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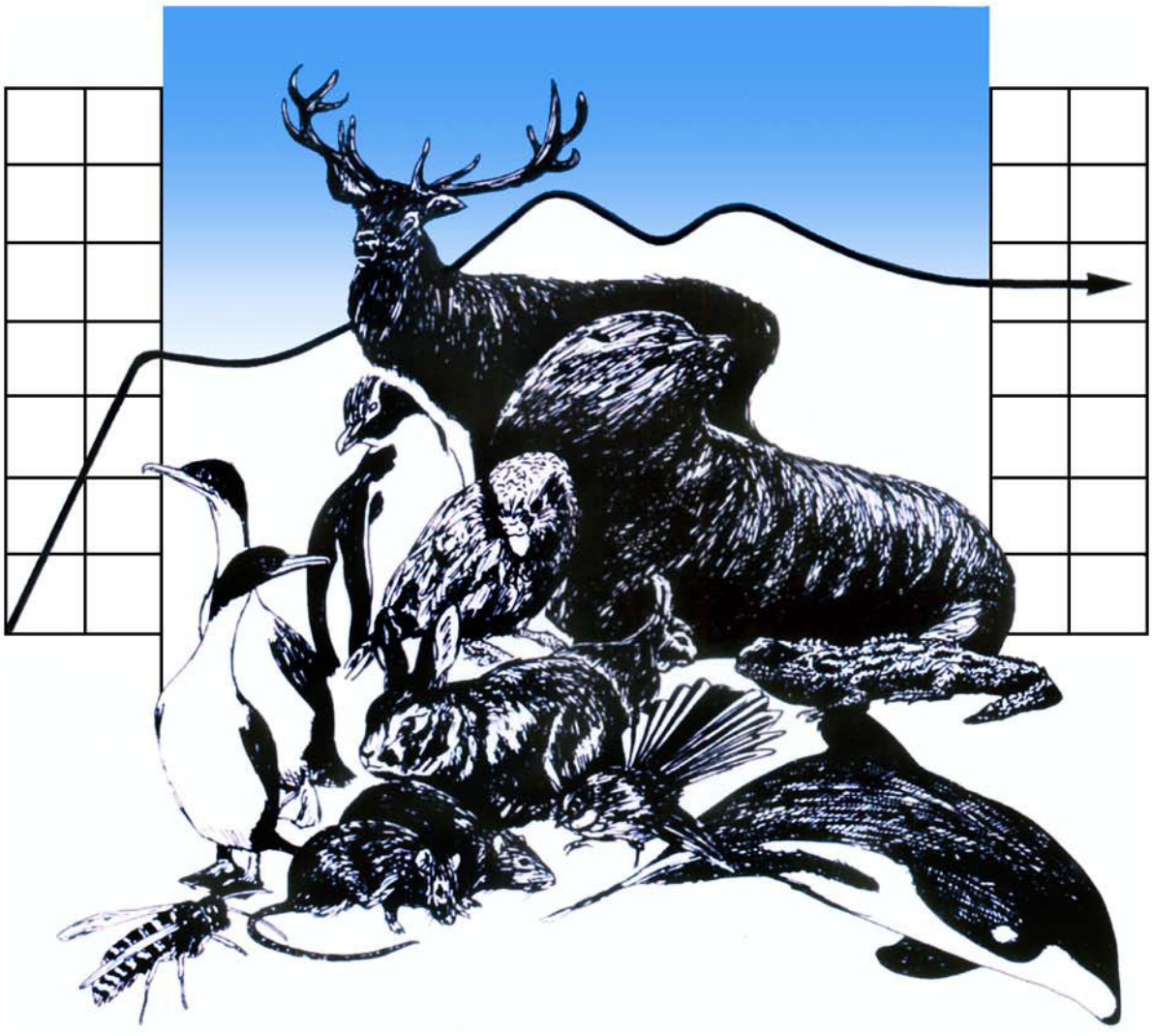

WILDLIFE MANAGEMENT

Investigation into the population plateau of the Southern New Zealand Dotterel

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Contents

Executive summary

The Southern New Zealand dotterel (*Charadrius obscurus obscurus*) was once widely spread across Southern New Zealand, but is now its range is highly restricted with breeding occurring exclusively on Stewart Island. Feral cats (Felis catus) are believed to be responsible for the 1992 population decline, leaving a historically low remanent population of just 62 individuals. Predator control has since been implemented across key breeding sites, which saw a subsequent increase in population size. Over recent years the population has been at a standstill of c.270 individuals.

