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## ANNUAL MOVEMENT PATTERNS AND BREEDING-SITE FIDELITY OF THE NEW ZEALAND DOTTEREL (*Charadrius obscurus*)

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### ABSTRACT

A post-breeding flock of New Zealand Dotterels was monitored for 3.5 years at a site on the east coast of Northland, New Zealand. The pattern of flocking and dispersal was the same each year; the flock began to form in January and was at peak numbers in February and March. Birds began to return to their breeding grounds in late March, and two-thirds of those that bred away from the flock site had left by the end of April. Individual colour-banding showed a very high degree of breeding-site and flock-site fidelity. All the adults in the flock bred within a 16 km radius (the central study area) and none was found outside this area during the study. All adults in the central study area visited the flock each year; however, at two other localities in the greater study area a few birds were entirely sedentary on their breeding grounds and did not visit a flock. Breeding territories of birds resident at the flock site changed little between seasons. Unlike many migratory members of the genus *Charadrius*, NZ Dotterels of the northern population showed very high mate-retention from one season to the next, with both members of a pair usually occupying their territory for much of the year.

### INTRODUCTION

The New Zealand Dotterel (*Charadrius obscurus*) is a large, endemic plover with a population estimated at about 1500 and a restricted distribution. Most of the present population (probably about 90%) inhabit the coast of the North Island, north of 38°S. These northern birds frequent sandy beaches and tidal estuaries year-round and breed only on the coast. The southern birds breed on the mountain tops of Stewart Island at 47°S. In the 19th century, large numbers also bred inland in many parts of the South Island and southern North Island, often at high altitude (e.g. Buller 1882, Seebohm 1888).

One well-known characteristic of the species is the annual movement from breeding grounds to post-breeding flock sites. For the southern mountain-breeding birds, this was usually a descent to the coast (Potts 1872),

a pattern still seen on Stewart Island. Sibson (1967) showed that the coastal breeding birds in the Auckland area also gather in post-breeding flocks. He suggested that these flocks were formed mainly from the local breeding pairs and their progeny, there being no evidence of immigration from a distance. Flocks tended to become bigger between January and April and were breaking up by mid-winter. Counts collected by Edgar (1969) suggested similar local post-breeding movements and flocking throughout the northern population. Reed (1981) described the flocking period as short ("lasting approximately from February to early May") and noted that some birds remain in pairs all year round.

Although juvenile birds are known to wander widely (McKenzie 1978, Dowding, unpubl.) very little is known of adult movements other than the basic features of flocking and dispersal. McKenzie (1978), referring to the South Auckland district, noted very little regularity, some birds being sedentary, some moving back and forth in one area and others moving between areas.

Little information has been published on breeding-site fidelity. McKenzie (1978) described two banded pairs, one of which bred in the same locality for three consecutive seasons, the other for two. He cautioned, however, that such behaviour may not be the rule. "The species in general wanders so much that it could well be that most will find mates and breed wherever they happen to be when the breeding season comes round." In contrast, Reed (1981) monitored banded birds on the Mangawhai-Pakiri coast, North Auckland, and concluded that "Once established on a breeding ground, they return to the same area each year."

Although many aspects of the biology of the New Zealand Dotterel have been described in outline, there have been few detailed studies on the species. We have monitored the movements of a group of birds of the northern coastal population to learn more about the timing of flock formation and dispersal, distances travelled, ranges of individual birds, and breeding-site fidelity from one season to the next.

## STUDY AREA

Figure 1 shows the greater study area. During the study, this area contained 130-140 adult NZ Dotterels, roughly 10% of the North island population. Within it, two major post-breeding flocks formed, one at Mangawhai with a usual maximum of 60-65 adults and the other at Omaha with a maximum of 50-55 adults. Most of our observations were made in the central study area, which consisted of the coastline from Poutawa Stream to Beehive Island, including Omaha.

NZ Dotterels of the northern population often nest, roost and form post-breeding flocks on sandspits at the mouths of tidal estuaries or streams. It is likely that NZ Dotterels used the spit at Omaha before humans exploited and developed the area, but the establishment of the present flock seems relatively recent. Counts before 1979 are few but it is clear that the Whangateau Harbour was a feeding ground for the species before the current flock was present. In the 1940s, sand was mined from the spit and dredged from the harbour entrance. Recession of the spit head was first

