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Foraging behaviour and diet of a reintroduced population of the South Island saddleback *(Philesturnus carunculatus carunculatus)*

JOHANNA P. PIERRE
Department of Zoology, University of Canterbury, Private Bag 4800, Christchurch, New Zealand[1]
jpierre@gpu.srv.ualberta.ca

[1]Present address: Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2E9

Abstract The South Island saddleback (*Philesturnus carunculatus carunculatus*) is one of two subspecies of the New Zealand saddleback. Despite the endangered status of this subspecies, it was not studied in detail until 1994, when 26 birds were released onto Motuara Island in the Marlborough Sounds of New Zealand. I report the foraging behaviour and diet of this reintroduced population during the first breeding season after release. South Island saddlebacks used their bills in a variety of ways when foraging, and were predominantly insectivorous. They obtained most food from the ground and five-finger (*Pseudopanax arboreus*), and the number of prey captured generally reflected the amount of time saddlebacks spent on foraging substrates. North and South Island saddlebacks are very similar in terms of foraging behaviour, prey handling techniques and types of invertebrate prey consumed. The foraging patterns and diet of South Island saddlebacks on Motuara Island differed from all potential competitors. I conclude that the success of the South Island saddleback transfer to Motuara Island should not be threatened by a lack of food or foraging opportunities.

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INTRODUCTION

The South Island saddleback (*Philesturnus carunculatus carunculatus*) is a medium-sized endemic forest passerine, and one of two subspecies of the New Zealand saddleback. The saddleback was formerly widespread on both the main and offshore islands of New Zealand (Oliver 1955; Atkinson 1973). However, by 1900, the saddleback was virtually extinct on the main islands, due to the introduction of mammalian predators (Reischek 1887; Buller 1905; Oliver 1955; Merton 1973, 1975; Lovegrove 1992). The North Island subspecies survived on Hen Island, while the South Island form persisted on three small islands off the southern tip of Stewart Island.

Although anecdotal accounts of saddleback behaviour and ecology have been published (e.g., Guthrie-Smith 1925), the species was not studied scientifically until the 1960s, when the North Island saddleback's ecological niche was examined on Hen Island (Blackburn 1964, 1967; Kendrick 1964; Atkinson 1966; Atkinson & Campbell 1966; Merton 1966). This work was undertaken because transfers of North Island saddlebacks were planned, and managers wanted to maximise the success of these by minimising the chance of reintroducing saddlebacks to islands with inappropriate habitat (Atkinson 1964). Several detailed investigations followed this early work (e.g., Jenkins 1976, 1978; Lovegrove 1980, 1992, 1996; O'Callaghan 1980). To date, North Island saddlebacks have been transferred to 13 islands, and transfers to 10 of these islands have been successful (Lovegrove 1996; T. G. Lovegrove pers. comm.). As a result of these successful translocations, the conservation status of the North Island saddleback has been downgraded from endangered to rare (King 1979; Bell 1986).

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However, despite relatively extensive work on the North Island saddleback, and one emergency transfer which saved the South Island saddleback from almost certain extinction (Atkinson & Bell 1973; Merton 1973; Bell 1978), the South Island subspecies has never been studied in detail. The lack of research on the South Island saddleback is probably largely due to the remoteness of islands it inhabits. This subspecies is currently the focus of a Department of Conservation Recovery Plan, which includes the long term goal of reducing its conservation status from endangered to rare. This change in status is to be achieved through transfers to predator-free islands (Roberts 1991). To date, South Island saddlebacks have been transferred to 13 islands, and they have become established on 10 of these (Lovegrove 1996, pers. comm.; W.F. Cash pers. comm.).

In March 1994, 26 South Island saddlebacks were transferred from the Titi Islands near Stewart Island, to Motuara Island in the Marlborough Sounds of New Zealand. The translocated group consisted of 7 adult males, 11 adult females, 5 subadult males, one subadult female, and one adult and subadult whose sexes were not determined (W.F. Cash pers. comm.; pers. obs.). A minimum of 50% of the transferred group survived 8-10 months after release (Pierre 1999). The vegetation on Motuara Island has been regenerating since 1926, when farming ceased (W.F. Cash pers. comm.). The island is mostly forest-covered, and has a dense band of coastal scrub (Pierre 1995). The South Island saddleback transfer to Motuara Island was the first transfer of this subspecies to a relatively accessible island, and thus provided a unique opportunity for detailed study. Also, collection of ecological and other data was considered extremely important to help maximise the likelihood of success of future translocations (Sarrazin & Barbault 1996; Wolf *et al.* 1996). In this paper, I report the foraging behaviour and diet of the newly-released population of South Island saddlebacks on Motuara Island during the first breeding season after release.

