Mortality and dispersion of saddlebacks after reintroduction to Boundary Stream Mainland Island

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A B S T R A C T

On 10 September 2004, 36 North Island saddleback (*Philesturnus carunculatus rufusater*) were transferred to Boundary Stream Mainland Island (BSMI), Hawkes Bay, from Cuvier Island, New Zealand. This translocation, consisting of 11 adult males, 18 adult females, 6 juvenile males, and 5 juvenile females, was the first attempt to transfer a species which was previously extinct on the mainland to a mainland habitat with low predator abundance. The two key risks of this transfer were loss of individuals through predation, and dispersal. This study investigated the rate of initial mortality and the role of dispersal on the success of the reintroduction. A survey conducted 6 weeks after release resulted in an estimated survival rate of 57%. Ten saddlebacks had tail-mounted transmitters attached prior to release. These saddlebacks were located once per week. The mean daily dispersal distance of transmittered birds was 30 m (n = 10), with adults dispersing 42 m (n = 6) and juveniles dispersing 16 m (n = 4) per day. The largest total distance dispersed away from the release site was 1952 m. The risk of dispersal after release may be minimised by transferring juveniles.

Keywords: *Philesturnus carunculatus rufusater*, saddleback, mortality, dispersal, translocation, Boundary Stream Mainland Island, New Zealand

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1. Introduction

The North Island saddleback (*Philesturnus carunculatus rufusater*), an endemic passerine, was once found throughout the North Island's forest and scrubland habitat (Oliver 1955). Numbers rapidly declined with the introduction of carnivorous mammals. In 1964, the New Zealand Wildlife Service initiated the translocation of saddlebacks to pest-free islands which resulted in the species recovering from being endangered to now being considered 'range restricted' (Merton 1975; Hitchmough 2002). The North Island saddleback was restricted to Hen Island, but now has ten self-sustaining populations on North Island off-shore islands, and in the predator-fenced Karori Wildlife Sanctuary in Wellington. There are now a combined total of over 7000 North Island saddlebacks (T. Lovegrove, pers. comm.).

Most of the conservation efforts relating to saddlebacks have been directed towards off-shore islands, where predators have not occurred, or have been eradicated. However, there is now a growing emphasis towards mainland conservation and restoration (Davidson 1999). It was recognised in 1966 by Atkinson & Campbell (1966) that islands are vulnerable to environmental changes, and if saddlebacks are to be safeguarded permanently, it will be necessary to re-establish populations on the mainland. The key issue is that maintaining low predator densities and developing management techniques now allows the reintroduction of saddlebacks to their former range.

On 10 September 2004 a total of 36 North Island saddlebacks (consisting of 11 adult males, 18 adult females, 6 juvenile males, and 5 juvenile females) were transferred to Boundary Stream Mainland Island (BSMI) from Cuvier Island. This transfer was the first attempt to transfer a species which was previously extinct on the mainland to a mainland habitat with low predator abundance.

The BSMI reserve (Fig. 1) is situated on the eastern flank of the Maungaharuru Range, 60 km north-west of Napier. It covers 800 ha, and extends from 300 m to 1000 m above sea level. A coastal climate predominates in the lower parts of the reserve while in the higher areas the climate is more montane. It has 12 distinct vegetation types. These include mountain holly forest on the crest of the range, red beech, black maire and podocarp forest (mainly kahikatea, totara and matai), tawa forest, shrubs and ferns in the gullies, and open kamahi on ridges and areas of kanuka. BSMI is the largest and most intact tract of lowland forest remaining in Hawkes Bay. The intensive management of BSMI has developed an environment suitable for the re-introduction of threatened species, increasing indigenous biodiversity, and restoring forest processes such as seed dispersal. The size and quality of habitat, and the management and control of pests and predators are all factors that enhance the prospects for reintroductions.

The two key risks of this transfer were loss of individuals through predation and dispersal. This study investigates the rate of initial mortality and the role of dispersal of released saddlebacks on the success of the reintroduction.