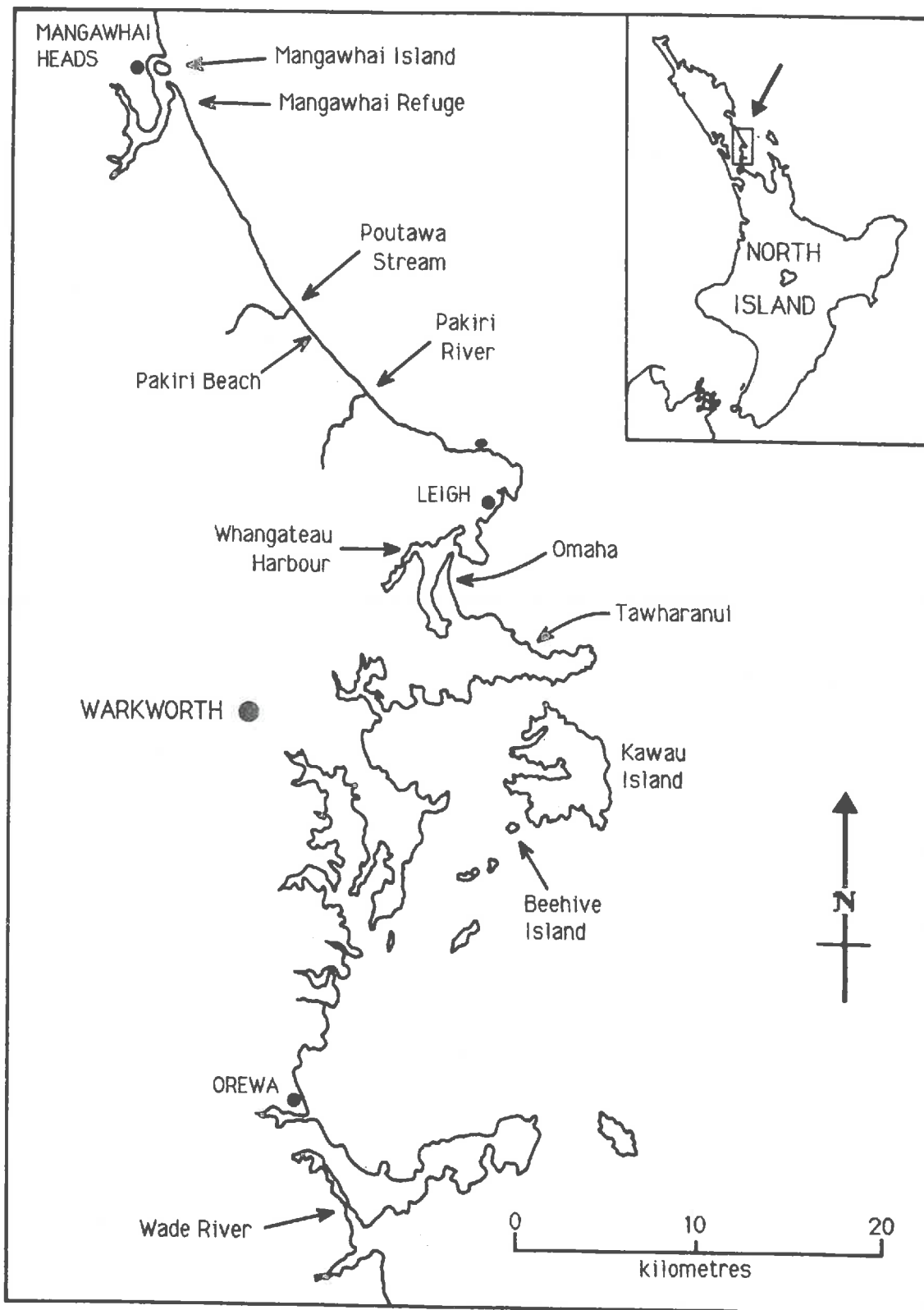


FIGURE 1 — Map of the greater study area. The central study area extends from Poutawa Stream to Beehive Island.

noticed in the 1950s and during the 1960s and 1970s erosion of the beach became increasingly severe and the spit almost disappeared. In 1979, three rock groynes were installed at the mouth of the estuary to reform and stabilise the spit. Most wader species in the area quickly adopted the new spit as

a high-tide roost and NZ Dotterels and Variable Oystercatchers (*Haematopus unicolor*) adopted it as both a breeding site and a post-breeding flock site.

## METHODS

Adults and fledged juveniles were caught at the flock site in mist-nets, adults were caught on their breeding grounds by nest-trap and chicks were caught before they fledged. Birds were weighed, measured and assigned individual colour-band combinations. Adults were given a size D metal band on the left tarsus and three coloured PVC bands on the right (e.g. M-YGR is metal on left, yellow over green over red on right). Large chicks and recently fledged juveniles have a tarsus of adult length but the top third is noticeably thicker. One tarsus cannot take three colour bands, and so we gave chicks and young juveniles a metal band and one colour on one leg and one or two colours on the other (e.g. MR-WB). Three birds with only two colour bands each (B-MB, M-YB and R-MB) were banded before this study began.

