Translocation is becoming increasingly commonly used for conservation, and can be defined as the intentional release of plants or animals to the wild to establish, re-establish or augment a population (IUCN 1987; Griffith et al. 1989). The technique has been applied to the conservation of mammals (e.g. Dufty et al. 1994; Short et al. 1994), invertebrates (e.g. Sherley 1994) and birds (e.g. Atkinson & Bell 1973; Merton 1973, 1975; Bell 1978; Butler & Merton 1992). In New Zealand, translocations have often been incorporated into species management programs in the past, and have been successful in saving some New Zealand birds from extinction. Since the 1880s, almost 400 translocations of 50 taxa (42 birds, five reptiles and three invertebrates) have been conducted in New Zealand, often in emergency situations, such as in 1962 when ship rats (Rattus rattus) arrived at the last stronghold of the South Island Saddleback (Philesturnus carunculatus carunculatus) (Atkinson & Bell 1973; Merton 1973, 1975; Bell 1978).

Despite the increasingly common application of...
translocations in conservation management, and wide recognition of the value of post-release monitoring (e.g. Scott & Carpenter 1987; Griffith et al. 1989; Sarrazin & Barbault 1996), such monitoring does not always occur. In fact, Wolf et al. (1996) reported that only 45% of 336 bird and mammal translocation programs included tagging of released individuals or post-release telemetry, and in about 30% of translocations, the causes of 90–100% of animal losses were never identified. In New Zealand, translocation continues to be widely used as a conservation tool. Post-release monitoring of translocated animals may be becoming more common (e.g. Nelson et al. 2002), but such monitoring seldom occurred in the past (Department of Conservation 1994; Lovegrove & Veitch 1994; Armstrong & McLean 1995).

Similar to post-release monitoring of survival, monitoring the habitat use of newly translocated organisms is important, yet seldom occurs. Globally, translocations are deemed most likely to succeed where animals are released into areas of high habitat quality and/or quantity (Wolf et al. 1996). This emphasizes the importance of thoroughly investigating the habitats at potential release sites before conducting translocations and monitoring the habitat use of translocated animals after they are released. Post-release monitoring of habitat use can confirm suitability of the new location, and produce valuable information relevant to future translocations, thereby facilitating adaptive wildlife management (Sarrazin & Barbault 1996). For example, mobile animals at low densities may occupy habitats on the basis of preference rather than requirement, and may colonise less ‘preferred’ areas as their population density increases (Jenkins 1976; Armstrong & McLean 1995). Therefore, monitoring spatiotemporal patterns of habitat use together with population growth can be informative in determining habitat requirements and preferences, and the ability of translocated organisms to colonise ‘novel’ environments.

The South Island Saddleback is a forest passerine endemic to the islands of New Zealand. It is an endangered subspecies of the near threatened New Zealand Saddleback (IUCN 2000). Diurnal, territorial and largely insectivorous, the South Island Saddleback forages on foliage, live and dead wood, and the ground. It uses cavities for roosting and is monogamous with apparently flexible nest site requirements (Guthrie-Smith 1925; Pierre 1995). Although the South Island Saddleback was formerly widespread over New Zealand’s South Island and southern offshore islands, it is unable to coexist with introduced predators, and consequently, was virtually extinct by 1900 (Oliver 1955; Roberts 1991). The total population of South Island Saddlebacks is currently about 650, with birds occurring on 11 islands, all of which are free of introduced predators.

Following the South Island Saddleback Recovery Plan (Roberts 1991) administered by the New Zealand Department of Conservation, 26 South Island Saddlebacks were translocated to Motuara Island in the Marlborough Sounds from the Titi Islands near Stewart Island, New Zealand, in March 1994. (See Figure 1 for the locations of islands mentioned in the text). Seven adult males, 11 adult females, 5 subadult males, one subadult female and one adult and subadult of unknown sex were included in the translocated founder population. Motuara Island (59 ha) was selected as the release site for translocated South Island Saddlebacks for three main reasons. First, introduced predators (*Rattus exulans*) were extirpated from the island in 1993. Second, vegetation on Motuara Island has been regenerating since farming was abandoned in 1926 (W.F. Cash pers. comm.), and finally, the bird was historically resident in the area. Conservation managers considered Motuara Island to be sufficiently large and with appropriate

![Fig. 1. Locations of islands mentioned in the text. (From Pierre 1999).](image-url)
habitat to support more South Island Saddlebacks than currently existed on any other island (W.F. Cash pers. comm.).

