An evaluation of the conservation of New Zealand's threatened biodiversity

Management, species recovery and legislation

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

Doctor of Philosophy

In

Ecology

at Massey University, Auckland,

New Zealand

Mark Nicholas Hawdon Seabrook-Davison

2010

Frontispiece

New Zealand endemic Pateke, brown teal *Anas aucklandica*

Photo: Mark Seabrook-Davison

This thesis is dedicated to my Great Uncle

Lieutenant E.B (Teddy) Davison

Wildlife Field Officer, Wildlife Division (1945-1956)

New Zealand Department of Internal Affairs

Abstract

It is only recently that New Zealand wildlife managers have become aware of both the taxonomic range of New Zealand' indigenous biodiversity and the number of species threatened with extinction. The entire New Zealand archipelago has been described as a biodiversity hotspot; a term with both negative and positive connotations as although its biodiversity is unique and diverse, it has lost three quarters of its primary vegetation and much of its remaining endemic biota is in decline. This thesis evaluated aspects of New Zealand's approach to the management of biodiversity with an emphasis on methods used in the recovery of threatened species. Possible solutions are presented that New Zealand could investigate to improve the delivery of species recovery. A survey was conducted amongst Department of Conservation (DOC) staff to investigate management tools available to them. Results suggest that inadequate resources, staff shortages and an overwhelming workload have resulted in a failure to achieve comprehensive recovery of threatened species. A review of New Zealand wildlife conservation legislation and a comparison with the USA Endangered Species Act 1973 and Australian Environment Protection and Biodiversity Conservation Act 1999, suggests that a lack of dedicated threatened species legislation is hindering the effective recovery of New Zealand's threatened species.

The thesis concludes that New Zealand has the advantage of a large conservation estate but lacks an integrated national management approach to the conservation of its biodiversity. Considerable improvement of the management and recovery of threatened species can be achieved with the enacting of dedicated threatened species legislation.

Keywords: Threatened species, biodiversity, biodiversity hotspot, conservation, management, recovery plans, recovery groups, Department of Conservation, legislation,

threat classification system, listing, ecological function, ecosystem services, staff survey, New Zealand

Preface

Thesis outline

The overall aim of this thesis was to examine the status of New Zealand's threatened species and to evaluate approaches to their management and recovery. Specific objectives were to evaluate the effectiveness of the Department of Conservation (DOC) in its role as New Zealand's principle conservation agency and to identify the strengths and weaknesses of the conservation tools available to DOC. New approaches to conservation biology such as improving the efficacy of pest control and the use of molecular analysis in taxonomic classification were investigated. A comparison of New Zealand's wildlife management legislation is made with that of the United States of America (USA) and Australia.

A number of methods have been used to achieve the objectives of this research including literature searches, field-based study, laboratory analyses and surveys.

Thesis structure

The thesis is comprised of four research chapters (Chapter Two to Five) with an introductory chapter (Chapter One) and a chapter (Chapter Six) detailing the overall conclusions and recommendations. The research from Chapters Three, Four and Five has all been published. Additional to the research for my thesis, I conducted molecular analysis into the phylogeny and taxonomy of the Australasian *Coturnix* quail complex and the published paper is included as an appendix at the rear of the thesis.

I have followed the protocol of Massey University by presenting all my research as independent research chapters. My supervisors, Assoc. Prof. Dianne Brunton and

Dr Weihong Ji are co-authors of all published papers resulting from these chapter manuscripts. Their assistance has been invaluable with experimental design, fieldwork logistics and statistical analysis. My advisors, Dr Leon Huynen, Prof. John Craig, Dr Graham Ussher and Ray Walter have provided me with advice and assistance with equipment design, molecular analysis and computer modelling. The contents of each chapter are as follows:

Chapter One: Introduces the research question of the thesis and reviews New Zealand and international literature relevant to the topic. This chapter also highlights the description of New Zealand as a biological hotspot and the uniqueness of its biodiversity.

Chapter Two: This chapter presents the results of a survey conducted amongst a sample of people domiciled in Auckland; representing New Zealand's largest population centre to gauge their perception of government spending on conservation. The survey was conducted according to the regulations of the Code of Ethical Conduct of the Massey University Human Ethics Committee which deemed the survey low risk. The survey questionnaire was designed by M. N. H. Seabrook-Davison. The manuscript resulting from this research has been submitted to the *New Zealand Journal of Ecology*. and co-authored by W. Ji and D. H. Brunton. The survey questionnaire is attached as

Appendix 7.1.

Chapter Three: This chapter presents the results of a survey conducted with New Zealand Department of Conservation (DOC) Biodiversity Assets staff responsible for the management and recovery of threatened species. The survey was conducted according to the regulations of the Code of Ethical Conduct of the Massey University Human Ethics Committee protocol #: 07/055. The aim of this chapter was to survey the

opinion of conservation workers directly involved in the management of threatened species and to identify the strengths and weaknesses of the management tools available to them. The open-ended questionnaire was designed by M. N. H. Seabrook-Davison. Questionnaires were distributed to DOC staff by the Conservator of each DOC conservancy. Analysis was conducted by M. N. H. Seabrook-Davison with assistance from D. H. Brunton. This chapter is based on a published paper: Seabrook-Davison, M.N.H; W, Ji; Brunton, D.H. 2010. Survey of New Zealand Department of Conservation Staff involved in the management and recovery of threatened species *Biological Conservation.* Vol. 143 pp. 212-219. The manuscript was written by M. N. H. Seabrook-Davison with the published paper co-authored by W. Ji and D. H. Brunton and improvements provided by K. A. Stockin, G. Taylor and G. Ussher. The survey questionnaire is attached as Appendix 7.2.

Chapter Four: This chapter presents a review of New Zealand's threatened species legislation. This research had two aims; 1) to identify and evaluate New Zealand government statutes enacted for the management, recovery and protection of threatened species and, 2), to assess the appropriateness of using the USA Endangered Species Act 1973 (ESA1973) and the Environment Protection and Biodiversity Conservation Act 1999 (EPBC1999) of Australia as models to create legislation in New Zealand dedicated to the recovery of threatened species. Surveys were conducted to obtain the opinions of experts on the operation, strengths and weaknesses of the ESA1973 and EPBC1999. Surveys were designed and implemented by M. N. H. Seabrook-Davison with all correspondence with respondents conducted by email. The manuscript for this chapter was written by M. N. H. Seabrook-Davison and the published paper was co-authored by W. Ji and D. H. Brunton. Seabrook-Davison, M.N.H; W, Ji; Brunton, D.H.

2010. New Zealand lacks comprehensive threatened species legislation – comparison with legislation in Australia and the USA. *Pacific Conservation Biology*, Vol. 16.

Chapter Five: Chapter five discusses the future direction for the conservation of New Zealand's biota. This chapter was the basis of a published response to the recent publication: L. N. Joseph, R. F. Maloney, S. M. O'Connor, P. Cromarty, P. Jansen, T. Stephens, H. P. Possingham (2008) *Improving methods for allocating resources among threatened species: the case for a new national approach in New Zealand*. *Pacific Conservation Biology* Vol. 14, issue 3, pp 154-158. The response: *Future direction for the conservation of New Zealand's biodiversity (2009)* was written by M. N. H. Seabrook-Davison, co-authored by W. Ji and D. H. Brunton and published in *Pacific Conservation Biology* Vol. 15, issue 3, pp. 153-157.

Chapter Six: Presents the overall conclusions of the research and provides recommendations on suggested improvements for the management of New Zealand's biodiversity and threatened species.

Acknowledgements

I sincerely thank my supervisor Associate Professor Dianne Brunton who has guided me through my studies and the challenges faced over the last four years. Dianne has always provided invaluable advice and has fully involved herself with my research. I have always appreciated Dianne's decisive manner where there is always a solution to any research problem. She never stops to amaze me that she finds time to regularly provide us with her home cooking and produce from her extensive garden.

I appreciate the additional supervision from Dr Weihong Ji and Dr Graham Ussher. Weihong's door is always open and she has a refreshingly forthright way in suggesting how research findings should be presented. Graham provided me with practical advice on how not to overcomplicate doctoral research. I have enjoyed receiving his pragmatic supervision which has pushed me to explore novel areas of threatened species management. Dr Mark Orams has provided me with inspiration and guidance, especially at the beginning of my research. Mark's advice on survey methodology enabled me to expand the scope of my PhD.

Dr Rosemary Barraclough and Dr Karen Stockin have always provided me with critical comments of my research writing and I also thank them for providing me with relevant reference material. The wisdom of Professor John Craig helped me decide on the objectives of my research, making me realise that conservation ecology is a dynamic science where controversial ideas should also be considered.

I am grateful to the organisations that have provided the funding for my research. I thank Massey University for my Vice Chancellor's Doctoral Scholarship which has funded most of my research and life for the last four years. Professor Russ Tilman of the Massey University Institute of Natural Resources provided funding for the molecular

analysis of quail. Dr Leon Huynen and Professor David Lambert of the Allan Wilson Centre have provided the time and equipment to assist me with the DNA gene sequencing and phylogenetic analysis of quail. Leon has been a joy to work with and I commend his patience with me as I came to grips with analysing minute molecular solutions and tolerating me continually emailing him asking...*"did the PCR work*?*"* Thanks are extended to the Supporters of Tiritiri Matangi who helped fund the field research of quail. Two Department of Conservation (DOC) Rangers, Ray and Barbara Walter were the inspiration to commence my doctoral studies. Ray and Barbara have incredible wisdom, wit and affection for wildlife and I thank them for their support of my studies. Jennifer Haslam and Ian Price are two other DOC Rangers who made research on Tiritiri Matangi an enjoyable experience.

My colleagues in the Ecology & Conservation Group are a fantastic bunch of people. My room mates Michael Anderson and Jo Peace have made the PhD experience great fun, sharing research, jokes and really good music. Thanks for the cakes Jo, you are a fantastic cook. I thank Manuela Barry for assisting me with statistical analysis and the boxes of herb tea. Thank you Marleen Baling for being very patient when I wanted a set of tracking tunnels or some other piece of field equipment and thank you for the valuable advice and assistance in preparing my research findings for conferences. Many thanks to Taneal Cope, Clare & Jamie Seabrook-Davison, Marleen Baling, Kevin Parker and Mark Delaney for assistance with fieldwork.

I thank all the museums that have provided tissue samples, photographs and reference material. New Zealand quail samples were supplied by Dr Brian Gill of the Auckland War Memorial Museum, Dr Paul Scofield of Canterbury Museum, Cody Fraser and Sue Michelsen-Heath of Otago Museum. Australian quail samples were supplied by Dr

Gavin Dally of Museum and Art Gallery of Northern Territory and Claire Stevenson of Museum of Western Australia.

Thank you to my family, Jane, Clare and Jamie for their support during my PhD studies. They have been invaluable in assisting me with many aspects of my research. My daughter Clare has always been able to keep my PhD ego in check with comments like this…*"I can think of better ways to use my stress".* A big thank you to my parents who are never surprised when I take on a new venture.

I dedicate this thesis to the many people who give so much of their time and passion to prevent the extinction of New Zealand's unique species.

Glossary and Acronyms

BACC Biosecurity Authority Clearance Certificate. New Zealand ports clearance certificate issued by Ministry of Agriculture and Forestry for the importation of animal or plant products.

CBD Convention on Biodiversity. International treaty to protect and promote sustainable use of biological diversity. Concluded at Rio de Janeiro on 5 June 1992.

CCG Community conservation groups. Groups of volunteers who are involved in rehabilitating degraded ecosystems and who advocate for sustainable use of natural resources.

Conservancy New Zealand is divided into 13 separate conservation management areas or DOC conservancies. Each conservancy has its own Conservator who manages the conservation assets (biodiversity, archaeological, commercial and public access) within the boundaries of the conservancy.

COSEWIC Committee on the Status of Endangered Wildlife in Canada. Canadian conservation agency which administers SARA2002 and the management of threatened species.

CWS Canadian Wildlife Service of Environment Canada. Conservation agency of Canada.

DEWHA The Department of the Environment, Water, Heritage and the Arts. Australian department that deals with environment protection and conservation of biodiversity.

DOC Department of Conservation. New Zealand's principal conservation agency.

DOW Colorado Division of Wildlife. The agency of the Colorado Department of Natural Resources, a USA state department which administers the management of game species and native biodiversity.

EIA Environmental Impact Assessment. Reporting tool that predicts the possible impacts of an activity on the natural environment and wildlife

EPBC Environment Protection and Biodiversity Protection Act 1999. Australian legislation that guides the assessment of natural resource use and directs the conservation of Australia's wildlife.

EPI Environmental performance index.

ESA Endangered Species Act 1973 of the United States of America. This is a USA Federal government Act dedicated to the recovery of threatened species and degraded critical ecosystems.

FOC Fisheries and Oceans Canada. Canadian Federal government ministry administering Canadian fisheries and marine resources.

FWS USA Fish and Wildlife Service. The USA Federal government agency that manages the conservation of freshwater and terrestrial biodiversity.

GAO	General Accounting Office of the United States of America Federal government
IPCC	Intergovernmental Panel on Climate Change. Scientific organisation with international membership with the objective to provide decision-makers with information about climate change. IPCC was set-up by the World Meteorological Organization (WMO) in association with the United Nations Environment Programme (UNEP).
ISSG	Invasive species specialist group of the IUCN, World Conservation Union**.**
IUCN	International Union for the Conservation of Nature. A global environmental network of scientists and conservation managers providing information on environmental and development issues.
LINZ	Land Information New Zealand. A government department that provides geographic information about New Zealand.
LIRP	Low impact research permit. Authority granted by Department of Conservation for research to be conducted on wildlife reserves and ecologically sensitive areas of the New Zealand conservation estate.
Listed species	Species that are included on central government registers that are legally assessed as threatened with extinction. Listing process developed by the USA as directed by the obligations under the USA. Endangered Species Act 1973 (ESA1973).

MAF Ministry of Agriculture and Forestry. A government ministry that administers the agricultural and forestry resources of New Zealand.

MOF Ministry of Fisheries. A government ministry that administers the fisheries resources of New Zealand.

MFE Ministry for the Environment. A ministry that advises the New Zealand government on environmental issues.

NGO Non governmental organisation. Organisations outside national governments with no political affiliations. NGOs tend to be advisory or advocacy organisations which promote social and environmental ideals.

NOAA National Oceanic and Atmospheric Administration. A USA Department of Congress agency responsible for the scientific monitoring and research of the marine and atmospheric environments. Responsible for the management and recovery of listed marine species under the ESA1973.

NZ New Zealand. A south Pacific country, part of Oceania.

NZBS New Zealand Biodiversity Strategy. A report produced by the Ministry for the Environment as part of New Zealand's commitment as a signatory to the CBD.

NZCA New Zealand Conservation Authority. An advisory group which advises the Minister of Conservation on planning and policy initiatives that affect the administration of the DOC estate.

NZCPS New Zealand Coastal Policy Statement. Proposed policy initiatives for the conservation and management of New Zealand coastal environment produced by DOC.

NZT New Zealand Treasury. A New Zealand public service department that advises the government on monetary issues and economic policy.

OSNZ Ornithological Society of New Zealand. A society with nationwide membership who conduct regular quantitative bird surveys. Results of their surveys and research is published in the journal *Notornis*.

PCE Parliamentary Commissioner for the Environment. A New Zealand public service office independent of the government which has the power to investigate issues of environmental concern.

PPP Project prioritisation protocol**.** A model developed by Joseph *et al.*, 2009 for prioritising recovery funding to threatened species. [Joseph, L. N., Maloney, R. F., Possingham, H. P., 2009. Optimal Allocation of Resources among Threatened Species: a Project Prioritisation Protocol. *Conservation Biology 23*: 328-338]

RMA Resource Management Act. New Zealand legislation that controls the use of natural resources and directs the issuing of building and land use permits.

SARA Species At Risk Act 2002. Canadian Federal government act that directs the conservation and recovery of threatened species.

SOTM	Supporters of Tiritiri Matangi. A New Zealand community conservation group who in partnership with the New Zealand Department of Conservation (DOC) have created the Tiritiri Matangi Scientific Wildlife Reserve.
SRG	Species recovery groups are composed of DOC staff and other experts who develop TSRPs and programmes for the recovery of threatened species.
TTM	Tiritiri Matangi. A New Zealand wildlife reserve established by DOC as an open sanctuary with public access to some of New Zealand's most threatened species.
TSRP	Threatened species recovery plans are produced by DOC to guide the recovery of threatened species.
UNEP	United Nations Environment Programme
USDI	United States Department of the Interior. A USA Federal government department that administers aspects of the Endangered Species Act 1973.
WMO	World Meteorological Organization
WWF	World Wildlife Fund. An international non-governmental organisation that raises awareness of threatened species and inhumane practices involving wildlife.

Table of Contents

AN EVALUATION OF THE CONSERVATION OF NEW ZEALAND'S THREATENED BIODIVERSITY I

FRONTISPIECE II

ABSTRACT IV

PREFACE VI

ACKNOWLEDGEMENTS X

GLOSSARY AND ACRONYMS XIII

TABLE OF CONTENTS XIX

LIST OF FIGURES XXII

LIST OF TABLES XXIII

CHAPTER 1 GENERAL INTRODUCTION 1

1.1 INTRODUCTION 2
1.2 NEW ZEALAND'S THREATENED SPECIES 2
1.3 CONSERVATION OF NEW ZEALAND WILDLIFE 4
1.3.1 New Zealand Department of Conservation 4
1.3.2 Conservation partnerships 5
1.4 BIODIVERSITY HOTSPOTS 6
1.5 BIOGEOGRAPHY OF NEW ZEALAND 8
1.6 ECOSYSTEM SERVICES 9
1.7 PEST MANAGEMENT 10
1.8 THREATENED SPECIES LEGISLATION 14
1.9 CHAPTER CONTENTS OF THESIS 15
1.10 REFERENCES 15

CHAPTER 2 SURVEY OF PUBLIC ATTITUDE TOWARDS CONSERVATION AMONGST A SAMPLE OF HOUSEHOLD'S IN NEW ZEALAND LARGEST POPULATION CENTRE (AUCKLAND) AND AWARENESS OF SOME OF NEW ZEALAND'S THREATENED SPECIES 40

2.1 ABSTRACT 41
2.2 INTRODUCTION 42
2.3 OBJECTIVES 44
2.4 METHODS 44
2.4.1 Sample size 46
2.5 RESULTS 46
2.5.1 Response rate 46
2.5.2 Sex/occupation/age 47
2.5.3 Awareness of rare and threatened New Zealand species 48
2.5.4 Priority for government spending 50
2.6 DISCUSSION 53
2.7 CONCLUSIONS 55
2.8 ACKNOWLEDGEMENTS 56
2.9 REFERENCES 57

CHAPTER 3 SURVEY OF NEW ZEALAND DEPARTMENT OF CONSERVATION STAFF INVOLVED IN THE MANAGEMENT AND RECOVERY OF THREATENED SPECIES. 63

3.1 ABSTRACT 64
3.2 INTRODUCTION 64
3.3 RESEARCH OBJECTIVES 67
3.4 METHODS 68
3.4.1 The survey design 68
3.4.2 Staff structure of the DOC conservancies 71
3.4.3 Analysis 71

3.5 RESULTS 73
3.5.1 Response rate and survey participants 73
3.5.2 Survey participants 73
3.5.3 Management of threatened species 76
3.5.4 Improvement of threatened species management 78
3.5.5 Effectiveness of Threatened Species Recovery Plans 78
3.5.6 Improvements for Threatened Species Recovery Plans 80
3.5.7 Funding for species recovery 81
3.5.8 New Zealand's threatened biodiversity. Identification of threats 82
3.5.9 Management of introduced pests and predators 83
3.6 DISCUSSION 85
3.6.1 A national threatened species strategy 85
3.6.2 Resources and tools for threatened species management. 86
3.6.3 Comparison of management by national conservation agencies 88
3.7 CONCLUSIONS 89
3.8 ACKNOWLEDGEMENTS 90
3.9 REFERENCES 91

CHAPTER 4 NEW ZEALAND LACKS COMPREHENSIVE THREATENED SPECIES LEGISLATION – COMPARISON WITH LEGISLATION IN AUSTRALIA AND THE USA. 98

4.1 ABSTRACT 99
4.2 INTRODUCTION 100
4.3 RESEARCH OBJECTIVES 101
4.4 METHODS 102
4.5 RESULTS 103
4.5.1 Extinction and the current status of New Zealand's biota 103
4.5.2 Current New Zealand legislation for the conservation of New Zealand biota: legislation relating to the management and recovery of threatened species 105
4.5.3 Recovery plans 107
4.5.4 The USA Endangered Species Act 1973 and Australian Environment Protection and Biodiversity Conservation Act 1999 108
4.5.5 Opinions of experts on the application, strengths and weaknesses of the USA ESA 1973 and Australian EPBC Act 1999 111
4.6 DISCUSSION 121
4.6.1 The relevance of threatened species legislation – the USA Endangered Species Act 1973 as a Benchmark 121
4.6.2 The first 10 years of the Australian Environment Protection and Biodiversity Conservation Act 1999 122
4.6.3 New Zealand threatened species legislation 123
4.6.4 Commitment to internationally agreed conventions 124
4.7 CONCLUSIONS 125
4.8 ACKNOWLEDGEMENTS 126
4.9 REFERENCES 127

CHAPTER 5 FUTURE DIRECTION FOR THE CONSERVATION OF NEW ZEALAND'S BIODIVERSITY 138

5.1 ABSTRACT 139
5.2 INTRODUCTION 140
5.3 REVIEW 142
5.3.1 Approaches to threatened species recovery 142
5.3.2 Species chosen to be managed 143
5.3.3 Return to foundation principles of management 146
5.4 CONCLUSIONS 147
5.5 ACKNOWLEDGEMENTS 149
5.6 REFERENCES 150

CHAPTER 6 GENERAL CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS 162

6.1 INTRODUCTION 163
6.2 NATIONAL APPROACH TO THREATENED SPECIES MANAGEMENT 164
6.3 RECOMMENDATIONS 165

6.3.1 Recovery plans *165*
6.3.2 Security of funding for recovery of threatened species *166*
6.3.3 Threatened species recovery groups *166*
6.3.4 Coordinated management of threatened species *167*
6.3.5 Coordinated pest management *168*
6.4 THREATENED SPECIES LEGISLATION 169
6.5 THREAT CLASSIFICATION SYSTEMS 170
6.6 MOLECULAR TOOLS 172
6.7 COMMUNITY CONSERVATION GROUPS 172
6.8 CONCLUSION 174
6.9 REFERENCES 176

CHAPTER 7 APPENDICES 179

7.1 PUBLIC SURVEY QUESTIONNAIRE 179
7.2 DEPARTMENT OF CONSERVATION SURVEY QUESTIONNAIRE 181
7.3 SURVEY FOR EXPERTS WITH EXPERIENCE WITH THE US ENDANGERED SPECIES ACT 1973 190
7.4 AUSTRALIAN EPBC SURVEY 191
7.5 CHAPTER 3; PUBLISHED VERSION 192
7.6 CHAPTER 4; PUBLISHED VERSION 200
7.7 CHAPTER 5; PUBLISHED VERSION 212
7.8 SUPPLEMENTARY PUBLISHED PAPER ON QUAIL PHYLOGENY. 217

List of Figures

Figure 2.1 Species first mentioned by survey respondents. 49

Figure 2.2 Taxonomic group of species mentioned by survey respondents. 50

Figure 2.3 Median ranking values for priorities of government expenditure on social services. 52

Figure 2.4 Average annual expenditure on services by New Zealand Government from years 2004-2008 (Data from New Zealand Treasury). 52

Figure 3.1 Time spent by survey participants as a member of a Species Recovery Group. Expressed as a percentage of the time participants have been employed with the New Zealand Department of Conservation (DOC) 76

Figure 4.1 Process of threatened species recovery in Australia, USA and New Zealand. Process to assess eligibility of candidate species for recovery and subsequent delisting from register once recovery has been achieved. 120

List of Tables

Table 1.1 Number of known or estimated New Zealand species showing number classified as threatened with extinction. (Data sourced from: Hitchmough 2007, de Lange 2004, 2009) 7

Table 1.2 Number of introduced pest species to New Zealand. The table includes species identified from a list of the world's 100 worst invasive alien species, compiled by The Invasive Species Specialist Group (ISSG) of the World Conservation Union (IUCN) http://www.issg.org/database/species/reference_files/100English.pdf..... 13

Table 2.1 Location and size of sample chosen from the greater Auckland area, New Zealand. 46

Table 2.2 Gender and age range of survey respondents. 47

Table 3.1 Objectives explored in the staff survey. The table contains four objectives and the questions relating to each objective. Please refer to Appendix 7.1 for full questionnaire. 66

Table 3.2 Conservancies of the New Zealand Department of Conservation. Table shows size of each conservancy, number of recorded threatened species and number of staff responding to survey 70

Table 3.3 Management tasks performed by survey participants. Data in this table relates to: Objective (1) To ascertain the role of DOC staff in the management and recovery of threatened species 74

Table 3.4 Reasons for lack of cross-boundary management of threatened species and suggestions for improvement. This table relates to: Objective (2) To ascertain the level of communication and knowledge sharing between conservancies. 77

Table 3.5 Strengths and weaknesses of threatened species recovery plans identified by DOC staff and suggestions for improvement. The data in this table relates to: Objective (3) To understand staff attitudes towards recovery plans as a management tool. 80

Table 3.6 - Attitudes towards the inclusion of costings in threatened species recovery plans. Table relates to: Objective (3) To understand staff attitudes towards recovery plans as a management tool. 82

Table 3.7 Pest management tasks conducted by survey participants. The data contained in this table relates to: Objective (4) To understand the level of commitment towards pest control within conservancies. 83

Table 4.1 Comparison between Australia, USA and New Zealand threatened species legislation and recovery process. 110

Table 4.2 Strengths and weaknesses of ESA1973 identified by USA experts. 112

Table 4.3 Strengths and weaknesses of EPBC1999 identified by Australian experts. . 114

CHAPTER 1 General Introduction

New Zealand woodpigeon Kereru *Hemiphaga novaeseelandiae*
(Photo: Mark Seabrook-Davison)

1.1 Introduction

It is widely recognised that New Zealand along with the rest of the world is experiencing a biodiversity crisis (Diamond and Veitch, 1981; Ehrlich and Daily, 1993; Myers, 1993; Clout, 2001; Abell, 2002; Olson *et al.*, 2002; Conrad *et al.*, 2006; Hector and Bagchi, 2007; Paterson *et al.*, 2008). Conservation science is alerting the world to the environmental and economic costs of biodiversity loss along with other global changes such as climate change and habitat modification (Montgomery *et al.*, 1999; Chapin *et al.*, 2000; Berrens, 2001; Symstad *et al.*, 2003; Esty, 2008; Hayward and Kerley, 2009; Wilson *et al.*, 2009). With the increasing recognition of biodiversity as important providers of ecosystem services (Costanza *et al.*, 1997; Milner-Gulland and Mace, 1998; Woodwell, 2002; Millenium Ecosystem Assessment, 2005; Goldman *et al.*, 2008; Ceballos and Ehrlich, 2009), management and recovery of threatened biota is being actively promoted (Foin *et al.*, 1998; McKee *et al.*, 2004; Darwall and Vie, 2005; Egoh *et al.*, 2005). Having an economy based on the primary industries of agriculture, fishing, forestry and tourism, New Zealand is heavily reliant on the ecosystem services provided by its biodiversity (Tilman, 1999; Ministry for the Environment, 2000, 2003, 2004, 2006, 2007; Haque, 2006; McAlpine and Wotton, 2009).

This thesis evaluates whether New Zealand is equipped to manage the demands on its biodiversity and specifically assesses the country's approach to the recovery of threatened species.

1.2 New Zealand's threatened species

It is only recently that wildlife managers have become aware of how much of New Zealand's biodiversity is threatened with extinction (Williams and Given, 1981; Bell,

1986; Molloy and Davis, 1994; Halloy, 1995; Hitchmough, 2002; Molloy *et al.*, 2002; Sekercioglu *et al.*, 2004; Hitchmough *et al.*, 2007). There has been a lack of data on the biology and ecology of threatened species in all taxonomic groups, a constraint that all countries have to contend with (Fitter and Fitter, 1987; Cresswell and Veitch, 1994; Halloy, 1995; Clout, 2001; Clark and Harvey, 2002; Thomas *et al.*, 2006; Long *et al.*, 2007; International Union for Conservation of Nature, 2008). As recently as the 1980's, it was unclear how many and to what degree, species in New Zealand were threatened. This situation was highlighted by Williams & Given (1981) in the first compilation of New Zealand's threatened species…*"not only is there dissension among experts about what groups of species should be included and disagreement about the degree of threat to which various species are subject, but some fundamental biological data may not be available."*(Williams and Given, 1981)

Williams & Given (1981) recorded 92 species as threatened with extinction using the IUCN classification system (International Union for Conservation of Nature, 1978). In 1986, the New Zealand Wildlife Service of the Department of Internal Affairs updated the list of threatened species to 197 (Bell, 1986). These early lists were rudimentary and did not record threatened species from all taxonomic groups owing to a lack of published biological data (Kinsky, 1970; Bell, 1975; Mills and Williams, 1979; Meads *et al.*, 1984), In a space of 28 years since the first threat classification systems were used, the number of New Zealand species/subspecies listed as threatened has increased to 2,788 (Molloy and Davis, 1994; Molloy *et al.*, 2002; de Lange *et al.*, 2004; Hitchmough *et al.*, 2007; Townsend *et al.*, 2008; de Lange *et al.*, 2009). These groups are: terrestrial invertebrates, freshwater invertebrates, marine invertebrates, marine fish, freshwater fish, terrestrial mammals, marine mammals, vascular plants, fungi, bryophytes, terrestrial amphibians, reptiles, birds and macroalgae. To some degree this

increase reflects the greater amount of dedicated research on New Zealand's biodiversity and a bias towards researching prominent taxa remains with less research dedicated to lower taxa. It is only since 2002, after the development of a comprehensive threat classification system (Molloy *et al.*, 2002) that the records of New Zealand threatened species can be considered accurate. It is also at this time that the New Zealand Department of Conservation committed to regularly updating these records (Hitchmough, 2002; Hitchmough *et al.*, 2007; Townsend *et al.*, 2008; de Lange *et al.*, 2009).

1.3 Conservation of New Zealand wildlife

Comprehensive reviews of New Zealand's approach to the management of wildlife and specifically threatened species, are relatively recent (Norton, 2001; Wassenaar and Ferreira, 2002; Moran, 2003; Joseph *et al.*, 2008; Walker *et al.*, 2008; Joseph *et al.*, 2009; Wallace, 2009). New Zealand is now realising the need to manage the sustainable use of remaining natural resources (Hartley, 1997; Park, 2000; Anstey and May, 2003; Ministry for the Environment, 2007; Higham and Bejder, 2008; McAlpine and Wotton, 2009) and recognising the importance of instigating recovery programmes for species threatened with extinction (Brown and Molloy, 1999; Wilson, 2004; Cullen *et al.*, 2005; Jamieson *et al.*, 2005; Holzapfel *et al.*, 2008; Joseph *et al.*, 2008; Joseph *et al.*, 2009).

1.3.1 New Zealand Department of Conservation

New Zealand wildlife management and the recovery of threatened species are conducted by the Department of Conservation (DOC), principally guided by legislation contained in the Wildlife Act 1953 and Conservation Act 1987. New Zealand is divided into 13 regional conservancies, which encompasses public conservation land (referred to as the conservation estate) administered by DOC and other land and territorial marine

areas administered by regional, rural or urban Councils. Each conservancy is an independent entity with its own Conservator (CEO), staff structure and budget. DOC has the responsibility for the management of species protected under the Wildlife Act 1953 (Department of Conservation, 1998a, 1998b, 2001, 2006b, 2007a, 2007b) and has total jurisdiction over any species within public conservation land.

Indigenous and introduced species outside public conservation land but within the administrative boundaries of each conservancy are managed in conjunction with other conservation agencies, local councils, landowners and non-governmental organisations. (Ministry for the Environment, 2000, 2003, 2007; Landcare Research, 2008). DOC also manages species not protected by the Wildlife Act 1953 such as plants and invertebrates on DOC land under the Reserves Act 1977 but only has an advocacy role for unprotected species on land outside the DOC estate. A third of the terrestrial land area of New Zealand is protected in a conservation estate with the first national parks created in the mid 19th century (Thom, 1987; Galbreath, 1993; Young, 2004). Tongariro National Park was created in 1887, 15 years after the establishment of Yellowstone in the USA (1872), the world's first national park (Hutching, 1998). Successive governments have added to the conservation estate with the goal of securing adequate areas of New Zealand to ensure protection of all ecosystem types and habitat of all indigenous flora and fauna (Ministry for the Environment, 2000; Department of Conservation, 2001, 2006, 2007b; Ministry of Research Science and Technology, 2007).

1.3.2 Conservation partnerships

To cope with the pace of exploitation of natural resources and declining biodiversity, the New Zealand government is entering into conservation partnerships with non

governmental organisations (NGO), community conservation groups (CCG) and the private sector. Although New Zealand has a large conservation estate, much of the remaining habitat for threatened species exists on private land or public land outside the protection of the conservation estate. Landcare New Zealand has identified 42 threatened ecosystems (Landcare Research, 2008) requiring investigation to fully understand their ecological function. With large areas of private land being converted for agricultural use, especially dairying, the New Zealand Ministry for the Environment has introduced a national strategy for protecting threatened native biota on private land through the formation of partnerships (Ministry for the Environment, 2003). There is an extensive network of partnerships between DOC, local councils and CCGs with 46 community conservation initiatives funded through a Community Conservation Fund (Scott, 2007; Department of Conservation, 2008). Community conservation groups are becoming extensively involved in rehabilitating both island and mainland habitat for the reintroduction of threatened species. Some of these projects operate according to an open sanctuary model where the public can see and get involved with the recovery of threatened species (McHalick, 1998; Rimmer, 2004; Armstrong, 2007).

1.4 Biodiversity hotspots

New Zealand has been identified as a group of islands containing flora and fauna of such international significance that the entire archipelago has been described as a biodiversity hotspot (Bellamy *et al.*, 1990; Reid, 1998; Chapin *et al.*, 2000; Myers *et al.*, 2000; Smith *et al.*, 2001; Mittermeier *et al.*, 2004). New Zealand is listed with 25 other areas that contain a high level of biotic endemism (Prendergast *et al.*, 1993; Duncan and Blackburn, 2004) and which have experienced a very high level of habitat loss (Ogden *et al.*, 1998; McGlone and Wilmshurst, 1999; Myers *et al.*, 2000; Worthy and Holdaway, 2002; Myers, 2003a, 2003b; Wilmshurst *et al.*, 2004).

New Zealand qualifies as a hotspot by meeting two principle criteria (Myers *et al.*, 2000) of having at least 0.5% (0.6%, n=2,300) of the world's plant species and having lost the majority (78%) of its primary vegetation. Endemism is very high within most taxonomic groups (Table 1.1). Biodiversity hotspots (Myers, 2002, 2003b) have been used as an advocacy tool to alert the world to the loss of biodiversity (Kitching, 2000; Thebault and Loreau, 2003; Sekercioglu *et al.*, 2004) and the important ecological function that all species perform (Chapin *et al.*, 1998; Chapin *et al.*, 2000; Smyth *et al.*, 2009). Myers *et al.* (2000) argues that because the world's 25 hotspots contain the remaining habitat of nearly one half of the world's remaining plants (44%) and a third of all vertebrate species (35%), a focussed international effort should be directed at conserving them.

Table 1.1 Number of known or estimated New Zealand species showing number classified as threatened with extinction. (Data sourced from: Hitchmough 2007, de Lange 2004, 2009)

Taxonomic group	Number of species	% endemic	Recorded threatened species	Species recorded as data deficient	% threatened
Bats	5	100	5	1	100
Birds	269	35	153	1	57
Bryophytes	256	?	175	51	68
Fish (Freshwater)	51	86	26	3	51
Fish (Marine exploited)	51	?	?	?	?
Fish (Marine not exploited)	1150	?	52	34	5
Frogs	4	100	4	none	100
Fungi	?	?	65	1447	?
Invertebrates (Freshwater)	?	?	114	3	?
Invertebrates (Marine)	?	?	270	8	?
Invertebrates (Terrestrial)	?	?	943	1316	?
Macroalgae	62	?	38	23	61
Marine mammals	52	6	8	14	15
Reptiles (Terrestrial)	97	100	63	10	65
Tuatara	4	100	4	none	100
Vascular plants	2,300		868	96	38

New Zealand was the last large land mass to be colonised by humans with the arrival of East Polynesians 700 years bp and Europeans in the late 18th early 19th centuries (Davidson, 1984; Andrews, 1986; Belich, 1996; King, 2003; Young, 2004; Wilson *et al.*, 2007). This recent colonisation (Wilmshurst, 2007; Wilmshurst *et al.*, 2008) of New Zealand has allowed an examination of the impacts of humans on an insular biota that has evolved in relative isolation (Holdaway, 1989; Wilmshurst, 1997).

1.5 Biogeography of New Zealand

New Zealand's biota has been influenced by its small land mass and separation from Gondwanaland before the dispersal of large terrestrial mammals and some plant groups (Hector, 1869; Arber, 1917; Carey, 1955; Allan, 1961; Cockayne, 1967; Moore and Edgar, 1970; Fleming, 1979; Craw, 1988; Stevens *et al.*, 1988). The popular literature also portrays New Zealand as a Gondwanan fragment that has been an ark for ancient vicarious biota such as Moa *Dinornis* spp., Kiwi *Apteryx* spp., Tuatara *Sphenodon* spp. (only representative of Order: Sphenodontia) and ancient frogs *Leiopelma* spp (Family: Leiopelmatidae) (Attenborough, 1979; Morris and Smith, 1988; Bellamy *et al.*, 1990; Wilson, 2004). A competing theory (Bunce *et al.*, 2005; Trewick *et al.*, 2007; Worthy *et al.*, 2007; Landis *et al.*, 2008) suggests that New Zealand, as part of Zealandia, may have fully submerged during the Oligocene period and the current biota is representative of a much younger New Zealand landform with current species having evolved from migrants over the last 22 million years. The anomaly of Tuatara *Sphenodon* spp and *Leiopelma* spp frogs present through the Oligocene submergence is explained by their survival on isolated ephemeral islands (Trewick *et al.*, 2007). The fossil record is incomplete and it is argued (Wilson, 1993) that recorded fossil taxa display varying

levels of evolutionary change. This postulation led to the theory (Eldredge and Gould, 1972; Gould, 1980; Eldredge, 1985) of Punctuated Equilibrium which suggests the pace of evolution is highly variable; at times rapid and at other times, slowing to a virtual halt (Gould, 1980).

Without a comprehensive understanding of the past dispersal of species to New Zealand, uncertainties will remain as to rates of evolution of New Zealand's biota and the degree to which this biota has been augmented by immigrants. Novel approaches to phylogenetics and biogeographical revisions suggest that dispersal has occurred between continents and distant oceanic islands (Harbaugh *et al.*, 2009; Seabrook-Davison *et al.*, 2009). Therefore, without a clear paleobiogeograhical understanding of New Zealand, it is unclear whether New Zealand's biota has primarily evolved from archaic vicarious Gondwanan ancestors or from progressive dispersal of immigrants. Such an understanding is important when instigating any strategies for the restoration or rehabilitation of ecosystems and habitat. Recent advances in molecular analysis (Huynen *et al.*, 2003; Huynen, 2006; Shepherd and Lambert, 2008) using ancient DNA is helping to piece together New Zealand's paleontological history and solving confusion over past distribution of distinctive taxa.

1.6 Ecosystem services

Conservation biology is a relatively young discipline (Chapin *et al.*, 2000; Clout, 2001; Clark and Harvey, 2002; Sutherland *et al.*, 2004; George and Mayden, 2005; Knight, 2009; Sutherland *et al.*, 2009) compared to the traditional areas of biological science and recently has had a strong influence over how the environment is viewed. Conservation biology has also recently directed its efforts to investigating the impacts of declining biodiversity on ecosystem function (Naeem *et al.*, 1994, 1995). As a

consequence, there is a realisation of the need to understand the linkage of different taxa to the provision of ecosystem services (Milner-Gulland and Mace, 1998; Armsworth *et al.*, 2007; Jack *et al.*, 2008). In a paper published recently (Sutherland *et al.*, 2009), 43 experts representing 24 international organisations were asked to …*"identify the 100 questions of greatest importance to the conservation of global biological diversity"* (Sutherland *et al.*, 2009). Ecosystem services was the focus of the top three questions with experts highlighting that declining biological diversity leads to degrading of ecological functions and ecosystem services (Walker, 1992; Wardle and Zackrisson, 2005; Ecology info, 2009).

1.7 Pest management

New Zealand's biodiversity has been considerably changed as a result of the impacts of introduced species (Thompson, 1922; Wodzicki, 1950; McDowall, 1994; Denslow, 2001; Gibbs, 2006; Cowan, 2007; Russell *et al.*, 2008; Eason and Ogilvie, 2009) As a primary producer of agricultural and horticultural products, the deliberate introduction of species such as sheep *Ovis aries*, cattle *Bos taurus*, goats *Capra hircus*, pigs *Sus scrofa*, fruit trees and pasture grasses *Lolium sp* has greatly benefitted New Zealand's economy. However, many of the introduced species have become pests with some reaching invasive (widespread throughout New Zealand) proportions such as rats, mustelids, possum, deer, varroa mite, Didymo algae, severely impacting both indigenous biota and New Zealand's primary industries (Atkinson, 2001; Dowding and Murphy, 2001; Duffey, 2001; Connolly, 2008). The impacts of these pest species is probably New Zealand's most critical ecological challenge (Choquenot and Parkes, 2001; Clout, 2002; Clout and Russell, 2008; Nugent *et al.*, 2001), a legacy the early settlers had not foreseen.

The anthropogenic impacts of early East Polynesians were extensive with fires contributing to large areas of primary vegetation being removed (Rogers, 1994; Ogden *et al.*, 1998; McGlone, 2001; Rogers *et al.*, 2007). Although these early human colonists introduced a very small number of species, the two mammal species, Kiore *Rattus exulans* and domestic dog *Canis sp*. had considerable impacts on the biota, especially invertebrates and small vertebrates such as reptiles, frogs and ground dwelling birds (Worthy and Holdaway, 1995; Worthy, 1997; Campbell and Atkinson, 1999; Worthy and Holdaway, 2002; Wilmshurst *et al.*, 2004; Wilson, 2004). There is discussion in the scientific literature as to when the Pacific rat (*Rattus exulans*) arrived in New Zealand with suggestions it may have arrived with humans reaching New Zealand earlier than 700 bp but who either did not settle or did not survive and leave evidence of their settlement (Worthy and Holdaway, 1995; Worthy, 1997; Worthy and Holdaway, 2002). Between 1769-1919, 1170 species were deliberately or accidentally introduced to New Zealand (Ritchie, 1922; Thompson, 1922; McDowall, 1994). It appears only basic environmental impact assessment was considered by early settlers before agricultural and game species were introduced (Henry, 1903; Galbreath, 1993; Marchant and Higgins, 1993; McDowall, 1994; Galbreath, 1998; King, 2005).