The flock was usually counted at intervals of 2 weeks (but occasionally 3 - 4 weeks) from October 1986 to July 1990. Counts were made within 1 hour of high water because birds often dispersed into the adjacent estuary (Whangateau Harbour) at other times. The entire study area (from Mangawhai in the north to Wade River in the south) was searched at least twice during each breeding season until all the banded birds from the Omaha flock had been found. The area was searched again, usually in late February or March, to find out which birds were still on their breeding territories and which were in the Omaha flock. Each search was made over a period of 6 - 10 days; during this time frequent visits to Omaha allowed us to detect occasional brief visits by banded birds. The central study area between Poutawa Stream and Beehive Island was also visited at many other times, particularly when the flock was forming or breaking up.

During the 1988-89 and 1989-90 breeding seasons, the approximate territories of the pairs breeding at Omaha were recorded on a sketch map. Territories were defined by (a) location of nests (b) observing territorial disputes with other NZ Dotterels, and (c) recording where birds were first seen during each visit, particularly early in the breeding season, before and during egg-laying and incubation. As chicks were highly mobile (even when young), their location was not a good indication of territory. A site at the mouth of the Wade River, where three or four pairs nested on a sand-bar, was similarly monitored.

Between October 1986 and July 1990, about 1400 sight recoveries were made of colour-banded birds in the greater study area; about 1100 of these were of birds in the central study area. These have yielded information on flocking and dispersal movements, on breeding-site fidelity and on the ranges of individual birds.

## RESULTS

### Counts at Omaha

Figure 2 shows the numbers of fledged New Zealand Dotterels recorded at Omaha between January 1987 and December 1989. These counts revealed an annual pattern that varied only slightly each year in numbers and timing.

Many birds arrived at Omaha during January and the flock was at its largest for a relatively short time in February and March. In April, some birds at Omaha began to acquire nuptial plumage, at the same time as the first birds were leaving the flock. Numbers then fell gradually over the 5 months May to September, although the flock size rose and fell occasionally during this time. Individual colour-banding revealed some of the reasons for the fluctuations, and these are described below. From September onwards, nearly all adult birds seen at Omaha were resident breeding birds.