This study monitored a total of five nests, two of which are strongly assumed to be of female/female pairs. The other three nests were three eggs clutches, however only the fate of Nest 5 could be determined and was shown to be successful. Recruitment rate could not be determined due to the failure to locate and identify chicks. There was no predation events recorded, however there were eleven recording of predators on the bait station cameras. Over half of the predator recordings were during November.

This study suggests that there is a female sex bias, a highly plausible contributing factor in the recent population plateau. Female/female pairing resulted in a lower reproduction rate and a greater predation risk as these infertile nests were incubated for up to fourteen weeks. A considerable limitation of this study was its small sample size. Previous research implies that predation and inbreeding are also impacting on the population recovery. Both were not observed during the duration of this study, likely due to the small sample size.

There are a number of future recommendations that could improve surveying techniques and aid the conservation effort. These include banding, microsatellite grouping, fertility checks, increasing management areas, encouraging the public to communicate resightings and increase the surveying period.

1 Introduction

The New Zealand dotterel (*Charadrius obscurus*) is a threatened endemic shorebird (Dowding & Davis 2007). There are two distinct subspecies defined by geographic, morphological, ecological and recently genetic differences (Dowding & Moore 2006; Barth et al. 2013). The northern subspecies (*C. o. aquilonius*) has an estimated population of 1700 individuals (Melville & Battley 2006, Hitchmough et al 2007), which is widely spread across the coastal habitat of the North Island, (Dowding 1994). Subsequently the Northern New Zealand dotterel is classified as nationally vulnerable on the bases that it is a moderate and increasing population but is conservation dependent (Hitchmough et al. 2007). In contrast, the southern subspecies (*C. o. obscurus*) has an estimated population of 270 and has a restricted distribution, breeding exclusively on Stewart Island (Dowding 1994). Unlike its northern relatives, the southern subspecies breeds above 300m a.s.l in exposed alpine areas, is larger and has darker plumage (Dowding 1994). The Southern New Zealand dotterel is classified as nationally critical due to its small population size, being found in one location and conservation dependant (Hitchmough et al. 2007).

The Southern New Zealand dotterel underwent a sever bottleneck event in 1992 where the population declined to a historical low of 62 individuals (Dowding & Davis 2007). Since then intense management has been put in place, which successfully increased numbers (McRitchie 2012). However annual population counts show that since 2009 the southern population has plateaued (Figure 1)(McRitchie 2012).

The aim of this study is to investigate the reasons behind the population plateau of the Southern New Zealand dotterel. The implications of sex bias, predation and

inbreeding are investigated and what impact they could potentially be having on the Southern New Zealand population recovery. A number of future recommendations and management options are stated to improve surveying technique and aid the recovery of this species.

