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Flexibility of diet of stoats on Fiordland islands, New Zealand

Elaine C. Murphy[1]*, Craig Gillies[2], Fraser Maddigan[1], Peter McMurtrie[3], Kerri-Anne Edge[3], Maheswaran Rohan[4], B. Kay Clapperton[5]

[1]Department of Conservation, Private Bag 4715, Christchurch 8140, New Zealand
[2]Department of Conservation, PO Box 516, Hamilton 3240, New Zealand
[3]Department of Conservation, PO Box 29, Te Anau 0640, New Zealand
[4]Department of Biostatistics and Epidemiology, Auckland University of Technology, Auckland 1142, New Zealand
[5]56 Margaret Avenue, Havelock North 4130, New Zealand
*Author for correspondence: (Email: emurphy@doc.govt.nz)

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Abstract: The eradication operations to remove stoats (*Mustela erminea*) from islands in Fiordland provided an opportunity to assess the diet of stoats in areas with no rodents or with only mice (*Mus musculus*) available as mammalian prey. The carcasses of stoats trapped on Chalky Island in 1999, Secretary Island and the adjacent mainland in 2005, and Resolution Island in 2008 were collected and their gut contents analysed. On rodent-free Chalky Island, most of the stoats had consumed birds, mostly passerines. Stoats on Secretary Island (rodent-free) and Resolution Island (mice present) preyed mostly on invertebrates, particularly wētā (Orthoptera). On Resolution Island, mice were probably at relatively low densities, and were consumed by only 12% of the stoats. While average consumption of birds and invertebrates was lower for stoats at the mainland site, the only significant differences amongst the sites were the high bird consumption and low invertebrate consumption on Chalky Island compared with the other sites. The diet of male stoats was similar to that of female stoats on both Secretary Island and Resolution Island. Chalky Island male stoats were heavier than those on the other islands, while the females on the various islands had similar body weights. The variability in diet of stoats from these islands may in part reflect the temporal and spatial differences between the samples. However, it demonstrates the adaptability of stoats, and their ability to survive without mammalian prey in different ways. It supports the hypothesis that differences in body weights of stoats are at least partly driven by variation in prey size and/or availability.

Keywords: bird predation; body weight; invertebrate; mouse; *Mus musculus*; *Mustela erminea*; weta

Introduction

Stoats (*Mustela erminea*) were introduced to New Zealand in the 1880s in an attempt to control rabbits (*Oryctolagus cuniculus*). At the time, conservationists warned that stoats would have a devastating impact on native birds but they were ignored (King & Murphy 2005). Stoats spread rapidly throughout the South Island and even remote islands in Fiordland had been invaded by the early 1900s (King & Murphy 2005).

In their native habitats in the northern hemisphere, stoats evolved as specialist predators of small vertebrates (rodents, birds and lagomorphs) and eat insects only rarely (King & Powell 2007). The main prey items of stoats in mainland New Zealand forests are usually house mice (*Mus musculus*) and/or rats (ship rats *Rattus rattus,* Norway rats *R. norvegicus*) (King & Murphy 2005). In non-forested areas, rabbits can predominate in stoat diet (e.g. Alterio & Moller 1997). Birds can also make up a high proportion of stoat diet (King & Murphy 2005; Smith et al. 2008). However, invertebrates can be important prey where mammals are relatively uncommon (e.g. alpine or open tussock/riverbed areas). They are a good alternative source of protein and other nutrients (Banjo et al. 2006). Orthoptera: Anostostomatidae (wētā) and Coleoptera (beetles) are the two most common orders of invertebrates found in stoat guts (Murphy & Dowding 1995; Purdey et al. 2004; Smith et al. 2005, 2008; Murphy et al. 2008).

