195 km by age 6 w 6 days; it was the product of a late reneest, as was BM-W (Table 3). However, late breeding was not the only reason for distance movement by comparatively young juveniles, for example, YM-R (Table 3) was a product of mid-season breeding.

Ages of birds found in the North Island suggest that families which moved north of the Christchurch area continued to vary in the time they lingered at staging areas (see Table 5). This behaviour appears to differ from that of the US Great Lakes population, whose juveniles "find their way to the wintering grounds very rapidly" (Ludwig 1965), but Ludwig does not give precise age/distance data.

Numbers at staging areas

At staging areas adults always outnumbered or equalled juveniles (Table 4). Each juvenile was accompanied by a parent, and other adults were failed breeders, parents moving independently of their families, or off-duty parents.

Birds on outward passage in the lower South Island typically moved in flocks of 2 to 4, and numbers at Fortrose and Karitane did not exceed 11 birds. The numbers only partially indicate the procession of birds which occurred and in some instances (for example Karitane 22, 25 and 26 January 1994) give a false

TABLE 6 – Numbers of juvenile Caspian Terns from the Invercargill colony found dead in the North and South Islands of New Zealand 1970-1994

	Months												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
North Island	0	0	1	0	2	0	0	1	0	0	0	0	4
South Island	0	0	1	0	1	1	0	2	1	0	0	0	6

impression of short-term lingering. Changes in the band combinations of the birds present proved changes in birds. Small numbers present at staging areas at any one time could mask the passage of larger total numbers.

The movement pattern reflected the colony's asynchronous breeding and its annual breeding history. For example, after late renesting following December 1990 washouts, the last family was seen at Karitane on 20 March 1991; the 1992 season was free of washouts, there was little renesting, and most families had passed through Karitane by mid-February 1993. Local weather conditions probably influenced distance travelled and time stayed. For example, at Fortrose on 10 and 11 February 1989 (Table 4) the weather was blustery with wind-gusts to 29 knots (NZ Meteorological Service) recorded at the nearest weather station 40 km distant; and on 17 February 1992 the birds sheltered beside shoreline vegetation for at least three hours during winds of up to 35 knots (NZMetS).

The 10 to 12 Caspian Terns at Kakanui 1-20 January 1950 (Billing 1950) were probably staging birds. An unusually large flock of 20 birds, roosting at All Day Bay on 4 March 1990 (Hocken & Hocken 1991 and A.G. Hocken, pers. comm.) behaved atypically, in my experience, by roosting on an open beach. Along the Otaki-Ohau coast, all Caspian Terns along beaches were flying, while most at estuaries were roosting (Powlesland & Robertson 1987).

Time spent at staging areas by families

There were few reports of identified birds (Table 5), and the unsatisfactorily small sample size indicates the need for daily observations at staging areas during the period January to March. Times spent by families at staging areas varied widely. Factors which influenced this variation were not identified, except that age of the juvenile appeared to be irrelevant. Possible factors included food supply, local weather conditions, seasonal change and adult moult. Observations of behaviour of birds while staging suggested that other factors may be under- or over-crowding, individual adult dominance, and the presence or absence of environmental conditions which satisfied the juvenile's developmental needs (for example in the identification, capture and manipulation of prey).

Behaviour at staging areas

Juveniles behaved conspicuously, begging and uttering high-pitched whining calls. They practised foraging behaviour by picking up and dropping sticks and other flotsam at the tide edge, washing sticks and dropped food items, and sometimes swallowing dropped food items after washing them. They dip-fed at the

TABLE 7 – Numbers of Caspian Terns of known age which had moved from the Invercargill Estuary colony and were sighted or recovered dead at coastal and inland locations.

