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SHORT NOTE

Causes of breeding failure in banded dotterel (*Charadrius bicinctus*) breeding on Ashley Spit, North Canterbury, New Zealand

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The nominate race of the banded dotterel (*Charadrius b. bicinctus*) is a relatively common endemic New Zealand wader that breeds in a variety of open habitats, both inland and coastal, including oceanic beaches. It is, however, reported as being in gradual decline by the recent breeding bird atlas (Robertson *et al*. 2007).

There have been some previous studies into the frequency and causes of breeding failure of banded dotterels at inland sites and on braided riverbeds (Hughey 1985, Pierce 1987, Bomford 1988; Rebergen *et al*. 1998; Norbury & Barlow 1998). The common finding of these studies is that breeding success was variable, both temporally and geographically. In contrast, there are few data on the breeding success of banded dotterel on oceanic beaches and spits in New Zealand. Unlike the sheltered inland sites of previous studies, the exposed environments of oceanic spits may have a strong effect on breeding success in this species. To study the causes of failure in such an exposed environment, I located and monitored nesting attempts of banded dotterels on the Ashley Spit during the spring and summer of 1993.

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The Ashley Spit lies approximately 30 km north of Christchurch (43° 16.27′S 172° 43.59′E). The spit, and its extension south, is popular for beach-based recreation, including swimming, surfing, dog walking, white-baiting (mid-Aug to end of Nov) and fishing. Vehicular access is controlled by permit, but was particularly common during the white-bait season. The study site was approximately 150 m by 800 m in area and covered by exposed sand, shingle, marram grass (*Ammophila aenaria*) and dune habitat. The site ran from the Ashley River mouth southwards to the car park at Waikuku Beach. Banded dotterels were the most common ground-breeding wading birds on the study site.

I commenced searching for nests in early Aug 1993, and finished on 23 Dec, when a large river flood effectively destroyed the site. The 1st nest was located on 25 Aug with the final nest being found on 10 Dec. I visited the Spit 45 times over the study period, with an average interval between visits of 2.9 days (range 1 to 13 days). The majority of intervals were between 1 and 4 days (34/45), which aided in the monitoring of nest outcomes. Nests were relatively easy to find as birds are sexually dimorphic, changeover often, and breed in open areas where they could be observed at a distance with binoculars and telescope. All nesting

Table 1. Fate of banded dotterel (*Charadrius bicinctus*) nesting attempts (n = 33) on the Spit at the Ashley River mouth, North Canterbury, New Zealand.

Fate of nests	Number nests	Percent of nests	Number of eggs	Percent of eggs
Flooded	12	36.3	32	40.0
Lost to disturbance	2	6.0	6	7.5
Crushed	6	18.2	17	21.3
Sand-blown	6	18.2	12	15.0
Depredated	4	12.0	6	7.5
Hatched	1	3.3	3	3.8
Unknown	2	6.0	4	5.0

attempts were identified by several co-ordinates or landmarks, using naturally occurring objects, such as stones, driftwood and marram grass; a new diagram was produced for each visit and co-ordinates were modified as the need arose. Although my observation of nests was also a form of disturbance, I took precautions to reduce this effect by watching from a distance and I erased any tracks to and from nests I approached.

A total of 33 nesting attempts were monitored, where there was at least 1 egg laid. However, the outcome of 2 nesting attempts was unequivocal and they were therefore recorded as unknown. While clutch size was noted, some birds lose the 1st egg and quickly lay the remainder in a new scrape, apparent clutch size can be reduced, without detection. This estimate of clutch size is, therefore, probably an underestimate. Monitoring breeding pairs was made easier as 7 individuals were colour banded from a previous study (Hughey 1985). One breeding male had a deformed stump-leg and was thus easy to identify.

Table 1 lists the causes of breeding failure of all monitored breeding attempts. Nest failure was extremely high, with only 1/33 nests surviving as far as the hatching stage; I was unable to relocate the 2 fledglings after 8 days of the single nest that survived to hatching and their fate is unknown. The most frequent cause of nest failure was flooding by high tides and high water flow in the Ashley River. Failure due to 'sand blown' accounted for 18.2% of lost nesting attempts and was verified by excavation of the buried nests. Human disturbance (crushing of eggs and possibly some cases of desertion) was also a frequent cause of failure. In contrast, predation was responsible for the loss of only 12% of nests.

