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

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Table of contents

Table of tables

Table of figures

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 $\delta\ ^{13}C$, and $\delta\ ^{15}N$ values. Comparisons between habitats, taxa, seasons, and sexes were conducted. Stable isotope analyses showed samples from native habitat had the lowest $\delta\ ^{15}N$ levels within taxa, with boundary samples usually showing an intermediate value, and pine plantation samples commonly having the highest $\delta\ ^{15}N$ 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 $\delta\ ^{13}C$ values of rat and tomtit samples, and for $\delta\ ^{15}N$ values of vegetation, rat, and tomtit samples. Within habitats, taxa were distinctly separated for both $\delta\ ^{13}C$ and $\delta\ ^{15}N$, and their foraging ranges spanned three to four TLs. The caterpillar and mouse samples collected did not show significant seasonal fluctuations in $\delta\ ^{13}C$ or $\delta\ ^{15}N$ values, and ship rats showed seasonal differences

only for $\delta^{13}C$ 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.