Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

Anchoring techniques for translocated Duvaucel's geckos (*Hoplodactylus duvaucelii*), and the use of cell-foam retreats by lizards and invertebrates

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Conservation Biology Massey University, Albany, New Zealand.

Alaine Holdom

2015



"You cannot get through a single day without having an impact on the world around you. What you do makes a difference, and you have to decide what kind of difference you want to make."

Jane Goodall

Abstract

Conservation management often requires translocations to isolated habitats, and determining the success of such events is reliant on the use of effective post-translocation monitoring (PTM) techniques. Many reptile populations are already difficult to monitor, and post-release dispersal often increases this difficulty. Effective monitoring techniques for nocturnal, semi-arboreal, cryptic lizards are consequently still lacking. Furthermore, very little research has been conducted on the use of anchoring techniques for improving the PTM of lizards by reducing post-release dispersal behaviour. In early 2013, two populations of Duvaucel's geckos (Hoplodactylus duvaucelii) were translocated to two offshore islands. This provided an excellent opportunity to investigate several aspects relating to the improvement of PTM techniques for this species. I investigated whether two anchoring techniques, i.e. temporary food provision and release into cell-foam retreats (CFRs), can reduce post-release dispersal and encourage CFR usage. Further, I assessed the usefulness of CFRs for the PTM of H. duvaucelii. Additionally, I investigated the usage of CFRs for a range of other lizard species and invertebrates. My research provided evidence that both anchoring techniques can improve the use of CFRs by H. duvaucelii in the short term. However, anchoring effects were not maintained beyond two months after release. While anchoring treatments may have delayed postrelease dispersal behaviour, they did not affect post-release dispersal distances. The study results suggest that CFRs can be a useful PTM tool for *H. duvaucelii*, particularly shortly after translocation, and also aid in the detection of young. In addition, I demonstrated that CFRs can detect a variety of other lizard and invertebrate species. In conclusion, this research provides valuable information for the improvement of monitoring techniques for cryptic, semi-arboreal lizards, also providing evidence that CFRs can be useful tool for monitoring a range of lizards and invertebrates.

Acknowledgements

There are many people I want and need to thank for getting me through this life changing experience. First and foremost, I want to say a massive thank-you to my main supervisor, Manuela Barry. Firstly, thank-you for providing me with the opportunity to conduct this amazing research on such a beautiful species. Thank-you also for all of your assistance and advice, and most of all for being so passionate, positive, and generally inspirational throughout both the research and write-up phase. Without your constant enthusiasm I don't known whether I would have had the motivation to make it through the analysis and write up of my thesis. I would also like to thank my second supervisor Dianne Brunton, who has also contributed valuable advice throughout the process.

I am also very thankful for my fellow Duvie's crazy masters student, Vivienne Glenday. I am very grateful for all of your help with my side of the Duvie's research, and for always being there to discuss the various things I needed advice on. The time spent in the field was certainly made a lot more enjoyable with your company, and it was always nice to know that someone else was suffering as much as I was!

A huge thank-you to the two Motuora Island rangers (at the time), Sian and Toby. You guys were always so enthusiastic about the geckos, and always willing to go out of your way to help with the research. I would especially like to thank you for making numerous volunteer trips to the mainland to pick me up/drop me off on your teeny boat, especially in the 'not-so-ideal' weather that was usually accompanying me. I would also like to thank the Tiritiri Matangi Island rangers, Dave and Jason, for being equally as interested and encouraging, and for helping out whenever possible.

Ш

There are also many individual volunteers I would like to thank for giving up their time to spend with the geckos (as I know it wasn't to spend time with me!). A special thank-you to Sam Bourke, Regan Dear, and Ash Jones, who all came out for entire weeks to help me with the monitoring. There are so many others who gave up their days to come out to the Islands, so I won't attempt to name you all (you know who you are!).

To the members of the community groups the Supporters of Tiritiri Matangi Island, and the Motuora Restoration Society, I would like to thank-you for the interest and support you had for the research. Without your support I would not have had the opportunity to do this amazing research. Thank-you also for providing me with many of the volunteers I had throughout my field work.