In this paper, I review the reintroduction biology of the South Island Saddleback. I discuss post-release dispersal, social organisation, survival, habitat use and foraging patterns of the newly released population on Motuara Island, New Zealand. Before the work described in this review was carried out, the South Island Saddleback had not been studied in detail. Also, future translocations were planned to increase the total population of this bird (Roberts 1991). For these reasons, post-release monitoring of the translocated population was critical.

METHODS

Saddlebacks were weighed, measured and their plumage examined on capture to determine sex and age (W.F. Cash pers. comm.; Nilsson 1978; Jenkins & Veitch 1991). Numbered metal and unique combinations of coloured plastic legbands were used to identify individuals. After release on Motuara Island, birds were relocated using a recording of South Island Saddleback male territorial song, and via their vocal responses and attraction to disturbances (e.g. logs breaking). The work reviewed here results from post-release monitoring involving intensively searching for birds for four days, six months after they were released, and searching for and monitoring birds for 56 days, from eight months after release, during their first breeding season on Motuara Island.

Territory boundaries were identified during the breeding season by conducting repeated searches for birds and recording the locations of song posts. I monitored birds for 90 minutes during these tracking episodes; tracking beyond five 90 minute sessions did not alter the perceived location of territory boundaries (Pierre 1999). As well as recording song posts, I monitored habitat use by birds, including substrates used for foraging and other activities, and heights of the forest that birds occupied (Pierre 1999). I also recorded prey identity when possible, and where prey were caught (Pierre 2000). Saddleback nests were located by following birds holding nesting materials, and by checking nest boxes. To avoid disturbing nesting birds, I did not check nests frequently after locating them. Instead, I monitored breeding activities indirectly by assessing the behaviour of adult birds (Pierre 1999).

I conducted analyses of habitat use and foraging data using paired t tests and analysis of variance (ANOVA) conducted in SPSS 8.0 (SPSS Inc. 1997). I used Games-Howell post-hoc tests (Day & Quinn 1989) to identify homogeneous subgroups after significant ANOVAs, and Bonferroni α adjustments when appropriate, including in G tests described below (Miller 1981). See Pierre (2001) for a discussion of how pseudoreplication and problems of independence were minimized.

I characterised vegetation using a transect-quadrat sampling method, and sampled both saddleback territories and one area uninhabited by saddlebacks (Pierre 2001). I defined plant availability as the cross-sectional area of each plant species at breast height, and the availability of dead wood as the proportion of total quadrat area it covered on each transect (Pierre 2001). Vegetation characteristics were compared between sites using G tests (Zar 1996).

RESULTS

After release, South Island Saddlebacks ranged widely through the forested areas of Motuara Island. By the start of the first post-release breeding season, both adult and subadult birds appeared to have settled on territories, which varied in size from 1.9–8.8 ha (X̄ = 4.21 ha, SD = 2.42, N = 6, Figure 2, Pierre 1999). Adult and subadult saddlebacks announced their presence vocally from a range of vertical locations in their territories, especially in the first two hours after dawn, and for approximately one hour just before dusk. However, confrontations between neighbours appeared very rare, and I observed only one during the study. This low frequency was despite saddlebacks venturing into each other’s territories, which I observed on five occasions during my research, and which at least sometimes appeared related to searches for water (Pierre 1999).

