IMPROVED LEGAL AND INSTITUTIONAL ARRANGEMENTS FOR PERI-URBAN INVASIVE ANIMAL MANAGEMENT IN AUSTRALIA

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ABSTRACT

Invasive species management is a key priority for Australia's biosecurity system because of the negative impacts of invasive species on primary industries, biodiversity and society. Despite financial and regulatory investments, the evidence indicates that urgent actions to control invasive animal species are needed, particularly in peri-urban areas of Australia.

Australia's biosecurity policy pursues a strategic approach for 'effective' control and management of invasive species. The strategic approach relies substantially on the potential of innovations to improve the control efficiency as part of a framework of shared responsibility with stakeholders. Despite legal requirements and policy guidelines to promote the use of innovations for invasive species management, the adoption and implementation of these innovations is impeded by multiple institutional challenges. The many overlapping urban and rural natural resource governance arrangements in peri-urban areas add to the institutional challenges for implementation.

This research examined how innovations for invasive animal management are implemented in the peri-urban context, by exploring peri-urban institutions. The complexity of institutions responsible for managing invasive species in peri-urban areas is a relatively under-examined area in legal scholarship. This thesis focussed on best practice as described in the *Australian Pest Animal Management Strategy* to consider the institutional elements that impede policy objectives.

The research employed an evidence-based policy approach to obtain a comprehensive view of peri-urban institutions relevant to invasive species management, using four inter-connected stages of evidence gathering. The conclusions are presented as hypotheses because, by their nature pure, deductive proof is not feasible given the very many variables that intersect. These hypotheses should guide invasive species policy makers in the design of more effective institutional arrangements.

In the first stage of the study, desktop research facilitated a broader understanding of institutions engaged in pest animal management.

In the second stage a scoping study helped develop preliminary hypotheses about institutional issues.

In the third stage, case studies in two Australian peri-urban jurisdictions provided data on peri-urban specific institutional issues that constrain front-line invasive animal control action, allowing the hypotheses to be refined. The institutional analysis led to the final hypotheses about peri-urban institutional impediments. The institutional analysis transcended traditional legal analysis, which tends to be focused around the legal instruments. It considered socio-political institutional elements, addressing institutional, political and risk based theories within an inter-disciplinary context. A small sample survey, conducted during the third stage of evidence gathering, further supported the hypotheses on peri-urban institutional impediments.

In the fourth stage, final results (obtained through the previous three stages of data gathering in this research) were compared with two recently conducted credible biosecurity policy reviews. The 'triangulation' of evidence further indicated the validity of hypotheses on peri-urban institutional impediments.

The research points to nine institutional impediments that constrain the implementation of innovations. The research argues that the national policy prescription of 'shared responsibility' hinges on an assumption of stakeholders' acceptance of innovations and compliance with the legal requirements. In practice, the idea of shared responsibility has not yet gained strong acceptance among participant stakeholders.

The study proposes recommendations for institutional innovations emphasising the use of multi-instrument strategies to improve implementation effectiveness. Importantly, it suggests that a deeper consideration of 'human-behavioural dimensions' is an indispensable element in addressing implementation risks. The evidence on institutional impediments in this study should stimulate further discourse to understand the gap between policy and practice for peri-urban invasive species management. The thesis encourages scholars and practitioners alike to reconceptualise their understandings of pest animal management processes with institutional impediments.

CERTIFICATION OF DISSERTATION

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis and all sources used have been acknowledged in this thesis.

Vivek V. Nemane

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Unreserved thanks to my parents and sister for their unwavering support, patience, love and encouragement.

PRESENTATIONS BY THE CANDIDATE RELEVANT TO THE THESIS:

Over the course of my candidature, I have presented aspects of my thesis at the following workshops and conferences:

- *Improved Legal and Institutional Arrangements for Peri-urban Invasive Animal Management* (Invasive Animals CRC Stakeholder Consultation Workshop, 3 June, 2015, Sydney, NSW, Australia).

- *Improved Legal and Institutional Arrangements for Peri-urban Invasive Animal Management* (UNE Post-graduate Conference 2016 - Session 2: saving the world, 19 January 2016, Armidale, NSW, Australia).

- *What impediments are you facing in peri-urban invasive species control? Institutional expectations for invasive animal management in peri-urban Australia* (Conference session on Institutions and program management, 17th Australian Vertebrate Pest Conference "Innovative Solutions and Future Directions", 1-4 May 2017, Canberra, Australia).

- *Why is implementation of natural resources law complex in peri-urban areas?* (Conference session on Stories of and within Livable Cities and Places, IUCN Academy of Environmental Law 15th Annual Colloquium, 31 May to 3 June 2017, Cebu, Philippines).

- *Implementation of the Convention of Biological Diversity principles for invasive species management in peri-urban Australia* (Workshop on governing mega-diversity in Brazil and Australia, 11 November 2017, Coffs Harbour, NSW, Australia.

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ACRONYMS AND ABBREVIATIONS

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AgLaw Centre	Centre for Agriculture and Law
Agvet	agricultural chemicals and veterinary medicines
ALOP	Australia's Appropriate Level of Protection
APAS	*Australian Pest Animal Strategy*
APVMA	Australian Pesticides and Veterinary Medicines Authority
AusBIOSEC	Australian Biosecurity System for Primary Production and the Environment
BPM	Best Practice Management
BRS	Bureau of Rural Sciences
CBD	*United Nations Convention on Biological Diversity*
CISS	Centre for Invasive Species Solutions
COAG	Council of Australian Governments
CoPs	Codes of Practice
CPE	Canid Pest Ejector
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture Forestry and Fisheries
DAWR	Department of Water and Resources
DEH	Department of Environment and Heritage
DEPI	Victorian Department of Environment and Primary Industries
DEWHA	Department of the Environment, Water, Heritage and the Arts
DPI	Department of Primary Industries
EADRA	Emergency Animal Disease Response Agreement
EDOC	Environmental Duty of Care
EPPRD	Emergency Plant Pest Response Deed
ESPL	Emergency Services Property Levy
FAAST	Feral Animal Aerial Shooting Team
FAO	Food and Agriculture Organization of the United Nations
FAWNA	For Australian Wildlife Needing Aid
GBD	General Biosecurity Duty
GBO	General Biosecurity Obligation
GPS	Global Positioning Systems
IACRC	Invasive Animals Cooperative Research Centre
IGAB	Intergovernmental Agreement on Biosecurity
IUCN	International Union for Conservation of Nature
LLS	Local Land Services
MoU	Memorandum of Understanding
NBC	National Biosecurity Council
NCC	Nature Conservation Council

NRC	Natural Resources Commission
NEBRA	National Environmental Biosecurity Response Agreement
NGO	Non Government Organisations
NLIS	National Livestock Identification System
NPA	National Park Association
NPWS	National Parks and Wildlife Service
NRM	Natural Resource Management
NSW	New South Wales
OEH	Office of Environment and Heritage
PAPP	Para-aminopropiophenone
PUB	peri-urban Brisbane
PUS	peri-urban Sydney
QDOG	Queensland Dog Offensive Group
QLD	Queensland
QPWS	Queensland Parks and Wildlife Service
RD&E	Research Development and Extension
RNP	Royal National Park
RSPCA	The Royal Society for the Prevention of Cruelty to Animals
SEQ	South East Queensland
SOE	*State of the Environment*
SoPs	Standard Operating Procedures
SPC	Supplementary Pest Control
SSAA	Sporting Shooters Association of Australia
STS	Science, Technology and Society
UN	United Nations
UNEP	United Nations Environment Program
WDBF	Wild Dog Barrier Fence
WHO	World Health Organization
WTO	World Trade Organization

CHAPTER 1: INTRODUCTION

1.1 Overview

Notwithstanding continuous efforts by governments and communities – as well as significant inputs of resources – invasive animal control and management remains a key biosecurity challenge for Australia. According to the 'Australian State of the Environment Report':

> Invasive species, particularly feral animals, are unequivocally increasing the pressure they exert on Australia's biodiversity, and habitat fragmentation and degradation continue in many areas … Urban and peri-urban areas continue to directly encroach into surrounding natural ecosystems and may also cause indirect impacts by acting as a source of invasive species.[1]

The 'State of the Environment Report' ('*SOE*') is the main national thematic assessment of the outcomes of efforts taken by the Australian government and communities for the protection of environment. The report aims to provide best available evidence to determine the course of future action for environmental protection in Australia. The past four '*SOE* Reports' consistently note that the problem of invasive species in Australia is growing worse.[2] The 2016 report specifically highlight urban and peri-urban areas as a major source of invasive species problem and the need of managing invasive species issues in the peri-urban context.[3]

An independent report based on multi-year stakeholder research on the requirements for effective community engagement identified many institutional challenges that

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[1] I D Cresswell and H T Murphy, 'Australia state of the environment 2016: Biodiversity' (Independent report to the Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy, Canberra, 2017) v, vii.

[2] Australian State of the Environment Council, 'Australia State of the Environment: Executive Summary' (Independent Report to the Commonwealth Minister for the Environment, CSIRO Publishing on behalf of the Department of the Environment Sport and Territories, 1996); Australian State of the Environment Committee, 'Australia State of the Environment 2001' (Independent Report to the Commonwealth Minister for the Environment and Heritage, CSIRO Publishing on behalf of the Department of the Environment and Heritage, Canberra, 2001); R J S (Bob) Beeton et al, 'Australia State of the Environment 2006' (Independent report by 2006 Australian State of the Environment Committee, to the Australian Government Minister for the Environment and Heritage, Department of the Environment and Heritage, Canberra); State of the Environment 2011 Committee, *Australia State of the Environment 2011 - In Brief* (DSEWPaC, 2011).

[3] Cresswell and Murphy, above n 1, 25.

must be addressed for invasive species management.[4] The report lists the difficulties in improving the effectiveness of invasive animal management, including inadequate resources, lack of stakeholder accountability, lack of coordinated action and lack of community engagement. Due to fragmentation, these institutional difficulties assume a complex dimension and pose particular challenges for invasive species management in peri-urban areas.