Last but not least I would like to thank my friends, family, and colleagues. To my fellow masters students, thank-you for suffering along with me and providing someone else who understood my pain. Thank you to my friends and family who every time upon seeing me asked how my writing was going, providing me with constant nagging to get the thing done! I'm sure that without this 'support' I would not have had the motivation to continue. Thank-you to the gang at 'Beach' (including all the random customers) who fully supported me in my endeavours, constantly nagged me about progress, and allowed me to spend hours in the place writing away at my computer with coffee in hand. A special thank-you to all those friends and colleagues who read my various drafts, especially Luis Ortiz Catedral, Aaron Harmer, Tom Dixon, and Rebecca Streith. You guys gave me advice in the area I struggled with the most, and I really appreciate the time you took to help me out.

Financial support for this study was provided by Massey University (Massey University Masterate Scholarship and translocation project funding). The opportunity for this study was presented through a translocation project implemented by researchers from the Ecology Behaviour and Conservation Group at Massey University, Auckland (see Barry (2014) for additional information).

IV

This research was approved by the New Zealand Department of Conservation (permit number 35179-FAU) and the Massey University Animal Ethics Committee (protocol number 12/94). I would also like to acknowledge the representatives of the Ngati Manuhiri, Te Kawerau a Maki, Ngatai Whanaunga INC, Ngatai Maru Ruunanga, Ngatai Wai, and Ngatai Paoa iwi (indigenous Maori people) for giving their consent and support for the overall translocation, and to carry out the research.

Table of Contents

ABSTRACT.		
ACKNOWL	EDGEMENTS	
TABLE OF C	CONTENTS	VI
LIST OF FIG	URES	IX
LIST OF TAE	BLES	Х
LIST OF API	PENDICES	XI
CHAPTER 1	LITERATURE REVIEW	1
1.1	Conservation History in New Zealand	1
1.2	TRANSLOCATIONS	2
1.2.	1 Translocation theory	2
1.2.	2 Translocation success	
1.2.	3 Importance of post-translocation monitoring	
1.2.		
1.2.		
1.3	REPTILE CONSERVATION IN NEW ZEALAND	
1.3.	1 Translocation history of Hoplodactylus duvaucelii	8
1.4	REPTILE MONITORING TECHNIQUES	
1.4.	1 Identification techniques	
1.4.	2 Tracking techniques	
1.4.	<i>3 Live-capture techniques</i>	
1.5	RETREAT-SITE SELECTION IN REPTILES	16
1.6	KNOWLEDGE GAPS	17
1.7	Research Goals	
1.8	THESIS OUTLINE	
CHAPTER 2	GENERAL METHODS	21
2.1	STUDY SPECIES	21
2.1.	1 Natural history	
2.1	2 Behaviour	
2.1.	3 Diet	
2.1.	4 Distribution and conservation status	
2.2	STUDY SITES	23
2.2.	1 Motuora Island	
2.2.	2 Tiritiri Matangi Island	
2.3	RESEARCH FRAMEWORK	27
2.3.	1 Source of geckos	
2.3.	2 Release sites	27
2.3.	3 Monitoring grids	
2.3.	4 Gecko release 2013	
2.4	Hoplodactylus duvaucelii Monitoring	32

2.4.1	1 CFR checks	. 32
2.4.2	2 Tracking tunnel checks	. 33
2.4.3		
CHAPTER 3	TESTING TWO ANCHORING TECHNIQUES TO IMPROVE POST-TRANSLOCATION	
	NG OF DUVAUCEL'S GECKOS (HOPLODACTYLUS DUVAUCELII)	35
3.1	INTRODUCTION	. 35
3.2	METHODS	
3.2.1	1 Anchoring treatments	. 39
3.2.2	2 Monitoring techniques	. 40
3.2.3	3 Data analysis	. 42
3.3	RESULTS	. 48
3.3.1	1 Effects of anchoring treatments on CFR use	. 48
3.3.2	2 Effects of anchoring treatments on dispersal distances	. 54
3.4	DISCUSSION	. 58
3.4.1	1 Effectiveness of anchoring techniques for increasing CFR use	. 58
3.4.2		
3.5	CONCLUSIONS	. 65

CHAPTER 4 EFFECTIVENESS OF DOUBLE-LAYERED CELL FOAM RETREATS AS POST-TRANSLOCATION MONITORING TOOLS FOR DUVAUCEL'S GECKOS (HOPLODACTYLUS DUVAUCELII) 66