In New Zealand forest habitats, the occurrence of birds and invertebrates in stoat diet can be linked with the changes in availability of their main mammalian prey. In beech forests (*Fuscospora* spp.) huge synchronous production of seeds occurs every few years (mast years) and mice, birds and invertebrates become very numerous (King 1983; Murphy & Dowding 1995; Alley et al. 2001). In mast years, mice are a major prey of stoats but in non-mast years when mice are scarce, stoats eat more invertebrates and lagomorphs (Murphy & Dowding 1995; Smith et al. 2005). This ability to change their diet is also seen in podocarp forests, where seasonal changes in rodent abundance induce functional responses in stoat feeding behaviour (Jones et al. 2011). Reductions in rat numbers following control operations also affect bird consumption by stoats (Murphy et al. 1998, 2008; Clapperton et al. 2011). So what happens in the complete absence of rodents and lagomorphs? No rats, mice or lagomorphs have been recorded from Chalky Island or Secretary Island, while the only rodent now found on Resolution Island is the house mouse. Veale et al. (2014) suggested that the presence of mice on Resolution Island was the cause of the larger body weight in the resident stoats compared with those on rodent-free Secretary Island. They recommended a study of the diet of these stoats, to test this hypothesis.

Predator-free islands are widely used as sanctuaries for threatened species and New Zealand has become very proficient at eradicating pests from islands (Parkes & Murphy 2003). Because of advances in stoat control, it was thought feasible to eradicate resident stoats and control their potential re-invasion on some islands in Fiordland (Elliott et al. 2010; King et al.

2014). Three such operations have been undertaken – on Chalky Island (Elliott 2010), Secretary Island (Edge et al. 2011; McMurtrie et al. 2011), and Resolution Island (Clayton et al. 2011). Stoat eradication operations on islands have used baited kill traps with protection to avoid non-target captures. They are placed along grid lines spaced such that all individual stoats are likely to encounter a trap within their home range (McMurtie et al. 2011). Stoat eradication operations being undertaken on Chalky Island, Secretary Island, and Resolution Island provided the opportunity for recovery of the captured animals for diet analysis. We assessed the effect of the absence of rodents and lagomorphs on the consumption of other prey, and investigated the link between the diet of stoats and their body weight.

Methods

Chalky Island (46°03'S, 166°31'E)

Chalky Island/Te Kākahu (509 ha; 150 m a.s.l.) is situated near the mouth of Chalky Inlet in southern Fiordland, exposed to the Tasman Sea (Fig. 1). The two Passage islands and Great Island together enable stoats to get to Chalky Island from the mainland by crossing water gaps of between 80 and 1080 m. Chalky Island is dominated by limestone geology and is likely to be more fertile than either Secretary Island or the mainland adjacent to Secretary Island (Brian Rance, Department of Conservation, pers. comm.). Approximately half the island is surrounded by steep cliffs. The canopy is dominated by mountain beech (*Fuscospora cliffortioides*) and podocarp–broadleaf forest. Before the stoat eradication, most of the common bush birds of Fiordland were present. However, there were no robins (*Petroica australis*), weka (*Gallirallus australis*) or kiwi (*Apteryx australis*), and yellow-crowned parakeets (*Cyanoramphus auriceps*) and kaka (*Nestor meridionalis*) were rare. This is presumed to be because of predation by stoats. Variable oystercatchers (*Haematopus unicolor*), sooty shearwaters (*Puffinus griseus*), blue and Fiordland crested penguins (*Eudyptula minor; Eudyptes pachyrhynchus*) bred on the island.

The stoat eradication on Chalky Island started in the winter of 1999, when stoats were thought to be hungriest, as sooty shearwaters and most of the penguins have left the island by then after breeding. Pairs of Mark IV Fenn traps (DB Springs Ltd, Redditch, UK) were placed inside 140 tunnel trap covers spread in a network over the island and pre-baited with either fish or hens eggs (Elliott et al. 2010). The traps were set about 2 weeks later and baited with either hen eggs or 1-day-old chicks. The stoat population was rapidly removed, with only one individual caught after the initial population knock-down in the first 2 weeks (Elliott et al. 2010). Fifteen stoats (six females, nine males) caught on Chalky Island during the first 2 weeks of trapping were autopsied.