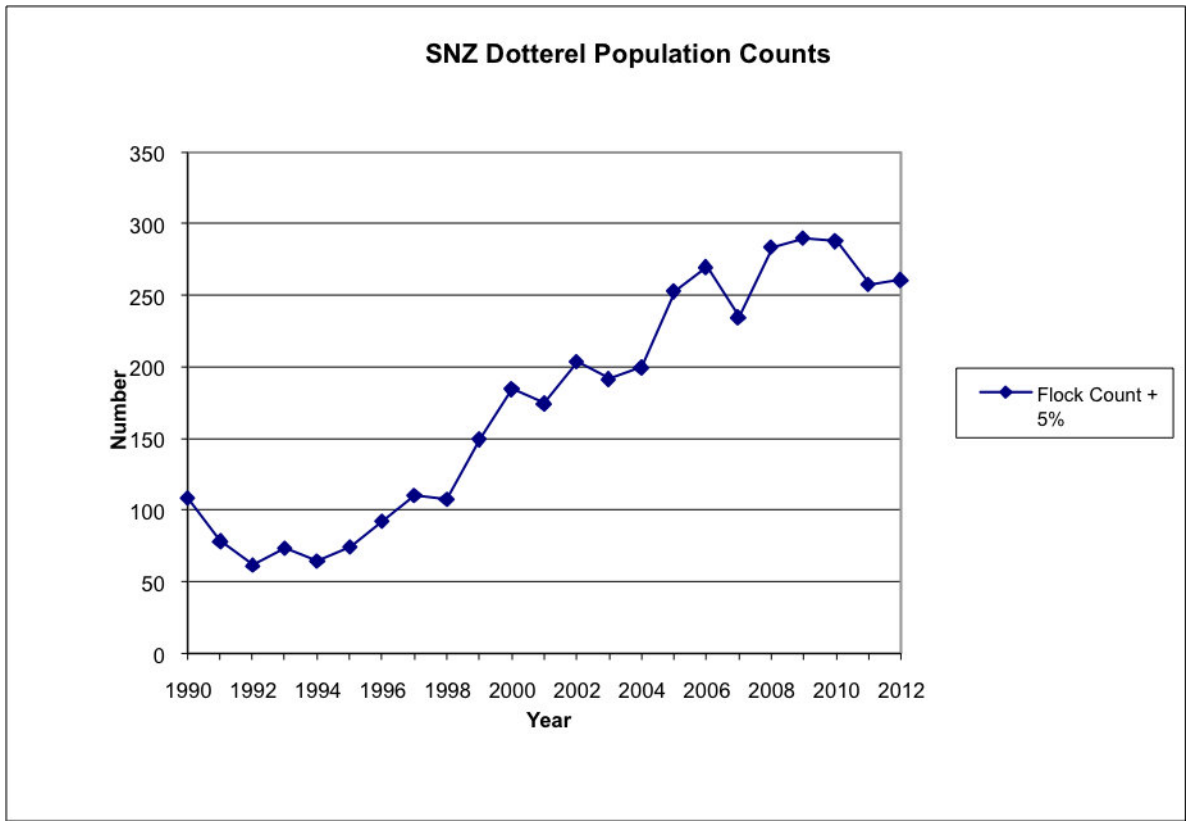

Figure1: Graph showing annual flock counts of the Southern New Zealand dotterel (Dobbins 2012)

1.1 Ecology and breeding behaviour of the Southern New Zealand dotterel

The movement patterns of the Southern New Zealand dotterel are reasonably well understood (Dowding & Moore 2006). They move annually between breeding and post breeding flocking sites (Dowding 1994). Winter flocks assemble from early February to August at coastal locations (Dowding 1994). During the breeding season, which is from October to late January, the southern dotterel migrates inland to sub-

alpine shrubland habitat (Dowding & Moore 2006). There have been the occasional occurrences of coastal breeding in the sand dunes at Mason Bay (Dowding 1999). Adult dotterels are highly faithful to their flocking site and are also believed to express site fidelity to breeding sites (Dowding & Moore 2006). The return rate of juveniles to their natal breeding site is believed to be around 50% (Dobbins per comm. (a)).

The Southern New Zealand dotterel breeds annually in alpine cushion fields and herb moors (Dowding & Davies 2007). They nest above ground creating small bowls amongst cushion plants and are lined with snow tussock (*Chionochloa pungens*) (Dowding & Murphy 1993; Dowding 1994). Clutch sizes ranges from two to five eggs, which are incubated for approximately 28 days (Dowding et al. 1999). Chicks become precocious shortly after hatching and fledging occurs at six to seven weeks of age (Dowding & Davies 2007). Juveniles then wander for the first 18 months to two years before becoming breeding adults (Dowding & Davies 1993). The New Zealand dotterel is a long-lived species with a lifespan of at least 12 years and is sexually monomorphic (Dowding 1993; Dowding 1994).

1.2 Past and present distribution of the Southern New Zealand dotterel

Prior to the 20th Century the Southern New Zealand dotterel was widely spread across the South Island breeding both inland and coastally (Dowding 1999; Dowding & Davies 2007). Over the last 100 years numbers have declines dramatically due to early settler hunting pressures and predation by introduced mammals including feral cats (*Felis catus*), rats (*Ratus spp.*) and the mustilid species; ferrets (*Mustela furo*), stoats (*M. ermiea*) and weasels (*M. niualis*) (Dowding 1999).