Individuals that disperse long distances are less likely to pair and, therefore, may not contribute to the population. Predation pressure is also likely to be higher on the edges of the reserve, so individuals that disperse to the edge may be at a higher

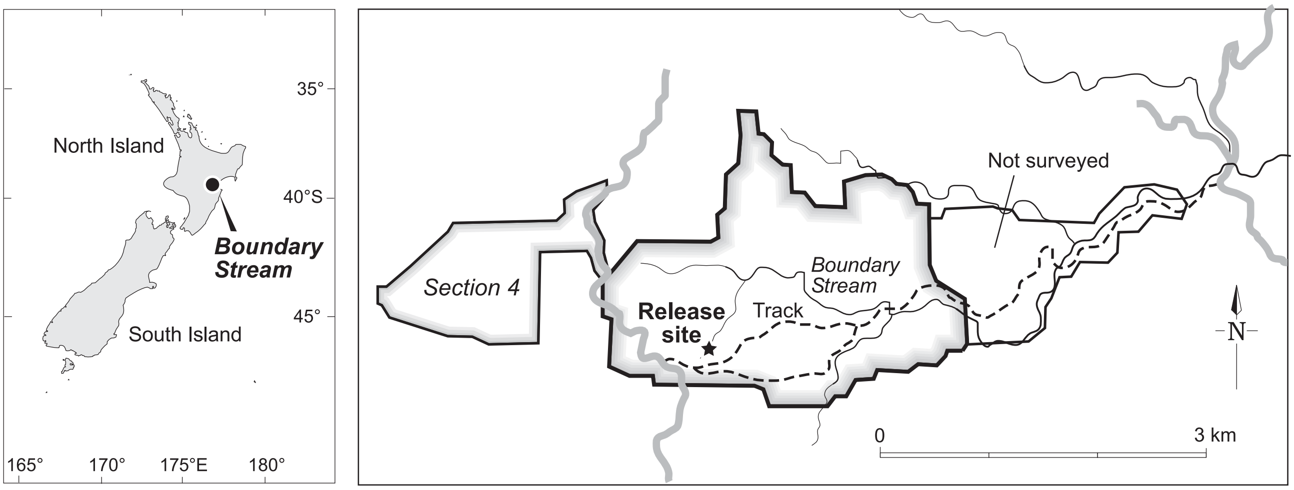


Figure 1. Map of Boundary Stream Mainland Island, Hawkes Bay, with areas mentioned in text. **Bold** solid line indicates area surveyed on 21 October 2004.

risk of predation. By understanding these factors, subsequent transfers may be able to reduce the risks of dispersal and increase the chance of success of the reintroduction by selecting age classes that are least likely to disperse.

Information on dispersal rates in most saddleback transfers has not been recorded in detail. The distance and area saddlebacks explore before forming a territory may influence the rate of dispersal outside of the reserve. While this could be a consequence of habitat selection, it may pose a limiting factor on the size of habitat that is required for the successful establishment of saddlebacks in a mainland situation. Certain age classes may also have higher survival rates. This study provides some valuable baseline information that may assist managers when planning future transfers to the mainland.

2. Methods

All saddlebacks were sexed and aged upon capture. Gender was determined by weight and tarsi measurements and age was determined by wattle size. Each bird was individually colour banded. Ten saddlebacks had tail-mounted transmitters (model BD-2; Holohil, Canada) attached immediately prior to release. These transmitters weighed 1.9 g (approximately 2.5% of body weight), and the batteries were designed to last 16 weeks. The study intended to have a 50:50 adult:juvenile transmitter ratio, however because of tail quality, the age and gender classes of the transmittered birds was three adult males, three adult females, two juvenile males, and two juvenile females.

The transmitters were attached using two-second ‘elephant’ glue and dental floss. The transmitter had a tunnel at the head end which the dental floss was threaded through and wrapped in a figure eight around the transmitter and four central tail feathers just below the ‘preen’ gland at the base of the tail. Each individual bird was radio-tracked and located approximately every 7 days.

