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SCIENCE & RESEARCH INTERNAL REPORT NO.98

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by

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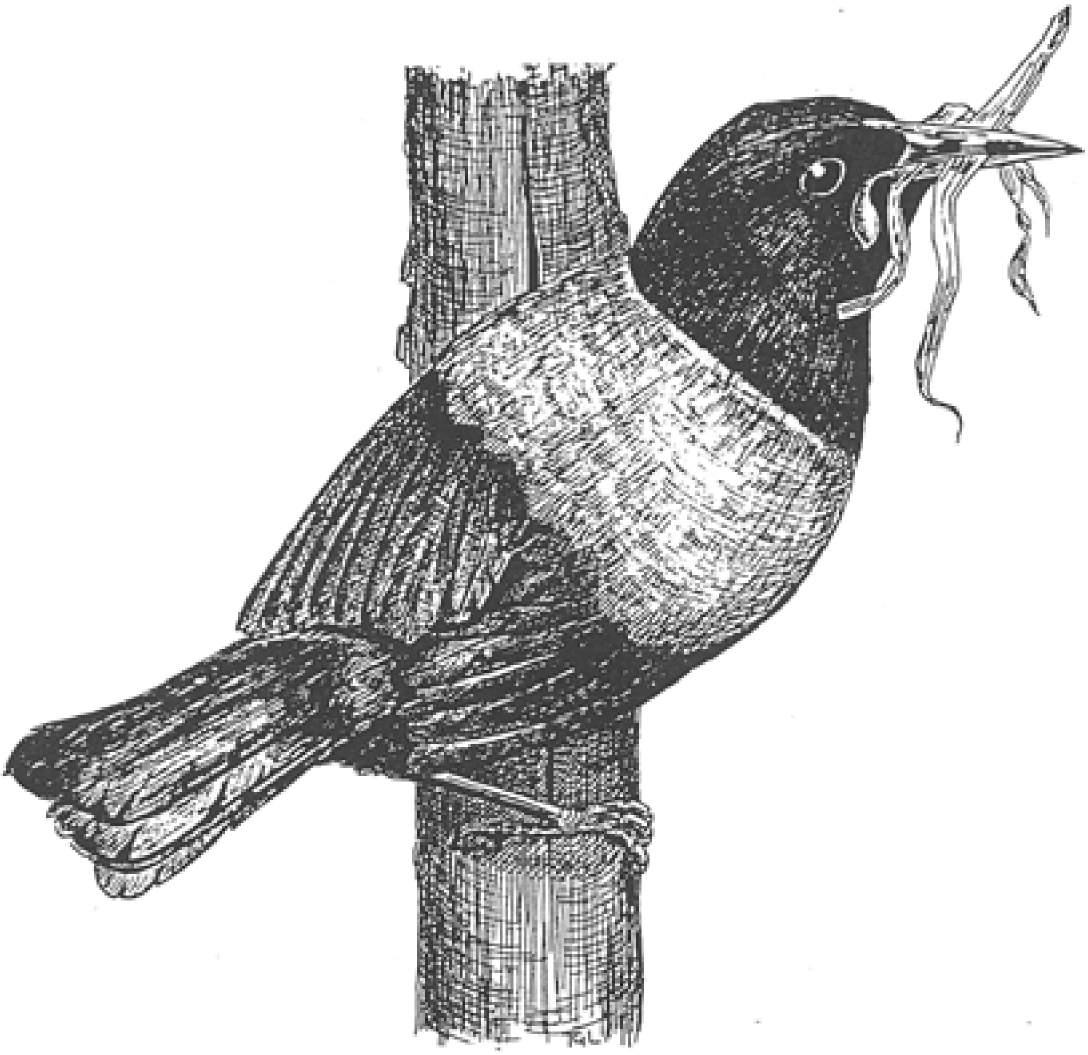
Published by
Head office,
Department of Conservation,
P O Box 10-420,
Wellington

April 1991

ISSN 0113-3713
ISBN 0-478-01278-0



Keywords: Saddlebacks, *Philesturnus carunculatus,* transfers, Stanley Island, Kapiti Island, roost boxes, rats, release, predation, 10.04, 39.01

CONTENTS

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by

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ABSTRACT

Between and 1989 there was a renewed effort to establish saddlebacks (*Philesturnus carunculatus*) on Kapiti Island, by introducing roost box-using birds and natural roost-using controls. An earlier series of translocations to Kapiti (1981-83) failed because the birds were preyed on by Norway rats (*Rattus norvegicus*) at ground roost and nest cavities. The roost boxes provided a defence against the ground-foraging Norway rats. Although box-using birds had significantly higher survival than natural roost-users, and box-users trained their young to roost in boxes, many young which had not learned to use boxes fell victim to rats at natural ground roosts. Overall too few survived to replace losses of adult birds, and the population is still declining. Unless Norway rats can be removed saddlebacks may not survive on Kapiti Island. Recent improvements in rodent eradication techniques on islands means that this could be achieved.

During the transfers the benefits of different release techniques (direct and gentle) were also examined. Birds released directly did not have significantly better survival than those released gently, and paired birds did not have significantly better survival than unpaired birds.

1. INTRODUCTION

1.1 Scope of Report

In my last report to the Department (16 October 1989) I gave details of the third transfer from Stanley Island to Kapiti, and the results of some observations of the new birds soon after release. This account provides an update on the present status of saddlebacks on Kapiti, and also discusses the long term prospects for the species on the island, following detailed monitoring during the 1989-90 season.

1.2 Introduction

The work on Stanley and Kapiti Islands has been carried out as part of my PhD research into the effects of predation on the saddleback (*Philesturnus carunculatus*). Saddlebacks vanished from the mainland last century, and rats e.g., Norway (*Rattus norvegicus*) and ship rats (*R. rattus*) have been blamed for the decline.

In 1981 Kapiti was chosen as the site for a series of experimental releases of saddlebacks. It was thought that saddlebacks might be able to survive on Kapiti despite Norway rats being present. The Norway rat was apparently the first of the European rat species to reach New Zealand, arriving in the 1770's with Captain Cook. The ship rat did not arrive until the 1850's (Atkinson 1973). Since Kapiti only has the Norway rat and kiore (*R. exulans),* the island is a biological relic of old New Zealand of the period from 1770 to 1850. In those days the saddleback was apparently still quite widespread, despite the fact that Norway rats had been present for about 80 years. The saddleback transfers to Kapiti provided a unique opportunity to study the effects of Norway rats in a "controlled" environment, because other predators such as ship rats, feral cats and mustelids do not occur there.

Between 1981 and 1983, 244 saddlebacks were introduced to Kapiti in a joint Wildlife Service and Department of Lands and Survey effort. I monitored these transfers between 1981 and 1985, and I found that the birds were suffering heavy predation from Norway rats, especially at their night-time roosts, many of which were located on or near the ground. Nests, especially those close to the ground were also preyed on. Saddleback roosts and nests are often sited in similar sorts of places, such as inside hollow trees, amongst epiphytes, and beneath overhanging banks. These are all places that are within reach of the mainly ground-inhabiting Norway rats. The birds that survived longest were those that roosted and nested high above the ground where the rats could not get them. More birds were preyed on at roosts than nests mainly because roosts are used every night of the year, while nests are only active during the breeding season (Lovegrove 1985).

Hitherto, roost predation by rats had not been documented as being a major cause of mortality, although it was suspected (among other things) as being a factor when saddlebacks disappeared from Big South Cape Island after ship rats got ashore in the early 1960s (Atkinson 1978). On the northern islands, such as the Hen and Chickens and Cuvier, where both saddlebacks and kiore are abundant, roost predation by kiore has not been detected. The kiore is the smallest of the three rat species in New Zealand. Although kiore on the northern islands sometimes reach 130g in weight, it seems that they do not take prey as big as roosting or nesting saddlebacks (60-90 g). However, they do prey on nests, taking eggs and nestlings. For example, seven (10%) of 67 nests studied on Little Barrier and Cuvier in and were preyed on by kiore. Eggs and nestlings were eaten, but no adults were taken. The major difference between kiore and Norway rats as predators of saddlebacks seems to be that kiore never take adult birds.

In 1984 I decided to erect safe artificial roost sites (roost boxes) on Kapiti in an attempt to reduce rat predation at roosts. It seemed worthwhile testing boxes because on Cuvier I noted that saddlebacks were quite opportunistic when choosing roost sites. For example on Cuvier birds often roosted inside the walls of the old buildings. These roosts shared features with natural tree-hole roosts, in that the birds entered from below and roosted in secluded cavities above the entrances. The saddleback roost boxes incorporated these features (Fig. 1). The first 60 boxes were erected on Kapiti in 1984. I placed boxes close to natural roosts so that the birds would see them. At first none of the roost boxes was used, it appeared that the birds were so used to their natural roost holes that they did not recognise the boxes as potential roost sites.

Saddleback Roost Box

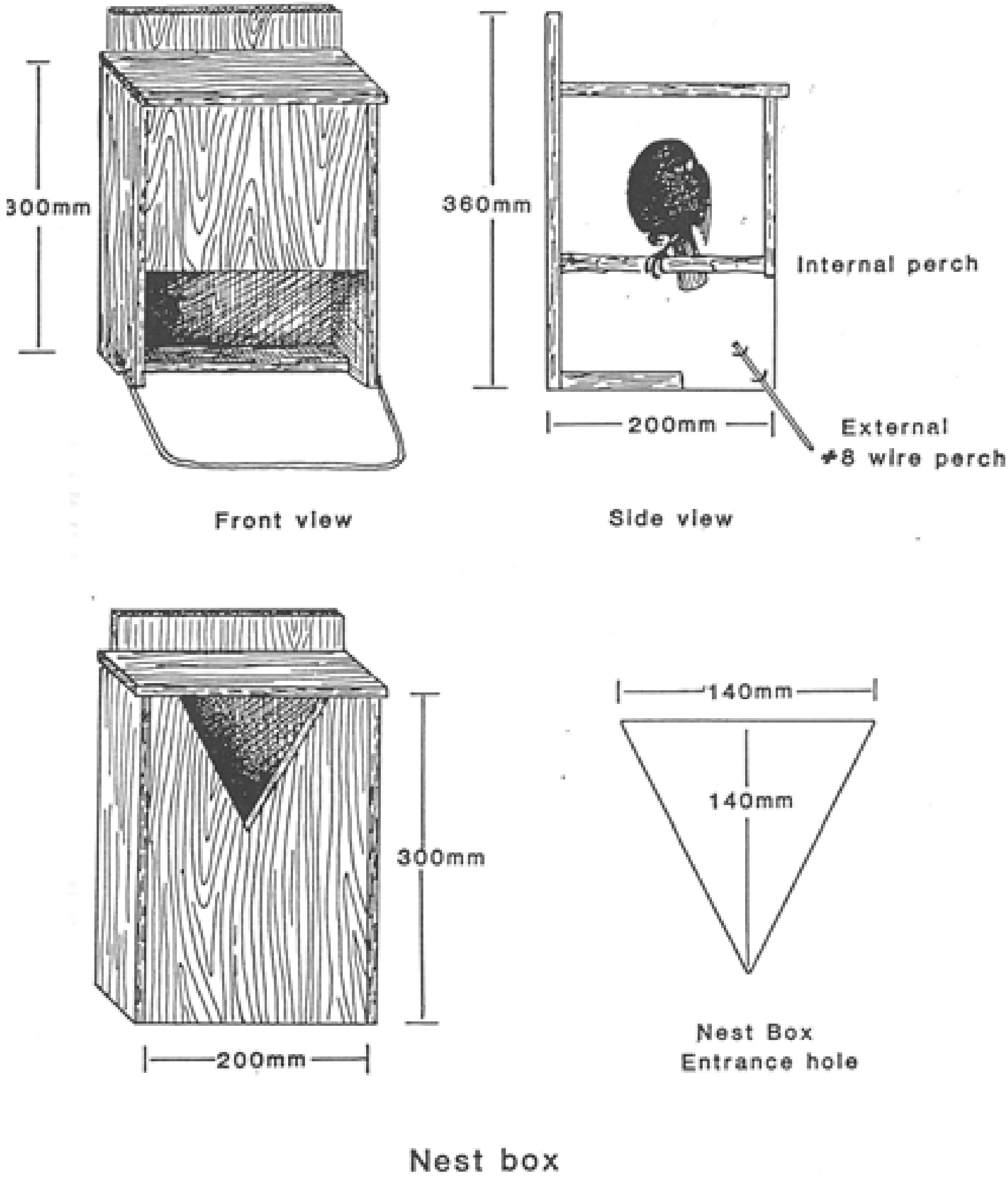

Fig. 1 Saddleback roost and nest boxes

At this stage I expanded the project to include Stanley and Tiritiri Matangi islands in the Hauraki Gulf. These islands were chosen because they had saddleback populations (only newly-established on Tiritiri in 1984) and young forest which lacked old rotted trees with natural roost holes. The plan was to provide artificial roosts in places where natural roosts were lacking, in the hope that the birds might use them. When there were sufficient numbers of box-using birds some of them would then be transferred to Kapiti and released in places where roost boxes were already provided. It was hoped that the transferred birds would carry on their box-using habit.

