An attempt to enhance survival of NZ dotterels on Stewart Island by control of feral cats

(1992 – 1993)

J E Dowding

June 1993

An attempt to enhance survival of NZ dotterels on Stewart Island by control of feral cats

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A report prepared for:

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EXECUTIVE SUMMARY

INVESTIGATION TITLE: An attempt to enhance survival of NZ dotterels on Stewart Island by control of feral cats

STUDY VENUE: Southland Conservancy (Stewart Island and Awarua Bay)
INVESTIGATION LEADER: J.E. Dowding
INVESTIGATION STATUS: Completed
CLIENT: Protected Species Policy Division, Department of Conservation
FINISH DATE: June 1993

BACKGROUND:
The continuing decline of the distinctive Stewart Island population of the NZ dotterel has been documented by Dowding & Murphy (1993). Mortality of adult birds is high and the decline appears to be caused largely by predation of adults on the breeding grounds, probably by feral cats. In April 1992 there were estimated to be 62 individuals remaining. The draft recovery plan for the species states that the highest priority should be given to reversing the decline on Stewart Island. Table Hill is currently the only breeding site on the island with sufficient NZ dotterels remaining to warrant protection. A proposal to control cats on Table Hill during the dotterel breeding season was outlined by Dowding (1992b), based on the use of a polymer-fishmeal bait containing 1080 developed by Landcare Research (Eason *et al.* 1991). This report describes the pilot cat control operation carried out during the 1992-93 season and its results.

OBJECTIVES:
- To test the effectiveness of cat control around Table Hill in reversing the decline of NZ dotterels on Stewart Island.
- To continue gathering basic information on the ecology of the Stewart Island dotterel population to aid in future management decisions.

METHODS:
- A cordon of cat-bait stations was set up around the dotterel nesting area on Table Hill in October 1992.
- Bait take was monitored monthly until mid-February 1993, when baits were removed.
- The birds breeding on Table Hill were monitored in December 1992.
- In March-April 1993 flocks were counted and banded birds were noted.

RESULTS:
- The level of bait take was consistent with the number of cats which might be expected in the area.
- Nests were already present in early October and two male birds were lost before bait was in place.
- No birds were lost on Table Hill after bait stations had been loaded.
- Many unpaired adults (probably all females) were present on Table Hill in December and at least one female-female pair laid a clutch. Two infertile clutches were also found.
- The southern population was estimated to total 74 birds in April 1993, compared to 62 in April 1992.
- Annual mortality of banded adult birds was lower than in the previous two years but the reasons for this are not clear.

CONCLUSIONS:
- The southern NZ dotterel population increased for the first time since accurate data has been available.
- The programme should be continued to determine whether the population can be successfully protected in the medium term.
- It is becoming increasingly apparent that there is an acute shortage of male birds in the population and this is having an obvious effect on productivity.
- In spite of the slight increase in numbers, the situation of the Stewart Island population is still extremely precarious, largely because of the shortage of male birds.

RECOMMENDATIONS:
- That the Department make a commitment to continuation of the Table Hill cat control programme for the next 4 seasons. A suggested timetable for 1993-94 is presented.
- That minor improvements be made to the programme and that ways to improve bait life be considered.
- That research be undertaken on habitat use by cats on Stewart Island and on their continuing impact on the remaining native fauna.

OUTPUTS:
- An interim report on the results of the programme was circulated in February 1993.
- A *Rare Bits* article on the programme appeared in March 1993.
- A 'Conservation Update' item on the project appeared in *Forest & Bird* in May 1993.
- This final report.

1. INTRODUCTION

The New Zealand dotterel (*Charadrius obscurus*) is an endemic plover with a population estimated at about 1400 birds. Formerly widespread in New Zealand, with an apparent stronghold in the central South Island, the species is now confined to two separated breeding populations. At least 95% of the birds are found on the coast of the northern part of the North Island, with a small population surviving on Stewart Island. The rapid decline of the Stewart Island population has been documented by Dowding & Murphy (1991, 1993), who suggested that the principal cause of the decline there was predation of adult birds by feral cats. Adult mortality occurs largely (if not entirely) during the breeding season, and it seems very likely that adults are most vulnerable while incubating nests or brooding small chicks.

The draft recovery plan for the NZ dotterel states that reversing the decline on Stewart Island is the highest priority task in management of the species (Dowding 1992a). By late 1991 it was clear that Table Hill was the only breeding site on Stewart Island with sufficient birds remaining to warrant protection. A proposal to control cats to enhance survival and productivity of NZ dotterels at Table Hill was outlined by Dowding (1992b). The proposed control was based on the use of a polymer-fishmeal bait containing 1080 developed by Landcare Research (Eason *et al.* 1991) under contract to DoC S&R. Baits were to be placed in stations in a ring around Table Hill to try and intercept cats entering the dotterel breeding area. Preliminary tests in December 1991 showed that cat density in the area was low, suggesting that a few animals (some of them possibly visiting the tops from forest lower down) were doing most of the damage. The tests also showed that neither NZ dotterels nor kiwis took non-toxic versions of the baits.

The control operation described in this report was largely experimental in nature. The Landcare baits used are still under development and this project was one of the few large-scale field trials conducted so far. In addition, little is known about the density, ranges and movements of cats on Stewart Island, so there was an element of guess-work in planning the location and density of bait stations.

Differences between northern and southern birds in morphometrics and behaviour have been described but the taxonomic status of the two populations is uncertain. During the monitoring associated with the cat control project, the opportunity was taken to collect blood samples from a number of NZ dotterels. A preliminary study (using the technique of allozyme electrophoresis) will test these samples for differences between North Island and Stewart Island birds.