An independent review of the capacity of Australia's biosecurity system stated: Governments are committed to addressing these (biosecurity including invasive species management) issues, but the efforts of biosecurity agencies are hampered by eroding biosecurity budgets, declining and uneven capability and expertise across the jurisdictions, leadership churn (ministerial and executive), patchy coverage by formal institutions and a lack of codified practices.[5]

The above-named reports indicate that effective invasive animal control is not just a matter of *strategic management* but also a question for *institutional arrangements*. (Strategic management in this thesis means the combination of control techniques, methods, strategies, plans, actions (and omissions) of stakeholders that influence invasive animal control outcomes.[6] Institutional arrangements are how formal and informal institutions, including a range of law and policy instruments, either facilitate or constrain the actions of stakeholders for on-ground implementation of controls.)[7] Drawing on these reports, it can be argued that, while strategic management of invasive animals has been well described, in-depth work is needed to understand the institutional issues that constrain effective invasive animal management. Strategic management emphasises continuous improvements in invasive animal management with innovations in control methods and managerial tools. This requires technological and managerial innovations along with institutional support to facilitate implementation.

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[4] P Martin et al, *Effective Citizen Action on Invasive Species: The Institutional Challenge (IACRC: Canberra*, 2016).

[5] W Craik, D Palmer and R Sheldrake, *Priorities for Australia's Biosecurity System*: *An Independent Review of the Capacity of the National Biosecurity System and its Underpinning Intergovernmental Agreement* (Canberra. IGAB 2017), 1.

[6] Mike Braysher, *Managing Australia's Pest Animals: A Guide to Strategic Planning and Effective Management* (CSIRO Publishing. 2017), 37-49.

[7] Paul Martin and Miriam Verbeek, *Sustainability Strategy* (Federation Press, 2006); Martin et al, above n 4.

Taking into account the constantly emerging problem of invasive animals in peri-urban areas and the importance of institutions for effective invasive animal management, this research seeks to identify institutional impediments in implementing control actions for effective invasive animal management in peri-urban Australia. The rationale behind identifying institutional impediments is to ascertain ways to improve institutions to facilitate on-ground implementation of control for effective invasive animal management.

This thesis is concerned with the intersecting challenges of:

1. Managing mobile, highly adaptive, fertile and harmful invasive animal species.
2. Public, and to a lesser degree, private rules and implementation arrangements.
3. The adoption and implementation of technological and managerial innovations.
4. The particular governance challenges of the frontiers of urban expansion (peri-urban areas).

Specifically, the question this thesis seeks to answer is:

What legal and institutional impediments need to be overcome to achieve effective invasive animal management in peri-urban Australia?

Related sub-questions address these issues in an implicit hierarchy:

1. What innovations are currently being implemented or have potential applicability for effective invasive animal management?
2. What are the possible institutional reasons that inhibit the adoption of innovations for effective invasive animal management in peri-urban areas of Australia?
3. What possible strategies, responses, actions can improve the uptake of innovations for effective invasive animal management?

In summary, invasive animals have negative impacts which needs an effective management regime. The current regime emphasises innovations in control techniques and their on-ground implementation. Despite the progress in innovations, the management regime is not effective because of impediments to the adoption of innovations, particularly at the institutional level. This research seeks to investigate these institutional impediments by using a mixed methods approach, drawing on

different types of evidence and responses to the research question. Figure 1 provides a schematic overview of the research problem.
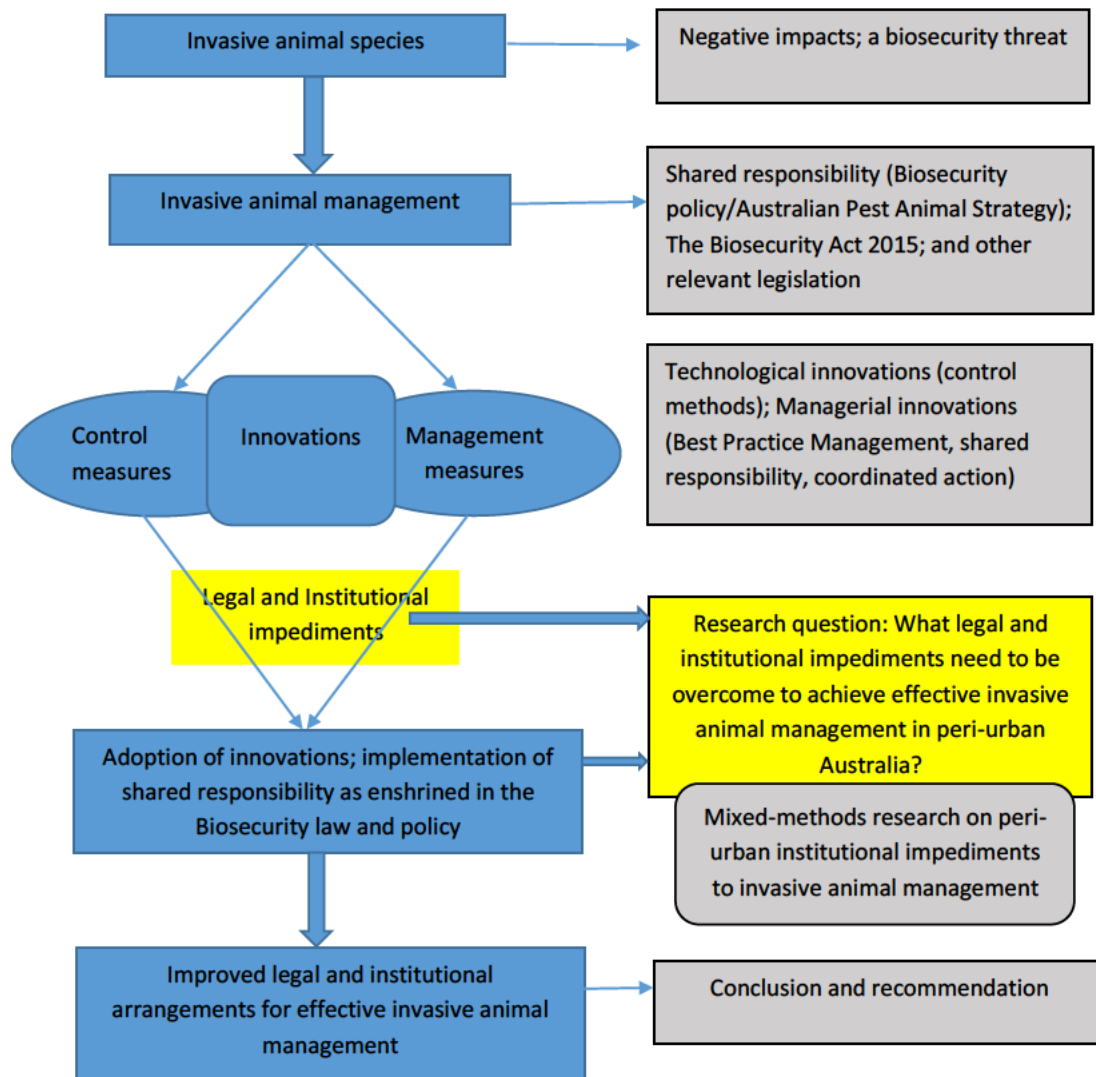
Figure 1.1: Schematic representation of the research problem

1.2 Institutional setting of the research

Recognising the need to address invasive animal challenges, the Australian Government under the Cooperative Research Centres (CRC) program provided funding to the Invasive Animals Cooperative Research Centre (IACRC) from 2005 to

2017.[8] The purpose of the IACRC was to address the threat of invasive animals by developing innovative technologies and strategies and by integrating control approaches across agencies and jurisdictions in Australia.[9] For this purpose, the IACRC collaborated with industries, research centres, commercial businesses and extension organisations to develop invasive animal control products, knowledge, strategies and services. It supported a range of programs and projects to further this purpose.[10]

One of these projects was 'legal and institutional impediments to community action',[11] which aimed to ensure availability and use of control innovations for effective community action including by addressing the institutional dimensions of invasive animal management. The key objective of this PhD was to address invasive animal management issues in the institutional context of peri-urban areas. To this end, the IACRC provided funding to explore ways to improve invasive animal management in peri-urban Australia. The Australian Centre for Agriculture and Law at the University of New England, Australia, (AgLaw Centre) was a partner institute in this project.[12] The AgLaw Centre provides academic scholarship on legal and institutional innovations, to address contemporary natural resource management challenges.

Within this institutional setting, the researcher pursued the research in the following stages:

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[8] Invasive Animals CRC, *About Us,* <http://www.invasiveanimals.com/about-us/>.

[9] Invasive Animals CRC, *IA CRC Corporate* <http://www.invasiveanimals.com/about-us/corporate/>.

[10] Invasive Animals CRC, Research Programs 2005-2012, <http://www.invasiveanimals.com/research/phase1; Invasive Animals CRC, Research Programs 2012-2017, http://www.invasiveanimals.com/research/phase2/>.

[11] Invasive Animals CRC*, Project – Reduction of Legal and Institutional Impediments* <http://www.invasiveanimals.com/research/phase2/community-engagement/reduction-of-legal-and-institutional-impediments>/; also see, Invasive Animals CRC, *Community Engagement 2012-2017* <http://www.invasiveanimals.com/research/phase2/community-engagement/>.

[12] The Australian Centre for Agriculture and Law, *About Us,* <https://www.une.edu.au/research/research-centres-institutes/the-australian-centre-for-agriculture-and-law/about-us>.

Stage 1: Between June 2015 and November 2015, the researcher participated as an observer in four workshops.[13] During these workshops, conversations occurred between:

- Invasive Animals CRC stakeholders. The stakeholders included a diverse group of invasive animal management experts and front-line workers on invasive species issue from government organisations, non-government organisations, industry and academia.
- Professor Paul Martin (Principal Supervisor of this thesis and Director of the AgLaw Centre).
- Professor Darryl Low Choy (Secondary Supervisor of this thesis based at Griffith University).

Observations in these workshops enabled the researcher to understand institutional issues in pest animal management. These issues are discussed in Chapter 4 of this thesis.

Stage 2: Between November 2015 and November 2016, the researcher conducted conversations, interviews and survey responses within the context of detailed peri-urban case studies on feral deer and wild dog management. The sources and processes followed during stage 2 of the research are described in the chapter on methodology (Chapter 3).

The objective of the IACRC through this research was to understand peri-urban institutional issues that would facilitate inputs for reform in pest animal management. The researcher chose specific approaches throughout this research to obtain the best insights that would help fulfil the expectations of IACRC's objectives.