METHODS

Transferred South Island saddlebacks were fitted with unique combinations of coloured plastic leg bands to allow individual identification after release on Motuara Island. The sexes of captured birds were estimated using weight and bill measurements (W.F. Cash pers. comm.; Nilsson 1978; Jenkins & Veitch 1991), and age was determined using plumage characteristics. [South Island saddlebacks have a distinct subadult plumage, and usually acquire full adult plumage by 16 months of age (Guthrie-Smith 1925; Oliver 1955; Nilsson 1978)]. I considered saddlebacks to be adults if they were paired, or actively defending a territory. My study took place from November 1994 to January 1995, during the first breeding season after South Island saddlebacks were released on Motuara Island.

I recorded foraging behaviour and diet of three adult male and four adult female saddlebacks. All birds were paired, except one male that was never seen with a female, but was actively defending a territory. I visited study territories at variable times between 0630-2100, on alternate days. I located saddlebacks by creating a loud disturbance, e.g., breaking dead logs, to which saddlebacks responded by calling, singing, or approaching. I stopped creating a disturbance as soon as I located a saddleback. I then identified the bird from its coloured leg bands, and continuously recorded the bird's activities, and the substrates activities occurred on (ground, dead wood, plant species, and live or dead leaves), for a maximum of 90 minutes. I recorded all observations on a portable cassette recorder and timed observations from the recorded tape using a stopwatch.

I used Wilcoxon signed-rank tests and the Kruskal-Wallis test (analysis of variance on ranked data) to analyse data (Zar 1996). I conducted Kruskal-Wallis analysis in SPSS 7.5 (SPSS Inc. 1996). I used means from data for each bird during the entire study in statistical tests, thereby avoiding pseudoreplication (Hurlbert 1984). I rejected null hypotheses at $P<0.1$ to offset reduced statistical power caused by small sample sizes (Underwood 1997).

RESULTS

South Island saddlebacks used a variety of different foraging techniques. On the ground, they foraged in leaf litter by tossing leaves aside with the bill. They dug into the earth and broke up dead wood using the bill in a woodpecker-like action, forcefully striking surfaces with the bill closed. Saddlebacks also foraged with their bills closed, lightly gleaning a variety of substrates such as tree bark, and probed in holes in trees and under bark. They removed strips of bark from trees such as kanuka (*Kunzea ericoides*) using their bill and body weight to strip the bark from the branches. Saddlebacks also scraped bark vertically with the bill open, and broke open small dead twigs by inserting the closed bill into the ends of twigs then forcefully opening it. They also used one

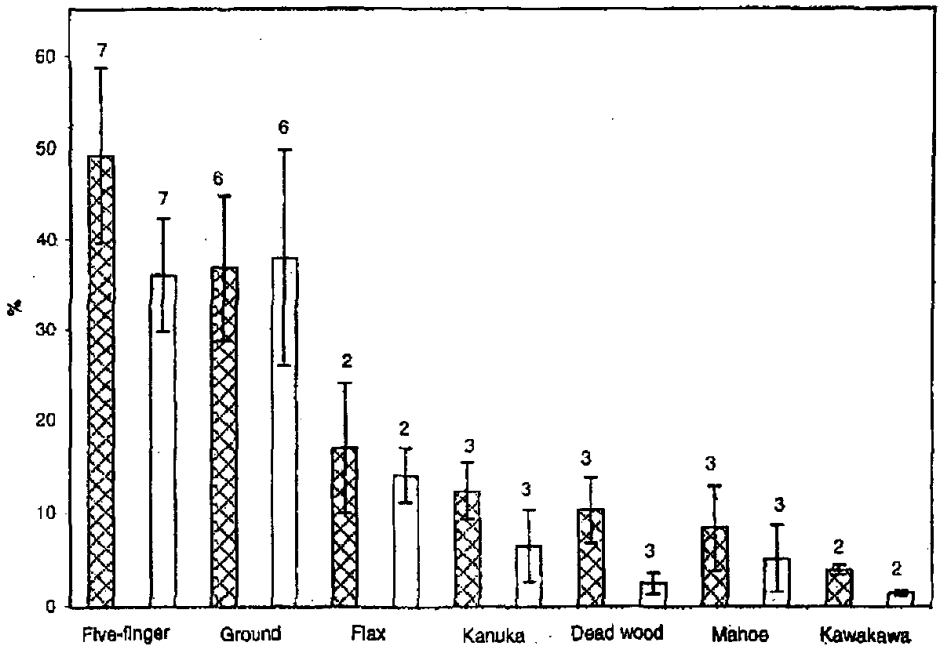

Fig. 1 Prey captured ($\bar{x}$ % ± 1 SE, hatched bars) and time spent ($\bar{x}$ % ± 1 SE, open bars) by South Island saddlebacks on different foraging substrates on Motuara Island. (Numbers above bars represent the number of birds contributing to each mean).