Initially 150 roost boxes were erected on Stanley and 100 on Tiritiri. The birds began using the boxes almost immediately. The project then concentrated on Stanley, where there was a larger saddleback population (c 250 birds), and thus greater potential as a source of birds for transfers. During and 1987, 300 more boxes were erected on Stanley and about 500 on Kapiti. Between 1988 and 1990 about 2000 additional boxes have been erected on Kapiti. Although the main thrust of the work has been with roost boxes, nest boxes have also been erected, (about one nest box for every four roost boxes), so that secure nest sites are also available (Fig. 1).

Three transfers have now been made from Stanley to Kapiti. Each transfer has included c. 20 roost box habituated birds and c. 20 non-box-using control birds, so that the benefits of boxes to subsequent survival could be tested. The composition of the three transfers is shown in Table 1.

Table 1. Composition of three saddleback releases on Kapiti 1987-89

Year	# roost box birds	# controls	Total released
1987	19	24	43
1988	19	20	39
1989	20	20	40
Totals	58	64	122

As well as a chance to test the benefits of roost boxes, the transfers have provided an opportunity to experiment with different release techniques. In previous saddleback transfers the birds have always been released directly, and high mortality (c. 60%) has occurred during the settling-in phase in the first few months after release. This has even been a feature of releases on predator-free islands such as Cuvier and Little Barrier (where kiore is the only rat). It has been suggested that this high initial mortality has something to do with the stress of the transfer itself, or with the birds failing to adjust to their new environment for some reason. In the transfers to Kapiti 1987-89 transfers to Kapiti various combinations of direct releases and gentle releases (e.g., pre-release aviaries and releases of pairs) have been tried, in an attempt to find out which technique gives the best survival.

In 1987, all 43 birds were released directly and no after-care was provided. In 1988 half of the birds were released directly, while the other half was held for two weeks in a large (5 m x 3 m x 2 m) pre-release aviary. All of the birds were given supplementary food after release. In 1989 all of the birds were held in pre-release aviaries. This batch was split into 20 held together in the same big aviary used in 1988, and 20 others which were held as ten pairs in ten widely scattered small (2 m x 2 m x 1 m) aviaries, which were located in potential territories. Supplementary food was again provided for all of the birds after release. In the 1988 and 1989 releases box-using and non-box-using birds were split evenly in the different release techniques. A breakdown of the three releases is shown in Table 2.

Table 2. Summary of saddleback release procedure on Kapiti 1987-89

1987	1988	1989
DIRECT RELEASE	**DIRECT RELEASE**	**BIG AVIARY**
24 controls	**10 controls**	**10 controls**
19 box users	**10 box users**	**10 box users**
	BIG AVIARY	**SMALL AVIARIES**
	10 controls	**5 prs controls**
	9 box users	**5 prs box users**
43	**39**	**40**

2. SURVIVAL

2.1 Survival from the Three Transfers

2.1.1 1987 Transfer. Survival of the 1957 birds is summarised in Tables 3 and 6 and Figures 2 and
5. The 1987 transfer consisted of 43 birds, which included 24 non-box-using controls and 19 box users. The birds declined quickly during the first few weeks after release. A month after release 25 (58.1%) were resighted; after two months this had declined to 13 (30.2%), and then to 9 (20.9%) six months after release. Since then the decline has been much more gradual. Another bird was lost in July 1985 and another in October 1958. This last bird was lost through misadventure and not predation, when it drowned in a drum of waste oil at the ranger's boatshed. Since October 1958 there have been no more losses from the 1957 batch, and seven (16.3%) of these birds are still alive. The survival curve for this group of birds is beginning to follow a similar trend to those of Cuvier and Stanley -two northern islands where kiore is the only rat (Fig. 6).

All of the surviving birds from the 1987 transfer are using roost boxes. Six of them were originally introduced as roost box conditioned birds, while the only surviving control bird became a roost box user after release. After release up to six (25%) of the control birds were noted using roost boxes, while 10 (53%) of the roost box birds were seen in boxes. When the birds dispersed it appeared that the roost box birds were more inclined to carry on their box-using habit, while the controls moved back into natural roosts, despite roost boxes being provided in their territories.

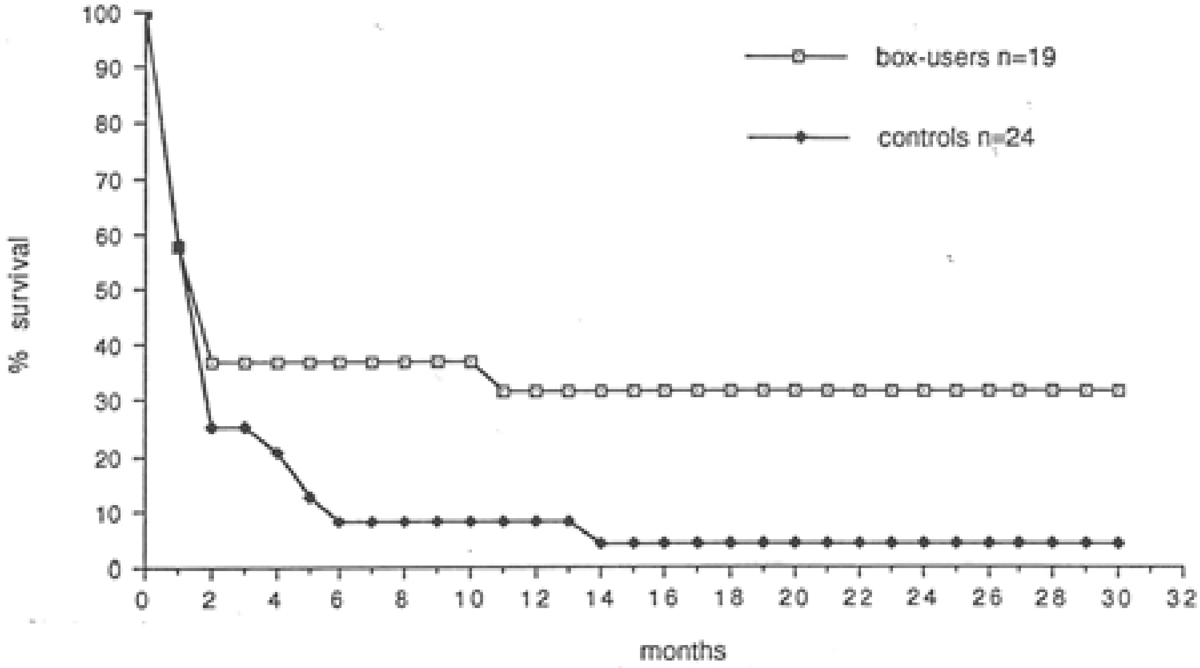

Fig. 2 Survival of box-users and controls - 1987 transfer.

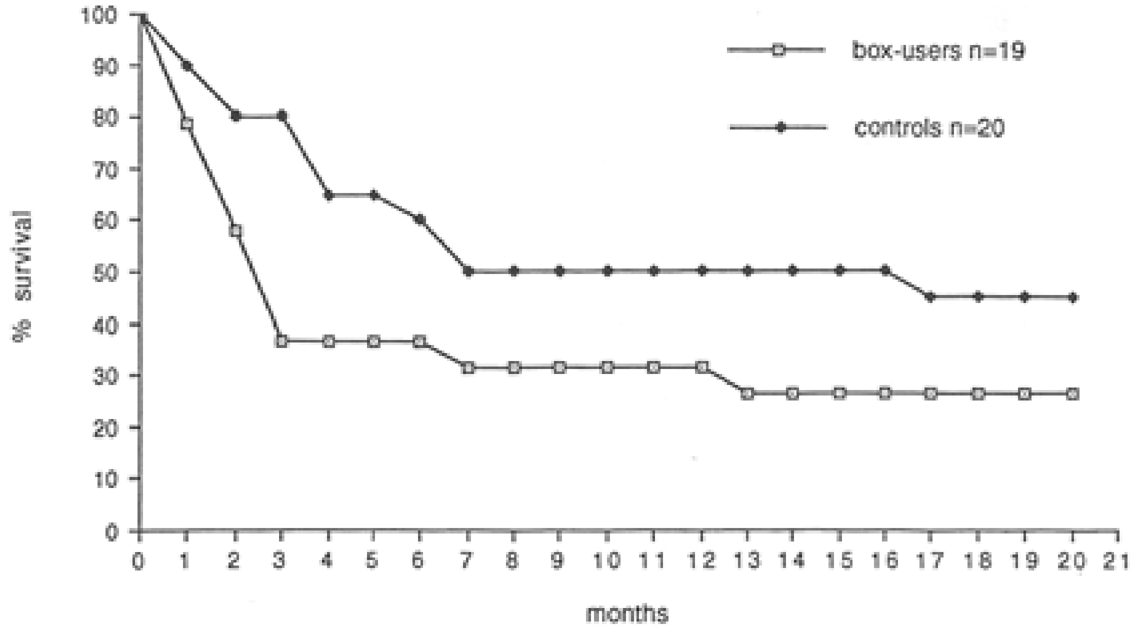

Fig. 3 Survival of box-users and controls - 1988 transfer.

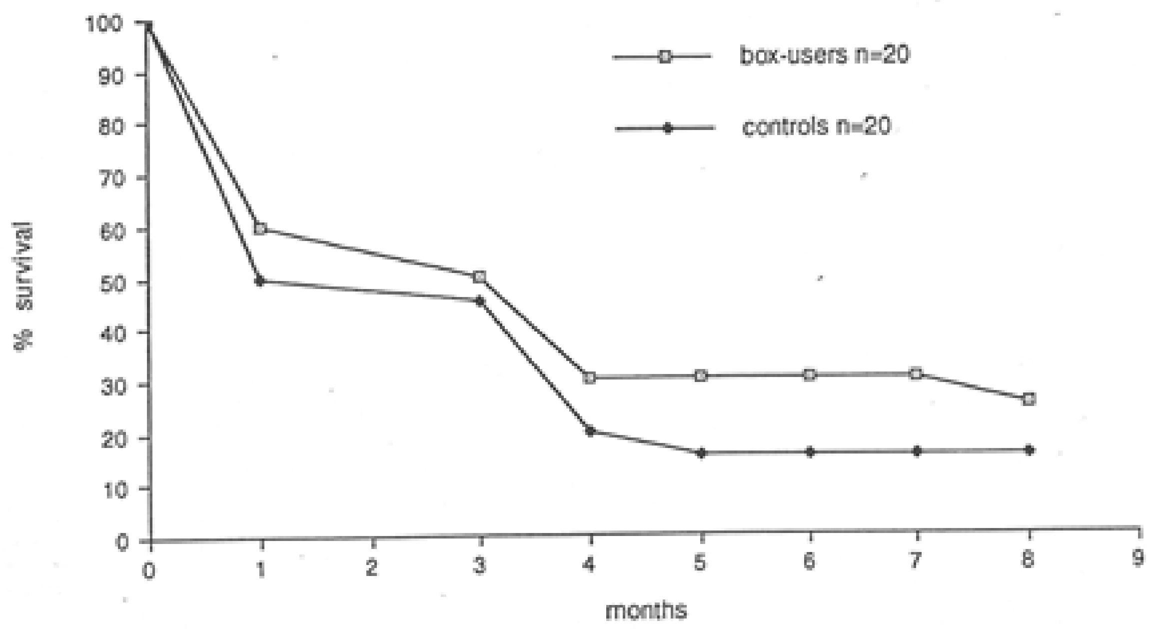

Fig. 4 Survival of box-users and controls - 1989 transfer.

