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The distribution and current status of New Zealand Saddleback *Philesturnus carunculatus*

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Summary

This paper reviews and updates the distribution and status of two geographically distinct subspecies of New Zealand Saddleback *Philesturnus carunculatus*, a New Zealand forest passerine that is highly susceptible to predation by introduced mammals such as stoats and rats. The recovery of the North Island and South Island saddleback populations has been rapid since translocations to offshore islands free of exotic predators began in 1964, when both subspecies were on the brink of extinction. South Island saddlebacks have gone from a remnant population of 36 birds on one island to over 1,200 birds spread among 15 island populations, with the present capacity to increase to a maximum of 2,500 birds. We recommend that South Island saddleback be listed under the IUCN category of Near Threatened, although vigilance on islands for invading predators and their subsequent rapid eradication is still required. North Island saddlebacks have gone from a remnant population of 500 birds on one island to over 6,000 on 12 islands with the capacity to increase to over 19,000 individuals. We recommend that this subspecies be downgraded to the IUCN category of Least Concern. The factors that limited the early recovery of saddlebacks are now of less significance with recent advances in predator eradication techniques allowing translocations to large islands that were formerly unsuitable. The only two predators that still cohabit some islands with saddleback are Pacific rats or kiore *Rattus exulans* and Weka *Gallirallus australis*, a flightless native rail. Although North Island saddlebacks coexist with kiore, South Island saddlebacks do less well in their presence, possibly because the relict population had no previous history with this species of rat. The impact of Weka as predators of saddlebacks is less clear, but population growth rates appear to be slowed in their presence. It is recommended that while current recovery strategies involving island habitat restoration and translocations be maintained, management effort should also be directed towards returning saddlebacks to selected, ''mainland island'' sites, where introduced pests are either excluded by predator-proof fences or controlled at very low levels by intensive pest management.

Introduction

New Zealand Saddleback *Philesturnus carunculatus* is a medium-sized (*c.* 25 cm, bill–tail) forest passerine and a member of the endemic New Zealand wattlebird family *Callaeidae*, which has two other known members, the endangered Kokako *Callaeas cinerea* and the extinct Huia *Heteralocha acutirostris*. Saddlebacks have two distinct geographical subspecies: *Philesturnus carunculatus rufusater* in the North

Island and *P. c. carunculatus* in the South Island. However, Holdaway *et al.* (2001) and Worthy *et al.* (in press) have recently argued the subspecies should be elevated to full species. For the purposes of this paper, we refer to the North and South Island saddlebacks as subspecies, but treat them as separate taxonomic entities.

Saddlebacks were formerly widespread throughout the North, South and Stewart Islands as well as many islands within 50 km of the New Zealand mainland (Oliver 1955, Williams 1976, Lovegrove 1992, Hooson 2000). Observations of early naturalists confirm that saddlebacks were still relatively common throughout New Zealand at the time of European settlement (Buller 1882). However, the species declined rapidly due mainly to its inability to coexist with introduced mammalian predators, particularly rats (Oliver 1955, Atkinson 1973, Merton 1975, Lovegrove 1992, 1996a, Roberts 1994, Hooson 2000). By the late 1880s, its range was greatly diminished, and it was ''extremely rare'' and ''very irregular in its distribution'' (Buller 1888). It was virtually extinct in the North Island by 1890 and in the South Island by 1905 (Merton 1975, Williams 1976).

North Island saddlebacks survived only on Hen Island (484 ha) off the east coast of Northland, and South Island saddlebacks became confined to Big South Cape Island (939 ha) and two adjacent islets, Pukeweka (2 ha) and Solomon (25 ha), situated south-west of Stewart Island (Figure 1) (Merton 1975, Roberts 1994). In August 1962, rats invaded the Big South Cape Island group, and quickly reached plague proportions. Six bird species including the South Island saddleback were exterminated (Atkinson and Bell 1973, Merton 1975, Bell 1978). Fortunately, the prompt action of the New Zealand Wildlife Service (now Department of Conservation) allowed for the capture and transfer of 36 saddlebacks to the nearby rodent-free Kaimohu (15 birds) and Big Islands (21 birds) (Figure 1) in 1964. This saved the South Island saddleback from certain extinction (Merton 1975). Subsequently there have been a number of transfers of South Island saddlebacks derived from the surviving pairs on Kaimohu and Big Islands, resulting in new populations on 15 southern islands. Likewise, translocations since the mid-1960s have successfully established North Island saddlebacks on 12 northern islands (see Merton 1975 and Nilsson 1978 for reviews of the early conservation management of the saddleback).

In the early 1990s, there were an estimated 650 South Island saddlebacks (Roberts 1994) and *c.* 4,800 North Island saddlebacks (Lovegrove 1996b). Although the *IUCN Red List of Threatened Animals* lists the saddleback as ''Lower Risk – near threatened'' (IUCN 2002: ver 2.3, 1994), the last formal assessment of the status of the two separate subspecies by Bell (1986) classified the North Island saddleback as ''rare'', and the South Island saddleback as ''endangered''. The status of the South Island saddleback prompted publication of its first recovery plan, and based on island habitat restoration and a series of island translocations, it was anticipated that the South Island saddleback's conservation status could be improved from ''endangered'' to ''rare'' by 2020 (Roberts 1994). The New Zealand Department of Conservation's most recent assessment lists the North and South Island saddleback as a ''threatened'' species (Molloy and Davis 1994).

