The Impact of Isolation from Mammalian Predators on the Anti-Predator Behaviours of the North Island robin (*Petroica longipes*)

A thesis presented in partial fulfilment of the requirements for the degree of Master of Science in Conservation Biology at Massey University, Auckland, New Zealand

Sarah Margaret Whitwell

(2009)
Abstract

Conservation in New Zealand has begun to focus heavily on the restoration of degraded mainland ecosystems and the reintroduction of native species that have become locally extinct. In many cases the individuals that are selected for reintroduction are harvested from ‘mammal-free’ offshore islands. This thesis examines the effects of isolation from mammalian predators on the predator avoidance behaviours and predator recognition abilities of New Zealand birds using the North Island robin as a model. It also investigates whether any effects of isolation from mammalian predators has a lasting impact on mainland populations founded by individuals from offshore islands.

Nest site selection behaviours were compared across three populations that are exposed to different suites of predators and have differing translocation histories; Benneydale, Tiritiri Matangi and Wenderholm. Point height intercept and point-centred quarter surveys were used to compare habitat availability between the sites and to compare nest sites with the available habitat. Eight nest characteristic variables were also compared across the three sites using a principle component analysis. Benneydale nests were located higher in the trees and were more concealed than nests at the other two sites. Nests on Tiritiri Matangi were supported by large numbers of thin branches and were located toward the periphery of the nest tree. Unfortunately these differences are very difficult to interpret due to a high degree of variation in the habitat types present at the three sites.

The anti-predator behaviours initiated in response to a model stoat, model morepork and control were used to test the ability of nesting robins to recognise the threat that each of these treatments might pose to nest success. Behavioural variables were
compared between Benneydale, Tiritiri Matangi and Wenderholm using a response intensity scoring system and a principle component analysis. The results indicated that isolation from mammalian predators on Tiritiri Matangi has suppressed the ability of robins on the island to recognise the predatory threat posed by a stoat. They also suggest that the intense mammal control carried out at Wenderholm may have inhibited the ability of local robins to produce strong anti-predator responses when faced with a stoat.
Acknowledgements

I have thoroughly enjoyed the challenge of undertaking this masters project and I am extremely grateful to all those who have assisted me along the way. First and foremost I would like to thank my supervisor Weihong Ji for the time and effort she has put into guiding and encouraging me this year. Thank you to Ian McLean who was willing to share his wealth of knowledge with me and to Tim Lovegrove for his valuable support throughout. I also greatly appreciated the statistical advice given to me by Dianne Brunton and the helpful comments and suggestions I received from Doug Armstrong.

I am extremely grateful for the help I received from Bianca Baars and Wouter Hendrix. Their boundless enthusiasm and commitment to the research was greatly appreciated. Thank you also to Barbara Egli, Stacey Hill, Rhonda Pike and Nic Gorman whose hard work went into finding the robin nests that I investigated.

I would like to thank all of those within the Massey University ecology and conservation research group who have supported me along the way, especially those who helped to proof read this thesis. Thank you to my mum and dad, Bruce and Sue Whitwell for their assistance in the field and support throughout my studies. Finally, I would like to thank my partner, Chris Budd, for his unwavering love and patience.

This project was funded by the Auckland Regional Council and the Massey University Vice Chancellors Masterate Scholarship. The research was approved by the Auckland Regional Council, the Massey University Animal Ethics Committee (Protocol No. 08/56) and the Department of Conservation (permits AK-21153-FAU, AK-23567-DOA and WK-23607-FAU).
Table of Contents

Abstract ........................................................................................................... ii
Acknowledgements ......................................................................................... iv
Table of Contents ............................................................................................. v
List of Plates ........................................................................................................ viii
List of Figures ...................................................................................................... ix
List of Tables ....................................................................................................... xi

CHAPTER ONE: General Introduction ......................................................... 1

1.1 A Short Evolutionary History of New Zealand ........................................ 1
1.2 The Impacts of Human Colonisation ..................................................... 1
1.3 Current Conservation Strategies and their Implications ......................... 3
1.4 Conservation and Predator Recognition in New Zealand’s Robins ......... 5
1.5 Aims and Thesis Structure ...................................................................... 8

