

FEEDING AND ROOSTING BEHAVIOUR OF SOME WADERS AT FAREWELL SPIT

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ABSTRACT

The feeding and roosting of the Banded Dotterel (*Charadrius bicinctus*), Turnstone (*Arenaria interpres*), Eastern Golden Plover (*Pluvialis dominica fulva*) and Far-eastern Curlew (*Numenius madagascariensis*) were studied for six days on Farewell Spit. Five habitat zones are defined and the use of these zones by the four species and their behaviour in them are given.

INTRODUCTION

Although there is now a large body of information on the numbers and distribution of waders in New Zealand, published information on the behaviour of waders, their use of habitat and their daily routines has been mainly incidental to description of species and census counts.

With this in mind, a visit was planned to Farewell Spit in February 1978 to study the feeding and roosting behaviour of selected species. Unfortunately, permission could not be obtained for the ten days planned, so that in the six full days allowed, only a small beginning could be made. No census was planned or attempted. Wildlife Service/Ornithological Society parties have visited Farewell Spit irregularly since 1961. Edgar (1974) summarised census results and listed 95 bird species recorded during these visits. A summary of census results since 1974 will appear separately (Dennison & Robertson, in prep.).

The party, consisting of W. F. Cash, A. Palliser and the authors, was on the Spit from 7 to 12 February 1978 inclusive. All but W. F. Cash had visited the Spit before during a course for young ornithologists in January 1977. As the spring tides (maximum 4.1 m at Nelson on 10 February) were at their peak around midday the activities of birds could be followed at both high and low tides.

The species studied were the Banded Dotterel (*Charadrius bicinctus*), the Turnstone (*Arenaria interpres*), the Eastern Golden Plover (*Pluvialis dominica fulva*) and the Far-eastern Curlew (*Numenius madagascariensis*).

HABITAT ZONES

Farewell Spit is a slightly curved finger of consolidated sand extending 25 km eastwards from the north-west tip of the South Island (Fig. 1). It is a Nature Reserve administered by the Abel

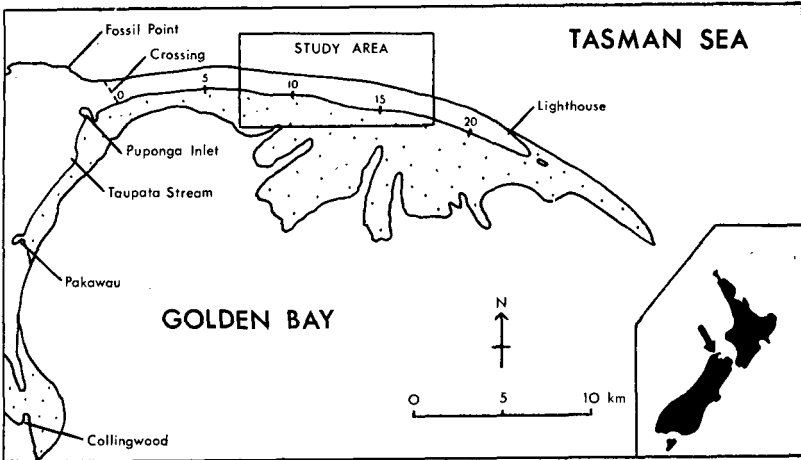


FIGURE 1 — Farewell Spit and Golden Bay, showing places mentioned in the text. The stippled area shows the extent of sand-flat at low tide.

Tasman National Park Board. At high tide the Spit is about 1 km wide, but at low tide sand-flats extending southwards widen the Spit to 8 km in parts. For the present study, the Spit was divided into five distinct zones: Ocean Beach, Ocean Dunes, Central Flats, Bay Dunes and Bay Flats (Fig. 2), in which 'Bay' refers to the Golden Bay side of Farewell Spit. Previous workers have called the Ocean Beach the 'Outer Beach,' the Central Flats the 'Inner Flats,' and the