2.1 SURVIVAL

If a saddleback was found dead a strict procedure was followed in an attempt to identify the cause of death. A detailed examination was first made of the site where the body was found, a search was made for scats, fur or prints, and photographs taken.

Saddlebacks not considered to have been killed by a predator were chilled in a refrigerator (not frozen) and sent to Brett Gartrell (Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Palmerston North) for necropsy as soon as possible. Saddlebacks considered to have been killed by a predator were frozen for later examination.

Six weeks after release, on the 21 October 2004, 80% of the reserve was surveyed using the bait station grid lines. At every bait station, 150 m apart, the observer stopped for 5 minutes and played a series of taped non-territorial calls. Saddlebacks encountered or heard were identified and a Global Positioning System (GPS; assorted brands) location was taken.

Data were entered in a Lincoln-Petersen model in the software MARK®, and included saddleback that had been sighted over the previous 7 days. The estimated population is given by

$$\hat{N} = \frac{n1 \times n2}{m2}$$

where $n1$ is the number sighted 7 days prior to the survey, $n2$ is the total number sighted during the survey, and $m2$ is the number of recaptures (i.e. animals caught on both occasions). The approximate standard error for the estimate is given by

$$\mathrm{SE}\ (\hat{N}) = \mathrm{sqrt}[n1 \times n2(n1–m2)/(m2)\text{^}3]$$

and confidence interval estimated using $\hat{N} \pm 1.96$*SE.

2.2 DISPERSAL

Each bird fitted with a transmitter was radio-tracked approximately every 7 days. The general location was obtained by getting a direction to the strongest signal from several remote sites around the reserve. The bird was then located by heading towards the strongest signal. Once sighted and identified, the GPS (brand 'Eagle Expedition') location was recorded. If the bird could not be sighted, or it was determined that the bird was continually moving away from the tracker, then a GPS location was taken at the estimated original location. General habitat, nearest landmark (e.g. bait station) and general behaviour was also recorded. The GPS locations were plotted on ArcGIS 9 and any that were seen to be inaccurate were adjusted using the nearest landmark as a guide.

Dispersal rates—distance (m) moved over time (x)—were calculated using the formula:

$$\frac{\text{GPS location of day A – GPS location of day B}}{\text{Number of days between day A and day B}}$$

Data were collected until either the transmitter fell off or failed, or the bird formed a pair. (Two birds were considered a pair if they had been sighted together on two consecutive occasions.) Incidental sightings of non-transmittered birds also had GPS locations recorded and data included in some calculations to increase sample size.

3. Results

The average duration transmitters were attached to the bird was 69 days (10 weeks). One transmitter could not be located; however, its signal continued for at least 18 weeks.

Five pairs were known to have formed. Two pairs were not transmittered, and three pairs had one bird that was transmittered.

3.1 SURVIVAL

Two weeks after release, four out of ten transmittered birds were found dead after a week of unseasonably cold weather. Two of the deaths (adult male and adult female) were due to aspergillosis, a fungal disease which affects the respiratory tract, which was likely to be caused by the combined stress of the transfer and cold weather. Both birds had poor fat reserves and no food in the gizzard. The third death (juvenile male) was caused by a break in the cervical spine, the cause unknown. The fourth body (juvenile female) was too decomposed for necropsy, but signs of predation were not apparent. These deaths at this time may extrapolate to a total loss of 15 saddlebacks (40% of the total population).

A dead saddleback was found by chance on the 1 November 2004, but because no bands were found with the remains, the bird could not be identified. Only feathers were found with all of the skeleton and skin absent. Analysis of the feather damage suggested that the death was not caused by falcon predation. The pile of feathers is suggestive of cat predation, but this conclusion is not absolute (C. Gillies, pers. comm.).

Five out of the remaining six transmitters fell off unhindered. Four of these birds were subsequently seen. The sixth transmitter, attached to a juvenile male, was found with eight tail feathers, four of them attached to the transmitter. This bird was not seen after the transmitter fell off, but had previously exhibited a secretive behaviour.