Apart from the creation of three wildlife reserves on Resolution, Little Barrier and Kapiti Islands formed under the Lands Act 1892, early wildlife legislation (Animal Protection and Game Act 1922) focussed protection on introduced species such as the possum *Trichosurus vulpectula*, stoat *Mustela erminea*, deer *Cervus spp*., game birds and the many freshwater salmonid species (Galbreath, 1993; McDowall, 1994). There was a concerted effort throughout the 19th century by the Acclimatisation Societies and the Agriculture Department to establish populations of fur bearing species, game species and sport fish throughout New Zealand (McDowall, 1994). Of the 220

introduced mammal, bird and fish species recorded by Thompson (Thompson, 1922), 36 are currently pests with 12 being invasive.

The greatest impact has been caused by mammals with 26 (56%) of the 46 introduced between 1769-1919 becoming pests. Thompson (1922) also recorded 596 plant and 346 invertebrate species, with most (plants 76%, invertebrates 97%) being accidental introductions. Most of the invertebrates recorded by Thompson (1922) were accidental introductions, initially establishing as pests of domestic animals or agricultural crops and stored grain. Some of these species persist today as serious agricultural and horticultural pests (Scott, 1984). Currently, the New Zealand Ministry for the Environment records 25,000 plants, 54 mammal and 2,000 invertebrate species having been introduced to New Zealand since human habitation (Ministry for the Environment, 2009). The Invasive Species Specialist Group (ISSG) of the World Conservation Union (IUCN) has released a list of the world's worst 100 invasive alien species (Lowe *et al.*, 2004) and 26 of these have been introduced to New Zealand, with 17 becoming serious pests (Table 1.2).

Table 1.2 Number of introduced pest species to New Zealand. The table includes species identified from a list of the world's 100 worst invasive alien species, compiled by The Invasive Species Specialist Group (ISSG) of the World Conservation Union (IUCN) http://www.issg.org/database/species/reference_files/100English.pdf

Species	Scientific name	Pest status	Severity	Commercial status
Plants				
Dutch elm disease	*Ophiostoma ulmi*	localised		
Frog chytrid fungus	*Batrachochytrium dendrobatidis*	expanding distribution		
Phytophthora root rot	*Phytophthora cinnamomi*	widespread		
Water hyacinth	*Eichhornia crassipes*	expanding distribution		
Black wattle	*Acacia mearnsii*	expanding distribution		fire wood species
Brazilian pepper tree	*Schinus terebinthifolius*	expanding distribution		ornamental species
Cluster pine	*Pinus pinaster*	expanding distribution		
Gorse	*Ulex europaeus*	widespread	invasive	
Kahili ginger	*Hedychium gardnerianum*	expanding distribution	invasive	
Lantana	*Lantana camara*	expanding distribution		
Privet	*Ligustrum nrobustum*	widespread		
Strawberry quava	*Psidium cattleianum*	expanding distribution		ornamental species
Invertebrates				
Argentine ant	*Linepithema humile*	localised		
Asian tiger mosquito	*Aedes albopictus*	recorded, not established		
Common wasp	*Vespula vulgaris*	widespread	invasive	
Gypsy moth	*Lymantria dispar*	localised, eradicated		
Fish				
Brown trout	*Salmo trutta*	widespread	invasive	game species
Carp	*Cyprinus carpio*	expanding distribution	invasive	
Rainbow trout	*Oncorhynchus mykiss*	widespread	invasive	game species
Mosquito fish	*Gambusia affinis*	widespread	invasive	
Birds				
Indian myna	*Acridotheres tristis*	widespread	invasive	
Starling	*Sturnus vulgaris*	widespread	invasive	
Reptiles				
Red eared slider	*Trachemys scripta*	localised		pet species
Mammal				
Brush tailed possum	*Trichosurus vulpectula*	widespread	invasive	harvested for fur
Domestic cat	*Felis catus*	widespread	invasive	pet species
Goat	*Capra hircus*	widespread	invasive	farmed species
Mouse	*Mus musculus*	widespread	invasive	pet species
Pig	*Sus scrofa*	widespread	invasive	farmed species
Rabbit	*Oryctolagus cuniculus*	widespread	invasive	pet species
Red deer	*Cervus elaphus*	widespread	invasive	farm & game species
Ship rat	*Rattus rattus*	widespread	invasive	
Stoat	*Mustala erminea*	widespread	invasive	

1.8 Threatened species legislation

To address the biodiversity crisis and especially the recent increase in the rate of extinction, countries such as Australia and Canada have followed the lead of the USA in implementing dedicated threatened species legislation (Douglas, 2002; Goble *et al.*, 2006; McGrath, 2006; Ferraro *et al.*, 2007). The US Endangered Species Act 1973 (ESA1973) has been the benchmark for the creation of the Australian Environment Protection and Biodiversity Conservation Act 1999 (EPBC1999) and Canadian Species At Risk Act 2002 (SARA2002) (Venter *et al.*, 2006; Godden and Peel, 2007; Mooers *et al.*, 2007; Australian Government, 2009). Part of the impetus for Australia and Canada to create these acts was to honour obligations as signatories to the Convention on Biodiversity (CBD) (Convention on Biological Diversity, 1993; Australian Government, 1996). New Zealand does not have a comparable statute despite a large number of threatened species and being an early signatory to the CBD (Ministry for the Environment, 2000; Green and Clarkson, 2005). New Zealand's native wildlife is protected under the Wildlife Act 1953 (WA1953) but this act does not have a directive for the conservation of threatened species (Crossen, 2007; Wallace, 2009).

Under their legislation, the USA, Canada and Australia have a legal directive to list all species classified as threatened and a central government mandate to instigate recovery planning (Douglas, 2002). In contrast under the WA1953, apart from some discretionary powers of the Minister of Conservation to produce general wildlife plans, there is no legal process for the listing of threatened species and subsequent directive for recovery (New Zealand Legislation, 1953).

1.9 Chapter contents of thesis

The overall research question of this research is to examine the status of New Zealand's threatened species and to evaluate approaches to their management and recovery. The thesis will explore this question, identifying gaps in the effective management of threatened species and will provide suggestions on ways this management can be improved. The intention of the thesis is to provide solutions that can be applied to the recovery of threatened species. Areas of improvement will be suggested to the New Zealand government where improvements in its governance and husbandry role can be made.

Sections 1.2 to 1.8 of chapter one introduce the scope of this thesis and provide an introductory literature review. My research findings relating to these sections are extensively discussed in the following chapters (chapters two to five) with concluding comments in chapter six. The results presented and discussed are supported by relevant references in each chapter.

1.10 References

Abell, R. 2002. Conservation biology for the biodiversity crisis: A freshwater follow-up. *Conservation Biology 16*: 1435-1437.

Allan, H.H. 1961. Flora of New Zealand. Volume 1 - Indigenous Tracheophyta, Psilopsida, Lycopsida, Filicopsida, Gymnospermae, Dicotyledones. *Government Printer, New Zealand*, Wellington.

Andrews, J.R.H. 1986. The southern ark: Zoological discovery in New Zealand 1769-1900. *Century Hutchinson New Zealand Ltd*, Auckland New Zealand.

Anstey, C., May, R. 2003 Reclaiming conservation: Dissolving the dichotomy of forest management in New Zealand through standards development. 2003 ANZIF Conference papers. 1-12pp. *The New Zealand Institute of Forestry*.

Arber, E.A.N. 1917. The earlier mesozoic floras of New Zealand. *Paleontological Bulletin of New Zealand Geological Survey 6*: 1-80.

Armstrong, D. 2007. 15 Years of research on Tiritiri Matangi robins. *Dawn Chorus 69*: 8-11.

Armsworth, P.R., Chan, K.M.A., Daily, G.C., Ehrlich, P.R., Kremen, C., Ricketts, T.H., Sanjayan, M.A. 2007. Ecosystem-service science and the way forward for conservation. *Conservation Biology 21*: 1383-1384.

Atkinson, I.A.E. 2001. Introduced mammals and models for restoration. *Biological Conservation 99*: 81-96.

Attenborough, D. 1979. Life on earth: A natural history. *Collins British Broadcasting Corporation*, London.

Australian Government. 1996. National strategy for the conservation of Australia's biological diversity. *Department of the Environment Water Heritage and the Arts*, Canberra.

Australian Government. 2009. Australia's biodiversity conservation strategy 2010-2020. *National Biodiversity Strategy Review Task Force, Australian Government, Department of the Environment Water Heritage and the Arts*, Canberra.

Belich, J. 1996. Making Peoples. A history of New Zealanders, from Polynesian settlement to the end of the nineteenth century. *University of Hawaii Press*, Honolulu.

Bell, B.D. 1975. The rare and endangered species of the New Zealand region and the policies that exist in their management. *International Council for Bird Preservation Bulletin 12*: 140-146.

Bell, B.D. 1986. The conservation status of New Zealand wildlife. Occasional Publication No. 12. *New Zealand Wildlife Service, Department of Internal Affairs*, Wellington, New Zealand.

Bellamy, D., Springett, B., Hayden, P. 1990. Moa's ark - The voyage of New Zealand. *Viking*, Auckland.

Berrens, R.P. 2001. The safe minimum standard of conservation and endangered species: a review. *Environmental Conservation 28*: 104-116.

Brown, A., Molloy, J. 1999. Species recovery planning standard operating procedure. *Department of Conservation*, Wellington.

Bunce, M., Szulkin, M., Lerner, H.R.L., Barnes, I., Shapiro, B., Cooper, A., Holdaway, R.N. 2005. Ancient DNA provides new insights into the evolutionary history of New Zealand's extinct giant eagle. *PLoS Biology 3*: 44-46.

Campbell, D.J., Atkinson, I.A.E. 1999. Effects of Kiore (*Rattus exulans* Peale) on recruitment of indigenous coastal trees on northern offshore islands of New Zealand. *Journal of the Royal Society of New Zealand 29*: 265-290.

Carey, S.W. 1955. The Orocline concept in geotectonics. *Proceedings of the Royal Society Tasmania 89*: 255-288.

Ceballos, G., Ehrlich, P.R. 2009. Discoveries of new mammal species and their implications for conservation and ecosystem services. *Proceedings of the National Academy of Sciences 106*: 3841-3846.

Chapin, F.S., Sala, O.E., Burke, I.C., Grime, J.P., Hooper, D.U., Lauenroth, W.K., Lombard, A., Mooney, H.A., Mosier, A.R., Naeem, S., Pacala, S.W., Roy, J., Steffen, W.L., Tilman, D. 1998. Ecosystem consequences of changing biodiversity: experimental evidence and a research agenda for the future. *Bioscience 48*: 45-52.

Chapin, F.S., Zavaleta, E.S., Eviner, V.Y., Naylor, R.L., Vitousek, P.M., H.L, R., Hooper, D.U., Lavore, S., SalaI, O.E., Hobbie, S.E., Mack, M.C., Díaz, S. 2000. Consequences of changing biodiversity. *Nature 405*: 234-242.

Clark, J.A., Harvey, E. 2002. Assessing multi-species recovery plans under the endangered species act. *Ecological Applications 12*: 655-662.

Clout, M. 2001. Where protection is not enough: Active conservation in New Zealand. *Trends in Ecology & Evolution 16*: 415-416.

Cockayne, L. 1967. New Zealand plants and their story. *Government Printer, New Zealand*, Wellington.

Connolly, T.A. 2008. The potential for re-invasion by mammalian pests at Maungatautari ecological island (unpublished MSc thesis). *Waikato University*, Hamilton, New Zealand.

Conrad, K.F., Warren, M.S., Fox, R., Parsons, M.S., Woiwod, I.P. 2006. Rapid declines of common, widespread British moths provide evidence of an insect biodiversity crisis. *Biological Conservation 132*: 279-291.

Convention on Biological Diversity. 1993. Convention on biological diversity (with annexes). Concluded at Rio de Janeiro on 5 June 1992. United Nations - Treaty Series. *United Nations*, Montreal.

Costanza, R., d'Arge, R., de Groot, R., Faber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. *Nature 387*: 253-260.

Cowan, P. 2007. Mammalia pest impacts in New Zealand. *In:* Pimentel, D. (Editor), Encyclopaedia of Pest Management, pp 329-331. *CRC Press Taylor and Francis Group*, Boca Raton, Florida, USA.

Craw, R.C. 1988. Continuing the synthesis between panbiogeography, phylogenetic systematics and geology as illustrated by empirical studies on the biogeography of New Zealand and the Chatham Islands. *Systematic Zoology 37*: 291-310.

Cresswell, M., Veitch, D. 1994. Threatened terrestrial insects: A workshop to advance conservation. Threatened Species Occasional Publication 6. *Department of Conservation*, Wellington.

Crossen, T. 2007. Should snails have standing? - Towards an Endangered Species Act for New Zealand. *Resource Management Journal April 2007*: 12-17.

Cullen, R., Moran, E., Hughey, K.F.D. 2005. Measuring the success and cost effectiveness of New Zealand multiple-species projects to the conservation of threatened species. *Ecological Economics 53*: 311-323.

Darwall, W.R.T., Vie, J.C. 2005. Identifying important sites for conservation of freshwater biodiversity: extending the species-based approach. *Fisheries Management & Ecology 12*: 287-293.

Davidson, J. 1984. The prehistory of New Zealand. *Paul Longman Limited*, Auckland, New Zealand.

de Lange, P.J., Norton, D.A., Courtney, S.P., Heenan, P.B., Barkla, J.W., Cameron, E.K., Hitchmough, R., Townsend, A.J. 2009. Threatened and uncommon plants of New Zealand (2008 revision). *New Zealand Journal of Botany 147*: 61-96.

de Lange, P.J., Norton, D.A., Heenan, P.B., Courtney, S.P., Molloy, B.P.J., Ogle, C.C., Rance, B.D., Johnson, P.N., Hitchmough, R. 2004. Threatened and uncommon plants of New Zealand. *New Zealand Journal of Botany 42*: 45-76.

Denslow, J.S. 2001. The ecology of insular biotas. *Trends in Ecology & Evolution 16*: 423-424.

Department of Conservation. 1998a. Biodiversity recovery unit: Roles and responsibilities. *Department of Conservation*, Wellington.

Department of Conservation. 1998b. Department of Conservation. Restoring the dawn chorus, 1988-2002 strategic business plan. *Department of Conservation*, Wellington.

Department of Conservation. 2001. Making the best choice for conservation. *Department of Conservation*, Wellington.

Department of Conservation. 2006a. Department of Conservation. Statement of intent 2006-2009. *Department of Conservation*, Wellington.

Department of Conservation. 2006b. Standard operating procedure - Species recovery planning (draft document) 2006. Threatened Species Section, Research, Development and Improvement. *Department of Conservation*, Wellington.

Department of Conservation. 2007a. Annual report Department of Conservation 2007. *Department of Conservation*, Wellington.

Department of Conservation. 2007b. Department of Conservation statement of intent 2007-2010. *Department of Conservation*, Wellington.

Department of Conservation. 2008. Community conservation fund guidelines (electronic source) http://www.doc.govt.nz/upload/documents/getting-involved/in-your-community/community-conservation-fund/ccf-round2-guidelines.pdf.

Diamond, J.M., Veitch, C.R. 1981. Extinctions and introductions in the New Zealand avifauna: cause and effect. *Sciences 211*: 499-501.

Douglas, K. 2002. Legislative summary Bill - The Species At Risk Act. *Library of Parliament*, Ottawa, Canada.

Dowding, J.E., Murphy, E.C. 2001. The impact of predation by introduced mammals on endemic shorebirds in New Zealand: a conservation perspective. *Biological Conservation 99*: 47-64.

Duffey, E. 2001. Introduced pest species and biodiversity conservation in New Zealand. *Biological Conservation 99*: 1-1.

Duncan, R.P., Blackburn, T.M. 2004. Extinction and endemism in the New Zealand avifauna. *Global Ecology and Biogeography 13*: 509-517.

Eason, C.T., Ogilvie, S. 2009. A re-evaluation of potential rodenticides for aerial control of rodents Department of Conservation, Research & Development Series No. 312. *Department of Conservation*, Wellington.

Ecology info. 2009. Biodiversity loss and the functioning of ecosystems (electronic source) http://www.ecology.info/article.aspx?cid=10&id=68.

Egoh, B., Rouget, M., Reyers, B., Knight, A.T., Cowling, R.M., van Jaarsveld, A.S., Welz, A. 2005. Integrating ecosystem services into conservation assessments: A review. Forum on sustainability well being and environmental protection, pp 714-721, Washington, DC.

Ehrlich, P.R., Daily, G.C. 1993. Population extinction and saving biodiversity. *Ambio 22*: 64-68.

Eldredge, N. 1985. Time frames: the rethinking of Darwinian evolution and the theory of punctuated equilibria. *Simon and Schuster*, New York, USA.

Eldredge, N., Gould, S.J. 1972. Punctuated equilibria: An alternative to phyletic gradualism. *In:* Schopf, T.J.M. (Editor), Models in Paleobiology, pp 82-115. *Freeman Cooper*, San Francisco, USA.

Esty, D.C. 2008. Climate change and global environmental governance. *Global Governance 14*: 111-118.

Ferraro, P.J., McIntosh, C., Ospina, M. 2007. The effectiveness of the US endangered species act: An econometric analysis using matching methods. *Journal of Environmental Economics and Management 54*: 245-261.

Fitter, R., Fitter, M. 1987. The road to extinction : problems of categorizing the status of taxa threatened with extinction. Proceedings of a symposium held by the Species Survival Commission. *Species Survival Commission (International Union for the Conservation of Nature)*, Gland, Switzerland.

Fleming, C.A. 1979. The geological history of New Zealand and its life. *Auckland University Press/Oxford University Press*, Auckland.

Foin, T.C., Riley, S.P.D., Pawley, A.L., Ayres, D.R., Carlson, T.M., Hodum, P.J., Switzer, P.V. 1998. Improving recovery planning for threatened and endangered species. *Bioscience 48*: 177-184.

Galbreath, R. 1993. Working for Wildlife: A History of the New Zealand wildlife service. *Bridget Williams Books Limited*, Wellington.

Galbreath, R. 1998. DSIR Making science work for New Zealand. *Victoria University Press, Victoria University of Wellington,*, Wellington, New Zealand.

George, A.L., Mayden, R.L. 2005. Species concepts and the Endangered Species Act: How a valid biological definition of species enhances the legal protection of biodiversity. *Natural Resources Journal 45*: 369-407.

Gibbs, G. 2006. Ghosts of Gondwana: The history of life in New Zealand. *Craig Potton Publishing*, Nelson.

Goble, D.D., Scott, J.M., Davis, F.W. (Editors). 2006. The Endangered Species Act at Thirty: Renewing the conservation promise. *Island Press*, Washington.

Godden, L.C., Peel, J. 2007. The Environment Protection and Biodiversity Conservation Act 1999 - Dark sides of virtue. *Melbourne University Law Review 31*: 106-145.

Goldman, R.L., Tallis, H., Kareiva, P., Daily, G.C. 2008. Field evidence that ecosystem service projects support biodiversity and diversify options. *Proceedings of the National Academy of Sciences 105*: 9445-9448.

Gould, S.J. 1980. Is a new and general theory of evolution emerging? *Paleobiology 6*: 119-130.

Green, W., Clarkson, B. 2005. Turning the tide? A review of the first five years of the New Zealand biodiversity strategy. The synthesis report. *Biodiversity New Zealand*, Wellington.

Halloy, S.R.P. 1995. Status of New Zealand biodiversity research and resources: how much do we know? *Journal of the Royal Society of New Zealand 25*: 55-80.

Haque, T. 2006. Funding recreational opportunity provision on the New Zealand conservation estate. *New Zealand Treasury - Policy Perspectives Paper*, Wellington.

Harbaugh, D.T., Wagner, W.L., Allan, G.J., Zimmer, E.A. 2009. The Hawaiian archipelago is a stepping stone for dispersal in the Pacific: an example from the plant genus Melicope (Rutaceae) *Journal of biogeography 36*: 230-241.

Hartley, P. 1997. Conservation strategies for New Zealand. *New Zealand Business Roundtable*, Wellington.

Hayward, M.W., Kerley, G.I.H. 2009. Fencing for conservation: Restriction of evolutionary potential or a riposte to threatening processes? *Biological Conservation 142*: 1-13.

Hector, A., Bagchi, R. 2007. Biodiversity and ecosystem multifunctionality. *Nature 448*: 188-190.

Hector, J. 1869. On the geographical botany of New Zealand. *Transactions of the New Zealand Institute 2*: 157-160.

Henry, R. 1903. The habits of the flightless birds of New Zealand: With Notes on Other New Zealand Birds. *Government Printer*, Wellington, New Zealand.

Higham, J.E.S., Bejder, L. 2008. Managing wildlife-based tourism: edging slowly towards sustainability? *Current Issues in Tourism 11*: 75-83.

Hitchmough, R. 2002. New Zealand threat classification system lists. Threatened Species Occasional Publication 23. *Department of Conservation*, Wellington.

Hitchmough, R., Bull, L., Cromarty, P. 2007. New Zealand threat classification system lists 2005. Threatened Species Occasional Publication. *Department of Conservation*, Wellington.

Holdaway, R.N. 1989. New Zealand's pre-human avifauna and its vulnerability. *New Zealand Journal of Ecology 12*: 11-25.

Holzapfel, S., Robertson, H.A., McLennan, J.A., Sporle, W., Hackwell, K., Impey, M. 2008. Kiwi (Apteryx spp.) recovery plan: 2008-2018 Threatened Species Recovery Plan 60. *Department of Conservation*, Wellington.

Hutching, G. 1998. The penguin natural world of New Zealand. *Penguin Group (NZ)*, Albany, New Zealand.

Huynen, L. 2006. Avian DNA extraction from tissue and feathers (unpublished laboratory protocol). *The Allan Wilson Centre, Institute of Molecular Biosciences of Massey University, New Zealand*, Auckland.

Huynen, L., Millar, C.D., Scofield, R.P., Lambert, D.M. 2003. Nuclear DNA sequences detect species limits in ancient moa. *Nature 425*: 175-178.

International Union for Conservation of Nature. 1978. Red data book of USSR. 14th General Assembly of the International Union for Conservation of Nature, . *IUCN*, Ashkhabad.

International Union for Conservation of Nature. 2008. International Union for Conservation of Nature, 2007 Red list of threatened species. *International Union for Conservation of Nature, World Conservation Union - Species Survival Commission (SSC)*, Gland.

Jack, B.K., Kousky, C., Sims, K.R.E. 2008. Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms. *Proceedings of the National Academy of Sciences of the United States of America 105*: 9465-9470.

Jamieson, I.G., Wallis, G.P., Briskie, J.V. 2005. Inbreeding and endangered species management: Is New Zealand out of step with the rest of the world? *Conservation Biology 20*: 38-47.

Joseph, L.N., Maloney, R.F., O'Connor, S.M., Cromarty, P., Jansen, P., Stephens, T., Possingham, H.P. 2008. Improving methods for allocating resources among threatened species: the case for a new national approach in New Zealand. *Pacific Conservation Biology 14*: 154-158.

Joseph, L.N., Maloney, R.F., Possingham, H.P. 2009. Optimal allocation of resources among threatened species: a Project Prioritization Protocol. *Conservation Biology 23*: 328-338.

King, C.M. 2005. The handbook of New Zealand mammals. *Oxford University Press*, Melbourne.

King, M. 2003. The Penguin history of New Zealand. *Penguin*, Auckland.

Kinsky, F.C. 1970. The annotated checklist of birds of New Zealand. *Reed*, Wellington.

Kitching, R. 2000. Biodiversity, hotspots and defiance. *Trends in Ecology & Evolution 15*: 484-485.

Knight, A.T. 2009. Is conservation biology ready to fail? *Conservation Biology 23*: 517-517.

Landcare Research. 2008. Statement of corporate intent for 2008-2009: your partner in an affordable sustainable future. *Landcare Research*, Lincoln.

Landis, C.A., Campbell, H.J., Begg, J.G., Mildenhall, D.C., Paterson, A.M., Trewick, S.A. 2008. The Waipounamu erosion surface: questioning the antiquity of the New Zealand land surface and terrestrial fauna and flora. *Geological Magazine 145*: 173-197.

Long, P.R., Szekely, T., Kershaw, M., O'Connell, M. 2007. Ecological factors and human threats both drive wildfowl population declines. *Animal Conservation 10*: 183-191.

Lowe, S., Browne, M., Boudjelas, S., De Porter, M. 2004. 100 of the world's worst invasive alien species. A selection from the global invasive species database. *The Invasive Species Specialist Group (ISSG) Species Survival Commission (SSC) of the World Conservation Union (IUCN)*, Auckland, New Zealand.

Marchant, S., Higgins, P.J. (Editors) 1993. Handbook of Australian, New Zealand and Antarctic birds. *Oxford University Press*, Melbourne, Australia.

McAlpine, K.G., Wotton, D.M. 2009. Conservation and the delivery of ecosystem services: a literature review. Science for Conservation 295. *Department of Conservation*, Wellington.

McDowall, R.M. 1994. Gamekeepers for the nation: the story of New Zealand's acclimatisation societies, 1861-1990. *Canterbury University Press University of Canterbury* Christchurch.

McGlone, M.S. 2001. The origin of the indigenous grasslands of south eastern South Island in relation to pre-human woody ecosystems. *New Zealand Journal of Zoology 25*: 1-15.

McGlone, M.S., Wilmshurst, J.M. 1999. Dating initial Maori environmental impact in New Zealand. *Quaternary International 59*: 5-16.

McGrath, C.J. 2006. Review of the EPBC Act. *Australian State of the Environment Committee, Department of the Environment and Heritage*, Canberra.

McHalick, O. 1998. Translocation database summary. Threatened Species Occasional Publication. *Department of Conservation*, Wellington.

McKee, J., K; Sciulli, P.W., Fooce, C.D., Waite, T.A. 2004. Forecasting global biodiversity threats associated with human population growth. *Biological Conservation 115*: 161-164.

Meads, M.J., Walker, K.J., Elliot, G.P. 1984. Status, conservation and management of the land snails of the genus *Powelliphanta* (Mollusca: Pulmonata). *New Zealand Journal of Zoology 11*: 277-306.

Millenium Ecosystem Assessment. 2005. Millenium Ecosystem Assessment Synthesis Report - A Report of the Millenium Ecosystem Assessment. *In*: Sarukhan, J., Whyte, A (Editors) Millenium Ecosystem Assessment. *World Resources Institute*, Washington DC.

Mills, J.A., Williams, G.R. 1979. The status of endangered New Zealand birds. The status of Australasian wildlife, pp 147-168. *Royal Zoological Society of South Australia*, Adelaide.

Milner-Gulland, E.J., Mace, R. 1998. Conservation of biological resources. *Blackwell Science Ltd*, Oxford, England.

Ministry for the Environment. 2000. The New Zealand biodiversity strategy: Our chance to turn the tide. *Department of Conservation and Ministry for the Environment*, Wellington.

Ministry for the Environment. 2003. Indigenous biodiversity and national policy statement. *Ministry for the Environment*, Wellington.

Ministry for the Environment. 2004. Freshwater for a sustainable future: issues and options. *Ministry for the Environment*, Wellington.

Ministry for the Environment. 2006. Freshwater for the future: a supporting document. *Ministry for the Environment*, Wellington.

Ministry for the Environment. 2007. Environment New Zealand 2007. (Publication number ME: 847). *Ministry for the Environment*, Wellington.

Ministry for the Environment. 2009. Introduced species (electronic source) http://www.mfe.govt.nz/environmental-reporting/biodiversity/pest-management.html.

Ministry of Research Science and Technology. 2007. Environment research. Roadmaps Science: A guide for New Zealand science activity. *Ministry of Research Science and Technology*, Wellington.

Mittermeier, R.A., Gil, P.R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J., de Fonseca, G.A.B. 2004. Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions. *Conservation International*, Mexico City, Mexico.

Molloy, J., Bell, B., Clout, M., de Lange, P., Gibbs, G., Given, D., Norton, D., Smith, N., Stephens, T. 2002. Classifying species according to threat of extinction. A system for New Zealand. Threatened species occasional publication 22. *Department of Conservation*, Wellington, New Zealand.

Molloy, J., Davis, A. 1994. Setting priorities for the conservation of New Zealand's Threatened Plants and Animals. (2nd Edition). Department of Conservation, Wellington. *Department of Conservation*, Wellington, New Zealand.

Montgomery, C.A., Pollack, R.A., Freemark, K., White, D. 1999. Pricing biodiversity. *Journal of Environmental Economics and Management 38*: 1-19.

Mooers, A., Prugh, L.R., Festa-Bianchet, O.M., Hutchings, J.A. 2007. Biases in legal listing under Canadian endangered species legislation. *Conservation Biology 21*: 572-575.

Moore, L.B., Edgar, E. 1970. Flora of New Zealand. Volume 2 - Indigenous Tracheophyta: Monocotyledones except Gramineae. *Government Printer, New Zealand*, Wellington, New Zealand.

Moran, E. 2003. An analysis of the costs of New Zealand threatened species programmes (unpublished MSc thesis), Lincoln University. *Lincoln University*, Christchurch.

Morris, R., Smith, H. 1988. Wild South: Saving New Zealand's endangered birds. *TVNZ & Century Hutchinson Ltd*, Auckland.

Myers, N. 1993. Systematics, ecology, and the biodiversity crisis *Nature 362*: 30.

Myers, N. 2002. Biodiversity and biodepletion: the need for a paradigm shift. *In:* O'Riordan, T., Stoll-Kleemann, S. (Editors), Biodiversity, sustainability and human communities: protecting beyond the protected, pp 46-60. *Cambridge University Press*, Cambridge.

Myers, N. 2003a. Biodiversity hotspots revisited. *Bioscience 53*: 916-917.

Myers, N. 2003b. Impact and acceptance of the hotspots strategy: response to Ovadia and to Brummitt and Lughadha. *Conservation Biology 17*: 1449-1450.

Myers, N., Mittermeiser, R.A., Mittermeiser, C.G., de Fonseca, G.A.B., Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*: 853-858.

Naeem, S., Thompson, L.J., Lawler, S.P., Lawton, J.H., Woodfin, R.M. 1994. Declining biodiversity can alter the performance of ecosystems. *Nature 368*: 734-737.

Naeem, S., Thompson, L.J., Lawler, S.P., Lawton, J.H., Woodfin, R.M. 1995. Empirical evidence that declining species diversity may alter the performance of terrestrial ecosystems. *Philosophical Transactions of the Royal Society London B 347*: 249-262.

New Zealand Legislation. 1953. Wildlife Act 1953. *New Zealand Government Parliamentary Counsel Office*, Wellington, New Zealand.

Norton, D.A. 2001. Is the amount and focus of ecological research in New Zealand sufficient to sustain indigenous biodiversity on private land? *New Zealand Journal of Ecology 25*: 77-82.

Ogden, J., Basher, L., McGlone, M.S. 1998. Fire, forest regeneration and links with early human habitation: evidence from New Zealand. *Annals of Botany 81*: 687-696.

Olson, D.M., Dinerstein, E., Powell, G.V.N., Wikramanayake, E.D. 2002. Conservation biology for the biodiversity crisis. *Conservation Biology 16*: 1-3.

Park, G.N. 2000. New Zealand as ecosystems : the ecosystem concept as a tool for environmental management and conservation. *Department of Conservation*, Wellington, New Zealand.

Paterson, J.S., Araujo, M.B., Berry, P.M., Piper, J.M., Rounsevell, M.D.A. 2008. Mitigation, Adaptation and the threat to biodiversity. *Conservation Biology 22*: 1352-1355.

Prendergast, J.R., Quin, R.M., Lawton, J.H., Eversham, B.C., Gibbons, D.W. 1993. Rare species, the coincidence of biodiversity hotspots and conservation strategies. *Nature 365*: 335-337.

Reid, W.V. 1998. Biodiversity hotspots. *Trends in Ecology & Evolution 13*: 275-280.

Rimmer, A. 2004. Tiritiri Matangi - A model of conservation. *Tandem Press*, Auckland, New Zealand.

Ritchie, J. 1922. Naturalisation of animals and plants. *Nature 110*: 868-870.

Rogers, G.M. 1994. North Island seral tussock grasslands. 1. Origins and land-use history. *New Zealand Journal of Botany 32*: 271-286.

Rogers, G.M., Walker, S., Basher, L.M., Lee, W.G. 2007. Frequency and impact of Holocene fire in eastern South Island, New Zealand. *New Zealand Journal of Ecology 31*: 129-142.

Russell, J.C., Towns, D.R., Clout, M.N. 2008. Review of rat invasion biology: implications for island biosecurity. Science for Conservation 286. *Department of Conservation*, Wellington.

Scott, R.R. 1984. New Zealand pest and beneficial insects. *Lincoln University College of Agriculture*, Christchurch.

Scott, S. 2007. Engaging urban communities: Six case studies of Auckland community-based restoration projects. Landcare Research Contract Report (prepared for New Zealand Landcare Trust, Hamilton). *Landcare Research*, Auckland.

Seabrook-Davison, M., Huynen, L., Lambert, D.M., Brunton, D.H. 2009. Ancient DNA resolves identity and phylogeny of New Zealand's extinct and living quail (*Coturnix* sp). *PLoS ONE 4(7)*: e6400.

Sekercioglu, C.H., Daily, G.C., Ehrlich, P.R. 2004. Ecosystem consequences of bird declines. *Proceedings of the National Academy of Sciences of the United States of America 101*: 18042-18047.

Shepherd, L.D., Lambert, D.M. 2008. Ancient DNA and conservation: lessons from the endangered kiwi of New Zealand. *Molecular Ecology 17*: 2174-2184.

Smith, T., B., Kark, S., Schneider, C., J., Wayne, R., K., Moritz, C. 2001. Biodiversity hotspots and beyond: the need for preserving environmental transitions. *Trends in Ecology & Evolution 16*: 431-431.

Smyth, A.K., Brandle, R., Chewings, V., Read, J., Brook, A., Fleming, M. 2009. A framework for assessing regional biodiversity condition under changing environments of the arid Australian rangelands. *The Rangeland Journal 31*: 87-101.

Stevens, G., McGlone, M., McCulloch, B. 1988. Prehistoric New Zealand. *Heinemann Reid*, Auckland.

Sutherland, W.J., Adams, W.M., Aronson, R.B., Aveling, R., Blackburn, T.M., Broad, S., Ceballos, G., Cote, I.M., Cowling, R.M., Da Fonseca, G.A.B., Dinerstein, E., Ferraro, P.J., Fleishman, E., Gascon, C., Hunter Jr., M., Hutton, J., Kareiva, P., Kuria, A., MacDonald, D.W., MacKinnon, K., Madgwick, F.J., Mascia, M.B., McNeely, J., Milner-Gulland, E.J., Moon, S., Morley, C.G., Nelson, S., Osborn, D., Pai, M., Parsons, E.C.M., Peck, L.S., Possingham, H., Prior, S.V., Pullin, A.S., Rands, M.R.W., Ranganathan, J., Redford, K.H., Rodriguez, J.P., Seymour, F., Sobel, J., Sodhi, N.S., Stott, A., Vance-Borland, V., Watkinson, A.R. 2009. One hundred questions of importance to the conservation of global biological diversity. *Conservation Biology 23*: 557-567.

Sutherland, W.J., Pullin, A.S., Dolman, P.M., Knight, T.M. 2004. The need for evidence-based conservation. *Trends in Ecology & Evolution 19*: 305-308.

Symstad, A.J., Chapin, F.S., Wall, D.H., Gross, K.L., Huenneke, L.F., Mittelbach, G.G., Peters, D.P., Tilman, D. 2003. Long-term and large-scale perspectives on the relationship between biodiversity and ecosystem functioning. *Bioscience 53*: 89-98.

Thebault, E., Loreau, M. 2003. Food-web constraints on biodiversity-ecosystem functioning relationships. *Proceedings of the National Academy of Sciences of the United States of America 100*: 14949-14954.

Thom, D. 1987. Heritage: The parks of the people. *Lansdowne Press*, Auckland.

Thomas, G.H., Lactot, R.B., Szekely, T. 2006. Can intrinsic factors explain population declines in North American breeding shorebirds? A comparative analysis. *Animal Conservation 9*: 252-258.

Thompson, G.M. 1922. The naturalisation of animals and plants in New Zealand. *Oxford University Press*, Oxford.

Tilman, D. 1999. The ecological consequences of changes in biodiversity: A search for general principles. *Ecology 80*: 1455-1474.

Townsend, A.J., de Lange, P.J., Duffy, C.A.J., Miskelly, C.M., Molloy, J., Norton, D.A. 2008. New Zealand threat classification system manual. Research, Development & Improvement Division. *Department of Conservation*, Wellington.

Trewick, S.A., Paterson, A.M., Campbell, H.J. 2007. Hello New Zealand. *Journal of Biogeography 24*: 1-6.

Venter, O., Brodeur, N.N., Nemiroff, L., Belland, B., Dolinsek, I.J., Grant, J.W.A. 2006. Threats to endangered species in Canada. *Bioscience 56*: 903-910.

Walker, B.H. 1992. Biodiversity and ecological redundancy. *Conservation Biology 6*: 18-23.

Walker, S., Brower, A.L., Clarkson, B.D., Williams, G.L., Myers, S.C., Shaw, W.B., Stephens, R.T.T. 2008. Halting indigenous biodiversity decline: ambiguity, equity, and outcomes in RMA assessment of significance. *New Zealand Journal of Ecology 32*: 225-237.

Wallace, P. 2009. Where the wild things are: examining the intersection between the RMA 1991 and the Wildlife Act 1953. *Department of Geography, Tourism and Environmental Planning, University of Waikato*, Hamilton.

Wardle, D.A., Zackrisson, O. 2005. Effects of species and functional group loss on island ecosystem properties. *Nature 435*: 806-810.

Wassenaar, T.D., Ferreira, S.M. 2002. Measuring conservation outcomes for depleted biological assets: Convergence theory and its applicability to New Zealand. Department of Conservation, Science Internal Series 38. *Department of Conservation*, Wellington.

Williams, G.R., Given, D.R. 1981. The red data book of New Zealand. Rare and endangered species of endemic terrestrial vertebrates and vascular plants. *Nature Conservation Council*, Wellington, New Zealand.

Wilmshurst, J.M. 1997. The impact of human settlement on vegetation and soil stability in Hawke's Bay, New Zealand. *New Zealand Journal of Botany 35*: 97-111.

Wilmshurst, J.M. 2007. The Polynesian revolution and the prehistoric transformation of New Zealand. *In*: "Feathers to Fur", New Zealand Ecological Society Conference 2007. *New Zealand Ecological Society*, Canterbury University, Christchurch, New Zealand.

Wilmshurst, J.M., Anderson, A.J., Higham, T.F.G., Worthy, T.H. 2008. Dating the late prehistoric dispersal of Polynesians to New Zealand using the commensal Pacific rat. *Proceedings of the National Academy of Sciences of the United States of America 105*: 7676-7680.

Wilmshurst, J.M., Higham, J., Allen, H., Johns, D., Phillips, C. 2004. Early Maori settlement impacts in northern coastal Taranaki. New Zealand. *New Zealand Journal of Ecology 28*: 167-179.

Wilson, D.J., Efford, M.G., Brown, S.J., Williamson, J.F., G.J, M. 2007. Estimating density of ship rats in New Zealand forests by capture-mark-recapture trapping. *New Zealand Journal of Ecology 31*.

Wilson, E.O. 1993. The diversity of life. *Penguin Group*, London.

Wilson, K. 2004. Flight of the Huia. Ecology and conservation of New Zealand's frogs, reptiles, birds and mammals. *Canterbury University Press*, Christchurch, New Zealand.

Wilson, K.A., Carwardine, J., Possingham, H.P. 2009. Setting conservation priorities. *Annals of the New York Academy of Sciences* 1162: 237-64.

Wodzicki, K. 1950. Introduced mammals of New Zealand. *Department of Scientific and Industrial Research*, Wellington, New Zealand.

Woodwell, G.M. 2002. On purpose in science, conservation and government: the functional integrity of the earth is at issue not biodiversity. *Ambio (Royal Swedish Academy of Sciences) 31*: 432-436.

Worthy, T.H. 1997. What was on the menu? Avian extinction in New Zealand. *Archaeology in New Zealand 19*: 125-160.

Worthy, T.H., Holdaway, R.N. 1995. Quaternary fossil faunas from caves on Mt. Cookson, North Canterbury, South Island, New Zealand. *Journal of the Royal Society of New Zealand 25*: 333-370.

Worthy, T.H., Holdaway, R.N. 2002. The lost world of the moa. Prehistoric life of New Zealand. *Indiana University Press*, Bloomington, Indiana.

Worthy, T.H., Tennyson, A.J.D., Archer, M., Musser, A.M., Hand, S.J., Jones, C., Douglas, B.J., McNamara, J.A., Beck, R.M.D. 2007. Miocene mammal reveals a mesozoic ghost lineage on insular New Zealand, southwest Pacific. *Proceedings*

of the National Academy of Sciences of the United States of America 103: 19419-19423.

Young, D. 2004. Our islands, our selves - A history of conservation in New Zealand. *University of Otago Press*, Dunedin.

CHAPTER 2 Survey of public attitude towards conservation amongst a sample of household's in New Zealand largest population centre (Auckland) and awareness of some of New Zealand's threatened species

North Island robin, *Petroica australis longipes* (Photo by Mark Seabrook-Davison).

This chapter is modified from the manuscript:
Seabrook-Davison M. N. H., Ji W. & Brunton D. H. Public attitude towards conservation in New Zealand and awareness of New Zealand's threatened species (submitted to *New Zealand Journal of Ecology*)

2.1 Abstract

A survey was conducted amongst a sample of households in Auckland, New Zealand's largest city, to gain an indication of the perception of government spending on conservation. The survey also obtained an understanding of the level of awareness these Auckland households had of New Zealand threatened species. Respondents ranked eight areas of government spending, namely health, education, superannuation, law and order, defence, conservation of native species, primary industry research & development and tourism. Overall, health and education were ranked the highest by Aucklander's, followed by law and order with conservation in fourth position. These rankings closely aligned with priorities of average annual government spending on social services. Aucklander's awareness of threatened species was the highest for endemic species such as kiwi (*Apteryx* spp), Hector's dolphin (*Cephalorynchus hectori*), kokako (*Callaeas cinerea cinerea*), kakapo (*Strigops habroptilus*), takahe (*Porphyrio mantelli*), Maui's dolphin (*Cephalorynchus hectori maui*) and tuatara (*Sphenodon* sp.) The high awareness for these flagship species may indicate that the Department of Conservation is achieving some success in its advocacy role to increase Aucklander's awareness of species threatened with extinction. With awareness of some of New Zealand's threatened species and the moderate ranking given to conservation expenditure, it is evident there is a level of public support in Auckland for expenditure on protection of biodiversity and natural heritage. This result was obtained from Auckland only and the results are not extrapolated to any other population centre within New Zealand.