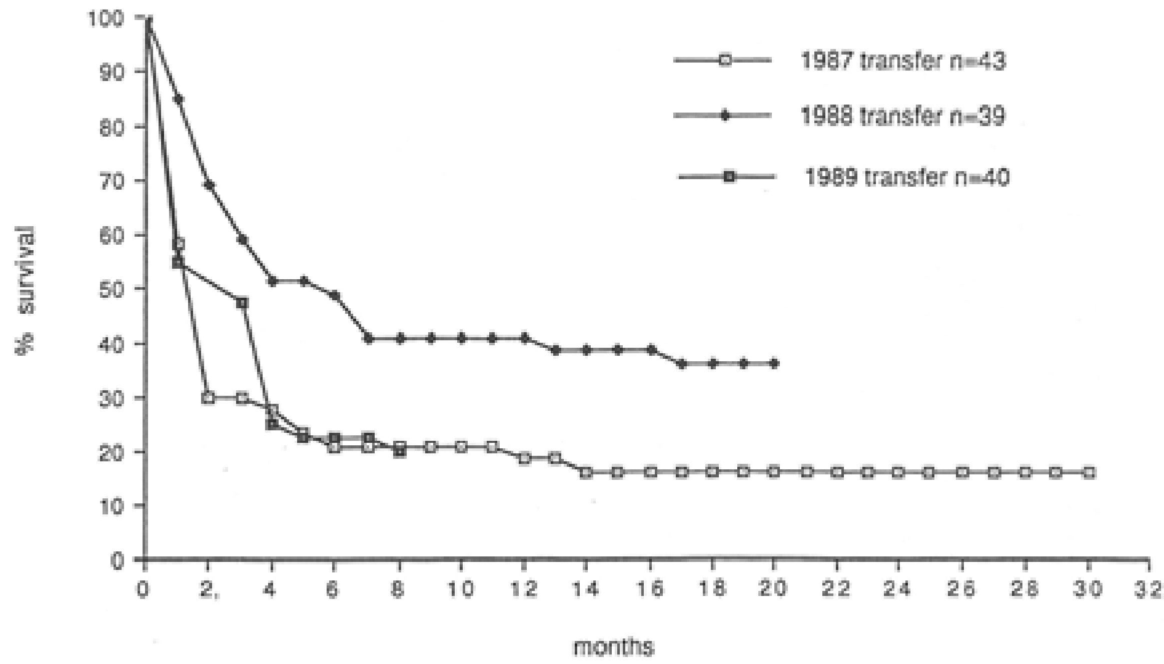

Fig. 5 Survival from 1987, 1988 & 1989 transfers to Kapiti

2.1.2 1988 Transfer. Survival of the 1988 birds is summarised in Tables 4 and 6 and Figures 3 and 5. 39 birds were released in 1988. Twenty of these (of which half were box-users and half controls) were released directly on arrival at Kapiti on 24 August. The remaining 19 (9 box-users and 10 controls) were held in the pre-release aviary at Rangatira and were released on 6 September. Survival of the 1988 birds was about double that of the batch during the settling-in phase. About a month after release 33 (84%) were still alive, and after two months there were at least 27 (69%). Six months after release there were 19 (48.7%). Since then the total has declined to 14 (35.9%). Three of these birds disappeared in early March (two taken by rats at roosts and one taken at a roost by a morepork); the fourth was lost between April and September 1989, and the last was taken by a rat at its nest in early January 1990.

The 14 surviving birds include five originally introduced as box-using birds and nine controls. Some of the box-users went back to using natural roosts, while some of the controls became box users on Kapiti. Nine of the 14 are currently using boxes; this includes three of the original box-conditioned birds and six of the control birds.

2.1.3 1989 Transfer. Survival of the 1989 birds is summarised in Tables 5 and 6 and Figures 4 and 5. Forty birds were released on 6 September 1989 after twelve days in the pre-release aviaries. Twenty were held in the big aviary at Rangatira, while the other 20 were held as ten pairs in the widely scattered small aviaries. Although supplementary food was provided at all eleven aviary release sites, the pairs from the small aviaries dispersed very quickly and seemed to benefit very little from the extra food. Those from the big aviary dispersed more slowly, and up to 17 were seen visiting the feeding table during the first week.

A month after release 22 (55%) were resighted, after two months there were 19 (47.5%); after six months, nine (22.5%) remained. After the initial sharp drop in numbers soon after release the decline was more gradual, especially from December onwards. The 1989 birds have followed a very similar trend to the 1987 batch (Fig. 5) despite quite different release procedures.

2.2 Survival after Release - Benefits of Different Release Methods

Gentle release techniques (in which birds were held in pre-release aviaries) were tries on Kapiti in an attempt to reduce mortality of newly-released birds. Most previous saddleback releases have been direct or hard (birds released immediately on arrival), and there has usually been high mortality during the settling-in phase. Even on the best predator-free islands, (e.g. Little Barrier) less than 50% of the birds remained after the first year (Table 7). Most losses seem to occur during the first month or two after release. Once the birds form pair bonds and establish territories mortality is usually lower (e.g., less than 10% per annum on Cuvier and Stanley).

In 1988 20 birds were released directly and 19 were held for twelve days in a pre-release aviary. Both groups had access to supplementary food after release, but only half of the direct release birds made use of it. There was no significant difference in survival of these groups after two months ($\chi^2 = 0.264$, df =1, p> 0.5).

Table 4. Summary of survival of saddlebacks in 1988 transfer from Stanley Island to Kapiti Island, August 1988 - April 1990.

X - bird seen, not using R box
R - bird seen, using R box
D - direct release
A - held in aviary

Prr - preyed on by rat at nat. roost
Prb - preyed on by rat at nest box, or at nest built in roost box
Pmr - preyed on by morepork at roost

Roost box birds (19)

Band Comb.	age	sex		A (1988)	S	O	N	D	J (1989)	F	M	A	M	J	J	A	S	O	N	D	J (1990)	F	M	A	
WR-RA	A	M	D	X																					
YA-R	J	M	D	X	R	X	X	X	X	X	X	X	X	X	X	X	R	R	R	R	R	R	R	R	
BW-RA	A	F	D	X																					
WD-RA	A	F	D	X	X	X	X	X	X	X	X	X	X	X	X	X	R	R	R	R	R	R	R	R	
RA-Y	J	M	D	X																					(Prr night after release)
WA-B	J	M	D	X	R	X																			
BG-A	J	M	D	X	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
RW-A	J	M	D	X																					
YG-A	J	F	D	X	X	X	R	R	R	R	R	R													
GY-RA	J	F	D	X																					
GA-B	A	M	A	X	X	X	X	X	X	X	X														(Prr? c 10/3)
YR-A	J	M	A	X																					
GA-Y	A	F	A	X																					
A-BB	J	M	A	X																					
RA-B	A	M	A	X	R	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
B-A	J	M	A	X	R	X																			
RR-RA	A	F	A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WB-RA	J	F	A	X	X	X																			
GB-RA	J	M	A	X	X	X																			

Control birds (20)

Band comb.	age	sex		A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	
RY-WA	A	M	D	X																					
RG-WA	J	F	D	X	R	X	X	X	X	X	X	X	X	X	X	X	R	R	R	R					(Prb 7/1)
YY-WA	J	F	D	X	X	X	X	X	X	X															(Pmr? c 1/3)
YW-WA	A	F	D	X																					
YG-WA	J	M	D	X	X	X	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
WR-WA	A	F	D	X	R	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WW-WA	A	M	D	X	X	X	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
WG-WA	A	F	D	X	X	X	X	X	X	X															(Prr? before 10/2)
GW-WA	J	M	D	X	X	X	X	X																	(Prr? before 4/12)
GG-WA	A	M	D	X	X																				
RR-WA	J	F	A	X	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
RW-WA	J	M	A	X	X	X	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
RB-WA	A	F	A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
YR-WA	A	F	A	X	X																				
YB-WA	A	F	A	X	R	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WY-WA	A	F	A	X	R	X	X	X	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
WB-WA	A	M	A	X	R	X	X	X	R	R	X	X	R	R	R	R	R	R	R	R	R	R	R	R	
GR-WA	A	M	A	X	R	X	X	X	X	X															(Pmr c 20/2)
GY-WA	A	F	A	X	R	R	R	R																	(Prb c 20/12)
GB-WA	J	M	A	X	X	X	X	X																	(Pmr c 9/12)

Table 5. Summary of survival of saddlebacks in 1989 transfer from Stanley Island to Kapiti Island, August 1989 - April 1990.

X - bird seen, not using R box
R - bird seen, using R box
B - released from big aviary
- # of small release aviary

Prr - preyed on by rat at nat. roost
Prn - preyed on by rat at nat. nest
Pmb - " by morepork at nest box

Roost box birds (20)

Band Comb.	age	sex		S (1989)	O	N	D	J (1990)	F	M	A	
YW-YA	J	F	B	R								
GA-Y	J	F	B	X								
BB-RA	I	F	B	R	X	X	X	X	X	X		(Prr? c 21/3)
BR-RA	I	M	B	R								
RR-YA	I	F	B	R	R	R	R	R	R	R	R	
BG-RA	I	M	B	R	R	R	R	R	R	R	R	
GR-RA	I	F	B	X								
GG-RA	I	F	B	X								
RG-YA	I	M	B	R								
Y-A	J	M	B	R	R	R	R	R	R	R	R	
R-A	A	M	2	X	X	X						(Prr? c 12/11)
W-A	A	F	2	X								
YY-A	A	M	5	X								
RB-RA	A	F	5	X	X	X						(Prn? c 16/11)
-RA	A	M	8	X								
-WA	A	F	8	R	R	R	R	R	R	R	R	
B-A	I	M	10	R	R	R	R	R				(last seen 12/2)
RW-A	I	F	10	R	R							(Prn 16/11)
WA-	A	M	9	R	R	R	R	R	R	R	R	
-GA	A	F	9	X								

Control birds (20)

Band comb.	age	sex		S	O	N	D	J	F	M	A	
RW-GA	I	M	B	X								
YW-GA	J	F	B	X	X	X	X					(Prn? c 21/12)
YB-GA	J	F	B	X	X	X						
WY-GA	A	A	B	R								(Pmb?)
WW-GA	J	M	B	X	X	X						(last seen 3/11)
WG-GA	A	M	B	R								
WB-GA	I	M	B	R								
GR-GA	J	M	B	R	R	R	X	X	X	X	X	
GW-GA	A	F	B	R								
GG-GA	A	F	B	R								
YG-GA	A	M	1	X								
WR-GA	A	F	1	R								
YR-GA	A	M	3	X								
YY-GA	A	F	3	X	X	X						(Prr 2/12)
GY-GA	A	M	4	X	X	X	X	X	X	X	X	
-YA	A	F	4	R	X	X	X	X	X	X	X	
RG-GA	A	M	6	X	X	X	X					(Prr c 12/12?)
RB-GA	A	F	6	X	X	X	X					(Prr c 14/12?)
RY-GA	A	M	7	X								
RR-GA	A	M	7	X								

Table 6. Survival of saddlebacks transferred to Kapiti 1987 to 1990

1987 Transfer (43 birds - released 26/9/87)

Roost box birds (19)

	Sep 87	Oct 87	Nov 87	Mar 88	Jul 88	Sep 88	Nov 88	Feb 89	Apr 89	Sep 89	Nov 89	Dec 89	Jan 90	Feb 90	Mar 90	Apr 90
#	19	11	7	7	7	6	6	6	6	6	6	6	6	6	6	6
%	100	57.8	36.8	36.8	36.8	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6
Control birds (24)																
#	24	14	6	2	2	2	1	1	1	1	1	1	1	1	1	1
%	100	58.3	25.0	8.3	8.3	8.3	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
All 1987 birds (43)																
#	43	25	13	9	9	8	7	7	7	7	7	7	7	7	7	7
%	100	58.1	30.2	20.9	20.9	18.6	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3

1988 transfer (39 birds - 20 released 24/8/88, 19 in aviary released 6/9)

Roost box birds (19)

	Aug 88	Sep 88	Oct 88	Nov 88	Dec 88	Jan 89	Feb 89	Mar 89	Apr 89	Sep 89	Nov 89	Dec 89	Jan 90	Feb 90	Mar 90	Apr 90
#	19	15	11	7	7	7	7	6	6	5	5	5	5	5	5	5
%	100	78.9	57.9	36.8	36.8	36.8	36.8	31.6	31.6	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Control birds (20)																
#	20	18	16	16	13	13	12	10	10	10	10	10	9	9	9	9
%	100	90.0	80.0	80.0	65.0	65.0	60.0	50.0	50.0	50.0	50.0	50.0	45.0	45.0	45.0	45.0
All 1988 birds (39)																
#	39	33	27	23	20	20	19	16	16	15	15	15	14	14	14	14
%	100	84.6	69.2	59.0	51.3	51.3	48.7	41.0	41.0	38.5	38.5	38.5	35.9	35.9	35.9	35.9

1989 transfer (40 birds, 20 from big aviary, 10 prs from small aviaries) (Released 6/9/89)

Roost box birds (20)

	Aug 89	Sep 89	Nov 89	Dec 89	Jan 90	Feb 90	Mar 90	Apr 90
#	20	12	10	6	6	6	6	5
%	100	60.0	50.0	30.0	30.0	30.0	30.0	25.0
Control birds								
#	20	10	9	4	3	3	3	3
%	100	50.0	45.0	20.0	15.0	15.0	15.0	15.0
All 1989 birds (40)								
#	40	22	19	10	9	9	9	8
%	100	55.0	47.5	25.0	22.5	22.5	22.5	22.5

Of the three transfers to Kapiti survival was highest after the 1988 transfer, with 69% still alive after two months, (in Table 6 cf. 1987 at 30% and 1989 at 42.5%). Because many factors vary between years, these differences probably cannot be tested. The high survival of the 1988 batch was possibly due to low rat numbers during spring and early summer 1988.