After an outline of key terms used in this thesis, the balance of this describes the background and context of the research, advancing arguments for the need to understand institutional impediments to implement invasive animal control in peri-urban Australia. The chapter also provides an overview of the methodology of this research (discussed in more detail in Chapter 3) and the structure of the thesis.

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[13] The details regarding workshop observations and its process is described in chapter 4.

1.3 Key terms

Invasive species

Invasive species are also referred to as alien species or invasive alien species.[14] Invasive species come in many types primarily through four taxonomic groups: vertebrate animals, invertebrate animals, aquatic and terrestrial plants, and micro-organisms. A particular species is termed as invasive when, through the process of invasion, the species establishes and expands causing impacts on other native species, ecosystems, people and development.[15] This research deals with terrestrial invasive vertebrate animal species which are 'established' in Australia.[16] Multiple terms including pest animal, feral animal, exotic, introduced and non-indigenous animal are used in Australia to describe invasive animals.[17] Out of these, terms invasive animal and pest animal have been interchangeably used throughout this thesis.

Native species

Native species are plants, animals and other organisms which occur endemically in a specified area without any human intervention.[18] Native species in this research is as

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[14] Convention on Biological Diversity, Decision VI/23 of the Conference of Parties to the CBD <https://www.cbd.int/decision/cop/?id=7197>; For further explanation on invasive species, see Clare Shine, William Nattley and Gundling Lothar, *A Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species, Environmental Policy and Law Paper* (IUCN and The World Conservation Union, 2000).

[15] Cheryl Lyn Dybas (2004) Invasive Species: The Search for Solutions, (2004) 54 (7) *BioScience*, 617 <https://doi.org/10.1641/0006-3568(2004)054[0615:ISTSFS]2.0.CO;2>; Peter Fleming et al, (2017). Invasive Species and their Impacts on Agri-Ecosystems: Issues and Solutions for Restoring Ecosystem Processes. (2017) 39 *The Rangeland Journal*, doi 39.10.1071/RJ17046; Peter West, *Guide to Introduced Pest Animals of Australia* (CSIRO Publishing, 2018).

[16] Categorisation Working Groups of the Australian Weeds Committee and the Vertebrate Pests Committee, *National Categorization System for Invasive Species* (2011) <https://www.lgnsw.org.au/about-us/nsw-council-links>.

[17] Braysher 2017, above n 6, 1-3; Australian Government, Department of the Environment and Energy, *Feral Animals in Australia* <http://www.environment.gov.au/biodiversity/invasive-species/feral-animals-australia>.

[18] European Union, *Convention on the Conservation of European Wildlife and Natural Habitats* ('Bern Convention') (19.IX.1979, The Council of Europe, Bern, Germany); *IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species* (Prepared by the SSC Invasive Species Specialist Group, Approved by the 51st Meeting of the IUCN Council, Gland, Switzerland, 2000); For scientific discussion on the difference between a native species and an invasive species see, A J R Carthey and P B Banks, When Does an Alien Become a Native species? A Vulnerable Native Mammal Recognizes and Responds to its Long-Term Alien Predator (2012) 7 (2) *PLoS ONE* <https://doi.org/10.1371/journal.pone.0031804>.

defined under the *Environment Protection and Biodiversity Conservation Act of 1999* ('*EPBC Act*').[19]

Peri-urban

Peri-urban studies in Australia mainly come from disciplines of planning, geography and sociology. The term peri-urban has multiple meanings,[20] with no consensus on definition. However, the literature acknowledges the peri-urban area as a complex form of 'human habitation'.[21] Based on spatial attributes, the peri-urban landscape is the area which is not demarcated with clear boundaries between urban and rural regions. It is considered as a continuum between urban and rural areas. Spatially, peri-urban regions are defined as: 'the areas on the urban periphery into which cities expanded or which cities influence'[22] or 'a region between the outer suburbs and the countryside'.[23] In addition to spatial conception, the literature recognises a peri-urban area in a systems context as 'an intersection of urban and rural communities with diverse social, political and economic interests and activities and mixed landscape characteristics'.[24]

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[19] *Environment Protection and Biodiversity Conservation Act* 1999, (Cth) ('*EPBC Act*'), Section 528 (Definition of native species) "native species" means a species: (a) that is indigenous to Australia or an external Territory; or (b) that is indigenous to the seabed of the coastal sea of Australia or an external Territory; or (c) that is indigenous to the continental shelf; or (d) that is indigenous to the exclusive economic zone; or (e) members of which periodically or occasionally visit: (1) Australia or an external Territory; or (ii) the exclusive economic zone; or (f) that was present in Australia or an external Territory before 1400.

[20] M Buxton et al, *Change and Continuity in Peri-Urban Australia, State of the Peri-Urban Regions: A Review of the Literature* (RMIT University, 2006); Heather Aslin et al, *Peri-Urban Landholders and Bio-Security Issues: A Scoping Study* (Australian Government, Bureau of Rural Sciences, 2004).

[21] David Iaquinta and A W Drescher, 'Defining the Peri-Urban: Rural-Urban Linkages and Institutional Connections. Land Reform' (2000) *Land Settlement and Cooperatives* 8; Anne-Marie Willis, From peri-urban to unknown territory, (2015) 5 (2) *Design Philosophy Papers* 79, doi: 10.2752/144871307X13966292017432.

[22] D Low Choy et al, *Change and Continuity In Peri-Urban Australia: Peri-Urban Case Study, South East Queensland* (Griffith University, Nathan, 2007).

[23] S Coleman, 'Australia State of the Environment 2016: Built Environment' (Independent report to the Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy, Canberra, 2017), 126.

[24] Paul Martin Paul, Elodie Le Gal And Darryl Low Choy, 'Reconsidering the Effects Of Complexity and Fragmentation on Resource Governance' in Basant Maheshwari, Vijay P Singh and Bhadranie Thoradeniya (Eds), *Balanced Urban Development: Options And Strategies for Liveable Cities* (Springer, 2016), 470.

Biosecurity

'Biosecurity is the management of risks to the economy, the environment and the community of pests and diseases entering, emerging, establishing or spreading.'[25]

Australia's biosecurity system creates an overarching framework to protect national trade, socio-economic and environmental assets. The biosecurity framework, through an 'integrated biosecurity continuum' focusses on pre-border, border and post-border activities to protect human health, social amenity and biodiversity. Australia's Appropriate Level of Protection (ALOP)[26] aims for a high-level of biosecurity. It aims to provide a high level of sanitary and phytosanitary protection, reducing risk to a very low level, but not zero.[27] Australia's biosecurity system comprises of several components of threats to production systems, ecological-environmental systems and people. Biosecurity includes the prevention of pest animals and diseases from establishing and spreading in Australia.

Figure 1.2: Goal and objectives of Australia's biosecurity system
(Source: Craik et al, 2017)

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[25] Council of Australian Governments – Intergovernmental Agreement on Biosecurity (IGAB) 2012, Preamble <https://www.coag.gov.au/content/intergovernmental-agreement-biosecurity>.

[26] 'ALOP: The level of protection that is considered appropriate to protect human, animal or plant life or health within the Australian territory' – The Parliament of the Commonwealth of Australia, House of Representatives, *Biosecurity Bill 2014 – Explanatory* Memorandum (2013-14).

[27] *Biosecurity Act 2015* (Cth) s 5.

Invasive animal management

Invasive animal management is the process or practice of managing invasive animals through individual or coordinated efforts of stakeholders to accomplish specific operational goals (e.g. reducing the pest animal population to defined levels) and objectives (reduced impact and recovery of impacted values).[28] For the purposes of this research, unless otherwise indicated, the word management includes control. The word 'control' is specifically used to indicate the application of control to reduce the population of an invasive species. It is a sub-function within management, which involves on-ground action, continuous verification with the pre-determined objectives, and the assessment of progress as well as future needs.[29]

Institution

Institution is a social structure that shapes how people relate to each other[30] and, in particular, how information and resources flow between them.[31] Institutions are comprised of formal (eg, laws) and informal rules (eg, industry standards, contractual commitments) as well as organisations and their arrangements (eg, administration, enforcement).

Organizations are 'purposive entities designed by their creators to maximize wealth, income, or other objectives defined by the opportunities afforded by the institutional structure of the society'.[32] Institutions determine the existence and evolution of organisations. Once established, these organisations express certain norms and behaviours as they are valued and accepted. Institutions encompass shared beliefs[33] typically dominated by informal rather than formal rules and are shaped by the logics of power and economic efficiency.[34]

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[28] Natural Resource Management Ministerial Council, *Australian Pest Animal Strategy* (Canberra, Australia, 2007) 1; The Categorisation Working Groups (2011), above n 16, 11.

[29] Braysher (2017), above n 6, 37-49.

[30] Douglass North, *Institutions, Institutional change and economic performance* (Cambridge University Press, 1990).

[31] Martin and Verbeek (2006), above n 7.

[32] North, above n 30, 73.

[33] Bernard Chavance, *Institutional Economics* (Routledge, 2013).

[34] North (1990)), above n 30.

Institutions shape the process of individual and/or coordinated implementation for effective pest animal management.[35]

Institutional arrangement

An 'institutional arrangement is a set of institutions that work together, or processes involving a number of institutions'. These arrangements form the structural aspects of governance which manage various interactions within and across institutions and also determine the output and efficiency of management efforts.[36]

Innovation

Innovation has multiple meanings, depending on its application. Godin characterises innovation as 'any kind of novelty' in technological, socio-political and organizational context.[37] Innovation involves 'technological and social change'.[38] Innovation is 'a new program or process as well as any new instrument, tool or approach for the individuals adopting it'.[39]

For the purposes of this research, the term 'innovation' includes any new or significantly improved technological product or process, or a new managerial or institutional method or practice for the individuals adopting and/or implementing it for invasive animal management.

Stakeholder

A stakeholder is any person or group of persons significantly affected by or significantly affecting decisions or actions about invasive animal control and management.