Keywords: Public survey, New Zealand, Auckland, conservation, expenditure, threatened species

2.2 Introduction

A survey was conducted of a sample of Auckland households, New Zealand's largest population centre, to gain an understanding of their awareness of threatened species and their perception of expenditure on conservation. It is important for a society to be aware of conservation issues and to actively contribute to their government's policy on the management of biodiversity (Warren *et al.*, 2005; Naidoo *et al.*, 2006; Smith *et al.*, 2007; Karanth *et al.*, 2008). Trends in public opinion can be followed using surveys. For example, the 20 year United States Gallup poll which has consistently shown that public support in the United States is greater for the protection of the environment than for economic growth (Jacobe, 2008; Conservation-Magazine, 2009). From a survey based on randomly selected New Zealander's from the national Electoral Role (most accurate indication of New Zealander's aged 18 and above), a New Zealand Lincoln University survey has found that the majority of participants indicated they would be prepared to accept a lower standard of living if it meant more money was available for conservation and protection of biodiversity to ensure the benefits accrued to future generations (Hughey *et.al*. 2008).

The conservation of biodiversity is vital for both the effective functioning of a country's environment and its economy and social structure (Ehrlich and Daily, 1993; Costanza *et al.*, 1997; Milner-Gulland and Mace, 1998; Infield and Namara, 2001; Naidoo *et al.*, 2006). The aesthetic value of wildlife and the natural environment remain central to support for conservation but other values such as the conservation of biodiversity that provide ecosystem services and the sustainable use of natural resources are equally important (Clark *et al.*, 1994; Myers *et al.*, 2000; Myers, 2002; Soule' *et al.*, 2005; Smith *et al.*, 2007; Chan, 2008). To safeguard ecological function and the preservation of ecosystem services (Costanza *et al.*, 1997; Park, 2000; Armsworth *et al.*, 2007),

conservation of biodiversity is necessary in both protected and unprotected areas and this situation needs to be accepted by both government and the general public (McCracken, 1987; Norton and Cochrane, 2000).

It has been reported (Pretty, 2002) that 8.8% (13.5 million km^2, 30,354 reserves) of the world's land area (148 million km^2) is protected in dedicated biodiversity reserves and national parks. Of the 191 countries that have protected areas, New Zealand, with 30% of land area in a conservation estate, is in the group of 24 countries that have greater than 20% of their land area in reserves. But much of New Zealand's biodiversity with high conservation values and of importance in providing ecosystem services exists on private land (Norton and Roper-Lindsay, 2004). The two leading New Zealand conservation agencies, Department of Conservation (DOC) and Ministry for the Environment (MFE) promote joint stewardship and husbandry of New Zealand's biodiversity between private landowners and managers of the conservation estate (Ministry for the Environment, 2007; Miller, 2009).

The New Zealand archipelago was the last large landmass to be colonised (Belich, 1996) and with a pre-human fossil record and human archaeological record reasonably intact, it has been possible to record the anthropogenic impacts (Worthy and Holdaway, 2002) on New Zealand's biodiversity. The mitigation of these impacts is a considerable challenge (Clout, 2001) for New Zealand; a challenge that must be met to ensure the sustainability of its primary industries (agriculture, fishing), tourism and the conservation of its threatened biodiversity (Hartley, 1997; Craig *et al.*, 2000; Ministry for the Environment, 2007).

Awareness of threatened species as with any aspect of social, environmental or economic activity depends on how well people are informed. When surveys of

awareness are conducted, the species mentioned by participants can give an indication of the public profile of these species and a relationship can be established as to the effectiveness of communication from agencies such as the Department of Conservation (DOC) and other agencies advocating for the conservation of threatened biodiversity.

2.3 Objectives

This research had two principle objectives:

1. To record awareness of threatened species amongst a sample of Auckland households. Auckland is New Zealand's largest population centre.
2. To ascertain the perception of the sample of Auckland households to conservation and gain an indication of where this sample of Aucklanders ranks conservation in relation to other areas of government expenditure.

2.4 Methods

This research was conducted using a structured questionnaire methodology. Questionnaires were delivered to the mailboxes of residents (hereafter referred to as respondents) in the urban and immediate rural areas of Auckland, New Zealand. Auckland is New Zealand's largest centre of population (32% of NZ's total population) and is representative of all the major ethnic groups (European, Maori, Polynesian and Asian).

There was inevitable bias in the sampling with most respondents surveyed from suburbs of Auckland city and northern urban / rural areas with no coverage of South Auckland that has large concentrations of Maori and Pacific Islanders. It is probable that certain socio-economic groups were under-represented in the sample and it is equally probable that the responses from particular socio-political viewpoints have not been captured.

Outer areas of Auckland such as Riverhead, Huapai, Taupaki and Silverdale were surveyed which do contain a representative sample of New Zealand socio-economic and ethnic groups. However, there is no suggestion that people in these areas will provide a representative sample of the socio-political viewpoints of the Auckland region.

Questionnaires were delivered to all residents in these outer areas of Auckland by the rural delivery section of New Zealand Post. These areas are divided into delivery zones of 650 households each (refer Table 2.1). For each delivery zone, all 650 households received questionnaires. Households in the Auckland urban area were randomly chosen by street with alternating households chosen for delivery of questionnaires (refer Table 2.1). To standardise delivery time, for all rural and urban sub-regions of Auckland, questionnaires were delivered between 0900 hrs and 1300 hrs. The questionnaires were formatted in such a way that respondents could fold the completed questionnaire into thirds and post in any New Zealand Post letterbox. The questionnaire was embossed with a free post permit number, ensuring no postal charge to respondents.

The questionnaire (Appendix 7.1) contained two sections. Section one asked about the respondent's awareness of the names of threatened New Zealand species. Section two asked about respondent's attitudes to government expenditure on public services and how they would rank conservation of native species in order of spending priority. All collection of information and analysis was conducted under the conditions and provisions of the New Zealand Privacy Act 1993 and the Massey University Human Ethics Committee. *humanethicspn@massey.ac.nz.*

Respondents were asked to rank the priority of eight areas of government spending on a scale of 1- highest priority, to 8 - lowest priority. The eight areas of government spending were health, education, superannuation, law and order, defence, conservation

of native species, primary industry research and development, and tourism. For analysis, the total ranking scores of all respondents for each expenditure category was converted to a median value. Statistical analysis of data was done using SPSS version 15.

2.4.1 Sample size

General public distribution surveys (mail drops) are known for achieving low response rates (Visser *et al.*, 1996; Curtin *et al.*, 2000; Keeter *et al.*, 2006; Hughey *et al*. 2008). To mitigate this outcome, a large number of questionnaires (3000), (Table 2.1) were distributed. To achieve a possible 10% response rate, it was estimated that 10% of the total population in the area surveyed would need to be sampled (Watson, 2001). This estimate was verified by a sample size determination model developed by Watson (2001).

Table 2.1 Location and size of sample chosen from the greater Auckland area, New Zealand.

Population Area	Area Population	Sample Size	Percentage of Area Population (%)
Remuera West, One Tree Hill Central	5808	350	6
Kohimarama East	3570	350	10
Ponsonby West, Herne Bay	5226	350	7
Coatesville, Riverhead, Taupaki	4529	650	14
Dairy Flat, Redvale	4221	650	15
Kumeu, Huapai	6603	650	10
Total	29957	3000	10

Source: Statistics New Zealand 2006 national census. http://www.stats.govt.nz

2.5 Results

2.5.1 Response rate

The survey period ran for 111 days from 1 September 2007 to 20 December 2007, with 134 questionnaires returned representing a 4.5% return rate which was approximately a

half of what was anticipated. Three questionnaires were rejected owing to incomplete information. Although a low response rate, previous studies (Visser *et al.*, 1996; Curtin *et al.*, 2000) have found that low response rates do not necessarily mean reduced accuracy of the survey.

2.5.2 Sex/occupation/age

There was a stronger response from female respondents (n=99) than males (n=32). The majority of both gender (52% female, 41% male) were in the 31 to 50 yr age bracket (Table 2.2). The median age recorded in the 2006 census for people in Auckland was 33 years with the majority (40%) of both females and males aged between 30-50 yrs. This corresponded closely with the demographic profile of the survey respondents. Most of the respondents of either sex, males (53%) & females (44%) were professionals. This trend in the survey data also corresponds with the 2006 census which recorded 41% of Aucklanders in either a professional or managerial profession. The survey showed other female respondents were predominantly caregivers (38%) and other males were either trades people (22%) or retired (19%). It is important to be aware that the survey was skewed towards Aucklanders residing in inner city suburbs and northern areas which may mean the results are not representative of the socio-political views of all Aucklanders.

Table 2.2 Gender and age range of survey respondents**.**

Age bracket	Females No	%	Males No.	%
16 - 30 years	7	7	2	6
31 - 50 years	52	53	13	41
51 - 70 years	39	39	12	37
> 70 years	1	1	5	16
Total	99	100	32	100

2.5.3 Awareness of rare and threatened New Zealand species

Respondents were asked to record the first threatened or rare New Zealand species they were aware of and then asked to record all subsequent species up to a maximum of eight. The species identified by the Auckland respondents in this survey do not represent the species that people in other parts of New Zealand will necessarily recall. No assumption or inference is made that these species are representative of the recall or awareness of all New Zealanders. Recall of New Zealand's threatened and rare species depends on many factors such as level of media awareness, desire to understand social issues and personal ability to recall facts and information. Analysis was limited to the first, second and third species mentioned. The majority (71%) of first mentioned species were birds. Just under one half (44%) of all respondents identified kiwi *Apteryx spp*. as their first species (Figure 2.1). Other first mentioned bird species were kakapo *Strigops habroptilus* (7%), takahe *Porphyrio mantelli* (5%), black robin *Petroica traversi* (5%) and kokako *Callaeas cinerea wilsoni* (4%). For marine mammals, Hector's dolphin *Cephalorynchus hectori hectori* and Maui's dolphin *Cephalorynchus hectori maui* were first mentioned by 8% and 5% of respondents respectively. Eight respondents (6%) mentioned tuatara *Sphenodon spp*. first.

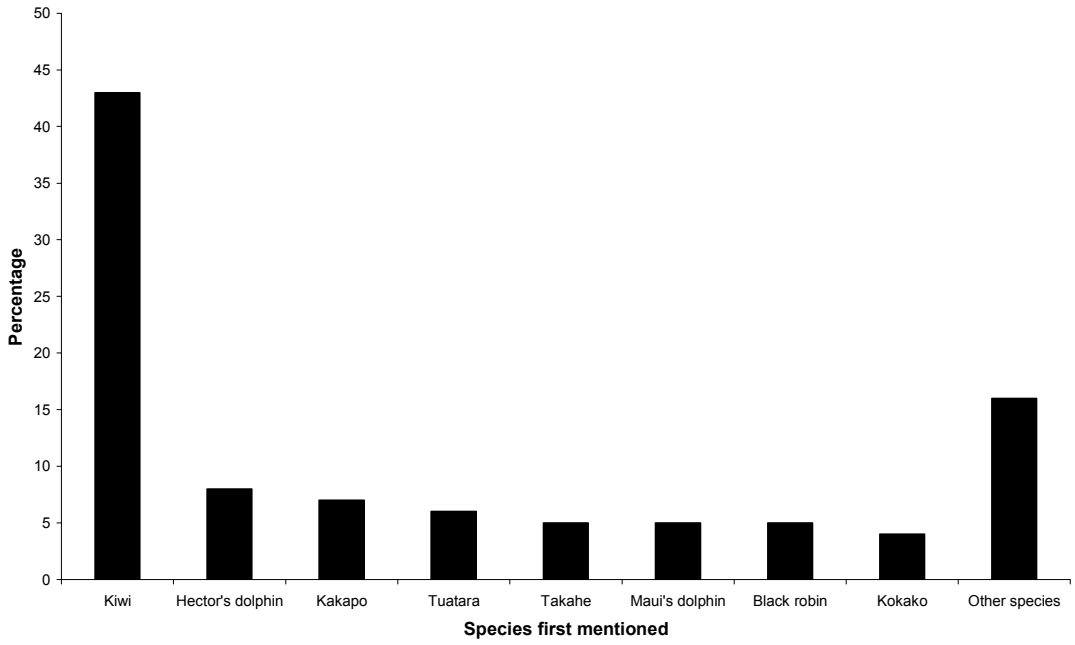

Figure 2.1 Species first mentioned by survey respondents.

The number of other species first mentioned represents an awareness of less prominent components of New Zealand's biodiversity such as wood rose *Dactylanthus sp*., Gecko *Hoplodactylus spp*, NZ falcon *Falco novaeseelandiae*, Cromwell chafer *Prodontria lewisii*, kauri snail *Paryphanta* spp**.** Overall, 76 species were mentioned (first, second and third), 56 of which are recorded as threatened (Hitchmough *et al.*, 2007) with extinction under the New Zealand threat classification system (Townsend *et al.*, 2008). The 76 species identified were representative of 10 taxonomic groups, with birds (50%), plants (16%) and marine mammals (9%) the most prominent (Figure 2.2).

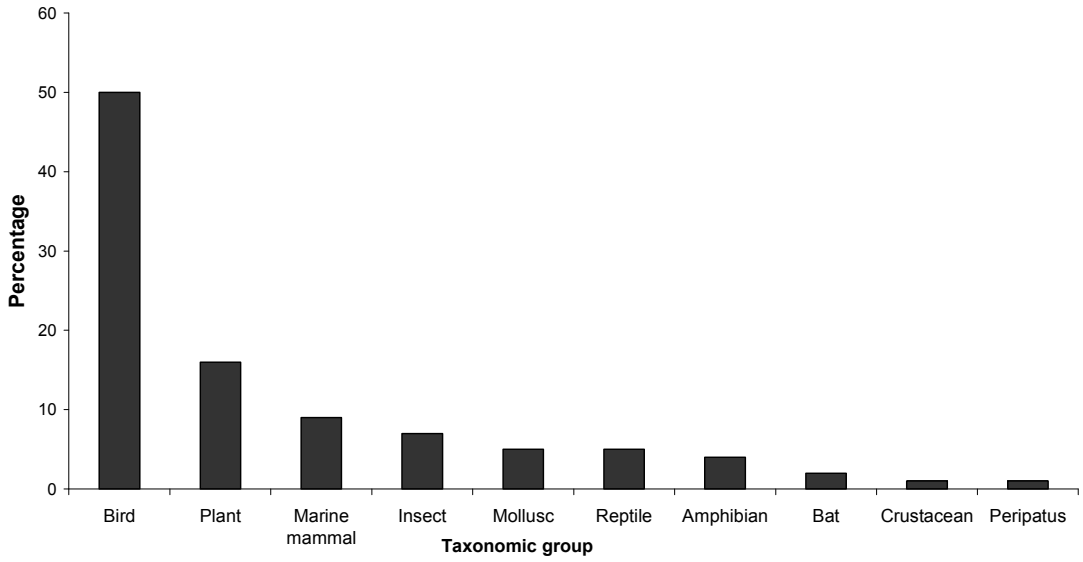

Figure 2.2 Taxonomic group of species mentioned by survey respondents.

2.5.4 Priority for government spending

Survey respondents in this Auckland sample clearly perceived, in their opinion, health and education as the most important spending priorities for the New Zealand government (Figure 2.3). These results do not represent the viewpoint of Aucklanders in general or people in other regions of New Zealand. Respondents displayed the highest median ranking scores for health, education and law and order. Conservation was ranked in fourth position, some distance behind the top three but with a median ranking score higher than, defence, superannuation, research and development, and tourism. Apart from superannuation, the ranking results corresponded to the historical trend in government spending over the last 5 years, (Figure 2.4) but it is accepted that this may only be coincidence and does not represent an empirical comparison whereby any quantitative inferences can be deduced. Although important, conservation is seen as a secondary priority for expenditure behind the main priorities of health and education. However, Hughey *et al.* (2008) did find in a nationwide New Zealand survey of people

18 years and older that most (>90%) were prepared to accept a lower standard of living if it meant conservation spending could be increased to protect biodiversity and the environment for future generations. Spending on conservation has been comparatively low over the last five years with NZ treasury recording average expenditure on conservation of approximately $NZ 130 million. This compares with average expenditure on health and education of $NZ 9.5 billion and $NZ 9.3 billion respectively. Please note that this average is for spending on all aspects of the work of the Department of Conservation. Focussed spending on biodiversity amounts to an average of $NZ 35 million per year.

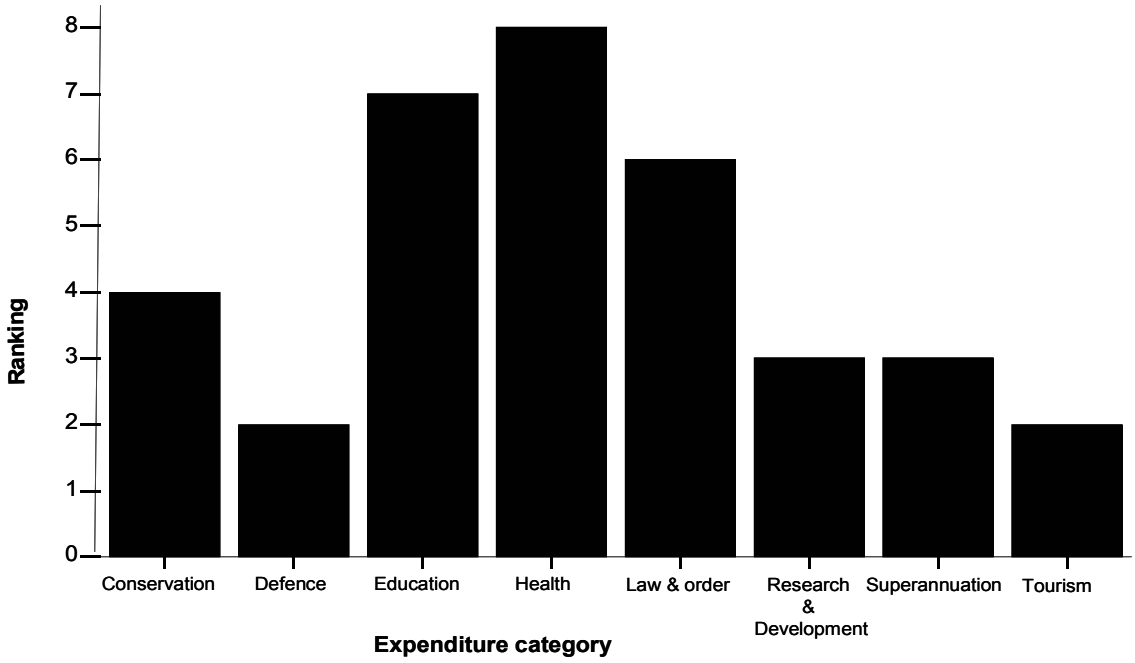

Figure 2.3 Median ranking values for priorities of government expenditure on social services.

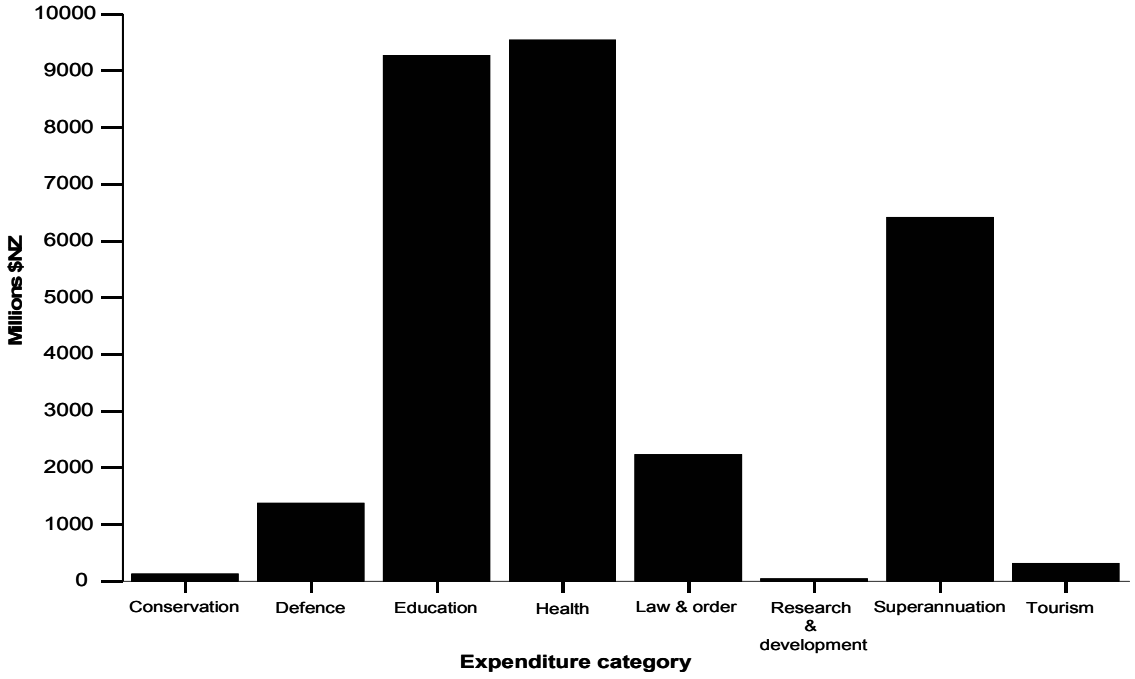

Figure 2.4 Average annual expenditure on services by New Zealand Government from years 2004-2008 (Data from New Zealand Treasury).

2.6 Discussion

These results indicate that the sample of Aucklander's surveyed has a reasonably high awareness of the country's most prominent threatened species. The results also suggest that there is comparatively high support for conservation amongst this sample of Aucklander's. This result is encouraging as it appears the conservation message advocated by the government via DOC and NGO's is reaching the households of New Zealand's largest population centre.

Despite the inherent biases in the survey results, it can be seen there is support for conservation amongst respondents surveyed in this study. It is important that the public continues to support conservation as a signal to the government to develop appropriate environmental policies. Current reviews of New Zealand conservation management (Norton and Cochrane, 2000; Cullen *et al.*, 2005; Joseph *et al.*, 2008; Joseph *et al.*, 2009) are calling for a critical assessment of the methods New Zealand uses to deliver conservation outcomes.

Respondent's high ranking for education and health can be aligned with the past and future expenditure pattern of the New Zealand government (New Zealand Treasury, 2008). However, respondents' low ranking for superannuation does not align with government expenditure for superannuation over the last five years. I am conscious that the results of the survey may not truly reflect the socio-political viewpoints of Aucklander's and that there maybe strong support for superannuation from Auckland households not captured in this survey. This constraint also applies to all other ranking recorded in this survey. In comparison, expenditure on conservation, has been very low for the last two years (0.4% of total annual expenditure for 2007 & 2008) and is forecasted to remain at this level for the foreseeable future. Currently, dedicated

expenditure on biodiversity is approximately $NZ 32 million per annum from a total operating budget for DOC of approximately $ NZ 130 million per annum. In a 2009 review of government spending, DOC has been directed to reduce its natural heritage spending by $NZ 10 million (Department of Conservation, 2009), therefore affecting the adequate delivery of management and recovery programmes for threatened species.

Current policy advice from the New Zealand Treasury is advocating a rationale for treating the conservation estate as a private good where charges (user pays) should be applied for recreational access (Haque, 2006; New-Zealand-Treasury, 2008). This rational was earlier raised by economists (Hartley, 1997) with the suggestion that the conservation estate should be viewed as a revenue earning government asset. The rational also called for the management of biodiversity assets to be a separate role for DOC with all non-conservation roles such as visitor access and tourism concessions managed by private operators. Currently DOC performs all management roles connected with the conservation estate. Funding for species recovery has not increased in recent years (unpublished DOC data) with DOC having to limit available funding to the top 6% of critically threatened species (unpublished internal DOC report). The current New Zealand government has raised the controversial issue of allowing mining within the conservation estate; suggesting that only areas of significant ecological value should be totally protected.

Internationally, New Zealand is perceived as implementing a high degree of conservation husbandry and protection of biodiversity. From a 2008 Environmental Performance Index (EPI) (Esty, 2008) which ranks 149 countries according to six environmental indicators of environmental health (air pollution, water resources, biodiversity and health, productive natural resources and climate change), New Zealand achieved 7th highest ranking of an EPI of 88.9 (max score 100). This ranking conflicts

with New Zealand internal assessments that report a degraded state of New Zealand's environment and biodiversity. A 2007 report (Ministry for the Environment, 2007) used a set of key environmental factors to assess the state of New Zealand's environment and its biodiversity. It concluded that past and present clearance of forests (70%) and drainage of wetlands (>75%) has reduced the available habitat for remaining biodiversity, caused widespread erosion and detrimentally affected soils and remaining waterways.

Support amongst the survey sample of Aucklander's for government spending on tourism was very low. There is an opportunity for the New Zealand government to improve the public's perception of tourism, considering it is an industry that contributes in excess of $NZ 17 billion per annum, representing 9% of the gross national product (GNP) over recent years (New Zealand Tourism, 2008). An unsupported assumption is presented that the Aucklander's responding to this survey maybe unaware that tourism is New Zealand's biggest export earner and that they may view tourism as many faceted with the perception that the tourism industry should fund its own operations.

2.7 Conclusions

The results in this survey need to be viewed in the context that a small sample of Aucklander's were surveyed and that all socio-political viewpoints were not captured. Also, the viewpoints of the Auckland households will not necessary correspond to viewpoints of households in other population centres of New Zealand.

This research provides an insight into a sample of Aucklander's awareness of threatened species and perception of the relationship of conservation to other core areas of government spending. Overall, health and education are perceived to have the highest priority for spending and ranked considerably higher than conservation. However,

conservation has a level of support amongst Aucklander's considerably greater than the level of current government funding. Public support is greater for conservation compared to defence and superannuation.

It appears there is good awareness amongst the sample of Aucklander's of New Zealand's high profile species and it is encouraging that a wide range of other rare and threatened taxa were mentioned. Although a small number of younger Aucklander's in the sample responded to the survey, there is an indication that awareness of threatened species maybe comparably lower amongst this age group. As the sub-sample of younger Aucklanders was very small, this suggestion is highly speculative and requires more quantitative investigation.

It is accepted that flagship species such as kiwi *Apteryx spp*, kakapo *Strigops habroptilus*, takahe *Porphyrio mantelli*, black robin *Petroica traversi,* kokako *Callaeas cinerea wilsoni* and Hector's dolphin *Cephalorynchus hectori hectori* are important advocates for conservation but it is recommended that New Zealand's less well-known taxa are also used to communicate the importance of conserving the wide variety of flora and fauna.

2.8 Acknowledgements

I thank Manu Barry for reviewing the statistical analysis of the survey and Karen Stockin for kindly reviewing manuscript drafts. Funding for M.N.H. Seabrook-Davison was provided by a Massey University Vice-Chancellor's Doctoral Scholarship. Thanks are extended to the Massey University Printery and New Zealand Post for facilitating distribution of the survey questionnaires.

2.9 References

Armsworth, P.R., Chan, K.M.A., Daily, G.C., Ehrlich, P.R., Kremen, C., Ricketts, T.H., Sanjayan, M.A. 2007. Ecosystem-service science and the way forward for conservation. *Conservation Biology 21*: 1383-1384.

Belich, J. 1996. Making peoples. *University of Hawaii Press*.

Chan, K.M.A. 2008. Value and advocacy in conservation biology: Crisis discipline or discipline in crisis? *Conservation Biology 22*: 1-3.

Clark, T.W., Reading, R.P., Clarke, A.l. 1994. Endangered species recovery: Finding the lessons, improving the process. *Island Press*, Washington Dc.

Clout, M. 2001. Where protection is not enough: Active conservation in New Zealand. *Trends in Ecology & Evolution 16*: 415-416.

Conservation-Magazine. 2009. When push comes to shove - Green vs. Growth. *Conservation Magazine 10*: 27.

Costanza, R., d'Arge, R., de Groot, R., Faber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. *Nature 387*: 253-260.

Craig, J.L., Anderson, S., Clout, M., R, C., Mitchell, N., Ogden, J., Roberts, M., Ussher, G. 2000. Conservation issues in New Zealand. *Annual Review of Ecological Systematics 31*: 61-78.

Cullen, R., Moran, E., Hughey, K.F.D. 2005. Measuring the success and cost effectiveness of New Zealand multiple-species projects to the conservation of threatened species. *Ecological Economics 53*: 311-323.

Curtin, R., Presser, S., Singer, E. 2000. The effects of response rate changes on the index of consumer sentiment. *Public Opinion Quarterly 64*: 413-428.

Department of Conservation. 2009. Vote conservation - Value for money and budget 2009 (New Zealand Government policy document, docdm-400963). *Department of Conservation*, Wellington.

Ehrlich, P.R., Daily, G.C. 1993. Population extinction and saving biodiversity. *Ambio 22*: 64-68.

Esty, D.C. 2008. Rethinking global environmental governance to deal with climate change: The multiple logics of global collective action. Conference - 120th Annual Meeting of the American-Economic-Association, pp 116-121, New Orleans, Los Angeles.

Haque, T. 2006. Funding recreational opportunity provision on the New Zealand conservation estate. *New Zealand Treasury*, Wellington.

Hartley, P. 1997. Conservation strategies for New Zealand. *New Zealand Business Roundtable*, Wellington.

Hitchmough, R., Bull, L., Cromarty, P. 2007 New Zealand threat classification system lists 2005. Threatened Species Occasional Publication . *Department of Conservation*, Wellington.

Hughey, K.F.D; Kerr, G.H; Cullen, R; Cook, A. 2008. Perceptions of conservation and the Department of Conservation: Interim findings from the 2008 Environmental Perceptions Survey. Report to the Department of Conservation, Wellington. Report No.1, LEAP (Land Environment and People), Lincoln University, Christchurch ISSN 1172-0891 (Online).

Infield, M., Namara, A. 2001. Community attitudes and behaviour towards conservation: an assessment of a community conservation programme around Lake Mburu National Park, Uganda. *Oryx 35*: 48-60.

Jacobe, D. 2008. Half of public favors the environment over growth (electronic source) www.gallup.com/poll/105715/Half-Public-Favors-Environment-Over-Growth.aspx. 1-3pp. *Gallup Poll*.

Joseph, L.N., Maloney, R.F., O'Connor, S.M., Cromarty, P., Jansen, P., Stephens, T., Possingham, H.P. 2008. Improving methods for allocating resources among threatened species: the case for a new national approach in New Zealand. *Pacific Conservation Biology 14*: 159-168.

Joseph, L.N., Maloney, R.F., Possingham, H.P. 2009. Optimal allocation of resources among threatened species: a project prioritization protocol. *Conservation Biology 23*: 328-338.

Karanth, K., K; Kramer, R., A; Qian, S., S., Christensen Jr, L. 2008. Examining conservation attitudes, perspectives, and challenges in India. *Biological Conservation 141*: 2357-2367.

Keeter, S., Kennedy, C., Dimock, M., Best, J., Craighill, P. 2006. Gauging the impact of growing non-response on estimates from a National RDD telephone survey. *Public Opinion Quarterly 70*: 759-779.

McCracken, J. 1987. Conservation priorities and local communities. *In:* Anderson, D., Grove, R. (Editors), Conservation in Africa: people, politics and practice. *Cambridge University Press*, Cambridge.

Miller, K.K. 2009. Human dimensions of wildlife population management in Australasia, history, approaches and directions. *Wildlife Research 36*: 48-56.

Milner-Gulland, E.J., Mace, R. 1998. Conservation of biological resources. *Blackwell Science Ltd*, Oxford, England.

Ministry for the Environment. 2007. Environment New Zealand 2007 (Publication number ME: 847). *Ministry for the Environment*, Wellington.

Myers, N. 2002. Biodiversity and biodepletion: the need for a paradigm shift. *In:* O'Riordan, T., Stoll-Kleemann, S. (Editors), Biodiversity, sustainability and human communities: protecting beyond the protected, pp 46-60. *Cambridge University Press*, Cambridge.

Myers, N., Mittermeiser, R.A., Mittermeiser, C.G., de Fonseca, G.A.B., Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*: 853-858.

Naidoo, R., Balmford, A., Ferraro, P.J., Polasky, S., Ricketts, T.H., Rouget, M. 2006. Integrating economic costs into conservation planning. *Trends in Ecology & Evolution 21*: 681-687.

New Zealand Tourism. 2008. Draft New Zealand Tourism Strategy 2015. *Ministry of Tourism*, Wellington.

New Zealand Treasury 2008. New Zealand Economic and Financial Overview 2008 (electronic source) http://www.treasury.govt.nz/economy/overview/2008/nzefo-08-1.pdf. *New Zealand Treasury*, Wellington.

Norton, D.A., Cochrane, C.H. 2000. Are we delivering indigenous biodiversity conservation outcomes in the best possible way? *Victoria Economic Commentaries*: 22-33.

Norton, D.A., Roper-Lindsay, J. 2004. Assessing significance for biodiversity conservation on private land in New Zealand. *New Zealand Journal of Ecology 28*: 295-305.

Park, G.N. 2000. New Zealand as ecosystems : the ecosystem concept as a tool for environmental management and conservation. *Department of Conservation*, Wellington, New Zealand.

Pretty, J. 2002. People, livelihoods and collective action in biodiversity action. *In:* O'Riordan, T., Stoll-Kleemann, S. (Editors), Biodiversity, sustainability and human communities: Protecting beyond protected, pp 61-85. *Cambridge University Press*, Cambridge.

Smith, K.N., Shaw, J.H., Bettinger, T., Caniglia, B., Carter, T. 2007. Conservation partnerships between zoos and aquariums, federal and state agencies, and non-governmental organisations. *Zoo Biology 26*: 471-486.

Soule', M.E., Estes, J.A., Miller, B., Honnold, D.L. 2005. Strongly interacting species: conservation policy, management and ethics. *Bioscience 55*: 168-176.

Townsend, A.J., de Lange, P.J., Duffy, C.A.J., Miskelly, C.M., Molloy, J., Norton, D.A. 2008. New Zealand threat classification system manual. Research, Development & Improvement Division. *Department of Conservation*, Wellington.

Visser, P.S., Krosnick, J.A., Marquette, J., Curtin, M. 1996. Mail surveys for election forecasting? An evaluation of the Colombia dispatch poll. *Public Opinion Quarterly 60*: 181-227.

Warren, J., James, B., Procter, L. 2005. Proposed framework for a social research strategy for the Department of Conservation. Department of Conservation Research & Development Series 223. *Department of Conservation*, Wellington, New Zealand.

Watson, J. 2001 How to determine a sample size (electronic source) http://www.extension.psu.edu/evaluation/pdf/TS60.pdf. *Penn State Cooperative Extension*.

Worthy, T.H., Holdaway, R.N. 2002. The lost world of the Moa. Prehistoric life of New Zealand. *Indiana University Press*, Bloomington, Indiana.

CHAPTER 3 Survey of New Zealand Department of Conservation staff involved in the management and recovery of threatened species.

South Island Takahe, *Porphyrio mantelli hochstetteri* (Photo by Mark Seabrook-Davison)

This chapter is a modified from the published paper:
Seabrook-Davison M. N. H., Ji W. & Brunton D. H. (2010). Survey of New Zealand Department of Conservation staff involved in the management and recovery of threatened New Zealand species. *Biological Conservation Vol. 143, pp 212-219*)

3.1 Abstract

In terms of managing biodiversity, a third of the land area of New Zealand is included in a conservation estate of national parks, reserves and sanctuaries. Administration of this large natural heritage asset is by 13 separate Department of Conservation (DOC) conservancies. A survey was conducted, across all conservancies, of DOC staff directly involved with the management and recovery of threatened New Zealand species. The aim of the survey was to gain an insight into how DOC staff regard the management tools available to them for the recovery of threatened species. The survey also assessed the perceived relevance of the threatened species recovery plans (TSRPs) currently in use by these staff. The results of the survey show that in general, the DOC staff consider that a lack of adequate funding, poor communication between conservancies and staff shortages have resulted in failure to achieve comprehensive management and recovery of threatened species. There was an expectation for TSRPs to comprehensively guide management and recovery actions but most staff concluded that TSRPs failed to meet this objective. It was identified that TSRPs need to be kept up-to-date and preferably in an electronic format accessible to all DOC staff throughout New Zealand. There was strong support for the establishment of a national approach for the recovery of threatened species. Concern was expressed that current resourcing only allowed recovery of a very small number of New Zealand's threatened species with staff calling for secure funding for the duration of threatened species recovery programmes.

3.2 Introduction

A number of recent studies have assessed New Zealand's approach to the management of its biodiversity (Clout, 2001; Cullen *et al.*, 2005; Seabrook-Davison *et al.*, (2009 *in press*)), with suggestions on how to improve conservation outcomes (Joseph *et al.*,

2008; Joseph *et al.*, 2009). The conservation of New Zealand's wildlife is administered by the Department of Conservation (DOC) which is New Zealand's lead conservation agency, guided in its operations by the Conservation Act 1987. After reviewing recent reports on the state of New Zealand's threatened species (Green and Clarkson, 2005; Department of Conservation, 2006a, 2006b; Ministry for the Environment, 2007) and undertaking discussions with senior managers involved in the management of New Zealand's indigenous biota, I identified the need to conduct a survey amongst DOC staff to assess strengths and weaknesses of current management and recovery programmes. For this research, I have related the findings of my survey to DOC's overall approach to management of threatened species which has allowed me to suggest improvements. In my view, valuable insights can be gained from the opinions of DOC staff (Rasch and Saunders, 1990), which are integral to the success of any management approach. The accuracy of management decisions can be improved through the knowledge gained by those directly involved with conserving threatened species (Wilder and Walpole, 2008).

As the challenge of conserving threatened species becomes more complex and in many cases essential for avoiding extinction, the need for the specialist knowledge and problem solving skills of experienced staff is paramount (Clark *et al.*, 1994). The implementation of effective conservation policy by any country is critical to safeguard the provision of ecosystem services (Armsworth *et al.*, 2007) derived from biodiversity and to manage the recovery of threatened species. The Millenium Ecosystem Assessment Synthesis Report (Millenium Ecosystem Assessment, 2005) stressed the importance of putting a value on biodiversity and its conservation to reduce the detrimental impacts on biota for the benefit of both humans and the environment. Conservation staff are at the frontline of implementing conservation strategies and

arguably, they are the metric to gauge the effectiveness of any applied strategies and management tools provided to them (Rasch and Saunders, 1990).

Staff surveys and personnel psychology studies (Considine, 2002; Walker and Boyne, 2006) conclude that organisations, whether they are private industry or government department, need to be aware of what staff can contribute to the healthy functioning of the organisation and that staff attitudes influence performance and outcomes. This advice is supported by surveys of threatened species recovery programmes (Moosbruker and Kleiman, 2001) which stress the need for structure and process in implementing recovery efforts where human collaboration is just as important as the recovery science used.

Table 3.1 Objectives explored in the staff survey. The table contains four objectives and the questions relating to each objective. Please refer to Appendix 7.1 for full questionnaire.

Objectives of survey	**Section of questionnaire relating to objectives**
(1) To ascertain the role of DOC staff, with a range of experience, in the management and recovery of threatened species	Questions 1,2,3, 4(a), 4(f), 4(g) and 9
(2) To ascertain the level of communication and knowledge sharing between conservancies	Question 4b,4c,4d and 4e
(3) To understand staff attitudes towards recovery plans as a management tool.	Questions 5 and 6
(4) To understand the level of commitment towards pest control within conservancies.	Questions 7 and 8

New Zealand is divided into 13 regional conservancies, which encompasses public conservation land administered by DOC and other land and territorial marine areas administered by Government, Regional, Rural or Urban Councils (Table 3.2). Each conservancy is an independent entity with its own Conservator (Chief Executive Officer), staff structure and budget. DOC has the responsibility for the management of species protected under the 1953 Wildlife Act and has total jurisdiction over any native

species within public conservation land. Indigenous species outside public conservation land but within the administrative boundaries of each conservancy are managed in conjunction with local councils and private landowners. DOC also manages species not protected by the Wildlife Act 1953 such as plants and invertebrates on DOC land under the Reserves Act but only has an advocacy role for unprotected species on land outside the DOC estate.

This study explores the organisational structure (Hartley, 1997) within DOC and uses a survey to assess how the staff view their roles in complementing the current structure and perceptions of DOC (Department of Conservation, 2007, 2008). The overall aim of this survey was to explore the role DOC staff have in the management and recovery of threatened species and their attitudes towards the management tools available to them. Considering DOC staff are spread throughout the islands of New Zealand and are involved in the management of a diverse range of taxa, we wanted to achieve responses from a comprehensive sample of staff. DOC staff were targeted who had had an active role in implementing management and recovery programmes and who could provide opinions on the effectiveness of these programmes.

3.3 Research objectives

This survey had the following four objectives (Table 3.1). *(1) To ascertain the role of DOC staff, with a range of experience, in the management and recovery of threatened species***.** I compared the attitudes of DOC staff in relation to their width of experience and length of time with DOC. *(2) To ascertain the level of communication and knowledge sharing between conservancies***.** I wanted to know what level of coordinated management currently exists between conservancies and how this can be improved. A second aspect of this objective was to assess the level of knowledge sharing between

staff within the 13 DOC conservancies and to ascertain what tools could be used to improve communication. *(3) To understand staff attitudes towards recovery plans as a management tool.* New Zealand has more than 60 published species recovery plans and I specifically wanted to understand staff attitudes towards how effective they found these plans in guiding their work. *(4) To understand the level of commitment towards pest control within conservancies***.** Pest species have significantly contributed to the decline or extirpation of New Zealand's critically endangered species (Atkinson, 2001) with some endangered species only existing in secure populations on pest free offshore islands (Towns, 2002) under intense conservation management. Therefore, I asked DOC staff to comment on the importance of pest management in their work plans.

3.4 Methods

3.4.1 The survey design

The survey was conducted using a questionnaire (Appendix 7.2) that included a series of structured questions aimed at addressing the four objectives (Table 3.2). The survey was carried out under the conditions and constraints of the Massey University Human Ethics Committee, protocol number 07/055.

Specific constraints were imposed upon the survey by both the Massey University Human Ethics Committee and the General Managers of Operations of the Department of Conservation. Under the accepted protocol, no researcher was to make direct contact with any of the respondents with security of all respondent's identity protected. All questionnaires received were to be opened by an independent staff member of Massey University and all reference to respondent's identity erased.

Extensive consultation was conducted with all 13 Conservators and the two General Mangers of Operations. Clear boundaries were established as far as access to staff with the survey approved at the highest level of the Department of Conservation. Each Conservator identified the appropriate staff within their Biodiversity Assets section who would be appropriate to participate in the survey.

A total of 195 staff members were identified and the relevant number of questionnaires were sent to the 13 Conservancies. The questionnaires were sent to each DOC conservancy with each conservancy Conservator (Chief Executive Officer) to select who he/she considered was appropriate to answer the questionnaire. To overcome any form of possible pseudo-selection, the Conservators were asked to only distribute questionnaires to staff members who were directly involved in the management and recovery of threatened species.