A review of the recovery plan is due every five years, but so far none has been undertaken. Lovegrove (1996b) provided the most recent update of the distribution and status of saddlebacks using census data from up to 1994, although the main focus of the paper was to identify the causes of translocation successes and

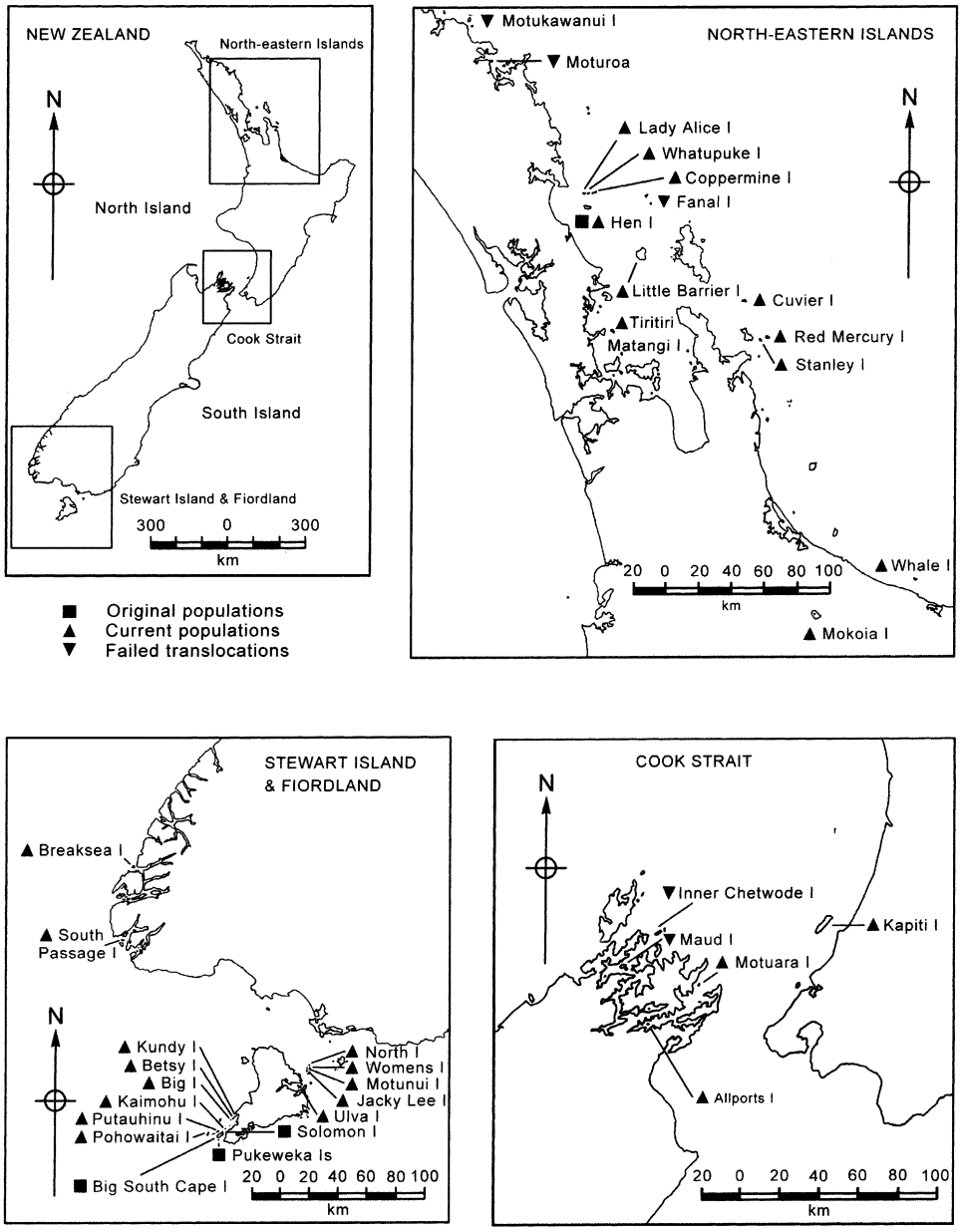

Figure 1. Island locations of saddleback populations in New Zealand's North Island, South Island and islands adjacent to Stewart Island.

failures. Since then North and South Island saddlebacks have been transferred to two and three new islands, respectively. Given the need for a review of the recovery plan and an update on the status of New Zealand Saddleback, the objectives of this paper are: (1) to review the current status of individual island populations and the overall status of North and South Island saddlebacks; (2) to

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present their current geographical distributions; and (3) to identify populations for which information is now obsolete. On the basis of the updated information, this paper evaluates the success of current conservation management strategies, identifies beneficial and detrimental factors affecting recovery, and provides an updated assessment of the conservation status for North and South Island saddlebacks. Additional recommendations for management are also provided.

Natural history

While several aspects of New Zealand Saddleback's natural history make the species highly vulnerable to introduced mammalian predators, other aspects facilitate conservation management, as noted below. Saddlebacks appear to be most susceptible to predation by stoats *Mustela erminea*, ship rats *Rattus rattus*, and Norway rats *R. norvegicus*, but the Pacific rat or kiore *R. exulans* and Weka *Gallirallus australis*, a large flightless native rail, are also known predators (Lovegrove 1996b). Unlike stoats, ship rats and Norway rats, which have swum to offshore islands or have been accidentally introduced (in the case of the rats), Weka and kiore were originally introduced to many of New Zealand's offshore islands by Máori as a potential food source.