2. METHODS

The timetable of fieldwork was as follows:

- 30 September-13 October 1992 – bait stations constructed, installed and loaded, birds checked.
- 09-12 November 1992 – bait stations checked, blood sampling (North Island).
- 02-15 December 1992 – bait stations checked, breeding birds monitored.
- 13 January 1993 – bait stations checked.
- 16-25 February 1993 – bait stations emptied, preliminary check of Mason Bay and Awarua Bay flocks.
- 22 March-05 April 1993 – annual monitoring (all southern flocks), blood sampling (Stewart Island).

Bait stations were constructed, installed and loaded from 1–10 October 1992. Of the 194 stations installed, 171 were placed in a cordon 9.2 km in length which roughly followed the scrub line around Table Hill (an average of one station every 54 m). Seven were placed just outside the cordon (in a line along the track to the hut) and 16 were scattered inside the cordon. The area enclosed by the cordon was approximately 250 ha (2.5 sq km). A sketch map of the area showing layout of bait stations and place names is shown in Figure 1.

Bait stations were constructed from 4-litre square-section plastic liver pails. A strip about 25 mm wide was cut from half the mouth of the pail, resulting in an overhang at the top of the station, and the pail stapled to a 50x25 mm stake. The strip was trimmed slightly and stapled on to form a lip at the front of the station to stop baits falling out. A photograph of a station is shown on page 4 of the May 1993 issue of *Forest & Bird*. Each station was loaded with 220–250 g of baits, which were levelled to assist detection of take. Baits were sampled at intervals for toxicity testing by Landcare Research.

Where possible, bait stations were sited in the lee of small patches of scrub, rocks or tussocks and were positioned so that the opening faced NE (the prevailing weather on the Tin Range is from the W and SW). Stations were installed tilting forward slightly; this allowed less rain to enter the station and ensured that any rain that did enter drained away quickly.

Birds on Stewart Island were captured for banding in December 1992 and for blood sampling and banding in March-April 1993. Nineteen blood samples were collected from the northern population in November 1992 and 11 from the southern. The analysis of these samples is the subject of a separate report (Herbert, Dowding & Daugherty, in preparation).

3. *RESULTS*

3.1 The control programme

3.1.1 Bait take

Table 1 shows the number of takes from bait stations. Some possible takes (where disturbance to the baits was slight) may have been by rats, but rat density in the area was low; one juvenile Norway rat was caught in 70 trap-nights in December. Definite takes were characterised by substantial disturbance to baits, baits obviously missing and in some cases baits spilt around the station. Although possums are common at lower altitudes, no sign of them has been found in the open areas or around the scrub line on Table Hill in the past two seasons, suggesting that most of the definite takes were probably by cats.

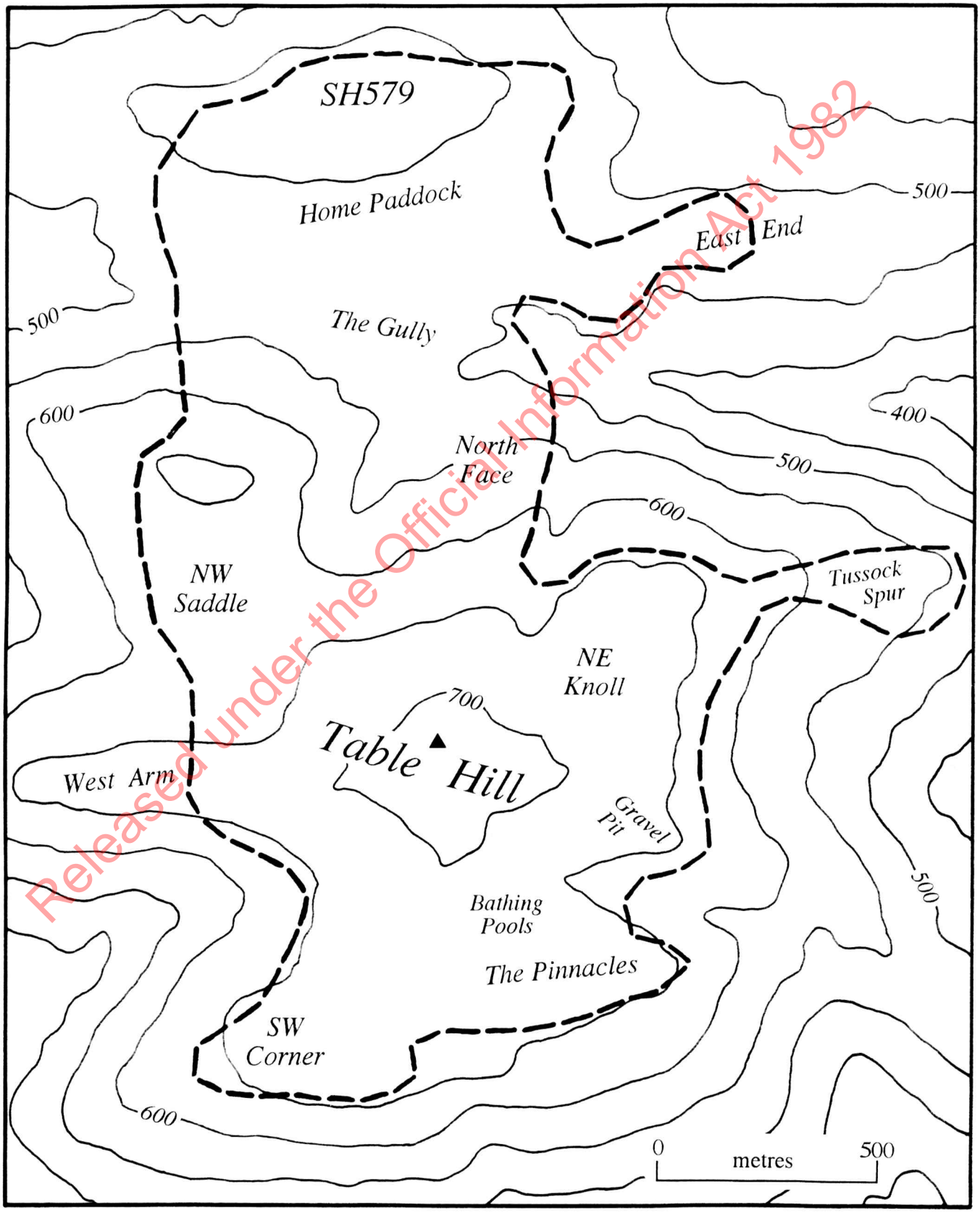
Table 1. Number of takes from bait stations on Table Hill, October 1992–February 1993.