CHAPTER TWO: Habitat composition and structure at three study sites, Tiritiri Matangi Island, Wenderholm Regional Park and Benneydale 11

Abstract ........................................................................................................... 12

2.1 Introduction ............................................................................................... 13
2.2 Methods ....................................................................................................... 15
  2.2.1 Study Sites ............................................................................................. 15
  2.2.2 Sampling ............................................................................................... 18
  2.2.3 Species Composition and Maturity ....................................................... 19
  2.2.4 Forest Structure .................................................................................... 20
2.3 Analysis and Results .................................................................................. 21
  2.3.1 Forest Composition .............................................................................. 21
  2.3.2 Forest Maturity .................................................................................... 25
  2.3.3 Forest Structure .................................................................................... 27
2.4 Discussion ................................................................................................... 31
  2.4.1 Forest Composition .............................................................................. 31
  2.4.2 Forest Maturity .................................................................................... 32
  2.4.3 Forest Structure .................................................................................... 33
  2.4.4 Conclusions .......................................................................................... 34
# CHAPTER THREE: The influence of isolation from mammalian predators on the nest site selection behaviours of North Island robins

**Abstract**

3.1 Introduction

3.1.1 Predator-Induced Phenotypic Plasticity

3.1.2 Predator-Induced Plasticity in Nest Site Selection

3.1.3 Risk Assessment and Predator Isolation

3.1.4 Risk Assessment and the North Island Robin

3.1.5 Aims and Hypotheses

3.2 Methods

3.2.1 Study Species

3.2.2 Study Sites

3.2.3 Forest Composition and Maturity

3.2.4 Forest Structure

3.2.5 Nest Characteristics

3.3 Analysis and Results

3.3.1 Forest Composition and Maturity

3.3.2 Forest Structure

3.3.3 Nest Characteristics

3.3.4 Ground and Aerial Concealment

3.4 Discussion

3.4.1 Forest Composition and Maturity

3.4.2 Forest Structure

3.4.3 Nest Characteristics

3.4.4 Ground and Aerial Concealment

3.4.5 Conclusions

# CHAPTER FOUR: The influence of isolation from mammalian predators on predator recognition in the North Island robin

**Abstract**

4.1 Introduction

4.1.1 Predator Recognition and Conservation

4.1.2 Naivety and the North Island Robin

4.1.3 Aims and Hypotheses

4.2 Methods

4.2.1 Study Sites

4.2.2 Nest Finding

4.2.3 Timing of the Experiment

4.2.4 Experiment Set Up and Equipment

4.2.5 Experimental Procedure

4.2.6 Methods of Recording and Scoring Responses

4.3 Analysis and Results

4.3.1 Testing for Confounding Factors

4.3.2 Response Intensity Score

4.3.3 Principal Component Analysis
4.4 Discussion

4.4.1 Confounding Factors ................................................................. 102
4.4.2 Response Intensity ................................................................. 103
4.4.3 Principle Component Analysis ................................................. 106
4.4.4 Conclusions ............................................................................ 110

CHAPTER FIVE: Implications for Management and Future Research 113

5.1 Introduction .................................................................................. 114
5.2 Key Findings and Implications ...................................................... 115
5.3 Pre-release Predator Training ......................................................... 116
5.4 Future Research Directions .......................................................... 120

LITERATURE CITED 123
## List of Plates

**Plate 2.1:** An aerial view of Wenderholm Regional Park (photograph by A. Jamison)  11

**Plate 2.1:** The tawa forest habitat typical of the Benneydale site (photograph by B. Whitwell)  29

**Plate 2.2:** The regenerating forest of Tiritiri Matangi. The dominant species, pohutukawa, is visible in the centre of the picture (photograph by W. Ji)  29

**Plate 2.3:** The forest of Wenderholm Regional Park. Young nikau palms are visible in the understorey and a puriri trunk dominates the foreground (photograph by T. Lovegrove)  30

**Plate 3.1:** A robin nest (dark area in the centre of the photograph) concealed amongst the foliage of a tawa tree (photograph by B. Whitwell)  35