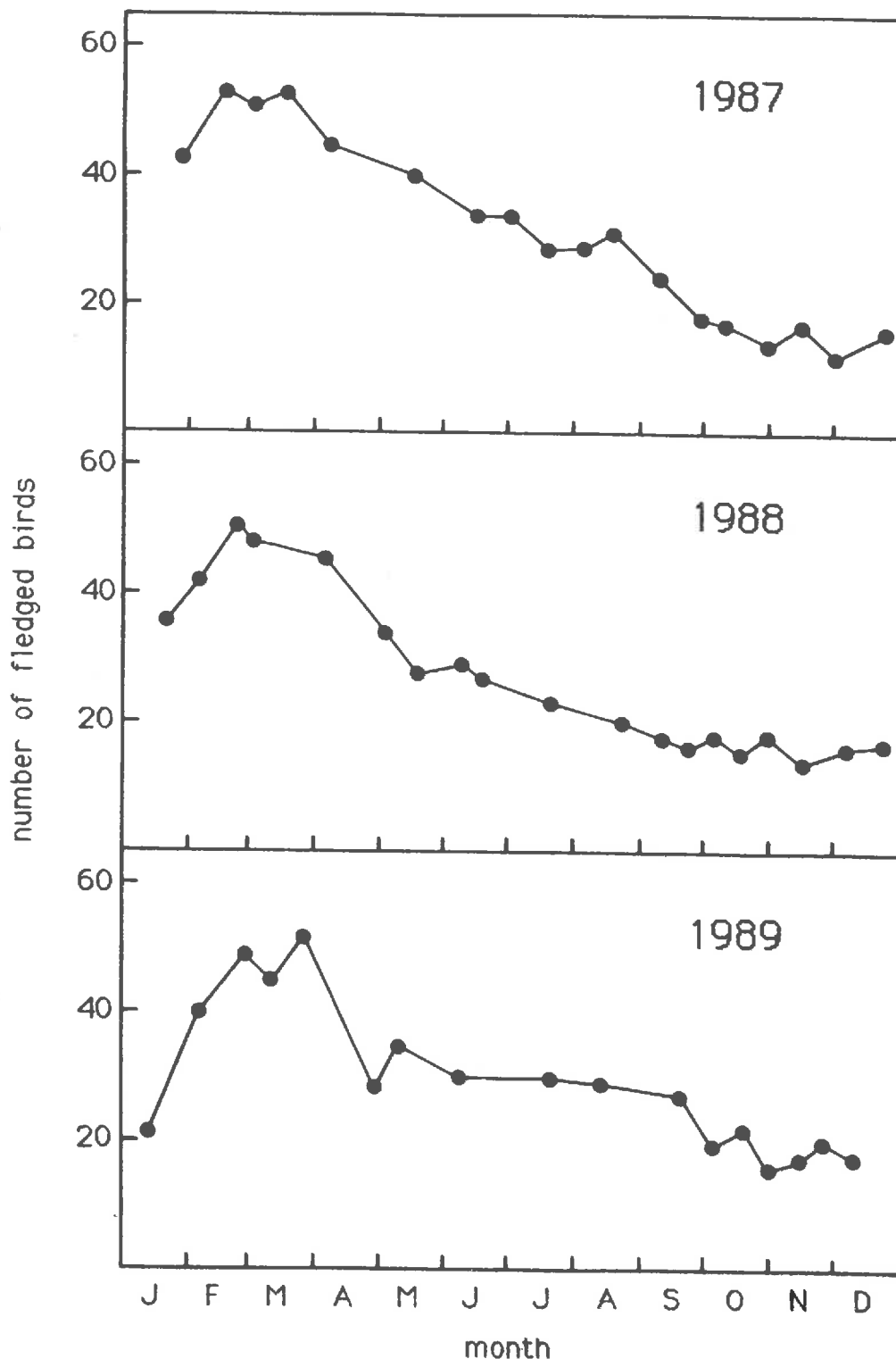


FIGURE 2 — Number of fledged NZ Dotterels counted at Omaha Spit

### **Mate fidelity**

We have little information on long-term stability of pair-bonds but two birds banded as a pair in December 1977 at Mangawhai are known to have bred together for at least 10 of the past 12 seasons. In our study, most (if not all) pairs were faithful both during and between breeding seasons. In 1987-88 both birds of three pairs were banded and all these pairings were retained in the following season. In the 1988-89 season 10 such pairs were in the greater study area. All these pairings were retained in the 1989-90 season, giving a total of 13 retained-pair years. In addition, we have not detected an exchange of mates within a breeding season. Of the 28 pairs in the central study area at the start of the 1989-90 season, 23 were recognisable by having one or both birds banded. In 1988-89 we found 27 pairs, of which 18 were recognisable.

### **Flocking**

Fidelity of individuals to the Omaha flock was very high. During our study all banded birds seen at Omaha in any autumn (and known to be alive the following year) returned there the next autumn. Two birds banded before this study began have been seen at Omaha each autumn for the past 8 years. Most birds arrived at the flock between mid-January and mid-February each year (Figure 2), but in a few cases birds arrived as late as mid-March when raising a late brood.

In the central study area birds that bred together also flocked together. Bonded pairs were therefore together for all or most of the year. In a few cases we detected members of a pair arriving to join the flock at different times. In 1989, for example, one member (M-GYR) of a pair which had nested 15 km to the south was first seen at Omaha on 4 February whereas its mate (M-YWB) was not seen there until 26 March. This pattern was repeated in 1990 and the interval was similar; M-GYR was first seen at the flock on 23 January and M-YWB on 17 March.

About 90% of the adult birds in the greater study area visited their flock each year, if only for a short time, but a few pairs appeared to be sedentary. All the banded adult birds breeding in the central study area visited Omaha each autumn during our study. In addition, the local breeding birds at Omaha ceased defending their territories after the breeding season and moved the short distances (up to 400 m) from their territories to roost with visiting birds in the flock. In contrast, in at least two places in the greater study area pairs remained on territory all year round. The four pairs breeding at the Wade River sand-bar were present in all months of the year and were recorded nowhere else; four of the eight birds have been banded for 18 months or more and none was seen elsewhere during the study (average of 18 sightings per bird, range 12-25 sightings). Two or three pairs which bred on Mangawhai Island either remained on territory all year or left so briefly that their absence was not detected, even though a large flock was less than 2 km away.

### **Return to breeding grounds**

Table 1 shows the numbers of banded birds leaving Omaha each month to return to their breeding grounds.