The Southern New Zealand dotterel now breeds exclusively on Stewart Island and flocks at three sites; Awarua Bay (Southland), Port Pegasus and Masons Bay (Stewart Island) (Dowding 1994; Dowding & Moore 2006; McRitchie 2012). Non-breeding juveniles have been reported around the coast of the South Island as far North as Farewell Spit (Dowding & Murphy 1993; Dowding 1999)

1.3 Current threats and conservation management

Predation is recognised as the main threat to the Southern New Zealand dotterel (Dowding 1999). Feral cats are believed to be the chief predator and thought to be responsible for the decline to 62 individuals in 1992 (Harper 2004; Dowding 1997). Rats are also believed to have some impact (Dowding 1997). Predation on predominately adult dotterels has resulted in a low life expectancy of c. 5years and female sex bias of a ratio of 1:2 (Dowding 1997). It is suggested that males are more susceptible to predation because they undertake most of the night-time incubation (Dowding 1997). A female bias population results in female/female pairs being formed where clutches are laid and incubated but fail to hatch (Dowding 1995).

The implications associated with inbreeding are also a potential threat to the Southern New Zealand dotterel due to the sever bottleneck event undergone in 1992. Bottleneck events have been found to reduce genetic diversity and increase inbreeding (Herber & Briskie 2010). The implication of inbreeding is reduced fitness and survival caused by decreased heterozygosity and increased expression of deleterious alleles (Briskie & Macintosh 2004).

Current management of the Southern New Zealand dotterel is carried out at four separate breeding sites; Table Hill, Mt Rakeahua, Mt Rocky and another mountain nicknamed 511. Bait station networks are positioned around the parameter of each breeding site. 1080 fish-polymer pellets are used to target cats and brodifacoum blocks to targe rats. Baiting commences from September through to February (Jacques per comm.).

2 Method

2.1 Study site

This study was carried out at the four control sites on Stewart Island. Table Hill with an altitude of 716m and is considered the most important breeding site remaining (Dowding 1997) Mount Rakeahua altitude of 687m, Mount Rocky altitude 549m and 511 with an altitude of 511m. All these sites have similar alpine environments suitable for Southern New Zealand dotterel breeding.

2.2 Surveying

Surveys where conducted between November and January in order to determine the location of nests and number of successful fledging. The transect lines used were based on a pervious study (Ray 2013) and loaded onto a handheld GPS. These lines covered the majority of the dotterel habitat and allowed a search area of 400m (200m each side of the line) to be surveyed.

Surveys were conducted at normal walking pace while the surveyor scans using their own sight and binoculars. Sighted dotterels were approached and their

behaviour analysed to determine status; single, pair, group, nest present, chick present. Birds with nests or chicks are very vocal and often fake injury to deter potential predators from their nest or fly overhead calling to their chicks to stay still. Adults with no nest or chicks are relatively calm in the surveyors presence. Waypoints of the birds' location and status were marked on a GPS.

The Southern New Zealand dotterel feeds at estuaries at low tide, therefore in order to maximise dotterel sightings, surveys were conducted two hours either side of high tide. Surveys were split into two days for trips with adverse weather conditions in order to avoid poor visibility conditions. Surveys were conducted approximately every two weeks and coincided with bait replacement trips as this was most feasible due to the remoteness of the locations. Five surveys were conducted this breeding season (12th, 27th of November, 16th December, 8th/9th, 21st/22nd of January).

2.3 Video surveillance

Once a nest was located it was then monitored using trail cameras. Little Acorn trail cameras were fitted with plastic container covers and strapped to wooden stakes. These were then place approximately one metre from the nest facing an Easterly direction where possible to minimize weather and moisture damage. These cameras are activated by heat and movement and were set to film 20second high quality videos when triggered. SD cards (16 GB) and batteries were changed during survey trips. Cameras were removed when chicks had hatched and left the nest or when the nest was abandoned.

On Mt Rakeahua, Mt Rocky and 511 trial cameras where also used (one at each site) to record predator activity. These were set up in the same fashion as the nest monitoring cameras at random bait stations.

2.4 Data analysis

The video recordings on the SD cards from both nest and bait station cameras were carefully analysed. Location, activity, species and dates were noted down and presented in tables.

3 Results

Nests 1 and 2 are presumed female/female pairs, as there had 6 and 5 eggs (Table 1). Nest 1 was abandoned after an estimated fourteen weeks and Nest 2 abandoned after an estimated twelve weeks. Nest 3, 4 and 5 were three egg clutches. Only the fate of Nest 5 could be confirmed, as Nest 3 and 4 had insufficient video footage to determine nest fate. Nest 5 had all three eggs successfully hatch (Table 1).