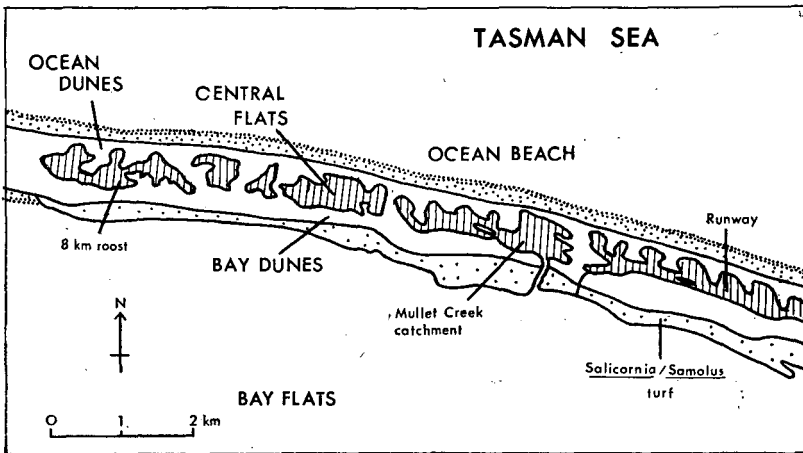


FIGURE 2 — Study area (between 7 km and 18 km) on Farewell Spit, indicating the five habitat zones and places mentioned in the text.



FIGURE 3 — Looking eastwards along Farewell Spit from the 10 km mark. The Ocean Dunes in the left background, the Central Flats in the middle, showing the vegetated southern edge flanked by the Bay Dunes on the right.

Bay Flats the 'Inner Beach.' We feel that the new names are less confusing. All distances have been converted to metric (e.g. the 5 mile mark now becomes the 8 km mark).

The Ocean Beach is normally smooth, hard sand. During the study, however, it was very soft and small pools were left behind at low tide in the lower regions of the beach. This was the result of a long period of unusually dry, settled weather.

The Ocean Dunes (Fig. 2 & 3) are a chain of bare, shifting sandhills often reaching 20 m in height. Gaps in the chain allow spring tides to flood the Central Flats.

The Central Flats (Fig. 2 & 3) are a series of vast, stable sand-plains, some of which are up to 100 ha in extent. These are separated from one another by bare or vegetated sandhills which extend inward from the Ocean Dunes. Vegetation on the Central Flats is confined to its southern edge and primarily consists of raised patches of *Samolus repens*, *Salicornia australis*, *Selliera radicans* and rushes (*Juncus* sp. and *Leptocarpus* sp.). Heavy rains or spring tides can flood the Central Flats to a depth of 40 cm, though the areas of vegetation are usually not fully submerged.

The Bay Dunes (Fig. 2) form an almost continuous line of well vegetated sandhills, up to 10 m high, broken only by Mullet Creek and an associated smaller creek feeding the Runway, a long, narrow sand-plain (Fig. 2). Vegetation is dominated by lupin, marram grass, blackberry, gorse, flax, *Coprosma acerosa* and *Cassinia*. Among these dunes there are shallow basins which were open lagoons previously when the Spit was grazed by sheep, cattle and deer, but which are now largely overgrown with rushes.

The Bay Flats (Fig. 4) stretch southwards from the Bay Dunes, forming an extensive zone of sand-flats at low tide, estimated to have an area of 2000 ha (McLay 1976). From the Base to 7 km, a firm shelly beach separates the dunes from the sand-flats. Beyond 7 km the Bay Dunes are flanked by rushes, with further out a 200 m wide carpet of glasswort (*Salicornia*) and shore pimpernel (*Samolus*) which is interspersed with shallow, unvegetated channels. At low tide levels, this carpet gives way to sand-flats sparsely covered with eelgrass (*Zostera muelleri*).

At each end of the Spit, near the Base and near the lighthouse at 22 km, the zones become indistinct, the Central Flats merging into low scrub-covered sandhills.

The most favoured wader habitat, with a good variety and number of birds, lies between 7 km and 18 km from the base of the Spit. Observations were made in and en route to this area, but most time was spent at the 8 km roost and its adjacent sand-flats, and in the Mullet Creek catchment (Fig. 2), sites reasonably within cycling range of the Base each day.