Secretary Island (45°14'S, 166°55'E)

Secretary Island (8140 ha; 1196 m a.s.l.) is the second-largest island on the Fiordland coast and is the largest inshore island free of rodents and possums (*Trichosurus vulpecula*) in New Zealand. It is located at the entrance to Doubtful Sound, in the middle of Fiordland (Fig. 1). This part of Fiordland is characterised by remote, enclosed, steep-sided fiords with compressed altitudinal sequences. The island supports a diverse range of plant communities and habitats, ranging from lowland beech-podocarp forest through to sub-alpine scrub, tussock tops and herb field (Mark 1963). The range of forest bird species present was similar to that on Chalky Island but kiwi and weka were also present. Very few, if any, sooty shearwaters nested on the island (Golding et al. 2005).

The eradication programme for stoats from Secretary Island is reported by McMurtrie et al. (2011) and details of the trapping methods are given by Golding et al. (2005) and McMurtrie et al. (2011). Pairs of Mark IV Fenn traps were placed in 945 tunnels in a network around the island. They were pre-baited twice with a hen egg plus rabbit, beef or venison meat in June 2005 and then set and rebaited in July 2005. Stoat eradication has not yet been achieved on Secretary Island and a low population remains as a result of immigration, and breeding by residual resident animals (McMurtrie et al. 2011). Ninety-five stoats were trapped in the first 10 days and 91 (54 females, 37 males) were autopsied.

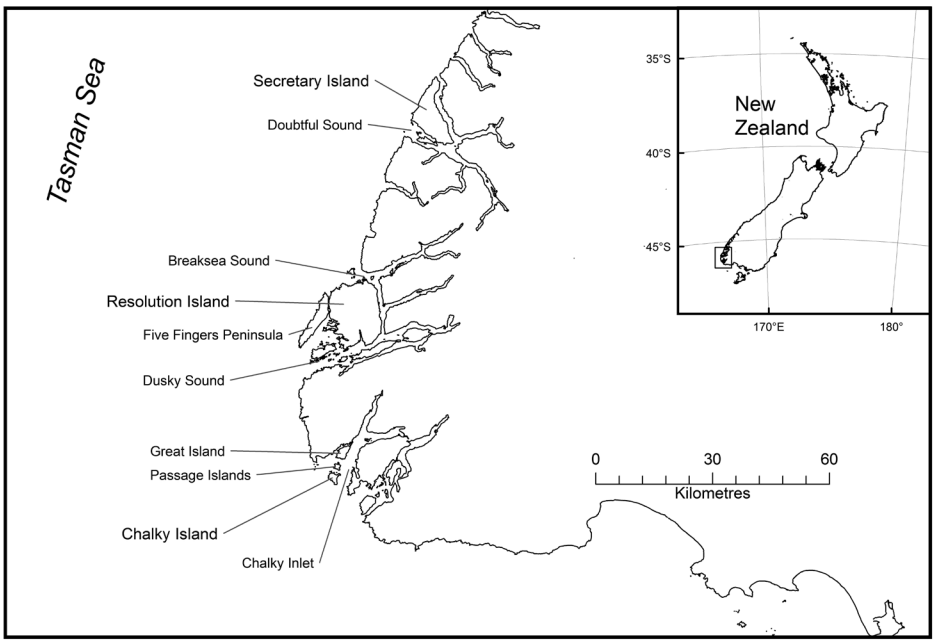

Figure 1. Trapping locations on the islands and mainland site in Fiordland, New Zealand.

Mainland site

A coastal trap line was established on the mainland adjacent to Secretary Island – from Open Cove to Deas Cove, along Thompson Sound and from Espinosa Point to Pack Point in Doubtful Sound (Fig. 1). The vegetation in the trapped areas was broadly similar to the lowland beech forest of Secretary Island. Trapping on the mainland comprised lines of 180 double-set Doc 150 traps (Department of Conservation), baited as for the traps on Secretary Island. Sixteen stoats (5 females, 11 males) caught in July 2005 were autopsied from the mainland trapping site.