Table 7. Comparison of survival of transferred saddlebacks on various islands in the first two years after transfer.

Island	Rat	# birds released	Year	% alive 1 yr	% alive 2 yr
Cuvier	Kiore	29	1968	?	41.4
Stanley	Kiore	24	1977	?	50.0
Motukawanui*	Kiore	16	1983	50.0	12.5 x
Tiritiri Matangi	Kiore	24	1984	79.2	45.8
Little Barrier	kiore	50	1984	44.0	34.0
Kapiti	Norway/kiore	100	1981	20.0	7.0 x
"	"	94	1982	10.6	5.3 x
"	"	50	1983	6.0	6.0 x
"	"	43 R&C	1987	18.6	16.3
"	"	19 R	1987	31.6	31.6
"	"	24C	1987	8.3	4.2
"	"	39 R&C	1988	38.5	35.9 +
"	"	19 R	1988	26.3	26.3 +
"	"	20 C	1988	50.0	45.0 +
"	"	40 R&C	1989	20.0 #	-
"	"	20 R	1989	25.0 #	-
"	"	20C	1989	15.0 #	-

***** **- Failed after stoats got ashore**
x **- Failed**
+ **- % survival after 20 months**
# **- % survival after 8 months**
R&C **-Roost box and control birds**
R **-Roost box birds**
C **-Control birds**

2.3 Releases of Pairs - Is There an Advantage?

In addition to the 20 mixed birds held in the big aviary at Rangatira, the 1989 release included ten pairs held in individual pre-release aviaries set up in potential territories. Four of the pairs were known long-established pairs of roost box users before capture on Stanley Island, while a fifth pair of previously-unbanded control birds was caught together, so was probably also an existing pair. The other five pairs were "created" for the experiment. After release the paired birds dispersed widely. Only two of the ten pair bonds remained intact when the birds eventually established territories. None of the four long-established pairs of colour-banded birds persisted; however, the presumed pair that was previously unbanded did persist, and they settled about five kilometres from their release site. The other pair that persisted (one created for the experiment), settled about 700 m from their release site. Thus survival of the pair bonds was split evenly between one previously bonded pair and one created for the experiment.

After two months, eleven (55%) of the 20 paired birds were still alive, compared with eight (40%) of the 20 unpaired birds. This difference in survival was not significant (χ^2 = 0.9, df = 1, p> 0.1). Although the numbers used in the experimental release of paired birds was small the results suggest that there was no obvious advantage in releasing paired birds.

2.4 Long-term Survival - Benefits of Boxes

In early April 1990 there were 29 survivors from the three transfers, including 20 roost box users and nine using natural roosts. The box-using birds have had significantly better survival than those using natural roost sites (χ^2 = 4.58, df = 1, p<0.05; see also Figs 2,3 and 4). Although Figure 3 (1988 batch) shows more birds originally released as controls surviving, six of the nine surviving controls birds are now roost box users. In Figure 6 survival of the three recent releases on Kapiti is compared with the original 1981 release on Kapiti and the releases on Cuvier (1968) and Stanley (On Cuvier and Stanley kiore is the only rat.) Survival after the 1987-89 releases shows a considerable improvement over the 1981 release, when there were no roost boxes, and the survival curve for the longest-established birds (1987 release) is beginning to follow a similar trend to that of Cuvier. The Stanley Island curve shows the highest survival (compare Cuvier), mainly because that release comprised juvenile and immature birds (all under 15 months). Since the entire release consisted of young birds, obviously more of them would be expected to survive longer. All of the other releases shown in Figure 6 comprised a mix of ages.

3. PREDATION

3.1 Predation at Roosts

As in previous years predation at roosts was the most important cause of mortality during the 1989-90 season (Tables 8 and 9). Known and probable losses at roosts totalled 47. This included 42 fledglings, many of which vanished without trace soon after they fledged, and five adults. Although only three birds, one adult and two fledglings, were actually found rat-killed at roosts, the timing of the losses and the behaviour of most of the other birds which disappeared, suggested that they too were most likely to have been taken at their roosts. Most of them were roosting on the ground where they would have been within easy reach of Norway rats.

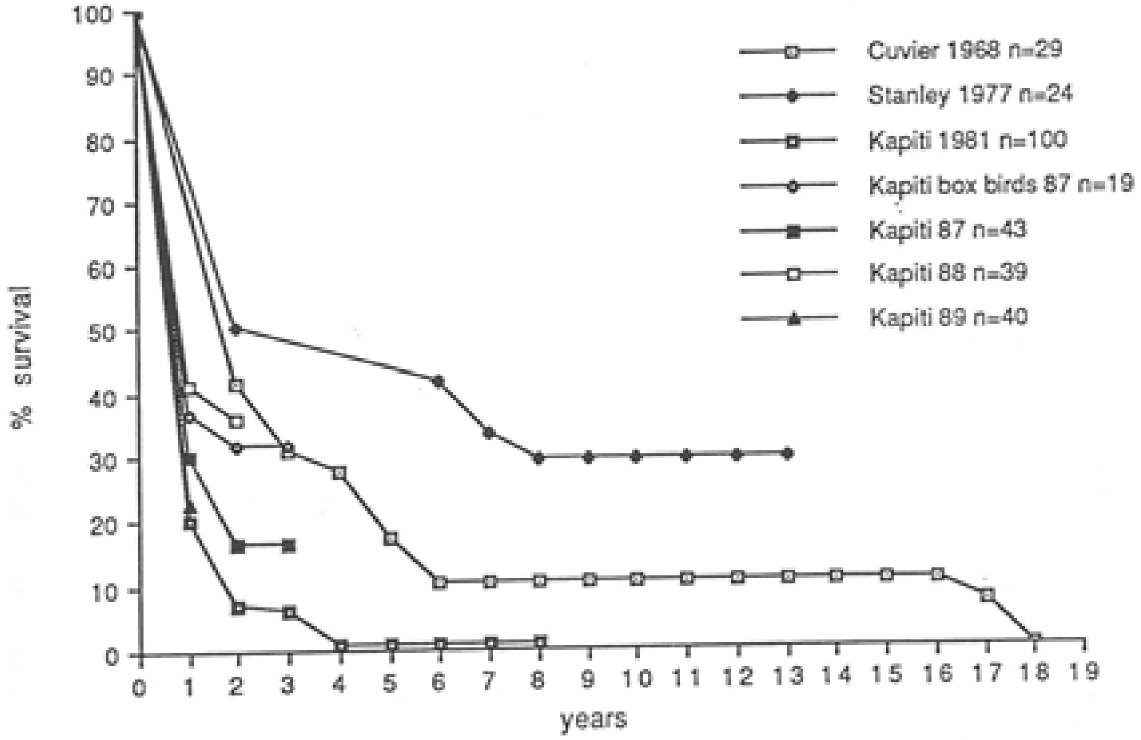

Fig. 6. Saddleback survival on three islands

The female YY-GA (Table 5) and her three young were taken at roosts shortly after the young had fledged. The rat-chewed remains of YY-GA were found on the ground below a hollow cavity in a leaning mahoe, where the bird had roosted about 0.5 m above the ground. The remains of one of her recently-fledged young were found about 5 m away at a ground roost site beneath a tangle of fallen passionfruit vines. There were two other young in the brood, but they vanished without trace; they probably suffered a similar fate.

The other bird found preyed on at its roost was a fledgling at the shag colony (pair RG-A and unb. female). It was found dead only about 5 m from the nest box from which it had just fledged. It had roosted on the ground in a cavity in a rocky bluff. It was probably taken during the first night after fledging. The shag colony has a high rat population compared with the rest of Kapiti, and the ground below the shag nest trees is honeycombed with Norway rat burrows. Evidently the rats feed on debris that falls from the nests. Although rats are abundant, the present saddleback pair in the shag colony has survived there for nearly two years. Both birds roost in boxes and all but one of the seven nests that the female has built during the past two seasons have been in nest boxes. Before boxes were erected at the shag colony, a pair that previously occupied the same territory survived only a few months. The male was taken by a rat at his ground roost (YW-YA in Table 3, and the female (WG-YA in Table 3) was eaten at a nest built in a hollow mahoe tree.

Table 8. Summary of possible and known predation of adults and young at roosts and nests on Kapiti Island 1981-1990

	81-82	82-83	83-84	84-85	87-88	88-89	89-90	Total
Losses at roosts								
Possible	14	21	11	10	2	14	46	118
Known	0	1	0	0	2	5	3	11
								128
Losses at nests								
Possible	0	2	1	2	0	0	4	9
Known	1	2	2	0	1	2	2	10
								19
Other losses								
Moreporks at nests and roosts	1	3	0	0	1	1	2	8
Young to wekas	1	0	0	0	0	2	6	9
								17

Note: Possible losses include annual natural mortality of c. 8%

Table 9. Summary of saddleback mortality during the 1989-90 season compared with the index of abundance of Norway rats.

	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Totals
a	2.5	1.7	2.5	4.3	1.7	4.3	4.3	-	
b	-	-	-	1	-	-	-	-	1
c	-	-	-	1	-	1	-	-	2
d	-	-	-	2	-	1	-	-	3
e	-	-	1	3	-	-	1	-	5
f	-	-	10	11	2	10	8	-	41
g	-	-	1	3	-	2	-	-	6
h	-	-	-	-	-	-	2	-	2
i	-	-	23	13	4	16	14	2	72
j	-	-	1	-	1	-	-	-	2
k	-	-	2	2	2	-	-	-	6

Details of categories:
a) Norway rats/100 trap nights; b) Known losses of adults at roosts (dead birds found);
c) Known losses of fledged young at roosts (dead birds found); d) Total known losses at roosts (dead birds found);
e) Adults probably lost at roosts; f) Fledglings lost per month;
g) Fledglings taken by wekas; h) Fledglings taken by moreporks;
i) Young known to have fledged per month; j) Known losses of adults at nests (dead birds found);
k) Known and probable losses of adults at nests:

Although the roost boxes reduce the chances of birds being preyed on by rats, there is a vulnerable stage for the young during the first week or so after they leave the nest, because it takes some time for the box-using adults to train their young to use roost boxes. Once the young begin roosting in boxes their chances of surviving through to independence are greatly enhanced.

So far I have found no evidence of any roosting birds being taken at roost boxes by rats, even though many of the boxes are sited only about 1.5 m above the ground. This season however, a brooding female and two young (RG-WA at Taepiro) were preyed on by Norway rat at a nest built in a roost box. Nests are possibly more attractive to rats because 'a lot of faecal sacs are scattered near the nests and the young are noisy during frequent feeding visits. On Kapiti, Norway rats are often seen by day, so a rat could easily locate a nest by sound alone during the birds' daytime feeding visits.

3.2 Predation at Nests

3.2.1 Rat Predation. Two females were found dead at nests (RW-A and RG-WA in Tables 4 and 5), and four others disappeared, probably when they were incubating or brooding (see rows j and k in Table 9).

In late November RW-A was preyed on by a rat while incubating on a nest which was sited in the base of a rotted mahoe. One of the nest entrances was at ground level on the uphill side of the tree, so the nest was very accessible to a rat. This bird had built a trial nest in a box, but she abandoned this for some reason, and built her second nest in the vulnerable hollow site.

RG-WA was preyed on at her nest which was built 1.4 m above the ground in a roost box. The female and two large nestlings were killed by the rat. Norway rat pellets were found amongst the remains of the female about 10 m downhill from the box. Either the rat had carried the dead bird there to eat it, or the rat and its prey ended up there after a struggle. The rat appeared to have eaten the two well-feathered young birds in the roost box.

The other four females disappeared when they were either known to have had (e.g., RB-RA in Table 5) or probably had nests. Unfortunately I did not find these nests in time to locate the missing birds; however, none had built in a nest or roost box.

Nest boxes have probably helped to reduce the level of nest predation by rats by making many more safe nest sites available in each territory. Although a breakdown of the number of nests preyed on by rats and other predators at boxes and natural sites (Table 10) shows that a slightly greater number of nests in boxes have been preyed on (cf 23.5% in boxes with 19.6% in natural sites), a much greater proportion of predation at natural nests was by rats (cf 18.8%in boxes with 55.6% in natural sites). Rat predation over the 1987-90 period is summarised in Figure 7.

3.2.2 Morepork Predation. Morepork (*Ninox novaeseelandiae*) predation at nest boxes has been much higher than at natural nests during the three seasons, and it is this predation which mainly accounts for the higher level of overall predation at boxes. It is possible that some moreporks developed a search image for nest boxes on Kapiti. This certainly appeared to be the case on Stanley Island during the 1987-88 season, when four (16.7%) of the 24 nests found that season were preyed on by moreporks. During the 1988 winter I shifted all 80 nest boxes on Stanley Island into more secluded sites. None of the 18 nests found in boxes on Stanley during the following season were preyed on by moreporks.