Table 1 Food sources ($\bar{x}$ % of number of prey items found ±1 SE) of three male and three female South Island saddlebacks on Motuara Island.

Prey source	Male	Female
Ground	44.4 ± 15.7	21.0 ± 7.7
Five-finger	30.4 ± 9.2	56.5 + 9.3
Flax	4.0 ± 0	10.0 ± 0
Kanuka	17.4 ± 0	9.9 ± 3.2
Mahoe	17.4 ± 0	3.8 ± 0.5
Dead wood	4 ± 0	13.3 ± 3.3
Kawakawa	4.4 ± 0	3.3 ± 0
Coprosma lucida	4.3 ± 0	0

Table 2 Diet composition of South Island saddlebacks on Motuara Island (percent of diet based on number of items).

Prey type	Male (36 items)	Female (30 items)
Weta	25.0	13.3
Scale insect	19.4	16.7
Invertebrate egg sac	5.6	13.3
Cockroach	0	3.3
Caterpillar	0	3.3
Spider	0	3.3
Scale insect or honeydew	8.3	0
Unidentified invertebrate	8.3	30.0
Flax nectar	16.7	10.0
Honeydew	5.6	3.3
Five-finger fruit	11.1	3.3

mandible alone to probe into the ends of twigs. When foraging in foliage, birds explored the leaves with the tip of the bill, scraped sideways with one mandible, or held leaf clusters down with one or both feet before examining leaf surfaces. Saddlebacks also foraged under small rocks on the forest floor, after placing the bill underneath rocks and pushing them aside.

On Motuara Island, South Island saddlebacks obtained most food from the ground and five-finger (*Pseudopanax arboreus*) (Table 1). Different foraging substrates provided saddlebacks with significantly different numbers of prey (Kruskal-Wallis test: $F_{4,15}$=8.16, P=0.003). The number of food items obtained roughly reflected the amount of time saddlebacks spent foraging on different substrates, although dead wood was a relatively rich foraging substrate (Fig. 1). Saddlebacks obtained more prey items from live plant materials than dead (prey obtained from live plant material: $\bar{x}$=81.6%, SE$\bar{x}$=7.4; prey obtained from dead plant material: $\bar{x}$=18.4%, SE$\bar{x}$=7.4; Wilcoxon signed-rank test: T_5=15, P<0.1), and from wood than leaves (prey obtained from wood substrates: $\bar{x}$=65.2%, SE$\bar{x}$=9.3; prey obtained from leaf substrates: $\bar{x}$=34.8%, SE$\bar{x}$=9.3; Wilcoxon signed-rank test: T_5=13, P<0.1).

Saddlebacks predominantly ate invertebrates, and occasionally fed on honeydew, flax (*Phormium cookianum*) nectar and five-finger fruits (Table 2). They picked scale insects (*Ctenochiton* sp.) off leaf surfaces with their bills, and licked honeydew off leaf surfaces while securing leaf bunches with a foot, parrot-fashion. Birds consumed large wetas (*Hemiandrus similis*, *Hemideina crassidens*, Moeed & Meeds 1981), holding them upside down by placing a foot on the weta's head and thorax then eating the abdomen. The head and thorax were later discarded. Sometimes saddlebacks ate some or all of the wetas' legs, particularly when smaller wetas

were captured. Wetas up to c. 6 cm long were captured and eaten.

South Island saddlebacks on Motuara Island foraged in some of the same locations as bellbirds (*Anthornis melanura*) and New Zealand robins (*Petroica australis*), as well as the introduced blackbird (*Turdus merula*). Bellbirds fed extensively on flax nectar and also ate honeydew and some invertebrates. They tended to focus their foraging in the upper levels of the forest. Robins fed on invertebrates, predominantly on the ground and in the lower levels of the forest. Blackbirds also foraged on the ground, but did not seem to dig into the earth as deeply as saddlebacks did.