Month	Definite takes	Possible takes
Oct-Nov	1	5
Nov-Dec	3	5
Dec-Jan	2	4
Jan-Feb	0	4
Totals	6	18

3.1.2 Bait life

Table Hill is often in cloud and humidity is high. Moisture condensed on the inside of stations (even in sheltered locations) and leached the green dye, 1080 and (presumably) lure components from the baits. New baits were an intense deep green colour and contained 0.1% 1080. Samples collected after one month in a station on Table Hill had a somewhat faded green-brown appearance, showed very little fungal growth and contained about 0.05% 1080. This fall in 1080 concentration (50%) is acceptable, as two of these baits would be a lethal dose for all but the largest cats. After two months however, most of the green dye had faded or been leached, nearly all stations showed heavy fungal growth and baits contained virtually no 1080. Even if 1080 had still been present, it seems likely that the thick mat of fungal mycelium around baits would have made them unpalatable to cats.

Figure 1. Map of the Table Hill study area, showing the layout of the bait station cordon (dashed line). All place names except SH579 and Table Hill are unofficial. Contour lines are at 50 m intervals.



3.1.3 Bait stations

The stations survived conditions on Table Hill very well and were left in place. Some care is necessary when changing baits or emptying stations, but there seems no reason why they should not last for some years to come.

3.2 The birds

3.2.1 Onset of breeding on Table Hill

Some birds were already on nests while bait stations were being installed at the beginning of October. A nest found on 4 October contained a complete clutch and was being defended vigorously, suggesting that it had been present for at least two weeks.

3.2.2 Survival of adults

Two males breeding on Table Hill (WYB-M and BYB-M) were lost before bait stations were installed. After control began, all 17 of the other banded birds seen on Table Hill survived the season and were found in autumn flocks. Overall mortality of banded adults in the southern population was 3/24 (13%) for the April 1992 - April 1993 year.

3.2.3 Gender bias

Although sexing NZ dotterels is difficult, males normally have darker breast plumage than their mates and average slightly larger in some measurements (Dowding, in prep.). Between October and December 1992, 19 banded birds aged one year or more were seen on Table Hill. We believe that no less than 12 of these were females and four were males. The remaining three birds may have been males but were not known to produce chicks or fertile eggs during the season. At least one female-female pair formed; both birds were caught just before laying and both were clearly gravid. Between them, they laid (and incubated) a five-egg clutch in a single nest (the normal clutch is three). Two infertile clutches were also found; whether these were of unfertilised eggs of male-female pairs, or were produced by other female-female pairs could not be determined.

3.2.4 Productivity

At least four chicks were present in the study area in December 1992, but without longer or more frequent visits to monitor progress, it was impossible to assess productivity accurately. It is clear however, that with only 4-6 males at the beginning of the season (and two of them disappearing early) relatively few chicks could be produced.

3.2.5 Total population size

Post-breeding flocks were counted in late March and early April, using the survey methods described by Dowding (1992b). In Table 2, the results of these counts are compared with data from the past three years (from Dowding & Murphy 1993).

Table 2. Autumn flock counts and population estimates, 1990-1993.

Flock	1990	1991	1992	**1993**
Awarua Bay	23	13	11	**15**
Mason Bay	64	52	43	**49**
Cooks Arm	13	7	3	**4**
wandering juveniles (estimated)	9	7	5	**6**
Totals	109	79	62	**74**

4. DISCUSSION

4.1 The control operation

The original proposal to control cats on Table Hill (Dowding 1992b) indicated that bait stations should be installed and loaded in late August - early September. The 1992-93 programme was not given the go-ahead until mid-September however, and the loss of two males this season was almost certainly a direct result of that delay. Based on the finding of a well-established nest at the beginning of October, it must be assumed in future that nests can be present on Table Hill from mid-September onwards. The control operation should begin a month before this, to clear any resident or visiting cats from the area before nesting begins.

How efficient the control programme was in killing cats cannot be determined (and is less important than how efficient it was in increasing dotterel survival). There is no information available on the current density of cats on Stewart Island; based on densities elsewhere (Fitzgerald 1990) it might be expected that in the order of 3-15 cats could have all or part of their ranges overlapping the dotterel nesting area on Table Hill. The fact that there were six definite (and 18 possible) bait takes is consistent with this estimate.