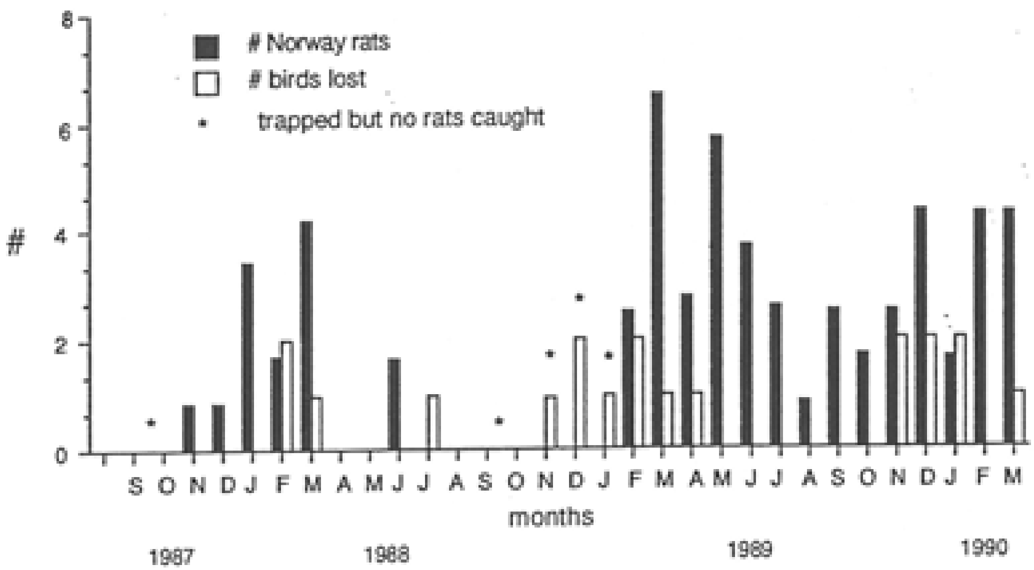

Fig. 7 # Norway rats/100 trap nights & # birds lost 1987-90

On Kapiti, nest boxes were protected from moreporks both by moving them into more secluded sites and by reducing the size of the entrance holes. This was done quite easily with existing boxes by screwing a plywood template with a smaller square hole (50 x 50 mm) over the existing large V-shaped entrance. Table 10 shows that although many more nests were built in boxes during the season, only one was preyed on by a morepork, compared with six the previous season. The one nest that was robbed by a morepork was already in a box placed in a secluded site. Unfortunately, I had not fitted the small morepork-proof entrance template in time to save the nest.

Moreporks also take fledged young and occasionally adult birds. Although no adults are known to have been killed by moreporks during the 1989-90 season, two young were taken from natural roosts in dense vegetation at the house. In previous years single birds were taken during the 1987-88 and 1988-89 seasons, three were taken during the 1982-83 season, and one during the 1981-82 season (Table 8).

3.2.3 Starling Predation. During the three seasons at least four nests were robbed by starlings (*Sturnus vulgaris*). All of these were sited in nest boxes. Nest boxes are very attractive as nest sites for starlings. Since saddlebacks are slightly bigger than starlings, it is not possible to exclude starlings from saddleback boxes by having smaller entrance holes. On Kapiti the starling problem tends to be a very local one with two saddleback territories adjacent to the open country at Rangatira being the only ones affected so far. I have not found that any nests in natural sites were robbed by starlings, as natural sites are usually well hidden.

All of the nests robbed have been during incubation and early in the season. Since starlings on Kapiti seem to be single brooded and nest early in the season (i.e., November-December), the later saddleback nests are unaffected. On Tiritiri Matangi there is a similar problem with mynas (*Acridotheres tristis*) robbing many of the early season saddleback nests built in boxes.

Fortunately, the later saddleback nests are more successful and seem to make up for these losses.

Table 10. Comparison of predation of nests in boxes and natural sites.

No.	87-88	88-89	89-90	Total	%	% rat pred
Pairs	8	18	26			
Nests	13	49	52	114		
Box nests	6	26	36	68	59.6	
Morepork predation	2	6	1	10		
Starling predation	-	3	1	4		
Rat predation	-	2	1	3		
Preyed on total	2	11	3	16	23.5	18.8
Natural nests	7	23	16	46	40.4	
Morepork predation	-	2	1	3		
Starling predation	-	-	-	-		
Rat predation	1	4	1	5		
Preyed on	1	6	2	9	19.6	55.6

At one of the saddleback nests a starling laid an egg without removing the saddleback clutch first. On 5 November the nest contained one saddleback egg. Next morning there were two eggs -but one was a starling's! I removed the starling egg, and later that day the saddleback apparently returned and laid her second egg, because next morning (7/11) she was incubating a clutch of two. However the starling returned, and on the morning of 13 November I found that the nest had just been robbed, and fresh egg yolk was dripping down the front of the box.

Saddleback nests can be distinguished from those of both starlings and mynas quite easily, as the two latter species always seem to use large feathers (and in places close to civilisation, plastic and pieces of paper) in the nest lining. I have never found a saddleback nest with feathers in it. The lining is always made of fine grasses, fern scales and bark fibres.

3.2.4 Weka Predation. Two young were taken by wekas (*Gallirallus australis*), and four others probably suffered the same fate, during the season (see Tables 8 and 9). All of these were offspring from three separate broods of the house pair. Wekas are more common round the homestead than elsewhere on Kapiti because there is plenty of food there. All of the young were probably taken on their first day out of the nest. Fledglings may spend a lot of time on the ground during the first day or two out of the nest, and they do not fly well. They can, however, fly onto branches out of harm's way, and the adults always give prolonged loud alarm calls whenever wekas are near their young. Evidently the young birds do have an escape response, because they either scuttle into dense cover and freeze or hop up into the branches. Some of them are not quick enough. In the house saddleback territory, the problem is made worse because some of the local wekas seem to have learned to search for the young saddlebacks once the adults start alarm calling.

4. THE 1989-90 BREEDING SEASON

4.1 Introduction

The 1989-90 breeding season began with 26 pairs and one unpaired male, and ended with 17 pairs and eight spare males. Two males and nine females were lost from the breeding population. Six of the females that were lost were probably preyed on at nests. Two were actually found dead at nests, while the other four vanished when they were incubating. Of the other three females that went missing one was found dead at its roost, while the other two disappeared between broods, and they too might have been taken at roosts.

Although saddlebacks normally form permanent pair bonds, once a partner is lost the remaining bird usually forms a new bond quite quickly if potential mates are available. As in previous seasons, females were more inclined than males to move if they lost their partner. For example, after her mate R-A disappeared in late November, the female -WA (pair 5 in Table 11) shifted 2 km and bonded with WW-WA (male of pair 14). -WA was last seen in her former territory with a dependent chick on 18/12/89. Sometime after that the chick presumably became independent, and by 8/1/90 -WA had moved and bonded with WW-WA. Last year two females which lost their mates moved 2 and 4 km respectively and formed new bonds with new males. One of these birds took only three days to shift 2 km to a new territory and form a new pair bond.

At the end of the 1989-90 season most of the eight spare males were still on their usual territories. However during the season at least one of them was known to have wandered about in search of a new mate. B-A (male of pair 22 in Table 11) was seen 5 km from his usual territory interacting with pair 17 on 12 February.

4.2 Productivity

The 1989-90 eason had the largest breeding population of any season so far on Kapiti -26 breeding pairs (Table 12). Since there was such a large breeding population it was not surprising that there was such a substantial output of young. At least 122 eggs were known to have been laid in 53 known nests. At least 91 eggs hatched and 72 young fledged. However, despite these large numbers of young fledging, only about 20 survived long enough to become independent. If survival of young follows a similar trend to previous seasons, probably less than half will be recruited into the breeding population next season. This will mean that there will be fewer pairs breeding next season.

4.2.1 Nests per Pair. During 1989-90, 26 pairs built 53 known nests or 2.04 nests/pair (Table 12). In 1988-89, 18 pairs averaged 2.72 nests per pair, and in the previous season eight pairs averaged only 1.5 nests per pair. The greatest number per pair was during the season when eight pairs averaged 3.0 nests per pair. At 2.04 nests per pair, 1989-90 was slightly below the average of 2.25 for the seven seasons on Kapiti.

4.2.2 Mean Clutch Size. The mean clutch size for 1989-90 was 2.39 (Table 12), slightly above the mean for the seven seasons of 2.38. The biggest mean clutch size was noted in 1982-83 (2.77), while the smallest was last season 1988-89 (2.14). Clutch sizes on Kapiti have been consistently higher than in the long-established population on Cuvier Island, where two egg clutches are normal. For example, the mean clutch size was 2.0 (n = 29) in the 1978 and 1979 seasons on Cuvier, and 1.98 (n = 54) during 1986-87.

Table 11. Summary of breeding on Kapiti during 1989 to 1990 season

#	Pair	R/C	Brood 1	Brood 2	Brood 3	Brood 4	Brood 5
1	RW-WA YY-GA	CC	N 3e,3n,3fl Xr	FXr			
2	BG-RA RR-YA	RR	N 2e,2n,2fl,1I	H 3e Xm	H 3e,3n,3fl Xr?	H 3e,2n,1fl,1I?	
3	A-Y BB-RA	rR	HN 3e,3n,1fl,1I	N 3e,3n,3fl,Xr?	FXr?		
4	RA-B RB-WA	RC	H 2e,2n,2fl,1I	H 1e A	N 2e,2n,2fl,2I		
5	R-A -WA	RR	H ? 2n,2fl,1I	MXr?			
6	unb RR-RA	cR	N 2e,2n,2fl,2I				
7	GY-GA -YA	CC	N ? 3n,3fl,1I	N 3e,2n A	H 3e,3n,2fl Xr?	N 3e,3n A	
8	A- A-	OO	H 2e,1n,1fl Xr?	H 2e,1n,1fl Xr?			
9	YG-WA RR-WA	CC	N 2e Xst	N 3e A inf.	N 3e A inf.	N 2e inf *1nXm?	N 1e A inf.
10	BR-A GA-	RR	H ? 1n,1fl Xw?	N 3e,3n,3fl Xw?	N 2e,2n,2fl Xw	N 2e,2n,2fl, Xm	
11	WB-WA WR-WA	CC	N ? 2n,2fl,2I	N 2e,2n,@,1fl,1I			
12	BG-A WA-W	RR	N 2e,1n,1fl,Xr?	N 4e,3n,2fl,1I	N 2e,1n,1fl Xr?		
13	unb WY-WA	rC	HN 2e,2n,2fl Xr?	H 2e,2n,2fl Xr?			
14	WW-WA -A	Cr	N 2e A inf.	H? FXr?			
14a	WW-WA -WA	CR	N 3e,2n,2fl, Xr?				
15	GB-A YY-YA	RC	N 2e,2n,2fl Xr?	N 3e,3n A	N 2e,2n,2fl,1I		
16	-A YB-WA	OC	H ? 2n,2fl,1I	H 2e,1n,1fl Xr?	H 2e unk		
17	unb WG-RA	rR	H ? 2n,2fl,2I	H 2e,2n,2fl,2I			
18	BA-B A-W	Rr	N 3e,3n Xm	N 3e,3n,3fl 1 coll.Xr?			
19	YA-R RG-WA	RC	N 2e,2n Xr FXr				
20	RG-GA RB-GA	CC	H 3e,3n,3fl Xr?	M&FXr?			
21	RG-A unb	Rr	N 3e,3n,3fl Xr?	N 3e,2n,2fl Xr	N 1e,1n,1fl,unk		
22	B-A RB-RA	RR	H? FXr?				
23	Y-A RW-A	RR	H 2e Xr FXr				
24	A-R -A	cc	H? FXr?				
25	unb YW-GA	rC	H? FXr?				
26	GR-GA A-B	Cc	No nest by 8/4/90?				

