



Diet of predators in *Nothofagus* forest, Nelson Lakes National Park



DOC RESEARCH AND DEVELOPMENT SERIES 328

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ISSN 1177-9306 (web PDF)

ISBN 978-0-478-14927-2 (web PDF)

This report was prepared for publication by the Publishing Team; editing and layout by Lynette Clelland. Publication was approved by the General Manager, Research and Development Group, Department of Conservation, Wellington, New Zealand.

Published by Publishing Team, Department of Conservation, PO Box 10420, The Terrace, Wellington 6143, New Zealand.

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Diet of predators in *Nothofagus* forest, Nelson Lakes National Park

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Abstract

The diet of stoats (*Mustela erminea*) from beech (*Nothofagus* spp.) forest in Nelson Lakes National Park was studied by assessing the gut contents of 554 animals trapped between 1998 and 2004. Mustelid traps were operated within an 825 ha area subject to intensive rat (*Rattus* spp.) control and in the surrounding c. 4000 ha without rat control. Stoats ate mostly mice (53%) and invertebrates (37%). Bird remains were less common (20%) than in stoat diet in other New Zealand beech forests. Rats were eaten by 9% of the stoats. Female stoats ate fewer rats than males and more mice and invertebrates. The peak mouse and rat abundance that followed the heavy seeding of beech and tussock in 2000 resulted in high rodent consumption (81%) by stoats in 2000/01. Conversely, bird consumption was low that year. It peaked in 2001/02 when rodent consumption was low, but the variation in bird consumption from year to year was not statistically significant. Stoats ate more birds in the rat-control area and more rats in the non-treatment area. Bird consumption was more closely correlated (inversely) with mouse than rat abundance, especially for female stoats. These results indicate that rat control in beech forests may affect levels of bird consumption by stoats, but to a lesser degree than in podocarp forests where rats are major prey items of stoats. The gut samples of 31 weasels (*M. nivalis*), 12 ferrets (*M. furo*) and 43 cats (*Felis catus*) revealed that although invertebrates and rodents predominated in the diet of these predators, birds and aquatic prey were also taken. Lagomorphs and other large mammals did not contribute as much to the diet of cats and ferrets in this beech forest as in more open habitats or podocarp forests.

Keywords: stoat, *Mustela erminea*, diet, beech forest, *Nothofagus* spp., mouse, *Mus musculus*, rat, *Rattus* spp.

© Copyright December 2011, Department of Conservation. This paper may be cited as:

Clapperton, K.; Maddigan, F.; Gillies, C.; Murphy, E. 2011: Diet of predators in *Nothofagus* forest, Nelson Lakes National Park. *DOC Research and Development Series 328*. Department of Conservation, Wellington. 12 p.

1. Introduction

The mixed beech forest ecosystem on the slopes of the St Arnaud Range of Nelson Lakes National Park is under intense pest management as part of the Rotoiti Nature Recovery Project, Nelson Lakes National Park (Butler 2003). This ‘mainland island’ is representative of the highly productive honeydew-producing *Nothofagus* forests of the upper South Island. Maintaining low mustelid densities in the Rotoiti Nature Recovery Project has aided the recovery of the local kākā (*Nestor meridionalis*) population (Taylor et al. 2009) and allowed for the reintroduction of great spotted kiwi (*Apteryx haastii*) (Paton et al. 2004a). The reduction of rat (*Rattus* spp.) densities is thought to have led to successful breeding of the robin *Petroica australis* (Butler 2003) and is likely to have other direct positive effects on the forest ecosystem (Innes et al. 1995).

Rat control can also have indirect negative effects. A lack of availability of rats following pest control operations can lead to increased predation by stoats (*Mustela erminea*) on birds in podocarp forests (Murphy et al. 1998). In an ecosystem where mice (*Mus musculus*) are abundant, however, the detrimental effect of rat control on conservation outcomes can be reduced by the release of the mouse population from competitive exclusion or predation by rats, providing an alternative prey source for stoats (Clout et al. 1995; Innes et al. 1995; Miller & Miller 1995; Murphy et al. 1999).

In this study, we aimed to determine the diet of stoats and other predators caught as part of pest management activities for the Rotoiti Nature Recovery Project. We describe how their diet varies with changes in prey availability, and the impact of rodent control on bird predation by stoats over 7 years of intensive management.