4.1	INTRODUCTION	
4.2	METHODS	70
4.2.1	1 Differences in CFR use by cohorts	70
4.2.2	2 Predicting CFR and tracking tunnel visitation using environmental factors	71
4.3	RESULTS	76
4.3.1	1 Longevity	76
4.3.2	2 Capture success	76
4.3.3		
4.3.4	4 Differences in temperature and humidity within CFRs	77
4.3.5	5 Visitation differences across islands and grids	78
4.3.0	5 Duration of CFR Use	80
4.3.2	7 Seasonality of CFR use	80
4.3.8	8 CFR use by different cohorts	83
4.3.9		
4.3.1	10 Effects of environmental factors on CFR and tracking tunnel visitation	87
4.4	DISCUSSION	91
4.5	CONCLUSIONS	105
CHAPTER 5 SPECIES	CELL FOAM RETREAT USAGE PATTERNS OF INVERTEBRATES AND OTHER LIZ	ARD

5.1	INTE	RODUCTION	106
5.2	Me	THODS	109
		Lizard sampling	
5.2.	2	Invertebrate sampling	110
5.2.	3	Data analysis	110
5.4	Res	ULTS	112

5.4.1	CFR use by lizards	
5.4.2	2 CFR use by invertebrates	116
5.5	DISCUSSION	129
5.5.2	Use of CFRs by other lizard species	129
5.5.2	2 Use of CFRs by invertebrates	132
5.6	CONCLUSIONS	142
CHAPTER 6	CONCLUSIONS, RECOMMENDATIONS AND FUTURE DIRECTIONS	1.4.4
CHAPTER O	CONCLUSIONS, RECOMMENDATIONS AND FOTORE DIRECTIONS	
6.1	Anchoring Techniques	
		144
6.1	Anchoring Techniques	144 149
6.1 6.2 6.3	ANCHORING TECHNIQUES CFRs as Monitoring Tools for <i>Hoplodactylus duvaucelii</i>	144 149 151