Saddlebacks are diurnal, long-lived (up to 20 years), monogamous and omnivorous, often foraging in pairs or family groups on or near the ground (Merton 1975, Jenkins 1978, Lovegrove and O'Callaghan 1982), behaviour that increases their vulnerability to predators. Although primarily insectivorous, they also eat fruit and nectar when available (Atkinson 1964, 1966, Merton 1966, Blackburn 1967, Pierre 1995, 1999). This generalist feeding ecology allows New Zealand Saddlebacks to survive in a broad range of habitats from coastal scrub to tall forest, and small territory sizes (*c.* 0.4 ha) result in dense populations on small islands (Lovegrove 1996b). Roosts and nests are often within 2 m of the ground in natural cavities, which significantly increases their susceptibility to introduced mammalian predators and Weka (Lovegrove 1996b), although they will readily nest and roost in purpose-built boxes designed to exclude predators (Lovegrove 1992). Saddleback reproductive rates are relatively low, but appear to be density dependent (Davidson 1999, Armstrong *et al.* 2002). In high-density populations, one clutch of two eggs (range 1–4) is laid between October and late December (Heather and Robertson 1996). However, in low-density populations following translocation, the breeding season is normally extended and up to four clutches of four eggs can be successfully raised between August and May (Craig 1994). Where there are no significant predators, this allows populations to increase rapidly. Saddlebacks fly poorly, which may increase their susceptibility to predation, and also limits their dispersal from ''refuge'' islands to which they have been translocated. They are often noisy and inquisitive and show little in the way of adaptations to recognize and avoid introduced mammalian predators. However, these features, and the fact that they are highly conspicuous and tame, facilitates monitoring and research. For further summaries of saddleback natural history see Robertson (1985) and Heather and Robertson (1996).

Present distribution and status

A search of the scientific literature and the New Zealand Department of Conservation's internal (unpublished) reports was carried out and information on the

distribution and status of saddleback populations was collated. Department of Conservation staff and researchers with previous and ongoing experience of saddlebacks were also contacted for information on local populations and the results of population surveys.

By 2002, North and South Island saddlebacks numbered *c.* 6,630 and *c.* 1,265, respectively. There were 12 populations of between *c.* 60 and *c.* 2,500 North Island saddlebacks on islands ranging in size from 80 to 3,083 ha (Table 1), and 15 populations of between 5 and 400 South Island saddlebacks on islands ranging in size from 6 to 270 ha (Table 2). The majority of these are small, exposed islands near Stewart Island (Figure 1). Since 1992, translocations have also established populations on Motuara, Allports (Marlborough Sounds), Breaksea and South Passage (Fiordland) islands off the South Island mainland. Translocations to Pohowaitai (1999) and Ulva (2000) Islands near Stewart Island have also established new populations (Figure 1). Since only four of the southern islands exceed 100 ha (Table 2), the combined total land area of islands supporting saddlebacks (1,034 ha) is small compared with that of the North Island populations (6,839 ha).

As a consequence of many translocations, both North and South Island saddleback populations have recovered rapidly since 1965, although overall recovery was slower for South Island saddleback mainly because a smaller source population was available and the recipient islands had much smaller areas of suitable habitat (Figure 2). For example, although the total area inhabited by South Island saddlebacks in 1965 and 1970 was over 200 ha (Figure 2), two failed (as a result of the combined predatory effects of Weka and kiore, see below) translocation attempts to Inner Chetwode Island (195 ha) meant that the total area was substantially reduced. Between 1975 and 1980, South Island saddlebacks were transferred to North (8 ha), Womens (8 ha), Kundy (19 ha), and Putauhinu (140 ha) islands, increasing the number of populations but only marginally increasing the total area inhabited. In 1980, South Island saddlebacks were translocated to the relatively large island of Maud (309 ha), but this failed when stoats invaded (Bell 1983). Growth of the South Island saddleback population has been most rapid since 1985 (Figure 2), as new translocations to eight islands have increased the number of populations and extended the available land area from 264 ha to 1,034 ha.

Like South Island saddleback, North Island saddleback population growth rates were initially slow (Figure 2). Following the first successful translocation from Hen to Whatupuke Island (102 ha) in 1964, the range was subsequently expanded between 1968 and 1978 by translocations to Red Mercury (225 ha), Cuvier (170 ha), Lady Alice (155 ha), Stanley (100 ha) and Fanal (75 ha) islands (Figure 1, Table 1), although the latter transfer failed for unknown reasons (Lovegrove 1996b). Further significant increases in the population became possible after 1984 following successful transfers to Little Barrier (3,083 ha), Tiritiri Matangi (197 ha) and Mokoia (135 ha) islands, the latter representing the first transfer to an island within a lake in the central North Island (Figure 1). Two attempts (1983 and 1984) to establish North Island saddlebacks on Motukawanui Island (380 ha) were unsuccessful after stoats invaded, and a second translocation to Fanal Island (1985) failed for unknown reasons (Lovegrove 1996b). Repeated translocations to Kapiti Island between 1981 and 1989 were compromised by the presence of several introduced predators including Norway rats, kiore, brushtail

Table 1. Summary of the status of North Island saddleback *Philesturnus carunculatus rufusater* populations.