2. Methods

2.1 Study area

The study was based around the Rotoiti Nature Recovery Project (hereafter RNRP), which comprises c. 5000 ha of montane mixed beech (*Nothofagus* spp.) forest on the western slopes of the St Arnaud Range and the southern part of Big Bush at Nelson Lakes National Park in the northern South Island. The study area occupies an altitudinal range from 680 m at the lake edge to c. 1400 m at tree line. The lower slopes are dominated by red beech (*Nothofagus fusca*) and silver beech (*N. menziesii*) with mountain beech (*N. solandri* var *cliffortoides*) and kānuka (*Kunzea ericoides*) on sites with poor drainage. Silver and mountain beech occupy the upper slopes, with pure mountain beech near the tree line. The area is bordered to the east by Lake Rotoiti and to the northeast by St Arnaud village and adjoining farmland. For the purposes of this paper, we consider the 5000 ha RNRP management area to be that encompassed within the 2001–2004 mustelid trapping lines (Fig. 1). It is home to South Island kākā, New Zealand falcon (*Falco novaeseelandiae*), yellow-crowned parakeet (*Cyanoramphus auriceps*), various common forest-dwelling bird species, long-tailed bats (*Chalinolobus tuberculatus*), *Powelliphanta* snails and a rich arthropod community (Saunders 2000; Ewers 2002; Paton et al. 2004b). The native beech mistletoes (*Peraxilla* and *Alepis* spp.) are found in RNRP (Butler 2003).

Rodents (specifically ship rats, *Rattus rattus*) and mustelids (primarily stoats) and cats (*Felis catus*) have been controlled since the start of the RNRP in February 1997 (see below). Possums (*Trichosurus vulpecula*) and wasps (*Vespula* spp.) have also been controlled at various intensities across significant areas of the RNRP area since the programme started, but details of these operations will not be reported here. Management also involved monitoring populations of a range of native and introduced animal species and seedfall of beech trees and tussock (*Chionochloa* spp.).