	Adults	Immatures	Juveniles	Totals
<u>Sightings</u>				
Coastal	83	51	38	172
Inland	0	1	0	1
Total	83	52	38	173
<u>Deaths</u>				
Coastal	6	9	8	23
Inland	3	3	2	8
Total	9	12	10	31
<u>Totals</u>	92	64	48	204

tide-edge, and some attempted plunge-dives. The accompanying parent spent much time standing beside and observing the juvenile. When the parent left to forage, the juvenile stood alone, sometimes flew and pitched no more than ca. 50 m from its original position, and stood, often looking up and around, until the parent returned. On four occasions, juveniles aged less than eight weeks were observed for 2 to 4 hours, sitting on sand/mud, not begging. On each occasion the parent attempted several times to feed a small fish to the juvenile, but only once did the juvenile stand and take the food. These juveniles appeared to be exhausted, not satiated. Some families moved in and out of loose groups of conspecifics, where they roosted and preened. Others joined or formed a group only when pushed up to a high tide roost.

Juvenile movement and mortality

No juvenile was recovered dead in January or February (Table 6), indicating that birds which fledged were likely to survive initial movement away from the colony.

Among the juveniles, four of the nine found in the North Island and six of the 39 found in the South Island were recovered dead. The probability that Invercargill-bred juveniles as a group spent more time in the South Island than in the North Island is indicated by comparisons of numbers sighted where frequent observations were made (Avon-Heathcote, Manawatu and Hawkes Bay Estuaries, Figure 2), and comparative ages of birds on arrival at these sites (Table 3). The sample size is small, but these data may indicate high mortality in juveniles which moved further than 900 km. This did not apply to other age groups, since all nine adult deaths and 10 of the 12 immature deaths occurred in the South Island. A possible reason for the difference was that some parents in families which moved long distances may have been long distance nomads, and deserted the juvenile before it was self-sufficient.

Sedentariness and nomadism in adults and juveniles

Adult sedentariness and nomadism were seldom proved because few adults were uniquely-banded. Birds which met the criteria for sedentariness (see Methods) were BW-M at Lake Catlins (4 months in 1993, 2 months in 1994); R-WM (2 months in 1995) and -RM (3 months in 1995) at the Avon Heathcote Estuary; -BM at Manawatu (6 weeks in 1992) and -RM at Manawatu (6 months in 1992 and 4 months in 1993, not certainly the same bird each year). None of these birds was uniquely marked, but individual identity of some was proved by association with banded offspring.

Local nomadism in off-duty parents has been discussed. Distant nomadism in Invercargill colony birds was best indicated by inland recoveries, because passage movement followed the coastal route and tended to obscure possible coastal nomadic movement by all birds except those uniquely marked.

Table 7 should not be used to measure percentages of birds which moved inland because 'sightings' favoured coastal recoveries but 'deaths' favoured inland recoveries. Of the 3 adults found inland (Table 7), only one (H18675, aged 8 y 5 m when found on 15 April 1978 at Wyndham), was certainly a nomad. The second, H18612, was aged 3 y 10 m when found at Kurow on 20 October 1972. Age, distance from the colony, the breeding season recovery date, and the high degree of fidelity by Invercargill colony birds to their natal site on first and subsequent breeding (Barlow unpubl. data), all suggest that this was a late-maturing immature bird. The third, H13543, aged 6 y 2 m on 5 January 1972 when found dead on the Oreti River, 38 km upstream from the colony site, was possibly foraging and still colony-based.

Not all adults found inland are nomadic. A few pairs have bred at Rotorua (Falla *et al.* 1979), and isolated pairs bred on some inland lakes and riverbeds in Canterbury, and appeared to move to the east coast for autumn and winter (Pierce 1984). Single birds occasionally visited inland Canterbury lakes in winter (Pierce 1984); Robertson *et al.* (1983) recorded one winter sighting on the Ahuriri River, and Robertson *et al.* (1984) recorded two winter sightings of two birds at Lake Aviemore and one bird in winter at Lake Waitaki. In July 1994, 11 were sighted on inland Canterbury lakes and rivers. Birds sighted inland in winter were probably nomads, and many were likely to be immatures (Table 7).

There was little proof of long-distance nomadism in Invercargill colony adults. Therefore, they may have behaved differently from adults at US Great Lakes, which Ludwig (1965) suggested may wander more widely than younger birds.