Questionnaires were mailed to each conservancy with guidelines on the specific type of staff to be surveyed. The questionnaire was targeted at DOC staff directly involved with the management of flora and fauna, who worked within the Natural Heritage Biodiversity Assets/Threats section of DOC. None of the participating DOC staff could be individually identified from the responses received, thus maintaining anonymity.

Questionnaires were collated and analysed according to the type of comments made and these were pooled and related to the employment particulars of respondents.

Table 3.2 Conservancies of the New Zealand Department of Conservation. Table shows size of each conservancy, number of recorded threatened species and number of staff responding to survey

Conservancy	Area of conservancy in public conservation land (hectares)	Number* of recorded threatened species	Percentage of conservancy as public conservation land	Natural heritage biodiversity staff	Natural heritage staff responding to survey
Northland	1,259,400	595	59	43	4
Auckland	36,000	381	7	41	3
Waikato	270,000	239	12	54	3
Bay of Plenty	178,000	209	10	25	6
East Coast/Hawkes Bay	217,000	198	31	39	16
Tongariro/Taupo	590,000	129	21	35	1
Wanganui	357,369	255	16	38	3
Wellington	191,626	378	17	36	3
Nelson/Marlborough	1,217,903	630	52	66	nil
West Coast	1,912,000	277	84	40	5
Canterbury	817,209	410	25	49	6
Otago	450,000	387	12	41	5
Southland	270,000	493	8	45	8
Total	**7,766,507**	**Total NZ (2,373)**	**Total NZ (27%)**	**552**	**63**

*Number of threatened species sourced from Hitchmough, R (2002) New Zealand Threat Classification System Lists.

Department of Conservation, Wellington, New Zealand. Threatened Species Occasional Publication 23, page 15, Table 2.

3.4.2 Staff structure of the DOC conservancies

Each of the 13 DOC conservancies operates as a separate entity but conforms to a uniform staff organisational infrastructure. This infrastructure is composed of three broad sections, Line Management (senior management team), Technical & Conservation Support and Business Services. This survey was sent to 34% of all DOC staff (primarily within the Natural Heritage division, Table 3.1).

3.4.3 Analysis

The questionnaire contained open-ended questions where there was no limit to the number of comments respondents could make. For each section of the questionnaire, similar comments made by staff have been pooled and the categories of comments are shown in the tables. Where appropriate the comments have been related to the respondent demographics such as, length of time employed by DOC, membership of recovery groups and staff designation. In these cases I used a Chi-squared analysis to compare responses between groups ($\alpha = 0.05$). The pooled data have been searched for common themes and these have formed the basis for discussion. The comments made by respondents have been related to the four objectives and these are shown in all tables.

The common themes derived from the staff responses are shown in the following results section of this chapter. The broad themes were as follows:

1. Staff designation or employment title within DOC and their specific role within the Biodiversity Assets section in relation to the management and recovery of threatened species.

2. Recording of the species within relevant taxonomic groups that were actively managed within each conservancy. Awareness of species actively managed in adjoining conservancies was also recorded.

3. To identify the level of joint management of threatened species between conservancies.

4. A principle theme explored was how staff felt towards the tools available to them for the management of threatened species. How effective did they consider these tools and how could these tools be improved and what other tools are necessary to be effective wildlife managers?

5. An important theme explored was how staff related to threatened species recovery plans and how relevant they were to achieving the goals of threatened species recovery programmes.

6. A literature search has revealed that pest management is a crucial part of achieving the successful management and recovery of New Zealand's threatened species. A theme explored in the research was to ascertain how important the role of pest management is in the overall workload of DOC Biodiversity Assets staff.

7. From the themes identified in this research, suggested recommendations have been made on how the management of threatened species can be improved.

Please note that in Chapter 3, I have suggested recommendations that are principally for the benefit of the Biodiversity Assets staff who implement the management and recovery programmes for threatened species. I have made recommendations in Chapter 2, 4, 5 and 6 which relate to the overall national conservation of threatened species.

These national recommendations are concerned with the governance and husbandry conservation strategies relevant to the Head Office of the Department of Conservation and the New Zealand government.

3.5 Results

3.5.1 Response rate and survey participants

Response rates varied between conservancies with all but the Nelson/Marlborough conservancy responding. The 12 conservancies that responded to the survey distributed 195 questionnaires to their Natural Heritage/Biodiversity staff, with the survey running for 120 days (14 October 2007 to 14 February 2008) and a response rate of 32% (completed questionnaires returned). This response rate compares favourably with rates achieved in other staff and general public surveys (Hamilton, 2003; Department for Environment Food and Rural Affairs, 2005).

3.5.2 Survey participants

Objective (1) *To ascertain the role of DOC staff, with a range of experience, in the management and recovery of threatened species* (questions 1 to 4(a), 4(f), 4(g) and 9 of the questionnaire).

Most of the participants were Rangers (35%) Technical Support Officers (35%) or Programme Managers (11%) who are staff involved for much of their time with applied tasks such as species monitoring or implementing recovery programmes. This bias in the results was expected as staff within the Natural Heritage (Biodiversity Assets/Threats) segment of the Technical & Conservation Support section were the staff specifically targeted for the survey and are staff implementing the majority of threatened species work. Other participants such as Conservancy Advisory Scientists

(6%) and Area Managers (8%) are staff who have an overseeing role in ensuring the successful implementation of the conservancy business plans which include threatened species recovery programmes.

A third (36%) of the participants have been with DOC for a relatively short time, working in their current position for 5 years or less. A similar proportion (35%) of staff have been with DOC for 6 to 15 years with fewer long term staff; 16-20 years (16%) or greater than 20 years (13%). The survey included staff who had worked for the Wildlife Service of the former Department of Internal Affairs (Galbreath, 1993, 1998) prior to the formation of the Department of Conservation (DOC) in 1987. Participants identified eleven broad categories of management tasks they performed; with all participants indicating they performed more than one role in the management of threatened species (Table 3.3).

Table 3.3 Management tasks performed by survey participants**.** Data in this table relates to: Objective (1) To ascertain the role of DOC staff in the management and recovery of threatened species

Management tasks described by respondents	**%**	**Staff implemented these tasks**
Day to day management	21	Ranger/Technical Support Officer
Technical support/advice & research	20	Ranger/Technical Support Officer
Species monitoring	15	Ranger/Technical Support Officer
Threatened species programme planning	14	Programme Manager
Staff management & conservancy administration	7	Area Manager
Recovery group tasks	5	Ranger/Technical Support Officer
Management & programme design	4	Programme Manager
Strategic overview and allocation of resources	4	Area Manager
Liaison with other conservation stakeholders & advocacy	4	Area Manager
Audit delivery of Conservation goals	3	Area Manager
Mainland island management	3	Ranger/Technical Support Officer
Total	**100**	

Prominent roles were day-to-day management, technical support and advice, species monitoring and threatened species programme planning. Participants indicated they had to divide their time between hands-on management tasks such as monitoring and pest control and more administrative tasks such as report writing and facilities/infrastructure management. Some participants felt it was not optimal to have to deal with infrastructure/administrative tasks when it eroded the time they should be spending on implementing recovery programmes for threatened species.

It appears that Natural Heritage staff are encouraged to join Species Recovery Groups (SRG) as 70% of the DOC staff participating in the survey were members of a SRG with 40% of them having been a member for at least half of their employment with DOC (Figure 3.1). It is also evident that there is commitment amongst DOC staff to participate in the SRG process, as the majority of SRG participants (72%) were members of more than one SRG with over a third of participants (39%) members of 3 or more Species Recovery Groups. Finally, experienced staff (with DOC > 5 years) were significantly more likely to be involved in recovery groups than less experienced staff (with DOC < 5 years) (64% versus 52%; $\chi^2_1 = 4.56$, P = 0.03, n = 63).

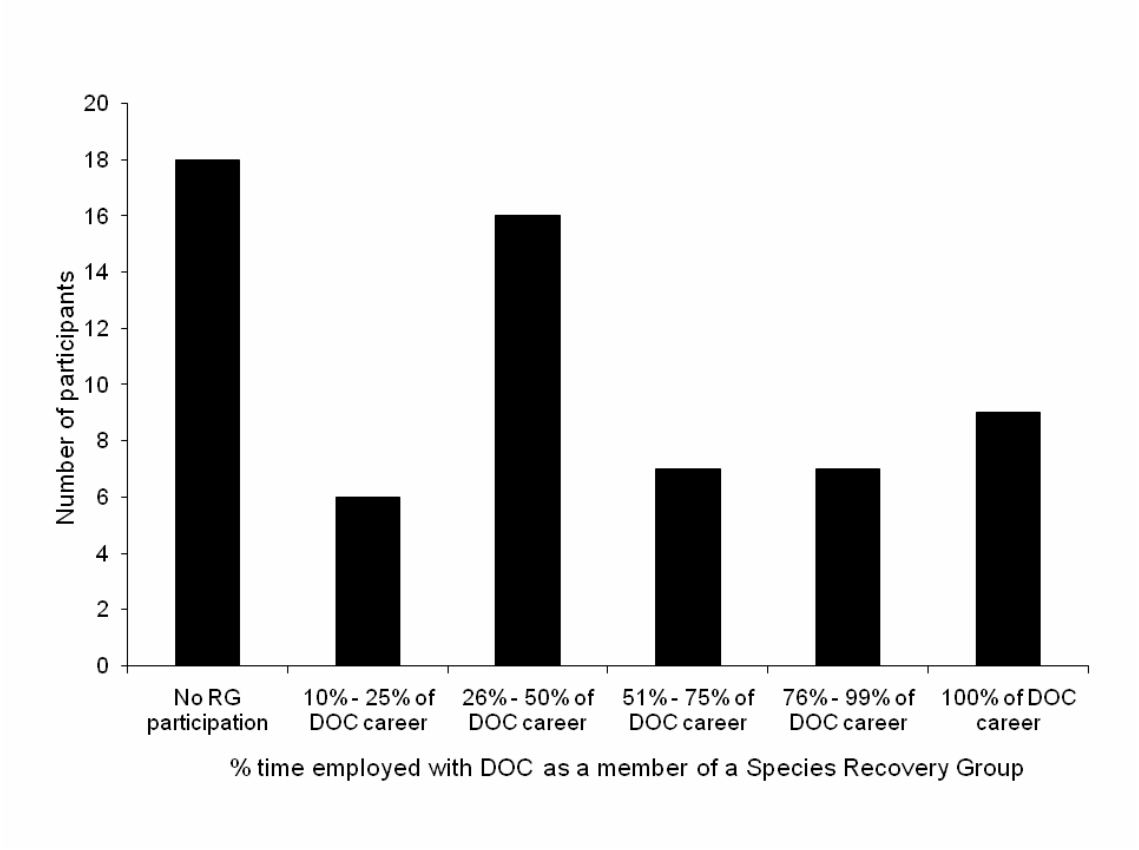

Figure 3.1 Time spent by survey participants as a member of a Species Recovery Group. Expressed as a percentage of the time participants have been employed with the New Zealand Department of Conservation (DOC)

3.5.3 Management of threatened species

Objective (2) To ascertain the level of communication and knowledge sharing between conservancies (question 4b to 4e of the questionnaire).

When asked to identify the number of threatened species that were actively managed within their conservancy, most participants (94%) identified between 10-30 species. This is a very low level of active management compared to the number of threatened species recorded for each conservancy (Table 3.2). Participants' awareness of the number of *actively* managed species that occurred in both their conservancy and adjoining conservancies was low with 45% identifying just 1-10 species.

Table 3.4 Reasons for lack of cross-boundary management of threatened species and suggestions for improvement. This table relates to: Objective (2) To ascertain the level of communication and knowledge sharing between conservancies.

Reasons for no cross-boundary management of threatened species	**%**
Limited resources with other priorities taking precedent	22
Different funding pressures exist within Conservancies	16
Conservancies operate in isolation	13
Sites & populations are discrete and management not shared	11
Fragmented nature of business planning for Conservancies	11
Lack of Recovery Group support	11
Cross-boundary management not supported or encouraged	9
Species only occurs in one Conservancy	7
Total	100

Suggestions for improving cross-boundary management	**%**
National coordination of threatened species management	20
Foster closer relationship between staff	17
Increase the number of recovery plans & recovery groups	14
Central coordination of funding	12
More efficient use of staff	11
Promotion of DOC goals rather than Conservancy goals	10
Change Conservancy structure	6
Dedicated staff to coordinate threatened species work	6
Rationalise & prioritise threatened species management sites	4
Total	100

When asked whether joint management occurred between conservancies, participants referred to the sharing of resources and staff expertise such as, advice and support from recovery groups, and the coordination of recovery programmes. However, reasons given for joint management not occurring were; limited resources with other priorities taking precedent, different funding pressures existing between conservancies and conservancies operating in isolation. Participants made a clear distinction between the

number of threatened species recorded in their conservancy and the number they were capable of managing with the resources available.

3.5.4 Improvement of threatened species management

The majority (90%) of staff surveyed provided comments (Table 3.4) to the question on how coordinated management of threatened species between conservancies could be improved. Most suggestions for improvement included support for a nationally (New Zealand wide) coordinated approach to management rather than a conservancy focus. Participants see fostering a closer relationship between staff and utilising the skill base of all DOC staff, irrespective of their conservancy, as an immediate and cost effective means of improving cross-boundary management. Participants also identified that improvements could be achieved by encouraging more staff exchanges and mentoring of junior and new staff by experienced staff. Participants would like to see more regular meetings at the informal and formal level to promote conformity of management objectives and to promote transfer of knowledge. Staff in remote area offices expressed strong support for better communication and sharing of knowledge. Coordinated management could be improved with the central allocation of funding for threatened species rather than recovery programmes funded from individual conservancy budgets.

3.5.5 Effectiveness of Threatened Species Recovery Plans

Objective (3) To understand staff attitudes towards recovery plans as a management tool (questions 5 and 6 of the questionnaire).

Threatened species recovery plans (TSRPs) are a management tool produced and published by the Research, Development & Improvement Division of DOC. Participants were asked to identify the strengths and weaknesses of the plans as a tool for the management of threatened species. The most prominent uses identified for

TSRPs are planning and setting management and research priorities for threatened species and getting guidance on how recovery programmes should be implemented. However, although nearly all participants (98%) had read at least one TSRPs, less than half (41%) considered TSRPs were important in guiding the management process of species recovery. Overall, participants appreciated the availability of TSRPs as a tool but were split over their comments about the strengths and weaknesses of the plans.

Slightly more comments on the weaknesses (57 %) of TSRPs compared to strengths (43%) were provided (Table 3.5) by participants. Some participants found the inclusion of priorities and key objectives as a strength whereas others found the plans were poorly structured in identifying important recovery priorities. Other conflicting views related to the plans ability to guide management and identifying threats. Some participants see TSRPs as raising the profile of threatened species but others criticised the narrow single-species perspective of plans and that species without TSRPs were poorly funded. There is a feeling amongst participants that the plans would be essential for their job if they contained current information and provided guidance on setting management priorities and helped them with funding applications. The following comment, expressed by an older DOC staff member, "*They tend to be a wish list rather than a clear plan,"* reflected the negativity felt towards the plans.

Table 3.5 Strengths and weaknesses of threatened species recovery plans identified by DOC staff and suggestions for improvement. The data in this table relates to: Objective (3) To understand staff attitudes towards recovery plans as a management tool.

Strengths of recovery plans	**%**
Identify priorities & key objectives	20.0
Provides a coordinated national view	18.0
Framework for strategic planning	16.0
Allows sharing of information	10.5
Provides direction for management	10.5
Source of reference material	8.5
Raise profile of species	5.2
Recovery groups can action goals	5.2
Allows determination of key sites	3.0
Identifies threats	3.0
Total	100

Weaknesses of recovery plans	**%**
Poorly constructed to identify priorities	18.0
Quickly become out of date	14.0
Lack funding to meet objectives	14.0
Lack of engagement by line-management	8.0
Recovery Groups dislocated from Conservancy operations	7.0
Species without TSRPs poorly funded	7.0
Do not link to other documents such as business plans	6.0
TSRPs external to Conservancy structure	5.5
Narrow single species perspective	5.5
Not all stakeholders involved	5.5
Slow to respond to new threats	5.5
Overambitious number of objectives	4.0
Total	100

Suggestions for improvements for recovery plans	**%**
Standardise plans with a relevant & concise layout	26
Link to funding sources	22
Link to other plans & programmes	14
Require more frequent up-dating	10
Encourage buy-in by line management	6
Strengthen function of Recovery Groups	6
Improve use as a best practice tool	6
Expand plans to all taxa	5
Improve distinction between vision & goals	5
Total	100

3.5.6 Improvements for Threatened Species Recovery Plans

Survey participants were asked to comment on how TSRPs could be improved. There was a strong recommendation for the standardisation of TSRPs to conform to a more relevant and concise layout. Some participants found the plans were inconsistent which reduced the value of them as management tools. The TSRPs are seen as needing a better

distinction between vision and reality with the goals linked to conservancy operational goals contained in other plans such as conservancy business plans. Participants see TSRPs being very relevant when these plans can provide information that can be incorporated into best practice plans and protocols that direct the management of threatened species.

Overall, participants support the need for TSRPs but there was criticism, especially from staff with a long career with DOC (>5 years), of a lack of compliance to implement the goals in the plans. The plans can be improved by encouraging more direct support from senior conservancy managers. This is seen as very important as most threatened species occur in multiple conservancies, requiring the cooperation of all conservators. These experienced (> 5 years employment) staff commented that TSRPs are non-statutory with no legal requirement for DOC to implement the goals, which lessoned support from senior conservancy management when resources were limited (Table 3.5).

3.5.7 Funding for species recovery

When asked whether TSRPs should include detailed costings or a budget outlining the cost to achieve recovery of threatened species, participants were evenly divided between supporting (46%) and not supporting (49%) this inclusion. Although half of the participants did not support the inclusion of costings, there was general opinion that plans are more relevant when they are linked to funding sources which provide some security that recovery programmes can be completed. Participants opposing the inclusion of costings said that plans went out of date quickly and consequently, fixed costings would also date (Table 3.6). Participants supporting the inclusion of costings see TSRPs being more relevant when the true cost of recovery is indicated. Experienced

staff (with DOC > 5 years) were no more likely to support including of funding in TSRPs than less experienced staff (with DOC < 5 years) (53% versus 40%; $\chi^2_1 = 0.89$, P = 0.35, n = 63). In addition, staff in more senior positions (Scientists and Senior Managers) were not statistically more likely to support including funding than more junior staff (Technical Support Officers and Rangers) (33% versus 48%; $\chi^2_1 = 1.18$, P = 0.28, n= 63).

Table 3.6 - Attitudes towards the inclusion of costings in threatened species recovery plans. Table relates to: Objective (3) To understand staff attitudes towards recovery plans as a management tool.

Comments supporting inclusion of costings in TSRPs	**%**
Allows objectives to be matched with costings	44
Provides security for completion of projects	28
Increases relevancy of plans	17
Indicates true cost of recovery	11
Total	100

Comments not supporting inclusion of costings in TSRPs	**%**
Accurate budgets cannot be achieved for 5 or 10 years	22
Costings involve information recovery groups do not control	18
Budgets are continuously being reviewed	14
Different costings are required for different aspects of recovery	14
Conservancies have a better idea of budgetary requirements	14
Not the job of recovery groups to cost recovery work	9
Costings in plans would not help day-to-day management	9
Total	100

3.5.8 New Zealand's threatened biodiversity. Identification of threats

Objective (4) To understand the level of commitment towards pest control within conservancies (questions 7 and 8 of the questionnaire).

From their experience, survey participants were asked what they considered were the causes for some of New Zealand's native species becoming threatened. The causes

identified by participants can be related mainly to anthropogenic influences. The most prominent causes were predation/competition from introduced species, habitat loss/degradation, extractive industries (e.g. mining, forestry, and fishing) and the negative impacts of agricultural practices (e.g. dairying, land clearance, high country pastoral farming, and water pollution). When asked for the rationale for choosing predation/competition as the main threat, the primary reason given was that it has a direct impact and is much faster acting than other threats and predators can penetrate into all habitats. Of all the threats, participants felt they were most effective in controlling pests as they could assess the results of this control on the populations of threatened species they monitored.

3.5.9 Management of introduced pests and predators

In the final part of the questionnaire, participants were asked to comment on aspects of the management of introduced pest species. Over three quarters (87%) of participants were involved with pest management with most (67%) involved with more than one pest management task (Table 3.7).

Table 3.7 Pest management tasks conducted by survey participants. The data contained in this table relates to: Objective (4) To understand the level of commitment towards pest control within conservancies.

Pest management tasks	%
Implementing pest control	41
Technical & scientific advice/best practice	23
Operational project management	12
Pest programme monitoring/audit	11
Mainland island management	5
Liaison with other pest management agencies	4
Public education/advocacy	4
Total	100

The most prominent pest management task was the hands-on implementation of pest control. Participants indicated that pest management is a complex issue with considerable planning involved before pest control programmes are implemented and the efficacy of programmes is continually being assessed by technical and scientific staff. Any improvements are incorporated into best practice protocols; especially the use of toxic pesticides and this information is shared with other agencies to ensure the standardisation of poison-use protocols.

Of the pests identified as impacting the most on threatened species, stoats *Mustela erminea* (19%), rats *R. rattus* and *R. norvegicus* (16%) and possums *Trichosurus vulpectula* (15%) were identified as the worst. Overall, participants identified rats (23%) and possums (23%) as receiving most of the pest control budget followed by weeds (21%) and stoats (14%). Although stoats are seen as the pest causing the most damage to biota, participants indicated that their pest control programmes were the most cost effective in controlling rats.

Staff identified that the dilemma for DOC is to allocate pest management funds in the most effective way to ensure the most destructive pests are controlled. This demands a decision to either commit most of the funds to targeting specific species, or to attempt to control as many pest species as possible with the same control strategy or programme. Participants commented that they could not guarantee that their pest management budgets were secure. Several comments were made regarding the reallocation of pest management funds between conservancies. It is evident that there is discontent over the appropriation of funds from one conservancy to fund the eradication or control of pests in another.

3.6 Discussion

This survey has given an insight into the type of knowledge that DOC staff need to achieve successful management and ultimately recovery of threatened species. Participants urged the sharing of skills and expert knowledge held by DOC staff, irrespective of what conservancy they worked for. The survey has shown that staff want the most up to date biological information on threatened species and information on improved management tools to be disseminated as soon as it is available. The issues raised by DOC staff in this survey fall within two broad categories: (1) a defined national strategy for the management and recovery of threatened species and 2) provision of adequate resources and tools for the management and recovery of threatened species.

3.6.1 A national threatened species strategy

A standardised national approach to threatened species management programmes was strongly advocated in a 1990 workshop (Rasch and Saunders, 1990) convened three years after the formation of DOC. Eighteen years later, staff participating in this survey feel that a defined and coordinated national approach to the management and recovery of threatened species has not been achieved. Participants felt that a coordinated approach is hindered by the competition between the conservancies for resources, especially funding. In the opinion of most DOC staff, better coordination is still required within and between conservancies when deciding on the allocation of resources to threatened species.

Participants at all levels of DOC experience said they would be more efficient at their jobs if they could share knowledge and expertise. This was particularly evident amongst the older participants who had worked for both the Wildlife Service and DOC who

stressed the importance of the transference of experience and were critical that this was not fully implemented. We argue that the results of our survey suggest that DOC needs to continue to develop the effective sharing of specialist threatened species management skills between conservancies.

For a conservation agency to function effectively there is a requirement for its staff to contain a mix of specialist skills drawn from older established staff and innovative experimental approaches of new younger recruits (Moyle, 1995; Griffiths, 2003). A criticism from the survey identified a lack of a coordinated approach to training of threatened species management staff across all 13 DOC conservancies. Participants commented on the high turnover of staff, especially young staff that would leave after a short tenure with DOC. In its 2003 Statement of Intent, DOC (Department of Conservation, 2003) identified areas of its organisational capability it needed to build-on to fully achieve its national priority outcomes. To achieve this, DOC identified it needed to provide greater support for its staff such as improving information systems and tools to support managers making decisions about conservations priorities. From the results of the survey, it appears these goals are not being successfully achieved.

3.6.2 Resources and tools for threatened species management.

Concern was expressed by participants that DOC staff were asked to accomplish too many tasks with inadequate funds. This situation is not unique to New Zealand with conservation agencies in other countries (Restani and Marzluff, 2002; Tisdell and Nantha, 2007) identifying the acquisition of funding and comprehensive biological information (Jenkins *et al.*, 2003) as major constraints to the effective management of threatened species. Participants were aware of the magnitude of the problem New Zealand faces with a large conservation estate and the large number (2,788) of

threatened species (Hitchmough *et al.*, 2007) to manage but voiced their frustration at being limited by what they could achieve.

This survey has shown there is an ambivalent attitude towards threatened species recovery plans as a management tool. Recovery plans are a widespread tool used in conservation but their effectiveness has been questioned by conservation biologists when they fail to contain criteria that lead to achievable goals (Tear *et al.*, 1993; Foin *et al.*, 1998). Participants in this current survey found recovery plans useful if they contained information that they could apply directly to specific recovery programmes such as new information allowing them to update annual work programmes and set new priorities. Participants suggested recovery plans could be improved if they were in an electronic format so they could be kept up-to-date and shared with colleagues within the DOC conservancy network.

The workshop held in 1990 (Rasch and Saunders, 1990) showed strong support for the concept of recovery plans but it was recommended that they should be compiled according to a standard format and the goals directly related to national strategies for the recovery of threatened species. Participants were critical of recovery plans for being unplanned and lacking a standard format and that plans were not representative of all taxonomic groups, especially plants and invertebrates.

Participants said very few of the recorded threatened species in their conservancies received active management. There was very little coordinated management between conservancies; in fact coordination was not encouraged to prevent scarce resources being stretched. The survey has identified the importance of distinguishing between successful monitoring of threatened species and achieving their recovery. Staff considered they accomplished the task of monitoring the population status of their target

species and evaluating the threats these species faced but were concerned a lack of resources hindered their attempts at recovery. A metric used by DOC in measuring success of recovery is to record which populations of threatened species are increasing in numbers and showing a trend towards self-sustainability and reduced conservation dependency (Dowding, 2007; Holzapfel *et al.*, 2008; Townsend *et al.*, 2008). The survey did not collect data on how effective this metric is but participants indicated that most of the species they monitored outside intensely managed areas (reserves, mainland islands), continued to decline.

Participants were especially concerned that there was no long term guarantee that their recovery programmes would be resourced as funds and staff could be channelled to other areas of DOC. The loss of experienced staff that had developed specific recovery skills was of particular concern. The 1990 workshop identified the importance for cooperation between threatened species management staff and the need for team building with senior staff ensuring staff got credit for their successes. International studies (Burnett, 1999; Smith *et al.*, 2007) have stressed the need for large organisations to nurture staff moral, especially within areas requiring special skills.

3.6.3 Comparison of management by national conservation agencies

We consider a failing of threatened species conservation in New Zealand is the lack of umbrella legislation to provide the legal process for the prevention of species extinction. The USA Endangered Species Act 1973 (ESA1973) was expressly enacted for this purpose with Canada (Species at Risk Act 2002, SARA) and Australia (Environment Protection and Biodiversity Act 1999, EPBC) both using the ESA1973 as a benchmark to formulate their own nationally integrated threatened species acts. Without an equivalent central government legal statute, there is no linear administrative process

available to the New Zealand Department of Conservation to monitor the progress of recovery programmes.

A criticism of the management of threatened species in the USA and Australian is the disjoint that can occur between different states when implementing federal policy on threatened species recovery (Czech and Krausman, 1999; McGrath, 2006; Schwartz, 2008). State interpretation of federal policy can vary between states, eroding the desire for a national approach in the implementation of recovery programmes. This situation parallels the criticism of DOC staff with respect to the lack of coordinated management effort between New Zealand's 13 separate conservancies.

Conservation agencies perform better and are more inclined to achieve positive recovery outcomes for threatened species when logical solutions to species recovery are promoted (Foin *et al.*, 1998; Goble *et al.*, 2006). Although the ESA1973, SARA2002 and EPBC1999 promote a linear process for the recovery of species, political interference and bureaucratic complexity can hinder this process (Macintosh and Wilkinson, 2005). Conservation managers pragmatically realise that recovery is a long term commitment and see the insecurity of central government funding and the lack of administrative action as reducing the effectiveness of recovery programmes.

3.7 Conclusions

This survey has highlighted DOC staff concerns that there is inadequate recognition from DOC head office and government that the management and recovery of threatened species requires security of funding and the retention of specialised staff. Compounding low staff moral is the government policy over the last two years for DOC to reduce its operating expenses which has lead to staff redundancies and loss of key skills. There is a general level of frustration amongst DOC staff that there has not been sustained

progress in the recovery of most threatened species. Therefore, it appears DOC is loosing the knowledge base of its experienced staff and the innovative thinking of younger staff, who are not committing to dedicated careers with DOC. There were frequent references to a breakdown in communication between scientific staff and the executive management of conservancies and DOC head office.

In the opinion of DOC staff surveyed, there has been little progress in the standardisation of the production of threatened species recovery plans with participants commenting that the process to choose candidate species for recovery plans remains biased towards iconic species to the detriment of less conspicuous taxa. There is a call for recovery plans to contain achievable objectives and to be produced using a standard format and to be regularly updated, preferably electronically so all staff distributed throughout New Zealand can benefit. A concern important to senior staff is the lack of guaranteed funding in the long term for threatened species and the lack of support for coordinated recovery effort across conservancy boundaries. DOC staff are calling for an effective national strategy for the management and recovery of threatened species to ensure DOC functions as a coordinated conservation agency.

Only by recognising and adequately resourcing the DOC staff skill base, and addressing the two broad issues discussed namely, national strategy for the management and recovery of threatened species, and provision of adequate resources and tools, will it be possible for DOC to function as New Zealand's lead conservation agency.

3.8 Acknowledgements

This research was supported by the following people. We thank the following staff at the New Zealand Department of Conservation who gave permission to conduct this survey, John Cumberpatch, Barbara Browne, Helen Price, Susan Clarke, Wendy

Osborne, Sharlotte Stainsby, Tracey Langmuir, Annie Ashworth, Penny Loomb, Jeannie Hogarth, Cecilia D'Costa, Angela Abbot, Leilani Fraser, Kathleen Brebner, Sandra Groves, Dawn Bramley, Leigh Romanos. This research was conducted under the regulations and protocol (number: 07/055) of the Massey University Human Ethics Committee and we thank Dr Denise Wilson and Merle Turner for their support and advice. Our colleagues at the Ecology & Conservation Group, Massey University were always there for support and advice. Most of all, we thank the DOC staff who participated in this survey, supplying us with their opinions and thoughts which in some cases were candid and frank.

Funding for this research was provided to Mark Seabrook-Davison from a Massey University Vice-Chancellor's Doctoral Scholarship. Implementation of the Department of Conservation staff survey was funded by the Ecology and Conservation Group, Institute of Natural Sciences of Massey University. We are grateful to the Department of Conservation for covering the costs of distributing the survey questionnaires to their staff.

3.9 References

Armsworth, P.R., Chan, K.M.A., Daily, G.C., Ehrlich, P.R., Kremen, C., Ricketts, T.H., Sanjayan, M.A. 2007. Ecosystem-service science and the way forward for conservation. *Conservation Biology 21*: 1383-1384.

Atkinson, I.A.E. 2001. Introduced mammals and models for restoration. *Biological Conservation 99*: 81-96.

Burnett, J.A. 1999. A passion for wildlife: A history of the Canadian wildlife service, 1947-1997. *Canadian Field-Naturalist 113*: 1-177.

Clark, T.W., Reading, R.P., Clarke, A.l. 1994. Endangered species recovery: Finding the lessons, improving the process. *Island Press*, Washington Dc.

Clout, M. 2001. Where protection is not enough: Active conservation in New Zealand. *Trends in Ecology & Evolution 16*: 415-416.

Considine, M. 2002. The end of the line? Accountable governance in the age of networks, partnerships and joined-up services. *Governance: An International Journal of Policy, Administration and Institutions 15*: 21-40.

Cullen, R., Moran, E., Hughey, K.F.D. 2005. Measuring the success and cost effectiveness of New Zealand multiple-species projects to the conservation of threatened species. *Ecological Economics 53*: 311-323.

Czech, B., Krausman, P.R. 1999. Public opinion on endangered species conservation and policy. *Society & Natural Resources 12*: 469-479.

Department for Environment Food and Rural Affairs. 2005. Staff survey 2005. *Civil Service, Great Britain*, London, England.

Department of Conservation. 2003. Statement of intent 2003 - 2006. *Department of Conservation*, Wellington.

Department of Conservation 2006a Annual report Department of Conservation. *Department of Conservation*, Wellington.

Department of Conservation 2006b Department of Conservation. Statement of intent 2006-2009. *Department of Conservation*, Wellington.

Department of Conservation 2007 Statement if intent 2007-2010. *Department of Conservation*, Wellington.

Department of Conservation. 2008. Role of the New Zealand Department of Conservation. About DOC's role. *Department of Conservation*, Wellington.

Dowding, J.E.D., M.D. 2007. New Zealand dotterel (*Charadrius obscurus*) recovery plan, 2004-14. Threatened species recovery plan number 58. *Department of Conservation*, Wellington.

Foin, T.C., Riley, S.P.D., Pawley, A.L., Ayres, D.R., Carlson, T.M., Hodum, P.J., Switzer, P.V. 1998. Improving recovery planning for threatened and endangered species. *Bioscience 48*: 177-184.

Galbreath, R. 1993. Working for wildlife: A history of the New Zealand wildlife service. *Bridget Williams Books Limited*, Wellington.

Galbreath, R. 1998. DSIR Making science work for New Zealand. *Victoria University Press, Victoria University of Wellington,*, Wellington, New Zealand.

Goble, D.D., Scott, J.M., Davis, F.W. (Editors). 2006. The Endangered Species Act at thirty: Renewing the conservation promise. *Island Press*, Washington.

Green, W., Clarkson, B. 2005. Turning The Tide? A review of the first five years of the New Zealand biodiversity strategy. The synthesis report. *Biodiversity New Zealand*, Wellington.

Griffiths, J. 2003. Balanced scorecard use in New Zealand government departments and crown entities. *Australian Journal of Public Administration 62*: 70-79.

Hamilton, M.B. 2003 Online survey response rates and times - Background and guidance for industry. *Super Survey*, Longmont, Connecticut.

Hartley, P. 1997. Conservation strategies for New Zealand. *New Zealand Business Roundtable*, Wellington.

Hitchmough, R., Bull, L., Cromarty, P. 2007 New Zealand threat classification system lists 2005. Threatened Species Occasional Publication. *Department of Conservation*, Wellington.

Holzapfel, S., Robertson, H.A., McLennan, J.A., Sporle, W., Hackwell, K., Impey, M. 2008. Kiwi (*Apteryx* spp.) recovery plan: 2008-2018 Threatened Species Recovery Plan number 60. *Department of Conservation*, Wellington.

Jenkins, M., Green, R.E., Madden, J. 2003. The challenge of measuring global change in wild nature: are things getting better or worse? *Conservation Biology 17*: 20-23.

Joseph, L.N., Maloney, R.F., O'Connor, S.M., Cromarty, P., Jansen, P., Stephens, T., Possingham, H.P. 2008. Improving methods for allocating resources among threatened species: the case for a new national approach in New Zealand. *Pacific Conservation Biology 14*: 159-168.

Joseph, L.N., Maloney, R.F., Possingham, H.P. 2009. Optimal allocation of resources among threatened species: a project prioritization protocol. *Conservation Biology 23*: 328-338.

Macintosh, A., Wilkinson, D. 2005 Environment Protection and Biodiversity Conservation Act A five year assessment. *The Australia Institute*.

McGrath, C.J. 2006. Review of the EPBC Act. *Australian State of the Environment Committee, Department of the Environment and Heritage*, Canberra.

Millenium Ecosystem Assessment. 2005. Millenium Ecosystem Assessment Synthesis Report - A Report of the Millenium Ecosystem Assessment. Millenium Ecosystem Assessment. *In:* Sarukhan, J., Whyte, A (Editors) Millenium Ecosystem Assessment, pp 1-219. *World Resources Institute*, Washington DC.

Ministry for the Environment. 2007. Environment New Zealand 2007. (Publication number ME: 847). *Ministry for the Environment*, Wellington.

Moosbruker, J., Kleiman, D.G. 2001. Forgotten elements: including structure and process in recovery efforts. *Endangered Species Update 18*: 63-68.

Moyle, B. 1995. Conservation and the principal-agency problem. *In:* Annual Conference of the Australia and New Zealand Society for Ecological Economics, Coffs Harbour, Australia.

Rasch, G., Saunders, A. 1990. Proceedings of a threatened species workshop held at Turangi. *Department of Conservation*, Turangi, New Zealand.

Restani, M., Marzluff, J.M. 2002. Funding extinction? Biological needs and political realities in the allocation of resources to endangered species recovery. *Bioscience 52*: 169-177.

Schwartz, M.W. 2008. The Performance of the Endangered Species Act. *Annual Review of Ecology Evolution and Systematics 39*: 279-299.

Seabrook-Davison, M.N.H., Ji, W., Brunton, D. (2009 *in press*). Future direction for the conservation of New Zealand's biodiversity. *Pacific Conservation Biology* 15(3).

Smith, K.N., Shaw, J.H., Bettinger, T., Caniglia, B., Carter, T. 2007. Conservation partnerships between zoos and aquariums, federal and state agencies, and non-governmental organisations. *Zoo Biology 26*: 471-486.

Tear, T.H., Scott, M., Hayward, P.H., Griffith, B. 1993. Status and prospects for success of the Endangered Species Act: A Look at Recovery Plans. *Science 262*: 976 - 977.

Tisdell, C., Nantha, H.S. 2007. Comparison of funding and demand for the conservation of the charismatic koala with those for the critically endangered wombat Lasiorhinus krefftii. *Biodiversity and Conservation 16*: 1261-1281.

Towns, D.R. 2002. Korapuki Island as a case study for restoration of insular ecosystems in New Zealand. *Journal of Biogeography 29*: 593-607.

Townsend, A.J., de Lange, P.J., Duffy, C.A.J., Miskelly, C.M., Molloy, J., Norton, D.A. 2008. New Zealand threat classification system manual. Research, Development & Improvement Division. *Department of Conservation*, Wellington.

Walker, R.M., Boyne, G.A. 2006. Public management reform and organisational performance. *Journal of Policy Analysis and Management 25*: 371-393.

Wilder, L., Walpole, M. 2008. Measuring social impacts in conservation: experience of using the Most Significant Change method. *Oryx 42*: 529-538.

CHAPTER 4 New Zealand lacks comprehensive threatened species legislation – comparison with legislation in Australia and the USA.

New Zealand's threatened Stitchbird, *Notiomystis cincta*. (Photo: Mark Seabrook-Davison)

This chapter is modified from the published paper:
Seabrook-Davison M. N. H., Ji W. & Brunton D. H. (2010).New Zealand lacks comprehensive threatened species legislation – comparison with legislation in Australia and the USA. *Pacific Conservation Biology Vol. 16*)

4.1 Abstract

New Zealand lacks dedicated threatened species legislation which is hindering the effective recovery of this country's threatened species. Few of New Zealand's recorded threatened species receive active management. New Zealand is recognised as a biodiversity hotspot which has undergone widespread anthropogenic change in a relatively short time. Using its own threat classification system based on the International Union for Conservation of Nature (IUCN) Red List but modified to suit the island characteristics of its biota, New Zealand has identified 2,788 species and subspecies within 14 taxonomic groups that are threatened with extinction. However, this level of awareness of the threatened state of New Zealand's biota is not supported by comprehensive threatened species legislation. I reviewed New Zealand's current legislation for the management and recovery of threatened species and made a comparison with the USA Endangered Species Act 1973 (ESA1973) and the Australian Environment Protection and Biodiversity Act 1999 (EPBC1999). It is argued that New Zealand needs to develop similar legislation to the ESA1973 and EPBC1999 to enable an integrated and legally accountable approach to the management and recovery of threatened species. A strength of the ESA1973 and EPBC1999 is that species that have been assessed to be threatened with extinction are listed on a central government register with a legal mandate for the production of recovery plans. A weakness of both acts is that species can languish on these lists without effective recovery actions. Although not always implemented, both acts have the provision for the protection and conservation of critical habitat.

Keywords: New Zealand, legislation, threatened species, USA Endangered Species Act 1973, Australian Environment Protection and Biodiversity Act 1999, Wildlife Act 1953

4.2 Introduction

Currently New Zealand does not have legislation to provide a national direction for the management and recovery of threatened species. In comparison, countries such as the USA and Australia have such legislation in the form of the USA Endangered Species Act 1973 (ESA1973) and Australian Environment, Protection and Biodiversity Protection Act 1999 (EPBC1999).

The conservation literature is unequivocally direct in describing the decline in species as a biodiversity crisis. Words such as crisis are usually considered emotive and unscientific and avoided but the term biodiversity crisis is extensively discussed in the scientific literature (Simberloff, 1984; Myers, 1993; Abell, 2002). I argue that the current New Zealand Wildlife Act 1953 (WA1953), although providing protection for indigenous wildlife, does not contain a directive for the conservation of threatened species, specifically their recovery. I also argue that by enacting a specific statute for imperilled wildlife, New Zealand would partly honour one of its international obligations as a signatory to the Convention on Biological Diversity (CBD) and assist in the governance of its endemic species which are internationally recognised as of critical importance in being contained within a biodiversity hotspot. The biodiversity crisis needs to be viewed in the context of declining functionality of ecological processes that can affect the provision of ecosystem services. To ensure a level of security of natural resources, there are calls for a concerted effort to predict the source and intensity of the threats to species (International Union for Conservation of Nature, 1996; Olson *et al.*, 2002). Governments are being urged to take responsibility for the decline in species at the regional level and to provide legal protection for remaining species and the services

they provide (Govey and Owen, 1996; Myers *et al.*, 2000; Olson *et al.*, 2002; Hutchings *et al.*, 2004; Millenium Ecosystem Assessment, 2005). Currently the New Zealand Department of Conservation (DOC) is investigating methods to improve the management and recovery of threatened species (Joseph *et al.*, 2009). We propose therefore, it is an opportune time to review current legislation, especially the WA1953 and to view a statute for New Zealand similar to the ESA1973 and EPBC1999.

New Zealand lacks an integrated approach to the management and recovery of threatened species; the importance of such an approach being advocated since the decline of New Zealand's biodiversity became evident (Henry, 1903; Williams and Given, 1981; Galbreath, 1993; Hartley, 1997). The only New Zealand statute to specifically address the legal status of threatened species is the WA1953. Owing to the hierarchy of legislation in New Zealand, there is concern that the WA1953 is subservient to legislation that directs the actions of extractive industries such as mining, farming and fishing (Walker *et al.*, 2008; Wallace, 2009). The WA1953 has been criticised for its inadequacy in conserving wildlife and its inability to guide DOC in recognising the full costs and benefits of natural resource use (Hartley, 1997; Moran, 2003; Cullen *et al.*, 2005). There is good understanding of the threats to New Zealand's biota but no legislative criteria to guide DOC on when and how to produce recovery plans. It is argued by McGrath (2005, 2006, 2007) that an effective environmental legal system is important for properly protecting the environment for the survival and quality of humans and all life on earth (McGrath, 2005; McGrath, 2006, 2007).