**Plate 4.1:** South Island robins carrying out a ‘wing-droop’ display. This particular display was directed toward a human near the nest (McLean *et al.* 1999) (photograph by I. McLean)  73

**Plate 4.2:** The hoisting rig in place near a nest at Wenderholm. The nest and cords are labelled (photograph by B. Whitwell)  87

**Plate 5.1:** Releasing North Island robins at Wenderholm Regional Park (photograph by T. Lovegrove)  113
List of Figures

**Figure 2.1:** Map of the North Island of New Zealand, with an enlarged view of the Hauraki Gulf, showing locations of the three study sites. 18

**Figure 2.2:** The point-centred quarter sampling layout. The sampling point is located at the centre of cross. Circles indicate the trunks of trees. Dotted lines indicate which trees would be selected for measurement and the distance to be measured. Figure adapted from Mitchell (2007). 20

**Figure 2.3:** The mean distance from the sampling point of the trees sampled at each site. Error bars represent ± the standard error. 26

**Figure 2.4:** The mean diameter of the trees sampled at each site. Error bars represent ± the standard error. 26

**Figure 2.5:** Mean number of species intercepting the PHI lines in each category. Coloured bars represent each of the three sites. Error bars represent ± the standard error. 27

**Figure 2.6:** The mean canopy height at each site. Error bars represent ± the standard error. 28

**Figure 3.1:** The orientation of PHI sampling points around the nest. Small circles indicate sampling points. The central point is located on the ground directly below the nest 48

**Figure 3.2:** The percentage of five dominant tree species in the available habitat (Random) and in the area surrounding the robin nests (Nest) at Benneydale. 52

**Figure 3.3:** The percentage of five dominant tree species in the available habitat (Random) and in the area surrounding the robin nests (Nest) on Tiritiri Matangi. 52

**Figure 3.4:** The percentage of five dominant tree species in the available habitat (Random) and in the area surrounding the robin nests (Nest) at Wenderholm. 53

**Figure 3.5:** Mean number of species intercepting the PHI lines at Benneydale. Coloured bars represent the results from random and nest specific surveys. Error bars represent ± the standard error. 55

**Figure 3.6:** Mean number of species intercepting the PHI lines on Tiritiri Matangi. Coloured bars represent the results from random and nest specific surveys. Error bars represent ± the standard error. 55

**Figure 3.7:** Mean number of species intercepting the PHI lines at Wenderholm. Coloured bars represent the results from random and nest specific surveys. Error bars represent ± the standard error. 56
**Figure 3.8:** The mean of PC1 (nest height, plant height, trunk diameter, concealment) at all sites. Error bars represent ± the standard error. 59

**Figure 3.9:** The mean of PC2 (Number and size of support branches, vertical and horizontal placement ratios) at all sites. Error bars represent ± the standard error. 59

**Figure 3.10:** The mean of the concealment scores given from the perspective of a ground predator and an aerial predator at Benneydale. Error bars represent ± the standard error. 60

**Figure 3.11:** The mean of the concealment scores given from the perspective of a ground predator and an aerial predator at Tiritiri Matangi. Error bars represent ± the standard error. 61

**Figure 3.12:** The mean of the concealment scores given from the perspective of a ground predator and an aerial predator at Wenderholm. Error bars represent ± the standard error. 61

**Figure 3.13:** The mean of the ground concealment scores allocated to nests at each of the three sites. Error bars represent ± the standard error. 62

**Figure 3.14:** The mean of the aerial concealment scores allocated to nests at each of the three sites. Error bars represent ± the standard error. 63

**Figure 4.1:** The models used in the experiment. Stoats (a) and (b) and morepork (c) were prepared especially for the experiment. Morepork (d) was borrowed from another research project. Models (e) and (f) are the controls. 84

**Figure 4.2:** Diagram of the hoisting rig. Cords are colour coded according to the key above. 86

**Figure 4.3:** The distribution of the estimated age of the chicks on the first day of the experiment. Error bars represent ± the standard error. 95

**Figure 4.4:** Mean composite response intensity scores for all three treatments carried out at all three sites. Error bars represent ± the standard error. 97