The two juveniles found inland (Table 7) were H18724, aged 5.5 m, at Huntly, 1125 km NE of the colony, on 8 May 1971, and H24593, aged 6 m, at Woodville, 900 km NE, on 17 May 1984. Their ages indicate that each was adult-dependent, and each may have been accompanying a nomadic parent. However, just as some individuals appeared to have exceptional dependency needs (demonstrated by begging when age 15 m to 18 m), others may be precocious, break early from the parent/off spring bond, and some of these may wander. Death of a parent, result-

TABLE 8 - Juvenile and immature Caspian Terns of known age which remained at one location for more than one month, and their periods of sedentariness

Bird	Location	Dates seen		Number of sightings	Bird age (days)	Time sedentary (approx. Days)
		first	last			
R-WM	Invercargill Estuary	9 Nov 92	4 Jan 93	23	690-750	60
R-WM	Waikawa Est	12 May 91	10 Dec 91	72	180-390	210
BM-B	"	21 Jun 92	26 Feb 93	17	210-450	240
R-WM	L Catlins	21 Aug 92	14 Jul 93	7	630-960	330
H27310 YM-B	"	26 Feb 93	4 Jan 95	4	120-780	660
M-RY	"	27 Feb 93	6 Jun 94	8	90-570	480
H27390 RB-M	"	27 Jan 94	7 Apr 94	5	60-120	60
-RM	Avon-Heathcote Estuary	19 Jan 88	24 Feb 89	4	60-450	380
-BM	"	24 Jan 89	28 Aug 89	3	60-270	210
R-WM	"	26 Feb 91	3 Jul 93	10	90-960	870
R-WM	"	24 Mar 91	28 Apr 91	3	120-150	30
H27287 WM-B	"	9 Apr 92	8 Mar 94	6	90-780	690
YG-M	"	6 Feb 94	8 Mar 94	3	90-120	30
M-RY	"	9 Feb 93	8 Mar 94	3	90-480	390
R-WM	L Ellesmere	8 Sep 91	4 Jul 93	4	300-960	660
R-WM	"	4 May 93	28 Jul 93	4	900-960	60
M-RY	"	28 Jul 93	8 Nov 94	5	240-720	480
YG-M	"	24 Jul 94	8 Nov 94	4	240-360	120
BM-B	Brooklands Lag	24 Aug 93	4 Apr 94	3	630-870	240
-BM	Manawatu Est	11 Mar 90	2 Oct 91	5	480-1050	570
R-WM	"	31 Mar 91	28 Mar 93	17	120-840	720
R-WM	"	2 Oct 91	10 Jan 93	4	330-780	450

ing in the juvenile becoming lost, cannot be excluded as a possible factor in the rare cases of juvenile nomadism.

Juveniles were highly sedentary after they reached their wintering grounds. (Table 8, discussed later)

Movements of immatures

Figure 3 depicts individual birds, not sightings. Birds found at the same site in more than one year are depicted only once in the appropriate time-period(s).

Immatures typically interspersed periods of sedentariness with locally nomadic and/or long distance movements. In their third year they tended to move less than formerly, showed little evidence of distance nomadism, many remained sedentary, and some were locally nomadic. Seasonal change appeared to have no direct influence on distance movements of immatures.

Seasonal movement

Return to the colony in spring was the only long-distance movement of immatures which appeared to relate to seasonal change (Figure 3), with one, or sometimes two or three, birds involved each year. Six of 10 identified birds which returned were 1-