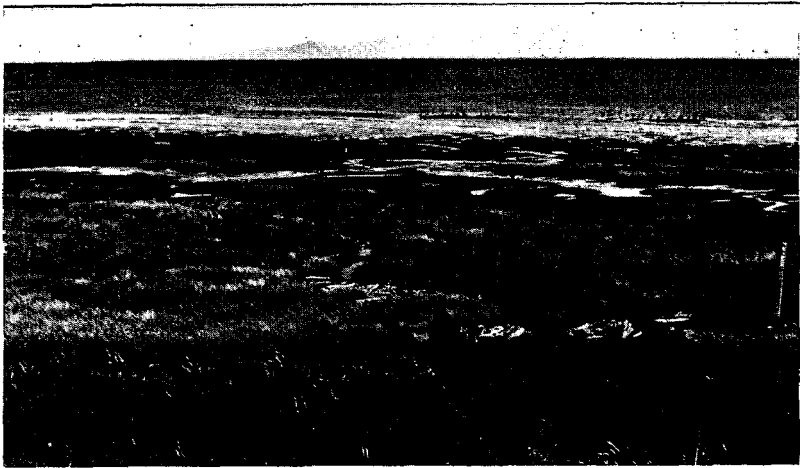


FIGURE 4 — Looking south over the Bay Flats at 8 km, showing *Juncus* sp. and the *Salicornia/Samolus* turf, at mid-tide.



FIGURE 5 — 8 km roost, showing the hide, centre left.

The 8 km roost (formerly called '5 mile'), at Grid Ref. 257222 (NZMS 1, S1 & S3), is a favoured place for Banded Dotterels and Turnstones. This roost (Fig. 5) is a stretch of *Salicornia/Selliera/Samolus* turf, enclosed by a semi-circle of dunes and a low spit of consolidated sand and rushes, which acts as a windbreak in rough weather. Most of the flat is bare, dry sand which is flooded in heavy rain, or at very high tides, but which remained dry during the study.

Mullet Creek catchment, which becomes an extensive lagoon at high tide, is the major roost of Farewell Spit. Immediately west of Mullet Channel, a 0.5 ha flat of *Salicornia* and *Samolus*, only partially covered at high tide, is a roost for Banded Dotterels, Turnstones, Eastern Golden Plovers, Sharp-tailed Sandpipers (*Calidris acuminata*) and Red-necked Stints (*C. ruficollis*). The rest of the catchment is bare sand, interspersed with sand-hummocks, which is used as a roost by large flocks of Bar-tailed Godwits (*Limosa lapponica*) and Knots (*C. canutus*), and a few Far-eastern Curlews and other species.

A hide was erected at each of these roosts.

BANDED DOTTEREL (*Charadrius bicinctus*)

The Banded Dotterel is the second most numerous endemic wader at Farewell Spit, following the South Island Pied Oystercatcher (*Haematopus ostralegus finschi*). Summer counts given by Edgar (1974) are: January 1961, 1088; January 1967, 930 and 1458; March 1974, 1134 and 1624. Previous census data indicated that most of the Banded Dotterels on Farewell Spit roost between 7 km and 18 km, our study area. In the January 1961 census (Bell *et al.* 1961) about 70% were within this region, and in January 1977, 64% (pers. obs.).

Most of the 1458 birds in January 1967 (Andrew 1967) were in various stages of juvenile plumage or post-nuptial adult moult, but at least two pairs were still displaying territorial behaviour. In February 1978, nearly all adults seen were in post-nuptial moult. By contrast two pairs still on territory, with flying young nearby, were in full breeding plumage.

Banded Dotterels at Farewell Spit probably come mostly from South Island riverbed breeding grounds. R. B. Sibson (pers. comm.) considers that Farewell Spit may be a major staging site for Banded Dotterels before trans-Tasman migration, which begins in February. A census from 10 km to 20 km in April 1965 yielded only 200+ Banded Dotterels (Bell 1966). However, in late May 1962, Edgar (1962) recorded 1255, which he considered an under-estimate. Whether most January-March birds migrate and a different set of late migrants or winter residents arrives later, could only be shown by a series of counts in the autumn and winter of the same year. Stidolph & Fleming (1941) found that by May, the exceptionally large North Auckland flocks had given way to a lower but steady wintering population. Edgar (1976) recorded a large influx of Banded Dotterels to Parengarenga Harbour in the Far North in May 1976, and results of monthly

counts at the Manawatu Estuary (MDD, HAR) indicate that Banded Dotterels are "on the move" until May. These migratory movements need much closer study.

Ocean Beach

Even though Banded Dotterels occur on sandy coastlines elsewhere in New Zealand, they were not seen on the Ocean Beach during our study. Only Edgar (1962) has recorded them (2 birds) in accounts of previous visits.

Central Flats

All Banded Dotterels used the Central Flats over high tide and small numbers remained even at low tide. They were among the first to arrive at the roosts, some being there at least three hours before high tide. Up until two hours before high tide more would fly in, low, over the Bay Dunes from the Bay Flats feeding grounds, alone or in small groups of less than ten. They quickly settled and rarely moved to another roost, unless disturbed. On arriving at the roost or after a period of inactivity, birds often preened.