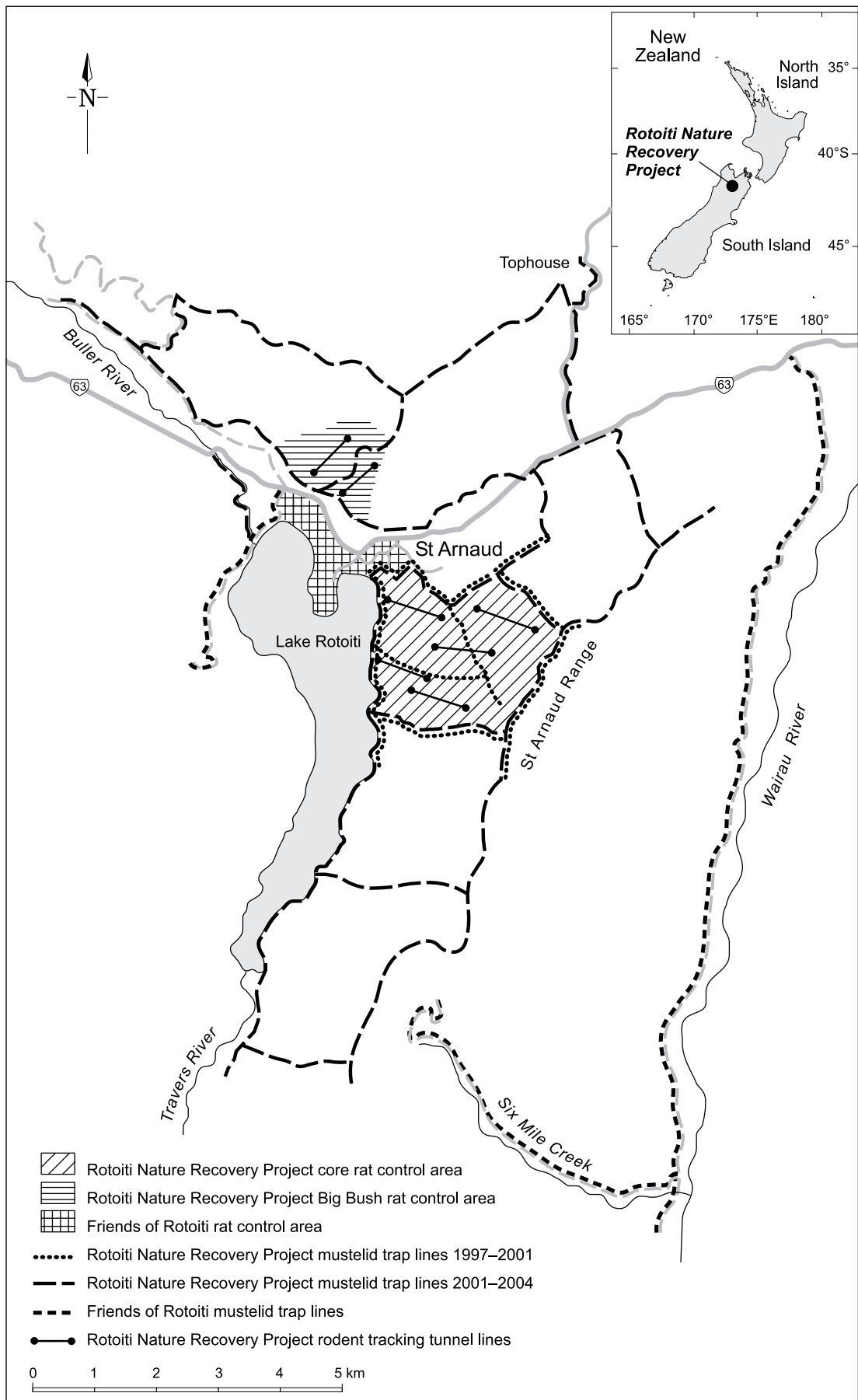


Figure 1. Map of the Rotoiti Nature Recovery Project study area showing the three rat control areas (shaded) and the surrounding c. 4000 ha of non-treatment area, the rodent monitoring tracking tunnel lines and the mustelid control trapping network.

2.2 Rodent control

Philproof bait stations (Philproof Pest Control Products, Hamilton, NZ), designed to deliver poison baits to both rats and possums, were set up in a grid over an area of 825 ha from the lake shore to the bushline (RNRP core rat-control area Fig. 1). Bait stations were spaced at 100 × 100 m intervals over the lower parts of the block and every 100–150 m above 900 m a.s.l. from December 1997 until July 2000. Brodifacoum (Talon[®] WB—Syngenta Crop Protection Ltd. Auckland, NZ) was placed in the bait stations to control both possums and rats. Bait stations were checked and re-baited every 4–6 weeks.

From August 2000, rat control was changed from poisoning to trapping (while possum control changed to cyanide poisoning and leg-hold trapping). A single Victor Professional rat trap (Woodstream Corp. Lititz, USA) was placed at each of the bait station locations. Traps were checked either weekly or fortnightly. A second area of intensive rat control was established in the Big Bush area north of St Arnaud village in October 2001 (Fig. 1), with 285 Victor Professional rat traps arranged in a 200 × 50 m grid (Paton et al. 2004a). Rat trap lines were also operated within St Arnaud village by concerned residents ('Friends of Rotoiti').

Until 2000, rodent poisoning targeted both rats and mice. It reduced rat numbers but did not affect mouse abundance (Butler 2003). As only rat and not mouse traps were used, mice were not targeted after the change to trapping (Butler et al. 2003).

2.3 Mustelid control

A network of Mark VI Fenn traps (FHT Works, Worcester, UK) was initially established to control mustelids in 1997/98). Trap-line configuration consisted of perimeter trapping of contiguous ~800 ha blocks. Initially targeting one 825 ha block with 293 traps, the trapping regime was expanded in 2001/02 and now covers c. 5000 ha, including the two rat-control areas and St Arnaud village and the surrounding c. 4000 ha non-treatment area (Fig. 1). Since December 2001, two additional mustelid trap lines have been managed by the 'Friends of Rotoiti' on the eastern side of the St Arnaud Range and along the ski-field access road on the western side of the lake (see Fig. 1). By November 2002, 893 trap sets were in operation (Paton et al. 2004b). Traps were spaced at 100 m intervals. They were enclosed in single-entrance wooden plywood tunnels and baited with a fresh egg or, occasionally, a piece of fresh rabbit. Traps were checked monthly or sometimes more frequently.