4.2 Survival and gender bias

Adult survival was higher this year than in the past two years but the reasons for this are not clear. It could be a natural fluctuation, a function of the relatively small sample of banded birds, or it may be that increased survival on Table Hill has raised the survival level of the population overall. It also seems likely however, that there is now such an acute gender bias in the population that the higher survival of the many non-breeding females present is affecting the overall figure.

The number of adult males surviving each breeding season now appears to be the single most important factor affecting the ability of the population to recover. Productivity of these few birds needs to be high enough to balance natural mortality, possible loss of juveniles through dispersal and loss of adults to cats elsewhere on the island.

4.3 Continuation of the programme

The cat control programme described in this report was very much a pilot operation. The control now needs to be trialled over a longer period, for a number of reasons.

4.3.1 Holding operation

The use of poison baits in stations for cat control around Table Hill is the only practical technique available at present that may improve dotterel survival. If the southern population is to be saved, control must be continued as a holding operation, at least until other techniques become available.

4.3.2 Natural fluctuations

There will be some natural fluctuations in dotterel survival and productivity from year to year, dependant on factors such as weather conditions during breeding, higher or lower cat (and/or rat) density in any year, etc. Although the results of the 1992-93 season are encouraging, it may not prove possible to achieve the same level of increase every season. We need to know whether the population can be maintained and/or increased successfully in the longer term, through these fluctuations.

4.3.3 Recruitment

The programme also needs to be trialled long enough to determine recruitment levels in the Table Hill area and elsewhere. Although natal site fidelity is not normally high (in the northern population at least), it seems likely that at least some first-time breeders will establish on Table Hill – birds are disappearing rapidly from other parts of the island and young males may not find mates elsewhere. Without some recruitment in the protected area the project will be more difficult to sustain, but it should also be possible to protect birds re-colonising adjacent or easily-accessible areas (such as Blaikies Hill and Mt Rakeahua) at little extra expense if necessary.

4.4 Modifications

4.4.1 The bait station cordon

In December, a pair of NZ dotterels were found to be using an area about 800 m to the west of SH 579. Although their nesting territory had been inside the bait station cordon, part of the foraging range they took their chicks to was outside it. This area can easily be included by adding about 10 new bait stations and re-positioning 3-4 others. Other minor

improvements in bait station density and location are desirable, particularly around East End and Tussock Spur, where nesting sites can be very close to the scrub line.

4.4.2 Bait life

The baits used in this trial (Dupont polymer-fishmeal, surface-loaded with 1080) had a life of between one and two months on Table Hill. As currently formulated and loaded, they therefore need to be replaced about every six weeks for control to be continuous. Consideration should be given to ways in which bait life can be increased. Baits need to be in place on Table Hill each year for a period of about six months; with bait changes at six-week intervals, five visits are necessary during a season (see Figure 2). If bait life could be extended to two months, this would be reduced to four visits, and to three if baits lasted three months. If bait life could be extended to six months (requiring one trip to load and one to empty stations) the operation would become extremely cost-effective. Baits used this season were surface-loaded with 1080; Landcare Research staff believe that 1080 life may be extended in damp conditions by mixing with petrolatum jelly and injecting this into the hollow core of each bait. Unfortunately, this must be done by hand at present and is extremely labour-intensive. Another development which might be considered is the incorporation of a fungicide in the bait formulation, to delay microbial degradation of 1080 and increase the time that baits remain palatable to cats. Obviously any anti-fungal would have to be tested to check that it did not deter cats.

4.4.3 Bait quantity

At the start of the 1992-93 season, it was not clear how much bait would be required and 220-250 g were used per station. No station ever had more than about 50-60 g taken however. With baits being changed every six weeks, less bait can be loaded in 1993-94; I suggest 100-120 g will be adequate. With four changes of 120 g in 200 stations, approximately 100 kg will be used; adding a safety margin of 20 kg means that a total of 120 kg of bait should be available.

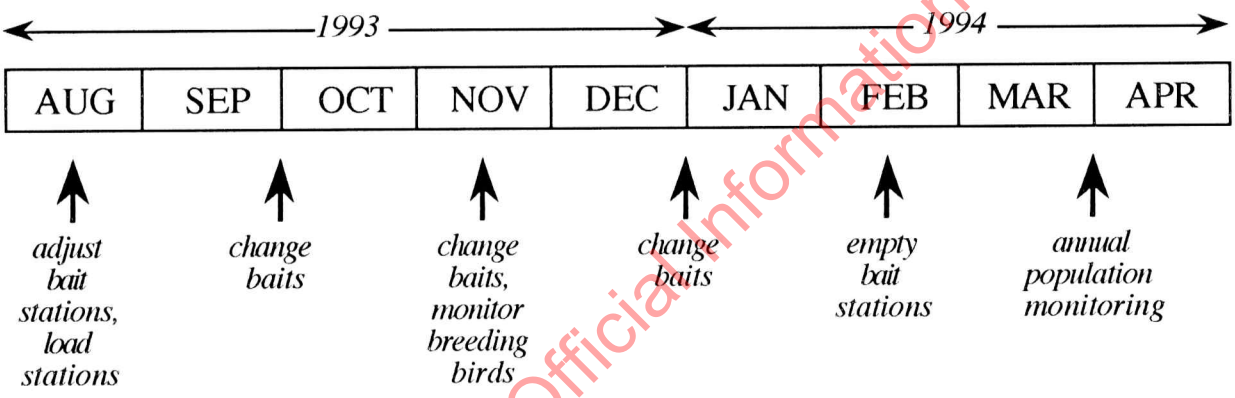
5. CONCLUSIONS

5.1. Continuation of the control programme

Indications from the 1992-93 season are positive, with an increase in the size of the southern population for the first time since accurate census figures have been available. However, maintenance of the Stewart Island population of the NZ dotterel now appears to depend very largely on the survival of the few remaining adult male birds and recruitment of juvenile males into the Table Hill breeding population.