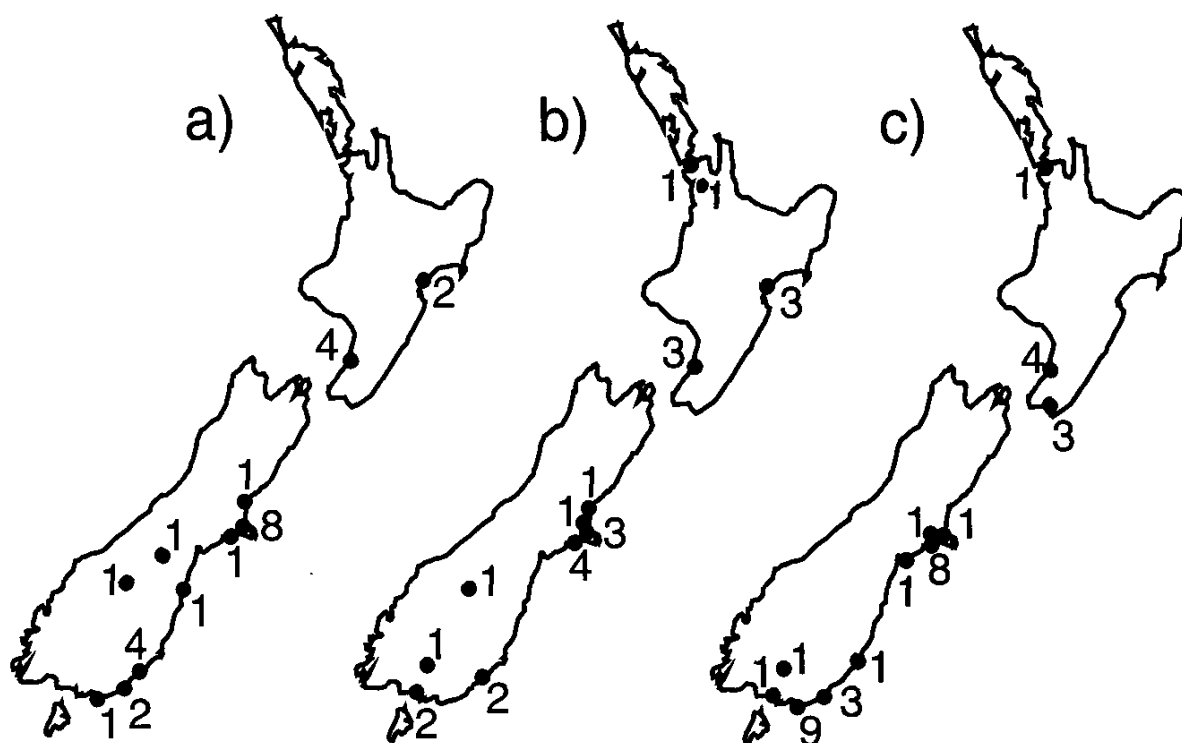


FIGURE 3 – Immature Caspian Terns which moved from the Invercargill Estuary colony 1967-1995. (a) January - April; (b) May - August; (c) September -December.

year olds which arrived at the same time as returning adults. One of these was found dead. The remaining five stayed two to 10 days, and four of them were seen begging unsuccessfully. Their behaviour suggested that bonding or dependence, not seasonal change, was the direct cause of their return. The four 2-year olds which returned behaved differently. None was seen begging although one whined and mewed; one stayed three weeks and another nine weeks. The latter bird wandered unmolested between nests and chicks throughout November and December 1992. The 2-year olds were first seen on 29 October 1993, 9 November 1992, 11 November 1989 and 4 January 1993. Those which arrived in October and November may have joined late-moving adults on their spring migration, but return to the colony by 2-year olds was believed to relate to nomadism rather than seasonal change.

Figure 3 suggests that local seasonal movement occurred between water-ways in the vicinity of Christchurch. Such movements probably related to food, which was not studied.

A few immatures were found inland at all seasons (Figure 3).

Local nomadism by immatures

Proof of local movement between Lake Ellesmere and Avon-Heathcote Estuary was obtained for H27287 WM-B which was seen at the Avon-Heathcote Estuary three times between 13 January 1993 and 8 March 1994, aged 12 to 26 months, was at Ellesmere on 8 November 1994 and was back at Avon-Heathcote on 19 November 1994, aged 34 months. Other indications that immatures moved between the two sites were (1) Seasonal distribution (Figure 3); (2) H13101, which

was recovered dead on 28 December 1968, aged 14 m, at Springston, in open country 10 km inland from Lake Ellesmere and 25 km from Avon-Heathcote. This recovery suggests that the flyway between the two sites did not follow the coastline but was across the isthmus at the base of Banks Peninsula; (3) 1993 year-coded birds YG-M: one and two YG-M-banded birds were seen at the Avon-Heathcote Estuary up to three times as juveniles, and at ages 8-10 months (one bird 3 sightings) and 11 months (two birds) were seen at Ellesmere. On 8 November 1994, after two weeks of stormy weather, four YG-M birds, aged 12 months, were sheltering from 30-knot winds at Ellesmere, among 62 terns which included M-RY, BM-G and WM-B, all Invercargill immatures. WM-B had moved from the Avon-Heathcote Estuary and BM-G from Lake Wairarapa. The Avon-Heathcote Estuary was not checked on 8 November 1994, but the numbers of YG-M birds suggest movement between the two sites, although some may, like BM-G, have moved further.

