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Comparison of human modified and native forest habitats in the Hunua Ranges, Auckland

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Joanne E Peace

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Table of contents

Acknowledgements.....	ii
General abstract	vi
General introduction	1
1.1 Thesis plan.....	7
Comparison of trophic structures between human modified and native forest.....	9
Abstract	9
2.1 Introduction	10
2.2 Methods.....	21
2.2.1 Study site.....	21
2.2.2 Study species	23
2.2.3 Stable isotope sample collection and pre-treatment	25
2.2.4 Analyses	29
2.3 Results.....	31
2.3.1 Stable isotope analyses.....	31
2.3.2 Stomach content analyses	37
2.4 Discussion	41
North Island Tomtit (<i>Petroica macrocephala toitoi</i>) foraging behaviour: variation with sex, season, year, and habitat type.....	58
Abstract	58
3.1 Introduction	58
3.2 Methods.....	62
3.3 Results.....	63
3.4 Discussion	68
Comparison of invertebrate availability at North Island tomtit (<i>Petroica macrocephala toitoi</i>) ground foraging sites between habitats, years, and sexes.....	73
Abstract	73
4.1 Introduction	73
4.2 Methods.....	76
4.3 Results.....	78
4.4 Discussion	86
General discussion	91
References	104
Appendix I.....	134
Appendix II.....	140

Table of tables

Table 2.1 Number of stable isotope samples analysed from each habitat	27
Table 2.2 Summary of between habitat and season stable isotope comparisons	33
Table 2.3 Summary of within habitat stable isotope comparisons	33
Table 2.4 Trophic level partitioning within each habitat	35
Table 2.5 Summary of intersexual stable isotope comparisons	36
Table 2.6 Comparison of selected terrestrial vegetation $\delta^{15}\text{N}$ and C_3 plant $\delta^{13}\text{C}$	45
Table 2.7 Comparison of selected rat mean $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values	47
Table 3.1 Foraging definitions and variables measured for each foraging event	63
Table 3.2 Foraging comparisons between male and female tomtits	64
Table 3.3 Foraging comparisons between breeding and non-breeding seasons	66
Table 3.4 Foraging comparisons for each sex between years	67
Table 3.5 Foraging comparisons between habitats	68
Table 4.1 Number of leaf litter samples collected by variable	77
Table 4.2 Invertebrate sample habitat comparisons	79
Table 4.3 Invertebrate sample annual comparisons	85
Table 4.4 Invertebrate sample seasonal comparisons (pine)	82
Table 4.5 Invertebrate sample seasonal comparisons (native)	83
Table 4.6 Invertebrate sample seasonal comparisons (boundary)	83
Table 4.7 Invertebrate sample annual comparisons for male tomtits	85
Table 4.8 Invertebrate sample seasonal comparisons for male tomtits (pine)	86
Table 4.9 Invertebrate sample seasonal comparisons for male tomtits (native)	86

Table of figures

Figure 2.1 Location of study site	22
Figure 2.2 Mean isotopic values of rats by habitat and season	32
Figure 2.3 Mean isotopic values of taxa sampled	34
Figure 2.4 Mean isotopic values of male and female tomtits	36
Figure 2.5 MDS plot showing boundary habitat rodent stomach content data	38
Figure 2.6 MDS plot showing rat stomach content data	39
Figure 2.7 Seasonal proportion of identifiable dietary components for rats	40
Figure 3.1 Proportional foraging height category utilisation by tomtits	65
Figure 4.1 MDS plot showing invertebrate samples by habitat and year	79
Figure 4.2 Proportion of invertebrate orders by habitat	80
Figure 4.3 Proportion of invertebrate orders by year (pine and native)	81

General abstract

Understanding the trophic structure of a habitat is vital to understanding the species composition and interactions of species and individuals within that habitat. It dictates which organisms may survive, their abundance, and biotic interactions. Pine (*Pinus radiata*) (hereafter pine) plantations in New Zealand are the most common type of silviculture, and, although primarily a commercial forestry enterprise, they are recognised as an ecosystem able to provide habitat for some native species. It is therefore pertinent to evaluate the ecological value of this habitat while keeping in mind its lack of permanence. New Zealand's native forests are a natural comparison for mature pine plantation, and I have tracked the diet and behaviour of selected species across both habitats and their contiguous boundary. This study utilised multiple techniques and collected two years of behavioural and prey availability data to compare the habitats of interest on a variety of trophic levels (TLs) and temporal scales.