The programme should be continued for the next 4 seasons (i.e. until autumn 1997) and the end of the trial will then coincide with the expiry of the current recovery plan. The trial could thus be evaluated in time for the results to be useful in compiling the subsequent plan. A suggested timetable for the 1993-94 season is shown in Figure 2. In future, the timetable will depend largely on whether bait life can be extended. From the 1994-95 season, unless changing circumstances dictate otherwise, the control operation should become a routine management task with little or no research input required.

Figure 2. Suggested timetable for cat control and NZ dotterel monitoring at Table Hill during the 1993-94 season, using baits as currently formulated.



5.2 Research

Virtually nothing is known about habitat use by cats on Stewart Island. They may be resident in sub-alpine areas or may just visit them. Information from a radio-tracking study of cats on Stewart Island would assist in planning the layout and density of bait stations, timing of baiting, etc. It would also help in planning other control or eradication operations.

Cats have probably played a large part in the observed declines of a number of endemic birds on Stewart Island (such as kakapo, brown teal and weka), particularly in the past 40 years (see Discussion in Dowding & Murphy 1993). Until biological control of cats is feasible, there is no reason to believe that this situation will improve, and it seems very likely that other birds (such as the three penguin species nesting on the island) and possibly lizards are currently also declining as a result of cat predation. Since the transfer of kakapo to other islands, it appears that very few resources are available to monitor the status of the remaining native fauna on Stewart Island. This situation needs to be remedied, with funding made available for baseline surveys and periodic monitoring of species known or suspected to be vulnerable.

6. RECOMMENDATIONS

It is recommended that:

1. A commitment be made by the Department to continue the Table Hill cat control programme for the next four breeding seasons. This would (a) act as a holding operation and (b) determine whether control can help the NZ dotterel population to stabilise and/or increase in the medium term.

2. Minor improvements be made to the programme in the 1993-94 season. These include:
   (a) loading of bait stations *no later than mid-August*,
   (b) changes in density and location of some stations around SH579,
   (c) replacement of baits at six-week intervals.

3. Consideration be given to possible improvements to baits to increase their life.

4. The NZ dotterel Recovery Group assess the programme annually and recommend any extensions or changes considered desirable.

5. Research be undertaken on habitat use by cats on Stewart Island and on their continuing effects on the remaining native fauna of the island.

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New Zealand dotterels on Stewart Island: a report on the 1993-94 season

J E Dowding

April 1994

New Zealand Dotterels on Stewart Island: a report on the 1993-94 season

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EXECUTIVE SUMMARY

INVESTIGATION TITLE:	NZ dotterels on Stewart Island: a report on the 1993-94 season
STUDY VENUE:	Southland Conservancy (Stewart Island and Awarua Bay)
INVESTIGATION LEADER:	J.E. Dowding
INVESTIGATION STATUS:	Completed
CLIENT:	Protected Species Policy Division and Southland Conservancy, Department of Conservation
FINISH DATE:	April 1994

BACKGROUND:

The NZ dotterel population on Stewart Island has declined rapidly over the past 40 years. The decline is believed to be due largely to predation of adults during the breeding season, probably by feral cats. During the 1992-93 season, a pilot cat-control programme was carried out on Table Hill, the only breeding site with significant numbers of dotterels remaining. The population increased for the first time since accurate data has been available, but it was difficult to determine to what extent this result was attributable to the cat control. It became clear that there are few adult males remaining in the population. The present report describes the results of cat control in the 1993-94 season.

OBJECTIVE:

- To continue the attempt to reverse the decline of NZ dotterels breeding on Stewart Island.

METHODS:

- The cat-control programme on Table Hill, set up during the 1992-93 season, was repeated in 1993-94 with minor changes.
- Baits were in place by the end of August 1993, before birds began nesting.
- Baits were replaced at six-week intervals (except in December), and removed in mid-February 1994.
- In late March 1994, flocks were counted and banded birds were noted.

RESULTS:

- Very severe weather conditons (including snow) in November reduced productivity on Table Hill.
- Rat density on Table Hill was much higher than in the past two seasons, and this had a number of direct and indirect effects.
- A combination of circumstances rendered the bait cordon ineffective from late November to mid-January; rats raided most bait stations, and fungus and fly-strike made remaining baits unpalatable.
- Helicopters landed in at least two breeding areas in early December; one landing on Mt Rakeahua probably caused desertion of a nest.
- The southern population was estimated to total 65 birds in March 1994, down from 74 in April 1993.

CONCLUSIONS:

- A number of unforeseen factors conspired to reduce the effectiveness of the programme this season.
- Although the total population fell slightly, given the circumstances the result is better than might have been expected.
- There is cause for optimism in the 1994-95 season, as recruitment should be higher than usual.
- The programme should be continued to determine whether the population can be successfully protected in the medium term.

RECOMMENDATIONS:

- That the cat control continue during the 1994-95 breeding season.
- That recruitment during the 1994-95 season be monitored, on Table Hill and elsewhere.
- That the Department and Landcare Research discuss ways in which bait life can be improved.
- That baits be replaced without fail every six weeks during the breeding season.
- That helicopter landings in (and over-flying of) breeding sites be avoided during the breeding season.

OUTPUTS:

- This final report.