Island	Size (ha)	Predators	Number released (year)	Census(es) (year)	References
Hen[a]	484	K	Original population	300 (1925)	Blackburn (1968)
				400[b] (1939)	Blackburn (1968)
				560[b] (1968)	Blackburn (1968)
				490 (1986)	Lovegrove (1986)
				500 (2000)	Anon., unpubl. data
Coppermine	80	K	Naturally colonized	20[b] (1979)	Newman (1980)
Cuvier[a]	170	K	29 (1968)	1000[c] (1988)	Lovegrove (1996[b])
Fanal	75	K	25 (1968)	3 (1973)	Lovegrove (1996[b])
			29 (1985)	5 (1987)	Lovegrove (1996[b])
Kapiti	1965	C,N,K,P,W	9 (1925)	Extinct by 1931	Wilkinson and Wilkinson (1952)
		N,K,P,W	25 (1981)		
			50 (1981)		
			25 (1981)		
			22 (1982)		
			50 (1982)		
			22 (1982)		
			50 (1983)	4 (1986)	Lovegrove pers. comm.
		N,K,W	43 (1987)		
			39 (1988)	38 (1991)	Lovegrove pers. comm.
			40 (1989)		
		W		41 (1997)	Lovegrove pers. comm.
				65 (1998)	Lovegrove pers. comm.
				97 (2000)	S. Rowe, from Lovegrove pers. comm.
Lady Alice[a]	155	K	6 (1950)	3 (1953)	Chambers *et al.* (1955)
			21 (1971)	300[c] (1986)	Lovegrove (1996[b])
Little Barrier	3083	C,K	9 (1925)	Disappeared quickly	Turbott (1947)
		K	50 (1984)		
			42 (1986)		
			47 (1987)		
			49 (1988)	1500[c] (1995)	Lovegrove (1996[b])
				2500 (2000)	Anon., unpubl. data
Mokoia[a]	135	M,W	36 (1992)	140 (1994)	Lovegrove (1996[b])
				200 (1999)	Owen and Blick (2000)
Motukawanui	380	S,K	16 (1983)		
			12 (1984)	Extinct by 1986	Lovegrove (1996[b])
Moturoa	150	S	26 (1997)	Extinct by 1999	P. Asquith pers. comm.
Red Mercury	225	K	29 (1966)	400[c] (1996)	Lovegrove (1996[b])
Stanley[a]	100	K	24 (1977)	250 (1986–89)	Lovegrove (1996[b])

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Table 1. *Continued.*

Island	Size (ha)	Predators	Number released (year)	Census(es) (year)	References
Tiritiri Matangi[a]	197	K	24 (1984)	200 (1991)	Craig (1990)
		Nil		500 (1997)	B. Walters pers. comm.
				600 (2002)	B. Walters pers. comm.
Whale	143	Nil	40 (1999)	22+ (2000)	Brunton (2000)
				60 (2001)	K. Owen pers. comm.
Whatupuke[a]	102	K	23 (1964)	90–120 (1967)	Blackburn (1968)
		Nil		500[c] (1996)	Lovegrove (1996[b])

[a] Source island for transfers
[b] Census figures based on numbers of pairs but have been converted to number of individuals.
[c] Figures from Lovegrove's (1996[b]) estimates are based on transect counts (Cuvier), time since release (Little Barrier) or island area and habitat quality (all other islands).
K, kiore; C, feral cat; N, Norway rat; P, brushtail possum; W, Weka; M, mice; S, stoat.

possums *Trichosurus vulpecula*, as well as Weka (Lovegrove 1996a, b). Finally, a recent attempt to establish North Island saddlebacks on Moturoa Island (1997) failed after stoats reinvaded the island (P. Asquith pers. comm.).

With the exception of Cuvier, Lady Alice, Stanley and Whatupuke islands, whose populations were last estimated between 1986 and 1989 (Lovegrove 1996b), there have been population size estimates or surveys of saddlebacks on all the northern islands since 2000 (Table 1). These indicated that the largest North Island saddleback population is on Little Barrier Island (*c.* 2,500 birds), with Cuvier (*c.* 1,000) and Tiritiri Matangi (600) islands supporting substantial populations, and Lady Alice, Whatupuke, Hen, Red Mercury and Stanley islands holding intermediate sized populations of 250–500 birds. Smaller populations exist on Whale, Mokoia, and Kapiti islands, but all three are increasing (Table 1). South Island saddleback populations are small in comparison, with only four (Big, Breaksea, Kundy and Putauhinu) exceeding 200 birds. Several of the smaller island populations in the vicinity of Steward Island (Jacky Lee, Kaimohu, Motunui, North and Womens) have not been surveyed since 1991 to 1997 (Table 2).

By calculating the density of saddlebacks in well-established island populations that were assumed to have reached their carrying capacity, we estimated that saddlebacks required 0.36 ha/bird. This figure was extrapolated to island populations thought to be below carrying capacity, to find an estimated maximum population size for each island, assuming all available habitat is occupied. Without further translocations, the estimated maximum population sizes for North and South Island saddlebacks in their present range are approximately 18,970 and 2,760 birds, respectively.