Distant nomadism

Of 64 immatures recovered, 17 (26.5%) were long distance nomads. They were: four found inland (Table 7); nine which returned to the colony, stayed briefly and left unaccompanied: (one of these, H27313 YM-Y, had spent its first winter at Avon-Heathcote, returned to the colony when aged 11 m, and was at Avon-Heathcote again when aged 27 m); three birds each seen only once at frequently-checked sites; and H27315 BM-G, at Lake Wairarapa with adults on 9 October 1994 and at Lake Ellesmere on 8 November 1994, aged 23 months. BM-G did not return to the colony, but may have moved south as far as Ellesmere with returning migrants, so possibly was not a true nomad. Somewhat similar movements were recorded by Finnish and Swedish birds which wintered in tropical West Africa, where a few one-year olds remained in winter quarters, but many moved north by late summer of the second calendar year, and most did not venture beyond the north shore of the Mediterranean; a few reached the Baltic but appeared not to visit colonies (Cramp 1985).

Ages of immatures which wandered

Of the 17 distance nomads, eight were aged 10 to 18 months, seven were aged 19 to 24 m, and two were aged 25 to 27 months. This movement pattern differed from that of birds of similar age in the US Great Lakes population, where Ludwig (1965) analysed movements of 370 birds of all ages from recoveries of dead birds, classing birds aged 6-18 months as 'immatures' and those aged 18-30 months as 'subadults'. A few (less than 10%) apparently found their way back to the lakes in their first summer, but Ludwig considered that most of these were probably birds which had died the previous fall and were found the following season. He found little evidence for Caspians wandering in the 6 - 18-month phase of their lives, and stated that Caspian Terns were 'quite sedentary' at this age. Unfortunately, Ludwig did not separate subadults from adults in his analysis of movement data, although when examining death distribution he found that, of 10 spring and summer recoveries of sub-adults only one (10%) had returned to the lakes.

Sedentariness in juveniles and immatures

Criteria for sedentariness of juveniles and immatures were a minimum of three sightings at one location within at least one month. Year-coded birds (Table 8) are those without numbers. Four birds (R-WM x 2, YG-M and M-RY) at Avon-Heathcote Estuary and Lake Ellesmere were possibly the same birds, locally nomadic between these sites.

Periods of sedentariness in juveniles and immatures varied widely, as did the ages of birds when they moved (Table 8). Of 13 juveniles, three (23%) moved after 1 to 2 months in one location, and ten (77%) were sedentary to age nine months. Of these 10 birds (then immatures), six moved before or during their second winter, and four remained sedentary. Four of the 13 (30.7%) therefore remained at their first wintering site through their second winter. One of these birds stayed on until the following summer; two stayed until autumn, but one of these, WM-B, moved only 30 km to Lake Ellesmere; and one stayed until late in its third winter.

Ten birds (45% of total found sedentary) moved between ages 6 and 18 m, either beginning or ending a period of sedentariness. Were sedentariness to include local nomadism, and Avon-Heathcote and Ellesmere birds R-WM x 2, YG-M and M-RY (Table 8) regarded as locally nomadic, the figures change from 10 of 22 to 7 of 18, i.e. 39%. These findings again differ from the 'quite sedentary' 6 to 18 month-old birds at US Great Lakes (Ludwig 1965).

Of 18 birds which were sedentary for varying periods during immaturity, 10 moved when between ages 26 and 35 months old. Five of these moved before their third winter, four moved late in their third winter, and the 35 month-old bird moved in October. These findings appear to conflict with those for distance nomadism, where no immature aged more than 27 m was found to move. The disparity is due, in some cases, to local nomadism, (for example WM-B (Table 8) was locally nomadic after 8 March 1994); and to movement back to the colony in August-October, before first breeding.