TABLE 1 — Numbers of banded birds leaving Omaha each month to return to their breeding grounds

	1988	1989	1990	Total
March	2	0	3	5
April	4	7	6	17
May	2	1	2	5
June	1	1	2	4
July	0	2	0	2
Total	9	11	13	33

The first birds left towards the end of March, approximately half (17 of 33 bird-years) left during April, and two-thirds (22 of 33 bird-years) had left Omaha by the end of April. Although we have limited data, it appears that birds consistently left the flock early or late. The same six individuals left in late March or April three years in succession; by contrast, two others left late (in June or July) each year, also for three years. Because observations were made at approximately two-week intervals, we have no precise information on whether members of a pair left the flock simultaneously. In 1990, however, four pairs breeding away from Omaha had both members banded; in each pair both birds left during the same two-week interval and it thus seems that partners depart within a short time of each other, if not together. Once birds had dispersed, most remained on or near their territories; although none returned to Omaha for long periods before breeding, we did record a few birds (2 in 1988, 2 in 1989, 1 in 1990) that visited Omaha briefly in June, July or August (see section on 'other movements' below).

At Omaha, where birds breed close to the flock site, the timing of territory occupation was more variable. Perhaps local breeding birds can remain in the flock and easily occupy and defend their territories when necessary. In 1988, for example, we found some birds (not all the same each time) on territory at each visit from the end of April onwards but there was considerable movement of birds back and forth between territory and flock through the winter. In 1989, by contrast, we found no birds on territory at Omaha until July; all territories were occupied by early August and defended from then onwards.

### Breeding-site fidelity

Table 2 shows the pattern of movement to breeding grounds in the central study area and the number of pairs at each breeding locality in the 1988-89 and 1989-90 seasons. All recognisable pairs (i.e. with one or both birds banded) dispersing from Omaha returned to the same stretch of coastline to breed each year. The number of such pairs increased during the study as more birds were banded; the five pairs recognisable in 1986 have all

TABLE 2 — Numbers of pairs at each breeding locality in the central study area. Numbers in brackets show the number of recognisable pairs. Localities are shown in Figure 1.

Breeding location	Distance (km) from Omaha	Pairs during 1988-89 season	Pairs during 1989-90 season
Poutawa Stream	16	2 (1)	2 (1)
Pakiri Beach	14	2 (2)	2 (2)
Pakiri River	10	5 (2)	6 (4)
Horseshoe Island	1	1 (1)	0 (0)
Omaha Spit	0	9 (8)	9 (9)
Tawharanui	7	6 (2)	7 (5)
Beehive Island	15	2 (2)	2 (2)
Totals		27 (18)	28 (23)

returned to the same localities for four consecutive years, the nine pairs in 1987 for three consecutive years and the 18 pairs in 1988 for two consecutive years.

During this study we detected only one case of breeding dispersal (*sensu* Greenwood & Harvey 1982). This occurred when pair K (both birds banded) moved 1 km from their 1988-89 site (Horseshoe Island, where they had bred successfully that season) to a new one (Omaha) for the 1989-90 season. A few individual birds are known, however, to have moved greater distances than this between breeding sites. The possible loss of colour bands casts doubt on some examples, but we verified two cases by retrapping and checking the numbered metal bands. B-MB was banded while nesting at Pakiri River in October 1981 and continued to breed there until 1984 or 1985; in November 1986 it was retrapped on a nest at Omaha (a straight-line distance of 10 km) and has bred there since. R-MB was banded (as was its mate R-MY) while breeding at Mairetahi, West Kaipara Harbour, in January 1980; it was retrapped on a nest in December 1986 at Whatipu 53 km away, breeding with an unbanded bird.

At each breeding locality, most pairs occupied the same (or similar) territories in consecutive years but there were some minor variations. Figure 3 shows the approximate territories of the pairs breeding at Omaha in the 1988-89 and 1989-90 seasons.

The overall pattern was very similar in the two seasons but there are two obvious differences. In September 1989, pair E disappeared (we believe one bird of the pair died and its mate left the area, returning to join the flock in late January 1990). Their territory was subsequently occupied by pair G. The other major change was the establishment of pair K; in the 1988-89 season this pair had bred on Horseshoe Island, 1 km to the west in Whangateau Harbour. In addition, pairs H and J both moved northwards slightly.

At the Wade River sand-bar, where three (later four) pairs were completely sedentary, territories were also very similar from one season to the next. The only change detected in the period 1987-1990 was the arrival and establishment of the fourth pair at the SW end of the sand-bar in 1988.