The term 'stakeholder' throughout this thesis includes four major categories: a) Government (eg, government agencies, government managers); b) Industry (eg, Industry groups, companies); c) Community (eg, non-government agencies, community groups); and d) Individual (eg, landholder, private land manager, public

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[35] Martin et al (2016), above n 4.
[36] Martin and Verbeek (2006), above n 7, 71.
[37] Benoit Godin, 'Innovation: The History of a Category' (Project on the Intellectual History of Innovation, Working Paper No. 1, 2008).
[38] Martin and Verbeek (2006), above n 7.
[39] Toddi A Steelman, 'Implementing Innovation: f=Fostering Enduring Change in Environmental and Natural Resource Governance (Georgetown University Press, Washington DC, 2010).

land manager, citizen). These major categories cover multiple sub-divisions and stakeholders with different roles. Primary stakeholders include people and organisations who are involved in pest animal management on the land (public or private) owned, occupied or managed by them. Secondary stakeholders include those who are indirectly involved in pest animal management as part of their role in decision-making process (eg, politicians, industry groups, animal welfare groups).[40] Stakeholders in peri-urban areas include individuals who are not formally attached to any group and may be totally unaware of their role in invasive animal control. For example, new peri-urban residents often do not have adequate knowledge and awareness of invasive species management issues.[41]

1.4 Context

Research on invasive species necessarily requires an understanding of how such species come to be termed 'invasive' and why the problem of invasion is significant. This section begins with an explanation of how species were introduced and spread in Australia before describing the contexts in which invasive animal control operates in Australia. Such contexts include the nature of invasive species themselves and the institutional arrangements that exist to control them. The discussion on context also describes the specific peri-urban context, which is the context of primary interest in this thesis.

1.4.1 Introduction and distribution of invasive species

Invasive species are introduced to an ecosystem generally through natural movement of species or through introduction (intentional or unintentional) by humans. Historically, human actions have introduced species outside their native range for various purposes, including for food and agriculture production, forestry, fisheries, hunting and recreation. Globally, the speed and the extent of dispersion of invasive species has increased due to growth in the human population, altered environment, and impacts of globalisation.[42] Natural variations in biological diversity generally

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[40] *National Wild Dog Action Plan* 2014, Appendix C <https://www.pestsmart.org.au/wp-content/uploads/2014/09/NWDAP_FINAL_MAY14.pdf>.

[41] D Low Choy et al (2007), above n 22.

[42] D Pimentel et al, 'Environmental and Economic Costs Associated with Non-Indigenous Species in the US' (2000) 50 (1) *Bioscience* 53; D Pimentel et al, 'Economic and Environmental Threats of Alien Plant, Animal and Microbe Invasions' (2001) 84 *Agriculture, Ecosystems and Environment* 1.

occur due to speciation, immigration, emigration and extinction[43] but human actions, both deliberate and accidental, are the leading cause behind the accelerated increase in the population of invasive species and a range of negative impacts in previously undisturbed environments.[44] Environmental degradation creates favourable conditions for some introduced species to establish and spread. It has been predicted that climate change will modify the whole process of invasion creating vulnerable ecosystems and drastic alternations in global species distribution.[45] An estimated 480,000 species have been identified as invasive around the world.[46] Almost no ecosystem on Earth is free of the impact of an invasive species.

In Australia, invasive animal species have primarily been introduced by humans to co-produce ecosystem services and promote a good quality of life for people. About 60 different species were released in Australia between 1840 and 1880 and many introduced species thrived in native Australian environments.[47] Over time, initial small populations of exotic animals have become established as invasive animals. It is estimated that 73 species of introduced vertebrate species have established within Australia of which approximately 25 are vertebrate mammals. Other vertebrates include 20 birds, four reptiles, one amphibian and 23 freshwater fish.[48] Data indicates that 10 nationally significant pest animals have spread across Australia: feral pigs, feral goats, rabbits, foxes, common carp, cane toads, common starlings, feral cats, wild dogs and dingoes, feral deer species.[49] Figure 1.4 shows distribution of these

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[43] C Bellard, P Cassey and T M Blackburn, 'Alien Species as a Driver of Recent Extinctions' (2016) 12 *Biology Letters* <http://dx.doi.org/10.1098/rsbl.2015.0623>.

[44] G Ceballos et al, 'Accelerated Modern Human-Induced Species Losses: Entering the Sixth Mass Extinction' (2015) 1 *Science Advances*, doi:10.1126/sciadv.140025.

[45] L Capdevila-Argüelles and B A Zilletti, *Perspective on Climate Change and Invasive Alien Species. Convention on The Conservation of European Wildlife and Natural habitat.* (T-Pvs/Inf (2008) 5 rev. Strasbourg, 16 June 2008).

[46] Pimentel et al (2001), above n 42.

[47] P Olsen, *Australia's Pest Animals: New Solutions to Old Problems* (Bureau of Resource Sciences and Kangaroo Press, 1998) 14.

[48] Invasive Plants and Animals Committee, *Australian Pest Animal Strategy 2017 to 2027* (Australian Government Department of Agriculture and Water Resources, Canberra, 2016) 7.

[49] National Land and Water Resources Audit and Invasive Animals Cooperative Research Centre, *Significant Invasive Species (Vertebrate Pests) —Status of Information for Reporting Against Indicators Under the National Natural Resource Management Monitoring and Evaluation Framework* (NLWRA, Canberra; Feral animals in Australia, 2008). <http://www.environment.gov.au/biodiversity/invasive-species/feral-animals-australia>.

species throughout Australia (Figure 1.4: Distribution of 10 nationally significant invasive animals in Australia).[50]
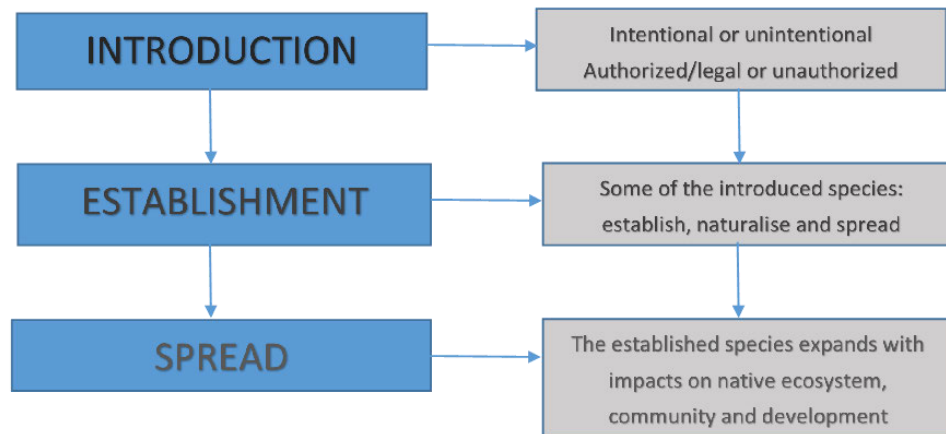
Figure 1.3: The process of invasion

The following list is helpful in describing the various modes of harmful invasion by vertebrates established in Australia:[51]

- An animal is introduced or transported by humans to a new native ecosystem. The animal (native or non-native) then successfully establishes itself and may overcome an otherwise intact, pre-existing native ecosystem.

- An animal (native or non-native) has a negative impact on or causes damage to a valued resource, such as the natural environment, agriculture, industry, people or communities.

- A non-native animal that has escaped from captivity establishes a self-sustaining population independent of humans.

- An animal lives outside of its natural range or distribution. It may be an animal that has been introduced to Australia from another country or it may be an animal that has been moved within Australia to a location where it does not normally occur.

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[50] Peter West, *Assessing Invasive Animals in Australia* (National Land & Water Resources Audit and Invasive Animals Cooperative Research Centre, Canberra, 2008).

[51] M Bomford, A Newsome and P O'Brien, 'Solutions to Feral Animal Problems: Ecological and Economic Principles' in R A Bradstock, et al (Eds) *Conserving Biodiversity: Threats and Solutions* (Surrey Beatty, Chipping Norton, 1995, 202).

- An animal conflicts with human interests or causes more damage than benefits to valued resources or social wellbeing.[52]
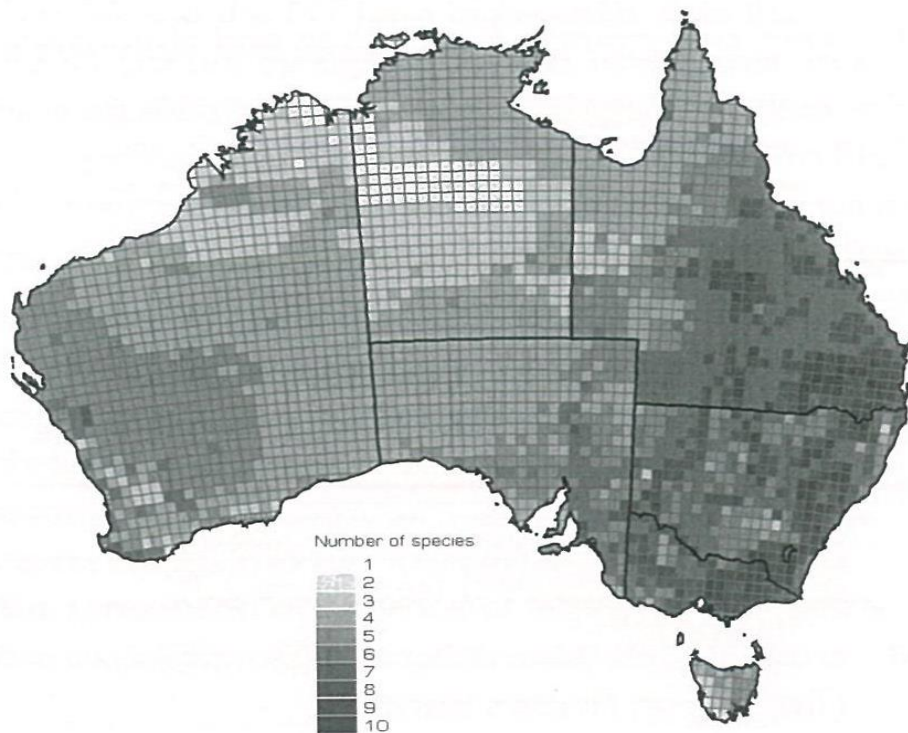
Figure 1.4: Distribution of 10 nationally significant Invasive animals in Australia (Source: West, 2008)

1.4.2 Autopoietic characteristics of invasive animals

Autopoiesis refers to a 'self-maintaining and self-regulating living system'.[53] The concept was originally used to describe the complexity of living systems.[54] For invasive species, autopoiesis facilitates their adaptation to new environments.[55] The following characteristics facilitate rapid evolution, adaptation and spatial distribution of invasive animals making invasive animal management a difficult task:

- Their self-generating capacity allows invasive animals to evolve new characteristics[56] which facilitate their adaptation to diverse environments and

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[52] Olsen (1998), above n 47.