4.3 Research objectives

The objectives in this research have been, (1) to identify and evaluate New Zealand government statutes that have been enacted for the management, recovery and

protection of threatened species and (2) to assess the USA ESA1973 and the EPBC1999 as benchmarks for New Zealand to develop its own threatened species legislation.

4.4 Methods

To accomplish this research, three techniques were used, (1) a review of the current New Zealand legislation relating to the management and recovery of threatened species, (2) an examination of the legislation for threatened species in USA (ESA1973) and Australia (EPBC1999) and (3) a survey to obtain the opinion of experts on the operation, strengths and weaknesses of the ESA1973 and EPBC1999.

Part (1) and (2) of this research was accomplished with a literature review of relevant information and publications. I reviewed all relevant New Zealand statutes and legislation and compared these with the USA Endangered Species Act 1973 and the Australian Environment, Protection and Biodiversity Protection Act 1999 (EPBC1999). I corresponded with legal and academic experts in New Zealand, Australia and the USA regarding aspects of legislation operating in these three countries. The methods for Part (3) are explained below

For the surveys, I used a modified form of the Delphi Method whereby questionnaires were sent to experts (people with knowledge and experience of the research topic) for their opinions on the topic of the survey (Hassen *et al.* 2000, Clark *et al*. 2006, MacMillan and Marshall 2006, Nevo *et al*. 2007, Patrick and Damon-Randall 2008, Sebastiao and Grelle 2009). The questionnaire was a set of questions with no formal structure which allowed respondents to provide their opinions and viewpoints. I chose to use email via the Internet as this allowed a quick response from experts who were prepared to participate in the survey. The email format also allowed the experts to ask me questions with a useful dialogue that inevitably ensued. Experts also suggested other

experts to whom they could forward-on the questionnaire. The formal Delphi Method uses a series of refined questionnaires until a consensus is formed. As a consensus of opinion was not required, my modified form of the Delphi Method achieved its purpose of identifying strengths and weaknesses of the two pieces of legislation I was surveying.

Experts were approached who had had direct experience with the ESA1973 or EPBC1999 as scientists, wildlife managers, academics, environmental lawyers, non-governmental organisation lobbyists or employees of USA and Australian government conservation agencies (see Acknowledgements for the organisations the experts represented). Questionnaires were distributed to members of Listserves via emails. Experts were also selected from the proceedings of ecology and environmental sciences conferences. Experts also forwarded-on the survey questionnaires to their colleagues. I also made contact with experts at conservation agencies, government departments, non-governmental organisations and universities. The survey used an open-ended approach to a series of questions where respondents were free to express their opinions. Where the possibility existed to get further information, experts were contacted several times to expand on their comments and to comment on the opinion of other experts (Appendices 7.3 and 7.4).

4.5 Results

4.5.1 Extinction and the current status of New Zealand's biota

It was not until 1981 with the publication of New Zealand's Red Data Book, one of the first International Union for Conservation of Nature (IUCN) inspired threatened species lists, that New Zealand was made aware of how many indigenous species were threatened with extinction (Williams and Given, 1981). At the time, Williams and Given (1981) gave New Zealand a timely warning...*"many species of plants and*

animals found only in New Zealand have become extinct over the last 150 years, and many more are threatened with extinction unless immediate action is taken to save them".

Using the simple IUCN threat classification system available at the time, Williams and Given (1981) assessed 30 vertebrate and 62 vascular plant species as threatened with extinction. It was not possible for them to extend their assessment to other taxonomic groups owing to the lack of baseline data and they were critical of the WA1953 for its lack of uniform protection of all native taxa. Of particular importance in my opinion is Williams and Given's (1981) criticism of the lack of threatened species legislation in New Zealand for both species and their habitat...*"it is perhaps surprising that virtually no legislation exists for the protection of a threatened species' habitat…there is obviously at least as much need for legislation to protect specific habitats as there is for more effective legislation for protection of individual species"*. In comparison, protection of both the threatened species and its critical habitat were given equal consideration when the United States ESA1973 was designed and subsequently implemented in 1973. Australia has taken a more comprehensive approach in the EPBC1999 giving protection to threatened species and large areas designated as ecological communities as well as producing threat abatement plans and plans for key threatening processes affecting wildlife.

In 1986 the New Zealand Wildlife Service of the Department of Internal Affairs updated its list of threatened species, recording 197 species as extinct or threatened with extinction (Bell, 1986). Although both the 1981 and 1986 lists were incomplete and rudimentary, their value was in increasing the awareness of New Zealand's threatened species. More recently, a threat classification system developed for New Zealand by Molloy *et al.* (2002) and updated by Townsend *et al.* (2008) has recorded 2,788

threatened species/sub-species in 14 taxonomic groups (Molloy *et al.*, 2002; Hitchmough *et al.*, 2007; Townsend *et al.*, 2008; de Lange *et al.*, 2009).

Extinction of New Zealand species as a result of anthropogenic changes has been dramatic (Holdaway, 1989; Holdaway and Jacomb, 2000). Since humans colonised New Zealand circa 700 years bp, a large number of amphibians (43%), bats (20%) and birds (20%) have become extinct (Wilson, 2004; Gibbs, 2006). Also, much of New Zealand's extant biota remain threatened with extinction with 100% of frogs (*Leiopelma spp*.), bats (*Chalinolobu*s and *Mystacina* spp.) and a large percentage of reptiles (89%), birds (57%) and freshwater fish (51%) classified as threatened.

4.5.2 Current New Zealand legislation for the conservation of New Zealand biota: legislation relating to the management and recovery of threatened species

Management of New Zealand wildlife and accordingly conservation and recovery of threatened species is the responsibility of DOC which is guided by four main acts, Conservation Act 1987, National Parks Act 1980, Reserves Act 1977 and the Wildlife Act 1953. DOC administers the legislation of a further 22 acts and has a functional role in another 15 (Department of Conservation, 2005, 2006, 2007, 2009). Under current New Zealand government statutes, none of these 41 acts provide DOC or other government agencies with the legal mandate to prevent the extinction of threatened species. In comparison, the ESA1973 and EPBC1999 have functions expressly directed at preventing the extinction of species.

The main statute guiding the protection of New Zealand's wildlife is the WA1953, described by Statutes New Zealand (31 October 1953) as, *"An Act to consolidate and amend the law relating to the protection and control of wild animals and birds, the*

regulation of game shooting seasons, and the constitution and powers of acclimatisation societies." Until the 1950s, most New Zealand legislation governing the use of land, water and wildlife favoured development and the hunting of game rather than conservation (Galbreath, 1993, 1998). In New Zealand, early legislation implemented for controlled use of wildlife focussed on statutory protection of introduced species. Early colonial legislation for all aspects of society, resource management and commerce in most Commonwealth countries was heavily influenced by English law. The early New Zealand Animal Protection Act 1867 was modelled on English hunting laws (Galbreath, 1993; Hutching, 1998; Young, 2004a). Upon its inception, the focus of the WA1953 was to control pest species and allow public access to both introduced and native game species (McDowall, 1994; Young, 2004a). The provision for the protection of native species was a secondary consideration. The WA1953 was a product of its time and as Young (2004) has identified, New Zealand at this time was rebuilding after the ravages of warfare and the 1930's depression, with resources viewed for exploitation rather than conservation.

Throughout the 1950s and 1960s, restrictions on resource extraction such as forestry, fisheries and agriculture were minimal with a concerted effort to develop these primary industries (Slack, 1969; Roche, 1990). With the expansion of forestry from 1950-1970, extra pressure was exerted on available land and the remaining habitat for threatened species. To provide land for increased forestry planting, the New Zealand government encouraged the clearing of indigenous forest for the establishment of fast growing pine *Pinus radiata* plantations (Galbreath, 1993, 1998). With a weak emphasis on habitat and native species protection, the WA1953 was subservient to the more powerful extractive acts such as forestry and mining acts. Amendments were made to the WA1953 in 1996, 2000 and 2003 but these did not involve a substantial review of the act; providing only

clarification on legal terminology, concessions for tourist operators and penalties for harming or killing protected wildlife.

4.5.3 Recovery plans

The WA1953 has been criticised for its lack of direction and guidance for the recovery of threatened species (Govey and Owen, 1996). To achieve recovery of a threatened species, there needs to be clarity of the process on how recovery is to be implemented, resourced and legally supported (Tear *et al.*, 1993; Clark *et al.*, 1994; Foin *et al.*, 1998; Possingham *et al.*, 2002; Helmink, 2009). Under the ESA1973 and EPBC1999, once a candidate species is classified and listed as threatened, the Federal government in each country is legally required to produce a recovery plan. The USA lists species and critical habitat as either *endangered* which are in immediate danger of extinction, or *threatened* which are in imminent danger of extinction. The conservation of threatened species and ecological communities under the Australian EPBC1999 extends further with the listing of key threatening processes and production of threat abatement plans. Both the ESA1973 and EPBC1999 outline the process whereby USA and Australian conservation agencies will prevent the species from becoming extinct. In both countries, all stakeholders including landowners, community conservation groups, NGOs and the general public are encouraged to be involved in the listing and recovery process.

Under the WA1953, there is no legal obligation for central government to prevent the extinction of threatened species. There is general reference made to the discretionary power of the Minister of Conservation to prepare "generic" wildlife plans but no directive to produce legally binding recovery plans for either species or ecological communities. Section 41(e) of the Wildlife Act 1953 is described as follows: *"The Minister may from time to time prepare and issue plans and publications for the*

advancement, conservation, management, and control of wildlife and the eradication of harmful species of wildlife." Conservation scientists argue that recovery plans are central to achieving the rehabilitation of threatened species and stress the need to produce recovery plans that are based on robust science but that are practical to implement (Foin *et al.*, 1998; Wilcove *et al.*, 1998; Boersma *et al.*, 2001; Hoekstra *et al.*, 2002; Bunnell *et al.*, 2009; Gosselin, 2009).

4.5.4 The USA Endangered Species Act 1973 and Australian Environment Protection and Biodiversity Conservation Act 1999

Once a candidate species has been categorised as either threatened or endangered by the USA Fish & Wildlife Service (USFWS) Threatened and Endangered Species System (TESS), the USA Federal government is legally mandated under the ESA1973 to produce two recovery plans; one for the species and one for the critical habitat in which the species resides. A similar process is conducted under the Australian EPBC1999 except the candidate assessment process extends to ecological communities as well as single species and multi species assemblages. The assessment of ecological communities goes beyond an ecosystem approach as candidate ecological communities can include large areas such as complete bioregions, forest systems and grasslands that encompass many ecosystems. Further protection is afforded to native species and ecological communities with the production of threat abatement plans. Of the three major provisions of the ESA1973 namely**,** (1) candidate species selected solely on the basis of scientific information, (2) legal protection to reduce the threat of extinction and (3) requirement for listed species to have a detailed recovery plan, Foin *et al.* (1998) argue that the third is the most important*..."Recovery planning….is specifically intended to promote an increase in the populations of listed species, rather than to just limit their further decline".*

Currently 85% of USA listed species and 24% of Australian listed species and ecological communities have a recovery plan. This compares with only 2% of New Zealand recorded species having a recovery plan. Australia currently has a further 445 recovery plans being prepared, representing 25% of all listed species and ecological communities (Table 4.1). A major advantage of the ESA1973 is that the statute has had 30 years to be assimilated into the legal and administrative infrastructure of the Federal and state governments as well as the conservation agencies that manage the recovery of threatened species (Goble *et al.*, 2006). The EPBC1999 has gone beyond a species focus to encompass ecological communities of considerable size. In both the USA and Australia, wildlife is managed from the inception stage of listing through recovery phase including protection of critical habitat and awareness of threats to listed species, finally to assessment of recovery that ultimately leads to delisting.

Table 4.1 Comparison between Australia, USA and New Zealand threatened species legislation and recovery process.

Type of legislation & threatened species data	New Zealand	USA	Australia
General legislation for the protection of wildlife	WA 1953	Dept of Interior	Dept of EWH & A
Dedicated threatened species legislation	None	ESA 1973	EPBC 1999
Entity responsible for the general conservation of wildlife	DOC	Dept. of Commerce	Dept of EWH & A
Entity to ascertain which species are threatened	DOC	USFWS/NOAA	TSSC
Entity to prepare legal lists of threatened species	None	USFWS/NOAA	TSSC/CSIP
Entity responsible for legal listing of threatened species	None	Fed Govt	TSSC/State & Fed Govt
Entity to prepare recovery plans	DOC	Fed Govt	Dept of EWH & A
Publicly notified recovery strategy	Not required	Federal Register Notice	Govt Notices Gazette
Publicly notified action/management plan for recovery	Not required	Federal Register Notice	Govt Notices Gazette
Entity to implement recovery plans	DOC (incomplete)	Fed Govt	TSSC/State & Federal Govt
Entity to monitor status of threatened species	DOC (incomplete)	Fed Govt	TSSC/State & Federal Govt
Entity responsible for legally delisting threatened species	Not required	Fed Govt	TSSC/CSIP
Number of recorded threatened species	2,788	Not applicable	Not applicable
Number of legally listed threatened species	Not required	305	1750
Number of legally listed endangered species	Not required	1009	all listed as threatened
Number of published recovery plans	59	557	427
Number of recovery plans being prepared	2	87	445
Number of legally delisted species	Not required	44	52
Number of delisted species due to recovered reason	No legal listing	19	17
Number of delisted species due to extinction reason	No legal delisting	9	4
Number of delisted species due to error in orig. data reason	No legal delisting	16	31
Number of threatened species with critical habitat design'	No crit' hab' desig'	489	Ecological community plans (11)
Species that have experimental populations of reintroduced individuals	100	37	42
Entity responsible for providing funding to species recovery	No dedicated funding	Fed Govt	Fed Govt

Abbreviations: (CSIP) Commonwealth's Species Information Partnership; (Dept of EWH & A) Australia Government Department of the Environment Water Heritage and the Arts; (DOC) Department of Conservation; NOAA National Oceanic and Atmospheric Administration; (TSSC) Threatened Species Scientific Committee; (USFWS) United States Fish and Wildlife Service; (Fed Govt) Federal Government; (Govt Notices Gazette) Government Notices Gazette

4.5.5 Opinions of experts on the application, strengths and weaknesses of the USA ESA 1973 and Australian EPBC Act 1999

The following results have been obtained from a survey of 37 USA and 32 Australian experts who work within the guidelines of either the ESA1973 or EPBC1999 to attempt the recovery of threatened species. This survey was not an in-depth analysis of these acts; rather its purpose being to gain an understanding of either acts application for the recovery of threatened species and to identify any strengths or weaknesses of their function.

4.5.5.1 Strengths of ESA1973

USA experts consider the ESA1973 has endured three decades of scrutiny and felt the foundation principles of the ESA1973 remain robust and relevant (Table 4.2). The ESA1973 is seen as working well as long as logical solutions to species recovery are promoted. A key strength of the ESA1973 is the requirement for recovery plans to be produced for all listed species. The all encompassing legal spread of the ESA1973 to include any person, company or Federal Government agency is seen as a major strength as no activity that affects threatened species is excluded from legal scrutiny. The provision of enforceable penalties for damage to species and habitat, the need to obtain reliable data for threatened species and the ESA1973 being applicable to all taxa and environments are all seen as strengths. The rigour of the ESA1973 is also seen in fostering support for the conservation of threatened species at the community level and encouraging landowners to be custodians of species on their land.

Table 4.2 Strengths and weaknesses of ESA1973 identified by USA experts.

Strengths	**%**
Foundation principles of ESA remain robust and relevant	20
ESA works well when it promotes logical solutions	17
ESA demands that recovery plans are produced for all listed species	15
ESA fosters strong support at community level	15
ESA promotes obtaining reliable data for endangered species	9
ESA provides for penalties for damage to biodiversity	9
ESA is applicable to all taxa and environments	9
ESA encourages landowners to be custodians of biodiversity	6
Total	**100**

Weaknesses	**%**
Disparity of which endangered species receive funding	17
ESA not enforced where there is no straight-forward solution	14
Recovery plans are not enforced by the ESA & funding is not guaranteed	14
Most recovery plans are out-dated, ineffective or use poor science	14
Recovery process is lengthy mainly due to protracted litigation	14
ESA effectiveness reduced by political interference	11
ESA adversely affected by bureaucratic complexity	8
The foundation principles of the ESA have become negotiable	8
Total	**100**

4.5.5.2 Weaknesses of ESA1973

The weaknesses identified by experts tended to be criticisms of how the ESA1973 was interpreted and manipulated rather than any failing of the legislation. The most prominent weakness identified by experts was the disparity of which threatened species receive the resources of conservation management (Table 4.2). There was some criticism of the USA Administration (party in power, Republican or Democrat) for funding the species with the most public appeal. Although involvement from all stakeholders is encouraged, lobbying and legal challenges from self-interest groups can

prolong the recovery process. Experts commented that one of the key weaknesses of the recovery of threatened was the disjoint between the ESA1973 and the policies of the incumbent administration. Experts saw the insecurity of Federal funding and the lack of administrative action as compounding the situation by reducing the effectiveness of the ESA1973 through political interference and adverse effects of bureaucratic complexity. Some experts went as far as saying the foundation principles of the ESA1973 have become "politically" negotiable.

Experts identified the problem of species languishing on the list for too long and recovery action being too late to prevent extinction. The USA administration at the time of the survey was criticised for the low number of new species listings and the lack of guaranteed funding for species currently on the Federal register. Some experts saw the Bush administration's aim to re-authorise the ESA1973 as the cause of these problems. Experts surveyed from NGOs such as the Center for Biological Diversity saw reauthorisation as a means of overriding conditions of the ESA1973 by allowing the USFWS to make decisions without getting the advice of independent scientists. This situation was observed two decades ago when the effectiveness of the ESA1973 was being evaluated (General Accounting Office, 1992; Scheuer, 1993). A report to the Subcommittee on the Environment of Congress identified that only 50% (650 species) of the eligible candidate species were listed under the ESA1973 and an additional 3,000 species were identified as meeting the ESA1973 criteria for candidate (assessed as threatened or endangered) species.

Table 4.3 Strengths and weaknesses of EPBC1999 identified by Australian experts**.**

Strengths	**%**
Provides cohesion between Federal and State conservation agencies	20
Provides for improved environmental impact assessment	13
With amendments, EPBC has become more effective	8
Provides integration of Commonwealth and State species management	8
Aims to provide certainty for all stakeholders in environmental decisions	8
Allows greater public input to wildlife management and development	7
Provides strategy for sustainable development	5
Instigating an integrated approach to wildlife protection	5
Provides for improved enforcement and compliance	5
Recognises Australia's obligations to international conventions & treaties	5
Has jurisdiction to prevent degrading of water systems	5
Designed to identify negative impacts early in the assessment process	5
Amendments have demanded more precise information from developers	3
Allows for intergovernmental (between countries) management of wildlife	3
Total	**100**

Weaknesses	**%**
Economic considerations can override environmental concerns	17
Improvements in biodiversity conservation has not occurred	11
Delay in implementing objectives of recovery plans	8
Improve transparency of EPBC and more involvement of the public	7
State based development interests can override national environmental goals	7
Funding is not guaranteed for listed species	6
Delay in listing of species & ecological communities	5
Reliance on subjective assessments in determining threat status of species	5
Regional forestry agreements allow for exceptions	4
Federal Court too often called to resolve conflict over EPBC decisions	4
EPBC can be influenced by political manipulation	4
EPBC lacks an emphasis on natural heritage issues	4
Inconsistencies in environmental impact assessment	4
Legal wording of EPBC can be confusing and ambiguous	3
EPBC doesn't address impacts of climate change on ecosystems such as Great Barrier Reef	3
EPBC has not solved water allocation issue	3
Gaps exist in regulatory framework of EPBC	2
EPBC lacks triggers for assessment of greenhouse gas emissions	2
Total	**100**

4.5.5.3 Strengths of EPBC1999

In identifying strengths of the EPBC1999 legislation (Table 4.3), Australian experts considered that although the EPBC1999 is not fully effective in conserving Australia's threatened species owing to its embedding phase, there now exists a legal mandate for the protection of wildlife. Experts expect the effectiveness of the EPBC1999 will improve with the recent and pending legislative amendments. The EPBC1999 was identified as the vehicle that provides the cohesion between Federal (national or Commonwealth) and State (e.g. Queensland, Victoria) conservation agencies.

Experts consider that the EPBC1999 has created the legal processes for improvements in environmental impact assessment (EIA). The importance of EIA is seen as critical to the effective operation of the EPBC1999 as the act has the dual function of conserving wildlife as well as providing the direction for the sustainable exploitation of natural resources. A design strength of the EPBC1999 recognised by experts is the act's ability to identify negative impacts of development early in the assessment process. This leads to the provision of certainty for all stakeholders in environmental decisions. The EPBC1999 is seen as encouraging greater involvement from the public in decisions relating to wildlife management and sustainable resource use.

4.5.5.4 Weaknesses of the EPBC1999

Some experts commented on the ambiguity of the EPBC1999 in providing the legal infrastructure for the conservation of threatened species and ecological communities as well as providing the consent process for the exploitation of natural resources (Table 4.3). Experts recognised there was merit in having the needs of both industry and biodiversity assessed in one statute, but were concerned that economic considerations can override environmental concerns and that certain exploitative activity, such as forestry, are exempt from the environmental impact assessment processes of the

EPBC1999. Experts were concerned at the level of incidental take of listed species in developments and activities exempted from the regulations of the EPBC1999. The level of take of listed species was also a concern raised by USA experts who identified an attitude of some landowners who covertly destroyed both threatened species and their habitat. This has been described as "Shoot, Shovel and Shut-up" (Mann and Plummer, 1995; Dierker, 1997).

With respect to threatened species recovery, comments from Australian experts criticised the delay in listing species and ecological communities that were in need of conservation management. This was seen as inaction by government administration rather than criticism of legislation contained in the EPBC1999. Further criticism is directed at the delay of implementing the objectives in recovery plans for listed species. Some of this delay is blamed on the preference of some State governments to allow exploitation of resources in the critical habitat of the listed species. This criticism is directed at State bureaucracy who is seen as disregarding the hierarchal directives of the Federal Government. Experts were concerned that a Federal overview of some developments did not occur, especially in areas that had been listed (or proposed for listing) as ecological communities. Gaps in the regulatory framework of the EPBC1999 are seen as a weakness and experts consider that the Federal Court is too often required to resolve conflict over EPBC1999 decisions. Experts consider appropriate triggers for the assessment of greenhouse gas emissions and the impacts of climate change are missing from the EPBC1999. Experts consider that the environmental effects of these two changes will heavily influence the survival of Australian wildlife, especially threatened species. Experts gave the Murray-Darling watershed and the Great Barrier Reef as two examples that are showing the effects of climate change.

4.5.5.5 Consensus of USA experts

Although experts identified more weaknesses (65%) compared to strengths (35%), the weaknesses referred to the interpretation and implementation of the ESA1973 rather than its structure. There is general agreement that the ESA1973 is a very relevant foundation legal statute for the recovery of threatened species and it fulfils its purpose of ensuring recovery plans are produced for both the species and their habitats. Concern was expressed that the principles and effectiveness of the ESA1973 are being eroded by political interference and protracted litigation. Experts expressed their confidence that the ESA1973 would survive any legal challenge to its legislative integrity but that listed species can languish on the Federal register owing to inadequate funding, staling tactics by affected stakeholders and the immense task of obtaining robust biological data. Experts agree that the ESA1973 demands that recovery plans are written for all listed species but they question the quality of many of the plans. With some species, recovery actions are seen as unplanned with a lack of baseline biological information driving recovery. It is perceived that the recovery process is often hijacked by the USA administration for its own propaganda purposes with iconic species such as the Ivory-billed woodpecker *Campephilus principalis* (Andrew *et al.*, 2007) and polar bear *Ursus maritimus* (Charles, 2008) being given extra funds to fast track their recovery to the detriment of less publically visible taxa.

In summarising the situation for threatened species in the USA, the experts stress the need to maintain the ESA1973 as the cornerstone legislation, but agree that funding is limited and not all threatened species will be prevented from becoming extinct. The following comments by one expert identify this predicament, "*The trouble is, it may be too late now. I think that here in the U.S. we are simply going to have to sit down and prioritise what species get recovery attention and therefore funds. I know that there are*

some endangered species for which there is little hope for recovery. There simply are not enough Federal funds to go around so perhaps hard decisions are just going to have to be made. Although this is unfortunate, I think this simply represents reality." A level of triage may be necessary to decide which species receive the limited funds for recovery but at least under the USA ESA1973 when a species does become extinct, substantial assessment is conducted so lessons can be learnt and instigated via adaptive management to other species on the Federal register.

4.5.5.6 Consensus of Australian experts

Experts surveyed were critical of aspects of the EPBC1999 but considered environmental protection and sustainable development was better managed since the act came into force nine years ago. During the survey, experts referred to the review of the operation and function of the EPBC1999 conducted in 2006 by the Australian State of the Environment Committee-Department of the Environment and Heritage (McGrath, 2006) and in 2009 by the Australian Senate (Australian Senate, 2009). In referring to these two reviews, experts considered there had been better management of wildlife and forests in the first five years after implementation of the EPBC1999 (2000-2005) compared to the subsequent four years (2006-2009). Although species listed under the EPBC1999 have protection across the whole country, experts expressed their concern at the lack of national control by the Federal government over the actions of individual States and Territories.

In summary, it appears that the EPBC1999 is seen as two separate pieces of legislation under the same statute and although the EPBC1999 is designed to be an over-arching legal instrument for the management of biota throughout Australia, the power of implementation of wildlife law appears to remain with State governments. State

governments appear also to control the issuing of consents for exploitation of natural resources, irrespective of the EPBC1999 directives from the Federal government.

4.5.5.7 Linear nature of the ESA1973 and EPBC1999

When conservation principles are applied to the implementation of the ESA1973 and EPBC1999, the listing and subsequent recovery of a species threatened with extinction is seen as a linear process (Goble *et al.*, 2006; McGrath, 2007) (Figure 4.1). The ESA1973 and EPBC1999 provide USA and Australian conservation agencies with a proven administrative and management tool to instigate the recovery of threatened species. The ESA1973 and EPBC1999 are structured to ensure there is a continuing awareness at the Federal government level of the progress of threatened species recovery. Without an equivalent central government legal statute, there is no linear administrative process available to the New Zealand DOC to monitor the progress of recovery programmes.

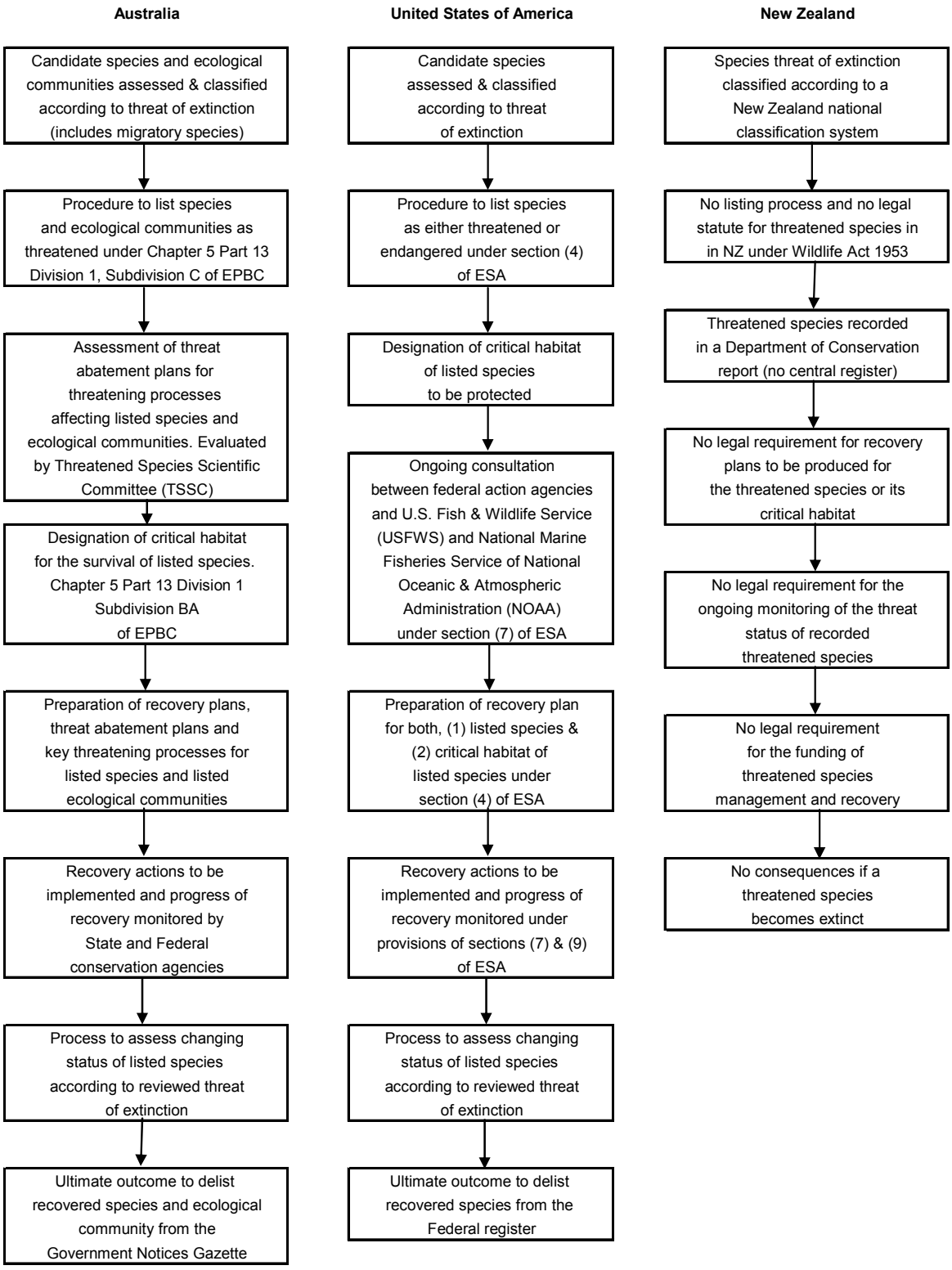

Figure 4.1 Process of threatened species recovery in Australia, USA and New Zealand. Process to assess eligibility of candidate species for recovery and subsequent delisting from register once recovery has been achieved.

4.6 Discussion

4.6.1 The relevance of threatened species legislation – the USA Endangered Species Act 1973 as a Benchmark

Both a review of the scientific literature and the survey of experts, identify the essence of the ESA1973 is still to prevent threatened species from becoming extinct, irrespective of the social and economic demands on species. After the extinction of high profile species such as the passenger pigeon *(Ectopistes migratorius)*, Carolina parakeet (*Conuropsis carolinensis*) and the near extinction of the American bison (*Bison bison*), the core directive of the ESA1973 was to make prevention of extinction of endangered species a legal responsibility of the USA Federal government (Rohlf, 1989; Ando, 1999; Doremus and Pagel, 2001; Clark *et al.*, 2002; Miller *et al.*, 2002; Roemer and Wayne, 2003).

The fundamental core of the ESA1973 is to provide the USA Federal government with the legal authority to prevent any activity that may cause a species to become extinct. It is mandated under the ESA1973, that a recovery plan is to be produced for all listed species. This mandate extends to demanding that, until a species is de-listed, the recovery plans are required to be regularly updated. The ESA1973 is seen as robust and relevant even after sustained lobbying and legal challenge to have its structure modified. The experts surveyed felt that the ESA1973 was well designed at its inception and was capable of being effective legislation in the long term. There is support for the ESA1973 when it achieves logical solutions to conflicts between different interested parties. Experts agreed that the best outcome from conflict resolution was when litigation could be avoided. When solutions to the management of endangered species can be achieved

at the local or community level, recovery actions can be achieved quicker resulting in streamlining the process through Federal channels.

4.6.2 The first 10 years of the Australian Environment Protection and Biodiversity Conservation Act 1999

The EPBC1999 differs from the ESA1973 in respect to its principal conservation aim. Whereas the ESA1973 is a legal tool expressly created to prevent the extinction of threatened species, the EPBC1999 exists to provide direction for the management of threatened species as well as to assess the environmental impacts of the economic use of species and natural resources (McGrath, 2005). For example, the EPBC1999 is legislation used by the Australian Central (Commonwealth) and State governments to assess the environmental impacts of proposed developments such as forestry, water extraction and hydro electrical power generation (Godden and Peel, 2007). McGrath (2005) refers to the EPBC1999 as providing ...*"an overarching federal umbrella for environmental decision-making in Australia."*

When assessing the environmental merits of listing a candidate species or proposed critical habitat, the ESA1973 is exempt from considering any economic impacts. A contradictory aspect of the EPBC1999 is that State interests can sometimes override the national environmental goals to conserve biota. Regional forest agreements (RFA) are given as an example where State decisions to grant the harvesting of indigenous forests are counter to the national goal of conserving Australia's remaining forest estate especially when identified as ecological communities of national environmental significant (Department of Agriculture Fisheries and Forestry, 2007). The most controversial is the RFA which covers the whole State of Tasmania. These forestry agreements have been criticised for not fully involving the public, not fully

understanding the environmental impacts of forestry practices and providing little opportunity for the agreements to be reviewed (McDonald, 1999; Foley, 2002; Godden and Peel, 2007). The provision in the EPBC1999 to exempt forestry operations under regional forestry agreements is seen as removing activities with probable harmful impacts from the national overview of fauna and flora conservation.

4.6.3 New Zealand threatened species legislation

New Zealand has no clear strategy for the recovery of threatened species. Legislative guidance is vague and scattered within a variety of acts with no definitive act providing the legal framework for the recovery of threatened species. Some reference to threatened species recovery is included in the Wildlife Act 1953 but this is not authoritative and the act is crucially out of date. Ideally, any legislation covering the conservation of native species should contain a directive for their recovery. In my opinion, recovery requires comprehensive conservation measures guided by an understanding of the biology of threatened species; something that can not be achieved with basic protection of species. The predicament for NZ is that the principal statute for threatened species recovery, the Wildlife Act 1953, has an emphasis on the management of game species and the control of agricultural pest species. The essence of the Act relates to the 1820-1930 colonial era of New Zealand when the country was seen as a group of resource islands. As a consequence, the early wildlife acts, Injurious Birds Act 1908, Animals Protection and Game Act 1921-22, were created to protect the economical and recreational access to native and introduced species. When created, the Wildlife Act 1953 had only a very weak reference to the conservation of threatened species and this weakness remains today.

4.6.4 Commitment to internationally agreed conventions

A positive aspect of the ESA1973 and EPBC1999 is that these acts provide a legal structure for the listing of species. The listing process is a comparative tool recognised by countries striving for conformity in the management of threatened species. Threatened species remain on these lists until the threat of extinction has been mitigated. In NZ, the recorded number of threatened species is published but there is no legal mandate to attempt to prevent their extinction.

New Zealand was early (16 September 1993) to ratify the Convention on Biodiversity (CBD) but as yet, has not implemented dedicated threatened species legislation. In partial response to its obligations under the Rio Convention (Foster 2003), New Zealand has produced the New Zealand Biodiversity Strategy (referred to as NZBS). Foster (2003) argues that the….*"NZBS is a significant and comprehensive approach to managing New Zealand's biodiversity. It provides a strategic framework for the conservation and sustainable use of New Zealand's biodiversity with principles to guide conflicting uses and decision-making, as well as action plans to achieve its goal".* (Foster, 2003). I argue that the NZBS is currently only a guiding or reference document with no legal mandate for implementation. It is also argued that, no strategy or action plan for the conservation of New Zealand's wildlife will be effective without the compliance and enforcement provided by legislation. This argument is supported by the IUCN (Young, 2004b) who stress the importance of countries that are signatories to the Convention on Biodiversity (CBD) to enact legislation that will implement agreements reached at the convention. The IUCN (Carrizosa *et al.*, 2004; Young, 2004b) has called for complete and consistent but functional national laws that will enforce multilateral agreements.

4.7 Conclusions

New Zealand is having difficulty in slowing the decline of its threatened species, partly due to its lack of specific threatened species legislation. Current recovery programmes are limited in their effectiveness as DOC admits it can not prevent the extinction of all recorded threatened species with available tools and funding. Successive governments since the passing of the WA1953 have failed to implement relevant legislation to keep pace with the increase in awareness of the risk of extinction faced by New Zealand's biota, much of which is endemic and internationally important. Existing New Zealand legislation (WA1953) does have provisions for the protection of indigenous wildlife but lacks a requirement for its conservation.

As a benchmark for threatened species legislation, Australia has used the ESA1973 but New Zealand has the advantage of reviewing the strengths and weaknesses of both the ESA1973 and EPBC1999 before designing its own state. USA conservation managers and practitioners using the ESA1973 consider it has been an effective tool in providing a legal framework for guiding the recovery of imperilled wildlife. New Zealand threatened species are only recorded and not legally listed; therefore their progress towards recovery is not legally monitored. This lack of monitoring or accountability is a failing of the New Zealand recovery programmes. Hence New Zealand recovery plans are reference documents rather than an active management tool.

Part of the solution for New Zealand is to define which species are the most endangered and to give them the legal status of a listed species. This will require the listing process to be driven by legislation that will identify all candidate species to be assessed for their threat of extinction. Once listed, there needs to be a legal directive to produce recovery plans for both the species and its critical habitat that serve as guiding documents to

prevent species from becoming extinct. Recently a management tool (project prioritisation protocol) has been produced by DOC (Joseph *et al.*, 2008; Joseph *et al.*, 2009) to allow selection and prioritisation of those species which will have the highest likelihood of successful recovery. We support the use of this conservation triage tool as long as there is legislation to guarantee the security of long term management to those species selected for recovery.

4.8 Acknowledgements

I appreciate the time and effort that a great number of people have contributed to this research. I thank the staff at the New Zealand Department of Conservation for discussions on aspects of conservation of threatened species. Thanks are extended to the scientists, academics and conservation managers from the USA and Australia who contributed to the survey. Thank you to Jo Peace and Karen Stockin for reviewing drafts of this chapter. Experts surveyed for this research were employed by the following USA and Australia organisations.

USA

Beam Reach Marine Science and Sustainability School, Buenos Aires National Wildlife Refuge (Arizona), Caesar Kleberg Wildlife Research Institute, Cascadia Research Collective, Center *for* Biological Diversity, Cetacean Society International, Colorado Division of Wildlife, Duke University, Endangered Species Division - National Marine Fisheries Service, (FWS) USA Fish & Wildlife Service, George Mason University, Journal of International Wildlife Law and Policy, Marine Mammal Commission, (NMFS) National Marine Fisheries Service, National Marine Sanctuaries Foundation, (NOAA) National Oceanic and Atmospheric Administration, New England Aquarium, Santa Clara University School of Law, Santa Cruz Predatory Bird

Research Group, Southern Resident Killer Whale Campaign, University of Vermont - Gund Institute for Ecological Economics, University of Virginia - Global Mammal Assessment, Ursinus College.

Australia

Biodiversity Assessment and Conservation Section - Department of Environment and Climate Change, (CSIRO) Commonwealth Scientific and Industrial Research Organisation – Sustainable Ecosystems, Griffith University, Melbourne Law School - The University of Melbourne, School of Government - University of Tasmania, School of Integrative Biology - The University of Queensland, School of Environmental Science - Murdoch University, School of Biological Sciences and Australian Centre for Biodiversity - Monash University, School of Animal Biology - University of Western Australia, Environmental Law - http://www.envlaw.com.au , Department of Sustainability and Environment – Victoria, Biology and Conservation Branch - Division of Forest Research and Development - Forestry Tasmania, School of Biological Sciences – Flinders University of South Australia, The University of Southern Queensland, Invasive Species Council of Australia.

4.9 References

Abell, R. 2002. Conservation biology for the biodiversity crisis: A freshwater follow-up. *Conservation Biology 16*: 1435-1437.

Ando, A.W. 1999. Waiting to be protected under the Endangered Species Act: The political economy of regulatory delay. *Journal of Law and Economics 42*: 29-60.

Andrew, J., Clark, E., Cooper, R., Foti, T., Fenwood, L., Fuller, D., Hunter, C., Jackson, J., Lammertink, M., Ribbeck, K., Rosenberg, K., Smith, R.V. 2007. Draft

recovery plan for the Ivory-billed woodpecker *(Campephilus principalis)*. *U.S. Fish and Wildlife Service Southeast Region*, Atlanta, Georgia, USA.

Australian Senate. 2009. The operation of the Environment Protection and Biodiversity Conservation Act 1999. *Senate Environment, Communications and the Arts Committee Parliament of Australia*, Canberra.

Bell, B.D. 1986.The Conservation status of New Zealand wildlife. Occasional Publication No. 12. *New Zealand Wildlife Service, Department of Internal Affairs*, Wellington, New Zealand.

Boersma, P.D., Kareiva, P., Fagan, W.F., Clark, J.A., Hoekstra, J.M. 2001. How good are endangered species recovery plans? *Bioscience 51*: 643-649.

Bunnell, F.L., Fraser, D.F., Harcombe, A.P. 2009. Increasing effectiveness of conservation decisions: a system and its application. *Natural Areas Journal 29*: 79-90.

Carrizosa, S., Brush, S.B., Wright, B.D., McGuire, P.E. (Editors) 2004. Accessing biodiversity and sharing the benefits: Lessons from implementing the convention on biological diversity. IUCN Environmental Policy and Law Paper No. 54. *IUCN The World Conservation Union*, Gland, Switzerland and Cambridge, UK.

Charles, D. 2008. Climate change - Polar bear listing opens door to new lawsuits. *Science 320*: 1000-1001.

Clark, J.A., Hoekstra, J.M., Boersma, P.D., Kareiva, P. 2002. Improving U.S Endangered Species Act recovery plans: Key findings and recommendations of the SCB recovery plan project. *Conservation Biology 16*: 1510-1519.

Clark, K.E.; Applegate, J.E.; Niles, L.J.; Dobkin, D.S. 2006. An objective means of species status assessment: Adapting the Delphi technique. *Wildlife Society Bulletin 34*: 419-425.

Clark, T.W., Reading, R.P., Clarke, A.l. 1994. Endangered species recovery: Finding the lessons, improving the process. *Island Press*, Washington Dc.

Cullen, R., Moran, E., Hughey, K.F.D. 2005. Measuring the success and cost effectiveness of New Zealand multiple-species projects to the conservation of threatened species. *Ecological Economics 53*: 311-323.

de Lange, P.J., Norton, D.A., Courtney, S.P., Heenan, P.B., Barkla, J.W., Cameron, E.K., Hitchmough, R., Townsend, A.J. 2009. Threatened and uncommon plants of New Zealand (2008 revision). *New Zealand Journal of Botany 147*: 61-96.

Department of Agriculture Fisheries and Forestry. 2007. Regional Forest Agreement Act 2002 (electronic source) http://www.daff.gov.au/rfa. *Australian Government*, Canberra.

Department of Conservation. 2005. Conservation general policy. *Department of Conservation*, Wellington.