Resolution Island (45°40'S, 166°38'E)

Resolution Island, including Five Fingers Peninsula (20 800 ha, 1069 m a.s.l.), between Breaksea Sound and Dusky Sound (Fig. 1), is the largest island on the Fiordland coast and has a diverse range of habitats, including beech and podocarp forests, several alpine areas, wetlands and a variety of coastal habitat (Clayton et al. 2011; Ledgard et al. 2011). The range of forest bird species present was similar to that on Secretary Island and seabirds and shorebirds were uncommon (Ledgard et al. 2011). The only introduced mammals present during the study were stoats, mice (*Mus musculus*) and deer (*Cervus elaphus*).

The eradication operation for stoats on Resolution Island started in 2008, with three sessions of kill trapping, in July and August, after pre-baiting in May and June. Single Doc 150 traps were set under covers every 100 m along the track network across the whole island (McMurtrie et al. 2008; Clayton et al. 2011). They were baited with a hen egg and salted rabbit meat. Over the trapping periods on Resolution Island, 295 stoats were removed from across the whole island, 229 of which were presented for diet analysis. There is still a resident breeding population of stoats on Resolution Island (Veale et al. 2014).

Diet analysis

All stoats were caught within a two-week period of the traps being set in winter. Stoats were frozen and later sexed (by visual assessment and/or presence/absence of baculum) and un-eviscerated body weight measured using Pesola spring scales (Pesola AG, Switzerland). On autopsy, whether there was fat around the kidneys and gut of the captured animals from Secretary Island only was also noted. Gut (stomach and intestine) contents were washed and finely sieved before sorting under a low-power microscope. Bird feathers were classified to Order where possible by the structure of downy barbules, and hairs were identified by the scale patterns (Day 1966; Brunner & Coman 1974; Prast & Shamoun 2001). Invertebrate remains were classified to Order where possible and further identified by Alison Evans, Warren Chin, and Peter Johns. The minimum number of wētā per gut sample was calculated by counting the number of left and right mandibles and the number of abdomens. The frequency of occurrence of prey items is presented as a percentage of the total number of guts containing food items. Differences in the frequency of the major prey items between stoat sexes were compared using chi-square analysis incorporating Yates' correction for continuity for the two islands with adequate sample sizes, Secretary Island and Resolution Island (the islands were analysed separately).

The differences between presence and absence of occurrence of the major prey remains (birds and invertebrate) in stoat guts from the four sites were compared using generalised linear regression with a binomial model. The variable time (Year) was not accounted for in the model; as sampling was only done once per site, we considered this to be a cross-sectional study. Presence/absence of rodents was highly correlated with location, so was not included as a categorical variable, avoiding the statistical issue of multi-collinearity.

The stoat body weights for the four sites were examined using a one-way ANOVA model. Male and female stoat weights were analysed separately because stoats show pronounced sexual dimorphism (King & Murphy 2005). All of these analyses were conducted using R software version 3.0.2 (R Development Core Team 2013).

Results

Chalky Island

All 15 stoats had prey in their guts, and the most common remains found were bird (93.3%, Table 1). Although about half the remains identified were passerines, other bird remains reflected the coastal environment, e.g. Sphenisciformes (penguins) and Charadriiformes (gulls, plovers, etc.). Also present in one sample each were Procellariiformes (petrels) and Sulidae, probably the Australasian gannet (*Morus serrator*). As expected, there were no mammalian diet remains found. The only other prey eaten were invertebrates, found in 20% of the stoat guts. The two identified invertebrate prey items were a wētā (Orthoptera) and a lepidopteran. Both males and females ate birds and invertebrates (Table 2).

Secretary Island

Of the 91 stoats autopsied, four females and three males had empty guts and were removed from further analysis. Bird

Table 1. Percentage frequency of prey occurrence in the gut contents of stoats caught from Chalky Island (n = 15), Secretary Island (n = 84), Resolution Island (n = 224) and the mainland (n = 14). Unid. = unidentified