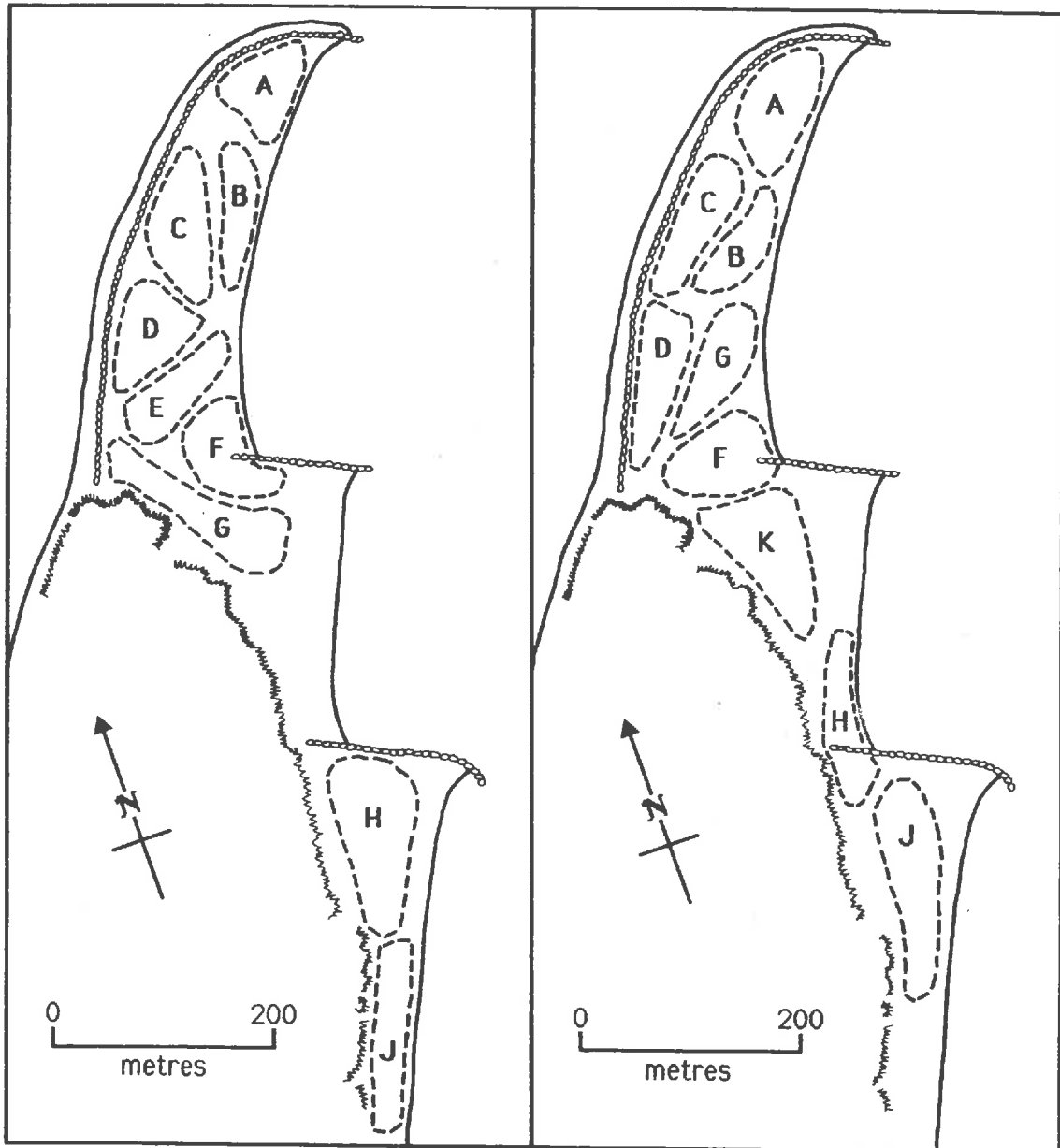


FIGURE 3 — Approximate territories of pairs breeding at Omaha during the 1988-89 season (left) and the 1989-90 season (right)

### Other movements

In addition to the annual movements for flocking or returning to breeding grounds, we detected other movements by a few birds during winter or early in the breeding season. Nearly all these were by birds that bred at Pakiri or Tawharanui, moving to Omaha and then back to their breeding areas, round trips of 15-25 km. Most of these movements seemed to be short-term, with the return trip completed within a day or two. As the Whangateau Harbour at Omaha is the only intertidal feeding ground of any size in the central study area, we assume these movements were feeding trips. In addition, one bird which bred at Omaha visited Pakiri River occasionally (10 km each way), although its mate, which is also banded, was not seen there.

### Ranges

Our study suggests that many adult NZ Dotterels live in discrete groups or 'cells' spread along the coast. None of the birds that bred in the central study area between Poutawa Stream and Beehive Island (see Figure 1) was seen outside that area (the Omaha cell) at any time of the year during the 3.5 years of this study. In addition, none of the 6 banded adults at the Wade River, the nearest breeding site to the south, has been recorded in the Omaha cell. Immediately north of the Omaha cell, the coast from Mangawhai Heads south appears to be another cell, with a flock at Mangawhai Refuge and a clear boundary between the two cells at Poutawa Stream. Of the 17 banded adults in the Mangawhai cell, only one was recorded in the Omaha cell during our study. This bird (M-YB) was banded in 1975, moved to Omaha in December 1989 and has been there since (to July 1990); previously it had been recorded only inside the Mangawhai cell (29 sightings).