Department of Conservation 2006 Leading innovative conservation solutions. Research, Development and Improvement Division 5-year strategy. *Department of Conservation*, Wellington.

Department of Conservation 2007 Statement if Intent 2007-2010. *Department of Conservation*, Wellington.

Department of Conservation 2009 Department of Conservation: Statement of intent. Statement of Intent to House of Representatives, New Zealand Government. *Department of Conservation*, Wellington.

Dierker, D. 1997. Shoot shovel and shut up: An analysis of the Endangered Species Act 1973. *Centre for Studies in Agriculture, Law and the Environment, University of Saskatchewan*, Saskatchewan.

Doremus, H., Pagel, J.E. 2001. Why listing may be forever: perspectives on delisting under the US Endangered Species Act. *Conservation Biology 15*: 1258-1268.

Foin, T.C., Riley, S.P.D., Pawley, A.L., Ayres, D.R., Carlson, T.M., Hodum, P.J., Switzer, P.V. 1998. Improving recovery planning for threatened and endangered species. *Bioscience 48*: 177-184.

Foley, T. 2002. Negotiating resource agreements: Lessons from ILUA's. *Environmental and Planning Law Journal 267*: 273-274.

Foster, A. 2003. New Zealand's oceans policy. *Victoria University of Wellington Law Review 34*: 1-23.

Galbreath, R. 1993. Working for wildlife: A history of the New Zealand wildlife service. *Bridget Williams Books Limited*, Wellington.

Galbreath, R. 1998. DSIR Making science work for New Zealand. *Victoria University Press, Victoria University of Wellington,*, Wellington, New Zealand.

General Accounting Office 1992 Endangered Species Act: Types and number of implementing actions (The Honourable George E. Brown, Jr. Chairman, Committee on Science,
Space, and Technology, House of Representatives). *United States General Accounting Office*, Washington, D.C.

Gibbs, G. 2006. Ghosts of Gondwana: The history of life in New Zealand. *Craig Potton Publishing*, Nelson.

Goble, D.D., Scott, J.M., Davis, F.W. (Editors) 2006. The Endangered Species Act at thirty: Renewing the conservation promise. *Island Press*, Washington.

Godden, L.C., Peel, J. 2007. The Environment Protection and Biodiversity Conservation Act 1999 - Dark sides of virtue. *Melbourne University Law Review 31*: 106-145.

Gosselin, F. 2009. Management on the basis of the best scientific data or integration of ecological research within management? Lessons learned from the Northern spotted owl saga on the connection between research and management in conservation biology. *Biodiversity and Conservation 18*: 777-793.

Govey, I., Owen, J. 1996. The New Zealand experience: legislation, priorities and recovery planning. *In:* Stephens, S., Maxwell, S. (Editors), Back from the brink: refining the threatened species recovery process, pp 37-39. *Surrey Beatty & Sons*, Sydney, Australia.

Hartley, P. 1997. Conservation strategies for New Zealand. *New Zealand Business Roundtable*, Wellington.

Hasson, F.; Keeney, S.; McKenna, H. 2000. "Delphi technique". *Journal of Advanced Nursing 32*: 1008-1015.

Helmink, K. 2009 President's report - Resource Management Law Association of New Zealand Inc. R M Newsletter. *Resource Management Law Association of New Zealand Inc.*, Auckland.

Henry, R. 1903. The habits of the flightless birds of New Zealand: With notes on other New Zealand birds. *Government Printer*, Wellington, New Zealand.

Hitchmough, R., Bull, L., Cromarty, P. 2007. New Zealand threat classification system lists 2005. Threatened Species Occasional Publication. *Department of Conservation*, Wellington.

Hoekstra, J.M., Clark, J.A., Fagan, W.F., Boersma, P.D. 2002. A comprehensive review of Endangered Species Act recovery plans. *Ecological Applications 12*: 630-640.

Holdaway, R.N. 1989. New Zealand's pre-human avifauna and its vulnerability. *New Zealand Journal of Ecology 12*: 11-25.

Holdaway, R.N., Jacomb, C. 2000. Rapid extinction of the Moas (Aves: Dinornithiformes): Model, Test, and Implications. *Science 287*: 2250-2254.

Hutching, G. 1998. The penguin natural world of New Zealand. *Penguin Group (NZ)*, Albany, New Zealand.

Hutchings, P.A., Lunney, D., Dickman, C.R. (Editors) 2004. Threatened species legislation: Is it just an Act? *Royal Zoological Society of New South Wales*, Mosman, Sydney, Australia.

International Union for Conservation of Nature. 1996. Factors influencing sustainability: A report of the activities of the International Union for Conservation of Nature, Sustainable Use Initiative to International Union for Conservation of Nature, members in compliance with recommendation. *In:* International Union for Conservation of Nature (Editor), First World Conservation Congress. *International Union for Conservation of Nature,* , Montreal, Canada.

Joseph, L.N., Maloney, R.F., O'Connor, S.M., Cromarty, P., Jansen, P., Stephens, T., Possingham, H.P. 2008. Improving methods for allocating resources among threatened species: the case for a new national approach in New Zealand. *Pacific Conservation Biology 14*: 159-168.

Joseph, L.N., Maloney, R.F., Possingham, H.P. 2009. Optimal allocation of resources among threatened species: a project prioritization protocol. *Conservation Biology 23*: 328-338.

Mann, C.C., Plummer, M.L. 1995. Noah's Choice: The future of endangered species. *Alfred Knopf*, New York.

McDonald, J. 1999. Regional forest (Dis)agreements: The RFA process and sustainable forest management. *Bond Law Review 295*: 11.

McDowall, R.M. 1994. Gamekeepers for the nation The story of New Zealand's acclimatisation societies, 1861-1990. *Canterbury University Press University of Canterbury* Christchurch.

McGrath, C. 2005. Key concepts of Environment Protection and Biodiversity Conservation Act 1999. *Environmental and Planning Law Journal 20*: 20-39.

McGrath, C.J. 2006. Review of the EPBC Act. *Australian State of the Environment Committee, Department of the Environment and Heritage*, Canberra.

McGrath, C.J. 2007. How to evaluate the effectiveness of an environmental legal system (unpublished PhD thesis). Faculty of Law. *Queensland University of Technology*, Brisbane.

MacMillan, D.C.; Marshall, K. 2006. The Delphi process - an expert - based approach to ecological modelling in data - poor environments. *Animal Conservation 9*: 11-19.

Millenium Ecosystem Assessment. 2005. Millenium Ecosystem Assessment Synthesis Report - A Report of the Millenium Ecosystem Assessment. *In*: Sarukham, J., Whyte, A (Editors) Millenium Ecosystem Assessment. *World Resources Institute*, Washington DC.

Miller, J.K., Scott, J.M., Miller, C.R., Waits, L.P. 2002. The Endangered Species Act: Dollars and Sense? *Bioscience 52*: 163-168.

Molloy, J., Bell, B., Clout, M., de Lange, P., Gibbs, G., Given, D., Norton, D., Smith, N., Stephens, T. 2002. Classifying species according to threat of extinction. A

system for New Zealand. Threatened species occasional publication 22. *Department of Conservation*, Wellington, New Zealand.

Moran, E. 2003. An analysis of the costs of New Zealand threatened species programmes (unpublished MSc thesis). Lincoln University. *Lincoln University*, Christchurch.

Myers, N. 1993. Systematics, Ecology, and the Biodiversity Crisis *Nature 362*: 30.

Myers, N., Mittermeiser, R.A., Mittermeiser, C.G., de Fonseca, G.A.B., Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*: 853-858.

Nevo, D.; Chan, Y.E. 2007. A Delphi study of knowledge management systems: Scope and requirements. *Information & Management 44*: 583-597.

Olson, D.M., Dinerstein, E., Powell, G.V.N., Wikramanayake, E.D. 2002. Conservation biology for the biodiversity crisis. *Conservation Biology 16*: 1-3.

Patrick, W.S.; Damon-Randall, K. 2008. Using a five-factored structured decision analysis to evaluate the extinction risk of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus). *Biological Conservation 141*: 2906-2911.

Possingham, H.P., Andelman, S.J., Burgman, M.A., Medellín, R.A., Master, L.L., Keith, D.A. 2002. Limits to the use of threatened species lists. *Trends in Ecology & Evolution 17*: 503-507.

Roche, M. 1990. History of New Zealand forestry. *New Zealand Forestry Corporation Limited and GP Books*, Wellington.

Roemer, G.W., Wayne, R.K. 2003. Conservation in conflict: the tale of two endangered species. *Conservation Biology 17*: 1251-1260.

Rohlf, D.J. 1989 The Endangered Species Act: A guide to its protections and implementation. Stanford (CA). *Stanford Environmental Law Society*.

Scheuer, J.H. 1993. Biodiversity: beyond Noah's Ark. *Conservation Biology 7*: 206-207.

Sebastião, H.; Grelle, C.E.V. 2009. Taxon surrogates among Amazonian mammals: Can total species richness be predicted by single orders? *Ecological Indicators 9*: 160-166.

Simberloff, D.S. 1984. Mass extinction and the destruction of moist tropical forests. *Zhurnal Obshchei Biologiil* (Journal of General Biology) 45:767-778.

Slack, E.B. 1969. Fisheries and New Zealand. *In:* Slack, E.B. (Editor), Proceedings of a seminar on fisheries development in New Zealand. *Department of University Extension, Victoria University of Wellington*, Victoria University of Wellington.

Tear, T.H., Scott, M., Hayward, P.H., Griffith, B. 1993. Status and prospects for success of the Endangered Species Act: A Look at Recovery Plans. *Science 262*: 976 - 977.

Townsend, A.J., de Lange, P.J., Duffy, C.A.J., Miskelly, C.M., Molloy, J., Norton, D.A. 2008. New Zealand threat classification system manual. Research, Development & Improvement Division. *Department of Conservation*, Wellington.

Walker, S., Brower, A.L., Clarkson, B.D., Williams, G.L., Myers, S.C., Shaw, W.B., Stephens, R.T.T. 2008. Halting indigenous biodiversity decline: ambiguity,

equity, and outcomes in RMA assessment of significance. *New Zealand Journal of Ecology 32*: 225-237.

Wallace, P. 2009. Where the wild things are: examining the intersection between the RMA 1991 and the Wildlife Act 1953. *Department of Geography, Tourism and Environmental Planning, University of Waikato*, Hamilton.

Wilcove, D.S., Rothstein, D., Dubow, J., Phillips, A., Losos, E. 1998. Quantifying threats to imperilled species in the United States. *Bioscience 48*: 607-615.

Williams, G.R., Given, D.R. 1981. The red data book of New Zealand. Rare and endangered species of endemic terrestrial vertebrates and vascular plants. *Nature Conservation Council*, Wellington, New Zealand.

Wilson, K. 2004. Flight of the Huia. Ecology and conservation of New Zealand's frogs, reptiles, birds and mammals. *Canterbury University Press*, Christchurch, New Zealand.

Young, D. 2004a. Our Islands, Our Selves - A history of conservation in New Zealand. *University of Otago Press*, Dunedin.

Young, T.R. 2004b. Legal issues and the international regime. *In:* Carrizosa, S., Brush, S.B., Wright, B.D., McGuire, P.E. (Editors), Accessing Biodiversity and Sharing the Benefits: Lessons from Implementing the Convention on Biological Diversity. *IUCN, The World Conservation Union*, Cambridge.

CHAPTER 5 Future direction for the conservation of New Zealand's biodiversity

Tuatara, (Northern subspecies) *Sphenodon punctatus punctatus* (Photo by Mark Seabrook-Davison).

This chapter is a modified from the published paper: Appendix 7.7):
Seabrook-Davison M. N. H., Brunton D. H. & Ji W. (2009). Future direction for the conservation of New Zealand's biodiversity. *Pacific Conservation Biology Vol. 15, Issue 3*

5.1 Abstract

The rate of change being experienced by the world's biodiversity demands a revitalised approach to its conservation. Recent analyses of the management of New Zealand's biodiversity have highlighted the challenge of allocating limited resources, especially the funding of threatened species. Reviews of conservation management practices have called for the justification of conservation research by quantifying biodiversity changes and testing solutions. It is appropriate that new tools are suggested for biodiversity conservation in New Zealand considering the degree to which the biota of this Pacific archipelago is threatened with extinction. I argue that threatened species management has been overwhelmed by the top end infrastructure of DOC with inadequate resources allocated to species management with funding for directed recovery programmes at the best short-term and at the worst, non existent. With only 6% of all recorded threatened species actively managed, New Zealand is far from meeting its national and international obligations. It is accepted a degree of conservation triage is required for the future management of New Zealand's threatened species considering the number of threatened species and with no prospect of increased funding. Conservation triage should only be considered as one tool along side the future implementation of dedicated threatened species legislation and a complete understanding of the biology of all threatened species in all taxonomic groups. Certain improvements can be made within the existing resourcing constraints such as improving recovery plans, with all taxonomic groups represented. It will be important to instigate a coordinated national approach to the management of threatened species between all 13 Department of Conservation conservancies which will ensure a more efficient use of resources and the skills of conservation staff.

5.2 Introduction

Recent analyses (Hartley, 1997; Clout, 2001; Cullen *et al.*, 2005; Joseph *et al.*, 2008; Joseph *et al.*, 2009) of the management of New Zealand's biodiversity have highlighted the challenge of allocating limited resources, especially the funding of threatened species. This review includes frequent citation of Joseph *et al.* (2008, 2009) as the Project Prioritisation Protocol (PPP) modal proposed in their papers is co-written by Department of Conservation (DOC) staff and will most probably be the metric used in future allocation of resources to New Zealand's threatened species. Limited resources for threatened species management and recovery are a worldwide problem extensively documented in the conservation literature (Spring *et al.*, 2007; Sutherland, 2009). Reviews of conservation management practices (Craig and Stewart, 1994; Ussher, 1999; Sutherland *et al.*, 2004; Sutherland, 2009) have called for the justification of conservation research by quantifying biodiversity changes and testing solutions. Therefore it is appropriate that novel strategies such as those presented by Joseph *et al.* (2008, 2009) are available for assessment. Any suggestions for improvement must engage a full debate on the current demands on natural resources (Millenium Ecosystem Assessment, 2005) and the emerging threats to biodiversity such as climate change (Kostyack and Rohlf, 2008). Development and implementation of management strategies for threatened species need to be cognizant of not only the ecological (Clark *et al.*, 1994) needs of threatened species but also cultural (Craig and Stewart, 1994; Charnley, 2006; McBride *et al.*, 2007) and economic (Craig, 1998; Moran, 2003; Sinden, 2004; Cullen *et al.*, 2005; Perhans *et al.*, 2008) factors.

The biodiversity crisis (Ehrlich and Ehrlich, 1981; Bibby, 1994; Butchart *et al.*, 2006; Simberloff, 2007; Paterson *et al.*, 2008; Sutherland *et al.*, 2009) is being exacerbated by

continual habitat modification and climate change at a time when conservation science is stressing the need for protecting the ecosystem services (Armsworth *et al.*, 2007; Likens *et al.*, 2009) provided by biodiversity. The successful management of threatened species will demand resolution as to which species receive the limited conservation resources (Mann and Plummer, 1995). Joseph *et al.* (2009) identify a failing of priority setting criteria for threatened species in ignoring two important factors, namely *"the cost of management and the likelihood that the management will succeed."* A level of conservation triage (McIntyre *et al.*, 1992; Frazee *et al.*, 2003; Marris, 2007; Bottrill *et al.*, 2008) is being advocated with debate amongst stakeholders as to which species to conserve and the realisation that prevention of extinction for all threatened species is not achievable.

I support the call for the efficient allocation of conservation resources and the pragmatism required to decide which threatened species management approaches will succeed. However, the effectiveness of resource allocation strategies is limited when adequate baseline biological information is unavailable (Halloy, 1995; Johns, 2007; Long *et al.*, 2007; O'Grady *et al.*, 2008; Currey *et al.*, 2009). This information is critical when deciding on which candidate species are appropriate for ranking in priority setting models (Joseph *et al.*, 2009). I also realise that complete biological information on all threatened species may not be achievable (Grantham *et al.*, 2009) and that conservation actions should not be delayed (Ussher, 1999).

5.3 Review

5.3.1 Approaches to threatened species recovery

The rate of change being experienced by the world's biodiversity demands a revitalised approach to conservation ecology (Hayward and Kerley, 2009), especially the management and recovery of threatened species. A comprehensive report produced by the New Zealand Ministry for the Environment (Ministry for the Environment, 2007) concludes that species which have survived the exploitative years of the industrial and agricultural revolution (18^{th} – 20^{th} centuries) now face intense pressure from the demand for resources, resulting in considerable habitat modification.

I support the aim of the Project Prioritisation Protocol approach proposed by (Joseph *et al.*, 2008) if it is a successful tool to guide the cost-effective allocation of resources to New Zealand threatened species management and recovery programmes. However, I stress that any novel tool needs to be supported by over-arching national threatened species legislation. Without this legislation, it is likely that any new approach to management of threatened species will not receive long term support. This is a lesson learnt from the Endangered Species Act 1973 of the USA (Doremus and Pagel, 2001; Goble *et al.*, 2006; Ferraro *et al.*, 2007; Carolan, 2008). Other countries such as Australia (Hutchings *et al.*, 2004; Jarmen and Brock, 2004) and Canada (Species at Risk Act, 2002; Mooers *et al.*, 2007) with similar governance structure and conservation challenges as New Zealand have used the ESA1973 as a benchmark to instigate their own dedicated threatened species legislation.

Without a legal requirement for the New Zealand Government and the Department of Conservation (DOC) to assign all possible effort and resources to prevent the extinction

of threatened species, any new management strategies will suffer the past failure of inconsistency and lack of clear objectives. Dedicated threatened species legislation will provide the framework for effective management and demand accountability for achievable results. These outcomes are demanded by both The Convention on Biological Diversity (Convention on Biological Diversity, 1993) which New Zealand was an early signatory and New Zealand's own Biodiversity Strategy (Ministry for the Environment, 2000; Green and Clarkson, 2005).

Joseph *et al.,* (2008) have identified that management of threatened species in New Zealand is inconsistent and there is a lack of coordination between conservancies of DOC as to which species are chosen for recovery. They also argue that there is no national overview for the management and recovery of threatened species. To some degree, this can be explained by the annual competitive process conservancies undergo to acquire funding. As a result, most species recovery programmes are funded separately by each of the 13 conservancies and this can result in multiple approaches to managing individual populations (Rhodes *et al.*, 2008) of a single species. The PPP approach advocated by Joseph *et al.,* (2008) could avoid the inefficiency of separate management by improving resource allocation for metapopulation management.

5.3.2 Species chosen to be managed

Considering its size and population New Zealand has a disproportionate number of threatened species (n= 2,788) (Hitchmough *et al.*, 2007; de Lange *et al.*, 2009). Much of New Zealand's biodiversity crisis can be attributed to the extensive removal of primary vegetation (Ogden *et al.*, 1998; McGlone, 2001; Wilmshurst *et al.*, 2004) during the first 700 years of human habitation and the introduction of exotic species (Thompson, 1922; Wodzicki, 1950; Clout, 1999) over the last 200 years. Many of the introduced

species have become invasive (Lowe *et al.*, 2004; Russell, 2004), overwhelming the pest management capabilities of DOC, forcing it to choose which of the suite of pest species to manage. Consequently, fewer funds have been available for recovery, forcing DOC to assign recovery programmes to even fewer threatened species (New Zealand Treasury, 2008).

Joseph *et al.,* (2008) are correct in their assertion that species currently managed by DOC (n= 188, 6% of total recorded as threatened, unpublished DOC data) do not represent the full range of taxa that are recorded as threatened and are not necessarily those in most urgent need of conservation attention. Species are not chosen for management according to ecological principles alone as social (Craig *et al.*, 2000), ethnic (Gillespie, 1999; Mclean and Smith, 2001), commercial (Easton, 1997; Hartley, 1997) and aesthetic criteria must also be considered (Cullen *et al.*, 2005; Joseph *et al.*, 2009).

DOC admits (pers. comm. DOC Head Office) that it does not have a clear outcome statement or goal for threatened species and it is unclear what it is striving for (unpublished correspondence). Senior managers at DOC Head Office identify that species recovery planning must be rationalised with the other commitments it has under the over-arching conservation mission, the Nature Heritage Strategy (Department of Conservation, 2007). With a third of New Zealand within the conservation estate (fully protected system of national parks, reserves and sanctuaries) the Nature Heritage Strategy demands that DOC apportions its resources to all aspects of managing the conservation estate.

When considering the concept of conservation-triage, Marris (2007) raises the controversial idea that some species have become functionally redundant and should be

left to go extinct. Joseph *et al.,* (2008) identify that New Zealand does allocate resources to species that are essentially functionally redundant but considers some species have a strong cultural reason for recovery. Species triage was raised as a conservation issue in 1992 by McIntyre *et al.* (1992) who identified that species-based recovery approaches were a form of distorted triage. They argued that cultural, political and taxonomic biases favoured recovery of iconic species that had a high public profile, and this could obscure the need to consider other less prominent taxa, that may be more at risk of extinction. They also argued that an integrated management approach, between human land-use and nature conservation, would provide a quantitative measure to identify species and ecosystems most at risk of extinction. A similar argument (Hutcheson *et al.*, 1999) was proposed to the New Zealand Department of Conservation in 1999 whereby effective management of biodiversity and land-use requires an understanding of the factors that are operating within natural systems.

New Zealand will need to debate the anomaly where a considerable amount of the recovery budget ($NZ 32 million in 2004/05) has been allocated to iconic species that are at such low numbers that they have ceased to have any ecological role. In 2004/05 (unpublished DOC data), four species were allocated 8% ($NZ 2, 500,000) of the total recovery budget. The two species, Kakapo *Strigops habroptila* and Takahe *Porphyrio hochstetteri*, that were allocated the largest amounts ($NZ 1,000,000 & $NZ 800,000 respectively) only survive in the wild as a result of intensive management (Jamieson, 2009). As these two species require intensive conservation management (Crouchley, 1994; Elliott *et al.*, 2001; Raubenheimer and Simpson, 2006; Wickes *et al.*, 2009), the hard question to ask is, “should they receive a disproportionate amount of the limited recovery funding?” Such a question conflicts with the ideal of maintaining species diversity and the rehabilitation of all ecosystem elements (biota). Limited resources

constrain such an ideal and demand taxa that are representative of a wide interpretation of ecological function are chosen as keystone or indicator species (Froude, 1998; Walpole and Leader-Williams, 2002; Leech *et al.*, 2008; Mattila *et al.*, 2008; Sebastião and Grelle, 2009; Smyth *et al.*, 2009; Wallach *et al.*, 2009).

5.3.3 Return to foundation principles of management

DOC has implemented a variety of sophisticated infrastructure and organisational assessment models, largely as a requirement to met the reporting commitments under the umbrella Nature Heritage Strategy. Joseph *et al.,* (2008) suggest that DOC has no clear objective upon which to focus its work. This criticism has been aired frequently in the New Zealand conservation literature (Craig and Stewart, 1994; Craig *et al.*, 2000; Clout, 2001; Moran, 2003).

Moran (2003) suggests that delays in the recovery of threatened species exacerbates the decline in biodiversity and increases the total cost of recovery programmes. New Zealand is seen as too reactive to species recovery which leaves managers with no long term certainty that sustainable recovery can be achieved. Pragmatists see the challenge of effective conservation in not developing further theory but rather collecting real data on species ecology and the impacts humans have upon threatened species (Tear *et al.*, 1993; Dickman, 2006, 2008).

Joseph *et al.,* (2008) recommend that New Zealand adopts Decision Analysis models such as the Project Prioritisation Protocol (PPP) to meet a national objective whereby the desirable outcomes of threatened species management are derived. Joseph *et al.,* (2008) assume that PPP will elucidate the trade-off between benefits, costs and probability of success of management options. Support for such a model is only warranted as long as baseline biological data is known for the appropriate number of

taxa to allow the PPP model to produce a quantitative ranking of species. New Zealand biological databases are biased towards birds, reptiles and freshwater fish with a paucity of data for vascular plants and especially lower taxa such as bryophytes, fungi, freshwater invertebrates and marine invertebrates (Dugdale and Hutcheson, 1997; de Lange *et al.*, 2004; Hitchmough *et al.*, 2007).

In prioritising conservation effort it is important that the most likely factors contributing to the extinction of a species are identified (Kruger and Radford, 2008). There is currently a demand by conservation scientists for a comprehensive approach (Gage *et al.*, 2004; Thomas *et al.*, 2006; Long *et al.*, 2007) in understanding the many factors that influence extinction risk and for managers not to rely on limited data. Krugar and Radford (2008) warn that inferences from large scale analysis and modelling can produce errors owing to data inadequacies.

DOC has tested a variety of models of increasing complexity with limited success and in my opinion of more value as administrative tools rather than as conservation tools. DOC argues that these models improve conservation of New Zealand biodiversity by making management more cost-effective, transparent and accountable. I suggest that the development and testing of these models can consume a disproportionate amount of limited funds. However, any novel strategy proven to improve the delivery of conservation resources and equip managers with better tools must be welcomed.

5.4 Conclusions

A similar call by Joseph *et al.,* (2008) for a national strategy for the management and recovery of threatened species has been demanded since the Department of Conservation was formed in 1987. Under the current 13 conservancy structure of DOC

this national strategy will not be possible as long as competitive acquisition of inadequate resources exists between conservancies.

In some respects, threatened species management has been overwhelmed by the top end infrastructure of DOC. Threatened species management is inadequately resourced with funding for directed recovery programmes at the best, short-term and at the worst, non existent. With only 6% of all recorded threatened species actively managed and only 38 recovery plans currently active (unpublished DOC data), New Zealand is far from meeting its national and international obligations.

A systematic and transparent approach to resource allocation can only be achieved under the direction of dedicated threatened species legislation. This legislation will provide the legal mandate to demand appropriate resources to ensure threatened species are managed to avoid extinction. Without this legislation, the decline of New Zealand's biodiversity will continue without any legal and political accountability.

In my opinion the decline in New Zealand's biodiversity can only be halted by a strategy of direct ecological husbandry. DOC is fully aware that there is a disproportionate allocation of resources to an unrepresentative number of threatened taxa. I agree with the conclusion of Joseph *et al.,* (2008) that all criteria such as ecological, social and economic need to be considered when prioritising management actions but stress the criterion of ecological function of species is the most important.

With no indication of further allocation of funds for threatened species recovery, a level of conservation triage will be inevitable whereby support will only be available for management programmes that are likely to succeed. The ability to predict this

likelihood is the main strength of the PPP model developed by Joseph *et al.,* (2008, 2009).

The changes being advocated are not radical and are needed for New Zealand to catch-up with threatened species management strategies and legislation already existing in countries (USA, Canada, Australia) with similar conservation challenges as New Zealand.

DOC is urged to return to the roles and responsibilities it clearly established for its Biodiversity Recovery Unit (BRU) in 1998 (Department of Conservation, 1998). The primary function of the BRU was to focus on the recovery of threatened species, guided by a national policy but to incorporate local and conservancy management issues. The output required of the BRU was to incrementally reduce the threat status of species. The overall goal of DOC is to re-establish self-sustaining populations of all threatened species within their natural range. To achieve this goal, the incremental reduction in threat status is a long term commitment that requires certainty of resourcing and stability of legislation.

5.5 Acknowledgements

I thank the New Zealand Department of Conservation staff who contributed to this work with discussion on the conservation issues facing New Zealand. Attendance at conferences in Wellington, New Zealand and Sydney, Australia was funded by the Institute for Natural Sciences, Massey University.

5.6 References

Armsworth, P.R., Chan, K.M.A., Daily, G.C., Ehrlich, P.R., Kremen, C., Ricketts, T.H., Sanjayan, M.A. 2007. Ecosystem-service science and the way forward for conservation. *Conservation Biology 21*: 1383-1384.

Bibby, C.J. 1994. Recent past and future extinctions in birds. *Philosophical Transactions: Biological Sciences 344*: 35-40.

Bottrill, M.C., Joseph, L.N., Carwardine, J., Bode, M., Cook, C., Game, E.T., Grantham, H., Kark, S., Linke, S., McDonald-Madden, E., Pressey, R.L., Walker, S., Wilson, K.A., Possingham, H.P. 2008. Is conservation triage just smart decision making? *Trends in Ecology & Evolution 23*: 649-654.

Butchart, S.H.M., Stattersfield, A.J., Collar, N.J. 2006. How many bird extinctions have we prevented? *Oryx 40*: 266-278.

Carolan, M.S. 2008. The politics in environmental science: The Endangered Species Act and the Preble's mouse controversy. *Environmental Politics 17*: 449-465.

Charnley, S. 2006. The northwest forest plan as a model for broad-scale ecosystem management: a social perspective. *Conservation Biology 20*: 330-340.

Clark, T.W., Reading, R.P., Clarke, A.l. 1994. Endangered species recovery: Finding the lessons, improving the process. *Island Press*, Washington Dc.

Clout, M. 2001. Where protection is not enough: Active conservation in New Zealand. *Trends in Ecology & Evolution 16*: 415-416.

Clout, M.N. 1999. Biodiversity conservation and the management of invasive animals in New Zealand. *In*: Sandlund, O.T., Schei, P.T., Viken, A (Editors), Invasive species and biodiversity management, pp 303-316. *Kluwer Publishers*, London.

Convention on Biological Diversity 1993 Convention on biological diversity (with annexes). Concluded at Rio de Janeiro on 5 June 1992. United Nations - Treaty Series. *United Nations*.

Craig, J.L. 1998. An economic Analysis of New Zealand's Conservation Strategies. *Agenda 5*: 311-322.

Craig, J.L., Anderson, S., Clout, M., R, C., Mitchell, N., Ogden, J., Roberts, M., Ussher, G. 2000. Conservation Issues in New Zealand. *Annual Review of Ecological Systematics 31*: 61-78.

Craig, J.L., Stewart, A.M. 1994. Conservation - a starfish without a central disc. *Pacific Conservation Biology 1*: 163-168.

Crouchley, D. 1994 Takahe recovery plan (*Porphyrio [Notornis] mantelli*). Threatened Species Recovery Plan 12. *Department of Conservation*, Wellington.

Cullen, R., Moran, E., Hughey, K.F.D. 2005. Measuring the success and cost effectiveness of New Zealand multiple-species projects to the conservation of threatened species. *Ecological Economics 53*: 311-323.

Currey, R.J.C., Dawson, S.M., Slooten, E. 2009. An approach for regional threat assessment under IUCN Red List criteria that is robust to uncertainty: The Fiordland bottlenose dolphins are critically endangered. *Biological Conservation* 142: 1570-1579.

de Lange, P.J., Norton, D.A., Courtney, S.P., Heenan, P.B., Barkla, J.W., Cameron, E.K., Hitchmough, R., Townsend, A.J. 2009. Threatened and uncommon plants of New Zealand (2008 revision). *New Zealand Journal of Botany 147*: 61-96.

de Lange, P.J., Norton, D.A., Heenan, P.B., Courtney, S.P., Molloy, B.P.J., Ogle, C.C., Rance, B.D., Johnson, P.N., Hitchmough, R. 2004. Threatened and uncommon plants of New Zealand. *New Zealand Journal of Botany 42*: 45-76.

Department of Conservation. 1998. Biodiversity recovery unit: Roles and responsibilities. *Department of Conservation*, Wellington.

Department of Conservation. 2007. Department of Conservation Statement of Intent 2007-2010. *Department of Conservation*, Wellington.

Dickman, C.R. 2006. Species interactions: indirect effects. *In:* Attiwill, P., Wilson, B. (Editors), Ecology: an Australian perspective, pp 303-316. *Oxford University Press*, Oxford.

Dickman, C.R. 2008. Indirect interactions and conservation in human-modified environments. *Animal Conservation 11*: 11-12.

Doremus, H., Pagel, J.E. 2001. Why listing may be forever: perspectives on delisting under the US Endangered Species Act. *Conservation Biology 15*: 1258-1268.

Dugdale, J., Hutcheson, J. 1997. Invertebrate values of kanuka (*Kunzea ericoides*) stands, Gisborne Region. Science for Conservation 55. *Department of Conseravtion*, Wellington.

Easton, B.H. 1997. The Commercialisation of New Zealand. *Auckland University Press*., Auckland.

Ehrlich, P.R., Ehrlich, A. 1981. Extinction: the causes and consequences of the disappearance of Species. *Random House*, London.

Elliott, G., P., Merton, D., V., Jansen, P., W. 2001. Intensive management of a critically endangered species: the kakapo. *Biological Conservation 99*: 121-133.

Ferraro, P.J., McIntosh, C., Ospina, M. 2007. The effectiveness of the US endangered species act: An econometric analysis using matching methods. *Journal of Environmental Economics and Management 54*: 245-261.

Frazee, S.R., Cowling, R.M., Pressey, R.L., Turpie, J.K., Lindenberg, N. 2003. Estimating the costs of conserving a biodiversity hotspot: a case study of the Cape Floristic Region, South Africa. *Biological Conservation 112*: 275-290.

Froude, V. 1998 An analysis of potential indicators for marine biodiversity. *Ministry for the Environment*, Wellington.

Gage, G.S., Brooke, M.D., Symonds, M.R.E., Wege, D. 2004. Ecological correlates of the threat of extinction in Neotropical birds species. *Animal Conservation 7*: 161-168.

Gillespie, A. 1999. Maori, Biodiversity and International Law. *Waikato University, FRST Research Programme on bi-cultural justice*, Hamilton.

Goble, D.D., Scott, J.M., Davis, F.W. (Editors) 2006. The Endangered Species Act at Thirty: Renewing the conservation promise. *Island Press*, Washington.

Grantham, H.S., Wilson, K.A., Moilanen, A., Rebelo, T., Possingham, H.P. 2009. Delaying conservation actions for improved knowledge: how long should we wait? *Ecology Letters 12*: 293-301.

Green, W., Clarkson, B. 2005. Turning the tide? A review of the first five years of the New Zealand biodiversity strategy. The synthesis report. *Biodiversity New Zealand*, Wellington.

Halloy, S.R.P. 1995. Status of New Zealand biodiversity research and resources: how much do we know? *Journal of the Royal Society of New Zealand 25*: 55-80.

Hartley, P. 1997. Conservation strategies for New Zealand. *New Zealand Business Roundtable*, Wellington.

Hayward, M.W., Kerley, G.I.H. 2009. Fencing for conservation: Restriction of evolutionary potential or a riposte to threatening processes? *Biological Conservation 142*: 1-13.

Hitchmough, R., Bull, L., Cromarty, P. 2007 New Zealand threat classification system lists 2005. Threatened Species Occasional Publication. *Department of Conservation*, Wellington.

Hutcheson, J., Walsh, P., Given, D. 1999. Potential value of indicator species for conservation and management of New Zealand terrestrial communities. Science for Conservation report 109. *Department of Conservation*, Wellington.

Hutchings, P.A., Lunney, D., Dickman, C.R. (Editors) 2004. Threatened species legislation: Is it just an Act? *Royal Zoological Society of New South Wales*, Mosman, Sydney, Australia.

Jamieson, I.G. 2009. Loss of genetic diversity and inbreeding in New Zealand's threatened bird species. Science for Conservation 293. *Department of Conservation*, Wellington.

Jarmen, P.J., Brock, M.A. 2004. The evolving intent and coverage of legislation to protect biodiversity in New South Wales. *In:* Hutchings, P.A., Lunney, D., Dickman, C.R. (Editors), Threatened species legislation: Is it just an Act? pp 1-19. *Royal Zoological Society of New South Wales*, Mosman, Sydney, Australia.

Johns, D. 2007. Like it or not, politics is the solution. *Conservation Biology 21*: 287-288.

Joseph, L.N., Maloney, R.F., O'Connor, S.M., Cromarty, P., Jansen, P., Stephens, T., Possingham, H.P. 2008. Improving methods for allocating resources among threatened species: the case for a new national approach in New Zealand. *Pacific Conservation Biology 14*: 154-158.

Joseph, L.N., Maloney, R.F., Possingham, H.P. 2009. Optimal allocation of resources among threatened species: a project prioritisation protocol. *Conservation Biology 23*: 328-338.

Kostyack, J., Rohlf, D.J. 2008. Conserving Endangered Species in an Era of Global Warming. *Environmental Law Reporter 38*: 10203-10213.

Kruger, O., Radford, A.N. 2008. Doomed to die? Predicting extinction risk in the true hawks Accipitridae. *Animal Conservation 11*: 83-91.

Leech, T.J., Gormley, A.M., Seddon, P.J. 2008. Estimating the minimum viable population size of kaka (Nestor meridionalis), a potential surrogate species in New Zealand lowland forest. *Biological Conservation 141*: 681-691.

Likens, G.E., Walker, K.F., Davies, P.E., Brookes, J., Olley, J., Young, W.J., Thoms, M.C., Lake, P.S., Gawne, B., Davis, J., Arthington, A.H., Thompson, R., Oliver,

R.L. 2009. Ecosystem science: toward a new paradigm for managing Australia's inland aquatic ecosystems. *Marine and Freshwater Research 60*: 271-279.

Long, P.R., Szekely, T., Kershaw, M., O'Connell, M. 2007. Ecological factors and human threats both drive wildfowl population declines. *Animal Conservation 10*: 183-191.

Lowe, S., Browne, M., Boudjelas, S., De Porter, M. 2004. 100 of the world's worst invasive alien species. A selection from the global invasive species database. *The Invasive Species Specialist Group (ISSG) Species Survival Commission (SSC) of the World Conservation Union (IUCN)*, Auckland, New Zealand.

Mann, C.C., Plummer, M.L. 1995. Noah's Choice: The future of endangered species. *Alfred Knopf*, New York.

Marris, E. 2007. Conservation priorities: What to let go. *Nature 450*: 152-155.

Mattila, N., Kotiaho, J., S., Kaitala, V., Komonen, A. 2008. The use of ecological traits in extinction risk assessments: A case study on geometrid moths. *Biological Conservation 141*: 2322-2328.

McBride, M.F., Wilson, K.A., Bode, M., Possingham, H.P. 2007. Incorporating the effects of socioeconomic uncertainty into priority setting for conservation investment. *In:* Conference proceedings of 1st European Congress of Conservation Biology pp 1463-1474 , Eger, Hungary.

McGlone, M.S. 2001. The origin of the indigenous grasslands of south eastern South Island in relation to pre-human woody ecosystems. *New Zealand Journal of Zoology 25*: 1-15.

McIntyre, S., Barrett, G.W., Kitching, R.L., Recher, H.F. 1992. Species triage - Seeing beyond wounded rhinos. *Conservation Biology 6*: 604 - 606.

Mclean, R., Smith, T. 2001. The crown and flora and fauna and practices. *Waitangi Tribunal,* Wellington.

Millenium Ecosystem Assessment. 2005. Millenium Ecosystem Assessment Synthesis Report - A Report of the Millenium Ecosystem Assessment. *In*: Sarukhan, J., Whyte, A (Editors) Millenium Ecosystem Assessment. *World Resources Institute*, Washington DC.

Ministry for the Environment. 2007. Environment New Zealand 2007. (Publication number ME: 847). *Ministry for the Environment*, Wellington.

Ministry for the Environment. 2000. The New Zealand biodiversity strategy: Our chance to turn the tide. *Department of Conservation and Ministry for the Environment*, Wellington.

Mooers, A., Prugh, L.R., Festa-Bianchet, O.M., Hutchings, J.A. 2007. Biases in Legal Listing under Canadian Endangered Species Legislation. *Conservation Biology 21*: 572-575.

Moran, E. 2003. An analysis of the costs of New Zealand threatened species programmes (unpublished MSc thesis). Lincoln University. *Lincoln University*, Christchurch.

New Zealand Treasury. 2008. Department's Statements of Intent. *New Zealand Treasury (electronic resource) http://www.treasury.govt.nz/budget/2007/sois/index.htm*, Wellington.

O'Grady, J.J., Reed, D.H., Brook, B.W., Frankham, R. 2008. Extinction risk scales better to generations than to years. *Animal Conservation 11*: 442-451.

Ogden, J., Basher, L., McGlone, M.S. 1998. Fire, forest regeneration and links with early human habitation: evidence from New Zealand. *Annals of Botany 81*: 687-696.

Paterson, J.S., Araujo, M.B., Berry, P.M., Piper, J.M., Rounsevell, M.D.A. 2008. Mitigation, Adaptation and the threat to biodiversity. *Conservation Biology 22*: 1352-1355.

Perhans, K., Kindstrand, C., Boman, M., Boberg Djupstrom, L., Gustafsson, L., Mattsson, L., Schroeder, L., Weslien, J., Kikberg, S. 2008. Conservation goals and the relative importance of costs and benefits in reserve selection. *Conservation Biology 22*: 1331-1339.

Raubenheimer, D., Simpson, S.J. 2006. The challenge of supplementary feeding: Can geometric analysis help save the kakapo? *Notornis 53*: 100-111.

Rhodes, J.R., Callaghan, J.G., McAlpine, C.A., De Jong, C., Bowen, M.E., Mitchell, D.L., Lunney, D., Possingham, H.P. 2008. Regional variation in habitat-occupancy thresholds: a warning for conservation planning. *Journal of Applied Ecology 45*: 549-557.

Russell, J.C. 2004. Invading the Pacific: biological and cultural dimensions of invasive species in the Pacific region. *Graduate Journal of Asia-Pacific Studies 2*: 77-94.

Sebastião, H., Grelle, C.E.V. 2009. Taxon surrogates among Amazonian mammals: Can total species richness be predicted by single orders? *Ecological Indicators 9*: 160-166.

Simberloff, D. 2007. Aliens amongst us. Given the stakes, our modus operandi in dealing with invasive species should be *"guilty until proven innocent."*. *Conservation Magazine 8*: 18-19.

Sinden, A. 2004. The economics of endangered species: Why less is more in the economic analysis of critical habitat designations. *Harvard Environmental Law Review 28*: 129-214.

Smyth, A.K., Brandle, R., Chewings, V., Read, J., Brook, A., Fleming, M. 2009. A framework for assessing regional biodiversity condition under changing environments of the arid Australian rangelands. *The Rangeland Journal 31*: 87-101.

Species at Risk Act 2002 Species at Risk Act - Bill C5 (electronic source) www.parl.gc.ca/37/2/parlbus/chambus/house/bills/government/c-5/c-5_4/c. *Canadian Government*, Ottawa.

Spring, D.A., Cacho, O., Mac Nally, R., Sabbadin, R. 2007. Pre-emptive conservation versus "fire-fighting": A decision theoretic approach. *Biological Conservation 136*: 531-540.

Sutherland, W.J., Adams, W.M., Aronson, R.B., Aveling, R., Blackburn, T.M., Broad, S., Ceballos, G., Cote, I.M., Cowling, R.M., Da Fonseca, G.A.B., Dinerstein, E., Ferraro, P.J., Fleishman, E., Gascon, C., Hunter Jr., M., Hutton, J., Kareiva, P., Kuria, A., MacDonald, D.W., MacKinnon, K., Madgwick, F.J., Mascia, M.B.,

McNeely, J., Milner-Gulland, E.J., Moon, S., Morley, C.G., Nelson, S., Osborn, D., Pai, M., Parsons, E.C.M., Peck, L.S., Possingham, H., Prior, S.V., Pullin, A.S., Rands, M.R.W., Ranganathan, J., Redford, K.H., Rodriguez, J.P., Seymour, F., Sobel, J., Sodhi, N.S., Stott, A., Vance-Borland, V., Watkinson, A.R. 2009. One hundred questions of importance to the conservation of global biological diversity. *Conservation Biology 23*: 557-567.