Prey	Chalky	Secretary	Resolution	Mainland
Mammal	0.0	0.0	11.6	21.4
Rodent	0.0	0.0	11.6	14.3
Unid. hair/bone	0.0	0.0	0.0	7.1
Bird	93.3	26.2	20.5	7.1
Passeriformes	53.3	14.3	12.0	7.1
Sphenisciformes	13.3	0.0	0.0	0.0
Charadriiformes	13.3	0.0	0.0	0.0
Gannet	6.7	0.0	0.0	0.0
Procellariiformes	6.7	0.0	0.0	0.0
Unid. bird	0.0	11.9	8.5	0.0
Fish	0.0	0.0	0.0	7.1
Invertebrate	20.0	92.3	96.9	1.4
Orthoptera (wētā)	6.7	81.0	88.0	50.0
Lepidoptera	6.7	2.4	0.1	0.0
Coleoptera	0.0	1.2	9.8	0.0
Diptera	0.0	0.0	0.4	0.0
Dermaptera	0.0	0.0	1.3	0.0
Spider	0.0	1.2	0.1	0.0
Acari	0.0	1.2	0.0	0.0
Oligochaeta	0.0	0.0	3.1	0.0
Unid. Invert.	6.7	14.3	1.8	21.4

Table 2. Frequency of prey occurrence in the gut contents of female (F) and male (M) stoats caught from Chalky Island (F = 6, M = 9), Secretary Island (F = 50, M = 34), Resolution (F = 173, M = 51) and the mainland (F = 4, M = 10)

Prey	Chalky		Secretary		Resolution		Mainland	
	F	M	F	M	F	M	F	M
Mammal	0	0	0	0	11.6	11.8	0	30
Bird	83.3	100	28	23.5	18.5	27.5	0	10
Fish	0	0	0	0	0	0	0	10
Invertebrate	33.3	11.1	96	88.2	97.7	94.1	100	60

remains were found only in a quarter of the gut samples (Table 1). Passeriformes were the only identifiable Order. Invertebrate remains were found in over 90% of guts, the majority of which were wētā. *Hemiandrus fiordensis* was the most common species identified, with up to four per gut being identified. Cave wētā (Rhaphidophoridae) were also identified. Invertebrates were the only remains in 73.5% of guts. There was no significant difference in the frequency of occurrence of bird ($\chi^2 = 0.042$, d.f. = 1, $P = 0.84$) or invertebrate remains ($\chi^2 = 0.855$, d.f. = 1, $P = 0.36$) in female and male stoats from Secretary Island (Table 2). Stoats from Secretary Island appeared in good condition with fat recorded around the gut mesenteries, kidneys and uterus in females and testes in males.

Resolution Island

On Resolution Island, there were two female and two male stoats with empty guts. Of the 224 stoats autopsied (173 females, 51 males) that contained prey remains, one fifth had consumed bird prey (Table 1). The only identified bird Order was Passiferiformes. Invertebrates, primarily wētā, were found in 97% of the guts. Four guts contained the remains of at least 15 wētā and 18 more had over 10 wētā. As in the Secretary Island sample, the most common wētā species identified was *Hemiandrus fiordensis*. Cave wētā (Rhaphidophoridae) were also identified. Male and female stoats on Resolution Island had eaten similar proportions of mammalian (mouse) and invertebrate prey (Table 2). There was no significant difference in the proportion of male and female guts containing bird remains ($\chi^2 = 1.331$, d.f. = 1, $P = 0.25$).

Mainland (adjacent to Secretary Island)

Of the 16 stoats autopsied, one female and one male had empty guts and were removed from further analysis. Invertebrates were the most common prey remains found in mainland stoats (71%), and the majority were wētā (Table 1). As on Secretary Island and Resolution Island, *Hemiandrus fiordensis* was the most common species identified. Mammalian remains were found in the gut of three male stoats and bird remains in one male stoat (Tables 1 & 2). The females had eaten only invertebrates.