Using the 33 nesting attempts that had at least 1 egg, I calculated the daily survival probability after the Mayfield method (Mayfield 1975). The daily survival probability of nests was 0.852 (i.e., 85.2% chance of survival per day). When this was multiplied by the duration of the nesting period (28 days; 4 laying and 24 incubation), the probability that a nest would hatch at least 1 young was only 0.0125 (or equivalent to a 1.25% chance). Overall, I found that 96.3% of eggs were lost before hatching. The average clutch size was 2.5 eggs (range 1 to 3, n = 33).

The rate of failure I observed in banded dotterels nesting on an oceanic sand spit appears much higher than that reported previously in other habitats. For example, Bomford (1988) reports 56% of nests failed in their study in the MacKenzie Basin; on the rivers of the central South I, Rebergen *et al.* (1998) found failure rates varied between rivers from 33 to 83% egg loss. These authors also reported that no eggs were lost to flooding while my study recorded 40% of eggs lost to tidal and river floods. In the northern New Zealand dotterel (*C. obscurus aquilonius*), a close relative of the banded dotterel, Willis *et al.* (2003) found that losses to tidal flood and storms varied between 9.1% and 80%. The percentage of successful nests also varied between seasons in an unmanaged area, from 0% to 57.1%. It is interesting to note that nesting success was more consistent in their managed area, improving to over 50% for the last 2 seasons. Rebergen *et al.* (1998) reported variable rates of between 11 and 42% for banded dotterel to fledge at least 1 chick. Hughey (1985) reports a 50% hatching success on the Ashley River. In contrast, my study, the only one on an oceanic spit, found a nest success rate (to hatching) of just 3.3%.

Predation accounted for 12% of nest failures in this study. Rebergen *et al.* (1998) reports 50% of banded dotterel nests were depredated and was the main cause of breeding failure in their study. Bomford (1988) reported a similar figure of 56% loss to predation. Willis *et al.* (2003), in the northern New Zealand dotterel, likewise found overall predation losses of 50.6%. While my study site was on an oceanic spit, it was connected to the mainland and thus was probably accessible to most mammalian predators. Rebergen *et al.* (1998) reported that nests on islands (without mammalian predators) were significantly more successful than nests on the mainland. Willis *et al.* (2003) later confirmed that managing predators has a beneficial effect on nesting success. The 12% of nests lost to predation in this study is relatively low when compared to some other studies and it may be that the exposed nature of the spit does afford some protection from introduced mammalian predators. However, this study was carried out for only for 1 season and predation rates may vary temporally.

A total of 18.2% of nests (6/33) were lost through crushing, 5 by vehicle (tyre tracks present) and 1 was stepped on (footprints through the nest). Two nests were lost to 'disturbance'; 1 had logs placed around it by white-baiters (perhaps for the protection of the nest), but this rapidly became sand filled during the 1st windy period. The other nest was abandoned when white-baiters set up nets close to the nest for the day. The highly agitated pair was watched for several hours, from distance, to monitor their behaviour. Overall, I found that 28.8% of egg loss was directly attributable to various forms of 'human disturbance'.

A high rate of failure due to human disturbance was also found by Willis *et al.* (2003) in a study of the northern New Zealand dotterel on the beaches of Matachana I over 8 seasons. Like my study site, Matachana I is exposed to considerable human recreational use and they concluded that nest failure from human disturbance came from "…trampled, crushed by vehicle...predation by dogs and through indirect causes such as reduced incubation attentiveness while people remained near nests". Lord *et al.* (1997) also reports on the effect of human activities on this species, suggesting that fledging success of chicks may be enhanced if human access to feeding areas is reduced during the chick rearing phase. It is salient to note that reports of human disturbance at nesting attempts of banded dotterel are not new (de Lisle 1950).

It should be noted that the data from this study is limited to 1 site and 1 season only. Considering the variable results obtained by others on this species, this is an important drawback of this study. Nevertheless, my study suggests dotterels may have a low success in a coastal environment in at least some years, and that the increasing use of this habitat for recreation may further compromise nesting success. Dowding and Murphy (2001) reviewed the status of all extant shorebirds in New Zealand and confirmed the perilous status of many; this study, while only undertaken over 1 season, shows that the seasonal breeding success of even an apparently abundant species can approach zero at some sites, and raises concern over whether these rates of failure can be sustained in the long term. Clearly, more detailed study of the impact of recreational use is needed at coastal sites to determine whether populations in this habitat are able to survive this added high rate of failure.

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