[53] Humberto R Maturana and Francisco Varela, *Autopoiesis and Cognition* (Dordrecht: Reidel, 1980) 78, 89.

[54] Humberto R Maturana. and Francisco J Varela, *The Tree of Knowledge* (Shambhala, 1987).

[55] Mary Jane Angelo and Anel Du Plesis (Eds), *Research Handbook on Climate Change and Agricultural Law* (Edward Elgar Publishing, 2017), 98.

[56] The invasive animal problem can be described in terms of the Anthropocene: F Biermann et al, 'Navigating the Anthropocene: The Earth System Governance Project Strategy Paper' 2010) 2 (3) *Current Opinion in Environmental Sustainability* 202, doi: 10.1016/j.cosust.2010.04.005.

climatic conditions. The ability to evolve rapidly allows their spread and expansion across ecosystems and regions. Control endeavours may lead to other problems. For example, wild dog control may reduce wild dogs but increase feral cats; fewer foxes may result in more rabbits.

- Invasive animals are highly mobile and can traverse large areas of land, covering several land titles, including private and public lands. Despite taking precautionary and diligent actions, a landholder may face the recurring problem of invasive animals due to their mobility, which may be exacerbated as a result of the negligence of neighbouring landholders to conduct controls. Their movement not only covers natural boundaries but also political and legal boundaries. This leads to difficulties in allocating institutional responsibilities for control.[57] Small scale, uncoordinated, localised control efforts can generally facilitate the re-establishment of species.

- Invasive animals can possess intelligence which help them to avoid control methods. For example, wild dogs and feral pigs can avoid control traps.

These autopoietic characteristics make it difficult to establish a causal connection between the cause and harm. The problem features non-linear dynamics which pose difficulties in selecting and implementing appropriate control measures.[58] Invasive animal species control can require long-term investments and co-ordination, with efforts spanning land titles and land uses; it is a complex phenomenon which is a threat to agri-environmental systems with the control and management of invasive animals itself is a systems problem.[59] Addressing such a biophysical, social and systemic challenge involves technical complexities, multiple solutions that may vary

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[57] Martin et al (2016), above n 4.

[58] Decker et al. 2014 – Decker, D.J., Riley, S.J., Organ, J.F., Siemer W.F. and Carpenter, L.H. 2014. Applying Impact Management: A Practitioner's Guide, Third edition. Human Dimensions Research Unit and Cornell Cooperative Extension, Cornell University, Ithaca, NY, 119.

[59] Martin and Verbeek (2006), above n 7, 11–23; Susan Schneider, 'Predicting the Future: Our Food System in 2025' (2015) 11 (21) *Journal of Food Law and Policy*; *Principles of Pest Animal Management*, principle 5 and 6, <https://www.pestsmart.org.au/wp-content/uploads/2014/05/GENFS2_principles.pdf>.

with stakeholders' values and interests[60] and sub-processes[61] which may characterize it as a 'wicked problem'[62] or perhaps a 'super-wicked problem'.[63]

1.4.3 Invasive animal impacts and costs

Invasive animals are a significant threat to Australia's biodiversity, an economic cost to industries and a prominent cause of socio-cultural losses. Invasive animals affect industries related to natural resources, export markets, food safety as well as leisure and wellbeing.

Well recognised as a food secure nation, Australia exports a major proportion of the food it produces.[64] Out of the A$58.1 billion worth of food and fibre produced in Australia in 2015-16, 77 per cent (A$44.8 billion) was exported.[65] The agricultural sector is primarily important in terms of international trade.[66] It provides a competitive foundation for Australia's processed food and beverage industry, which is the largest of Australia's manufacturing industries. Other processing industries in Australia, such as clothing, textile, footwear and leather also receive necessary foundational support from agriculture. Feral animals are a major source of economic costs to agriculture. They also pose significant risks. In livestock and poultry

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[60] K M Leong, S J Decker and T B Lauber, Stakeholders as Beneficiaries of Wildlife Management. In S J Decker, S J Riley and W F Siemer, W.F.(Eds), *Human Dimensions of Wildlife Management* (John Hopkins University Press, 2012) 26.

[61] Sub-processes involve development of policies and objectives, planning, setting goals, selection of control methods, partnerships, modes of implementing actions, monitoring and evaluation: Erin C McCance et al, 'Importance of Urban Wildlife Management in the United States and Canada' (2017) 42 *Mammal Study* 1.

[62] H W J Rittel and M M Webber, 'Dilemmas in General Theory of Planning' (1973) 4 *Policy Sciences* 155.

[63] K Levin et al, Overcoming the Tragedy of Super Wicked Problems: Constraining Our Future Selves to Ameliorate Global Climate Change, (2012) 45 *Policy Science* 123, <https://doi.org/10.1007/s11077-012-9151-0>.

[64] Prime Minister's Science, Engineering and Innovation Council, *Australia and Food Security in a Changing World* (Canberra, 2010); In 2016-17 Agricultural exports were expected to be worth $44 billion in 2016-17: Australian Bureau of Agricultural and Resource Economics and Sciences *Agricultural Commodities: September quarter 2016* (ABARES, 2016).

[65] Australian Bureau of Agricultural and Resource Economics and Sciences, *Agricultural Commodities – June Quarter 2017* (ABARES, 2017).

[66] John Lydon, David Dyer and Chris Bradley, 'Compete to Prosper: Improving Australia's Global Competitiveness' (McKinsey Australia, Agricultural Competitiveness Issues Paper, Canberra, Commonwealth of Australia, 2014) 19–28 <http://agwhitepaper.agriculture.gov.au/SiteCollectionDocuments/issues_paper.pdf>.

industries, they can potentially introduce and spread animal diseases including foot-and-mouth disease, avian influenza H5N1, Anthrax and rabies.[67]

Australia's environmental assets have an estimated value over A$6 trillion[68] and biodiversity plays a major role in preserving the distinct and unique Australian environment.[69] Australia's' 'clean and green' image and the viability of the Australian tourism sector relies on its unique biodiversity and natural grandeur; invasive animals cause widespread disturbances in Australia's biodiversity, which may negatively impact the tourism industry, which contributes A$38 billion to the Australian economy.[70]

Australia is one of the world's 17 megadiverse countries, which together account for 70 per cent of the world's biodiversity. Biodiversity is important in Australia for its economic, ecological, recreational, cultural and scientific reasons, as well as for human wellbeing.[71] Australian biodiversity includes unique endemic species, world heritage sites with outstanding natural features[72] and wetlands of international importance.[73] The balanced existence of multiple species is important for the maintenance of biodiversity and invasive species negatively affects this balance in Australia.[74]

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[67] *National List of Notifiable Animal Diseases* <http://www.agriculture.gov.au/pests-diseases-weeds/animal/notifiable>; D R Paini et al, 'Global Threat to Agriculture from Invasive Species, (2016) 20 *Proceedings of the National Academy of Sciences of the United States of America*.

[68] Australian Bureau of Statistics, *Australian Environmental-Economics Accounts* (Catalogue no. 4655.0, ABS, 2017).

[69] Commonwealth Scientific and Industrial Research Organisation, *Australian National Outlook 2015: Economic Activity Resource Use, Environmental Performance and Living Standards, 1970-2050* (CSIRO, 2015).

[70] Tourism Research Australia, *International Visitors in Australia: June 2016 Quarterly Results of the International Visitor Survey* (Australian Government Austrade, TRA, 2016).

[71] S R Morton and R Hill, 'What is Biodiversity, and Why is it Important?' S R Morton, A W Sheppard and W M Lonsdale (Eds), *Biodiversity: Science and Solutions for Australia* (CSIRO Publishing, 2014, 1); Millennium Ecosystem Assessment, *Ecosystems and Human Well-Being: Synthesis* (Island Press, 2005)

[72] United Nations Educational, Scientific and Cultural Organization, *World Heritage List – Australia* <http://whc.unesco.org/en/statesparties/au>

[73] Australian Government Department of Environment and Energy, *Australian Ramsar Wetlands* <http://www.environment.gov.au/water/wetlands/australian-wetlands-database/australian-ramsar-wetlands>.

[74] Cresswell and Murphy (2017), above n 1; Australian Government Department of the Environment, Water, Heritage and the Arts, 'Assessment of Australia's terrestrial biodiversity 2008' (Report prepared by the Biodiversity Assessment Working Group of the National Land & Water Resources Audit, DEWHA, 2009).

The 2016 IUCN Red List of Threatened Species, in its analysis of biodiversity conservation relating to animals, identifies that invasive species were responsible for extinctions around the world of 87 birds, 45 mammals and 10 reptiles. Invasive mammals, particularly cats, dogs and pigs, threaten 596 species, which are at risk of extinction.[75] Many unique and native species[76] in Australia are under threat from pest animals in Australia[77] aptly described as 'a costly catastrophe for native biodiversity'.[78]

The economic costs of invasive animals are derived by substantiating the including economic, social and environmental impacts[79] from beneficial impacts.[80] Table 1.1 provides a few examples of negative invasive animal impacts by categorising them as economic, environmental and social impacts. The examples are drawn from the *Australian Pest Animal Strategy* evaluation.[81]

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[75] IUCN Red List, 2016 <http://www.iucnredlist.org/>.

[76] *Environment Protection and Biodiversity Conservation Act 1999* (Cth) s 178.

[77] Cresswell and Murphy (2017), above n 1, 32; Australia's biodiversity, *A Summary* <https://www.wilderness.org.au/articles/australias-biodiversity-summary>.

[78] Jeff McNeely, 'Invasive Species: A Costly Catastrophe for Native Biodiversity' (2001) 2 *Land Use and Water Resources Research* 1.

[79] House of Representatives Standing Committee on Agriculture, Fisheries and Forestry, *Taking Control: A National Approach to Pest Animals* (Canberra, 2005); A J Norris et al, 'Costing the Impacts of Invasive Animals' (Proceedings of the IACRC workshop on social, economic and environmental impacts of invasive animals, Canberra, 2005).