Comparing Chalky Island, Secretary Island, Resolution Island, and the adjacent mainland

Figure 2 compares the proportions of stoat guts containing bird and invertebrate remains from Chalky Island, Secretary Island, the Mainland and Resolution Island. There were significant differences in the frequency of occurrence of bird remains in the stoat guts collected from Chalky Island compared with the other three sites (Chalky vs Secretary $z = -3.556$, $P = 0.0004$; Chalky vs Mainland $z = -3.657$, $P = 0.0003$; Chalky vs Resolution $z = -3.830$, $P = 0.0001$). There were differences in the frequency of occurrence of invertebrate remains in the stoat guts collected from the various sites. Invertebrate consumption on Chalky Island, especially wētā, was significantly lower than at the other three sites (Chalky vs Secretary Island $z = 4.466$, $P < 0.0001$; Chalky vs Mainland $z = 2.295$, $P = 0.0217$; Chalky vs Resolution Island $z = 6.104$, $P < 0.0001$). Although the stoats on the Mainland ate fewer birds and invertebrates than those on Resolution or Secretary Islands, these results were not statistically significant. The sample sizes were small from the Mainland site.

Body weights

Body weights of male and female stoats autopsied from each study site are graphed in Figure 3. The weights of the female stoats were similar on the three islands but those from Chalky Island were significantly heavier than those from the Mainland site ($t = -2.572$, d.f = 236, $P = 0.0107$). The male Chalky Island stoats were significantly heavier than those from all three other sites (Chalky vs Secretary $t = -4.976$, d.f = 106, $P < 0.001$; Chalky vs Mainland $t = -5.630$, d.f = 106, $P < 0.001$; Chalky vs Resolution $t = -4.040$, d.f = 106, $P < 0.001$).

Discussion

This study has described the diets of stoats living on Chalky Island and Secretary Island, two rodent-free islands in Fiordland, and compared them with the diet of stoats on Resolution Island, where mice are present, and on the nearby mainland. The consumption rates of birds and invertebrates by stoats at the different sites did not separate clearly into sites with and without mammalian prey present. Chalky Island stoats had a different diet from the other sites, with the vast

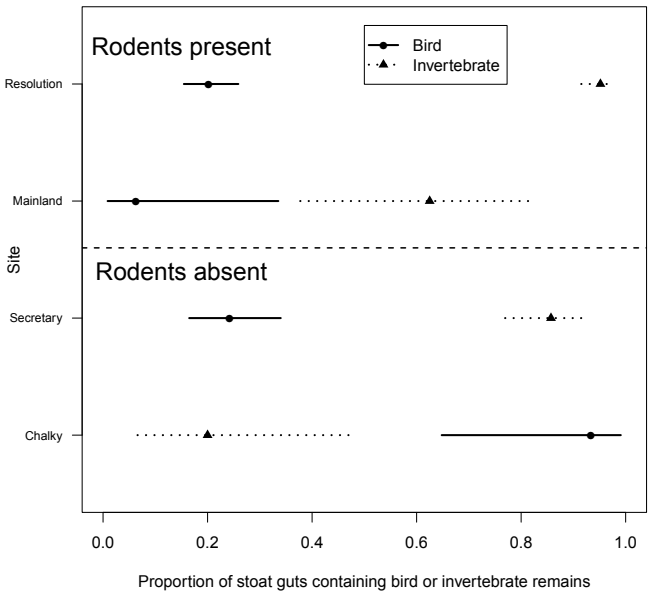

Figure 2. The proportion of guts containing bird or invertebrate remains (95% binomial confidence interval based on the logistic regression) from stoats caught on rodent-free Chalky Island ($n = 15$) and Secretary Island ($n = 84$), and from the two sites with rodents, the mainland adjacent to Secretary Island ($n = 14$) and Resolution Island ($n = 224$).