1. INTRODUCTION

Once widespread in New Zealand, the NZ dotterel (*Charadrius obscurus*) is now confined to two separate breeding populations; most of the birds are found on the northern North Island coast, with a small population surviving on Stewart Island. Based on consistent differences in measurements and behaviour between northern and southern birds, it has recently been proposed that the two populations be recognised as separate subspecies (Dowding, submitted for publication).

The rapid decline of the Stewart Island population over the past 40 years has been described by Dowding & Murphy (1993). The decline appears to be due largely to predation of adult birds during the breeding season, probably mainly by feral cats. The NZ dotterel recovery plan (Dowding 1993b) emphasises that reversing this decline has the highest priority of all management tasks for the species.

Because Table Hill is the only breeding area on Stewart Island with more than two pairs of NZ dotterels remaining, a pilot cat control operation was carried out there during the 1992-93 season (Dowding 1993a). Polymer-fishmeal baits containing 1080 (developed by Landcare Research) were placed in stations around the hill to remove resident cats and intercept any entering the area.

The total southern population increased during the 1992-93 season, the first increase detected since accurate counts have been made. The extent to which the Table Hill cat control programme was responsible for that increase is difficult to determine, but the programme appears to be the only low-cost management technique currently available that may help to slow or reverse the decline. During the 1992-93 season, it became clear that there is a severe gender bias in the Stewart Island population, with few adult males remaining; much now rests on the survival of breeding male birds and the recruitment of juvenile males into the Table Hill breeding population

In line with recommendations in the recovery plan (Dowding 1993b), it was proposed that the programme be continued (with minor improvements) for a further four seasons (Dowding 1993a); apart from acting as a holding operation, this would help decide whether the programme could help the Stewart Island population survive in the medium term. While there has been no decision on the long-term future of the programme, the cat control operation was carried out again during the 1993-94 breeding season.

This report describes the results of the season's work, discusses management options for future seasons, and makes specific recommendations for the 1994-95 season.

2. METHODS

The timetable of fieldwork during the season was as follows:

- 23-31 August 1993 – extra bait stations constructed and added to the existing cordon, some stations re-positioned, all stations loaded, birds checked.
- 1-2 October 1993 – bait takes recorded, baits replaced.
- 16-20 November 1993 – bait takes recorded, baits replaced, birds monitored.
- 7-15 December 1993 – birds monitored.
- 12 January 1994 – bait takes recorded, baits replaced.
- mid-February 1994 – bait stations emptied.
- 21-31 March 1994 – annual monitoring of southern flocks, birds banded.

As recommended in last year's report (Dowding 1993a), bait stations were added at the north-western and north-eastern corners of the cordon. There are now 187 stations in a cordon approximately 10.7 km long, 4 stations on the track to the hut, and 15 internal stations – a total of 206 bait stations. The revised layout is shown in Figure 1.

This season, each station was loaded with about 95-100 g of bait (compared to 220-250 g in 1992-93) at each change; this was adequate early in the season but not later (see *Bait take* below). Stations were loaded by 28 August this season, well before dotterels began nesting.