The vegetation composition of saddleback territories on Motuara Island differed significantly, and was different again in areas uninhabited by saddlebacks (G tests, vegetation composition in all territories compared to all other territories and a vegetated area not occupied by saddlebacks: G₈ > 2117.36, P < 0.005, Pierre 2001). However, all territories were in forest areas and included plants of similar size distributions (G tests: plant sizes in all territories compared to all other territories, G₅ ≤ 14, P > 0.005, NS). In contrast, saddlebacks did not inhabit a locality covered by smaller diameter plants, in this case scrub (G tests: all territories compared to an area uninhabited by saddle-
At least five, and possibly six pairs of saddlebacks were present during the first post-release breeding season on Motuara Island. Pairs were not knowingly transferred together, and after release at least some birds interacted with more than one potential mate before settling on a territory with what appeared to be a stable partner (Pierre 1999). Both adult birds and those in subadult plumage formed pairs and attempted breeding during the first post-release breeding season. Pairs were able to form and then initiate breeding with what appeared to be minimal delay; one pair built a nest and reared two offspring no more than 35 days after pairing. This pair then appeared to renest (Pierre 1999). The nests of two other pairs were found in a tree hole and a nest box, and held one and two eggs, respectively. However, these nests were deserted for unknown reasons. In all, an estimated 10 fledglings were hatched the first breeding season after saddlebacks were released onto Motuara Island (Pierre 1999; W.F. Cash pers. comm.).

Translocated saddlebacks utilised a range of foraging substrates, including various plant species, dead wood and the ground. Foraging patterns differed between males and females, with males spending the most foraging time on the ground, whereas females preferred to forage in five-finger (Pseudopanax arboreus) (ANOVA: F5,29 = 4.59, P = 0.003, Figure 3, Pierre 2001). Overall, birds apportioned their foraging time differently among different foraging substrates, and spent the most time foraging on the

Fig. 2. South Island Saddleback territory boundaries during 11 Nov 94–13 Jan 95, the first breeding season after release. Letters denote legband combinations: B = blue, G = green, M = metal, R = red, W = white, Y = yellow. (From Pierre 1999).

Fig. 3. Percent time spent on foraging sites (X ± 1 SE) by male (open bars) and female (hatched bars) South Island Saddlebacks on Motuara Island. Brarep = Brachyglossis repanda, Copluc = Coprosma lucida, Corlae = Corynocarpus laevisgatus, Dead = dead wood, Hedarb = Hedycriya arborea, Kuneri = Kanzea ericoides, Macexc = Macopiper excelsum, Melram = Melicytus ramifloris, Phcocoo = Phormium cookianum, Psearb = Pseudopanax arboreus. Numbers above bars represent the number of birds contributing to means. (From Pierre 2001).
South Island Saddleback reintroduction

ground and five-finger (ANOVA: $F_{5,29}=13.08$, $P<0.001$, Figure 3, Pierre 2001). However, birds used most plant species (and dead wood) in proportion to their availability (t tests: $t_{1,5}=-1.14–2.87$, $P=0.21–0.99$), except for five-finger (used more than expected, $t$ test: $t_6=2.74$, $P=0.03$). Flax ($Phormium cookianum$) may also have been used more than expected, although small sample size rendered this impossible to test statistically (Pierre 2001). The number of prey items South Island Saddlebacks obtained from foraging substrates was roughly in proportion to the amount of foraging time spent, although dead wood was a particularly rich foraging substrate. Saddlebacks were largely insectivorous, but also fed on nectar and honeydew (Pierre 2000).

Saddlebacks were recorded significantly more frequently in the lowest two metres of the forest than at any other level (ANOVA: $F_{4,30}=41.31$, $P<0.001$, Pierre 2001). This was the case for both males and females, whose vertical use of the forest did not appear to differ (ANOVA: $F_{4,30}=0.20$, $P=0.94$, however $1-\beta=0.16$ at $\alpha=0.1$, Pierre 2001).

Saddlebacks were observed drinking water frequently, both from natural sources and troughs constructed on the island before birds were released. They also bathed in these human-made water troughs frequently (Pierre 2000).

Mortality of South Island Saddlebacks was 35% (9/26 birds dead) at six months after release. Maximum mortality was 50% 8–10 months after release. Of the surviving 13/26 translocated saddlebacks, there were 3/7 adult males, 4/11 adult females and 6/7 subadults remaining (Pierre 1999).