Many of the smaller North Island saddleback populations have already reached their theoretical carrying capacity, but two of the larger islands, Little Barrier (6,050 birds) and Kapiti (5,350) can support significant population expansion (Figure 3a). Within their present range, South Island saddlebacks have also reached carrying capacity on several small islands, whilst Ulva Island and South Passage Island have the capacity to support further growth (Figure 3B).

Table 2. Summary of the status of South Island saddleback *Philesturnus carunculatus carunculatus* populations.

Island	Size (ha)	Predators	Number released (year)	Census(es) (year)	References
Allports	15	Nil	12 (1999)	8 (2000)	W. Cash pers. comm.
				5 (2001)	W. Cash pers. comm.
Betsy[a]	6	Nil	16 (1969)	12 (1976)	Nilsson (1978)
				14 (2001)	P. McClelland pers. comm.
Big[a]	23	Nil	21 (1964)	18 (1965)	Blackburn (1965)
				77 (1972)	Nilsson (1978)
				63 (1974)	Nilsson (1978)
				81 (1976)	Nilsson (1978)
				79 (1978)	Nilsson (1978)
				50 (1978)	Nilsson (1978)
				80 (1986)	Roberts (1994)
				180 (1992)	Roberts (1994)
				200 (2000)	P. McClelland pers. comm.
Breaksea[a]	170	Nil	59 (1992)	30+ (1993)	Rasch and McClelland (1993)
				400 (2001)	S. Hooson, unpubl. data
Inner Chetwode	195	K, W	30 (1965)		
			17 (1970)	Extinct by 1973	Merton (1975)
Jacky Lee[a]	30	W	46 (1986)	65 (1991)	Roberts (1994)
Kaimohu[a]	11	Nil	15 (1964)	11 (1965)	Blackburn (1965)
				21 (1978)	Nilsson (1978)
				30 (1978)	Roberts (1994)
				30 (1997)	P. McClelland pers. comm.
Kundy[a]	19	W	38 (1978)	80 (1986)	Roberts (1994)
		Nil		180 (1992)	Roberts (1994)
				200 (1999)	P. McClelland pers. comm.
Maud	309	S,W	34 (1980)		
			38 (1982)	Extinct by 1983	Bell (1983)
Motuara[a]	59	Nil	26 (1994)	30 (1995)	Lovegrove (1996[b])
				130 (2001)	S. Hooson, unpubl. data
Motunui	48	W	20 (1981)	60 (1991)	Roberts (1994)
North[a]	8	Nil	19 (1972)	22 (1978)	Nilsson (1978)
				30 (1988)	Roberts (1994)
				60 (1995)	P. McClelland pers. comm.
Pohowaitai	50	Nil	30 (1999)	Status unknown	P. McClelland pers. comm.
Putauhinu	141	K	23 (1974)		
			22 (1976)	15 (1978)	Nilsson (1978)
			41 (1984)	20 (1991)	Roberts (1994)
		Nil		300 (2001)	P. McClelland pers. comm.
South Passage	176	W	35 (2001)	11+ (2001)	Gutsell and Munn (2001)
				16+ (2002)	S. Hooson, unpubl. data

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Table 2. *Continued.*

Island	Size (ha)	Predators	Number released (year)	Census(es) (year)	References
Ulva	270	W	30 (2000)	22 (2000)	B. Beaven, unpubl. data
				30+ (2001)	S. Hooson, unpubl. data
Womens	8	Nil	20 (1972)	22 (1978)	Nilsson (1978)
				25 (1988)	Roberts (1994)
				30 (1994)	P. McClelland pers. comm.

[a] Source island for transfers.
S, stoat; W, Weka; K, kiore.

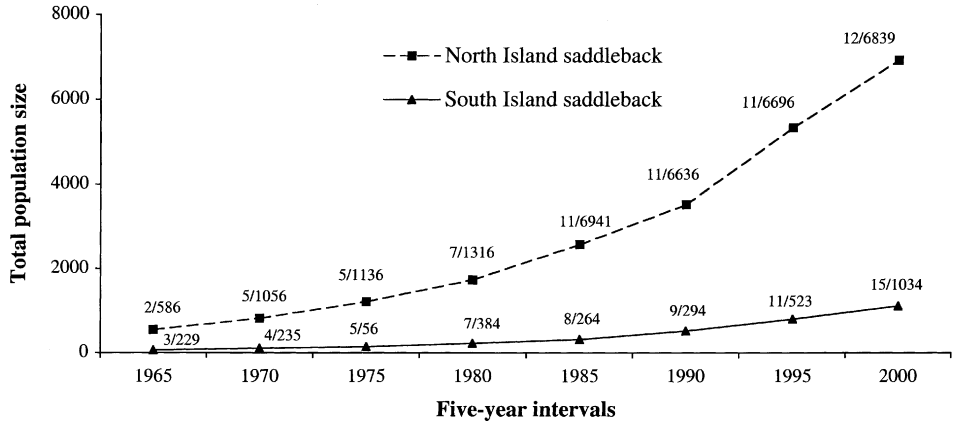

Figure 2. Cumulative total population growth of North Island (dashed line) and South Island (solid line) saddlebacks since 1965 at five-year intervals. Values above data points are number of populations/total area (in ha). A reduction in area as the number of populations increased reflects the fact that some populations on larger islands failed. Sources for the census data are given in Tables 1 and 2.