2.4 Rodent monitoring

Rat and mouse abundance in the rat-control area was monitored using standard DOC tracking tunnel protocol (King et al. 1994; Gillies & Williams 2007). Tunnels baited with peanut butter and containing tracking papers treated with ferric nitrate and tannic acid were checked monthly between December 1998 and September 2001 and then quarterly until February 2004. Details of the rodent monitoring lines, methods and results are given by Butler (2003), Butler et al. (2003) and Paton et al. (2004a, b). The monitoring lines ran through the main RNRP rat control area and the additional Big Bush rat control area (Fig. 1). Rat and mouse footprint records are expressed as the percentage of tunnels tracked. Monthly records were averaged to provide quarterly data throughout the study period.

2.5 Diet analysis

Stoats and other predators caught in Fenn traps in both the rat control and non-treatment areas were collected and frozen for later autopsy and analysis. Stomach and intestinal contents were washed in a 0.5-mm sieve and stored in 70% ethanol. Gut contents were sorted under a low power ($\times 10$) microscope. The remains of mammals were identified as either mice, rats, lagomorphs—rabbits (*Oryctolagus cuniculus*) or hares (*Lepus europaeus*)—or mustelids from bones, teeth or hair scale patterns (Day 1966; Brummer & Coman 1974). Bird remains were identified to order (where possible) by analysing the structure of downy barbules under a compound microscope and could sometimes be identified to species by claws or diagnostic feather patterns (Day 1966). Invertebrates, lizards and other animal remains were identified to order, and genus or species where possible. Mustelid remains are excluded from the analyses, as it is not possible to determine whether they were eaten as prey or were the individual's own hairs ingested unintentionally. Eggshell remains that could not be distinguished from hen egg (used as bait in the traps) are also excluded. Those stoats with empty stomachs were recorded.

The frequency of occurrence of prey items is presented as a percentage of the total number of stomachs containing food items. The occurrence of the minor prey items—lagomorph, hedgehog (*Erinaceus europaeus*), possum (*Trichosurus vulpecula*), sheep (*Ovis aries*), and fish, freshwater crayfish (*Paranephrops* sp.) and frog—were assessed for homogeneity and then combined in the analyses as 'other mammals' and 'aquatic', respectively. Differences in the occurrence of prey items between males and females and amongst years (spring to winter) between rat-control and non-treatment areas were compared using Chi-square analysis of frequency data. The frequencies of occurrence of each prey item in each year were used as data for further analysis of the differences in diet between the rat-control and non-treatment areas. The data were expressed as arcsine-transformed proportions and analysed using paired *t*-tests.

The relationship between the consumption of various prey items by stoats and rat or mouse abundance in the rat-control area was analysed using Spearman's rank correlation, after subdividing the % frequency of occurrence stoat diet data into quarterly sums (using summer and autumn data only to avoid biases from low sample sizes and male/female catch rate differences).

3. Results

3.1 Stoats

In total, 686 stoats were captured in the Fenn traps in the study area between January 1998 and June 2004. Of these, 545 contained identifiable gut contents. They included 286 stoats caught in the rat-control area (including 7 from St Arnaud village), 261 in the non-treatment area and 7 with no location records.

Of the trapped stoats, 40% were female, 59% were male and the remaining 1% could not be sexed. Captures of males and females were proportionate across the different years of the study and between the rat-control and non-treatment areas. Males made up a higher proportion of the captures in spring (78%) than in the other seasons (44–60%). Females were caught relatively more often in autumn (Table 1).

Overall, mouse remains appeared in 53% of the stoat guts analysed (Table 1). Invertebrates were the next most commonly consumed food group, occurring in 36% of guts. Birds and/or eggshell were found in 19%, and rats in 9% of the samples. Lagomorphs and other mammals, lizards and aquatic prey were seldom eaten (Table 1). Vegetation was found in 18% of the samples.

Fifty-two per cent of the bird remains were identified as passerines, including chaffinch (*Fringilla coelebs*), possibly yellowhammer (*Emberiza citrinella*) and *Turdus* spp. (blackbird or thrush). Invertebrates included orthopterans (tree weta, ground weta, cave weta and grasshoppers), coleopterans (including scarab, carabid and longhorn beetles), hymenopterans (ants and

Table 1. Frequency of occurrence (%) of the prey items found in guts of stoats captured in the Rotoiti Nature Recovery Project subdivided by sex and season, and in each year (spring to winter) from 1998/99 to 2003/04. *P*-values are for Chi-square goodness-of-fit tests; – indicates expected frequencies too small for Chi-square testing.