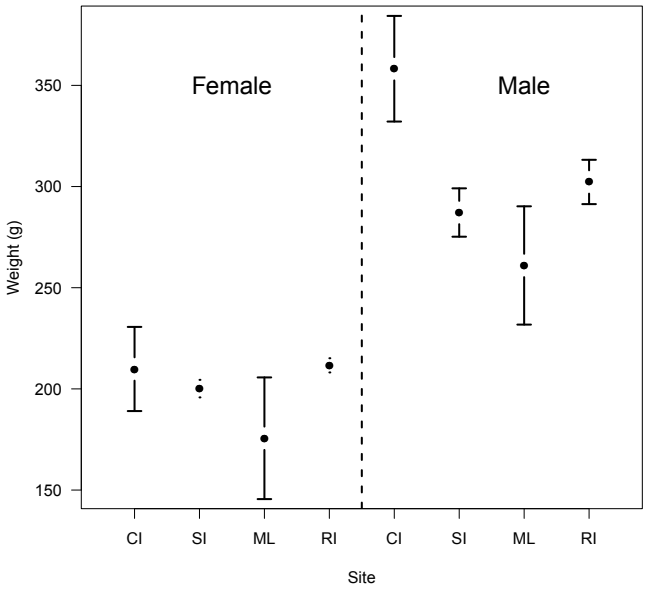

Figure 3. Mean body weights (g) with 95% confidence intervals, of male and female stoats captured from Chalky Island (CI), Secretary Island (SI), the coastal mainland adjacent to Secretary Island (ML), and Resolution Island (RI). The data include the stoats with empty guts.

majority of the guts containing bird remains and only 20% containing invertebrates. Bird consumption was much lower on Secretary Island, where over 90% of the gut samples contained invertebrate remains. Secretary and Resolution Islands had similar consumption rates of both birds and invertebrates, even though stoats on Resolution Island also consumed mice. Mainland stoats, although consuming mammalian prey, also consumed invertebrates at higher rates than those recorded from most other mainland forest stoat populations (King & Murphy 2005).

Birds generally comprise over half the prey recorded from stoats in New Zealand, but the frequency of occurrence (93%) of bird remains in stoats from Chalky Island is one of the highest recorded (King & Murphy 2005). It is similar to that recorded by Cuthbert et al. (2000), who studied stoat diet in a Hutton's shearwater (*Puffinus huttoni*) colony. They found shearwater remains in 99.6% of stoat scats. Birds appear to have taken the place of mammalian prey at these sites. An adult Fiordland crested penguin has been seen with a stoat hanging from its neck (Morrison 1980), suggesting that stoats may be able to kill penguins as well as scavenge carcases.

It is not known whether the different occurrence of birds in the stoat diets between the study areas was because bird abundance was higher on Chalky Island than on the other study sites. The proportion of coastal habitat to forest was much higher on Chalky Island than on Secretary Island, perhaps explaining why stoats on Chalky Island ate more coastal birds. A similar ready source of large birds may not have been available on Secretary Island (Golding et al. 2005) or Resolution Island (Ledgard et al. (2011).

Some of the differences in stoat diet between the sites may also have been a consequence of being sampled in different years. The Chalky Island stoat eradication programme was conducted in 1999, a beech mast year in Fiordland (Dilks et al. 2003; Kelly et al. 2013). Beech seeds are a nutritious food source (Murphy 1992) and forest birds and invertebrates, as well as rodents, increase in abundance in mast years (Murphy & Dowding 1995; Alley et al. 2001; O'Donnell & Hoare 2012). By contrast, the Secretary Island stoats were captured in 2005, a year after a beech mast year. The Resolution stoats were trapped in 2008, two years after a mast year, when prey abundance would have been relatively low (Veale et al. 2014). This is consistent with the low frequency of occurrence of mice in the diet of the Resolution Island stoats compared with stoats sampled in mainland beech forests in peak mouse abundance years (Murphy & Dowding 1995; White & King 2006), and may explain why there was little difference between the diet of stoats from Resolution Island, Secretary Island and the Mainland site. Beech forest cannot sustain high densities of rodents, except during mast years (Murphy & Dowding 1994), and this may have forced the stoats to use invertebrates as an alternative prey.

An alternative explanation for the difference in stoat diet between the islands could be the relative availability of invertebrates. No invertebrate surveys have been conducted on the islands, but Secretary Island is considered to have an ample invertebrate biota (Wickes & Edge 2009). However, it is not known how this compares with invertebrate abundance on Chalky Island. Because there were no rodents on Secretary Island or Chalky Island, and only mice on Resolution Island, invertebrates may have been at a much higher densities than in similar habitats on the mainland.