The exception to this pattern occurred in the Mullet Creek catchment where Banded Dotterels fed in the region of damp sand just ahead of the incoming tide, being slowly forced up the catchment until the tide turned, when they fed in the region of wet sand just above the falling tide.

Loose flocks of 5-100 birds were scattered throughout the length of the Central Flats at high tide. They clearly preferred the southern edge where sheltered pockets extend into the Bay Dunes (e.g. 8 km roost) and where the *Samolus/Selliera* turf occurs. Here they roosted beside flocks of Turnstones, Golden Plovers and Sharp-tailed Sandpipers. They were not seen with the large South Island Pied Oystercatcher, Godwit and Knot flocks which generally roosted towards the northern edge of the Central Flats. Most dotterels foraged during high tide, and at any instant only a small percentage of a flock would be sleeping. This behaviour differed from that at the Manawatu Estuary, for example, where all Banded Dotterels stop feeding at high tide.

Banded Dotterels foraged on the dry sand-flats near their roosts with a regular sequence of actions: (a) running or walking quickly a variable number of paces, (b) stopping and standing upright, (c) looking around, (d) taking another pace or two, before (e) pecking* at the substrate, sometimes several times in quick succession. We

* One important feature of feeding behaviour is how deeply the bill is inserted into the substrate, if at all. In this study the two depth classes given by Baker & Baker (1973) were used:—

(1) Pecking — bill inserted less than $\frac{1}{2}$ of its length into the substrate, or taking food from the surface. Visual feeding.

(2) Probing — bill inserted for more than $\frac{1}{2}$ of its length, normally down a burrow. Tactile feeding.

abbreviated this pattern as "run-and-stop, look, step, peck." Evidently the short run disturbs prey, the bird stops to see it move, then runs a couple of paces to secure the prey. Several times MDD saw a dotterel fly a couple of metres into the air in pursuit of a small insect that had been disturbed by its running, follow it to the ground and step forward to pick it up. There was no definite pattern to where birds foraged; they seemed to wander randomly over a large area of sand, sometimes doubling back over an area previously searched, or crossing paths of other individuals.

In the tidal regions of the Central Flats, e.g. Mullet Creek catchment, some Banded Dotterels moved from the dry sand to feed in the area of damp sand left as the tide receded. In this region, presumably in response to a less mobile prey, they changed to the method described by Heather (1977) as "run-and-stop, peck." This differed from the behaviour on the dry flats in that the bird pecked upon stopping, rarely running forward again before feeding. Banded Dotterels shared this damp sand zone with Turnstones, Red-necked Stints and Sharp-tailed Sandpipers.

There was considerable interchange of feeding and sleeping birds. Sleeping birds stood or more often sat facing into the breeze, with their head tucked under one wing and, on hot days with back and flank feathers often raised. On one particularly windy day most dotterels stopped foraging and sheltered behind clumps of vegetation.

Bay Flats

About one hour after high tide, small flocks of Banded Dotterels began leaving non-tidal areas of the Central Flats, but they were forced to return, until the Bay Flats became exposed. The birds could not see the tide level from their roosts, and it is of interest that they had apparently not adjusted their roosting time to the spring tides, continuing to leave prematurely at a time appropriate for lower tides.

Shortly after the carpet of *Salicornia/Samolus* on the Bay Flats near the Bay Dunes became exposed, small groups of dotterels began feeding. They arrived in flocks of up to 20 birds which quickly broke up into groups of three to six birds. These smaller groups moved from area to area as a compact unit but spread out to feed in each area.

On the *Salicornia/Samolus* turf the dotterels foraged in a different way from on the Central Flats. In a carpet of vegetation about 10 cm high, prey is less visible, and dotterels cannot run quickly as they do on the open sand. Instead, they walked slowly, with their heads down, pecking at the substrate as they moved through the vegetation. In vegetation, the prey is probably not as active as in clear, dry areas, so that birds could peck at it as it was encountered. This foraging method of "walk-peck-walk" is similar to that of Turnstones.