Most adults in the central study area had limited and predictable ranges, usually being found either on or near their breeding territories or, while flocking, within 2 km of Omaha Spit. Birds that bred at the flock site were thus the most sedentary. Of the birds breeding at Omaha that have been banded for 2 years or more, 10 out of 12 were not seen away from Omaha or the adjacent estuary during the study (average of 54 sightings per bird, range 44-66 sightings). One exception was B-MB, seen on several occasions at Pakiri River, where it had bred before moving to Omaha. The other was a banded adult (M-BYW), which disappeared from its usual breeding site at Omaha in September 1989. Searches of the greater study area failed to find this bird, but it reappeared at Omaha in January 1990.

### Movement of juveniles

Colour-banding showed that juveniles were highly mobile and not restricted to cells in the same way as most adults. Chicks raised in the central study area moved in and out of the Omaha cell and we recorded four juveniles banded elsewhere that moved into or through it. Two of these were raised at Wade River (37 km to the south), one on Whale Island, Bay of Plenty (260 km to the south-east), and one at Ruakaka (55 km to the north-west). The time visiting juveniles spent at Omaha varied considerably from a week or less to 4 months. The arrival and departure of these wandering juveniles was the main factor contributing to the fluctuations seen in flock size during winter.

## DISCUSSION

### Annual movement patterns

Most adult NZ Dotterels of the northern population move annually from their breeding site to a post-breeding flock site and back (Sibson 1967). In our greater study area about 10% of adults were sedentary away from a flock site and the remainder visited a flock for 2 weeks to 5 months. As some birds visit their flock for a very short time, regular monitoring is necessary before deciding that a particular pair stays on territory throughout the year. In our central study area the distance between breeding and flocking sites ranged from 0 to 16 km, although it could easily be greater in other areas.

Birds of the southern population now breed in any numbers only on Stewart Island, although the species formerly bred in many parts of the South Island. On Stewart Island breeding sites are inland on the open mountain-tops, usually in areas where vegetation is sparse or it is very low (Dowding & Murphy, in prep.). The available historical evidence (e.g. Potts 1872) suggests that most South Island birds (and some in the southern part of the North Island) also nested inland at high altitude and formed wintering flocks on the coast.

This difference in breeding habitat may account for the early dispersal of the northern birds we studied. Southern birds are unlikely to spend the winter on their breeding grounds, where climatic conditions are harsh and food may be scarce. Counts of the flock at Awarua Bay, Southland (Maida Barlow, pers. comm.) support this suggestion; the birds there do not return to breeding grounds until at least late July or August. Another New Zealand plover which still breeds inland in the South Island, the Wrybill (*Anarhynchus frontalis*), stays in flocks on its North Island wintering grounds until July or August (Hay 1983). Similarly, most Banded Dotterels (*C. bicinctus*) breeding inland in the South Island winter in Australia and return in August or September (Ray Pierce, pers. comm.). NZ Dotterels of the northern population, moving relatively short distances along the coast in a temperate zone, do not face problems of food shortage or harsh climate. They can thus reoccupy their breeding sites at any time of the year and can even become completely sedentary.

It seems likely that when birds arrive at the flock is partly governed by their state of breeding, with failed breeders and early successful breeders arriving first, usually in mid-January. Occasionally birds arrived as late as March when raising a late brood. The factors governing the timing of return to breeding grounds are difficult to assess but the defence of territories (particularly high-quality ones) is presumably important. Edgar (1969) reported red birds guarding territory in the second week of May but believed this to be exceptional. Our study, however, shows that many birds are on territory at that time.

### **Mate fidelity**

In most members of the genus *Charadrius* that have been studied, the pair bond is not usually maintained after the breeding season. Occasionally pairs may re-form in subsequent years but many or most birds change mates between seasons. This has been demonstrated for the Piping Plover (*C. melodus*) (Wilcox 1959), Killdeer (*C. vociferus*) (Lenington & Mace 1975), Kentish Plover (*C. alexandrinus*) (Lessels 1984), Banded Dotterel (Pierce 1989), and others (Cramp & Simmons 1983). Most of these species are migratory. In general, males tend to show higher breeding-site fidelity than females, returning earlier to establish territory and attract a mate. There is thus an element of chance in whether pairs re-form.