List of Figures

FIGURE 1.1. DORSAL PHOTOGRAPHS OF TWO ADULT FEMALE DUVAUCEL'S GECKOS, SHOWING THE DIFFERENCES IN PATTERNING	
ALLOWING INDIVIDUAL IDENTIFICATION.	12
FIGURE 2.1. SATELLITE IMAGE OF MOTUORA ISLAND	24
FIGURE 2.2. SATELLITE IMAGE OF THE HAURAKI GULF REGION	25
FIGURE 2.3. SATELLITE IMAGE OF TIRITIRI MATANGI ISLAND	26
FIGURE 2.4. LAYOUT OF THE DUVAUCEL'S GECKO MONITORING GRIDS	29
FIGURE 2.5. DESIGN AND SET-UP OF THE DOUBLE-LAYERED CFRS USED THROUGHOUT THIS STUDY.	30
FIGURE 2.6. SETUP OF THE TRACKING TUNNELS AT EACH SAMPLING POINT	31
FIGURE 2.7. TWO TRACKING CARDS SHOWING DUVAUCEL'S GECKO FOOTPRINTS.	34
FIGURE 3.1. AN ADULT DUVAUCEL'S GECKO CAUGHT INSIDE A FUNNEL TRAP, AND A TYPICAL SET-UP OF A FUNNEL TRAP	42
FIGURE 3.2. THE NUMBER OR PERCENTAGE OF TREATMENT AND CONTROL CFRS THAT WERE USED AT LEAST ONCE OVER THE	
FOURTEEN MONTH SAMPLING PERIOD, AND DURING EACH OF THE FOUR SEPARATE 'SEASONS' FOLLOWING RELEASE	49
FIGURE 3.3. THE NUMBER OR PERCENTAGE OF TREATMENT AND CONTROL GECKOS THAT USED CFRS AT LEAST ONCE OVER THE	
FOURTEEN MONTH SAMPLING PERIOD, AND DURING EACH OF THE FOUR SEPARATE 'SEASONS' FOLLOWING RELEASE	52
FIGURE 4.1. DIAGRAM OF THE GRIDS USED TO SAMPLE SURROUNDING VEGETATION COVER	73
FIGURE 4.2. THE MEAN DIFFERENCE IN TEMPERATURE AND HUMIDITY BETWEEN EACH PAIRING OF THE THREE MEASURED CFR	
AREAS.	78
FIGURE 4.3. AVERAGE NUMBER OF CFRS USED PER 2013 MONITORING GRID PER CHECK DAY FOR EACH SEPARATE SAMPLING	
MONTH.	81
FIGURE 4.4. AVERAGE NUMBER OF TOTAL GECKOS FOUND IN CFRS PER MONITORING GRID PER CHECK DAY FOR EACH SEPARATE	
SAMPLING MONTH	81
FIGURE 4.5. AVERAGE NUMBER OF ADULT GECKOS FOUND IN CFRS PER MONITORING GRID PER CHECK DAY FOR EACH SEPARATE	
SAMPLING MONTH.	
FIGURE 4.6. AVERAGE NUMBER OF JUVENILE GECKOS FOUND IN CFRS PER MONITORING GRID PER CHECK DAY FOR EACH SEPARAT	
SAMPLING MONTH.	
FIGURE 5.1. A COPPER SKINK (<i>OLIGOSOMA AENEUM</i>) FOUND IN A CFR.	
FIGURE 5.2. TWO MOKO SKINKS (<i>OLIGOSOMA MOCO</i>) FOUND IN CFRS.	
FIGURE 5.3. PHOTOS OF VARIOUS INVERTEBRATES FOUND INSIDE CFRS	
FIGURE 5.4. PHOTOS OF COCKROACHES FOUND INSIDE CFRS	
FIGURE 5.5. PHOTOS OF WETA FOUND INSIDE CFRS	
FIGURE 5.6. PHOTOS OF SPIDERS FOUND INSIDE CFRS	
FIGURE 5.7. BOXPLOT OF AVERAGE INVERTEBRATE DENSITIES PER CFR PER CHECK SESSION FOR EACH MONITORING GRID1	
FIGURE 5.8. BOXPLOTS OF AVERAGE INVERTEBRATE RICHNESS PER CFR PER CHECK SESSION FOR EACH MONITORING GRID1	23
FIGURE 5.9. MEAN INVERTEBRATE DENSITY PER CFR PER CHECK SESSION FOR EACH MONITORING MONTH	25
FIGURE 5.10. MEAN INVERTEBRATE RICHNESS PER CFR PER CHECK SESSION FOR EACH MONITORING MONTH	25
FIGURE 5.11. MEAN ISOPTERA DENSITY PER CFR PER CHECK SESSION FOR EACH MONITORING MONTH	26
FIGURE 5.12. MEAN BLATTODEA DENSITY PER CFR PER CHECK SESSION FOR EACH MONITORING MONTH	26
FIGURE 5.13. MEAN COLEOPTERA DENSITY PER CFR PER CHECK SESSION FOR EACH MONITORING MONTH	27
FIGURE 5.14. MEAN TOTAL NUMBER OF ORTHOPTERA PER CFR PER CHECK SESSION FOR EACH MONITORING MONTH, IN TOTAL	
AND FOR EACH SIZE CLASS SEPARATELY	27
FIGURE 5.15. MEAN TOTAL NUMBER OF ARANEAE PER CFR PER CHECK SESSION FOR EACH MONITORING MONTH, IN TOTAL AND	
FOR EACH SIZE CLASS SEPARATELY	28