3. RESULTS

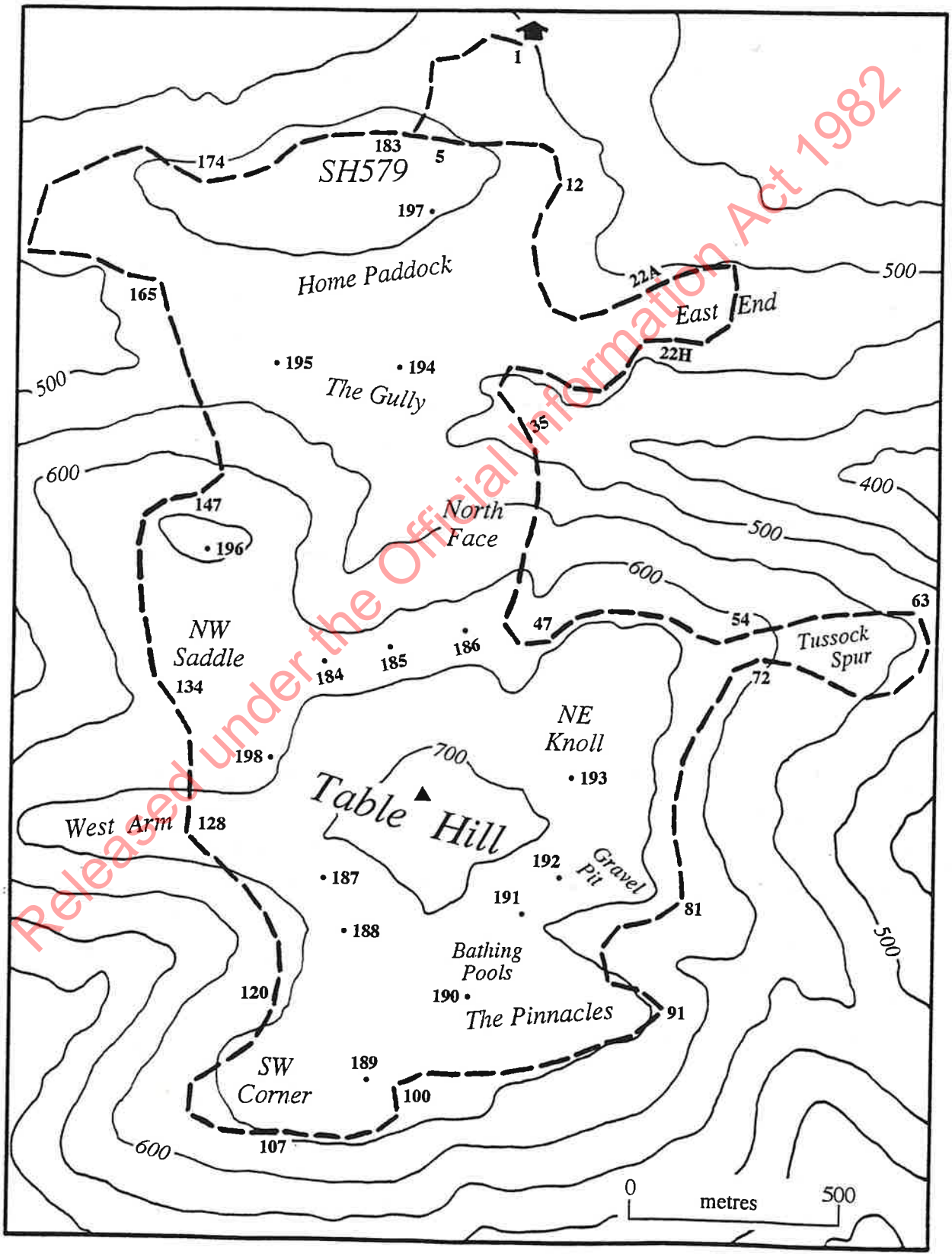
Bait take

Early in the season, takes by cats were at a similar or slightly higher level than in the previous season – 3 in August-September and 3-5 in October-November. From late November onwards, it was virtually impossible to detect definite takes by cats because many stations were raided by rats. In January 80% of stations were affected, with 30% being emptied altogether (M. Dobbins, pers. comm.). These takes were characterised by baits and rat droppings scattered around the station, and baits buried in rat-holes nearby.

Bait life

There continue to be problems with bait life. In spite of the fact that baits were changed every six weeks (except in December), roughly one-third of stations showed significant fungal growth within that period. A further problem, not encountered in 1992-93, was widespread fly-strike of baits, particularly later in the season. There seems little doubt that baits with fungus or fly-strike will rapidly become unpalatable to cats.

Figure 1. Map of the Table Hill study area, showing layout and numbering of the bait station cordon (dashed line) and positions of internal stations, at September 1993. All place names except SH579 and Table Hill are unofficial; contour lines are at 50 m intervals.



Weather

In mid-late November, at the time when first clutches were hatching, there was a period of unusually cold weather on Table Hill; temperatures were below freezing most of the time, snow accumulated on the ground to a depth of 5-10 cm, tarns and seepages were frozen, and there were regular hail showers. Both New Zealand and banded dotterel chicks were known to be lost at this time because of the severe conditions; as well as being susceptible to the low temperatures, chicks of both species would have been prevented from foraging by the snow and ice cover. It seems very likely that these conditions also affected productivity adversely in other parts of the island, particularly further south on the Tin Range and on the Mt Anglem ridge.

The severe weather in November (and persistent rain and high winds in December) affected our ability to monitor or band birds on Table Hill, and probably reduced the number of birds present. It also precluded any checks further south on the Tin Range. In addition, baits could not be changed in late December because of weather conditions.

Survival and productivity

One adult male (YRO-M) appears to have been lost on Table Hill late in the season, when the bait cordon was ineffective. Two banded females (both unpaired) were seen on Table Hill early in the season but were not present at their usual flocks in autumn; as they were not attempting to breed, they should have been at little risk and are probably wandering in search of mates. Whether they have survived or not will only be resolved by sightings at flocks during the coming winter, or on the breeding grounds early next season.

Productivity was clearly lower than last year, and this was reflected in the fall in number of birds at Awarua Bay, where the flock normally contains a high proportion of juveniles. However, some chicks did fledge on the island during the season; there were at least two birds of the year at Awarua Bay (one was caught and banded), and two (possibly three) at Mason's Bay. Three chicks were present on Table Hill in mid-December, but all were too small to band and it is not known whether any of them fledged.

Total population size

Post-breeding flocks were counted in late March, using the survey methods described by Dowding (1992b). In Table 1, counts are compared with data from the past two years (from Dowding & Murphy 1993 and Dowding 1993a).

Unfortunately, transport to Cooks Arm was not available this season and that flock was therefore not checked. However, past counts (and sightings of birds in other flocks) suggest that the estimate of three is unlikely to be out by more than one. It should also be noted that

there was high productivity in the 1992-93 season, and band sightings at flocks in late March 1994 suggest that many of these one-year-olds (and probably more unpaired adults than usual) are wandering away from flocks this year. The number of birds estimated to be wandering has been raised accordingly; I believe this to be a conservative estimate.

Table 1. Autumn flock counts and population estimates, 1992-1994.

Flock	1992	1993	**1994**
Awarua Bay	11	15	**10**
Mason Bay	43	49	**42**
Cooks Arm	3	4	**3**
wandering juveniles and unpaired adults (estimated)	5	6	**10**
Totals	62	74	**65**

Disturbance

In the North Island, low-flying helicopters have often been found to cause panic among adult NZ dotterels, and have resulted in desertion of nests and loss of chicks (fixed-wing aircraft do not seem to have the same effect). During the 1993-94 season on Stewart Island, there were two instances of helicopters actually landing in dotterel nesting areas.

In the first, a helicopter landed on Table Hill and other points along the Tin Range in early December to collect samples of *Bulbinella*. This incident should have been avoided at this time of the year; Table Hill is by far the most important breeding site known, and the Tin Range probably now holds at least half the breeding pairs in the entire population.