No fledglings where accounted for due failure to locate and identify chicks. No predation events were recorded, however a rat was videoed on four nights at Nest 5 after the chicks had hatched.

Table 2 shows that there were eleven different of predator activity at bait stations. These occurred on Mt Rocky and 511 only, with no predators being videoed on Mt Rakeahua. The majority of the predators sighted were rats with only two cats being recorded. Over half of the recorded predator sightings were early in the season during September.

Table 1: Description and fate of Southern New Zealand dotterel nest found during the 2013/2014 breeding season

Nest #	Location	Clutch size	Nest fate	Fledglings
1	Table Hill	5	Abandoned (12weeks)	None
2	Table Hill	6	Abandoned (14weeks)	None
3*	Mt Rocky	3	Unknown	Unknown
4*	Table Hill	3	Unknown	Unknown
5	Table Hill	3	All hatched	Unknown

* Camera SD card ran out of space therefore nest fate was not recorded

Table 2: Results from cameras recording events at bait stations on Mt Rakeahua, Mt Rocky and 511

Location	Predator species	Date	Bait taken
Mt Rocky	Cat	23-10-13	No
	Rat	15-11-13	Yes
511	Cat	09-12-13	Yes
	Rat	17-10-13*	Unknown
		20-10-13*	Unknown
		21-11-13	Yes
		24-11-13	Unknown
		25-11-13	
		26-11-13	Yes
		03-12-13	
		04-11-13	Yes
			Yes
			Unknown

* Video recording not long enough therefore bait take could not be determined

4 Discussion

4.1 Influences to recovery

This study identified female sex bias as the major influence in reduced recruitment rate and ultimately a possible cause to the recent plateau in the population recovery. The pairs of Nest 1 and 2 are very likely female pairs, however without molecular sexing this cannot be confirmed. This presumption is based on the fact both nests had large clutches resulted by both females contributing (Dowding 1995) and because no eggs were fertile as none hatched.

It has been suggested that sex ratio imbalances are associated with different physiological or behavioural traits between sexes (Donald 2007). In this case there is a female bias sex within the Southern New Zealand dotterel population caused by the males predominately undertaking the night incubation at which they are at a higher predation risk (Dowding 1997). The skewed sex ratio of the Southern New Zealand dotterel needs to be identified in order to understand its severity. This is important to the conservation and management of this species as heavily skewed sex ratios in critically endangered populations is thought to result in a lower reproductive population size, resulting in future populations becoming functionally extinct (Donald 2007).

Adult mortalities during the incubation period has resulted in population declines and skewed sex ratios in other New Zealand bird species, such as the North Island kaka (Moorehouse et al. 2003). It can therefore be suggested that adult birds are most vulnerable to predation during the nesting period. This becomes a serious concern

when female/female pairs are formed. This study shows that female pairs incubate their infertile nests for up to fourteen weeks, ten weeks longer than a normal incubation period and therefore placing these individuals at a significantly greater risk of predation (Dowding et al. 1999).

4.2 Other Influences

The major limitation of this study is that it has a small sample size and, although no predation events or infertile eggs from Nest 3, 4 and 5 were identified the influence and occurrence of predation and inbreeding to the recent plateau cannot be ruled out.

Predation has been identified as the major cause of Southern New Zealand dotterel mortality (Dowding 1999). This and the fact that predators were recorded on camera within dotterel territory indicate that predation is still a real threat. There are a number of factors that could have influenced the lack of predation events recorded on monitored nests this season such as weather, no observation of predation and effective control of predators.

Firstly weather is suggested to be a major influence on predator behaviour, especially cats. November was the driest since 1998 with only 84mm of rain recorded. In contrast the rest of the breeding season was very wet with 147mm in December and 166mm in January (Department of Conservation 2014). The influence of this weather pattern on predator activity is evident, as over half of all predator activity and both cat sightings were recorded over the dry period during November. Similar findings were found in a study that investigated feral cat behaviour and homerange on Stewart Island (Harper 2004). Cats were found to rest more in wet weather and

tended to venture into the alpine environment during periods of dry weather (Harper 2004). It could therefore be suggested that predation events were low due to the relatively wet breeding season.

A second factor is that predation events may not have even been recorded. Predation could have occurred before nest were found and monitored or on nests that were not found from surveying. An earlier start and increasing survey areas could have minimised this factor and produced a better estimate of the predation risk.