[80] The literature also discusses beneficial impacts of invasive animals: For eg, Rabbits as a prey for various raptor species: see W Steele and D Baker-Gabb, 'A National Community-Based Survey of the Diurnal Birds of Prey (BOP Watch)' (Paper presented at the Australasian Raptor Association National Conference, Coffs Harbour, New South Wales, 30 August – 31 August 2008); Foxes as predator of rabbits: see S Adams, 'Impact of Vertebrate Pests on Agricultural Production and the Environment' (Fact Sheet, IACRC, 2008); Dingoes as predator of wild goats: see, P Fleming et al, 'Managing the Impacts of Dingoes and Other Wild Dogs' (Bureau of Rural Science, 2001); A Wallach and C Johnson, 'Reviving Ecological Functioning with Dingo Restoration' (The Hermon Slade Foundation, 2009); C N Johnson, et al, 'Rarity of a Top Predator Triggers Continent-Wide Collapse of Mammal Prey: Dingoes and Marsupials in Australia' (2007) 274 *Proceedings of the Royal Society of Biological Sciences* 341.

[81] Vicki Woodburn, 'Australian Pest Animal Strategy Evaluation Final Report' (Prepared for the Evaluation Steering Committee – Vertebrate Pests Committee, 2013) <https://www.pestsmart.org.au/wp-content/uploads/2015/02/APASFinalReport_29April2013.pdf>.

Table 1.1: Economic, environmental and socio-cultural impacts of invasive animals

Economic:
Impacts on agriculture, soil, water; damages to infrastructure including culturally important sites Predation of livestock or companion animals Harboring and transmission of stock diseases Threats to human health (such as exposure to diseases, allergies, injuries, toxicity, as well as effects on air and water quality, food availability, threat to physical safety) Impact on trade and international relations
Environmental:
Competition with native plant and animal species Predation of native wildlife The spread of weeds Disease transmission between invasive animals and wildlife parasitism Poisoning/toxicity of non-target wildlife from invasive animal control programs Overgrazing and over browsing leading to changes in native vegetation River and stream bank destabilization/stream turbidity
Socio-cultural:
Adverse animal behaviors (for e.g. disruptive noise) impacting quality or way of life Emotional harm and well-being Modification of cultural and aesthetic values Damages to culturally important sites Alteration on recreation use & tourism impacting community values Impact on relationships (e.g. conflicts with neighbours owing to control preferences)

(Source: Woodburn (2013)

The damage caused by invasive animals is diverse in its nature and extent. It is difficult to derive precise objective estimates of invasive animal impacts because of the overlap between each of the above-mentioned categories. For example, a study aimed at quantifying social impacts of invasive species conducted by the IACRC found a considerable overlap between economic and environmental impacts.[82] An average of A$7,023 is spent per agricultural business on undertaking pest animal management activities.[83] Another study published in 2009 stated that 11 vertebrate pests cost $720 million per year to the Australian economy.[84] The *State of Environment* ('*SOE*') Report identifies rabbits, cane toads, foxes, camels, wild dogs

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[82] G Fitzgerald and R Wilkinson, *Assessing the Social Impact of Invasive Animals in Australia*, (IACRC, 2009).

[83] N Stenekes, R Kancans and B Binks, 'Pest Animal and Weed Management Survey: National landholder Survey Results' (ABARES research report 17.5, May. CC BY 4.0, 2017).

[84] R McLeod, *Counting the Cost: Impact of Invasive Animals in Australia* (Cooperative Research Centre for Pest Animal Control, Canberra, 2004); W Gong, J Sinden, M Braysher and R Jones, *The Economic Impacts of Vertebrate Pests in Australia* (IACRC, 2009).

and feral cats as Australia's current worst invasive pests, which cost Australia an estimated A$964 million each year.[85] The most recent reported estimates put the potential aggregate economic costs from selected invasive animal species at over A$1 billion annually.[86] The cost is significant but, Martin et al., believe that the actual costs, including risk pricing are even higher.[87] There is a general consensus that the impacts and damages caused by invasive species to ecosystem services and biodiversity including the costs of control and management, are increasing.

1.4.4 Compliance with international law

Invasive species are one of the three prominent problems Australia must deal with to fulfil its obligations under the *United Nations Convention on Biological Diversity* ('*CBD*').[88] The key objective of the *CBD* is to protect ecosystems and their biodiversity. The *CBD* identifies invasive animal species as a major cross-cutting theme.[89] The signatory states are obliged to 'prevent the introduction of or control or eradicate those invasive species that threaten ecosystems, habitats or species through a three-tiered approach of prevention, eradication and control'.[90]

Australia ratified the *CBD* in 1993. The ratification triggered the *National Strategy for the Conservation of Australia's Biological Diversity*,[91] with invasive species control a

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[85] Cresswell and Murphy (2017), above n 1.

[86] R McLeod and Esys Development Pty Ltd, 'Cost of Pest Animals in NSW and Australia, 2013-14' (Report prepared for the NSW Natural Resources Commission, 2016).

[87] Martin et al (2016), above n 4.

[88] Australian Government Department of Environment, *Australia's Fifth National Report to the Convention on Biological Diversity* (DE, Canberra, 2014): The Next CBD Report due date is December 2018. *Convention on Biological Diversity* ('*CBD*'), decision adopted by the COP to the CBD, 13th meeting, Cancun Mexico, 4-17 December 2016; Agenda item 19] <https://www.cbd.int/doc/decisions/cop-13/cop-13-dec-27-en.pdf>.

[89] Australian Government Department of Environment 2014, above n 88.

[90] Article 8(h) of the *CBD* states: Biological diversity means 'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'. That is, biological diversity encompasses three levels: ecosystem diversity (ie, variety of ecosystems), species diversity (ie, variety of different species), and genetic diversity (ie. variety of genes within species).

[91] *National Strategy for the Conservation of Australia's Biological Diversity,* 1996, Canberra, ACT <http://www.environment.gov.au/archive/biodiversity/publications/strategy/pubs/national-strategy-96.pdf>.

priority for action under the strategy and highlighted as one of the principal causes of decline in biodiversity.[92]

Other international instruments where invasive species are relevant to Australia's international obligations include:

- Obligations under the *World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures 1994* ('*SPS Agreement*'): As a member of the World Trade Organisation (WTO) and signatory to the *SPS Agreement*, Australian governments have international obligations to maintain ALOP for life or health within borders. This level also applies to the control and management activities pertaining to invasive animals.[93]

- Obligations under the *World Health Organization International Health Regulations 2005*.[94]

- Other non-binding institutional instruments include optional commitments to comply with the standards and recommendations by International Union for Conservation of Nature (IUCN),[95] United Nations Environment Program (UNEP)[96] and Food and Agriculture Organization (FAO).[97] For example, IUCN has developed and regularly updates a list of the worst invasive species in the world, which includes invasive animals.[98]

Invasive species problems and the available evidence about their increasing impacts justify a strong focus on invasive animal control and management by the government

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[92] Natural Resource Management Ministerial Council, *Australia's Biodiversity Conservation Strategy 2010-2030* (Australian Government, Department of Sustainability, Environment, Water, Population and Communities, Canberra, 2010), 24.

[93] Department of Agriculture and Water Resources, *Australia's international biosecurity obligations* <http://www.agriculture.gov.au/biosecurity/risk-analysis/conducting/international-obligations>.

[94] Department of Health, *Australia's International Health Obligations Joint External Evaluation of IHR Core Capacities of Australia* (WHO Licence: CC BY-NC-SA 3.0 IGO, 2018) <http://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-biosec-health-regulations.htm>.

[95] The IUCN encourages its members to achieve the Aichi target 9, by providing technical and scientific advice, https://www.iucn.org/theme/species/our-work/invasive-species.

[96] The UNEP promotes regional coordination to control invasive species by developing specific regional agreements and overseeing their implementation.

[97] Devin M Bartley, Felix J B Marttin and Matthias Halwart, FAO Mechanisms for the Control and Responsible Use of Alien Species in Fisheries <http://www.fao.org/docrep/009/a0113e/A0113E02.htm>.

[98] IUCN Red List, 2016 <http://www.iucnredlist.org/>.

and community. The next section describes how the invasive animal problem is addressed in Australia.

1.4.5 Invasive animal management

The focus of invasive animal management in Australia until 1990 was to reduce and eradicate pest animals rather than manage production or conservation related outcomes.[99] The continued existence of pest animals and their impacts, despite concerted efforts by Australian governments, prompted deliberations regarding the effectiveness of vertebrate pest management strategies that focussed on killing large numbers of pest animals. Recognising the importance of assessment, a system of continuous review of pest management practices was established. The first review conducted by the Bureau of Rural Resources[100] in 1991 established a series of principles and guidelines for managing the damage due to pest animals. One of the outcomes of this review was the adoption of a strategic approach for the management of invasive animals. The strategic management approach was subsequently endorsed and incorporated nationally in the *Australian Pest Animal Strategy* ('*APAS*')[101] which continues to guide pest animal management in Australia today.

1.4.5.1   Strategic management

The strategic approach shifted the aim of pest animal management to reduce damage and achieve sustainability and/or conservation outcomes rather than killing large numbers of pest animals. It is now accepted that many established pest animals in Australia are unlikely to be eradicated; it is not technically or economically feasible to achieve this, though major innovations may make this possible in the future. The focus of established pest animal management is thus to control or reduce economic

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[99] M Braysher, *Managing Vertebrate Pests: Principles and Strategies* (Bureau of Resource Sciences, AGPS, 1993).

[100] The Bureau of Rural Sciences (BRS) was the scientific agency within the Australian Government Department of Agriculture, Fisheries and Forestry which provided nationally focused advice to support evidence-based policy development and decision making by government on the sustainable use and management of natural resources, Between 1988 until 1998, BRS was also known as Bureau of Rural Resources (BRR) and Bureau of Resource Sciences (BRS) <https://web.archive.org/web/20041014223154/http://www.affa.gov.au/brs>. In 2010, BRS was merged with the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) within the Australian Government Department of Agriculture and Water Resources <http://www.agriculture.gov.au/abares>.

[101] Natural Resource Management Ministerial Council (2007), above n 28.

and environmental harm created by the pest animal.[102] Current invasive animal management approaches vary according to the stages of incursion: prevention, eradication, containment and asset-based protection (see Figure 1.5).