	<i>n</i>	RAT	MOUSE	TOTAL RODENTS ¹	OTHER MAMMAL ²	BIRD ³	INVERTE- BRATE	LIZARD	AQUATIC ⁴
Overall ⁵	545	9.0	52.7	66.1	3.9	19.3	36.3	2.2	0.9
Male	292	11.6	51.0	67.1	4.8	19.9	36.0	1.4	0.7
Spring	59	6.8	71.2	86.4	1.7	11.9	33.9	0.0	0.0
Summer	166	13.9	44.6	62.0	6.0	24.1	34.9	1.8	1.2
Autumn	48	14.6	47.9	66.7	4.2	16.7	33.3	0.0	0.0
Winter	19	0.0	52.6	52.6	5.3	15.8	57.9	5.3	0.0
Female	200	4.0	55.5	62.5	2.5	17.0	41.0	3.5	1.0
Spring	15	6.7	73.3	80.0	0.0	13.3	40.0	0.0	0.0
Summer	110	4.6	49.1	56.4	2.7	20.9	40.0	5.5	0.9
Autumn	61	3.3	60.7	67.2	1.6	11.5	44.3	1.6	1.6
Winter	14	0.0	64.3	71.4	7.1	14.3	35.7	0.0	0.0
1998/1999	36	5.5	58.3	66.7	0.0	19.4	27.8	2.8	0.0
1999/2000	97	4.1	63.9	73.2	4.1	20.6	26.8	3.1	1.0
2000/2001	170	7.1	68.8	81.2	1.8	11.8	30.6	1.8	0.6
2001/2002	52	5.8	32.7	42.3	9.6	30.8	42.3	3.9	0.0
2002/2003	104	16.4	33.6	53.8	7.7	21.2	39.4	2.9	1.0
2003/2004	86	12.8	40.7	57.0	1.2	23.3	54.7	0.0	2.3
<i>P</i>		–	0.0002	0.013	–	0.089	0.020	–	–

¹ Includes the rats and mice from the previous columns and other unidentifiable rodents.

² Includes lagomorph, possum, sheep, hedgehog.

³ Includes eggshell other than bait.

⁴ Include fish, freshwater crayfish and frog.

⁵ Includes specimens that could not be sexed.

common wasps, *Vespula vulgaris*), lepidopteran larvae, dipterans, hemipterans (cicada), two centipedes or millipedes, earthworms and a spider. Aquatic prey included unidentifiable fish matter and one freshwater crayfish.

Female stoats ate a third fewer rats than males ($\chi^2 = 97.769$, $df = 1$, $P \leq 0.0001$). The male stoats consumed rats mostly during the summer and autumn months, at the expense of mouse consumption, which remained high (>50%) throughout the year in females (Table 1).