The final factor is that predator species are not venturing past the bait stations and that the current control is having the desired effect. This is supported by last year's report that also found no predation by rats or cats in the same controlled area on Table Hill (Ray 2013). This is a positive sign, however a number of breeding sites are not being managed and predation at these sites could be creating a population sink resulting in the observed recovery lull, as has been previously observed in the Blue Duck (*Hymenolaimus Malacorhyncos)* (King et al 2000). Expanding control into these areas would further protect the Southern New Zealand dotterel and possible result in increased overall population size.

Genetic variation is vital to the persistence of a population as it allows adaption to a changing environment and buffers against stochastic events such as disease and weather (Jamieson 2008). Inbreeding is a consequence of sever bottlenecks and reduces genetic variation. Inbreeding results in decreased heterozygosity and increases expression of deleterious alleles within the population (Briskie & Macintosh 2004; Herber & Briskie 2010). This results in what is known as inbreeding depression, which is a reduction of fitness and survival (Briskie & Macintosh 2004).

Bird populations that undergo a bottleneck event of less than 150 individuals have a greater rate of hatching failure (Herber & Briskie 2010). This implies that the Southern New Zealand dotterel is at risk of hatching failure, which could be contributing to the halt in population growth. This study has no evidence that indicates hatching failure due to inbreeding, however a similar study found 35.3% of monitored eggs failed to hatch for reasons other than predation (Ray 2013). These results suggest that inbreeding is impacting the recovery of this species. However without genetically testing unhatched eggs it cannot be known for certain that the eggs were unviable due to inbreeding as there are other factors such as weather and parent conditions that could cause hatch failure (Potti & Merino 1996).

4.3 Future recommendations

There are a number of protocols and changes that can be adopted in order to improve Southern New Zealand dotterel management.

One is the banding of all adults and chicks, which can be carried out at both the flocking and breeding sites. The advantage of banding birds at flocking sites is that there is the potential to catch and band more birds, as they are in high densities in these few post-breeding sites. It is also necessary to band during breeding seasons in order to band chicks before they fledge. The importance of banding chicks is that it allows exact ages to be known. Banding the Southern New Zealand dotterel would benefit the conservation effort in a number of ways (Cossee 1998). It will allow a better understanding of population structure and pressures, especially when and were predation and other mortalities are occurring. It would also identify population sinks and sources. Banding would make recruitment calculation easier and more precise as well as give a better idea of longevity.

Taking blood samples from individuals would also play a vital roll in the management of the Southern New Zealand dotterel and can easily coincide with banding. Blood samples provide the DNA necessary to conduct microsatellite grouping as described in Robertson et al. (2009). This process allows molecular sexing to be conducted and quantifying genetic variation and relatedness (Robertson 2006). Microsatellite grouping has been a vital aspect to the conservation effort of the iconic and critically endangered kakpo (*Strigops habroptilus*) and would also be a great benefit to the management of the Southern New Zealand dotterel. Quantifying the genetic variation of the Southern New Zealand dotterel population would identify to what extent the impact of the bottleneck event had, similar to the research on Takeha (*Porphyrio hochstetteri*) (Gruber et al. 2010). It would also identify the severity of the sex bias, as without this technique it is difficult to estimate as there is no distinct sexual dimorphism.

During nest monitoring fertility checks should be carried out on the eggs using the technique candling. If a nest has an infertile clutch then the eggs should be destroyed. As previously mentioned, infertile eggs were found to be incubated for extended periods. Removing an infertile clutch should minimise the predation risks to the adult dotterels. This technique is used throughout the conservation of highly endangered birds such as the Fairy Tern (*Sterna nereis davisae*) and Takeha (Jamieson & Ryan 2000; Hanson 2006).

Mount Anglum/Hananui is identified as an important breeding site for the Southern New Zealand dotterel (Dowding & Moore 2006) and should therefore be

managed. Bait stations should be set up on Mt Anglum in order to safeguard this population and increase genetic diversity of the population as a whole.

Breeding pairs have been sighted at Mason Bay on the West coast of Stewart Island in recent years (Ray 2013, Dobbins per comm. (a)) and in order to protect these individuals it is recommended that cat control should take place in this area. Trapping would be the most cost effective as trapping does not require regular trips which are necessary for control using 1080 bait and can coincide with the Mason Bay weed trips that take place between October to April (Dobbins per comm. (b)). Mason Bay is also recognised as an important post-breeding sites with 105-120 dotterels flocking there (Dowding & Moore 2006). Though there is no literature on the threats to the Southern New Zealand dotterel over the post-breeding period, reduced cat numbers may provide protection to this large number of roosting dotterels.

