Predicting reintroduction outcomes using data from multiple populations

A thesis presented in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

in

Ecology

at Massey University,

Palmerston North, New Zealand

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2014

Abstract

Predicting reintroduction outcomes before populations are released is inherently challenging. Reintroductions typically involve small data sets from specific locations, making it difficult to know whether results from individual case studies are more widely applicable. However, a number of species have now been reintroduced to multiple sites, providing an opportunity to move beyond the inferences possible from single-site studies. I present a novel approach where data from multiple reintroduced populations are modelled simultaneously, allowing *a priori* predictions that account for random variation among sites to be made before new reintroductions are attempted. I construct models using data from multiple reintroductions of the North Island robin (*Petroica longipes*) to identify important factors influencing population establishment, vital rates and growth across existing reintroduction sites, and use the best supported models to make predictions for a candidate reintroduction site under alternative management scenarios. My results indicate that rat tracking rate (an index of rat density) and the surrounding landscape at reintroduction sites are important for both establishment and growth of reintroduced robin populations, and that sourcing founders from habitat similar to that at the reintroduction site (forest type and predators present) is also important for post-release establishment. I then extend the multi-population approach to integrate data from multiple species, and use the resulting model to predict growth of a reintroduced population at a range of predator densities when the candidate species for reintroduction (the North Island saddleback, *Philesturnus rufusater*) has never been observed in the presence of those predators. I predict saddleback population growth at different rat tracking rates using the relationship modelled for North Island robins, with the strength of the relationship adjusted to account for the greater vulnerability of saddlebacks to predation. The relative vulnerability to predation of saddlebacks (and 24 other New Zealand forest bird species) is estimated by measuring range contraction following the arrival of introduced mammalian predators on New Zealand's mainland. My results suggest that saddlebacks could be successfully reintroduced to sites with very low rat densities. This study illustrates how an integrated approach to modelling reintroductions improves the information available to managers, providing guidance about site suitability and appropriate management measures. For species reintroduced to multiple sites, integrated models provide an ideal opportunity to develop understanding over time of the key drivers of reintroduction success.

I dedicate this thesis to

my Mum, who never ceases to inspire

and

my Dad, whose love and support know no limits

Preface

I have had a love of nature for as long as I can remember. I think, perhaps, it stemmed from the time I spent as a child on our family's beautiful bush-clad property on Great Barrier Island. To this day, I am filled with a sense of peace and awe whenever I am in native forest, along with a deep knowledge that this is my happy place. It was this love of the natural world that led me to do a Bachelor of Science majoring in Zoology. I still remember the day I was sitting in a lecture, listening to someone called Doug Armstrong talk about something called "reintroduction". That hour changed my life. I knew instantly that I wanted to be involved with reintroductions – they fulfilled all of my idealistic dreams of conserving native species and helping to redress the effects of humans on the world. I was sold. And so I embarked on a Masters project to study one of the first North Island robin reintroductions to a New Zealand mainland site. After completion of my Masters, I worked in conservation jobs in New Zealand and overseas; but always dreamt of doing a reintroduction-related PhD. Dream became reality when I was awarded a Doctoral scholarship from Massey University, meaning I was lucky enough to have the autonomy to develop my own research topic. I knew I wanted to contribute towards increasing reintroduction success, so I set out to develop an approach that could help us learn from past reintroductions to improve the outcomes of those carried out in the future. This was a somewhat ambitious undertaking, as I had little quantitative modelling experience; but I figured PhDs are all about learning, and modelling was the means to the end I was after. I have since come to greatly enjoy the challenge of writing code although, I must confess, not quite as much as I enjoy the challenge of finding a well hidden nest.

So here it is, after all these years, my attempt at contributing to the field of reintroduction biology. I hope that in some way, the work in this thesis will benefit reintroduced individuals and populations, and will make the hard decisions faced by the dedicated people who manage them a bit easier.