Impact of predators on population recovery

Lovegrove (1996b) summarized the impact predators have had on the success or failure of saddleback translocations. The impact of predators on the long-term survival of saddleback populations has been further quantified here. The analysis examines what effect varying suites of introduced mammalian predators (including no predators) have had on the mean annual percentage rate of increase of saddleback populations from the time of release. Annual rates of increase are expressed as percentages of final population size to control for initial differences in the number of birds released. Translocations that had been too recent to determine rates of increase (Ulva, Pohowaitai and South Passage islands) or populations on small islands (< 15 ha) that reached their carrying capacity soon after the initial release (Allports, Betsy, Kaimohu, North and Women islands) or where there were too few population censuses (Coppermine and Whatapuke islands), were excluded from the analyses. It is clear from the details of the translocations given above that stoats can extirpate any saddleback

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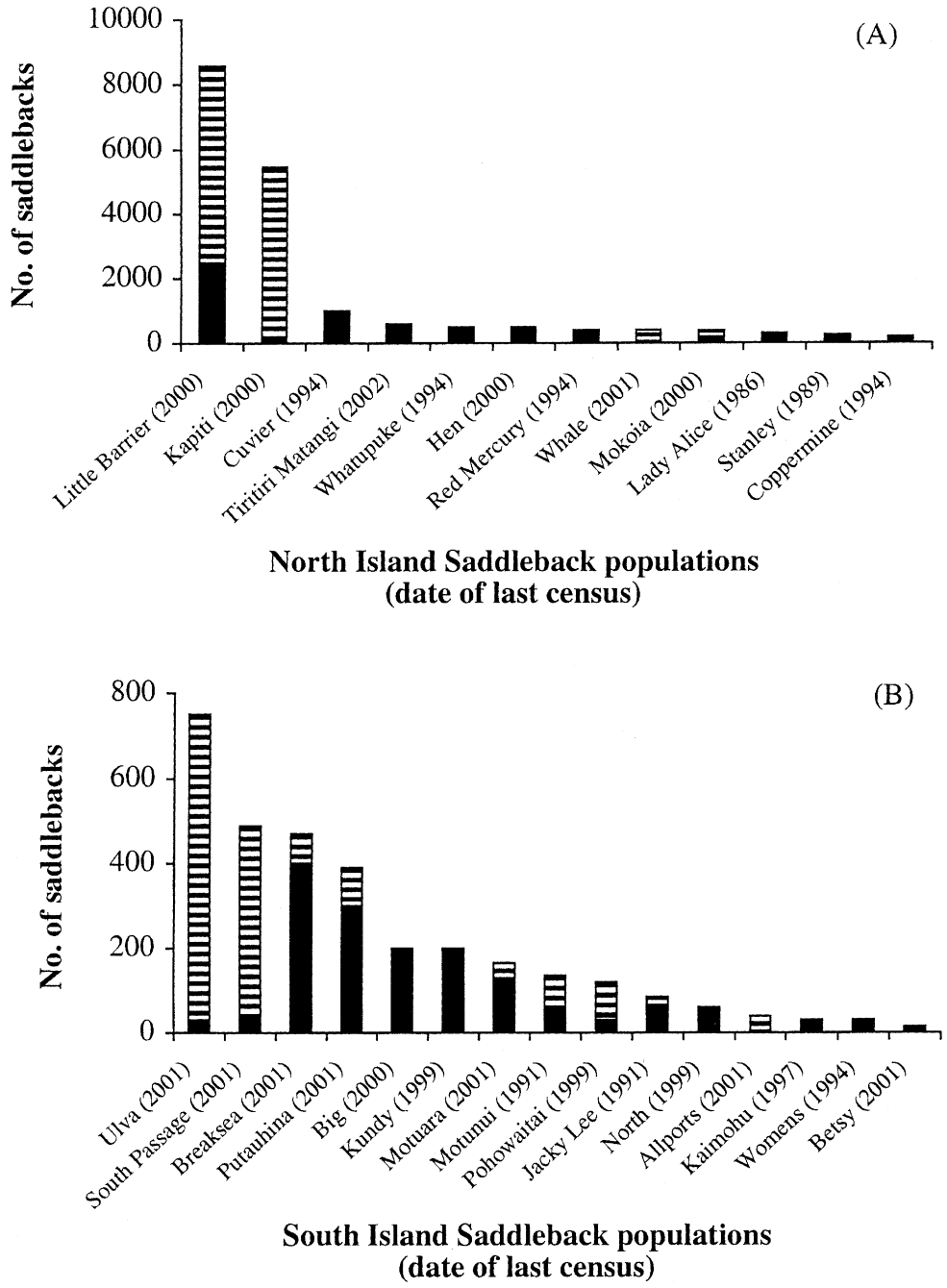

Figure 3. Frequency histogram of present population size (solid bars) and estimated maximum population size once carrying capacity is reached (hatched bars) of North Island (A) and South Island (B) saddlebacks within their existing geographical range. Populations with no hatched bars are assumed to have reached estimated carrying capacity. See text for how maximum carrying capacity was calculated. Sources for the census data are given in Tables 1 and 2.

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population, and hence islands which had been invaded by stoats (Motukawanui, Moturoa and Maud) were also not included in the analysis below.