As the tide dropped still further, clear mud/sand patches and runnels were exposed in the *Salicornia/Samolus* carpet. On moving into this new zone most dotterels used the same "run-and-stop, peck"

technique as in damp areas of the Central Flats. A further change noted was that, while foraging, the dotterels now walked more often than ran, and probed much more often than pecked, behaviour we termed "walk-stop-probe-walk." Thomas & Dartnall (1971) found that Curlew Sandpipers (*Calidris ferruginea*) and Red-necked Stints in south-east Tasmania, pecked more often in dry zones furthest above mean low water, with probing progressively more common as the substrate became wetter near mean low water.

Quite often Banded Dotterels on Farewell Spit entered shallow water (lower than a bird's tarsal joint) while searching and feeding.

Towards low tide Banded Dotterel groups spread out over the whole of the Bay Flats. Most moved from the *Salicornia/Samolus* turf to the damp, low-lying, *Zostera* sand-flats. This seemed to be the preferred low-tide feeding ground. Unlike godwits, Knots and South Island Pied Oystercatchers, the Banded Dotterels were not seen to move any great distance along the Spit. Instead, they fanned out on the Bay Flats straight out from their high-tide roosts. As a result few dotterels were encountered between 7 km and the base of the Spit.

Single dotterels flying out late to the Bay Flats from the Central Flats, well after the majority had started feeding, would call repeatedly until this was answered by a feeding bird. The new arrival would quickly settle into the feeding group. Several times individuals or small parties were noted returning to the Central Flats after several hours' feeding on the Bay Flats.

Foot-trembling (see Heather 1977) was not observed even though Dunn (1975) recorded this behaviour, especially in very damp sand, among 150 dotterels over-wintering at Aramoana, Dunedin. Heather (pers. comm.) has found no other record of it in Banded Dotterels, and so Aramoana birds may have been responding to some unidentified, locally abundant food.

TURNSTONE (*Arenaria interpres*)

Large flocks of Turnstones spend the New Zealand summer at Farewell Spit, and only the Southland lagoons have permanent summer populations of similar size (Muller 1969). In the last complete census of the Spit (January 1977) 1635 Turnstones were counted, the fourth largest wader population behind godwit, Knot and South Island Pied Oystercatcher. Previous summer counts, 808 (January 1961) and 700 (January 1967), suggest that Turnstones may be increasing at Farewell Spit and Veitch (1978) noted a similar trend in Turnstone numbers on Manukau Harbour and the Firth of Thames.

Within the study area Turnstones frequented three zones: Ocean Beach, Central Flats and Bay Flats. Most birds occupied the last two over a tidal cycle and a smaller, apparently separate group kept to the Ocean Beach.

Ocean Beach

A small population of Turnstones fed and roosted in the Ocean Beach/Dunes zone. In 1961, 62 of 808 birds (7½%) were on Ocean Beach and a similar proportion was noted in 1977 (MDD).

Turnstones are well known for their technique of flicking over tidal wrack when fossicking. In January 1977, they were seen working at large storm-washed clumps, particularly of *Macrocystis pyrifera*, which were ringed with their tracks and with disturbed sand where birds had probed and dug underneath. Fresh debris is ignored until animals such as amphipods and isopods have taken shelter beneath it. The settled weather prior to and during our visit had produced less tidal debris than usual. Turnstones were ignoring recently stranded pieces of *Ulva lactuca* and were only occasionally seen to upturn sticks. Instead, they were fossicking on the wet sand left after each wave.

From about 3 km onwards, small groups of two or three but more commonly single birds were scattered along the Ocean Beach. Most fed progressively along the beach but often others worked a single area back and forth, gradually being forced up the beach as the tide rose. They avoided the surf, running up the beach as each fresh wave broke, returning promptly to the wet sand as the wave receded. It is likely that they were feeding on small annelids and crustaceans disturbed from below the surface by each wave. Their feeding action was reminiscent of the "run-and-stop, peck" style of a dotterel. They dashed forward to peck or probe, at times up to three-quarters of the bill length. It was common to see birds running almost continuously as they foraged, covering the beach rapidly. A single bird might feed along more than 100 m of shoreline in two to three minutes. Turnstones must have acute eyesight, for they were undoubtedly seeing their scuttling prey before dashing to pick it up.

Ocean Beach Turnstones fed for as long as there was wet sand, ceasing only when the tide lapped the first sand hillocks (Ocean Dunes). They roosted just above the high tide line on these first low dunes. Suitable hummocks were covered with Turnstone tracks and up to 33 birds would rest on a single rise. Birds arrived to roost in singles or pairs, flying along the dune edge.