Sutherland, W.J., Pullin, A.S., Dolman, P.M., Knight, T.M. 2004. The need for evidence-based conservation. *Trends in Ecology & Evolution 19*: 305-308.

Tear, T.H., Scott, M., Hayward, P.H., Griffith, B. 1993. Status and prospects for success of the Endangered Species Act: A look at recovery plans. *Science 262*: 976 - 977.

Thomas, G.H., Lactot, R.B., Szekely, T. 2006. Can intrinsic factors explain population declines in North American breeding shorebirds? A comparative analysis. *Animal Conservation 9*: 252-258.

Thompson, G.M. 1922. The naturalisation of animals and plants in New Zealand. *Oxford University Press*, Oxford.

Ussher, G.T. 1999. Restoration of threatened species populations: tuatara rehabilitations and reintroductions (unpublished PhD thesis). *University of Auckland*, Auckland.

Wallach, A., D; Murray, B., R; O'Neill, A., J. 2009. Can threatened species survive where the top predator is absent? *Biological Conservation 142*: 43-52.

Walpole, M.J., Leader-Williams, N. 2002. Tourism and flagship species in conservation. *Biodiversity and Conservation 11*: 543-547.

Wickes, C., Crouchley, D., Maxwell, J. 2009. Takahe (Porphyrio hochstetteri) recovery plan Threatened Species Recovery Plan. *Department of Conservation*, Wellington.

Wilmshurst, J.M., Higham, J., Allen, H., Johns, D., Phillips, C. 2004. Early Maori settlement impacts in northern coastal Taranaki. New Zealand. *New Zealand Journal of Ecology 28*: 167-179.

Wodzicki, K. 1950. Introduced mammals of New Zealand. *Department of Scientific and Industrial Research*, Wellington, New Zealand.

CHAPTER 6 General conclusions and management recommendations

Kokako (North Island subspecies) *Callaeas cinerea wilsoni* (Photo: Mark Seabrook-Davison)

6.1 Introduction

The overall aim of this thesis was to examine the status of New Zealand's threatened species and to evaluate approaches to their management and recovery. This aim has been achieved principally with an evaluation of the role of the Department of Conservation (DOC) (Chapter 3 Seabrook-Davison *et al.* 2009a (*published*)) and an examination of the legislation directing the management and recovery of threatened species (Chapter 4 Seabrook-Davison *et al.* 2010 (*published*)) and a critique of a proposed new management tool (Chapter 7 Seabrook-Davison *et al.* 2009c (*published*)).

The key findings from each chapter are summarised in the following sections of chapter 6, from 6.2 to 6.8. In reporting the results of my thesis, there has been a deliberate emphasis placed on the new Project Prioritisation Protocol (PPP) being implemented by DOC. The PPP model is explained in Chapter 7 and described in detail in Joseph *et al.* (2008, 2009). This is a conservation triage strategy where all threatened species are assessed for their likelihood of survival over the long term. All threatened species are given a value, based on current biological information and their cultural and genetic significance. My deliberate emphasis on PPP is important as it will be the metric DOC and the government use to fund threatened species recovery in the foreseeable future; at least 10 years, and most likely 50 years. It is the intention of DOC that all other management strategies relating to species recovery will be either subservient to the PPP strategy or discarded. DOC has been directed to contain all threatened species management and recovery within a budget of $NZ 33 million per year for at least the next four years, New Zealand Government (2009).

6.2 National approach to threatened species management

A strong result emerging from this research is the need for a national and integrated approach to the management of threatened species. Such an approach was strongly advocated by DOC staff that convened a workshop (Rasch and Saunders, 1990) three years after the formation of the new department (DOC). Conclusions from this workshop stressed the need to "*establish priorities"* for threatened species management according to a "*planned approach"*. DOC staff surveyed for this thesis (Chapter 3) suggested threatened species management would be more effective with a national programme that used staff skills and resources from any of the 13 DOC conservancies. Some DOC staff criticised the separate conservancy structure of DOC for a lack of coordinated management and lacking an overview of which species should be managed. There is potential for this problem to be partly solved by a new tool developed in part by DOC scientists (Joseph *et al.*, 2008; Joseph *et al.*, 2009) that prioritises which threatened species will be managed (Chapter 7 Seabrook-Davison *et al.* 2009c *Pacific Conservation Biology Vol. 15*). This will formalise and quantify the informal conservation triage that DOC has recently been forced to implement. Joseph *et al.* (2009) describe this novel tool as follows:…"*We devised a project prioritisation protocol (PPP) to optimise resource allocation among New Zealand's threatened-species projects, where costs, benefits (including species values), and the likelihood of management success were considered simultaneously"*(Joseph *et al.*, 2009). Using the PPP approach, it should be possible to predict for each threatened species whether successful recovery is achievable. With limited resources available, there has been a call for a pragmatic approach (Moran, 2003) where economic factors as well as biological and cultural values need to be considered. The PPP approach would also be favoured by analysts (Cullen *et al.*, 2005) who recommend that single species recovery programmes

are more effective than multi-species approaches. **Key results**: (Chapter 3). The need for a reassessment of New Zealand's approach to the management and recovery of threatened species with the development of a national approach that will coordinate the recovery programmes of all Biodiversity Assets staff within the 13 DOC conservancies.

6.3 Recommendations

6.3.1 Recovery plans

A recommendation from the survey of DOC staff (Chapter 3 Seabrook-Davison *et al.* 2009a (*published*)) is for recovery plans to be produced in an electronic format so they can be kept up to date and information is available to all staff, especially staff in remote areas such as offshore islands. DOC staff see recovery plans as a valuable tool as long as they conform to a standard format and contain realistic and achievable goals. DOC staff surveyed suggested the main strength of recovery plans was as a reference tool rather than a tool to direct their management actions. This thesis concludes that the current New Zealand recovery plans lack the relevancy that they should represent as foundation documents and there is a poor representation of all taxa threatened with extinction. Since 2002 when a comprehensive threat classification system identified 2,373 species threatened with extinction, only 12 recovery plans have been produced with six (50%) for birds and seven are updates of previous plans. **Key results**: (Chapter 3). It is apparent that current recovery plans are not adequately providing wildlife managers with guidance on the most effective ways of ensuring the recovery of threatened species. A complete review of how recovery plans are produced is required with a recommendation that they are produced according to a standard format, with achievable goals and that plans are available to all DOC staff, preferably available in an electronic format.

6.3.2 Security of funding for recovery of threatened species

DOC staff were divided over whether recovery plans should contain detailed costings but there was agreement that there should be security of funding for how long its takes to secure the recovery of threatened species. The thesis highlights this point with the recommendation that threatened species are listed on a central government register (Chapter 4 Seabrook-Davison *et al.* 2010 (*published*)) where their progress towards recovery is monitored via a legally and nationally scrutinised process. This thesis has identified a lack of consistency in the length of time recovery programmes are funded, largely due to the lack of understanding for how long it takes for the populations of threatened species to stabilise. Currently, the metric New Zealand uses to measure the success of its threatened species management is a record of the number of populations showing an annual increase in number of individuals. There is an understanding that recovery for all threatened species is not possible but for the species that are chosen for recovery, it will be important that long term funding is guaranteed. **Key results**: (Chapter 3, 4, 7). There is a call by DOC staff, especially senior conservancy staff, for the security of funding and other resourcing for recovery plans. The results of this thesis show that only a small number of threatened species in each conservancy are actively managed. Security of funding will be critical for any species that are chosen for long-term recovery under the new conservation triage Project Prioritisation Protocol (PPP) being implemented by DOC.

6.3.3 Threatened species recovery groups

The skill base and knowledge of its staff is one of DOC's principle assets and it is recommended that DOC promotes the role of recovery groups to take an active part in directing the management of threatened species. The DOC staff survey (Chapter 3 Seabrook-Davison *et al.* 2009a (*published*)) indicated that much of the work done by

members of recovery groups is voluntary and it is recommended that adequate remuneration is provided to these members. New DOC staff should be encouraged to join recovery groups so they can learn from the experience of older staff. The membership of recovery groups should be extended to include all stakeholders such as developers and people in primary industries such as agriculture, mining and fisheries enabling them to be kept informed and involved in any decision making. **Key results**: (Chapter 3, 7). There is an indication from the results of the DOC staff survey that key skills are being lost with staff redundancies. Conservation skills are accumulated over a relatively long time and it will be important that these are retained, especially with DOC relying on its conservation triage tool (PPP) to effectively restore threatened species to self-sustaining populations.

6.3.4 Coordinated management of threatened species

To avoid the duplication of management programmes and to share resources, it is recommended that DOC encourages greater coordination of threatened species management between conservancies. It will be important that the goals of a national strategy are incorporated into the business plans of each conservancy. This thesis (Chapter 3 Seabrook-Davison *et al.* 2009a (*published*)) found that successful recovery methods and staff expertise is not always shared between conservancies. It is recommended that the strengthened recovery groups should be given the authority to direct and coordinate recovery actions between the conservancies with scientific input from the conservancy scientists. It is also recommended that conservancy scientists are officially sanctioned to work outside their domiciled conservancy with the recovery groups directing their research rather than the conservancy Conservators. **Key results**: (Chapter 3, 4, 7) Refer section 6.2.

6.3.5 Coordinated pest management

The control of pest species is a considerable challenge for all countries that have endured the detrimental impacts of introduced species. These impacts have been especially severe in isolated land masses such as New Zealand where the biota has not evolved defences against novel species. The control of pests has been identified as consuming a disproportionate amount of resources available to conservation managers. It appears from discussions with DOC staff and the results of the DOC staff survey that there is no national strategy for the control of pests. Owing to limited funding, it is evident that managers are forced to be selective in which pests they control. It is therefore recommended that a national pest control strategy is created to ensure coordination of pest control for all pest species. This strategy should be devised by all agencies involved in pest control including DOC, other government agencies, local councils and the private sector. Successful pest control methods could be shared via an exchange of best practice manuals that can be regularly updated and available in an electronic format as companion documents to the electronic recovery plans. I am continuing with research into aspects of pest behaviour that will assist in increasing the efficacy of pest control methods. The intentional of my longitudinal study will be to understand the behaviour of pests that exist as species assemblages. With the growing public concern over the widespread use of toxic poisons used to control pest species, it will be important to devise control strategies that are not so reliant on the use of these poisons. **Key results**: (Chapter 2, 3). The results of a literature review and the DOC staff survey show that controlling pests is one of the major constraints to effective management of threatened species.

6.4 Threatened species legislation

For management to be effective, this thesis recommends that New Zealand implements dedicated threatened species legislation which will enable any management approach to operate within a legal context. The current wildlife legislation guided by the Wildlife Act 1953 is not appropriate for the level of threat faced by New Zealand's biota. This act is considerably out of date, with no legal directive for the implementation of recovery programmes. An examination of legislation in the USA and Australia (Chapter 4 Seabrook-Davison *et al.* 2009b (*in press*)) reveals the benefits of a transparent legal process that identifies species threatened with extinction and ensures their progress towards recovery is monitored. An advantage with a national statute is the involvement of all stakeholders that are fully informed and encouraged to contribute to the development of conservation solutions and decision making. Under the US ESA1973, private landowners are encouraged to be the custodians of their land and the species it contains. This is proactive management which reduces the amount of state funded recovery action. It also encourages a degree of husbandry from the landowners. This also benefits the environment and the economy by protecting ecosystem services. It also prevents disjunction of the flow of ecosystem services where private landowners represent links in ensuring continuity of ecological networks. Biodiversity conservation and the sustainable use of natural resources requires a joint management approach where all stakeholders are aware of the needs of biota and the need to safeguard ecosystem services (Millenium Ecosystem Assessment, 2005; Naidoo *et al.*, 2008).

The current New Zealand Wildlife Act 1953 fails to provide appropriate guidance for the management and recovery of threatened species, being an act designed more for managing the access to game species and the control of pest species. Another failing of the Wildlife Act 1953 is that it is subservient to resource use legislation such as fishing,

mining, forestry and agriculture acts. A dedicated threatened species act would provide long-term security for recovery programmes. In supporting the creation of a New Zealand endangered species Act, Crossen (2007) argues that concise threatened species legislation should guide central government decisions and that…*"the protection of biodiversity should be a legal imperative, rather than a policy directive"* of the administration of the Department of Conservation. The ESA 1973 is an act designed to prevent the extinction of threatened species by providing a legal mandate for the protection of threatened species and their critical habitat. New Zealand has the benefit of evaluating the strengths of legislation in three countries (USA, Australia, Canada) with similar political governance. A proven strength of the ESA1973, EPBC1999 and SARA2002 is their direct focus on the welfare of imperilled wildlife with a clear linear process for the implementation of recovery actions. **Key results**: (Chapter 3, 4, 7). The results of an evaluation of New Zealand's wildlife legislation indicates it is inappropriate for the level of threat New Zealand's biodiversity is currently facing. From a comparison of wildlife legislation in Australia and the USA, it is suggested that New Zealand adopts similar dedicated threatened species legislation that exists in these two countries. It will be important for New Zealand to create a central government register of listed species to ensure they are monitored for the full duration of their recovery. This is especially important once the full impact of the conservation triage strategy (PPP) becomes evident. Currently there is no legal redress once a species becomes extinct.

6.5 Threat classification systems

One major advance since the formation of DOC has been the development of a threat classification system (Molloy *et al.*, 2002; Townsend *et al.*, 2008) specifically designed to assess the threat status of New Zealand's biota. New Zealand has also complied with

the objective of the IUCN to have an international system of classifying threatened species (International Union for Conservation of Nature, 2001) yet ensuring regional and biogeographical aspects are built into each country's classification system. Another recent advance has been DOC's formation of panels of experts to evaluate the threat status of recorded species and the intention to publish lists (2,788 species in 14 taxa) at regular intervals (Hitchmough, 2002; Hitchmough *et al.*, 2007; de Lange *et al.*, 2009). A conservation challenge for DOC will be to decide what resources are provided to the additional 3,031 species that are suspected of being threatened but owing to a lack of baseline biological data, have been categorised as "data deficient." Hitchmough *et al.*, 2007. The IUCN recommends that in the absence of conclusive information, the precautionary principle should apply and data deficient species should be seen as threatened to ensure they are considered for recovery. If the IUCN (2001) recommendations are to be followed, New Zealand should consider it has a combined (2,788 and 3,031) 5,819 species as requiring assessment for recovery action. Such a number of species is beyond the resources and capabilities of DOC and a level of conservation triage will be required to identify which species are likely to have long term potential for survival. It is prudent to instigate recovery actions early in the knowledge that a species is threatened with extinction. In prioritising which taxa receive the scarce resources available for recovery, it will require a comprehensive assessment of all taxonomic groups. **Key results**: (Chapter 2, 3, 7). A positive advance for conservation ecology in New Zealand is the development of a threat classification system that categorises the level of threat faced by New Zealand species, that are peculiar to an insular group of islands. This threat classification system has been successful in identifying 5,819 (includes 3,031 species classified as data poor) species threatened with extinction. However, it will be important with the implementation of the

PPP strategy that species from all taxonomic groups are assessed for their likelihood of survival, hence receiving funding under the PPP model. The IUCN (2001) also stresses the importance of considering the 3,031 data poor classified New Zealand species as threatened until proven otherwise.

6.6 Molecular tools

Information derived from DNA sequencing allows clarification of taxonomic relatedness between species and the ability to construct phylogenies for species complexes. The resultant information is not only useful for taxonomic purposes and evolutionary analysis, but can have important implications for conservation. The results of published research (Seabrook-Davison *et al*. 2009) into the phylogeny of New Zealand's extinct quail *Coturnix novaezelandiae* is attached as an appendix to this thesis Seabrook-Davison, M., Huynen, L., Lambert, D. M., Brunton, D.H. 2009d. There is no content of this research included in the thesis. However, this published research is of value when considering the possible use of introduced species as ecological replacements for extinct species.

6.7 Community conservation groups

A survey included in this thesis (Chapter 2 Seabrook-Davison et al (2009 submitted *New Zealand Journal of Ecology*)) indicated a good awareness amongst a sample of households in Auckland, (New Zealand's largest population centre), of New Zealand's rare and threatened species as well as showing strong support for the funding of conservation. To some degree, this awareness can be related to the close affinity that some New Zealander's have towards environmental issues and New Zealand's image portrayed to the world of a "clean green" ecologically responsible country.

There has been an increasing impetus for local communities to establish protected wildlife areas managed by community conservation groups (CCG). Conservation projects established by CCGs have a common goal to promote conservation and rehabilitate degraded ecosystems. Although these groups are rehabilitating mostly land administered by DOC or Regional Councils, an increasing amount of privately owned land is being converted into wildlife reserves or covenanted to protect biodiversity.

Community conservation groups (CCGs) have shown that they can provide volunteer labour and fund-raising skills to considerably supplement the conservation effort of DOC. DOC has recently assessed this contribution from CCGs, estimating that these groups contribute $NZ 15 million per year to the conservation and management of New Zealand's biota Hardie-Boys (2010). Such a contribution is seen as critical to the effectiveness of DOC's management and recovery programmes, especially with the current New Zealand government reducing DOC's overall operating budget by $NZ 14 million per year over the next four years. Although there is no formal nationwide governance infrastructure that CCGs adhere to, some are formalising their relationship with DOC and Regional Councils with the formation of Memorandums of Understanding (MOU). Some of the more established restoration projects such as Tiritiri Matangi Open Wildlife Sanctuary (www.tiritirimatangi.org.nz) and Karori Wildlife Sanctuary are actively involved with threatened species research; contributing expertise and funding to translocations and monitoring programmes. The establishment and management of these conservation projects are succeeding by a momentum of their own. To augment the success of CCGs, it is recommended that the conservation advocacy role, research and educational benefits of these projects could be promoted by DOC and the Ministry of Education. The memoranda of understanding existing for some DOC/CCG partnerships could be used as a benchmark. Wildlife tourism

contributes $NZ 2 billion per year to the New Zealand economy with the contribution from conservation projects of CCGs becoming increasingly important. **Key results**: It will be important for the actions of CCGs to conform to the goals of any national management strategy. This is especially important when considering the recovery of species managed under a metapopulation strategy. CCGs perform an important advocacy role where the general public has access to New Zealand's rarest species, but the impetus for advocacy should not take precedence over the conservation needs of threatened species.

6.8 Conclusion

Some advances have been made in the management of New Zealand's threatened species largely due to the adoption of improved conservation tools but some very important tools are missing. The number of species being recorded far outweighs the resources available to ensure their recovery. Many of the tools developed and implemented by DOC are only effective at a limited scale, such as eradicating pests from offshore islands and creating mainland islands. New Zealand has too much of a reliance on a Noah's Ark strategy of protecting a limited number of prominent species on offshore islands. This approach results from DOC taking a pragmatic approach to what it can achieve with available resources.

In summary, this thesis concludes the management and recovery of New Zealand's threatened species is not supported by the umbrella conservation tools such as dedicated threatened species legislation and the long-term security of resourcing recovery programmes. Concerns were raised in a survey of DOC staff that the 13 conservancy infrastructure of DOC is failing to achieve satisfactory conservation outcomes owing to a lack of coordinated management and the competitive means of acquiring resources.

From a review of species recovery planning processes, it is evident that there is no formalised and legal process for the production of recovery plans and a bias towards certain taxa, especially birds. It is recommended that New Zealand reviews threatened species legislation existing in the USA, Australia and Canada with the intention to implement its own statute specifically for the recovery of threatened species and their critical habitat.

By implementing this legislation, New Zealand will be equipped with the important conservation tools that are missing. The most important will be the listing of all threatened species on a central government register that will ensure recovery plans are produced and the recovery of the species are monitored. Legally listing threatened species provides the opportunity to produce recovery plans according to a standard format and including a timeframe for their implementation. The listing process also eliminates any bias towards prominent or iconic taxa. A legal listing process will provide DOC with relevant biological data that it can incorporate into its new system of prioritising the allocation of resources. This thesis also recommends that New Zealand follows the USA example whereby recovery plans are produced for both a threatened species and its critical habitat.

Management and recovery of New Zealand's declining biodiversity is beyond the resources of DOC, a conservation agency that has experienced reduced staffing levels and no real increase in funding. There is a need for New Zealand to emulate the integrated approach being implemented in the USA, Australia and Canada where all stakeholders who derive benefit from biodiversity and natural resources are involved in decisions regarding the management of threatened species. The implementation of appropriate legislation and a nationally directed strategy will enable New Zealand to

make progress with the management and recovery of threatened species and assist New Zealand to meet its obligations under international treaties and conventions.

6.9 References

Cullen, R., Moran, E., Hughey, K.F.D. 2005. Measuring the success and cost effectiveness of New Zealand multiple-species projects to the conservation of threatened species. *Ecological Economics 53*: 311-323.

de Lange, P.J., Norton, D.A., Courtney, S.P., Heenan, P.B., Barkla, J.W., Cameron, E.K., Hitchmough, R., Townsend, A.J. 2009. Threatened and uncommon plants of New Zealand (2008 revision). *New Zealand Journal of Botany 147*: 61-96.

Hardie-Boys, N. (2010). Valuing community group contributions to conservation. Science for Conservation No. 299. Department of Conservation, Wellington, New Zealand.

Hitchmough, R. 2002. New Zealand threat classification system lists. Threatened Species Occasional Publication 23. *Department of Conservation*, Wellington.

Hitchmough, R., Bull, L., Cromarty, P. 2007. New Zealand threat classification system lists 2005. Threatened Species Occasional Publication. *Department of Conservation*, Wellington.

International Union for Conservation of Nature .2001. The International Union for Conservation of Nature, Red List of Threatened Species 2001: Categories & Criteria (version 3). International Union for Conservation of Nature, Species Survival Commission. International Union for Conservation of Nature Council.

Joseph, L.N., Maloney, R.F., O'Connor, S.M., Cromarty, P., Jansen, P., Stephens, T., Possingham, H.P. 2008. Improving methods for allocating resources among threatened species: the case for a new national approach in New Zealand. *Pacific Conservation Biology 14*: 154-158.

Joseph, L.N., Maloney, R.F., Possingham, H.P. 2009. Optimal allocation of resources among threatened species: A project prioritization protocol. *Conservation Biology 23*: 328-338.

Millenium Ecosystem Assessment .2005. Millenium Ecosystem Assessment Synthesis Report - A Report of the Millenium Ecosystem Assessment. *In:* Sarukhan, J., Whyte, A (Editors) Millenium Ecosystem Assessment. *World Resources Institute*, Washington DC.

Molloy, J., Bell, B., Clout, M., de Lange, P., Gibbs, G., Given, D., Norton, D., Smith, N., Stephens, T. 2002. Classifying species according to threat of extinction. A system for New Zealand. Threatened species occasional publication 23. *Department of Conservation*, Wellington, New Zealand.

Moran, E. 2003. An analysis of the costs of New Zealand threatened species programmes (unpublished MSc thesis). Lincoln University. *Lincoln University*, Christchurch.

Naidoo, R., Balmford, A., Costanza, R., Fisher, B., Green, R.E., Lehner, B., Malcolm, T.R., Ricketts, T.H. 2008. Global mapping of ecosystem services and conservation priorities. *Proceedings of the National Academy of Sciences 105*: 9495-9500.

New Zealand Government. 2009. New Zealand Government Cabinet Minute. CAB Min (09) 13/8 (12).

Rasch, G., Saunders, A. 1990. Proceedings of a threatened species workshop held at Turangi. *Department of Conservation*, Turangi, New Zealand.

Seabrook-Davison, M.N.H., Ji, W., Brunton, D.H. 2009a. Survey of New Zealand Department of Conservation staff involved in the management and recovery of threatened New Zealand species. *Biological Conservation* Vol. 143, pp. 212-219

Seabrook-Davison, M.N.H., Ji, W., Brunton, D.H. 2010. New Zealand lacks comprehensive threatened species legislation – comparison with legislation in Australia and the USA. *Pacific Conservation Biology* Vol. 16

Seabrook-Davison, M.N.H., Ji, W., Brunton, D.H. 2009c.. Future direction for the conservation of New Zealand's biodiversity. *Pacific Conservation Biology Vol. 15, Issue 3.*

Seabrook-Davison, M., Huynen, L., Lambert, D. M., Brunton, D.H. 2009d. Ancient DNA resolves identity and phylogeny of New Zealand's extinct and living quail (*Coturnix* sp). *PloS ONE 4(7):* e6400.

Townsend, A.J., de Lange, P.J., Duffy, C.A.J., Miskelly, C.M., Molloy, J., Norton, D.A. 2008. New Zealand threat classification system manual. Research, Development & Improvement Division. *Department of Conservation*, Wellington.

CHAPTER 7 Appendices

7.1 Public survey questionnaire

The Ecology & Conservation Unit

Institute of Natural Resources

Massey University Albany **September 2007**

Hello,

Could you please spare a few minutes of your time to answer some questions about the conservation of New Zealand's rare and endangered animals and plants. My name is Mark Seabrook-Davison and I am a researcher at Massey University. Once you have finished, please fold this page into thirds so the address faces outward and place in any mailbox. There is no stamp required.

1. Can you please tell me the name of a rare or endangered New Zealand animal or plant that you first think of?

Write in one animal or plant you first think of:
……

2. Can you think of any other New Zealand animals or plants that are rare or endangered ?

Write in as many animals or plants you can think of:	
1……	2……
3……	4……
5……	6……
7……	8……..,……..

3. I would like you now to consider how the New Zealand Government distributes its spending on public services such as health, education etc. Could you please consider where you would put conservation of native species in order of spending priority. The most important priority would be 1 and 8 would be the lowest spending priority for the Government

Please rank these from 1 to 8 where 1 is the most important spending priority and 8 is the least important spending priority **(Please write in a number in the brackets)**

( )Health……( ) Defence…….

( )Education ……..……( ) Conservation of native species……..

( )Superannuation……( ) Primary industry research and development …..…...

( )Law and order (police, courts and prisons)….( ) Tourism ……...……...

4. For the purposes of analysis, I would like to know a little about you. The information you provide me is added to a database to show trends within the total New Zealand population. No individual's information is identified. (Please circle appropriate number or write in details)

Gender: (Please circle)

Male 1

Female 2

Age group: (Please circle)

16 – 20	1	51 – 60	5
21 – 30	2	61 - 70	6
31 – 40	3	71 – 80	7
41 – 50	4	>80	8

Your principle Occupation: (please circle)

Student	1	Trade	3
Professional	2	Parent/caregiver	4

Other (please write in)……

Thank you for taking the time to answer these questions. The information you have given me will be used in the study I am doing about the conservation of New Zealand's wildlife. All information collected from this survey is put into a database where individual information is not identified. All collection of information and analysis is conducted under the conditions and provisions of the New Zealand Privacy Act 1993 and the Ethics protocol of Massey University.

"*This project has been evaluated by peer review and judged to be low risk. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher, please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone (06) 350-5249, e-mail* ***humanethicspn@massey.ac.nz***"

Could you please fold this page into thirds so the address faces outward and place in any mailbox. There is no stamp required. Thank you very much for your help. If you would like to contact me with any other information you may have on rare and endangered New Zealand species, you can contact me via email **msd@massey.ac.nz** or phone (09) 414-0800 ext 41197.

Thank you again for your help, Regards, Mark Seabrook-Davison 18 September 2007

……

Free post No: 800 INR
Mark Seabrook-Davison
Ecology & Conservation Group
Institute of Natural Resources
Massey University, Albany Campus
PB 102904
North Shore Mail Centre, AUCKLAND

Freepost
800 INR

7.2 Department of Conservation survey questionnaire

The Ecology & Conservation Unit

Institute of Natural Resources

Massey University, Albany. **May 2007**

Introduction

Thank you for participating in this survey. My name is Mark Seabrook-Davison and I am conducting some research relating to the New Zealand threatened species recovery plans published by the Department of Conservation and how these plans are used in the conservation of New Zealand's flora and fauna.

I am a PhD student with the Conservation & Ecology Group of Massey University, Albany.

I would appreciate it if you could give me some of your time to look at this questionnaire and to complete any parts that you feel are relevant to you. I am keen to get the opinion of as many people as possible who are involved with the management and conservation of threatened species.

Please let me assure you that any information you provide will be treated in the strictest confidence. All information I receive will be collated into a database where no individual's comments can be identified. All results from this survey are for my research only and the conclusions obtained from the results will be contained in my completed thesis

If you have any questions, please do not hesitate to contact the researcher, Mark Seabrook-Davison, telephone (09) 414-0800 ext 41197, email: msd@massey.ac.nz. You can also contact the Human Ethics Committee of Massey University. The approval statement and contact person is below:

"This project has been evaluated by peer review and judged to be low risk. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher, please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone (06) 350-5249, e-mail humanethicspn@massey.ac.nz"

Could all participants answer all questions except where the question directs you to a specific question. Please feel free to answer the questions in your own way as there is no right or wrong answers. I am interested in receiving your thoughts and opinions about the issues raised in this survey.

Questions:

Q1. First I would like to know about the conservancy you work within and the type of conservation work you do.

Q1.a Could you please tell me the name of the conservancy where you primarily work ?

Conservancy (main)_____

Q1.b Do you work in any of the other DOC conservancies ? Could you please name these ?

Conservancy (other)

1._____2._____

3._____4._____

Q 2. I would now like to know about the role you have within DOC. Could you please describe the job you do? For example, are you a Ranger, Scientist, Head Office staff member or other ?

Role within DOC:_____

_____

Q.3. I would like to know the level of involvement you have with the management and recovery of New Zealand's threatened species. Threatened species are those listed in the 2007 DOC publication ***"New Zealand Threat Classification System Lists"***, by Rod Hitchmough, Leigh Bull and Pam Cromarty.

3.a. Are you aware of the 2007 DOC publication ***"New Zealand Threat Classification System Lists"***, by Rod Hitchmough, Leigh Bull and Pam Cromarty ?

PLEASE CIRCLE ONE

3.a.1 Yes

3.a.2 No

3.b. Are you aware of the threat classification system developed by DOC, ***"Classifying species according to threat of extinction – a system for New Zealand"***, by Janice Molloy, Ben Bell, Mick Clout *et al.* (2002) ?

3.b.1 Yes
3.b.2 No

3.c Do you have any involvement with threatened species management or recovery ? PLEASE CIRCLE ONE

3.c.1 Yes

3.c.2 No

Management of threatened species

Q.4. Within your conservancy, how many threatened species are you aware of that are actively managed ? (Actively managed refers to threatened species that receive some form of human help, such as population monitoring, pest control, supplementary feeding, nest monitoring, weed control, translocation or transfer etc.) PLEASE LIST THEM BELOW **(If there are more than 20, please list them on the back of this page)**

Spp.1_____ Spp.2_____

Spp.3_____ Spp.4_____

Spp.5_____ Spp.6_____

Spp.7_____ Spp.8_____

Spp.9_____ Spp.10_____

Spp.11_____ Spp.12_____

Spp.13_____ Spp.14_____

Spp.15_____ Spp.16_____

Spp.17_____ Spp.18_____

Spp.19_____ Spp. 20_____

Q.4.a In your job, are you involved with the management of any of these threatened species? In what capacity are you involved? For example, is your role administration, research, day-to-day management or some other role? PLEASE DESCRIBE YOUR ROLE

Management role:

_____

Q.4.b Do any of these threatened species occur **only** in your conservancy? COULD YOU PLEASE RECORD THESE SPECIES **(If there are more than 20, please list them on the back of this page)**

Spp.1_____	Spp.2_____
Spp.3_____	Spp.4_____
Spp.5_____	Spp.6_____
Spp.7_____	Spp.8_____
Spp.9_____	Spp.10_____
Spp.11_____	Spp.12_____
Spp.13_____	Spp.14_____
Spp.15_____	Spp.16_____
Spp.17_____	Spp.18_____
Spp.19_____	Spp. 20_____

Q.4.c And which threatened species occur in the **adjoining** conservancies to the conservancy you work in ? COULD YOU PLEASE RECORD THESE SPECIES **(If there are more than 20, please list them on the back of this page)**

Spp.1_____	Spp.2_____
Spp.3_____	Spp.4_____
Spp.5_____	Spp.6_____
Spp.7_____	Spp.8_____
Spp.9_____	Spp.10_____
Spp.11_____	Spp.12_____
Spp.13_____	Spp.14_____
Spp.15_____	Spp.16_____
Spp.17_____	Spp.18_____
Spp.19_____	Spp. 20_____

Referring to the species you have identified in Q.4.c

Q.4.d Is there any coordinated management of these threatened species across conservancy boundaries. Do the staff in the different conservancies where the species occur coordinate their management effort ? PLEASE CIRCLE ONE

Q.4.d.	Yes	PLEASE GO TO QUESTION 4.d.1
Q.4.d.	No	PLEASE GO TO QUESTION 4.d.2

Q.4.d.1 **If yes**, in what form does this management take. How are the species managed when they occur in more than one conservancy?

Cross boundary management:

Q.4.d.2. **If no**, could you please suggest reasons why this does not happen? Are you aware of any reasons why cross boundary management of threatened species does dot occur?

Reasons why cross boundary management does not occur:

Could all participants please answer this question

Q. 4.e. Can you suggest ways in which coordinated management can be improved so threatened species occurring in adjacent conservancies can be adequately managed? ALL SURVEY PARTICIPANTS TO PLEASE ANSWER

Improvement in coordinated management:

Recovery groups

I would now like to ask some questions about species recovery groups.

Q.4.f. Are you a member of a Recovery Group for any threatened species?

Q.4.f. 1 Yes PLEASE GO TO QUESTION 4. g

Q.4.f. 2 No PLEASE GO TO QUESTION 5

Q.4.g. Could you please tell me what Recovery Groups you are a member of?

Spp.1_____ Spp.2_____

Spp.3 _____ Spp.4_____

Spp.5_____ Spp.6_____

Spp.7_____ Spp.8_____

Threatened species recovery plans

Q.5. Now, I would like to talk about the Threatened Species Recovery Plans produced by DOC. These are the plans published by the Research, Development & Improvement Division of DOC. The most recent plan is No.59, the Pateke (*Anas chlorotis*), Brown Teal recovery plan, 2005.

Q.5.a. Are you aware of **any** of these Threatened Species Recovery Plans produced by DOC? PLEASE CIRCLE 5.a.1**(yes)** or 5.a.2 **(no)**

Q.5.a.1 Yes PLEASE GO TO QUESTION Q.5.b

Q.5.a.2 No PLEASE GO TO QUESTION Q.6.1

Q.5.b. In your work for the Department of Conservation, do you refer to Threatened Species Recovery Plans to accomplish your work? Are they used as a tool in your job?

How Threatened Species Recovery Plans are used in job:

Q.5.c. How do you find the Threatened Species Recovery Plans as a tool to allow you to accomplish your job?

Threatened Species Recovery Plans as a tool

Q.5.d. As they apply to your job, could you please identify the strengths and weaknesses of Threatened Species Recovery Plans?

Strengths of threatened Species Recovery Plans

Weaknesses of Threatened Species Recovery Plans

Q.5.e. Are there any other comments you would like to make about Threatened Species Recovery Plans.
For example: How do you find the layout of plans and are the goals achievable within the context of your job?

Other comments about Threatened Species Recovery Plans

Q.5.f. If you had to identify **one** major improvement for Threatened Species Recovery Plans, what would this one improvement be? PLEASE LIST THE MOST IMPORTANT TO YOU. Could you please tell me your reasons for choosing this one major improvement?

Major improvement for Threatened Species Recovery Plans

Reasons for choosing this improvement

Funding for species recovery

I would like to know your thoughts on the level of funding for species recovery.

Q.6.1. Currently, Threatened Species Recovery Plans do not include detailed costings. Early plans did contain costings but were discontinued after Recovery Plan # 18; Native Frog 1996 *(Leiopelma* spp.). Could you please tell me your opinion on whether a Threatened Species Recovery Plan should include a costing or budget to achieve the recovery of the species?

Costing/ Budget:

New Zealand's threatened biodiversity

I would like you now to consider the reasons many of New Zealand's species are threatened with extinction.

Q.7.a. In your opinion and from your experience, what do you consider are the causes for some of New Zealand's native species (consider any species, plants and animals) becoming threatened?

Causes for species becoming threatened

Q .7.b.

Please refer to the causes you have given above in Q.7.a

Q .7.b. If you had to identify the main cause that some of New Zealand's biodiversity is threatened with extinction, what would that be?

Please write in only one cause.

Main cause

Q. 7.c. Could you please tell me the reasons you chose the one reason you gave in question (Q.7.b)

Reasons for choosing one cause

_____

Introduced pests and predators

Q.8 An area common to threatened species conservation around the world is the management of introduced or exotic pests and predators.

Q.8.a. In your work, do you deal with the management of introduced pests and predators?

8.a.1	Yes	PLEASE GO TO QUESTION Q.8.b
8 a.2	No	PLEASE GO TO QUESTION Q.9

Q.8.b. For your work with pest management, could you please describe what this involves?

Pest management

_____

Q.8.c. Considering the funding that you receive for pest management, how is this allocated to the various pests that you have to control or manage? ***(Please note that you do not have to give me money values. I am only interested in an estimated percentage of your budget allocated to each pest species. E.g 50% to rats, 35% to possums, 15% to stoats etc.)***

Pest management funding allocated to pest species

_____

Thank you very much for spending the time to complete this questionnaire. The final part of the questionnaire asks you to provide some information about yourself and your job.

Q.9. For the purposes of analysing all the data I receive from this project, I would like you to provide me with the following details. All the information you provide me will be collated into a database where information provided by individuals can not be identified. This survey is being conducted under the strict guidelines of the Massey University Human Ethics Committee and the New Zealand Privacy Act. No information will be provided to any other parties.

Q.9.1 How long have you been in your current role? PLEASE CIRCLE ONE. **If you have had more than one job with DOC (i.e. non-continuous), please indicate total number of years you have worked for DOC.**

Number of years within DOC
Less than 1 year…...1
1-5 years……2
6-10 years……..……3
11-15 years……4
16-20 years……5
21-25 years……6
26-30 years……7
Greater than 30 years……...…..8

Q.9.2 How many of these years have you been working with threatened species?

Number of years working with Threatened species

Q.9.3 If you have been a member of a threatened species recovery group, could you please tell me for how long?

Number of years as part of a recovery group

Again, thank you for your comments. Could you please put the questionnaire in the self-addressed Envelope and send it back to me. No stamp is required.

7.3 Survey for experts with experience with the US Endangered Species Act 1973

Survey of ESA

Mark Seabrook-Davison

Massey University Albany, New Zealand msd@massey.ac.nz

My Name is Mark Seabrook-Davison and I am looking at the effectiveness of the USA Endangered Species Act (ESA) 1973 as a legal framework for the recovery of threatened species. I am comparing the legislative structure for threatened species that exists in New Zealand with that which exists in Australia (Environment Protection and Biodiversity Act 1999) and USA (Endangered Species Act (ESA) 1973).

Thank you for agreeing to participate in this survey. The aim of the survey is to obtain opinions on the effectiveness of the ESA as legislation for the conservation of endangered and threatened species and to identify any strengths and weaknesses of the act.

I have included a list of questions below. This is not a structured questionnaire and I am happy to receive any comments you can provide. The questions are based on a literature review and other comments people have made to me. Please email me your comments.

Q.1 The ESA has been established for over 30 years. What is your opinion on its success as legislation guiding the management and recovery of US threatened and endangered species?

Q.2 I am especially interested in the positive and negative experiences people may have had with the implementation and success of US recovery plans under the ESA. Do you feel the recovery plans produced for species and critical habitat have been effective?

Q. 3 Could you please identify the strengths and weaknesses of the recovery plans produced under the ESA?

Q. 4 Has the ESA improved the recovery plan process?

Q. 5 How representative are the taxa included in recovery plans listed on the federal register?

Q. 6 In your opinion, are all imperiled US species listed on the federal register?

Q. 7 I would be interested in your thoughts on the level of funding for threatened species recovery provided from the federal government.

Q. 8 Do you feel that recovery plans for species and critical habitat should include funding guaranteed at the federal level? Currently under ESA recovery plans have no guarantee of funding.

Q. 9 How do you see the ESA functioning at both the state and federal level? Is there a national approach to the management and recovery of threatened and endangered species that all states conform?

Q. 10 I am interested in your thoughts on the effectiveness of the ESA in demanding that recovery plans are produced for both threatened/endangered species and their critical habitat.

Q. 11 Do you feel that the ESA involves all stakeholders in decisions to list species on the federal register?

Q. 12 There has been criticism that political interference can impede the effective implementation of the ESA. What are your thoughts on this?

Q. 13 What is your opinion of the ESAs role with respect to the commitment of the US to international wildlife treaties and conventions?

Q. 14 Could you identify any aspects of the ESA that a country such as New Zealand could use as a guide for the formation of its own threatened species legislation?

Q. 15 There has been criticism that listed species can languish on the US federal list of threatened and endangered species without adequate recovery actions. What is your opinion or experience with this?

7.4 Australian EPBC survey

Survey for experts with experience with the Australian Environment Protection and Biodiversity Act 1999

Survey of EPBC
Mark Seabrook-Davison
Massey University Albany, New Zealand msd@massey.ac.nz

Thank you for agreeing to participate in this survey. The aim of the survey is to obtain opinions on the effectiveness of the EPBC since it was implemented in 2000.

I have included a list of questions below. This is not a structured questionnaire and I am happy to receive any comments you can provide. The questions are based on a literature review and other comments people have made to me. Please email me your comments.

Q.1 How did you see the state of Australia's natural heritage (biodiversity, environment) before the implementation of the EPBC? For example, how degraded did it appear to you?

Q.2 What were the threats to Australia's wildlife that you were aware of before the implementation of the EPBC?

Q. 3 Since it was implemented, has the EPBC been an effective tool in managing Australia's wildlife, especially the conservation of threatened species?

Q. 4 What is your opinion of the dual role of the EPBC in managing nationally-listed threatened species and ecological communities as well as granting consent for the sustainable exploitation of natural resources? For example, Regional Forestry Agreements (RFA's)?

Q. 5 Some opponents of the RFA's consider forestry interests are exempt from the conservation aspects of the EPBC; what is your opinion on this?

Q. 6 Could you tell me your thoughts on the criticism that State (i.e. NSW, Victoria, Queensland etc.) based economic considerations can sometimes override national (Commonwealth) environmental goals?

Q. 7 Do you feel the recovery plans produced for species and ecological communities are effective?

Q. 8 Could you please identify the strengths and weaknesses of the recovery plans produced under the EPBC?

Q. 9 Has the EPBC improved the recovery plan process?

Q. 10 How representative are the taxa included in recovery plans?

Q. 11 Does the EPBC provide adequate triggers for the assessment of climate change and greenhouse gas emissions?

Q. 12 What is your opinion of the EPBC's role with respect to Australia's commitment to international wildlife/biodiversity treaties and conventions?