The survey conducted in October resulted in seven saddlebacks being encountered. The total number of individuals sighted was 21 prior to the survey. Six of these were pairs either transmittered or monitored. The model predicted a 57% survival or 21 saddlebacks (CI: 7–32). The model was not sensitive and can only be used as a rough guide, but suggests that any bird alive was being seen. This estimate is also consistent with the survival rate extrapolated using the survival of the transmittered birds. The survival rate for the BSMI population is comparable with the survival rates from the first three Kapiti Island transfers which occurred when Norway rats (*Rattus norvegicus*) and kiore (*Rattus exulans*) were present on the island (Table 1).

TABLE 1. SURVIVAL RATES OF SADDLEBACKS FROM THE KAPITI ISLAND, KARORI WILDLIFE SANCTUARY, AND BSMI TRANSFERS.

RELEASED	WEEKS AFTER RELEASE	SURVIVAL RATE (%)	PREDOMINANT CAUSE OF DECLINE	REFERENCE
Kapiti Island (1987)	6; 8	58.1; 30.2	Norway rats and kiore	Lovegrove (1991)
Kapiti Island (1988)	8	69	Norway rats and kiore	Lovegrove (1991)
Kapiti Island (1989)	8	47.5	Norway rats and kiore	Lovegrove (1991)
Karori Wildlife Sanctuary (2002)	8	78.8	Unknown	R. Empson (pers. comm.)
BSMI (2004)	6	57	Unknown	

3.2 DISPERSAL

The mean daily dispersal distance of transmittered birds was 30 m (n = 10), with adults dispersing a mean of 42 m per day (n = 6) and juveniles dispersing a mean of 16 m per day (n = 4). Mean daily distance for all birds which subsequently formed territories was 28 m (n = 10, five pairs). mean daily distance dispersed for transmittered birds that did not form territories was 21 m, 27 m for adults (n = 3) and 16 m for juveniles (n = 4). The larger dispersal distance for birds that formed territories compared to birds that did not form territories is likely to be due to the fact that only one juvenile formed a territory and juveniles have a lower dispersal rate. Incidental sightings of non-transmittered birds were excluded, because calculation from one distance measurement is likely to underestimate total movement.

Excluding the pair WG-RM/RM-WR, who formed a territory 1721 m from the release site, all other pairs formed territories on average 307 m from the release point (range from 161 m to 462 m). These four pairs remained within calling distances from at least one other pair.

There was little difference between male and female dispersal with average daily distance dispersed being 33 m and 31 m respectively.

The longest distance known to have been covered in one day was 1623 m, where the adult female (RM-WR; Fig. 2) was tracked over 4 hours. This bird subsequently formed a territory with an adult male (WG-RM). It is unknown whether they dispersed together, but they had not been seen together prior to the movement.

The largest distance dispersed from the release site was 1952 m by a juvenile female (YM-BG; Fig. 3), who travelled this distance within the first 7 days. This female's transmitter was later found 40 m outside the reserve's boundary. YB-RM (adult male) was tracked moving 500 m from the main reserve across farmland to 'Section 4' using a sparsely vegetated scrubby creek (see Fig. 1). These two incidents were the only occasions birds were recorded outside the reserve's boundaries.

Figure 4 shows that juveniles and adult females dispersed initially within the first week since release, settled for a period of time, then dispersed widely. Adult males dispersal rate increased at a slower rate over time, and after approximately 40 days dispersed less.

Figure 2. Dispersal patterns from weekly GPS locations of six adult transmittered saddleback following release.