Another recommendation is to utilise Stewart Island's popularity with tourist in order to understand the movements of the Southern New Zealand dotterel. The relative Department of Conservation visitor centres could increase the public awareness of the species status and the conservation effort being undertaken. They could encourage visitors and locals to report any sightings and band combinations that they may see across the island. This goes for the South Island when identifying the movements of wondering juveniles. Using the public would help increase important information without having to increase resources.

It is also recommended to change the fortnightly surveys to weekly, with someone ideally being on Table Hill for the entire breeding season. This would allow surveys to

be more flexible and minimise weather being a limiting factor. Age estimates of nests and chicks would be more precise which is critical for banding. This is because chicks having to be older than 3 weeks so that the band is not to big but younger than 4 weeks as this is when they are fledging and capture becomes increasingly difficult (Dobbins per comm. (a))

The final recommendation is a change to the methodology referring to camera placement. Firstly the orientation of the camera should change from West facing to South facing where possible. This means that the camera is facing away from the sun, increasing picture quality as there will be less glare and it will minimise the possibility of the camera being set off by the sun (Dobbins per comm. (b)). The distance of the camera from the nest should be increased from 1m to 3m. When the camera is only 1m away it picks up fine movements using up the memory on the SD card quicker than it can be replaced. A greater distance also allows for a larger field of view, which will capture more information, such as a predation event that occurs off the nest (Dobbins per comm. (b)). If the camera is further than 3m it may make it difficult to interpret smaller details, such as number of chicks hatched (Nicholas per comm.)

4.4 Management options

First class option:

- Adults and chicks banded and blood samples taken at both flocking and breeding sites annually.
- Fertility checks to be carried out on eggs and infertile clutches destroyed.
- Bait station network set up on Mt Anglum
- Cat control at Mason Bay through trapping

- Increase Southern New Zealand dotterel advocacy in order to encourage the public to record and communicate resightings of banded birds through Stewart Island and the South Island.
- Weekly surveys with someone on Table Hill all season

Mid range option 1:

- Adults and chicks banded and blood samples taken at flocking and breeding sites for the first two years in order to band as many individuals as possible. In the following years annual banding only at breeding sites.
- Fertility checks to be carried out on eggs and infertile clutches destroyed.
- Visit Mt Anglum and undertake a population count in order to determine whether management would be cost effective.
- Cat control at Mason Bay through trapping
- Increase Southern New Zealand dotterel advocacy in order to encourage the public to record and communicate resightings of banded birds through Stewart Island and the South Island.
- Weekly surveys covered by three day trips

Mid range option 2:

- Adults and chicks banded and blood samples taken annually at breeding sites only.
- Fertility checks to be carried out on eggs and infertile clutches destroyed.
- Increase Southern New Zealand dotterel advocacy in order to encourage the public to record and communicate resightings of banded birds through Stewart Island and the South Island.

- Fortnightly surveys that continue to coincide with bait replacements.

Change nothing:

- Fortnightly surveys that continue to coincide with bait replacements.

5 Conclusion

The Southern New Zealand dotterel's population has been at a standstill over recent years despite the large conservation effort currently undertaken. Reasons behind this plateau have yet to be fully explored and understood. Sex bias within the population, predation and reduced genetic variation due to inbreeding are believed to be the major factors.

This study found that the female sex bias is resulting in a lowered reproduction rate and increased predation risk, as incubation periods are significantly longer than normal. No evidence of predation or inbreeding was found, however numerous studies suggest that the Southern New Zealand dotterel is still at risk to both of these. Predation is believed to be the major threat to this species, however the wet weather conditions, surveying period and the control around the surveying site may have been why predation events were not recorded.

Inbreeding is of major concern to the population recovery as the Southern New Zealand dotterel underwent a sever bottleneck. Species that have undergone bottlenecks of less than 150 individuals have a higher hatching failure rate. Given the subsequent bottleneck event undergone by the Southern New Zealand dotterel it is likely that similar hatching outcomes may be observed in this species.

In order to gain a better understanding of what is impacting the recovery of this species there are a number of changes and techniques that need to be adopted in future management plans.

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