Key to symbols in Table 11

R - roost box bird (status when released)
C - control bird
O - old bird surviving from 1981-83 transfers
r - locally-bred box-using bird raised 87-88, 88-89
c - locally-bred, not-box-using raised 88-89
M - male
F - female
Mx - male preyed on
Fx - female preyed on
H - nest built in natural site
N - nest built in nest box
HN - nest shifted from ground into nest box
e - eggs in nest (i.e. 2e = two egg clutch)
n - nestlings
fl - fledglings
I - independent young
X - nest preyed on; r - rat, m - morepork, st - starling
Xw - fledgling preyed on by a weka
A - nest abandoned
inf. - eggs infertile or did not hatch
@ - other nestling given to pair 9
* - nestlings transferred from nest of pair 11
coll - fledgling collected - could not fly

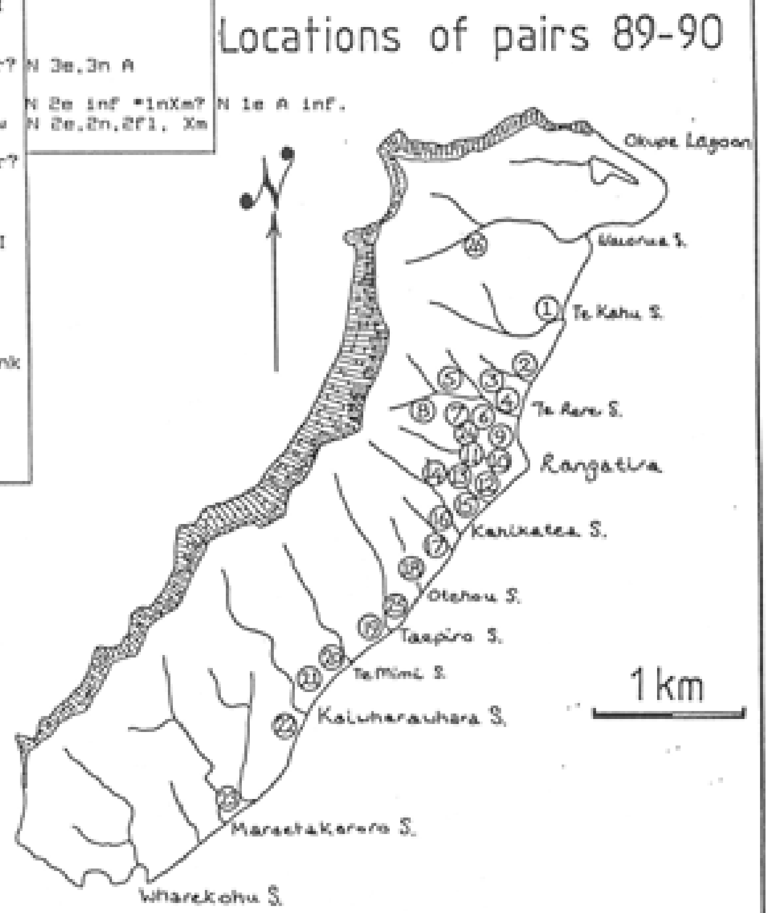

Table 12. Summary of saddleback breeding results for seven seasons on Kapiti I.

Details	81-82	82-83	83-84	84-85	87-88	88-89	89-90
# breeding pairs	10	11	8	6	8	18	26
# nests	23	19	24	16	12	49	53
# nests per pair	2.3	1.73	3.0	2.67	1.5	2.72	2.04
% pairs with multiple broods	80.0	86.6	100.0	100.0	83.3	93.3	93.8
# successful nests	10	9	14	10	7	20	36
# eggs laid	48	46	56	31	27	104	122
# nests with known clutch	12	10	16	4	9	43	46
# eggs laid in known clutches	29	27	39	9	20	92	110
Mean clutch size	2.42	2.7	2.44	2.25	2.22	2.14	2.39
# eggs hatched	35	24	33	23	23	74	91
# young fledged	25	18?	28	19	10?	38	72
Mean # young fledged per pair	2.2	1.64	3.5	3.17	1.25	2.11	2.77
# young independent	19?	6	23	18	9?	22?	20?
% fledged young independent	76.0	33.3	82.1	89.5	90.0	57.9	27.7
# young recruited	4	0	5	?	4	8	8?
% independent young recruited	21.1	0.0	21.7	?	44.4	36.4	40.4?
# nests preyed on	10	3	6	2?	4	16	5
# nests preyed on by rats	7	3	4	2?	2	6	2
# nests preyed on by possums	1	0	0	0	0	0	0
# nests preyed on by moreporks	2	0	2	0	2	7	2
# nests robbed by starlings	0	0	0	0	0	3?	1
# young taken by wekas	1	0	0	0	0	2	6?
# broods lost in bad weather	0	4	0	0	0	0	0
# infertile clutches	0	5	3	2?	1	9	5
# males lost during season	2	5	1	0	1	4	2
# females lost during season	2	7	3	1	3	4	9
# intact pairs after breeding	6	6	4	5	5	14	17
% total pairs left " "	62.5	46.2	50.0	71.4	62.5	77.7	65.4

The 122 eggs produced in the nests which were actually found represents 5.5 eggs per female for the 1989-90 season. This has been exceeded in the past by two seasons, (1983-84, 7.0 eggs/female and 1988-89, 5.7 eggs/female).

4.2.3 Multiple Broods. Multiple broods have been a feature on Kapiti, along with other islands (e.g., Tiritiri Matangi) where new saddleback populations have been established. Multiple broods were also noted during the early years of the Cuvier population, during the establishing phase. On Kapiti a high proportion of the pairs have produced multiple broods. This has ranged from 80% of the pairs producing multiple broods in 1981-82 to 100% in 1983-84. in 1989-90 the figure was 93.8% (Table 12). This contrasts with the population on Cuvier (now at equilibrium), in which none of the pairs (n = 83) was known to have had a second brood during the 1979-80 and 1986-87 seasons.

4.2.4 Number of Young Fledged. The 1989-90 season was a good one, and 72 young fledged (Table 12). This is by far the greatest number in any season since the recent series of saddleback introductions to Kapiti began in 1981. An average of 2.77 young fledged per pair in 1989-90. This has been exceeded in only two previous seasons: 1983-84 (3.5 young/pair) and 1984-85 (3.17 young/pair).

4.2.5 Number of Young Independent. Despite the large number of young (72) fledging successfully during 1989-90, only about 20 (27.7%) of these apparently became independent (Table 12). As a percentage of the young that fledged, fewer young became independent after the 1989-90 season than in any previous year. The 1982-83 season had a slightly greater percentage with 33.3% becoming independent. All of the other years ranged between 57.9% and 90%.

Most of the losses of fledged young during the season occurred in the first few days after the young had left nests. Although some were known to have been taken by wekas, most were probably taken by rats at roosts on the ground.

4.3 Recruitment

Since the roost box project started on Kapiti in 1987, a greater proportion of the young that have become independent have been recruited into the breeding population the following season (for example, compare 21% in 1981-82 and1983-84 with 44.4% and 36.4% in 1987-88 and 1988-89, Table 12). It is possible that the level of recruitment during the season will be somewhere between the figures for 1987-88 and 1988-89. The mean value for the two seasons is 40.4% or eight young. Assuming an even sex ratio of recruited young, four males and four females could be recruited. Since the previous season began with 26 pairs and ended with 17, at most there could be 21 pairs at the start of the 1990-91 season – a decline of five pairs from last year.

4.4 Long-Term Prospects

Of the nine emales lost during the 1989-90 season, seven were new in the Kapiti population, i.e., either newly-introduced in 1989 (six individuals) or locally bred from the last season (one individual). The other two that were lost included one female from the release, and one locally-bred female from the season. Only one of these nine birds that were lost was taken at a box (RG-WA, Table 11). Since more naive "new" non-box-using birds were lost it is possible that next season losses of females will be lower, because more of them will be older experienced Kapiti residents, which are more likely to be using roost and nest boxes. There will be no transfer in 1990, so the only input of new birds this year will be the young recruited from the 1989-90 season. Although there has been a sharp decline in the potential number of breeding pairs if we take the above considerations into account, we might see the population stabilise at around about 20 pairs during the next year or two. Further monitoring will be needed to see if this is indeed what happens.

Obviously a small population of just 20 pairs on Kapiti contributes very little for long term conservation of the North Island saddleback. The island has enough habitat to support a very big population (perhaps some 2000 pairs), but despite providing roost and nest boxes and introducing trained birds, a large population is clearly not a realistic objective while the island still has Norway rats.

4.5 Protecting and Moving Nests Last year I tested for the first time with saddlebacks the feasibility of shifting nests and broods from vulnerable to safe sites. This was very successful, and the birds proved to be very tolerant when I interfered with their nests. Young fledged successfully from the four nests that were protected or moved during the 1989-90 season (Table 13).

Table 13. Manipulating breeding

	1987-88	1988-89	1989-90
Existing nests protected	1	1	2
Nests moved into boxes	0	2	2
Nestlings given to other pairs	0	3	1

During the 1987-88 and 1988-89 seasons only a few of the nests built in vulnerable sites were protected. I attempted where possible to protect all vulnerable nests during the 1989-90 season, but some of the nests were preyed on before I had a chance to protect them. Where possible I tried to leave the nests in their original sites and protect them there. This was easiest with nests built inside hollow trees. However, nests built on the ground in or beneath *Collospermum* and *Astelia* clumps were more difficult to protect. These were shifted into nest boxes.

In both of the nests protected in hollow trees (Fig. 8a) it was quite easy to make the entrance holes higher off the ground so that Norway rats would be less likely to climb in. The two trees had rotted crevices, open on one side and extending about 2 m above the nests. I tacked lino over these holes in stages, so that the entrances were gradually made higher (usually over a period of one to two days). During the 1987-88 season I protected one low nest in a hollow tree by using galvanised iron. (For all recent efforts at protecting tree holes I have used lino.) This is much easier to use than iron being easy to cut, flexible and easy to attach. It is also very slippery for a rat to climb on. There was no evidence that any rats attempted to gnaw through the lino, even though they would almost certainly be capable of chewing through it. I think for low nest sites the main function of a lino or iron baffle is merely to provide a barrier so that rats cannot blunder into nests by accident.

The techniques used for moving nests from the ground into boxes were similar to those used last season. So far I have waited until the eggs have hatched in all nests moved in this way. This means that there is the added advantage of having the male as well as the female visiting the nest. (In saddlebacks only the female incubates.) With two birds searching for their young after the appearance of the nest has been altered, there is probably a better chance of the birds both finding and accepting the changes more quickly.

The first nest to be moved was built below ground level in a rocky crevice at the foot of a bluff. It was moved into a box when the young were 15 days old. The move was carried out in several steps over two days. In the first step the nest and young were removed from the hole and placed into a nest box, which was placed on its back over the former entrance hole. The original nest cavity and a second entrance to the crevice were blocked with kanuka brush. At first I put an irregularly-shaped entrance on the box -of similar dimensions to the natural hole. After the birds had made several visits I stood the box upright, fitted a smaller 60 mm x 60 mm entrance hole, and attached the box with #8 wire loops on to a horizontal beam. Over the next day or so the box was slid about 30 cm at a time along the beam to move the nest away from the ground. The birds seemed to accept the changes very quickly, especially once they were tuned into going into the box entrance hole. When the box was in its final position c. 2 m above the ground and c. 1.5 m out from the bluff, a rat baffle (corrugated iron) was dropped over the beam.

The second nest, built under an *Astelia* was boxed and moved in a similar way. The beam was thrust into the centre of the *Astelia* above the nest, and the box was attached with loops onto the roof. The first step (carried out in about 10 minutes between feeding visits), involved the biggest changes to the nest. The beam was put in place and the nest was placed into the box, which was then pushed into the former nest cavity beneath the *Astelia.* At this stage the top half of the front of the box was left open, so that the nest was clearly visible to the birds. A skirt of pendant dead *Astelia* leaves which had helped to conceal the original nest was draped down in front of the box. Later the small entrance template was fitted, and the box was slid out along the beam in stages out of harm's way. A rat baffle was also fitted (see Fig. 8b).

One nestling was moved into the nest of another pair (from nest 2 of pair 11 to nest 4 of pair 9, Table 11). Pair 9 had repeatedly produced infertile clutches during the 1989-90 season, despite producing fertile clutches the previous year. The two infertile eggs in pair 9's nest were swapped for a three-day-old nestling from the nest of pair 11. The female accepted it immediately. Unfortunately the chick vanished about a week later. This nest was built in a roost box, so it did not have the additional protection that nest boxes have with a morepork-proof entrance. The nest might have been robbed by a morepork.