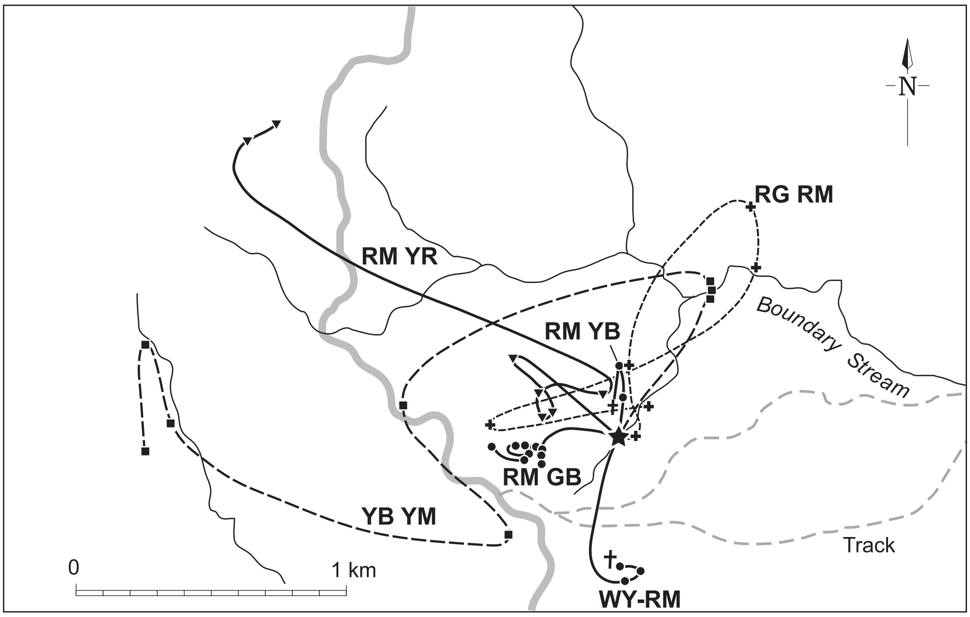


Figure 3. Dispersal patterns from weekly GPS locations of four juvenile transmittered saddleback following release.

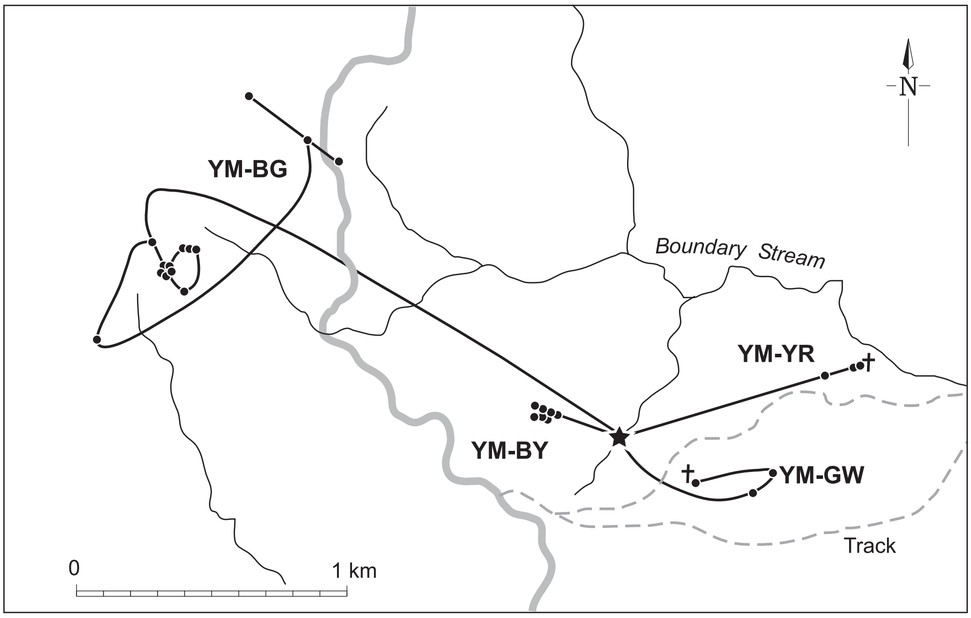
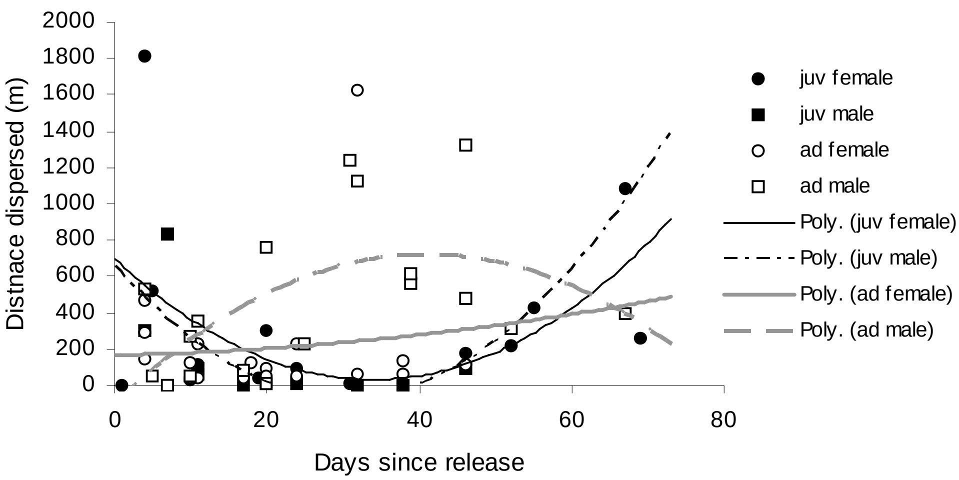