Although sample sizes were too small for statistical analysis, some trends in the patterns of growth were apparent. For example, North Island saddlebacks tended to do well in the presence of kiore, but South Island saddlebacks did much worse (Figure 4). For comparison, 24 North Island saddleback were released on kiore-inhabited Tiritiri Matangi Island (197 ha) in 1984 and seven years later (1991) the population census was 200, a 35.4% mean annual increase. By contrast, 23 (1974) and 22 (1976) South Island saddlebacks were released on kiore-inhabited Putauhinu Island (141 ha), but by 1978 only 15 birds were recorded. In 1984, a further 41 birds were released, and seven years later (1991) the population census was 20, a 9.7% mean annual decline. When kiore were eradicated in 1997, the population subsequently grew to 300 birds by 2001, a 31.1% mean annual increase. Two translocations of 30 (1965) and 17 (1970) South Island saddlebacks to Inner Chetwode Island (195 ha) failed in the presence of both kiore and Weka, further suggesting the South Island saddlebacks are unable to persist in the presence of kiore although in this case Weka may have quickened the decline. Both North and South Island saddlebacks can coexist with Weka, although the rate of population growth appears to be lower for South Island saddlebacks. Evidence in support of suppressed growth rates comes from Kundy Island (19 ha) where Weka have been removed. Thirty-eight South Island saddlebacks were released in 1978 and the population increased to 80 birds by 1986, a mean annual increase of 9.8%. However, after the Weka were removed, the numbers increased to 180 over a six-year period, a mean annual population increase of 14.5%.

Other rat species such as Norway rats are known to have more devastating effects on native bird populations. North Island saddlebacks maintained a minimal mean annual rate of population growth of 1.3% on Kapiti Island (1,965 ha)

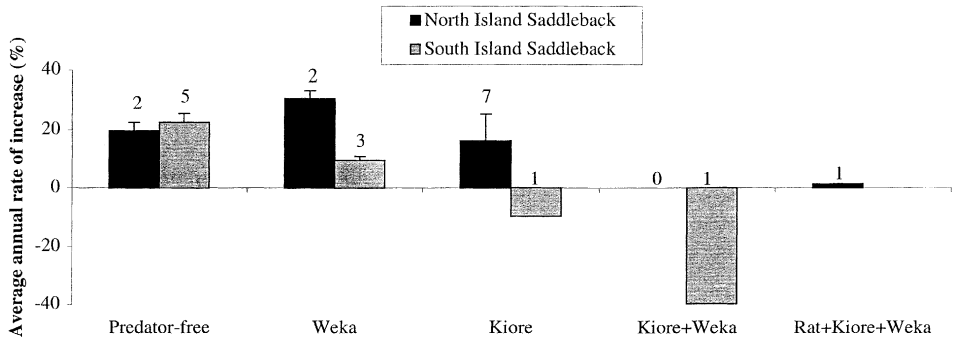

Figure 4. Mean annual percentage population increase of North Island and South Island saddlebacks on islands with varying suites of introduced mammalian predators including no predators. Annual population growth rates were taken from time of releases. The values above the columns are the number of island populations and vertical bars indicate standard errors. Some islands appear in more than one column following changes to their predator status as a result of management actions (see text for further explanation). Data are derived from Tables 1 and 2.

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between 1991 and 1997 when Norway rats, kiore and Weka were all present (Figure 4). Population modelling indicated that the Kapiti Island population would probably go extinct in the presence of these three predators, even though survival was enhanced by roost and nest boxes (Lovegrove 1992). Norway rats and kiore were eradicated from Kapiti Island in 1996 (Empson and Miskelly 1999). Subsequently, in the presence of Weka alone, the North Island saddleback population more than doubled between 1997 and 2000, with the population's mean annual growth rate increasing from 1.3% to 33.2%. It is important to note that Weka were less numerous on Kapiti Island following the 1996 rat eradication, as some were removed from the island before the poison was laid while others were killed by the poison. However, the rate of saddleback population growth continued to increase even as the Weka population presumably recovered following the poison operation.

Discussion

It is not clear where exactly saddlebacks should be placed using the most recent version of IUCN's threatened species categories and criteria (IUCN 2001; version 3.1). On one hand, South Island saddlebacks' projected total population is less than 10,000 individuals and all of the subpopulations would have less than 1,000 birds; this would place it in the Vulnerable category (IUCN 2001). On the other hand, total numbers of birds are unlikely to decline unless any of the populations (especially the larger ones) are invaded by stoats, ship rats or Norway rats. Of New Zealand's endemic birds, New Zealand Saddleback is one of the most susceptible to predation by introduced mammalian predators and thus the risk these predators pose to this species is real. However, because of recent management efforts, South Island saddlebacks are now spread geographically among 15 island populations, and the chances of systematic invasion of many of these islands over the short term are remote. Therefore we recommend that South Island saddlebacks be listed as Near Threatened (IUCN 2001), although vigilance on islands for invading predators and their subsequent rapid eradication is still required. Because the North Island saddleback population is presently estimated to be over 6,000 and has the capacity to increase to over 19,000 individuals, spread across 12 widely dispersed islands, we recommend that this subspecies be downgraded to Least Concern (IUCN 2001).