The NZ Dotterel differs from its migratory congeners in these respects. Adults of the northern population are essentially non-migratory and the pair-bond appears continuous, with members of most pairs together all of the year. In addition, the pair-bond lasts for a number of consecutive seasons

(and possibly life) in most or all cases. This situation is similar to that of the White-fronted Plover (*C. marginatus*) of southern Africa; this species is also non-migratory, shows prolonged pair-bonds and occupies its territory for a large part of the year (Summers & Hockey 1980).

### **Breeding-site fidelity**

Site fidelity varies among charadriids; experienced male Banded Dotterels nested an average of 42 m from their previous site (Pierce 1989), whereas older Little Ringed Plovers (*C. dubius*) settled a mean of 5.5 km from past sites (Cramp & Simmons 1983). Our study shows that NZ Dotterels display very high breeding-site fidelity, with nearly all pairs occupying the same or very similar territories from one season to the next. We did not measure precise inter-nest distances between years, but nearly all nests at Omaha were less than 200 m from previous nests (Figure 3). The species is largely sedentary and pairs appear to occupy and defend territories together; in most other (migratory) charadriids, however, the male occupies a territory and attracts a female.

Studies on a number of wader species, such as Redshank *Tringa totanus* (Thompson & Hale 1989) and Semipalmated Sandpiper *Calidris pusilla* (Gratto *et al.* 1985), have shown that breeding-site fidelity is highest among birds that bred successfully the previous season. Breeding success at Omaha was very low during the three seasons of the present study (Dowding, unpubl.) but site-fidelity was nevertheless high (Figure 3). The only example of breeding dispersal that we detected (pair K from Horseshoe Island to Omaha) came, in fact, the season after the pair successfully raised a chick to fledging. These findings may indicate that high-quality breeding territories are scarce and that holding one is in the long term more important than moving in an attempt to improve breeding success in the short term. The fact that most birds returned to their breeding sites early in the winter is consistent with this suggestion.

### **Movement of adults**

We confirmed Sibson's (1967) observation that flocks of NZ Dotterels are made up of local breeding pairs and their progeny. Sibson reported no evidence of immigration from a distance; we found only one case of immigration by an adult bird but saw juveniles at the Omaha flock which had been banded outside the study area, one of them 260 km away.

We found the whereabouts and movements of adult birds in the Omaha cell to be largely predictable; they were usually found either on their breeding grounds or, for a variable period between January and July, at the Omaha flock site or nearby. It remains to be seen whether this situation holds in other parts of the northern population (cf. McKenzie 1978). Why an adult occasionally wanders and then returns to its flock (such as M-BYW) or moves from one flock to another (M-YB) is unknown but one obvious possibility is to search for a new mate after the death of an old one. The observation that R-MB was found breeding with a different mate after having moved from Mairetahi to Whatipu is consistent with this suggestion.

### **Movement of juveniles**

Juvenile NZ Dotterels are known to wander widely (McKenzie 1978) and our study confirms this. In doing so they pass freely through cells. As NZ Dotterels of the northern population are rarely seen inland, it seems likely that juveniles follow the coast for the most part, stopping where they find other NZ Dotterels and/or suitable feeding grounds. We are currently collecting information on natal philopatry and it does not appear to be particularly high (Dowding, unpubl.). As adults are normally either sedentary or confined to a cell, gene flow in the species may be brought about largely by natal dispersal (*sensu* Greenwood & Harvey 1982) of juveniles.

### **Concluding remarks**

Our study shows that NZ Dotterels of the northern population display very high breeding-site fidelity, that they pair for many years (if not life), and that most visit a post-breeding flock for only a short time each year. It seems clear that the adult birds joining the flock are not moving to a winter feeding ground because most have left the site again by May. The brief migration to the flock may, however, persist as a means for bereaved birds (and presumably also first-time breeders) to find a mate.

In the greater study area (see Figure 1), many birds are individually colour-banded and in 13 pairs both birds are banded. Continued observations will yield information on long-term pair-bond stability and on longevity. Regular checks on the status of this group of birds can also be used as one indicator of the status of the species; a significant decline in numbers is more likely to be noticed here, where many banded birds are being monitored regularly.

The NZ Dotterel's range has contracted, its numbers have declined considerably in the past 150 years, and it is now a threatened species (Bell 1986). In many areas breeding success is very low, partly because of human disturbance during the breeding season. It seems likely that there will be further housing development at Omaha in the near future, with a corresponding increase in recreational use of the beach and sandspit. It is also possible, however, that measures will be instituted to provide some protection for NZ Dotterels during the breeding season. With many of the breeding birds at Omaha banded and with the present study as a base, we are well placed to record the consequences of these changes.

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