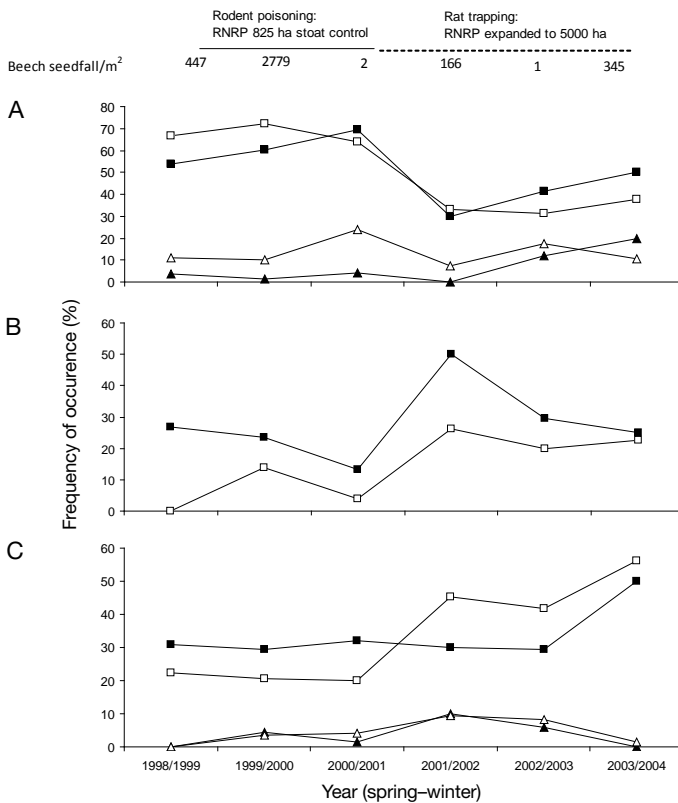


Figure 2. Frequency of occurrence of the major prey items in the diet of stoats caught in the rat-control area (closed symbols) and in the non-treatment area (open symbols) of the Rotoiti Nature Recovery Project between 1998/99 and 2003/04: (A) mouse (square) and rat (triangle); (B) bird; (C) invertebrates (square) and other mammals (triangle). Bird could include eggshell (other than bait material). 'Other mammals' includes lagomorphs (rabbit or hare), possums, sheep and hedgehogs. Data for lizards and aquatic prey are not shown. Beech seedfall data are numbers of viable *Nothofagus fusca*, *N. menziesii* and *N. solandri* seed per m² (adapted from Paton et al. 2004b and Paton et al. 2005).

There was significant variation in stoat diet from year to year between 1998/99 and 2003/04 (Table 1). Mouse consumption was much higher in the first 3 years of the study, corresponding with high beech seedfall, than in the latter 3 years in both the rat-control and non-treatment areas (Fig. 2A). Rat consumption fluctuated, peaking in the later years but also in 2000/01 in the non-treatment area. Bird consumption did not vary significantly from year to year, although the highest percentage consumption was in 2001/02, when both rat and mouse consumption was low. This followed the poor beech seedfall of autumn/winter 2001 (Fig. 2). Bird consumption was lowest in 2000/01, when rodent consumption peaked. Invertebrates made up 20–56% of stoat diet, peaking in 2003–04. Other prey categories combined never reached more than 15% of the diet.

Stoats ate more rats in the non-treatment area than in the rat-control area ($t = 2.45$, $df = 5$, $P \leq 0.037$) but no more mice ($t = 0.050$, $df = 5$, $P > 0.1$). The difference in rat consumption between the areas was greatest in 2000/01 (Fig. 2A). Bird consumption was higher in the rat-control area than the non-treatment area ($t = -2.76$, $df = 5$, $P \leq 0.020$; Fig. 2B).

Within the rat-control area, monthly mouse consumption rates were positively correlated with mouse abundance, as expected ($r_s = 0.742$, $P < 0.025$). Bird consumption was not significantly correlated with either mouse abundance ($r_s = -0.363$, $P > 0.05$), or rat abundance ($r_s = -0.179$, $P > 0.05$). Nor were there any relationships between invertebrate or other diet items and rodent abundance. When considering data from female stoats only, there was a significant negative correlation of the rate of bird consumption with mouse abundance ($r_s = -0.66$, $P < 0.05$) but not with rat abundance ($r_s = -0.48$, $P > 0.05$), as well as the expected relationship between mouse consumption and mouse abundance ($r_s = 0.62$, $P < 0.05$) (Fig. 3).

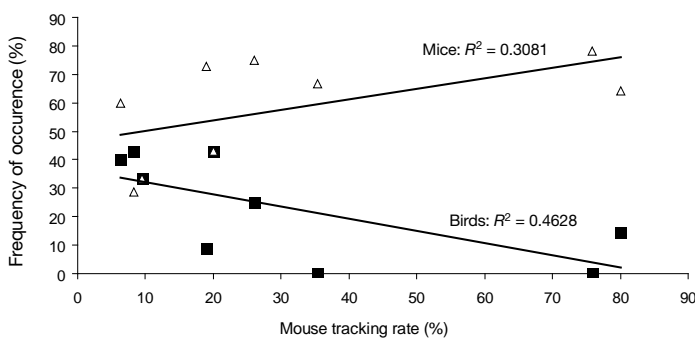


Figure 3. The relationship between the frequency of occurrence of birds (square) and mice (triangle) in the diet of female stoats in the rat-control area of the Rotoiti Nature Recovery Project and the abundance of mice expressed as the proportion (%) of tracking tunnels with mouse prints, measured every summer and autumn between summer 1998/99 and summer 2003/04.