These birds were spending considerably more time feeding before high tide than those which frequented the Bay Flats and roosted on the Central Flats. It could not be determined whether these birds fed and roosted solely on the Ocean Beach or whether some were moving across from the Bay Flats feeding grounds, instead of going to roost.

Central Flats

In the January 1977 census of the Spit, 1015 of the 1635 Turnstones counted were on roosts between 7 km and 18 km, our study area. Most of the detailed roosting observations were made at the roost at 8 km, where between 115 and 132 Turnstones normally rested over high tide.

Although Turnstones arrived on the roost about 2½ hours before full tide, they were among the last, as the large flocks of godwit, Knot and South Island Pied Oystercatcher flew to roost about 3½ hours before high tide and Banded Dotterel were generally already present on the roost. Small Turnstone groups, usually of 2-5, flew from the Bay Flats across the Bay Dunes to the Central Flats. Occasionally birds flying to the roost were seen chasing one another aerobically. The swift, twisting flight, also seen as Turnstones left the roost, involved pairs or trios of birds. Bent (1929), reporting similar behaviour among Turnstones on their breeding grounds in Greenland, suggested they were courtship flights.

On landing at the roost, birds preened vigorously for up to ten minutes before settling on the edge of the roosting group. They roosted in a tight flock, quietly standing or sitting on the bare sand. In a wind they sheltered behind *Samolus* clumps and in the lee of a small spit on the roost. They always roosted facing into the wind, a habit common to all waders. Although Banded Dotterels were present in relatively high numbers they did not associate closely with the Turnstones. However, Golden Plovers and Sharp-tailed Sandpipers often roosted on the edge of a Turnstone flock, and occasionally Knots were found with them. The association of Golden Plovers with Turnstones has been noted elsewhere (Sibson 1946; Wall 1953).

Turnstones seldom fed while on the roost. On one occasion, however, 20 birds fossicked over dry sand at the edge of the roost, dashing forward to pick up prey, probably the fast-moving isopod *Ligia novaezelandiae*. They fed as a tight group, often on a front, but it was not urgent feeding and lasted less than 20 minutes.

Turnstones were the last birds to leave the roost and resume feeding after the tide had dropped. They, and the Golden Plovers and Sharp-tailed Sandpipers with them, always preened before leaving. Turnstones from the 8 km roost dispersed over the Bay Flats feeding grounds directly opposite the roost. This habit of roosting close to the feeding areas was noted elsewhere on the Spit, in contrast to most godwit, Knot and South Island Pied Oystercatcher flocks which flew long distances up the Spit to their roosts.

Although Turnstones preferred to roost in the smaller, sheltered Central Flat areas with other small waders, some flocks were found on the larger roosts such as in the Mullet Creek catchment. 140+ birds roosted on the *Salicornia* area on the eastern side of Mullet Creek (see Fig. 2), but kept apart from the huge aggregations of Bar-tailed Godwit, Knot and South Island Pied Oystercatcher.

Bay Flats

All the Turnstones from the study roost at 8 km, and probably most of the Spit's population, fed on the Bay Flats. This vast area of sand-flats is the major feeding ground on Farewell Spit where 45 000+ waders and many thousands of Black Swans (*Cygnus atratus*)

disperse at low tide. Godwits, Knots and South Island Pied Oystercatchers feed over an area extending from beyond the Tip to the flats opposite Pūponga and Pakawau. Turnstones, however, were more restricted in their feeding habitat on the Bay Flats, and were not encountered until the stretch of *Samolus* and *Salicornia* turf beginning at 7 km.

Turnstones did not appear on the Bay Flats till about 2½ hours after high tide, an hour later than godwit, Knot and South Island Pied Oystercatcher, and coinciding with the stage when the marsh turf was becoming exposed. The small groups which had flown across the Bay Dunes to the feeding grounds remained together as "feeding parties," at least initially. They foraged first over the *Samolus* and *Salicornia* clumps, a preference which probably accounts for the Turnstones' absence below 7 km. A feeding party fed close together, often on the same clump, searching the vegetation by peering beneath the canopy as they walked, in a manner reminiscent of groups of Starlings (*Sturnus vulgaris*) foraging on a lawn. The *Samolus* clumps had a layer of decaying vegetation below the canopy, providing both shelter and food for sand-flat invertebrates. A feeding bird would thrust its head below the canopy, probing beneath the litter layer or turning debris in its search. They fossicked through these clumps more commonly on the falling than the rising tide, probably taking drowned animals trapped in the clumps or prey concealed beneath the litter.