The level of invertebrate consumption on Chalky Island was similar to that reported elsewhere in New Zealand. In forest habitats on the mainland, the percentage occurrence of invertebrates in the stoat diet is usually below 60% (King & Murphy 2005; Murphy et al. 2008; Clapperton et al. 2011). Even lower invertebrate consumption figures were given for other coastal studies, where birds and/or lagomorphs were plentiful (King & Moody 1982; Alterio & Moller 1997). Most of the gut samples from Secretary and Resolution Islands and the Mainland site contained only invertebrates. Resolution Island was sampled in a rodent 'crash' year (Veale et al. 2014), and mice comprised only 12% of the stoat diet, with the stoats strongly reliant on invertebrate prey. Invertebrate consumption can rise when rodent densities fall (Rickard 1996; Purdey et al. 2004; Smith et al. 2005) and wētā consumption has been shown experimentally to be affected by the availability of mammalian prey (Smith et al. 2011).

The high frequency of occurrence of wētā was also a feature of the diet of stoats on Secretary and Resolution Islands. Although it may be simplistic to consider wētā as 'the invertebrate mouse' in New Zealand ecosystems (Griffin et al. 2011), the term may have some merit with regard to stoat diet, as Orthoptera are a good source of proteins and other nutrients (Banjo et al. 2006). Not only were wētā eaten by most of the stoats but they were consumed in large numbers. However, predation by stoats does not appear to have affected their abundance – wētā were not scarcer on Resolution Island than on the adjacent stoat-free Inner Gilbert Island 6 (Bremner et al. 1984). Wētā also made up the majority of invertebrates eaten in the tussock grasslands and adjacent beech forest of the Murchison Mountains in Fiordland (Smith & Jamieson 2003), alpine grasslands in Borland Valley, Fiordland (Smith et al. 2005) and in podocarp forest of Okarito Forest, South Westland (Rickard 1996).

The stoats on Secretary Island were in good physical condition, so the strong reliance on an invertebrate diet does not appear to have been a disadvantage. Wētā are large orthopterans that could provide good nutrition. However, stoats are carnivores with very high energy requirements (Brown &

Lasiewski 1972), and it has been suggested that reliance on an invertebrate diet may limit body size and breeding success (Carbone et al. 1999; Purdy et al. 2004; Veale et al. 2014) – although the density of stoats on Secretary Island was similar to that on Resolution Island, so breeding success and survival did not seem to have been impacted.

The differences in diet of the stoats described here support the hypothesis proposed by Veale et al. (2014) that the higher body weights recorded for stoats from Resolution Island, compared with those from Secretary Island, was a function of the availability of mice as prey on Resolution Island. While the high body weights of male stoats on rodent-free Chalky Island would appear to be an exception to this pattern, the data presented here on their diet show that the consumption of birds may have offset the lack of rodent prey. In fact, the Chalky Island male stoats were even heavier than those from Resolution Island, which were sampled in a year of low rodent abundance. The density of stoats was higher on Chalky Island as well; 3.14 stoats caught per km^2 (Elliott et al. 2010) compared with 1.55 stoats per km^2 on Resolution Island and 1.40 stoats per km^2 on Secretary Island (Veale 2014).

The lack of differences in the diet of male and female stoats in this study is similar to the results of Murphy and Dowding (1995) for stoats in beech forest. Where there were mice but no rats as mammalian prey, male and female stoats ate similar proportions of both birds and invertebrates. In habitats where there are larger mammals available, males usually consume more large prey items than do females (King & Murphy 2005; Murphy et al. 2008; Clapperton et al. 2011). Sample sizes from Chalky Island were too small for a statistical comparison but five of the six large bird species were eaten by male stoats.

The variability in the diet of stoats trapped from the three islands and one mainland site in Fiordland in this study reflect the flexibility and opportunistic feeding habits of stoats. Stoat diet can vary with availability of prey species, and from year to year because of fluctuations in abundance of prey. On Secretary and Resolution Islands, which lacked mammalian prey, there was a strong reliance on invertebrate prey, while stoats on Chalky Island made use of the high availability of birds.

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