3.2 Weasels, ferrets and cats

Thirty-six weasels (*Mustela nivalis*), 18 ferrets (*M. furo*) and 49 cats were also caught in the Fenn traps, providing 31, 12 and 43 identifiable gut samples, respectively. Details of the diet of these predators are provided in Table 2. There were too few captures to subdivide the samples by rat control vs. non-treatment or by year. None of the ferrets was caught in the rat-control area.

The weasels ate mostly invertebrates and mice (Table 2). They also ate birds and rats. Lizard, sheep, possum and fish remains were each found in one gut. As for the stoats, male weasels ate more rats and fewer mice and invertebrates than female weasels.

Invertebrates, lagomorphs, birds and rats were the most common prey items of cats (Table 2). They also consumed mice, possums, fish and a crayfish. Male cats ate more rats and less mice and birds than female cats.

Invertebrate remains were found in five of the 12 ferret guts, rats in three, birds and lagomorphs and mice each in two, and eggshell in one. One ferret had eaten a whistling frog (*Litoria ewingii*) and there was sheep wool in one other ferret gut. Only female ferrets had eaten birds (Table 2).

Table 2. Frequency of occurrence (%) of the prey items found in guts of male and female weasels, cats and ferrets captured in the Rotoiti Nature Recovery Project from 1998 to 2004.

	<i>n</i>	RAT	MOUSE	ALL RODENTS ¹	OTHER MAMMAL ²	BIRD ³	INVERTE- BRATE	LIZARD	AQUATIC ⁴
Weasel	31	12.9	25.8	45.3	6.5	12.9	54.8	3.2	3.2
Male	20	20.0	15.0	45.0	10.0	15.0	40.0	5.0	5.0
Female	11	0	45.5	45.5	0.0	9.1	81.8	0.0	0.0
Cat	43 ⁵	20.9	16.2	39.5	34.9	23.3	51.2	0.0	4.7
Male	18	22.2	5.5	27.8	44.4	16.7	55.5	0.0	5.5
Female	22	9.1	27.3	40.9	31.8	31.8	50.0	0.0	4.5
Ferret	12	25.0	16.7	41.7	25.0	25.0	41.7	0.0	8.3
Male	5	20.0	20.0	40.0	40.0	0.0	40.0	0.0	0.0
Female	7	28.6	14.3	42.7	14.3	42.9	42.9	0.0	14.3

¹ Includes the identified rats and mice from the previous columns and other unidentifiable rodents.

² Includes lagomorph, possum, sheep, hedgehog.

³ Includes eggshell other than bait.

⁴ Includes fish, freshwater crayfish and frog.

⁵ Includes three of undetermined sex.

4. Discussion

The high incidence of mice, invertebrates and birds in the diet of stoats caught at RNRP is typical of stoats living in beech forest habitat (summarised by King & Murphy 2005), while in other habitats, rats and/or lagomorphs can contribute more to the diet (e.g. Murphy & Bradfield 1992; Murphy et al. 1998, 2004; Dowding & Elliott 2003; Murphy et al. 2008). The frequency of occurrence of birds in the current study was lower and that of mice higher than in other published data for beech forests (King & Moody 1982; King 1983; Murphy & Dowding 1994; Smith 2005) but similar to those of Murphy & Dowding (1995).

Even with relatively few rats and lagomorphs available, there were differences between the diet of male and female stoats (and weasels) caught at RNRP. This contrasts with the results of Murphy & Dowding (1995), who found no difference in diet between the sexes in stoats in beech forest that were also strongly dependent on mice, but with no rats in the diet. The sexual dimorphism in diet seen within RNRP is more typical of that found in habitats where the larger prey items are more abundant (Murphy et al. 1998; Murphy et al. 2008). In podocarp forest, however, rat consumption by female stoats is typically higher than that observed at RNRP. Rat control at RNRP is likely to affect only the diet of male stoats because females ate few rats there. So it is likely that the rat control will have less of an effect on the consumption of birds and invertebrates than at sites where female stoats are also dependent on rats and are likely to switch prey items if rats are removed as a food source (Murphy et al. 2008).