Research was conducted in the Hunua Ranges, New Zealand, between March 2006 and June 2009 and considered three habitats (pine plantation, native forest, and the contiguous boundary of these habitats). Vegetation samples from leaf litter (hereafter vegetation), Lepidopteran larvae (hereafter caterpillars), predacious adult Coleoptera (hereafter beetles), rats (*Rattus rattus*) (hereafter rats), house mice (*Mus musculus*) (hereafter mice), and North Island tomtits (*Petroica macrocephala toitoi*) (hereafter tomtits) were analysed in terms of $\delta^{13}\text{C}$, and $\delta^{15}\text{N}$ values. Comparisons between habitats, taxa, seasons, and sexes were conducted. Stable isotope analyses showed samples from native habitat had the lowest $\delta^{15}\text{N}$ levels within taxa, with boundary samples usually showing an intermediate value, and pine plantation samples commonly having the highest $\delta^{15}\text{N}$ levels. This suggests that the native forest provides a lesser amount of available nitrogen to the fauna inhabiting it, whereas the pine plantation (potentially due to fertilisation) contains a higher level of available nitrogen. Significant separation of taxa was seen between habitats for $\delta^{13}\text{C}$ values of rat and tomtit samples, and for $\delta^{15}\text{N}$ values of vegetation, rat, and tomtit samples. Within habitats, taxa were distinctly separated for both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$, and their foraging ranges spanned three to four TLs. The caterpillar and mouse samples collected did not show significant seasonal fluctuations in $\delta^{13}\text{C}$ or $\delta^{15}\text{N}$ values, and ship rats showed seasonal differences

only for $\delta^{13}\text{C}$ values. Seasonal difference in ship rat isotope signatures may indicate season related foraging locations with variation occurring between summer and autumn compared to winter and spring. Stomach content analyses for rats and mice did not show separation by habitat within species, but did show significant differences between rat and mouse diet in the boundary habitat. The volume of invertebrates, vertebrate remains, and vegetation in rat stomachs showed significant differences between seasons with a greater proportion of vegetation found during winter; however no evidence of this was seen for mice. Neither technique showed evidence of intersexual dietary differences for rodents, and isotopic values were also similar between tomtit sexes within each major habitat type. The use of stable isotope and stomach content analyses to assess rodent diet was a valuable combination as it clarified this aspect better than either method alone.

Tomtit sexes differed in foraging behaviour, with males observed foraging more frequently on the ground than females and females using vegetation (in particular substrates between 0 - 3 m) more than males. Foraging by both sexes varied between breeding and non-breeding season in 2006, with more ground use occurring in the non-breeding season and more vegetation use (males: 3 - 6 m; females: 0 - 3 m) in the breeding season. Tomtit foraging behaviour in three habitats (pine plantation, native forest, and the contiguous boundary of these habitats) was compared. Overall, tomtit foraging in native forest occurred more frequently in vegetation 3 - 6 m compared to the use of this strata in either pine or boundary habitat. Males showed inter-annual differences in foraging, using the ground significantly more in 2006 than 2007. The research described tomtit foraging and habitat use, illustrating the complexity of foraging behaviour and the difficulty of understanding sex, habitat, and season associated foraging variation.

The availability of the ground-prey items for tomtits differed most widely between habitats. Annual and seasonal differences were also found within pine and native forest habitat. Prey availability varied between seasons within pine (spring versus summer), native (winter versus spring), and boundary (winter versus summer) habitats. No differences between prey availability were found for male and female tomtits.

However, male foraging samples showed annual separation in the pine and native habitats, and between some seasons within the pine (winter versus summer) and native (winter versus spring) forests. No significant seasonal differences were found for female comparisons. Through comparison of habitat and temporal prey availability for tomtits I have begun to determine the role that pine plantation invertebrates play in the diet of insectivorous native birds. Many questions have been raised by this study, and there is much scope for future research into the trophic structure of pine versus native forest.