The Bay Flats are mostly bare sand with a thin covering of *Zostera* grass. As the tide receded, feeding parties progressed from the marsh turf zone to runnel edges on the sand flats. Here *Zostera* growth is noticeably denser and a mat of living and dead grass traps tidal debris as well as harbouring animals. Feeding birds would insert the bill at an angle of 45° under *Zostera* strands or debris, with the head tilted to the side. When the head was raised and straightened the object was lifted, flicked over and the substrate exposed. As well as this characteristic sideways flick of the head to dislodge small debris, a "bunting" action was also used for large or stubborn objects. This technique involved a direct rather than sideways, probe and lift. The bill was inserted under the object, feet braced and the bird pushed forward and up with the head and breast to up-end the debris. If nothing was disturbed by either method, the Turnstone quickly withdrew its bill and the object fell back in place. If prey was disturbed, the object was flipped out of the way for the bird to feed.

On the incoming tide Turnstones fed mainly on the open sand runnels between *Samolus* clumps. The crab *Helice crassa* is particularly abundant in these sheltered channels, which are riddled with their angled burrows. Turnstones were seen to prey on *Helice* crabs only on the incoming tide, chasing them on the surface or taking them from their burrows. Most commonly, birds probed into a burrow, sometimes

right to the base of the bill, often side-stepping around the hole to work the crab loose and extract it. Once successful, the Turnstone used a modified bunt to expose the crab's softer underparts, wedging the bill under the crab to flip it "head over heels" on the sand, before striking. One Turnstone was seen to flip a crab six times before it could strike. Birds sometimes struck a crab under the carapace from the side, but normally the crab was upturned and the Turnstone struck powerfully straight downwards to open up the ventral surface. Turnstones on rocky coasts feed on barnacles and molluscs in a similar way to birds feeding on crabs at Farewell Spit, delivering one or two sharp blows to the barnacle (Groves 1978), and its technique of dealing with crabs may be modified from this. One bird, apparently with a method of its own, dug at the burrows, inserted its bill and catapulted the crabs out with a vigorous sideways flick of the head. In one case a stream of sand flew from the hole as the bird worked feverishly to get at the crab. Three crabs taken in this way were left after a brief inspection, suggesting that the size of crab was important. Birds also ignored larger crabs moving on the surface and would chase after only small crabs.

Aggression among feeding birds was seldom seen except when they were feeding on crabs. At this stage feeding parties were loosely associated, not compact as on the receding tide. One bird would dash at another, forcing it into hasty retreat, often with the crab in its bill. Displays were seen when one bird encroached on another's feeding area, or when a bird attempted to poach prey. Groves (1978) recorded two common aggressive postures in Turnstones on their North American wintering grounds, a tail-level posture and a tail-depressed posture, the latter being of greater aggressive intensity. On the Bay Flats only the tail-depressed display was seen, and it was always used during short, vigorous chases between two birds. The tail of the aggressor was depressed till nearly touching the sand and the rectrices spread to display an alternating pattern of black and white. Three terminal white spots were exposed, resembling "eye-spots." The head was dropped close to the ground, bill pointing skyward, and the feathers of the mantle and scapulars were raised to form a hackle. This threatening posture was maintained only as long as the aggressor chased the other bird.

The increase in aggressive displays at this stage is probably related to the breaking up of the feeding parties as the birds spread out on the sand channels and sand flats, where crabs and other prey are scattered. With larger and more conspicuous prey taken on the incoming tide, feeding becomes more active; birds dashing across the sand flats, chasing crabs and infringing on other feeding birds. Feeding seems to become urgent as the time of roosting approaches, perhaps further intensifying the reaction of one bird to another.

EASTERN GOLDEN PLOVER (*Pluvialis dominica fulva*)

Farewell Spit seems to provide only marginal habitat for the Golden Plover, the number being remarkably low compared with other New Zealand wader localities. Andrew (1967) noted this, suggesting a lack of true estuarine mudflat or drier sand flats as the cause. It has been noted by many observers (e.g. Sibson 1946) that at some harbours flocks fly a short distance inland to marshes, ploughland and to pastures with thin or short vegetation. This may partly explain the low number of Golden Plover at Farewell Spit. The maximum count has been 49 in January 1977. We saw at least 27 but they were difficult to study because of their irregular movements at all stages of the tide. It would be interesting to know why the Farewell Spit flocks are so mobile.