**DISCUSSION**

After release on Motuara Island, South Island Saddlebacks traversed forested areas widely, before settling on territories after about eight months. Translocations of North Island Saddlebacks ($P. c. rufusater$) also result in wide post-release dispersal, suggesting that this is the norm for the species (Jenkins 1976; Armstrong & Craig 1995). South Island Saddlebacks settled on territories that were unusually large and variable in size. There is little data on territory size in saddlebacks, but on Cuvier Island (170ha), two pairs of North Island Saddlebacks held territories of 0.89 ha and 1.22 ha in November/December, the height of the breeding season. The smallest territory on Motuara Island was about 1.5–2 times this size, suggesting that the low density of saddlebacks on Motuara Island had strong effects on the area of territories. The size of North Island Saddleback territories has been recorded to change temporally, with territories being largest during breeding (O’Callaghan 1980).

South Island Saddlebacks on Motuara Island were much less vocal than North Island Saddlebacks occurring in higher density populations. However, temporal singing patterns appear similar for both subspecies (pers. obs.; Jenkins 1976; Murphy 1989). Territorial confrontations occurred rarely on Motuara Island, relative to North Island Saddleback populations (Jenkins 1976; O’Callaghan 1980). This is probably because saddleback territories on Motuara Island were sufficiently large that neighbours would seldom meet, and may have been out of earshot of each other often, if not most of the time. The utility and importance of song in maintaining territorial integrity might be expected to increase with increasing population densities, however Murphy (1989) showed that the number of neighbours around North Island Saddleback territories did not affect singing rates. The frequency of territorial displays, however, is known to increase with population densities in North Island Saddlebacks (Jenkins 1976; O’Callaghan 1980).

South Island Saddleback territories on Motuara Island were not areas of completely exclusive use by territory ‘owners’. This may not be unusual for the species. In a relatively high density population, O’Callaghan (1980) documented areas of overlap between North Island Saddleback territories, as well as subadults and non-territorial adults moving through the territories of others.

Vegetation composition of all saddleback territories differed on Motuara Island. Further, saddlebacks seemed to prefer areas with larger trees; all territories were at least partially forested, compared to uninhabited areas in which the dominant vegetation type was scrub. The species composition of forest however, did not seem important. Habitat characteristics, e.g. the availability of food, affect the size of North Island Saddleback territories (Blackburn 1964; O’Callaghan 1980). Despite this, South Island Saddleback territories were probably much larger than the area required to support a breeding pair (also see above) and as previously mentioned, the large size is almost certainly a product of low population density.

In low density North Island Saddleback populations, birds also preferentially occupy forest habitat. However, with increasing density, birds will colonise scrub areas, and can breed very successfully in this habitat type (Jenkins 1976; Craig 1994; B. Walter
pers. comm.). Thus, it is expected that as the South Island Saddleback population density increases on Motuara Island, birds will colonise scrub areas. On Tiritiri Matangi Island, the suitability of scrub may have been increased by the erection of roost and nest boxes (B. Walter pers. comm.). Thus, the addition of roost and nest boxes may enhance the suitability of scrub areas for saddlebacks on Motuara Island. In any case, the colonisation of scrub demonstrates the behavioural plasticity of saddlebacks. Both for saddlebacks and other organisms, behavioural plasticity can be an important factor increasing the success of translocations.

After release on Motuara Island, but before settling on a territory in a stable pair, some South Island Saddlebacks were observed with more than one bird of the opposite sex. This has also been reported in newly translocated North Island Saddleback populations (Armstrong & Craig 1995). Further, pairs of North Island Saddlebacks translocated together did not maintain their pair bond after release (Armstrong & Craig 1995). Also, similar to my results for South Island Saddlebacks, North Island Saddlebacks in low density populations are recorded breeding at one year old (Craig 1994). However, in high density populations, North Island Saddlebacks breed at two or more years of age (Lovegrove 1980). Further, South Island Saddlebacks were able to breed successfully with one pair taking a maximum of only 35 days between pairing and nest building. This pair fledged two chicks and probably renested in the first breeding season after translocation. Although there are no published records of the length of time taken from pairing to nesting, newly released North Island Saddlebacks have also been reported to raise more than one brood per breeding season (Jenkins 1976; Craig 1994; Armstrong & Craig 1995).