Q. 13 Has environmental impact assessment improved under the EPBC?

Q. 14 What is your opinion on how "usable" the EPBC is for the public? For example, does the EPBC encourage public input?

Q. 15 Does the EPBC allow for improved access to information? For example, are all stakeholders involved in the legislative process?

Q. 16 There has been criticism that listed species can languish on the federal list of threatened species without adequate recovery actions. What is your opinion or experience with this?

Q. 17 Do you feel that recovery plans for species and ecological communities should include funding guaranteed at the federal level. Currently under the EPBC and the US Endangered Species Act (ESA) 1973, recovery plans have no guarantee of funding?

7.8 Supplementary published paper on Quail phylogeny.

OPEN ACCESS Freely available online

PLoS one

Ancient DNA Resolves Identity and Phylogeny of New Zealand's Extinct and Living Quail (*Coturnix sp.*)

Mark Seabrook-Davison[1]*, Leon Huynen[2], David M. Lambert[3], Dianne H. Brunton[1]

1 Ecology and Conservation Group, Institute of Natural Sciences, Massey University, Auckland, New Zealand, **2** Institute of Natural Sciences, Massey University, Auckland, New Zealand, **3** Griffith School of Environment and School of Biomolecular and Physical Sciences, Griffith University, Nathan, Australia

Abstract

Background: The New Zealand quail, *Coturnix novaezealandiae*, was widespread throughout New Zealand until its rapid extinction in the 1870's. To date, confusion continues to exist concerning the identity of *C. novaezealandiae* and its phylogenetic relationship to *Coturnix* species in neighbouring Australia, two of which, *C. ypsilophora* and *C. pectoralis*, were introduced into New Zealand as game birds. The Australian brown quail, *C. ypsilophora*, was the only species thought to establish with current populations distributed mainly in the northern part of the North Island of New Zealand. Owing to the similarities between *C. ypsilophora*, *C. pectoralis*, and *C. novaezealandiae*, uncertainty has arisen over whether the New Zealand quail is indeed extinct, with suggestions that remnant populations of *C. novaezealandiae* may have survived on offshore islands.

Methodology/Principal Findings: Using fresh and historical samples of *Coturnix sp*. from New Zealand and Australia, DNA analysis of selected mitochondrial regions was carried out to determine phylogenetic relationships and species status. Results show that *Coturnix sp.* specimens from the New Zealand mainland and offshore island Tiritiri Matangi are not the New Zealand quail but are genetically identical to *C. ypsilophora* from Australia and can be classified as the same species. Furthermore, *cytochrome b* and *COI* barcoding analysis of the New Zealand quail and Australia's *C. pectoralis*, often confused in museum collections, show that they are indeed separate species that diverged approximately 5 million years ago (mya). Gross morphological analysis of these birds suggests a parallel loss of sustained flight with very little change in other phenotypic characters such as plumage or skeletal structure.

Conclusion/Significance: Ancient DNA has proved invaluable for the detailed analysis and identification of extinct and morphologically cryptic taxa such as that of quail and can provide insights into the timing of evolutionary changes that influence morphology.

Citation: Seabrook-Davison M, Huynen L, Lambert DM, Brunton DH (2009) Ancient DNA Resolves Identity and Phylogeny of New Zealand's Extinct and Living Quail (*Coturnix sp.*). PLoS ONE 4(7): e6400. doi:10.1371/journal.pone.0006400

Editor: Simon Joly, McGill University, Canada

Received February 3, 2009; **Accepted** June 23, 2009; **Published** July 28, 2009

Funding: This project was supported by a Massey University Vice Chancellor Doctoral Scholarship; research funding from the Supporters of Tiritiri Matangi; and a research grant from the Institute of Natural Resources, Massey University. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

* E-mail: msd@massey.ac.nz

Introduction

Quail in the *Coturnix* complex are widely distributed throughout Australasia, Asia, and various Pacific Islands [12]. All species are well established in their home ranges except for the New Zealand quail *C. novaezealandiae* [3,4] which, although common until the mid-1800s, declined rapidly to extinction by the late-19th century [5–7].

We wished to investigate the phylogenetic relationship between the two extant Australian quail species, *C. ypsilophora* and *C. pectoralis*, and the New Zealand quail *C. novaezealandiae*, as well as an extant New Zealand quail (*Coturnix sp.*) that has been resident on Tiritiri Matangi Island for over 100 years [8]. Both the Australian brown quail, *C. ypsilophora*, and stubble quail, *C. pectoralis*, are widespread throughout Australia but are particularly abundant in the continent's southern and eastern regions. Early records [3,4] from New Zealand suggest that *C. novaezealandiae* was widespread throughout the archipelago but declined rapidly in the mid-1800s as a result of large-scale habitat burning and predation by dogs, cats, and rats and was declared extinct by 1875 [2,9].

Phenotypic similarity between the three quail species has led to confusion in historical reports and museum records ([2]; Figure 1). Distinguishing *C. pectoralis* from *C. novaezealandiae* is particularly difficult by morphology alone and has led to the mislabelling of numerous museum skins (B. Gill, Auckland Museum, pers comm. 2006). Taxonomic confusion was compounded by the release of *C. ypsilophora* and *C. pectoralis* into New Zealand during the years 1866–1872 [10,11] and the subsequent reported decline of remnant populations of *C. novaezealandiae*, possibly aided by the spread of diseases from the introduced game birds [13]. The isolation and relatively untouched habitats on New Zealand's offshore islands such as Tiritiri Matangi has led to speculation that some populations of *C. novaezealandiae* may have survived to present day.

Using DNA sequences from selected mitochondrial regions we determine the identity of New Zealand quail species, and clarify its relationship with other Australasian quail as well as Asian and Pacific *Coturnix* species and other genera in the *Phasianidae* family.

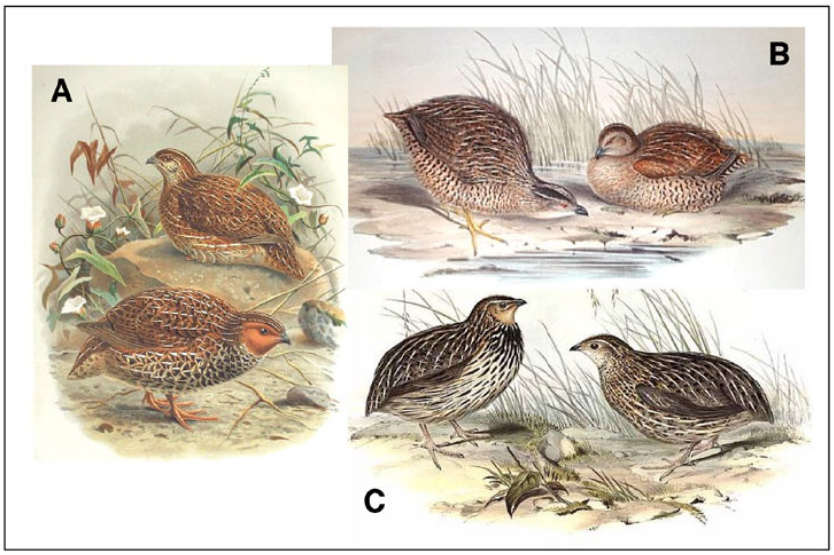

Figure 1. Illustrations of Australasian quail. Each is a breeding pair with males on the left. **A**. *C. novaezealandiae* (image from; A History of the Birds of New Zealand, Sir Walter Buller, 1888) **B**. *C. ypsilophora*. **C**. *C. pectoralis* (images from; Birds of Australia, Volume V, John Gould, 1848).
doi:10.1371/journal.pone.0006400.g001

Results

Despite detailed analysis using the mitochondrial genes *cytochrome b* (*cytb*) and *NADH dehydrogenase* 2 (*ND2*), the general phylogeny of the *Phasianidae* family is largely unresolved [14–17]. However, using either of these genes has been useful for grouping closely related quail species in their respective genus [15]. We show, using a number of samples (Figure 2), and 456 base pairs (bp) of the mitochondrial *cytb* gene, that

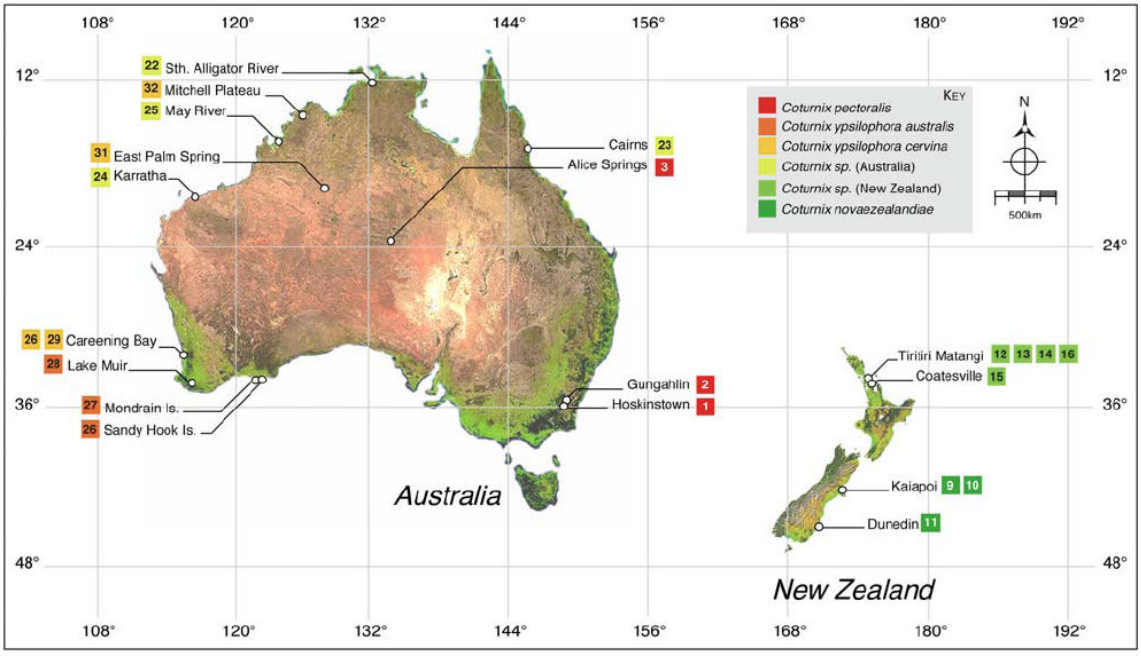

Figure 2. ***Coturnix sp.*** **samples used for which location data were available.** Nearest location to samples used are shown. Numbers correspond to those shown in Table 1. Each square represents a single sample. Colours delineate species and sub-species (see Key).
doi:10.1371/journal.pone.0006400.g002

the New Zealand quail *C. novaezealandiae*, is a likely sister species of *C. pectoralis*, endemic to Australia, with both being very closely related to the Japanese quail *C. japonica* (Figure 3A). Furthermore, little difference could be detected between *cytb* sequences from the Australian quail *C. ypsilophora*, and extant *Coturnix sp.* present in New Zealand, suggesting that these are likely to be the same species, and are a sister species to the king quail *C. chinensis*. *Cytb* sequence from the New Zealand based Californian quail was, as expected, identical to that from *Callipepla californica* (data not shown).

Using the DNA barcoding region (approximately 600 bp of the 5′ terminus of the mitochondrial *cytochrome oxidase I* gene, *COI*; [18]) we tested the species status of *C. novaezealandiae*, *C. pectoralis*, *C. ypsilophora*, and extant New Zealand quail. *COI* has, to date, successfully distinguished over 3000 avian taxa, including *C. japonica* and *C. chinensis*, by simply measuring *COI* sequence divergence within or between species (http://www.boldsystems.org/views/taxbrowser.php?taxid=51). Individuals differing by less than 2% over this DNA region have been shown to belong to the same species (http://www.boldsystems.org/views/taxbrowser.php?taxid=51). *COI* divergence between *C. pectoralis* and *C. novaezealandiae* was calculated to be 3.0%. This high value, in addition to the time these species have spent in geographic isolation suggests that they are very likely to be separate taxa. In contrast, *COI* sequences for *C. ypsilophora* and extant New Zealand quail differed by less than 0.78%, suggesting that they belong to the same taxon.

Detailed analysis of New Zealand and Australian quail populations was carried out using mitochondrial sequence from a region, HVRI, of the highly variable d-loop and show that the extant New Zealand quail population is genetically identical to that of the Australian brown quail, in particular to the subspecies *C. ypsilophora cervina*. An unrooted phylogram constructed from HVRI sequences suggests the existence of two lineages within this subspecies, each distinct from the subspecies *C. ypsilophora australis*, and shows no clear geographic structure (Figure 2 and Figure 4).

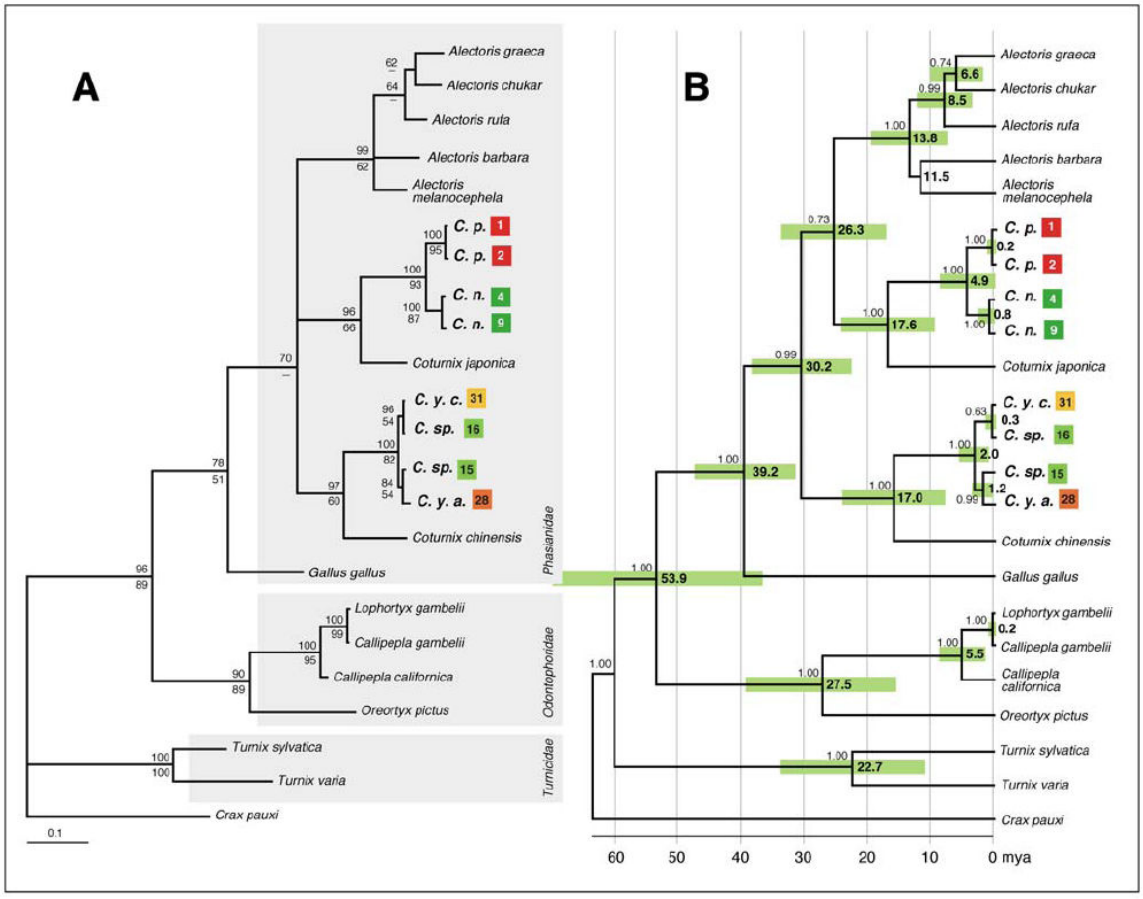

Figure 3. Phylogenetic relationships and split times between *Coturnix sp.* **A.** A distance neighbour-joining tree was constructed with 456 bp of mitochondrial *cytochrome b* sequence in PAUP* v4.0beta10 using the TrN+I+G model of nucleotide substitution where the proportion of invariable (I) sites was calculated to be 0.438 and the Gamma distribution shape parameter (G) was 0.755. Node bootstrap values were determined using both Distance (above line) and ML (below line) -based methods. Only values greater than 50% are shown. *Crax Pauxi* from the *Cracidae* family was used as outgroup. **B.** BEAST v1.4.8 maximum clade credibility tree. Divergence times are given in millions of years ago (mya; 95% HPD indicated by the green boxes). Node posterior probability values were calculated in BEAST v1.4.8 and values greater than 0.6 are shown above the branch lines. Abbreviations, colours, and numbers are as outlined in Figure 2.
doi:10.1371/journal.pone.0006400.g003

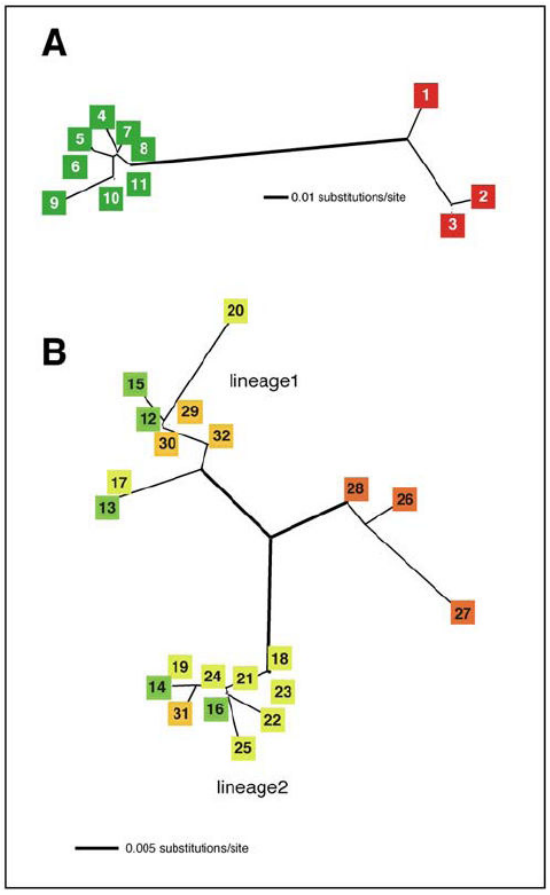

Figure 4. Network analysis of Australasian *Coturnix sp.* An unrooted distance neighbour-joining tree was constructed with 213 bp of mitochondrial HVR1 sequence in PAUP*4.0beta10 using both the HKY85+G (G = 0.150); Ti/tv = 3.0(**A**) or K81+I (I = 0.79) (**B**) model of substitution [24]. **A**. *C. novaezealandiae* and *C. pectoralis*. **B**. *C. ypsilophora* and extant New Zealand quail. Colours and numbers correspond to sample descriptions in Figure 2.
doi:10.1371/journal.pone.0006400.g004

Divergence times for New Zealand and Australian quail species were determined in BEAST v1.4.8 [19] calibrated with a *Gallus gallus/ Coturnix chinensis* split time, using *cytb* sequences, of 40.4±4.1 mya (Figure 3B) [20]. The divergence time between *C. novaezealandiae* and *C. pectoralis* was estimated to be 4.9 mya (95% highest posterior density interval (HPD); 2.2–7.9 mya). Similarly a split time for lineage 1 and lineage 2 of *C. ypsilophora cervina* was shown to be 2.0 mya (95%HPD; 0.7–3.6 mya) and the divergence time of *C. ypsilophora cervina* lineage 1 and *C. ypsilophora australis* was calculated to be 1.2 mya (95%HPD 0.2–2.3 mya).

Discussion

The results presented clarify queries concerning the phylogenetic relationship between Australian and New Zealand *Coturnix* species. Confirmation has been provided from both mitochondrial HVR1 and *cytb* sequences that the New Zealand quail *C. novaezealandiae* is closely related to the Australian stubble quail *C. pectoralis* and does not show a close relationship with the Australian brown quail *C. ypsilophora* (data for the latter not shown using HVR1 sequences). Furthermore, New Zealand's extant quail from the offshore Island Tiritiri Matangi is *C. ypsilophora* and not *C. novaezealandiae*. Questions remain whether *C. novaezealandiae* has survived on other offshore islands such as the Three Kings Islands, approximately 55 km northwest of New Zealand's most northern tip, Cape Reinga. However, close examination of Official Acclimatisation Society and museum records [10,11] suggests that this is unlikely. All quail specimens from distant offshore islands recorded by the Auckland Museum, Acclimatisation Society or New Zealand Ornithological Society are listed as *C. ypsilophora* [32]. Divergence time estimates indicate that the common ancestor of *C. pectoralis* and *C. novaezealandiae* existed approximately 5 mya and in the absence of an Australian/New Zealand land-bridge since the Late Cretaceous (~65–145 mya) [12], was likely to be capable of sustained long-range flight between the two land masses. Both *C. pectoralis* and *C. novaezealandiae* appear to have lost this trait independently in preference to clear changes in other phenotypic traits such as plumage or skeletal structure.

The Australian brown quail is distributed throughout Australia, New Guinea, and the Lesser Sunda Islands. Morphological examination of museum specimens by Marchant and Higgins (1993) [2], suggests the existence of as many as seven polytypic variants and three subspecies of *C. ypsilophora*. However, Marchant and Higgins (1993) [2] have called for a review of the taxonomy of *C. ypsilophora* but in the absence of this analysis they nominate *C. ypsilophora ypsilophora* for the Tasmanian subspecies, possibly *C. ypsilophora cervina* for north Australia, and *C. ypsilophora australis* for the rest of Australia. The unrooted phylogenetic tree of HVRI sequences presented here, shows a clear split between *C. ypsilophora australis* and *C. ypsilophora cervina* (Figure 4B), and suggests that two lineages exist for the latter subspecies. Both *C. ypsilophora cervina* lineages are present in New Zealand and these are most likely derived from the game birds that were introduced in the mid-19th century [10].

Results from a phylogenetic analysis using *cytb* sequences show a close relationship of *C. novaezealandiae* and *C. pectoralis* with the Japanese quail, *C. japonica* (Figure 3A). The Japanese quail is resident in the Japanese archipelago but has a recorded distribution throughout China and Korea. Unlike Australasian quail, it is a migratory species that breeds in Manchuria, southeast Siberia, and northern Japan with a feeding, over-wintering stage in China, Korea, and southern Japan [21,23]. Interestingly, *C. japonica* has never been found further south through the Cambodian, Malaysian Peninsula or through the Indonesian archipelago to Australia and New Guinea. Phylogenetic analysis also shows a close relationship between *C. ypsilophora* and *C. chinensis*, suggesting that they are sister species. The current distribution of these two species overlaps throughout Australia, Papua New Guinea, and Indonesia. From all *Coturnix* species in Australasia, Asia, the Pacific Islands, and India, the only insular taxon is (now extinct) *C. novaezealandiae*.

All Australasian *Coturnix sp.* are almost indistinguishable by plumage alone, with all sporting brown feathers with vertical buff streaking. Although nearly all group together genetically, the Australian brown quail *C. ypsilophora* is unusual in that it is most closely related to the highly colourful *C. chinensis*.

Molecular analysis has proven to be a valuable tool in understanding phylogenetic relationships between species. The ability to extract DNA from ancient tissue is now becoming routine, making it possible to assign species names to unknown museum specimens as well as constructing phylogenies for species complexes. The resultant information is not only useful for taxonomic purposes [22] and evolutionary analysis, but can have important implications for conservation [29,30]. Taxonomically, specimens held in museum collections can be correctly labelled. In conservation terms, phyloge-

netic lineages can be better understood when species assemblages are being considered for restoration.

Materials and Methods

Sample collection

Samples used in this work are outlined in Table 1. All samples were stored at a dedicated ancient DNA laboratory at the Institute of Natural Sciences (INS) Massey University, Auckland, New Zealand. Fresh tissue was kept at −80°C, whilst feathers, bone, and footpads were kept at room temperature.

Blood was taken from live quail immediately after they were caught. Less than 1% of the total blood volume of quail was taken from the wing brachial artery and stored in Queens lysis buffer [24] at 4°C. Feathers were collected from both fresh and preserved specimens. To ensure that adequate genetic material was obtained, the whole feather including the shaft and tissue contained in the hollow end of the shaft was removed from the bird. Feathers were collected in paper envelopes and stored in a dry humidity free facility. Footpad samples were taken from frozen specimens when required. Preserved footpad samples were obtained from museum specimens throughout New Zealand and Australia.

DNA extraction

DNA was extracted using proteinase K digestion and column purification [25,26]. Briefly, tissue samples, footpads, ~2 ul of blood, or feather bulbs were incubated in 200 ul of SET buffer (50 mM Tris-Cl pH 8.0, 5 mM EDTA, 50 mM NaCl) supple-

Table 1. Quail samples.

Sample ID	Fig ID	Tissue	Species	Location (map co-ordinates)	Collector, date, notes
NTM_T.1207	1	fp	*C. p.*	Hoskinstown, NSW, Aust.	B. Brown, 12/05/1976
NTM_T.1209	2	fp	*C. p.*	Gungahlin, ACT, Aust.	W. H. Ewers, 15/04/1963
NTM_T.2453	3	fp	*C. p.*	Alice Springs, NT (23°42'00"S 133°53'00"E), Aust.	C. H. Brown, 05/03/1955
OM_Av8209	4	bn	*C. n.*	Otago, NZ?	
OM_Av8114	5	bn	*C. n.*	Otago, NZ?	
CM_Av2349	6	fp	*C. n.*	Canterbury, NZ?	z204 0.1121.0 immature
CM_Av2350	7	fp	*C. n.*	Canterbury, NZ?	
CM_Av2351	8	fp	*C. n.*	Canterbury, NZ?	chick
CM_Av1665	9	fp	*C. n.*	Kaiapoi, Canterbury, NZ.	Buller Collection, 1859
CM_Av1666	10	fp	*C. n.*	Kaiapoi, Canterbury, NZ.	Buller Collection, 1859
CM_Av33172	11	fp	*C. n.*	Dunedin, NZ?	ex Norman Potts
TtM_A1	12	bl	*C. sp.*	Wharf rd., Tiritiri Matangi, Ak, NZ	M. Seabrook-Davison, 04/12/2006
TtM_A3	13	ft	*C. sp.*	Fishermans Bay, Tiritiri Matangi, Ak, NZ	M. Seabrook-Davison, 05/12/2006
TtM_A4	14	ft	*C. sp.*	Fishermans Bay, Tiritiri Matangi, Ak, NZ	M. Seabrook-Davison, 05/12/2006
Cv_17.10	15	ft	*C. sp.*	Coatesville, Ak, NZ	M. Seabrook-Davison, 17/10/2005
TtM_7.7	16	ft	*C. sp.*	Tiritiri Matangi, Ak, NZ	M. Seabrook-Davison,
MAGNT_T970	17	fp	*C. y.*	Northern Territory, Aust.?	
MAGNT_T1027	18	fp	*C. y.*	Northern Territory, Aust.?	
MAGNT_T1588	19	fp	*C. y.*	Northern Territory, Aust.?	
MAGNT_T2454	20	fp	*C. y.*	Northern Territory, Aust.?	
MAGNT_T4102	21	fp	*C. y.*	Northern Territory, Aust.?	
MWA_A28208	22	fp	*C. y.*	Sth Alligator River, NT (13°05'00"S 132°18'00"E), Aust.	18/10/1902
MWA_A28213	23	fp	*C. y.*	Cairns, QL (16°55'00"S 145°46'00"E), Aust.	00/11/1889
MWA_A34652	24	fp	*C. y.*	Karratha, WA (20°44'00"S 116°52'00"E), Aust.	28/08/2000
MWA_A34751	25	fp	*C. y*	May River, WA (17°17'00"S 123°59'00"E), Aust.	03/10/1996
MWA_A15336	26	fp	*C. y. a.*	Sandy Hook Island, WA (34°02'00"S 122°00'00"E), Aust.	19/11/1904
MWA_A15338	27	fp	*C. y. a.*	Mondrain Island, WA (34°08'00"S 125°15'00"E), Aust.	28/04/1906
MWA_A20107	28	fp	*C. y. a.*	Lake Muir, WA (34°29'00"S 116°40'00"E), Aust.	01/04/1986
MWA_A12637	29	fp	*C. y. c.*	Careening Bay, WA (32°13'58"S 115°40'58"E), Aust.	26/06/1973
MWA_A12638	30	fp	*C. y. c.*	Careening Bay, WA (32°13'58"S 115°40'58"E), Aust.	26/06/1973
MWA_A13879	31	fp	*C. y. c.*	East Palm Spring, WA (19°20'00"S 128°20'00"E), Aust.	24/06/1975
MWA_A15741	32	fp	*C. y. c.*	Mitchell Plateau, WA (14°48'00"S 125°50'00"E), Aust.	27/09/1978

Fig ID refers to the sample identification number used in subsequent figures. Abbreviations are: MWA – Museum of Western Australia, MAGNT – Museum & Art Gallery of the Northern Territory, OM – Otago Museum, CM – Canterbury Museum, fp – footpad, bn – bone, ft – feather, bl – blood, *sp. - species*, *C. p. - Coturnix pectoralis*, *C. n. - Coturnix novaezealandiae*, *C. sp – Coturnix species*, *C. y. – Coturnix ypsilophora*, *C. y. c. – Coturnix ypsilophora cervina*, *C. y. a. – Coturnix ypsilophora australis*. States in Australia (Aust.) are represented as; NSW – New South Wales, QL – Queensland, ACT – Australian Capital Territory, WA – Western Australia, NT – Northern Territory. New Zealand (NZ) locations are; Ak – Auckland, TtM – Tiritiri Matangi, Cv – Coatesville, ? – likely location.
doi:10.1371/journal.pone.0006400.t001

mented with dithiothreitol (DTT) to 50 mM, sodium dodecyl sulphate (SDS) to 1% (w/v) and approximately 50 ug of proteinase K.

Samples were incubated with rotation overnight at 56°C, and the DNA was extracted with an equal volume of phenol:chloroform (1:1), before being purified using a QIAQuick® DNA purification kit (Qiagen). Purified DNA was eluted in 100 ul of elution buffer and stored at –20°C. DNA was extracted from bone in the same way, except for an initial decalcification of the bone shavings (~10–50 mg) by incubation at room temperature, with rotation, overnight in ~500 ul of 0.5 M EDTA pH 8.0.

DNA amplification and sequencing

A number of quail mitochondrial genes were investigated to provide information on phylogeny (*cytochrome b*), species status (*cytochrome oxidase subunit I*), and genetic relationships within quail species (HVRI). These regions were selected because each are characterized by appropriate rates of molecular change in relation to the problem under investigation. All Amplified DNA products were obtained using the same conditions. Approximately 1 ul (~1 – 20 ng) of DNA was amplified by polymerase chain reaction (PCR) in 10 ul volumes containing 50 mM Tris-Cl pH 8.8, 20 mM $(NH_4)_2SO_4$, 2.5 mM $MgCl_2$, 1 mg/ml BSA, 200 uM of each dNTP, 40 ng of each primer, and ~0.3 U of platinum Taq (Invitrogen). The reaction mix was overlaid with mineral oil and subjected to amplification in a Hybaid OmniGene thermal cycler using the following parameters: 94°C for 2 min (×1), 94°C for 20 sec, 54°C for 20 sec, 72°C for 20 sec (×15), and then 94°C for 20 sec, 50°C for 20 sec, and 72°C for 20 sec (×35). Amplified DNAs were detected by agarose gel electrophoresis in Tris-borate-EDTA buffer (TBE), stained with 50 ng/ml ethidium bromide in TBE, and then visualized over UV light. Positive amplifications were purified by centrifugation through ~40 ul of dry Sephacryl™ S300HR and then sequenced at the Allan Wilson Centre Genome Sequencing Service using Applied Biosystems (ABI) BigDye® Terminator v3.1 chemistry and an ABI3730 Genetic Analyzer. Amplification and sequencing primers are shown in Table 2.

Ancient DNA

Both "fresh" and historical samples were treated using criteria set for the retrieval of DNA from ancient tissues. All DNA extractions were carried out in a physically separate, dedicated ancient DNA laboratory at Massey University away from the main laboratory where amplifications were performed. Sequences were obtained in both directions from separate amplifications and in most cases from multiple extractions. Sequences from several samples were verified by extraction and amplification at the Griffith University Ancient DNA Facility, Nathan, Australia.

Phylogenetic analysis

DNA sequences were edited and aligned in Sequencher™. All sequences have been deposited in GenBank with accession numbers: mitochondrial HVRI, GQ150346-GQ150377; *cytochrome b* (*cytb*), GQ150388-GQ150395; *cytochrome oxidase subunit I* (*COI*), GQ150378-GQ150387. The most likely evolutionary model for each set of sequences was determined using the Akaike Information Criterion (AIC) in ModelTest v3.7 [27]. Optimal phylogenetic trees were constructed using the distance neighbour-joining method in PAUP* v4.0beta10 [28]. Node bootstrap values for the tree constructed using *cytb* sequences were determined in PAUP* v4.0beta10 using both Maximum Likelihood (ML; 1000 "fast" stepwise-addition replicates) and Distance (1000 full heuristic replicates) algorithms. Node ages were determined for the same tree using BEAST v1.4.8 [19] and the GTR + G model of nucleotide substitution. A relaxed uncorrelated lognormal clock was stipulated and Yule process was set as tree prior. A normal prior distribution of 40.4±4.1 mya for the *Gallus gallus*/*Coturnix chinensis* split was used to calibrate the tree [20]. Three independent runs of 10 million trees each were carried out with one tree sampled every 200 generations and the first 12,500 trees discarded as "burn-in". Chain convergence was analysed for each run using Tracer v1.4 [31] and the most probable maximum clade credibility tree was found using TreeAnnotator v1.4.8. The resultant tree was visualized and edited in FigTree v1.2.2. *Cytochrome b* sequences retrieved from GenBank for tree construction were: *Coturnix japonica*, AF119094; *Coturnix chinensis*, AB073301; *Alectoris graeca*, Z48772; *Alectoris chukar*, AM850828; *Alectoris rufa*, AM850844; *Alectoris melanocephela*, Z48773; *Alectoris barabara*, Z48771; *Oreortyx pictus*, AF252860; *Gallus gallus*, AP003322; *Lophortyx gambelii*, L08382; *Callipepla gambelii*, DQ485889; *Callipepla californica*, AB120131; *Turnix sylvatica*, DQ385232; *Tumix varia*, AF168104; and *Crax pauxi*, AF068190.

Table 2. Oligonucleotide primers.

Primer name	Sequence (5′–3′)	Mitochondrial target [5′ binding site]	Tm (°C)
ctcF1n	TCGTGCATACATTTATATTCCACA	Hypervariable region I (HVRI) [76]	63
ctcR1n	TGATACGACGAGCATAACCAA	Hypervariable region I (HVRI) [333]	63
cCOIF1ii	AAGGACTACAGCCTAAC	*cytochrome C oxidase* I (*COI*) [6506]	48
cCOIR1ii	ACGAGTCAATTTCCGAAG	*cytochrome C oxidase* I (*COI*) [6798]	58
cCOIF2ii	GTAATyGTCACAGCCCATG	*cytochrome C oxidase* I (*COI*) [6716]	59
cCOIR2ii	GAAAAGATGGCTAGrTCTAC	*cytochrome C oxidase* I (*COI*) [6996]	52
cCOIF3iii	TTAGCyGGyAACCTAGCCCA	*cytochrome C oxidase* I (*COI*) [6944]	63
cCOIR3iii	AGGGTCGAAGAATGTGGTGTT	*cytochrome C oxidase* I (*COI*) [7216]	61
ccytBF1ii	GAAATGTACAGTACGGCTGACT	*cytochrome b* (*cytb*) [15018]	60
ccytBR1ii	CTGAGAATAGGTTTGTGATGAC	*cytochrome b* (*cytb*) [15260]	58
ccytBF2	CCATTCCTAATCGCAGGAA	*cytochrome b* (*cytb*) [15362]	63
ccytBR2	ATTGAACGTAGGATGGCGTA	*cytochrome b* (*cytb*) [15657]	62

All primers were ordered dry from Sigma-Genosys, resuspended in milliQ water to 2 ug/ul and stored at −20°C. Primer binding site positions (5′ terminus) were determined using the complete mitochondrial sequence of *Coturnix chinensis*, GenBank accession number: AB073301.
doi:10.1371/journal.pone.0006400.t002

Acknowledgments

The authors are grateful to Brian Gill from the Auckland Institute and Museum, Paul Scofield from Canterbury Museum, Gavin Dally from Museum & Art Gallery of the Northern Territory, Cody Fraser and Sue Michelsen-Heath from Otago Museum, Claire Stevenson from Western Australian Museum for providing preserved quail samples. Field assistance was provided by Ray and Barbara Walter, Jennifer Haslam, and Ian Price of the Department of Conservation and Tanel Cope, Marleen Baling, Shauna Baillie, Mark Delaney, Kevin Parker, Rosemary Barraclough of the Ecology Group, Massey University. Grateful thanks to Sankar Subramanian for helpful comments on the manuscript. Gratitude is extended to John Craig and Mark Hauber of Auckland University for assistance in research design.

Author Contributions

Conceived and designed the experiments: MSD DHB. Performed the experiments: MSD LJH. Analyzed the data: MSD LJH. Contributed reagents/materials/analysis tools: MSD LJH DML DHB. Wrote the paper: MSD LJH DML DHB.

References

1. UNEP/WCMC, (2009)UNEP-WCMC Species Database: distribution of Coturnix chinensis. In: Species Database (UNEP/WCMC, ed). Cambridge England: United Nations Environment Programme http://www.conservationcommons.org/ Conservation Monitoring Centre.
2. Marchant S, Higgins PJ (1993) Handbook of Australian, New Zealand and Antarctic Birds. In: Handbook of Australian, New Zealand and Antarctic Birds, 1st ed. Marchant S, Higgins PJ, eds. Melbourne, Australia: Oxford University Press, 984.
3. Buller WL (1873) History of the birds of New Zealand, 1st ed. London, England: Van Voorst.
4. Potts TH (1870) On the Birds of New Zealand. Transactions of the New Zealand Institute 2: 40–80.
5. Gill B, Martinson P (1991) New Zealand's extinct birds. Auckland, New Zealand: Random Century New Zealand Ltd.
6. Heather B, Robertson H (1996) Field Guide to the Birds of New Zealand: Penguin Books, New Zealand Ltd.
7. Adams MP, Cooper JH, Collar NJ (2003) Extinct and endangered (E&E) birds: a proposed list for collection catalogues. Bulletin BOC Supp-0228: 338–354.
8. SOTM (2006) Anecdotal information on the release of quail onto Tiritiri Matangi http://www.tiritirimatangi.org.nz/ In: Supporters of Tiritiri Matangi.
9. Holdaway RN (1999) A spatio-temporal model for the invasion of the New Zealand archipelago by the Pacific rat Rattus exulans. Journal of the Royal Society of New Zealand 29: 91–105.
10. Thompson GM (1922) The naturalisation of animals and plants in New Zealand, 1st ed. Oxford: Oxford University Press.
11. McDowall RM (1994) Gamekeepers for the Nation The story of New Zealand's acclimatisation societies, 1861–1990. Christchurch: Canterbury University.
12. Fleming CA (1962) New Zealand Biogeography, A Palaeontologist's Approach. Tuatara 10(2): 53–108.
13. Knox AG, Walters MP (1994) Extinct and endangered birds in the collections of The Natural History Museum. British Ornithologists' Club, Occasional Publications 1.
14. Fumihito A, Miyake T, Takada M, Ohno S, Kondo N (1995) The genetic link between the Chinese bamboo partridge (Bambusicola thoracica) and the chicken and junglefowls of the genus Gallus. Proc Natl Acad Sci U S A 92(24): 11053–11056.
15. Kimball RT, Braun EL, Zwartjes PW, Crowe TM, Ligon JD (1999) A molecular phylogeny of the pheasants and partridges suggests that these lineages are not monophyletic. Mol Phylogenet Evol 11(1): 38–54.
16. Nishibori M, Hayashi T, Tsudzuki M, Yamamoto Y, Yasue H (2001) Complete sequence of the Japanese quail (Coturnix japonica) mitochondrial genome and its genetic relationship with related species. Anim Genet 32(6): 380–385.
17. Nishibori M, Tsudzuki M, Hayashi T, Yamamoto Y, Yasue H (2002) Complete nucleotide sequence of the Coturnix chinensis (blue-breasted quail) mitochondrial genome and a phylogenetic analysis with related species. J Hered 93(6): 439–444.
18. Hebert PD, Stoekle MY, Zemlak TS, Francis CM (2004) Identification of birds through DNA barcodes. PloS Biol 2(10): e312.
19. Drummond AJ, Rambaut A (2007) "BEAST: Bayesian evolutionary analysis by sampling trees." BMC Evolutionary Biology 7: 214.
20. Pereira SL, Baker AJ (2006) A mitogenomic timescale for birds detects variable phylogenetic rates of molecular evolution and refutes the standard molecular clock. Mol Biol Evol 23(9): 1731–1740.
21. Birdlife-International (2008) Species factsheet: Coturnix japonica. In: Birdlife International; Factsheet on bird distribution.
22. Del Hoyo J, Elliott A, Sargatal J (1992) Handbook of the birds of the world, In: Barcelona, Spain: Lynx.
23. Cooper JH, Adams MP (2005) Extinct and endangered bird collections: Managing the risk. Zool Med Leiden 79: 123–129.
24. Seutin G, White BN, Boag PT (1991) Preservation of avian blood and tissue samples for DNA analyses. Canadian Journal of Zoology 69: 82–90.
25. Huynen L, Millar CD, Scofield RP, Lambert DM (2003) Nuclear DNA sequences detect species limits in ancient moa. Nature 425: 175–178.
26. Shepherd LD, Lambert DM (2008) Ancient DNA and conservation: lessons from the endangered kiwi of New Zealand. Mol Ecol 17(9): 2174–2184.
27. Posada D, Buckley TR (2004) Model selection and model averaging in phylogenetics: advantages of the AIC and Bayesian approaches over likelihood ratio tests. Systematic Biology 53: 793–808.
28. Swofford DL (2000) PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). Version 4. Sunderland, Massachusetts: Sinauer Associates.
29. Baling M, Brunton D (2005) Conservation genetics of the New Zealand fairy tern. In: Auckland, New Zealand: Department of Conservation (New Zealand); 32.
30. Barker GM (2002) Phylogenetic diversity: a quantitative framework for measurement of priority and achievement in biodiversity conservation. Biological Journal of Linnean Society 76: 165–194.
31. Rambaut A, Drummond AJ (2007) Tracer v1.4; available from http://beast.bio.ed.ac.uk/Tracer.
32. Robertson CJR, Hyvonen P, Fraser MJ, Pickard CR (2007) Atlas of bird distribution in New Zealand 1999–2004, 1st ed. Wellington, New Zealand: The Ornithological Society of New Zealand Inc.