Central Flats

Golden Plover roosted on the Central Flats, loosely associated with flocks of Banded Dotterels and of Turnstones. Occasionally single birds were encountered, but normally there were flocks of 4 to 17 birds. These flocks were very mobile over the high tide period and had no regular roost. Tight groups flew from roost to roost throughout the study area for no apparent reason. Flocks would split up or combine with other flocks over the course of high tide. This restlessness may be due to the large number of roosts available. By comparison, Golden Plovers at Manawatu Estuary, for example, remain on one roost over high tide. On the roosts Golden Plovers were not seen to forage; they either stood erect and alert, or, in a wind, sat preening or sleeping. They did not form compact flocks but were scattered, usually slightly apart from the other waders.

Times of movement to or away from the Central Flats roosts could not be precisely noted.

Bay Flats

At low tide Golden Plovers fed on the Bay Flats but again groups moved about continually, making observation difficult. Some birds were seen feeding in the region of the *Samolus/Salicornia* flats with Banded Dotterels about two hours after high tide. They were not seen on, but may well have used, the extensive wet sand flats beyond this zone.

FAR-EASTERN CURLEW (*Numenius madagascariensis*)

Farewell Spit is one of the main feeding grounds for Far-eastern Curlew in New Zealand with more than half the New Zealand population in some years. A flock of 37 in September 1962 (Bell & Zumbach 1963) is the largest recorded yet. A flock of 15 was seen during the present study. Like Andrew (1967), we found them too wary to be watched closely while feeding. Some of their behaviour could well be studied from a hide set up on the *Samolus/Salicornia* flats near Mullet Creek.

Ocean Beach

On several occasions single birds or groups of up to 7 roosted near the high-tide mark of the Ocean Beach between 5 km and Mullet Creek. As the tide dropped, some resumed feeding on the Ocean Beach near the tide line. Others remained resting for several hours after high tide before flying across the Spit to the Bay Flats.

Central Flats

On the Central Flats, curlew were seen only in the Mullet Creek catchment. Andrew (1967) also noted that a flock spent most of its time near Mullet Creek. On 10 February 1978, WFC made detailed notes on the movements of a flock of 11 over high tide. The curlews were the last waders to arrive, about 1½ hours before full tide. Instead of roosting on dry land, they stood in shallow water. As the tide rose to belly-level, the flock was forced to seek shallower water, until finally, just before high tide, they joined a large flock of godwits and Knots on the dry sand on the northern side of Mullet Creek catchment. While roosting, the curlews stood, sometimes preening, in a loose group slightly apart from the other waders. About one hour after high tide the flock returned to the Bay Flats to feed.

Bay Flats

When the curlews arrived after high tide, the *Samolus/Salicornia* flats were covered with water to a depth of 20 cm. Birds waded "knee-deep," probing for crabs (*Helice crassa*), which were very common in this zone. Most of the curlews remained feeding in this zone even after the sand-flats had become exposed. In this area a few White-faced Herons (*Ardea novaehollandiae*) and Bar-tailed Godwits were feeding alongside them.

Twice WFC noted aggressive behaviour by a curlew towards another species. One feeding curlew chased a godwit when it ventured too close. Another curlew, with neck and head outstretched, ran after a Red-billed Gull (*Larus novaehollandiae*), vigorously sparring at the bird as it flew off.

DISCUSSION

Farewell Spit is an important wader habitat, both in terms of numbers of birds and richness of species. Because it is a Nature Reserve human disturbance is at a minimum, enabling studies to be done under natural conditions. Also, there now exists a good base of census data, particularly from summer months, on the bird species inhabiting the Spit (Edgar 1974). Similar data bases are now available for other New Zealand estuaries (e.g. Manukau Harbour/Firth of Thames, Manawatu estuary).

This study was only a preliminary look at aspects of the feeding and roosting behaviour of a few wader species. The behaviour patterns described can relate only to periods of spring tides and to the time of year we were at Farewell Spit.

More detailed, quantified studies are needed at Farewell Spit, and at other New Zealand estuaries, to clarify movements and increase understanding of the non-breeding biology of New Zealand's endemic waders and those migrants for which New Zealand is a major wintering area.

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