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Acknowledgements

I would firstly like to express my immense gratitude to my primary supervisor Doug Armstrong whose guidance, enthusiasm and support have been constant throughout this project. I know how fortunate I am to have had such a talented, astute supervisor whom I get along with so well on a personal level. Doug, I will always appreciate what you have given me (and yes, that includes the pumpkin pies!).

I would also like to say a special thanks to my co-supervisor John Innes, who has been a wonderful positive support from start to finish. His suggestions along the way have been highly constructive and our thoroughly enjoyable discussions of ideas helped to shape this work.

I could not have done this research if it wasn't for the incredible people involved with the reintroduction projects I studied: Tony Bouzaid, Natasha Coad, Raewyn Empson, Denise Fastier, Judy Gilbert, Craig Gillies, Janice and Laurie Hoverd, Sandra Jack, Tim Lovegrove, Kahori Nakagawa, Terry O'Connor, Kevin Parsons, Gordon Stephenson and Tamsin Ward-Smith. I owe this opportunity to them. Their support and generosity with providing data (including original field notes) reinforced to me what an amazing conservation community we have in New Zealand.

I am very grateful to the team at Landcare Research who gave me access to a workstation for my GIS work. Mapping every piece of woody vegetation (including individual trees) within 2 kilometres of reintroduction site boundaries took a decidedly long time (months and months…), and their friendliness and banter helped keep me sane. I am especially grateful to Peter Newsome who taught me the art of landcover mapping and who has shown me nothing but kindness. I would also like to thank Mike Tuohy for helping me start in the world of ArcGIS, as well as the organisations that gave me access to aerial imagery: Landcare Research, Terralink International Limited, Department of Conservation, Auckland Regional Council and Hawkes Bay Regional Council; and the Ornithological Society of New Zealand for providing distributional data.

My thanks also go to the people who have given advice on my research and/or reviewed parts of this thesis: Simon Blomberg, Phillip Cassey, John Ewen, Jay Gedir, Ian Jamieson, Jim Nichols, Yvan Richard, Kate Richardson and Steve Trewick. I greatly appreciate their insights and assistance.

I have had the pleasure of working alongside a fantastic group of people in the Ecology Group, and we have shared many laughs along the way. Special thanks to Yvan Richard, Jay Gedir, Jay McCartney, Emma Williams, Kate Richardson, Kyle Morrison, Matt Krna, Christie “French” Le Coeur and Christy Getzlaff for helping to make this time in my life so much fun.

And my parents. I owe so much to my Mum, who encouraged me to pursue my dreams. Her love and belief in me has helped get me through. She, who was unable to see me get to this point, but who knew I could do it. I love you forever Mum. This is for you. Huge thanks to my Dad, who has given me sage advice throughout my PhD and has dedicated so much time to helping me finish this thesis – he has enriched my children’s life with the time he’s given them. For that I am eternally grateful.

And finally, to my husband Craig, whose support has been unwavering throughout. Every day I appreciate his kindness, generosity, insightfulness, and integrity, and I feel so fortunate to have him as my partner in life. His love enabled me to make this journey. Since the start of this PhD we have been joined by Cohen and Grayson, our two beautiful children, who are the light and joy of my life. They make me soar.

My PhD research was funded by a Massey University Doctoral Scholarship and by Landcare Research (from core funding for Crown Research Institutes from the Ministry of Business, Innovation and Employment’s Science and Innovation Group [previously from Contract CO9X0503]).

Co-authors

While this thesis is my own original work, all four research chapters include input from one or both of my supervisors that warrants co-authorship.

Doug Armstrong (Ecology Group, Massey University)

As my primary supervisor, Doug has worked extensively with me to develop my research ideas and provide guidance on data analysis and interpretation. He reviewed all chapters (including manuscripts for publication), and has collaborated with me on every part of this research. He is consequently co-author on Chapters 2-5.

John Innes (Landcare Research)

As my secondary supervisor, John provided advice on my research concepts and his suggestions for Chapter 4, in particular, were invaluable. John reviewed Chapters 1, 4 and 6, and is a co-author on Chapter 4.