List of Tables

TABLE 3.1. MAXIMUM POINT DISTANCE (M) TRAVELLED BY GECKOS DURING EACH SEASON
TABLE 4.1. VERTICAL AND DEPTH POSITION OF EACH GECKO ENCOUNTERED IN A CFR DURING EACH CHECK SESSION OVER THE
ENTIRE FOURTEEN MONTH STUDY PERIOD77
TABLE 4.2. NUMBER OF CFRS USED AT LEAST ONCE AT EACH OF THE 2013 AND 2006 RELEASE GRIDS DURING EACH OF THE FOUR
STUDY SEASONS, AND OVER THE ENTIRE FOURTEEN MONTH STUDY PERIOD
TABLE 4.3. NUMBER OF GECKOS IN EACH COHORT ON EACH ISLAND THAT USED CFRS AT LEAST ONCE OVER THE ENTIRE FOURTEEN
MONTH SAMPLING PERIOD
TABLE 4.4. NUMBER AND PERCENTAGE OF GECKOS RELEASED IN DIFFERENT COHORTS THAT USED CFRS AGAIN AT LEAST ONCE
DURING EACH OF THE FOUR SEPARATE STUDY SEASONS, DURING SEASONS TWO TO FOUR COMBINED AND OVER THE ENTIRE
FOURTEEN MONTH STUDY SEASON, AND THE RESULTS OF CHI-SQUARE TESTS RUN FOR EACH COHORT COMPARISON
TABLE 4.5. ALL FACTORS CONSIDERED IN THE MODEL SELECTION PROCESS FOR DETERMINING WHICH HABITAT FACTORS EFFECTED
CFR visitation and tracking tunnel visitation rates
TABLE 5.1. USE OF THREE CFRS BY TWO NATIVE SKINK SPECIES, INCLUDING THEIR POSITIONS WITHIN THE CFRS AND THE
CORRESPONDING TEMPERATURE AND HUMIDITY READINGS OF THE CFR AT THE TIME THE CFR WAS CHECKED
TABLE 5.2. RESULTS OF MULTIPLE PEARSON'S CORRELATIONS RUN BETWEEN THE DENSITIES OF THE FIVE MAIN INVERTEBRATE
GROUPS, TOTAL DENSITY AND RICHNESS, AND AVERAGE TEMPERATURE AND HUMIDITY.