Prevention stage: At this stage, the risk of new pests entering a region is minimised by quickly removing pest animals before they have a chance to spread and establish breeding populations. This is primarily a government responsibility.

Eradication stage: At this stage, small and isolated pest animal populations are removed. Eradication programs are successful only when a) the control operations can remove pest animals faster than they can reproduce, b) the immigration of pest animals from another area or source can be prevented and c) when all reproductive pest animals can be removed by employing effective control techniques. This is primarily a mixed government/industry responsibility.

Containment and Asset-based protection: At this stage, pest animals have already spread and multiplied in number. The focus of management shifts to asset-based protection or to reduce the damage caused by pest animals. Government increasingly relies on industry and the community for this work.
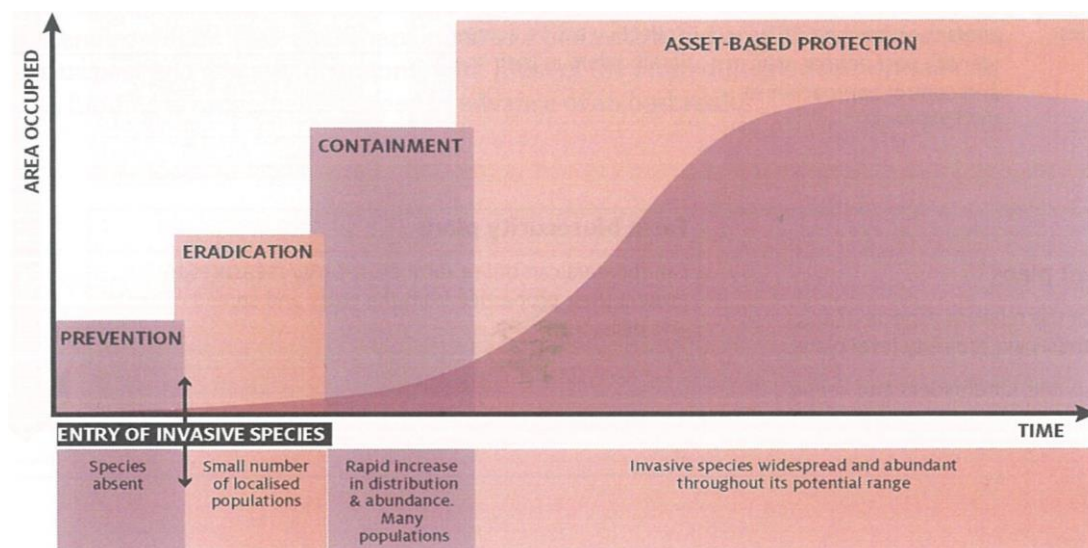
Figure 1.5: Four stages of pest animal management – the generalised invasion curve
(Source: Invasive Plants and Animals Policy Framework, 2010)

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[102] Braysher (2017), above n 6, 11; Invasive Plants and Animals Committee, 2016, above n 48, 25-26; Olsen (1998), above n 47.

The APAS suggests that the management of pest animals should focus on the protection of priority assets.[103] To this end, the APAS has included goals and priorities (see Table 1.2) to address the problem of established pest animals through strategic management.

Table 1.2: Goals and priorities of action for the management of established pest animals

Goal 2: Minimise the impact of established pest animals	**Goal 3**: Improve leadership and coordination for the management of pest animals
Priority 2.1: Develop and implement national action and coordination plans for species prioritised as nationally significant **Priority 2.2**: Continue to develop and improve best practice management methods and increase overall adoption of these practices among landholders **Priority 2.3**: Increase participation in coordinated management approaches across a range of scales and land tenures	**Priority 3.1**: Develop the knowledge, capacity and commitment of stakeholders to take responsibility for pest animal management **Priority 3.2**: Improve information collection and sharing mechanisms to support effective pest animal management **Priority 3.3**: Maintain and enhance long-term research, development and extension capacity and capability **Priority 3.4**: Monitor the pest animal management approach and identify and improve areas of weakness

(Source: Invasive Plants and Animals Committee 2016)

The process of strategically managing established species involves multiple inter-related activities (eg, gathering pest animal intelligence through monitoring, control application).[104] These inter-related activities involve planning, resourcing and coordinated action.[105] The effectiveness of management cumulatively depends upon the performance of the overall system. The processes can be broadly described in the following three steps:

1. Defining the problem

This step involves identifying the dimensions of the pest animal problem including:
- Specifying who has the problem;
- Identifying location, extent, level of damage/impacts believed to be caused by the pest animals; and

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[103] Invasive Plants and Animals Committee 2016, above n 48, 5 (principle 4).
[104] Braysher (1993), above n 99.
[105] Invasive Plants and Animals Committee 2016, above n 48, (principle 3).

- Determining how to alleviate the damage caused by pest animals.

Defining the pest animal problem requires: information about pest animal location, movement and level of threat. Information on the elements of the pest animal problem (eg, animal species, their characteristics, scale, presence, rate of dispersal and impact) helps in providing the reliable evidence necessary to strategise and instigate control action. Information facilitates decision-making about the need for control action, selection of control methods, feasible steps for implementing control and the resources required to attend control objectives.[106] The required information is gathered through pest animal intelligence techniques and methods of threat assessment.[107] Technologies facilitate the provisioning of information and assessment of a pest animal problem through intelligence and data.[108] These include mapping and monitoring technologies; for example, surveillance technologies, such as FeralScan[109] would be a useful way to detect and monitor pest animals.

2.   Determining management option

The decision as to which pest animal management option to use involves the following considerations:[110]

- Functional capacity to address the problem, including the availability of economic and human resources;

- Availability of control methods and their effectiveness;

- Social parameters of control, including how society perceives the use of control; and

- Environmental factors which can affect the implementation of control

Selection of the appropriate management option requires understanding of landholders and other stakeholders including government agencies and farmer groups, and decision-making by stakeholders. Decision-making requires data on variables,

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[106] Braysher (2017), above n 6, 40–49.

[107] Invasive Plants and Animals Committee 2016, above n 48, 34.

[108] National Biosecurity Committee, *National Surveillance and Diagnostics Framework*, 2014 <http://www.agriculture.gov.au/SiteCollectionDocuments/animal-plant/pihc/bepwg/national-surveillance-diagnostic-framework.pdf>.

[109] FeralScan <https://www.feralscan.org.au/>; Peter West, *What is FeralScan?* <https://www.feralscan.org.au/docs/FeralScan%20Poster%202016.pdf>.

[110] G Saunders and M Braysher, *Pestplan Toolkit: A Guide to Setting Priorities and Developing a Management Plan for Pest Animals* (Australia: Natural Heritage Trust, 2003); Mike Braysher and Glen Saunders, *PESTPLAN Toolkit* (IACRC, 2010).

including impact/damage and socio-economic and environment factors, for developing performance indicators. Technology enables the availability of data and a discourse among different stakeholders.

3. Implementation of control

1. Implementation requires efficient control methods and stakeholders' support to carry out on-ground application of the control. Pest animal control methods vary with the intensity of incursion, the objective, and the level of control to be achieved.[111] The effectiveness of control methods in pest animal management is 'context-specific'.[112] Based on species characteristics, the control methods are broadly classified into conventional and biological methods including:[113] killing or removal (baiting, shooting, trapping or mustering); exclusion (fencing or netting); biological or fertility control; habitat manipulation (removal of surface refugia); and changes in land use and agricultural practices (timing of lambing or planting different crops).[114] For effective application of control methods, the *APAS* suggests integrated use of several of these methods since single methods may not be effective in controlling pest animals. For example, a combination of control methods is an effective way to address wild dog control.[115] Technologies can increase the efficiency of control methods.[116] For example, the use of mechanical ejectors with Para-aminopropiophenone (PAPP) baits in poisoning for wild dogs and foxes[117].

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[111] For example, eradication is not a feasible option when invasive animal populations are large in numbers and pervasive: Department of Primary Industries (VIC), Invasive Plants and Animals Policy Framework, 2010 <http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/protecting-victoria-from-pest-animals-and-weeds/invasive-plants-and-animals/invasive-plants-and-animals-policy-framework>

[112] 'Context-specific' here means type and level of pest animal incursion, objective of pest animal control, limits of control techniques.

[113] Invasive Plants and Animals Committee (2016), above n 48, 13 (Principle 4).

[114] Braysher (2017), above n 6, 80 –102.

[115] B Binks, R Kancans and N Stenekes, 'Wild Dog Management 2010 to 2014 National Landholder Survey Results (ABARES report to client prepared for Australian Wool Innovation Ltd, Canberra, June. CC BY 3.0, 2015).

[116] Linton Staples, 'Submission to House of Representatives Enquiry into Pest Animals In Australia' (Animal Control Technologies, August 2004).

[117] Canid Pest Ejector Controlling Wild Dogs and Foxes, <http://www.animalcontrol.com.au/news/2014/20140522-1.htm>; Rob Hunt et al, 'Scientific Report New Technology for Management of Fox Impacts on Agriculture'

Evaluations of control approaches primarily focus on lethality and cost-effectiveness. The control approaches are expected to be target-specific, with consideration of animal welfare. This requires specific control standards for control methods and techniques used in pest animal management. The standards for pest animal management include Standard Operating Procedures (SoPs) and Codes of Practice (CoPs).[118]

Pest animal management requires engagement of stakeholders and the community at various stages of control. The notion of a 'pest animal' is a human construct, which means pest status of an animal is decided by humans.[119] Human decisions influence managerial actions at different control stages. The engagement of stakeholders helps in accommodating multiple views about pest animals to implement common/agreed control approaches during pest animal management. Due to pest animal mobility, control actions are required across multiple land tenures including private and public lands. Effective stakeholder and community engagement facilitates coordinated and collective action for pest animal management.[120]

Institutional issues have a fundamental impact on this engagement. Continuous innovations are needed to improve the effectiveness of strategic pest animal management in the face of increasing challenges. Innovations can be broadly categorised as:

1. *Technological innovations*: Technologies facilitate the efficiency of pest animal management at each stage of control.

2. *Managerial innovations*: Managerial innovations facilitate continuous improvement in standards of control and managerial practices.