5. SUGGESTIONS FOR FURTHER WORK ON KAPITI

5.1 Monitoring

For the time being there will be no more transfers of birds from Stanley Island, and during the 1990-91 season the population on Kapiti will not be monitored in as much detail as previously. I will probably spend about a month at Kapiti during the season surveying survival of pairs and checking roost and nest boxes. Raewyn Empson from the Wellington Conservancy of will also visit the island at regular intervals to check the status of the population. Future monitoring should concentrate on the following points:

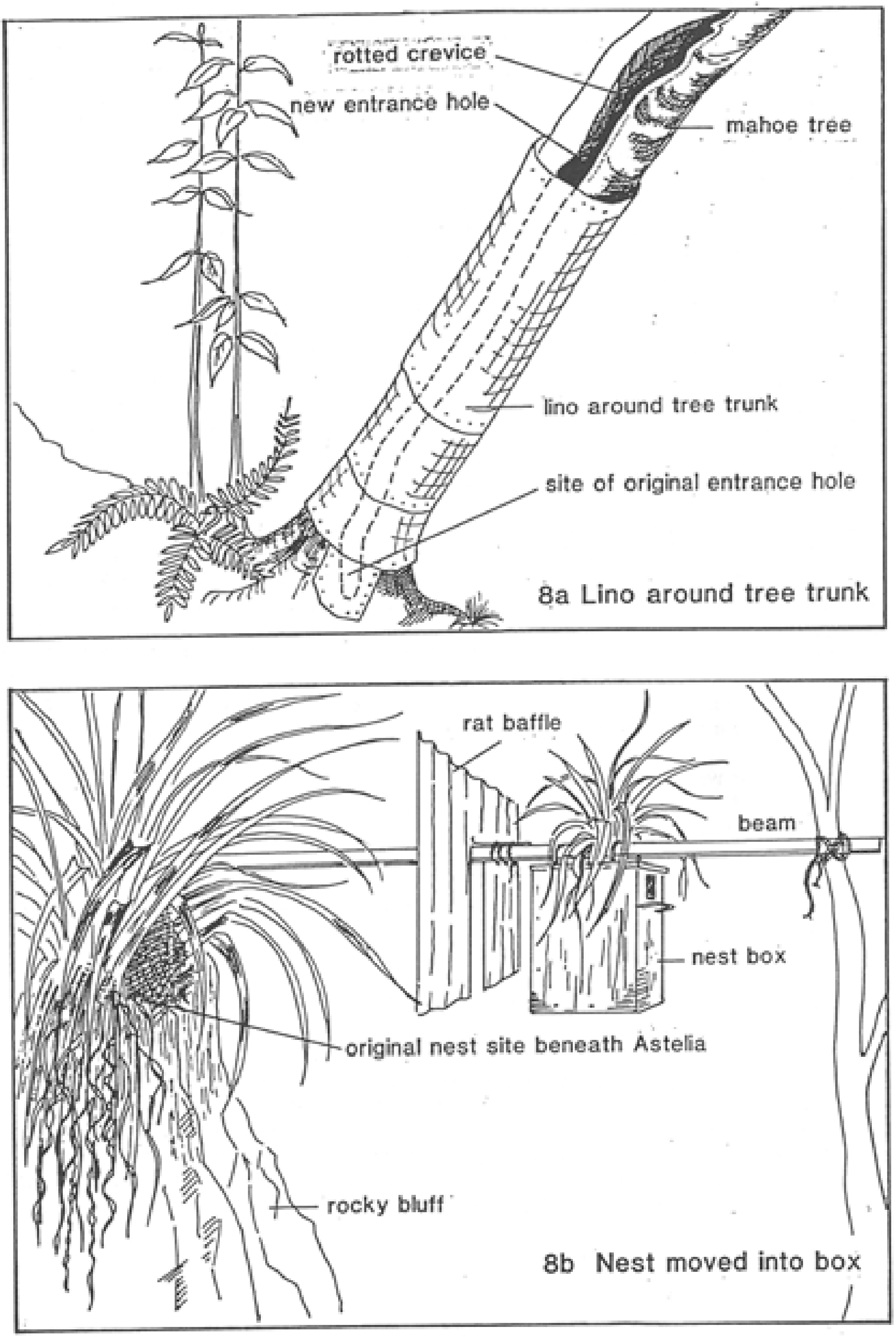

Fig. 8 Methods of protecting nests.

5.1.1 Number of Pairs. The easiest way to measure the success of the population will be to survey the numbers of breeding pairs each season. It should not be too difficult to locate birds, because at present most of them are settling near the coast in places where saddlebacks have occurred previously. If the population maintains itself at about 20 pairs, it is most likely that new recruits will fill gaps in existing territories, and few new territories will be colonised. Therefore at the start of the season a survey of all 26 localities where pairs occurred last year should be reasonably comprehensive.

5.1.2 Monitoring Recruitment. If possible newly-recruited birds should be colour-banded each year (mistnetting would probably be most effective from August to January), so that records can be kept of the number of young recruited each year, and their long term survival. By late winter most of the new recruits should be site-attached and should have formed pair bonds in the territories that they will frequent thereafter.

5.1.3 Box Use. Roost and nest boxes in all territories will need to be checked to determine the box-using status of the resident pairs. Observations of roosting behaviour might be necessary to confirm which birds are actually using boxes, and to locate roost sites of birds not using boxes, so that these can be checked if the birds disappear.

Routine checks of nest boxes during the summer should reveal the nests of females that are regular box-users. Where necessary morepork-proof entrances should be fitted to boxes in exposed places, once active nests are located. At the same time as entrances are fitted, nests should be dusted with mite powder. This is especially important for very late nests during the warmest part of the summer. Routine dusting of nests (one dusting usually sufficient), eliminates needless losses from red mite infestations. Red mites are usually not a problem in saddleback nests on islands such as Cuvier and Stanley, where the birds have just one brood and where most have fledged by mid-December. However new populations (e.g., Kapiti) have long breeding seasons, and there is a greater risk of losing late broods to mites. At the end of the season old nests should be cleaned out of boxes.

5.1.4 Natural Nests. Where possible, natural nests should be located in case they need to be protected or moved off the ground into boxes. Nest searches can be time consuming, but past experience has shown that many of the long-established birds nest in the same parts of their territories year after year. Nest searching can thus be concentrated into quite a small area, which increases the chance of finding the nest.

5.1.5 Banding Young. Nestlings should be banded where possible. I fit only metal bands to nestlings, adding colour bands later when the young have been recruited into the population. This saves colour combinations because mortality of young is heavy. If the young are banded one can then trace their origins and monitor subsequent survival. By knowing where the young have come from it is possible to identify which pairs are contributing the most young to the population. For example these could be the pairs which always have the biggest clutches and the most broods, or those which successfully train their young to use roost boxes. Management can then be directed to the most productive pairs, e.g., providing extra nest and roost boxes in their territories, improving the siting of existing boxes, and monitoring nests and roosts more intensively than elsewhere, so that the productivity of these successful pairs might be enhanced.

5.1.6 More Boxes. There are now about 2500 boxes on Kapiti (2000 roost boxes and 500 nest boxes), spread from the Waiorua and Okupe valleys in the north to Wharekohu in the south, and they are mainly within a few hundred metres of the eastern coastline. There is still room for more boxes, and there are plenty of volunteers available locally (e.g., Forest and Bird, Ornithological Society) to help build and erect them. If funds are available, 500 more boxes could be built during the 1990-91 season.

Materials needed:
850 m, 200 x 25 mm rough-sawn tanalised pine (# 1 grade)
25 kg, 50 mm galvanised jolt-head nails
25 kg, 75 mm galvanised flat-head nails

5.2 Rat Poisoning

There are three options: (1) do nothing, (2) poison about 60 ha (12 saddleback territories near Rangatira), or (3) eradicate rats totally from Kapiti.

5.2.1 Do-nothing Option. At the outset of the saddleback roost and nest box project I hoped that the boxes alone would provide sufficient protection against Norway rat predation. It now appears that although the boxes do enhance survival, too few young are being recruited to sustain the population. If we do nothing the saddlebacks will probably gradually decline and become extinct on Kapiti. It would be a great pity if this was to happen, because Kapiti fulfils a very important role as a place to educate the public about endangered species conservation. Unlike other endangered species on Kapiti e.g., little spotted kiwi (*Apteryx owenii*), and stitchbird (*Notiomystis cincta*), saddlebacks are highly conspicuous, and most visitors to Kapiti see and hear this spectacular species. Interpretation by the Ranger is an important part of a trip to Kapiti, and visitors leave the island having not only seen endangered species but also having learned why they are rare and what is being done to conserve them.

5.2.2 Poisoning near Rangatira. In 1984-85 I set up at Rangatira a rat poison grid covering about 40 ha (Fig. 9). About 200 Novacoil rat bait stations (similar to those used successfully in recent rodent eradication projects on Breaksea and other islands) were set out at 25 pace intervals on lines 50-100 m apart. These were kept baited between March 1984 and March 1985. At first Warfarin baits were used; in October 1984 these were replaced with Talon baits. A trapline was run inside and outside the poison block to monitor the effects of the poisoning. The poison programme appeared to reduce the numbers of rats inside the poison block (Table 14), because no rats were caught inside the block after July 1984, while rats continued to be caught outside.

During 1984-85 there were three pairs of saddlebacks inside the poisoned area. There were no losses of any of these established birds between March 1984 and March 1985. Although some of the bait stations have been removed from the lines and used elsewhere, many of them are still set out at their original sites. It would be quite easy to re-establish the poison block on Kapiti and run it again during 1990-91 - perhaps longer. Such a project would have several benefits:

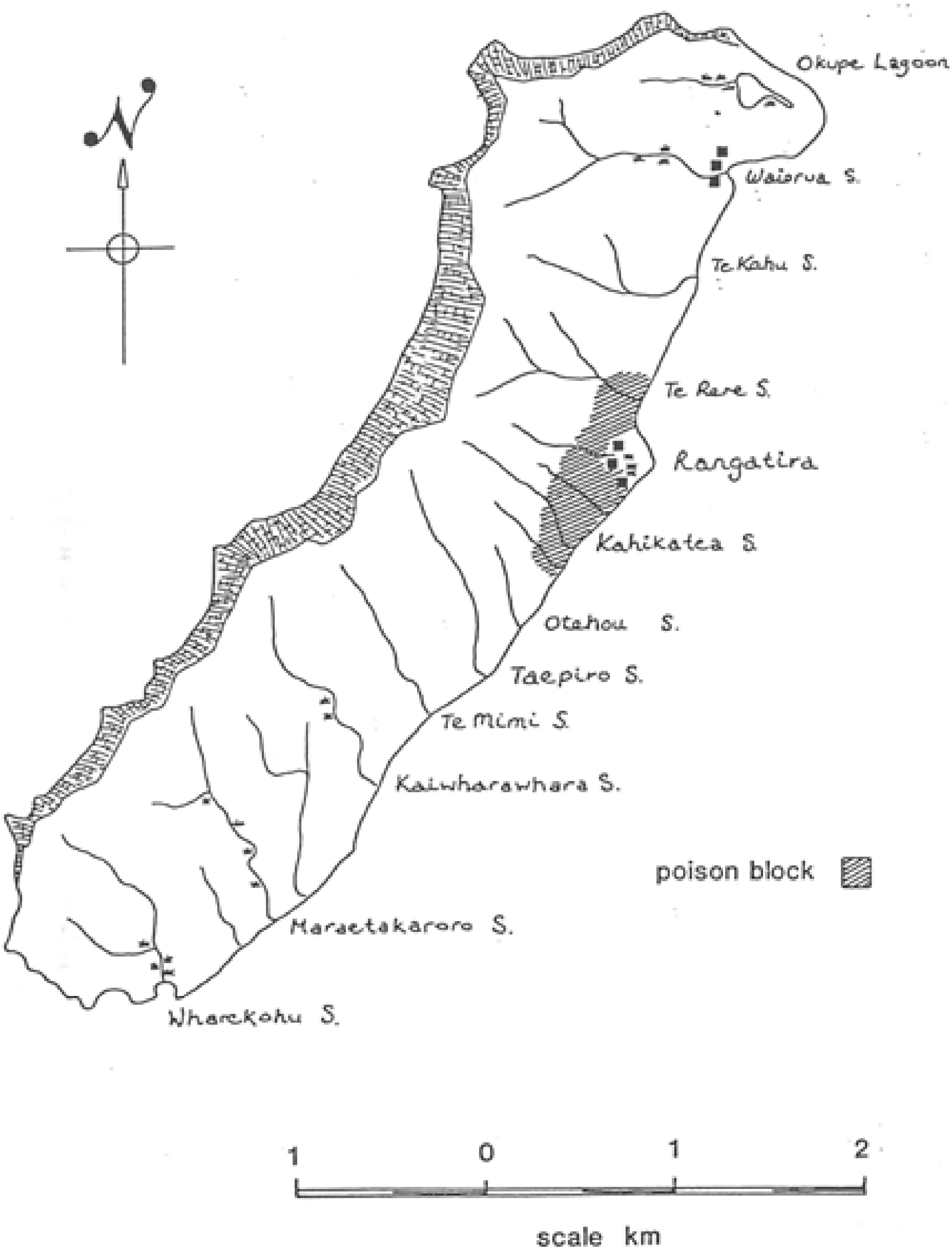

Fig. 9 Kapiti Island showing poison block

Table 14. Results of rat trapping inside and outside poison block

Month	Rats/100 trap nights	
	Inside and outside before poisoning (1 trapline)	
March 84	7.27	
	Inside and outside just after poison laid (1 trapline)	
May 84	7.24	
	Rats/100 trap nights (separate traplines)	
	Inside poison block	Outside poison block
July 84	3.1	11.1
October 84	0.0	1.4
January 85	0.0	7.7

It would protect the saddlebacks inside the area. Recent releases have boosted the numbers of pairs near Rangatira considerably, and now 12 pairs occupy the area covered by the original poison block. During the season there could be about 8 pairs outside the poison block which would serve as a useful control.