Although census updates are required for some populations (North Island saddlebacks: Coppermine, Cuvier, Lady Alice, Stanley and Whatupuke islands; South Island saddlebacks: Jacky Lee, Kaimohu, Motunui, North, Pohowaitai and Womens islands), the rapid recovery of both subspecies attests to the success of current management strategies. The two factors that limited the early recovery of saddlebacks, namely predators and insufficient land area for population expansion, are now of less significance. Recent advances in predator eradication techniques have allowed translocations to large islands that were formerly unsuitable. With the exception of Weka and kiore, which still occur on some saddleback islands, all other significant predators have now been eradicated. However, as mentioned above the reinvasion of mammalian predators, particularly rodents, remains one of the most serious threats to the saddleback's survival.

Population growth for South Island saddleback is much lower in the presence of kiore than it is for North Island saddlebacks. Kiore and saddlebacks may have coexisted on New Zealand's main islands for up to 2,000 years since the rats were introduced by the first Polynesian immigrants (Holdaway 1996, 1999). Many North Island saddleback populations coexist with kiore, including the original remnant population on Hen Island. Lovegrove (1996a) hypothesized that because all remaining South Island saddlebacks are derived from the previously kiore-free Big South Cape Island, they may not have adapted behaviourally to kiore.

Both North and South Island saddlebacks coexisted historically and currently with Weka, and although their impact as predators needs further study, Weka appear to be a much less significant threat than introduced mammals. Weka were introduced by Máori to many islands as a source of food. Consequently, their eradication or removal from these islands may be viewed as culturally inappropriate and would only be considered for major ecological reasons (A. Roberts pers. comm.). Future decisions regarding the suitability of islands for further translocations should take into account the presence of kiore, especially for South Island saddlebacks, and whether they can be feasibly eradicated. However, the saddlebacks' potential impact on native invertebrate fauna such as endangered weta (Orthoptera: Anastostomatidae) also needs to be taken into account when considering future translocations (A. Roberts, pers. comm).

Saddlebacks are weak fliers (Merton 1975, Newman 1980), so gene flow between island populations occurs only rarely. This, combined with the small source populations from which all current populations are derived (*c.* 500 and 36 individuals for North and South Island saddlebacks respectively; effective population sizes would have been smaller), means that all current populations are presumably highly inbred. Allozyme electrophoresis of North Island saddlebacks revealed that only one of 24 loci showed polymorphism (Livingston 1994). In small populations, the negative effects of inbreeding may result in reduced survival and fecundity or increased susceptibility to disease, which could potentially increase the probability of extinction (for a recent review, see Keller and Waller 2002). Although populations with long histories of inbreeding may be able to eliminate or reduce inbreeding depression by natural selection at the contributing loci, evidence of the occurrence of genetic ''purging'' is still controversial (Keller and Waller 2002). One way to reduce further loss of genetic variation within island populations would be to facilitate low levels of gene flow between islands. Research on the effects of inbreeding and loss of genetic variation on fitness components in saddlebacks is presently in progress (I. G. Jamieson, unpubl. data).

Current conservation strategies involving island habitat restoration and translocations (Roberts 1994) should continue to restore saddlebacks to islands within their former range. However, the number of islands capable of supporting South Island saddleback is limited, (currently 26, with a total area of only 4,934 ha; Roberts 1994), although long-term visions of eradicating and then controlling stoats on large inshore islands such as Secretary (8,220 ha) and Resolution (21,100 ha) islands in Fiordland would significantly improve the scope for island conservation. Ultimately, however, the long-term goal of recovery efforts should be to re-establish saddlebacks in parts of their former range on the mainland of the

North and South islands. The development of effective pest-exclusion fences, such as that at the Karori Wildlife Sanctuary (see below), and recent advances in predator control, mean that mammalian predators can be eradicated or kept to low levels at unfenced ''mainland island'' sites through intensive and integrated pest management strategies (Saunders and Norton 2001). In unfenced mainland sites, a series of experimental translocations would probably be needed to determine whether the level of predator control was adequate (Davidson and Armstrong 2002). The experiences on Maud, Motukawanui and Moturoa islands show that saddlebacks are quickly extirpated when stoats are present, even at very low densities, and therefore stoats would need to be totally excluded if saddlebacks were to survive in an unfenced mainland site. On the other hand, the high susceptibility of saddlebacks to mammalian predators means they could be used as an early-warning system or indicators of predation risk for more critically endangered species found in the same habitat (see Etheridge and Powlesland 2001).

Postscript

Since the submission of this manuscript it has been confirmed that South Island saddlebacks have self-colonized Taimaitemioka Island (16 ha) from Pohowaitai Island in 2000 or 2001 by flying a 20 m gap of water (P. McClelland pers. comm.). A recent survey of the small South Island saddleback population on Allports Island failed to find any birds (W. Cash pers. comm.). In June 2002, the first reintroduction to the New Zealand mainland took place with the release of 39 North Island saddlebacks into the Karori Wildlife Sanctuary, a 250 ha patch of native forest surrounded by a predator-proof fence within the city limits of Wellington (see Campbell-Hunt 2002). Plans are also under way to release South Island saddlebacks into the Rotoiti Nature Recovery area (825 ha), an intensively managed and pest-controlled (unfenced) beech forest located on the western slope of St Arnaud Range in the Nelson district (M. Maitland, unpubl. report).

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