Hiatus in movement data

The staging data obtained from families and adults without juveniles in the lower South Island indicated that birds with North Island destinations would almost certainly have further broken their journey, at some point or points between the Christchurch waterways and the North Island, as would birds on return movement. It is possible that northern South Island sites were also used by some Invercargill colony birds as wintering grounds, and by immatures as year-round habitat. The possibility is supported by the presence of Caspian Terns from Cape Campbell northwards and throughout the Marlborough Sounds (Bull *et al.* 1985), although many of these would be birds from the Nelson and Farewell Spit colonies. Bull *et al.* (1985) also show Caspian Terns present along much of the South Island west coast north of Fiordland, but only 1 to 2 birds are occasionally seen in that area. No Invercargill-banded bird has been reported from that coast, nor from any area west of the Southern Alps. Maynaud (1956), cited in Cramp (1985),

found some evidence in Switzerland of flight over the Swiss Alps, but those birds were in passage through Europe, whereas in New Zealand the Southern Alps do not intervene between the terns' breeding and wintering grounds.

To date, no Invercargill-bred Caspian Tern has been recovered in Australia, suggesting that, unlike some juvenile White-fronted Terns (*S. striata*) (Clark & Dawson 1957), Caspian Terns from this population do not cross the Tasman Sea.

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LITERATURE CITED

- BELLROSE, F. 1967. Radar in orientation research. Proc. XIV Int. Ornithol. Cong.: 281-309.
- BERGMAN, G. 1953. Verhalten und Biologie der Raubseeschwalbe (*Hydroprogne tschegrava*). Acta Zool. Fenn. 77: 1-50.
- BILLING, G.J. 1950. Summarised Classified Notes. Notornis 4:49.
- BULL, P.C.; GAZE, P.D.; ROBERTSON, C.J.R. 1985. The Atlas of Bird Distribution in New Zealand. Ornithological Society of New Zealand, Wellington.
- CHALLIES, C.N. 1985. Caspian Tern. P. 226 in Robertson, C.J.R.(ed.). Complete Book of New Zealand Birds. Reader's Digest, Sydney.
- CLARK, W.C.; DAWSON, E. W. 1957. The trans-Tasman dispersal of the White-fronted Tern (*Sterna striata*). Notornis 7: 65-69.
- CRAMP, S. (ed.) 1985. The Birds of the Western Palearctic, Volume IV. Oxford University Press.
- CROSSLAND, A.C. 1993. Birdlife of the Avon-Heathcote Estuary and Rivers, and their margins. Canterbury Conservancy Technical Report Series No. 6. Department of Conservation, Christchurch.
- CUTHBERT, F.J. 1988. Reproductive success and colony-site tenacity in Caspian Terns. Auk 105: 339-344.
- FALLA, R.A.; SIBSON, R.B.; TURBOTT, E.G. 1979. The New Guide to the Birds of New Zealand. Collins, Auckland.
- HOCKEN, A.G.; BAKER, A.R. 1991. Otago Bird Report 1985-1989. Ornithological Society of New Zealand, Dunedin.
- HOCKEN, A.; HOCKEN, A.G. 1991. Classified Summarised Notes. Notornis 38:334.
- JOSEFIK, M. 1969. Caspian Tern, *Hydroprogne caspia* Pallas in Poland: the biology of migration period. Acta Ornithol. 11: 381-443.
- LUDWIG, J.P. 1965. Biology and structure of the Caspian Tern (*Hydroprogne caspia*) population of the Great Lakes from 1896-1964. Bird-Banding 36: 217-233.
- McKENZIE, H.R. 1972. In Search of Birds in New Zealand. A.H. & A. W. Reed, Wellington.
- MAYNAUD, N. 1956. Etude sur la Migration et les Zones D'Hivernage des Sternes Caspiennes *Hydroprogne caspia* (Pallas) d'Eurasie. Alauda 24 : 206-218.