It would allow greater numbers of young to become independent, and thus more young (many of which will be box-using offspring of the successful pairs) would be recruited the following year. Further transfers to Kapiti may not be needed.

It could serve as a useful trial run to see if it is feasible to poison the whole island. A trial run could help to identify possible problems with non-target species such as weka and little spotted kiwi.

As a result of recent successful rodent eradications elsewhere in New Zealand (Thomas and Taylor 1988, Taylor and Thomas 1989) some refinements could be made to a poisoning effort on Kapiti. On Breaksea Island the stations were 50 m apart on lines c. 50 m apart. The spacings of 25 m between bait stations on the existing Kapiti lines could be increased to 50 m. Some additional lines may be needed on Kapiti, because some of the original poison bait stations were placed on tracks cut for the possum project, which were up to 100 m apart.

On Hawea Island (9 ha) Taylor and Thomas (1989) used two baits per station, and the baits were replenished daily over an eleven day poison programme. By then most of the rats had been killed, and bait take had ceased. A poison programme on Kapiti should be run on similar lines, with daily replenishing of stations for the first fortnight. Two or three people will probably be needed during this period. Once rat numbers have been reduced one person should be able to handle the job of rebaiting, because this will be at less frequent intervals. The Kapiti poison block will suffer reinvasion from outside, so the poisoning will be an ongoing effort, especially on the bait station lines around the edges.

5.2.2.1 Disadvantages in Poisoning a Small Area on Kapiti. Although a poison programme for part of Kapiti will help the saddlebacks such projects do have their disadvantages, and some of these are very important. Taylor and Thomas (1989) outlined some of the shortcomings of repeated control with poison or traps, and stressed the need for rapid eradication. On Kapiti the most important disadvantage would be that it could compromise a future project to eradicate rats totally from the island:

> Some rats could get sublethal doses and become bait shy. Although this has not yet been documented with new anti-coagulant poisons such as Talon, it is a possibility. This problem can be aggravated by rats learning from one another to avoid baits and bait stations, and such behaviour may persist for some time.
>
> Rats could become resistant to Talon poison. (This has happened with Warfarin.) Although resistance to Talon and other modern anti-coagulants has not been documented it is a possibility. By running a small poison block on Kapiti, perhaps for several years, we could unwittingly create the right selective pressures for developing resistance.

5.2.2.2 Risks to Non-target Species. During the poisoning programme on Kapiti during 1984-85 there was no evidence that any birds were killed either by Warfarin or Talon. Wekas were seen interfering with the bait stations and, in some cases, removing baits. Although the bait stations had been lengthened to 60 cm to reduce the chances of weka reaching the baits, they were very persistent, and unless the tubes had been very firmly anchored, weka would drag the tubes out from the wire hoops holding them down, and shake the baits out. Although the bait stations do reduce the chances of non-target species such as weka from taking baits, it is important to realise that the main function of a bait station is to provide a known site for laying baits and monitoring bait take; excluding non-target species is secondary. During previous poisoning efforts on Kapiti, I noticed that rats removed the baits and scattered them about over a wide area. Obviously, the bait stations on Kapiti did little to reduce the chances of baits being eaten by non-target species.

Weka are numerous, and losses of weka in the poison block could be difficult to detect because new birds from outside would quickly replace any that were lost. Wekas are known to be vulnerable to rat poison (and were entirely removed from two small islands in the Marlborough Sounds during a project to eradicate ship rats). It would be useful to colour-band as many weka as possible in the poison block and monitor their survival. The existing colour-banded weka in Tony Beauchamp's old study area near the trig would serve as a handy control.

On Mana Island, dead birds were found where Storm anticoagulant was laid in bait stations to eradicate mice. These were mainly introduced species, which had possibly eaten the poisoned grain in the waxed bait pellets. In October 1989 Ian McFadden (pers. comm.) spread Storm baits by hand (no bait stations) and by air on Double Island to eradicate kiore. There was no evidence that any bird was poisoned. Potentially vulnerable species such as the red-crowned kakariki (*Cyanoramphus novaezelandiae*), which feed on fallen fruits and seeds on the ground, were unaffected.

5.2.2.3 Risks of Secondary Poisoning. Taylor and Thomas (1989) found no evidence of secondary poisoning during the Hawea Island poisoning programme, and Ian McFadden (pers. comm.) found no sign of it on Double Island. Taylor's group found no dead rats on the surface on Hawea Island, and potentially vulnerable species such as falcons (*Falco novaesaeelandiae*) and southern skuas (*Catharacta skua lonnbergi*) (the latter a known scavenger) were apparently not affected.

Taylor and Thomas mentioned that insects are not known to be affected by feeding on Talon.

However, insectivorous birds could be at risk by feeding on prey that had consumed poison. Phil Todd tells me that on Mana Island slugs were often found in the bait stations, where they were feeding on the poison. Apparently they were unaffected, but slugs could have been eaten by some of the birds that were found dead on Mana.

5.2.3 Total Rat Eradication. The recent successes eradicating Norway rats on Breaksea (170 ha), Whale (170 ha) and Mokoia (150 ha) Islands suggest that it could be possible to eradicate rats from Kapiti. Although Kapiti is more than ten times bigger than these islands, the methods for eradication could be a scaled-up version of the same approach; the major constraint is obviously funding. Further refinements in eradication methods as a result of experience elsewhere could mean that substantial savings in costs could be made. For example, the work on and other islands seems to show that poisoning non-target species may not be a major problem. This could mean that air drops of poison baits on Kapiti might be feasible, which would reduce labour costs, although some bait station lines would be needed to monitor the success of the operation.

Without rats, Kapiti would be one of our most valuable nature reserves. Not only would saddlebacks thrive as they do on the northern islands, but many other endangered taxa could be introduced. Kapiti would be more suitable than many other islands for such introductions, because in addition to its large size, the island has diverse habitats ranging from open country with lagoons and wetlands to montane broadleaf forests.

Now that we have achieved such remarkable success with rat eradication projects on medium-sized (c. 150-200 ha) islands, we should investigate what might be possible on a larger scale. There are only a few rat-infested islands in the 500-1000 ha range with rats, which could be tried as stepping stones to a project on Kapiti. Hen Island (kiore only and 500 ha in area) is a possibility, but perhaps not such a high priority (Taylor 1989). Codfish (also kiore only; 1360 ha) would also be a possible candidate, but now that Codfish has kakapo (*Strigops hadroptilus*) we cannot afford to threaten their survival by laying poison. A restoration project on Big South Cape (910 ha) would be another possibility, but DOC managers may be unwilling to undertake such a project on an island not part of the DOC estate.

The Southland Conservancy is planning to eradicate Norway rats from Ulva Island (270 ha), off Stewart Island as part of the South Island saddleback recovery plan (Andy Roberts pers. comm.). Ulva will also have considerable value as a refuge for other endangered fauna.

In Auckland plans are afoot (John Craig pers. comm.) to eradicate all noxious mammals from Rangitoto and Motutapu (2320 and 1560 ha), a combined area nearly twice that of Kapiti. The project will involve removing wallabies and possums first, and then rodents and stoats. In the case of the latter two, the pair of islands can essentially be regarded as one, because apart from being joined by a causeway, the coastlines are for some distance well within their swimming range. An even more ambitious scheme is the plan to eradicate ship rats from 3500 ha Norfolk Island (Brian Bell pers. comm.).

Even as recently as the mid 1980's we did not imagine that rodent eradication on such a grand scale was possible (Atkinson 1986). These projects have far-reaching implications for world-wide efforts to save many endemic island species. This is because rather than having to guarantee costly ongoing conservation management, a one-off rodent eradication effort provides a permanent solution.

I urge the Wellington Region of the Department of Conservation to begin planning and budgeting to eradicate rats from Kapiti. The island is far too valuable to be kept in its present rodent-infested state. Although we have not yet attempted to remove rodents from an island this size (2000 ha), recent successes elsewhere suggest that eradication is an achievable goal.

We can still take advantage of the huge amount of work that was put into the possum programme because much of the track network still exists, and where tracks have grown over, light slashing will quickly open them up again. It has been suggested that the privately-owned land at Waiorua would compromise any effort to remove rats. However, I think if the landowners are informed of the benefits of such a project, and the issues are handled carefully and sensitively, we can expect their enthusiastic support. Also once all rodents have been removed from Kapiti it will be quite easy to protect the island from reinvasion, because without rats it will be feasible to have permanently set bait stations at all landing places.

6. SUMMARY AND CONCLUSIONS

In a renewed effort between 1987 and 1989 to establish saddlebacks on Kapiti Island three transfers of c. 40 birds were made from Stanley Island in the Mercury Group. An earlier series of transfers to Kapiti between 1981 and 1983 (totalling 244 birds) failed because of Norway rat predation at roost and nests.

The 1987-89 transfers were different because about half of the birds were conditioned to roost in boxes designed to protect them from Norway rats. The conditioning was carried out on Stanley Island, and the box-using birds were then transferred to Kapiti where hundreds of roost boxes were provided. The transfers also included control birds not known to use boxes. Survival of the two groups is being compared.

Although many of the box-using birds that survived carried used boxes, some returned to natural roosts, while some of the non-box-using controls became box-users. In April 1990 there were 29 survivors from the three transfers. This total included 20 box users and 9 non-box-users. Box-users had significantly higher survival than non-box-users.

The recent transfers also provided an opportunity to refine release techniques. All previous saddleback releases have been direct. Combinations of direct and gentle releases were tried on Kapiti to see which technique gave the best survival. Gentle releases did not give significantly higher survival. Ten pairs were released from ten widely scattered aviaries sited in potential territories to test the benefits to survival of releasing paired birds. Only two pairs remained intact after release, and all moved away from their release sites. Although a few more paired individuals survived, there survival was not significantly better than unpaired birds.

Predation by rats at roosts was the most important cause of mortality. Although only three birds were actually found dead at roosts during the season, the timing of other losses suggested that they were also due to rat predation. There was no evidence that any birds actually roosting in boxes were taken by rats, but a female and two nestlings were preyed on by a Norway rat at a nest in a roost box. Two females were found rat-killed at nests in natural sites and four other females disappeared when they were probably on nests.

Nest boxes probably helped to reduce the level of nest predation by making more safe nest sites available. Overall, similar numbers of nests were preyed on by all predators in boxes and natural sites; however, a greater proportion of the nests in natural sites was preyed on by rats.

Morepork predation at nest boxes has been a problem on both Kapiti and Stanley Islands. This season many of the nests in boxes were protected by fitting smaller entrance holes and by moving boxes to more secluded sites. At least four nests in boxes have been robbed by starlings. There is a similar problem on Tiritiri Matangi Island, where starlings and mynas have destroyed many nests in boxes. About six fledglings were taken by weka during the season.

The 1989-90 breeding season began with 26 pairs and one spare male, and ended with 17 pairs and eight spare males. It was a productive year, with 72 young fledging, and about 20 became independent.

As a result of using boxes, more of the young produced since 1987 have been recruited compared with previous years. However, between 1987 and 1990 there were still too few being recruited to make up for losses of adults, and the Kapiti population is declining.

In 1989-90 several nests were protected from possible rat predation by shifting them off the ground into nest boxes or by raising the entrance holes. Young fledged successfully from all four nests that were protected.

Monitoring during the 1990-91 season will be less intensive than previously. Priority will be given to surveying the numbers of pairs at the beginning of the season, to assessing how many young have been recruited, to checking roost and nest box use by surviving birds and doing some nest monitoring.

A poison programme using existing bait stations and Talon poison could be undertaken during 1990-91 near Rangatira. This would protect about 12 saddleback territories, and also serve as a trial for a poison project to cover the whole island.

The Department of Conservation should now look very seriously at eradicating rats from Kapiti. This would greatly enhance the value of the island for endangered fauna.

7. ACKNOWLEDGEMENTS

I would like to thank the many volunteers who have assisted with the project. Thanks also to our boatman, Neil Hopkins of Whitianga, who provided transport to and from Stanley on the ‘Maire’. Sincere thanks also to Peter and Linda Daniel on Kapiti Island for their enthusiastic support throughout the project. I am much indebted to the Hauraki Gulf Maritime Park Board for permission to work on Stanley Island, and to the Department of Conservation for permission to work on Kapiti, to carry out the saddleback transfers, and for scholarship and logistic support.

I would also like to acknowledge the generous grants from the New Zealand Lottery Board, which have funded all of the field work. Generous sponsorship has also been received from the Auckland University Research Committee, Ltd., New Forest Products Ltd., Red Express Ltd., and Air Coromandel.

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