Figure 4. Distance dispersed by transmittered saddleback since release. The marked points are the distances of each age/gender class with the lines representing the polynomial trend lines.



4. Discussion

The BSMI saddleback population was likely to be affected by both initial mortality and dispersal. Both factors reduce the number of birds available for pairing and subsequent breeding.

The survival rate 6 weeks after release was approximately 57%. Few translocations have estimated survival rate following release; however, this estimate is comparable with the Kapiti Island transfers, with both populations existing in the presence of predators. It is considerably lower than that of Karori Wildlife Sanctuary, which is smaller, but predator-free. This suggests that predation did have an effect on the population; however, monitoring of the transmittered birds shows that predation is not a significant cause of decline in the initial phase of the translocation. A number of birds were affected by aspergillosis. This disease is common and can lie dormant in most healthy birds, but can become fatal if the bird is under extreme stress. In this case it was likely to be caused by a combination of transfer stress and extreme and unseasonable weather. The sample size of four known deaths is too small to determine if juveniles or adults have a greater survival rate. The BSMI saddleback population may decline at a faster rate over the coming breeding season and subsequent winter. The Little Barrier Island and Motukawanui Island releases had 66% and 50% survival respectively one year after release (Lovegrove 1996).

Saddlebacks have poor dispersal ability and a year-round site attachment (Lovegrove 1996), attributes which potentially reduce dispersal in a new environment. However, the rapid movement of saddlebacks after release into BSMI, prior to forming territories, demonstrates their high mobility in a low-density environment. While saddlebacks cannot sustain flight (O'Callaghan 1980), they move by short flights from tree to tree and may disperse using shelterbelts or riparian strips. Saddlebacks on Mokoia Island have been observed flying 20–30 m between bush patches (I. Castro, pers. comm.). This study shows that movement is highly variable between individual birds. A number of birds dispersed widely and frequently while some dispersed short distances and others dispersed irregularly.

In this study, adults dispersed 37% further than juveniles after release. In Karori Wildlife Sanctuary, juveniles established territories closer to the release site (mean 380 m) while adults dispersed on average 710 m to the forest edge where habitat was most similar (scrub, lower canopy height) to the source (R. Empson, pers. comm.; Empson 2003). However, dispersal ceases once a territory is formed. Of the saddlebacks released into BSMI that subsequently formed territories, 90% were adults, and birds generally did not move far from the release site.