List of Appendices

APPENDIX A. NUMBER OF CFRs and geckos of each treatment type, at each of the six 2013 release grids	166
APPENDIX B. INFORMATION ON ALL 180 ADULT GECKOS RELEASED IN 2013.	167
APPENDIX C. DATES OF CFR CHECKS, GRID FOOD TREATMENT, AND THE ORIGIN OF GECKOS RELEASED ONTO EACH MONIT	ORING
GRID	172
APPENDIX D. AVAILABILITY OF GPS LOCATION DATA FOR EACH RADIO-TRACKED GECKO	173
APPENDIX E. NUMBER AND PERCENTAGE OF TREATMENT AND CONTROL CFRS USED MULTIPLE TIMES FOR EACH ANCHORI	NG
TREATMENT	174
APPENDIX F. DESCRIPTIVE STATISTICS FOR THE VISITATION RATES TO TREATMENT AND CONTROL CFRS WITHIN TWO MON	THS, AND
BETWEEN THREE AND FOURTEEN MONTHS FOLLOWING RELEASE	175
APPENDIX G. MODEL EFFECTS FOR THE TWO GENERALISED LINEAR MODELS EXPLORING THE EFFECTS OF GRID FOOD TREAT	MENT
AND RELEASE TREATMENT ON CFR VISITATION RATES AND USE OF CFRS BY GECKOS.	176
APPENDIX H. PARAMETER ESTIMATES FOR EACH OF THE SIGNIFICANT FACTORS CALCULATED IN THE TWO GENERALISED LIN	IEAR
MODELS ON THE EFFECTS OF GRID FOOD TREATMENT AND RELEASE TREATMENT ON CFR VISITATION RATES AND CF	R use by
GECKOS	
APPENDIX I. NUMBER AND PERCENTAGE OF GECKOS IN TREATMENT AND CONTROL GROUPS THAT USED CFRs AT LEAST OF	NCE AND
MORE THAN ONCE DURING THE ENTIRE FOURTEEN MONTH MONITORING PERIOD	178
APPENDIX J. DESCRIPTIVE STATISTICS FOR THE NUMBER OF VISITS TO CFRS BY TREATMENT AND CONTROL GECKOS WITHIN	ITWO
MONTHS, AND BETWEEN THREE AND FOURTEEN MONTHS FOLLOWING RELEASE	179
APPENDIX K. CROSS-TABULATION OF THE NUMBER OF TREATMENT AND CONTROL GECKOS (OF THE GRID FOOD TREATMEN	лт)
LOCATED AT EACH CATEGORY DISTANCE DURING EACH SEASON AND TIME PERIOD.	180
APPENDIX L. DESCRIPTIVE STATISTICS FOR THE EFFECTS OF GRID FOOD TREATMENT ON THE MEAN DISTANCE TRAVELLED BY	Y GECKOS
DURING EACH OF THE TIME PERIODS FOLLOWING RELEASE	181
APPENDIX M. RESULTS OF THE GENERALISED ESTIMATING EQUATIONS RUN ON DATA FROM WITHIN TWO MONTHS FOLLOW	WING
RELEASE TO DETERMINE THE SHORT TERM EFFECTS OF GRID FOOD, CFR FOOD AND RELEASE ANCHORING TREATMEN	ITS ON
CATEGORY AND POINT DISTANCES TRAVELLED BY RELEASED GECKOS.	182
182	
APPENDIX N. DESCRIPTIVE STATISTICS FOR THE EFFECTS OF CFR FOOD TREATMENT ON THE MEAN DISTANCE TRAVELLED B	Y GECKOS
DURING EACH OF THE TIME PERIODS FOLLOWING RELEASE	183
APPENDIX O. DESCRIPTIVE STATISTICS FOR THE EFFECTS OF RELEASE TREATMENT ON THE MEAN DISTANCE TRAVELLED BY G	SECKOS
DURING EACH OF THE TIME PERIODS FOLLOWING RELEASE	184
APPENDIX P. LOCATION OF FOUR JUVENILE GECKOS (J2, J3, J8, AND J9) AT EACH CFR CHECK SESSION DATE.	185
APPENDIX Q. RESULTS OF THE MANN-WHITNEY U TESTS RUN ON DATA FROM EIGHT AND TWELVE MONTHS FOLLOWING	RELEASE
TO DETERMINE THE LONG TERM EFFECTS OF GRID FOOD, CFR FOOD AND CFR RELEASE ANCHORING TREATMENTS O	N
CATEGORY AND POINT DISTANCES TRAVELLED BY RELEASED GECKOS	186
(T=TREATMENT GROUP, C=CONTROL GROUP)	186
APPENDIX R. RESULTS OF THE GENERALISED LINEAR MODEL BACKWARD ELIMINATION MODEL SELECTION FOR CFR MICRO	HABITAT
EFFECTS ON CFR VISITATION.	187
APPENDIX S. RESULTS OF THE GENERALISED LINEAR MODEL BACKWARD ELIMINATION MODEL SELECTION FOR CFR MICROI	HABITAT
EFFECTS ON TRACKING TUNNEL VISITATION.	188
APPENDIX T. RESULTS OF THE GENERALISED LINEAR MODEL BACKWARD ELIMINATION MODEL SELECTION FOR SURROUNDIN	NG
VEGETATION EFFECTS ON CFR VISITATION.	188
APPENDIX U. RESULTS OF THE GENERALISED LINEAR MODEL BACKWARD ELIMINATION MODEL SELECTION FOR SURROUND	NG
VEGETATION EFFECTS ON TRACKING TUNNEL VISITATION.	189

Appendix V. Results of the generalised linear model backward elimination model selection for surrounding flax
(Phormium tenax) effects on CFR visitation
APPENDIX W. RESULTS OF THE GENERALISED LINEAR MODEL BACKWARD ELIMINATION MODEL SELECTION FOR SURROUNDING FLAX
(PHORMIUM TENAX) EFFECTS ON TRACKING TUNNEL VISITATION
APPENDIX X. NUMBER OF INVERTEBRATES ENCOUNTERED THROUGHOUT THE ENTIRE NINE MONTH SAMPLING PERIOD
APPENDIX Y. NUMBER OF CFR HOUSING TREES OF EACH SPECIES, AND THEIR CORRESPONDING AVERAGE INVERTEBRATE DENSITIES.
APPENDIX Z. NUMBER AND PERCENTAGE OF TREES OF EACH SPECIES THAT CFRS WERE ATTACHED TO
APPENDIX AA. MEAN INVERTEBRATE DENSITY AND RICHNESS FOR EACH INDIVIDUAL CFR, FOR EACH OF THE EIGHT MONITORING
GRIDS SEPARATELY
APPENDIX BB. DESCRIPTIVE STATISTICS (MINIMUM, MAXIMUM, MEAN AND STANDARD ERROR) FOR THE AVERAGE INVERTEBRATE
density and richness per CFR per check session for each monitoring grid and Tiritiri Matangi and Motuora
ISLANDS SEPARATELY