Like South Island Saddlebacks on Motuara Island, North Island Saddlebacks appear to be flexible in terms of foraging substrates they can use (Atkinson 1964, 1966; Lovegrove 1980). Male and female South Island Saddlebacks had slightly different foraging strategies in terms of substrate used and vertical location. Similarly, albeit at high density, North Island Saddleback males spent more time foraging on the ground than their female counterparts (Blackburn 1964; Lovegrove 1980; O’Callaghan 1980), however, whether there are intersexual differences in their foraging patterns at low density is unknown. Out of all plant species (including dead wood) that saddlebacks on Motuara Island foraged on, five-finger and possibly flax were used more than expected. Foraging selectivity of high or low density North Island Saddleback populations cannot be compared, due to lack of research. However, I expect that as population density increases, South Island Saddlebacks may use a wider spectrum of plants to increase the efficiency of foraging in smaller territories. Published data reporting relative richness of locations of prey capture are nonexistent for North Island Saddleback populations. However, as saddlebacks appear flexible with respect to foraging strategies and diet, these are expected to vary with habitat type as well as season, as are the importance of different foraging substrates and prey types (Atkinson 1964, 1966; Blackburn 1964, 1967; Lovegrove 1980, 1992; O’Callaghan 1980; Pierre 1995).

South Island Saddlebacks on Motuara Island foraged mostly in lower levels of the forest, like North Island Saddlebacks at high density (Lovegrove 1980; O’Callaghan 1980). However, high density populations of North Island Saddlebacks also display vertical stratification within pairs when foraging (Lovegrove 1980; O’Callaghan 1980). This may function to reduce intersexual competition within pairs, and improve the efficiency of resource use in territories. As increasing population density causes territory sizes to decrease on Motuara Island, birds may develop vertically stratified foraging behaviour. Coincident with this speculation, an increased degree of vertical stratification in North Island Saddleback foraging behaviour has been related to decreases in territory size (Lovegrove 1980).

Although the diet of saddlebacks contains some water, most of Motuara Island is very dry, and birds used both natural and human-constructed water sources frequently. That saddlebacks used water sources outside their own territories suggests a very strong need for water, and as predicted prior to the translocation, the instalment of water troughs may have increased the quality of saddleback habitat on Motuara Island, possibly increasing the likelihood of success of the translocation.

Mortality rate is one of the most important factors determining the size of founder groups, making it a key consideration when planning translocations. On Motuara Island, maximum mortality was 50% 8–10 months after saddlebacks were released. Published records of North Island Saddleback mortality range from 8% at six months to 52% at two years after release (Jenkins 1976; Armstrong & Craig 1995). Naturally, mortality will vary due to site-specific charac-
teristics as well as the ability of birds to deal with the stresses of capture and translocation, and their flexibility in adapting to new environments. Weather conditions after release and the abundance of natural predators are other important considerations.

In general, for a translocation into excellent quality habitat to have a 60% chance of success, the recommended size of the founder group is fifty individuals (Griffith et al. 1989). Only 26 South Island Saddlebacks were released onto Motuara Island, but in the past, translocations of 15–59 South Island Saddlebacks have been successful (Nillson 1978; Roberts 1991). Thus, from the outset, the success of the transfer to Motuara Island may not have been jeopardized by the relatively small founder group. In combination with the predator-free environment of Motuara Island, the saddlebacks’ flexible habitat requirements and foraging strategies, ability to readily adapt to ‘new’ habitats, and potential for high reproductive output increased the likelihood that translocations to this island would be successful.

In the eight years since translocation, estimates of the number of saddlebacks Motuara Island can support have ranged from about 70 (in years of cold, wet climatic conditions, when breeding success is low) to 150–200 (in the first years after release, with high reproductive output, an abundance of prey and favourable climate) (Pierre 1995; W. F. Cash pers. comm.). Social organisation, survival, foraging ecology and diet have not been investigated in detail since my work was completed. However, due to the success of this translocation over the first eight years at least, the Motuara Island population is now being used as a source population for other South Island Saddleback translocations.

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