Baker (1978) defined two types of discovery dispersal:

- The animal searches many sites and returns to a good one
- The animal explores until it stops and settles

This study suggested that the second option occurred. The difference between the dispersal pattern of adult males and adult females suggests that adult males select a suitable territory, rather than selecting a potential mate then settling. The dispersal rate of adult females increased steadily over time as the population declined, suggesting that they were searching for a suitable mate. Both male and female juvenile saddlebacks dispersed widely initially, probably exploring the new environment, settled, then dispersed widely after approximately 40 days. This coincides with the recorded decrease in population size. This suggests that juvenile saddlebacks were looking for other saddlebacks once the population diminished.

The majority of the birds moved to higher altitudes in a west or north-west direction; however, search effort for non-transmittered birds was less at lower altitudes and results may reflect the encounter rate. There could be many reasons for this direction of dispersal: altitude preference, habitat selection and availability, or a random event. Interpretation of the reasons behind dispersal direction is beyond the scope of this study. Four birds dispersed from the main reserve into 'Section 4' (see Fig. 1), however, this area is connected by a scrubby corridor and a series of vegetated creeks, and is in view from the boundary of the main reserve.

At Karori Wildlife Sanctuary, ten saddlebacks (25%) were sighted outside the fenced area after release. The majority of these died of unknown causes, while two were confirmed to have been preyed upon (R. Empson, pers. comm.). Because of the small sample size, this study cannot determine the interaction between dispersal and mortality. Nevertheless, with the constant invasion of predators from surrounding farmland, some degree of predation is to be expected.

The results suggest that by transferring juveniles, the immediate risk of dispersal is minimised. Adults dispersed at a greater rate than juveniles; however, adults formed territories earlier than juveniles, which ceased their dispersal. Whether juveniles adapt to the new surroundings over time and, therefore, do not disperse as they mature, or whether they are slower to form territories so over time the risk of greater dispersal becomes higher, is currently unknown. Dispersal rates and patterns may be different if a population is transferred in early winter, where the adult drive to breed is lessened. There was no difference in the overall dispersal rates between genders; however, there was a difference in dispersal patterns between adult males and females.

5. Conclusions

The study was limited by the small sample size, the early deaths of four transmittered birds, and the short transmitter attachment life. However, it provides baseline data for future transfers and research. It is important that areas proposed for future transfers are chosen with respect to the saddleback's flight capabilities. Even the poorest-quality corridor can be utilised by saddlebacks during dispersal, and saddlebacks can disperse widely before forming a territory. By dispersing out of protected areas, the risk of predation is increased, and they are lost to the local breeding population, even if they do survive.

The use of transmitters is a tool which can assist managers in determining the impact of initial mortality and dispersal on the population. Transmitters allow the body to be recovered and necropsied. Determining cause of death of individual birds after a transfer assists managers in determining and thus minimising causes of decline. The impact of disease and stress-related mortalities may be under-estimated in many transfers. However, there are still concerns about the effect of transmitters on the survival and well-being of the animal. The saddlebacks with transmitters at Karori Wildlife Sanctuary had a slightly lower survival rate than non-transmittered birds (R. Empson, pers comm.). This did not appear to be the case at BSMI, as non-transmittered saddlebacks disappeared at similar rates to the mortality rate of transmittered birds. However, without recovering the bodies this is not conclusive.

6. Recommendations

From the information gained in this research, the author recommends the following considerations when saddlebacks are being translocated:

- Juveniles should be chosen for transfer if dispersal has the potential to limit population growth, such as to a mainland site. However, breeding success of adults and juveniles should be compared to determine the greatest long-term beneficial result for the population.
- Adults may be the preferred age class to transfer if the transfer occurs immediately prior to the breeding season because they form territories quicker; juveniles may be better if the transfer occurs away from the breeding season because they disperse less.
- Selection of proposed transfer sites should take into account the saddleback's flight capabilities.
- Transmitters should be used as a tool to monitor dispersal and behaviour of recently transferred birds to assist in determining preferred transfer-site characteristics, such as size.
- Transmitters used for monitoring after transfer will assist in the recovery of bodies to determine cause of death.

7. Acknowledgements

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