In the second incident, a helicopter landed on Mt Rakeahua in early December to effect repairs to the repeater station there, following a lightning strike. About one week later, I found a recently-abandoned nest 50-60 m from the repeater; nests are not commonly abandoned and it seems quite likely that the landing was responsible for this desertion. In this case the landing was probably unavoidable, but it was particularly unfortunate because dotterels have only begun to re-colonise this site in the past two seasons after being extirpated in 1990 and 1991 (Dowding & Murphy 1993).

4. DISCUSSION AND CONCLUSIONS

Rat density

There is no doubt that rats reached a much higher density on Table Hill in 1993-94 than in the past two seasons. This was presumably due to increased winter 1993 survival of rats, caused possibly by the mild winter on the island and/or a temporary abundance of food, such as a podocarp mast. The high rat density this season almost certainly had a number of significant (and unforeseen) effects, both direct and indirect:

1. Predation of NZ dotterel eggs or small chicks by rats may have been significantly higher than usual. It is not known whether Norway rats are capable of taking adult NZ dotterels.
2. The presence of large numbers of rats may have attracted more cats than usual to the area.
3. From late November onwards, rats were completely emptying many bait stations. In addition, baits were not replaced in December, and the baits not taken by rats became unpalatable due to fungus and fly-strike. This combination of circumstances rendered the bait cordon essentially ineffective for much of December and January. This would have increased the likelihood of cat predation within the cordon.

Outcome of the control operation, 1993-94

Given the very limited time that could be spent in the Table Hill study area as well as the weather conditions last spring, it is difficult to draw definite conclusions about the success or otherwise of the programme this season. The fall in total population size is a disappointing result, but given the severe conditions in November when chicks were hatching and the effects of high rat densities later in the season – neither of which could have been predicted – it is not surprising. As noted in last season's report, there will be fluctuations in dotterel survival and productivity from year to year, depending on weather conditions and cat and rat density. However, it is by no means certain that control was ineffective this season – it is quite possible that without control, the situation would have been even worse. In a season when many factors conspired to reduce productivity and survival, holding the population at a level just above that of 1992 is probably a significant achievement.

The outlook for 1994-95

The high productivity seen during the 1992-93 season gives grounds for optimism for the 1994-95 season. NZ dotterels normally first breed at two years old, and with the excess of females in the present population (Dowding 1993a), all the male chicks produced in 1992-93 that are still alive should have little trouble finding mates. This situation should result in a significant burst of recruitment during the 1994-95 breeding season. It will be particularly important to the future of the programme to monitor the level of this recruitment on Table

Hill, which commonly has considerable numbers of unpaired birds looking for mates, as well as large areas of apparently suitable breeding habitat.

If resources allow, other breeding areas should also be checked in late September or early October to see if newly-recruited birds have established. Mt Rakeahua and Blaikies Hill are the two obvious places to check – both are reasonably accessible and have had breeding dotterels in the recent past. Should breeding birds be found at these or any other sites, small-scale local cat control operations can be considered.

Management options

While techniques for widespread biological control of feral cats are being developed, there appear to be three broad levels of management available to halt or slow the decline of NZ dotterels on Stewart Island. In order of increasing management intensity and cost, they are:

1. Control of feral cats around breeding areas, as at present. This seems to remain the only practical low-cost method. It may be possible to improve the overall effectiveness of this control at little extra expense, e.g. by increasing the size and/or number of protected areas, or by using longer-life baits. As noted in last year's report (Dowding 1993a), baits need to be more weatherproof (to reduce leaching of 1080) and incorporate a fungicide which does not deter cats. It is now clear that the addition of an insecticide (or repellent) to reduce fly-strike is also desirable. Unfortunately, further development of the baits along these lines will not occur in the near future; recent discussions with Landcare Research revealed that no DoC funds are available for such work this year. Until longer-life baits are available, baits should be changed *without fail* at least every six weeks. Severe weather resulted in a failure to replace baits in December this year; in combination with other factors, this rendered the bait cordon ineffective for part of the season. During bad weather, some flexibility may be necessary in future to allow staff to remain on the hill a few extra days to ensure that baits are changed on schedule.
2. Continuation of the present cat control operation plus intensive management (including nest manipulations) on site at Table Hill, and possibly at other sites nearby. This would be less expensive than captive breeding but would require the presence of skilled personnel on the breeding grounds for three months or more. Some relevant techniques are outlined in the recovery plan, section 9 (Dowding 1993b).
3. Captive breeding. The recovery plan (Dowding 1993b) indicates that a captive-breeding programme should be designed in case it is needed. Preliminary results from Otorohanga suggest that hatching and raising NZ dotterels in captivity should not present many problems. Captive breeding is a particularly expensive option however, and would require a major increase in funding for the project, either from within the Department or from an external grant-giving body or sponsor.

5. RECOMMENDATIONS

It is recommended that:

1. The cat control operation on Table Hill should continue in the 1994-95 season, to protect surviving adults and the first-time breeders expected there after the high productivity of the 1992-93 season.
2. Recruitment be monitored during the 1994-95 season, at least on Table Hill but preferably also on Blaikies Hill and Mt Rakeahua. If appropriate, small-scale cat control operations should be considered in these areas.
3. The Department of Conservation and Landcare Research should discuss ways to fund research aimed at improving baits; for cost-effective use on Stewart Island, baits need to be resistant to damp conditions for longer and be less prone to fungal growth and fly-strike.
4. Until longer-life baits are available, baits should be changed without fail at least every six weeks.
5. Helicopter landings in known or suspected NZ dotterel breeding areas (and low-level flights over such areas) should be avoided whenever possible during the breeding season.

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