**Figure 4.5:** Mean of PC1 (Wing-flicks, Latency of return, Alarm calls) across all sites and treatments. Error bars represent ± the standard error. 100

**Figure 4.6:** Mean of PC2 (Flights, Wing-droops) across all sites and treatments. Error bars represent ± the standard error. 101

**Figure 4.7:** Mean of PC3 (Hops, Minimum approach) across all sites and treatments. Error bars represent ± the standard error. 101
List of Tables

Table 2.1: Results from random point-centred quarter survey at Benneydale. 22

Table 2.2: Results from random point-centred quarter survey on Tiritiri Matangi. 23

Table 2.3: Results from random point-centred quarter survey at Wenderholm. 24

Table 2.4: Result of Kruskal Wallis Test comparing mean distance from sampling point and mean diameter of the trees sampled at each site, Benneydale (B), Tiritiri Matangi (T) and Wenderholm (W). Test statistics are $H_{df}$ for Kruskal Wallis and $U$ for post-hoc Mann Whitney $U$ Tests. Post-Hoc tests were subject to a Bonferroni correction that reduced the significance threshold to 0.016. Statistically significant results are highlighted in bold. 25

Table 2.5: Result of Kruskal Wallis test comparing the mean canopy height at each site, Benneydale (B), Tiritiri Matangi (T) and Wenderholm (W). Test statistics are $H_{df}$ for Kruskal Wallis and $U$ for post-hoc Mann-Whitney $U$ tests. Post-hoc tests were subject to a Bonferroni correction that reduced the significance threshold to 0.016. Statistically significant results are highlighted in bold. 28

Table 3.1: Nest characteristic variables 50

Table 3.2: Results of non-parametric test comparing mean distance from sampling point and mean diameter of the trees sampled during the random and nest specific surveys at each site. 54

Table 3.3: Eigenvalues, variance explained and loadings of the original variables in the first two principle components extracted from the eight nest characteristic variables recorded. Variables with principle component values greater than 0.5 are highlighted in bold 57

Table 3.4: Results of ANOVA analyses and post-hoc Tukey pair wise comparisons assessing differences among the mean values Principle Components 1 and 2 across the three sites, Benneydale (B), Tiritiri Matangi (T) and Wenderholm (W). Statistically significant results are highlighted in bold. 58

Table 4.1: Definition of behaviours, distances and time intervals of interest used in this study, following Maloney and McLean (1995). 90

Table 4.2: Response intensity scoring criteria for all response variables (Maloney and McLean 1995). 90

Table 4.3: Results of statistical tests comparing the mean frequency of movement behaviours when one or two birds were observed. Test statistic ‘$t_{df}$’ = two sample t-test, ‘$U$’ = Mann-Whitney $U$ test. 92
Table 4.4: The results of tests comparing the mean frequencies of movement behaviors across the three possible treatment presentation orders (first, second or third). Test statistic \( H_{DF} \) = Kruskal-Wallis, \( F_{DF} \) = ANOVA.

Table 4.5: The results of tests comparing the mean response intensity scores when one or two birds were observed (t-test) and across the three possible treatment presentation orders (ANOVA). Test statistics \( t_{DF} \) = two sample t-test, \( F_{DF} \) = ANOVA.

Table 4.6: Results of statistical tests comparing the PC scores when one or two birds were observed. Test statistic \( t_{DF} \) = two sample t-test, \( U \) = Mann-Whitney \( U \) test.

Table 4.7: The results of tests comparing the mean PC values across the three possible treatment presentation orders (first, second or third). Test statistic \( H_{DF} \) = Kruskal-Wallis, \( F_{DF} \) = ANOVA.

Table 4.8: Eigenvalues, variance explained and loadings of the original variables in the first three principal components extracted from the seven anti-predator behaviour variables recorded. Variables with principal component values greater than 0.5 are highlighted in bold.

Table 4.9: Results of two-way mixed factorial ANOVA on Principal Component values produced by the PCA. One missing value resulting from a recording error reduced the Benneydale sample size to 9 for all treatments. Sample sizes for Tiritiri Matangi and Wenderholm were 10 and 5 respectively for all treatments. p-values less than 0.05 are highlighted in bold.