DISCUSSION

The foraging techniques of South Island saddlebacks appeared to be much the same as those described for the North Island subspecies. Like the South Island subspecies, North Island saddlebacks probe for food under bark, in tree holes and in dead wood (Atkinson 1964; Blackburn 1964; Atkinson & Campbell 1966; Lovegrove 1980). Both subspecies share the woodpecker-like chiselling behaviour, and both use one mandible like a skewer, inserting it into twigs and holes too small for both mandibles (Atkinson 1964; Blackburn 1964; Lovegrove 1980; O'Callaghan 1980). North Island saddlebacks also insert their closed bills into twigs and forcefully open them when foraging (Blackburn 1964; Jenkins 1976; Lovegrove 1980). Both North and South Island saddlebacks forage by tossing leaf litter aside on the forest floor (Atkinson 1964; Blackburn 1964; Atkinson & Campbell 1966; Jenkins 1976; Lovegrove 1980; O'Callaghan 1980), and digging in the ground (Atkinson 1964, 1966; Atkinson & Campbell 1966; Lovegrove 1980). Like their South Island counterparts, North Island saddlebacks forage among leaves, examining them with the bill whilst holding them down with one foot (Blackburn 1964, 1967; Atkinson 1966; Lovegrove 1980; O'Callaghan 1980).

South Island saddlebacks on Motuara Island obtained most prey from five-finger and the ground. Studies of North Island saddlebacks do not report the amount of prey caught in different foraging locations, and as saddlebacks of both subspecies are flexible in their use of different foraging substrates (Atkinson 1964, 1966; Blackburn 1964, 1967; Lovegrove 1980, 1992; Pierre 1995), prey capture locations are expected to vary with habitat type. However, invertebrate prey consumed by North and South Island saddlebacks appears similar (Atkinson 1964; Atkinson & Campbell 1966; Merton 1966; Jenkins 1976; Lovegrove 1980). North Island saddlebacks have been reported taking a wider variety of fruit and nectar than South Island saddlebacks on Motuara Island. Few trees were in flower or fruit during my study period and I saw birds consume five-finger fruits only. Karaka (*Corynocarpus laevigatus*) and kohekohe (*Dysoxylum spectabile*) fruits were abundant but not ripe. In season, the South Island saddlebacks on Motuara Island may consume fruits of *Coprosma* sp., karaka, kawakawa (*Macropiper excelsum*), kohekohe, mahoe (*Melicytus ramifloris*), mapou (*Myrsine australis*), wharangi (*Melicope ternata*) and pate (*Schefflera digitata*). The fruits of these species are consumed by North Island saddlebacks (Atkinson 1966; Merton 1966; O'Callaghan 1980; Lovegrove 1992). Reischek (1887) reported that North Island saddlebacks fed on flax nectar. On Motuara Island, all South Island saddlebacks studied fed on flax nectar, but they were not observed taking nectar from other plants. North Island saddlebacks consume nectar from a number of species including *Clematis* sp., five-finger, kohekohe, pohutukawa (*Metrosideros excelsa*) and puriri (*Vitex lucens*) (Atkinson 1964, 1966; Atkinson & Campbell 1966; Lovegrove 1992). The composition of the North Island saddleback diet varies between locations, and seasonally (Atkinson 1964, 1966; Merton 1966; Lovegrove 1980, 1992; O'Callaghan 1980). Thus, the diet of South Island saddlebacks is expected to vary also. Prey are probably processed prior to ingestion in similar ways for both saddleback subspecies (e.g., Merton 1966; Lovegrove 1980).

The bellbird, robin and introduced blackbird are all potential competitors of the South Island saddleback on Motuara Island. All these species feed on invertebrates, at least in part, and the bellbird also consumes nectar. Although the bellbird and robin forage from some of the same substrates as the saddleback, robins are considerably smaller than saddlebacks, thus it is assumed they take smaller prey. Bellbirds were never seen foraging on the ground, tending to occupy upper levels of the forest, whereas saddlebacks preferred lower levels. Blackbirds foraged on the ground on Motuara Island but did not appear to probe as deeply as saddlebacks when foraging. Thus, saddleback foraging strategies appear to differ in some way from all potential competitors on Motuara Island. Atkinson & Campbell (1966) concluded that the saddleback was more suited than any other native New

Zealand animal to foraging on invertebrates living under bark or in holes and fissures. Thus, it appears that interspecific competition should not affect the success of the South Island saddleback translocation to Motuara Island.

When I conducted my study, South Island saddlebacks had only been present on Motuara Island for 8-10 months. Before their reintroduction, saddlebacks had not occurred on Motuara Island for at least 70 years (W.F. Cash pers. comm.). Therefore, during my study, the food supply being exploited by South Island saddlebacks may have been especially abundant. Also, the abundance of some prey items, e.g., large wetas, may decrease the longer saddlebacks are present on the island, which may in turn alter the composition of the saddleback diet. However, similarities between North and South Island saddleback foraging behaviour and diet, and the high success rate of previous translocations of both subspecies, suggest that the new South Island saddleback population on Motuara Island should not be threatened by a lack of food or foraging opportunities.

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