The frequency of occurrence of mice in the stoat guts was exceptionally high in some years of the current study, peaking in 2000/01. This was the year of maximum mouse and rat abundance. This was probably not related to the change in rodent control from poisoning to trapping—the pattern of stoat diet changes were the same in both the rat-control and non-treatment areas. However, any differences between the areas may have been obscured. The small size of the control area (825 ha) in that (and previous) years meant that the stoats may have consumed prey outside the control area before being caught in it. The most likely driver of the high rodent consumption in 2000/01 is the major beech seedfall in 2000 that led to an increase in available rodent prey (Butler 2003). Although 1999 and 2002 also had high seedfall, the overall energy input into the beech forest ecosystem was markedly higher in 2000 (Paton et al. 2005). This is because of the different proportions of seeds from the various beech tree species that contain different levels of energy content (Beggs 1999; Paton et al. 2005), and heavy seeding of alpine tussocks coinciding with the beech mast that year (Butler 2003). The increase in mouse consumption by stoats following mast seedfall years in New Zealand beech forests has been well documented (King 1983; Murphy & Dowding 1995; Purdey et al. 2004).

The high dependence on mice by stoats, and their presence in the diets of cats, ferrets and weasels, provided a buffering effect to minimise the impact of rat control on the diet of predators at RNRP. While more birds were eaten by stoats in the rat-control area each year than in the non-treatment area, overall, the diet switch was more to eating mice than to eating birds or invertebrates. In winter, and following non-mast years, when mice were scarcer (Butler 2003), stoats did increase bird consumption, but they also supplemented their diet with a range of other prey items, including larger mammals. It was only in 2001/02, when both rats and mice were scarce (Butler et al. 2003), that bird consumption levels equalled rodent consumption levels.

The lack of dependence of stoats on rats as a major prey item means that at RNRP we did not see the strong diet switching from rat to bird that has been observed elsewhere (Murphy & Bradfield 1992; Murphy et al. 1998, 2008). This may have been partly because the rat-control operations enhanced mouse survival (Innes et al. 1995; Miller & Miller 1995). There was a possible inverse relationship between rat and mouse abundance at Rotoiti during the current study, but this may have been an artefact of mice having better access to monitoring tunnels and baits when rats were scarce (Butler 2003).

The diet of weasels at RNRP was similar to that of stoats. It was dominated by mice and invertebrates, as recorded in other studies in New Zealand (summarised by King 2005), but not to the same extent as in podocarp forests at Mapara and Kaharoa (Murphy et al. 1998). Birds and rats were found in a higher percentage of weasel guts from Rotoiti than reported from elsewhere (King 2005). At RNRP, ferrets and cats ate fewer lagomorphs and other large prey and more rodents than they do in open habitats (summarised by Clapperton & Byron 2005 and Gillies & Fitzgerald 2005) and in podocarp forest (Murphy et al. 1998). While bird consumption varies from site to site (Clapperton & Byron 2005), the 43% consumption rate by female ferrets recorded here is relatively high, as is the consumption rate of invertebrates by both sexes.

5. Conclusions

The diet of stoats at RNRP was typical of stoats living in New Zealand beech forests, with a strong dependency on mice. Male stoats ate more rats and fewer mice than females. Stoat diet varied from year to year, with the highest consumption of birds in non-mast years, when mouse consumption was low. Stoats ate fewer rats in the rat-control area than in the non-treatment area. They ate more birds where rats were controlled than the non-controlled area in most years of the study, but this result was not strongly linked to changes in consumption of rats. The limited impact of rat control on bird predation by stoats is attributed to the strong reliance on mice in the diet (especially in females), and the either neutral or possibly even positive effect on mouse abundance of the rat control operations, and the buffering effect of invertebrate and other prey availability. The presence of mice in the diet of weasels, cats and ferrets suggests that these predators also consumed mice when rats were scarce, but they also consumed high levels of both birds and invertebrates.

6. Acknowledgements

This study was funded by the Department of Conservation (Investigation Number 3440). The authors are grateful to Matt Maitland, Genevieve Taylor, Brian Paton, David Butler and all the other Rotoiti team members, Friends of Rotoiti and other workers for many hours of fieldwork. Thanks to Alison Evans for identifying invertebrates and Peter Alspach for alerting us to Simpson's Paradox. Thanks also to Chris Edkins for drafting Fig. 1.

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