(APAMP Project GMS 0090, 2015) <https://www.pestsmart.org.au/wp-content/uploads/2015/04/Dall2009_APARPfinalreport.pdf>.

[118] T Sharp and G Saunders, Humane Pest Animal Control: Codes of Practice and Standard Operating Procedures. (NSWs Department of Primary Industries, 2005).

[119] The principles of pest animal management (principle 1): Braysher (2017), above n 6, 23, 24.

[120] Ibid 23–26.

3. *Governance innovations*: Governance innovations are crucial to the effectiveness of management given the increasing pressure of the invasive animal problem and the declining availability of public funds.[121]

Since the launch of *APAS* in 2007, the coordinated efforts of government and non-government organisations have contributed towards innovations for effective pest animal management. The IACRC has played a key role in furthering pest animal innovations, involving research, government and other organisations. Table 1.3 describes some of the sample innovations in technology that facilitate strategic management. The stages for pest animal management are drawn from strategic process described by Braysher.[122] Chapter 2 (Sections 2.2 and 2.3) provides a detailed discussion of current and potentially applicable innovations for effective invasive animal management.

Table 1.3: Example of innovations to facilitate strategic pest animal management

Stages in strategic management	Requirements	Area of Innovations	Relevant technological or managerial component
Stage 1: Define the problem	Assessment of problem through intelligence and information	Mapping through involvement of stakeholders	Collars mounted with Global Positioning Systems (GPS) for tracking;[123] camera trapping and sensors for monitoring pest animal movements,[124] FeralScan, a web-based platform for pest mapping.[125]
Stage 2: Determine management priorities	Assessment of options based on available knowledge and information; involvement of stakeholders	Best practice management; Communities of practice; Knowledge databases, information	Information and communication technologies (eg, PestSmart is a web-based participatory technology that uses information sharing technologies).[126]
Stage 3: Decide feasibility	Assessment of the availability of resources (financial and human)		

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[121] Paul Martin and Jacqueline Williams, *Productive, Biodiverse Farming Landscapes: Why is Governance Innovation Essential?* (Agricultural Productivity Summit, 2014).

[122] Braysher (2017), above n 6, 37–49.

[123] Brad V Purcell et al, *Use of GPS Collars for Tracking Wild Dogs* (Paper presented at the Queensland Pest Animal Symposium, Queensland. Dept of Natural Resources, Mines and Water, Brisbane, Qld, 2006).

[124] P Meek et al, 'Are We Getting the Full Picture? Animal Responses to Camera Traps and Implications for Predator Studies' (2016) 6 *Ecological Evolution* 3216. doi:10.1002/ece3.2111; A Bengsen et al, 'Camera Trap Surveys to Evaluate Pest Animal Control Operations' (2014) 15 *Ecological Management and Restoration* 97, doi:10.1111/emr.12086.

[125] FeralScan <https://www.feralscan.org.au/>.

[126] PestSmart Connect <https://www.pestsmart.org.au/>.

Stages in strategic management	Requirements	Area of Innovations	Relevant technological or managerial component
	within the given social and environmental context through expert judgements, analysis, data estimation; involvement of stakeholders	management systems	
Stage 4: Determine objectives	Assessment of goals and expert feedback; involvement of stakeholders		
Stage 5: Develop the program	Preparing a plan of action	Data management systems; participatory planning; involvement of stakeholders	Planning software, Information and Communication technology enabled smart applications
Stage 6: Implement the program	Control methods Poisoning/baiting Trapping Containment Biological control Fertility control	Control products	PAPP baits for poisoning[127]
		Control tools and instruments	Mechanical ejectors[128], electric fences[129]
		Assessment of humaneness; animal welfare considerations and non-target impact	Codes of Practices (CoPs), Standard operating Procedures (SoPs).[130]
	Institutional support	Innovations in Resourcing	Potential market innovations (eg, payments for ecological services, risk-based instruments, crowd-funding).[131]
		Laws and regulatory enforcement	The Biosecurity Act 2015; General Biosecurity Duty (GBD) or General Biosecurity Obligation (GBO).[132]
	Individual and/or coordinated action;	Community engagement	Information and communication technologies[133]

[127] PAPP for wild dog and fox control <https://www.pestsmart.org.au/papp-for-wild-dog-and-fox-control/>.

[128] Canid Pest Ejector (CPE) for Fox and Wild Dog Control (video) <https://www.pestsmart.org.au/canid-pest-ejector-cpe-fox-wild-dog-control/>.

[129] Australian Wool Innovation Limited, *Wild dog Exclusion Fencing, A Practical guide for Woolgrowers* <https://www.wool.com/globalassets/start/about-awi/publications/awi-wild-dog-exclusion-fencing-guide-2017.pdf>.

[130] Sharp and Saunders (2005) above n 118.

[131] Discussed in Chapter 2.

[132] *Biosecurity Act 2015* (NSW*),* part 3 *General Biosecurity Duty*; *Biosecurity Act 2014* (Qld) ch 2, part 1, *General Biosecurity Obligation.*

[133] T R Alter et al, *Using Information Technology to Enhance Community Engagement* (PestSmart Toolkit Publication, Centre for Invasive Species Solutions, Canberra, ACT, 2017).

Stages in strategic management	Requirements	Area of Innovations	Relevant technological or managerial component
		Behavioral sciences, education	Information and communication technologies
Stage 7: Monitor and evaluate	Assessment of data, measurement of outcomes, progress monitoring[134]	Data assessment and data management systems	Information and communication technologies including mobile devices, laptops/computers, GPS, biometric devices

1.4.5.2   Requirements for effective pest animal management

Drawing on the principles and process of strategic pest animal management (as described above) three elements are needed for management effectiveness:

• Control methods and technologies

• Functional capacity

• Participation of stakeholders and the community

Control methods and technologies

Based on the strategic approach, the use of one particular control method to the exclusion of others is not recommended for managing pest animals.[135] Scientific and technological research has contributed to more effective control technologies and indicates further potential for technological improvements (see table 1.3 for examples). Managerial research continues to improve best management practices by connecting strategic goals with stakeholders' performance. The emphasis on research development and innovation suggests that technologies and strategic management methods based on scientific approaches still continue to improve.

Functional capacity

There is no broadly accepted definition and a common frame of reference that explains the word 'capacity'.[136] Capacity for invasive animal control at the systems level comprises of capability to act, generate results, relate, adapt and integrate. The functional capacity for pest animal management is the ability at an individual or organisational level to put a theoretical plan of action in practice. It requires the support of institutions and stakeholders, involving a combination of attitudes,

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[134] Braysher (2017) above n 6, 123–146.

[135] Invasive Plants and Animals Committee (2016), above n 48, 5, 13.

[136] Peter Morgan, *The Concept of Capacity*, 2006 <http://ecdpm.org/wp-content/uploads/2006-The-Concept-of-Capacity.pdf>.

resources, strategies and skills. The functional capacity to implement pest animal control primarily depends upon economic and human resources; this includes:

- Government funding for on-ground implementation and to support voluntary action;

- Private investments by the landholders, industry and community organisations;

- Public and private investments for technological research, development and innovations;

- Public and private investments to improve pest animal management across the biosecurity continuum;

- Government investments in extension services;

- Government investments in administration, including in law and regulatory enforcement;

The literature suggests that government support in terms of resources for pest animal management is dwindling and landholders have limited capacity to implement pest animal control.[137]

Participation of stakeholders and community

The autopoietic characteristic of pest animals and limits to the functional capacity of individual stakeholders necessitates participation of stakeholders and community. Effective participation involves securing a community consensus on the requirements of strategic pest animal management (including need, objectives and control methods) to secure 'landscape-scale' coordinated collective action. This requires a thorough consideration of human dimensions of pest animal management[138] including, for example:

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[137] J Marsh and A Brown, *Understanding the Capacity of NRMs to Manage Invasive Animal Impacts: Results from the 2013 National NRM Survey* (PestSmart Toolkit publication, IACRC, Canberra, Australia, 2013) <https://www.pestsmart.org.au/wp-content/uploads/2014/08/NRM-Survey_2013.pdf>; M Brown and C Munckton, *Scoping Study: Training and Capacity Building in Vertebrate Pest Management*. (IARC, 2010) <https://www.pestsmart.org.au/wp-content/uploads/2011/01/TrainingScopingStudy2010.pdf>.

[138] Paul Martin, Scientific Improvement in the Human Dimension of Invasives (keynote paper) presented at the Fifth Victorian Weeds Conference, 13–15 May 2014, Mercure Hotel, Geelong, Victoria, Australia; J A McNeely (Ed). 2001. The Great Reshuffling: Human Dimensions of Invasive Alien Species (IUCN, 2001) vi, 242.

- Attitudes, values and interests of multiple stakeholders involved in pest animal management;

- Approaches adopted by the government extension agencies for the engagement of non-government stakeholders, in particular private and indigenous landholders;

- Approaches adopted in laws and regulations governing pest animal management; and

- Approaches adopted by government agencies for law and regulatory enforcement and/or compliance.

On the consideration of human dimensions in current pest animal management practices, Martin et al, in the *Invasive Animals CRC Report*, identified that 'an established culture' of scientific management of human dimensions had not yet been embraced as part of best practice pest animal management in Australia.[139]

1.4.6 Invasive animal management as a systemic problem

The increase in abundance and distribution of pest animals and a growing understanding of their negative impacts have caused Australian governments to effect innovations that aim to control impacts. Such innovations have often proven ineffective. This is partly because of a mis-match between the characteristics of the problem and the system intended to govern that problem. For example, Fleming et.al. stated the need of institutional collaborations in implementing strategic approach for the management of wild dogs and foxes.[140]

Governance systems, which comprise governance instruments (laws and institutions) and strategies and the processes of governing (including decision-making), are an integral part of addressing environmental challenges.[141] That is, the process of

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[139] Martin (2016), above n 4, 10.

[140] P J S Fleming et al, 'Strategic Approach to Mitigating the Impacts of Wild Canids: Proposed Activities of the Invasive Animals Cooperative Research Centre' (2006) 46 (6-7) *Australian Journal of Experimental Agriculture* 753.

[141] O R Young et al, 'The Globalization of Socio-Ecological Systems: An Agenda for Scientific Research' (2006) 16 (3) *Global Environmental Change* 304, doi: 10.1016/j.gloenvcha.2006.03.004; Governance is the 'intentional shaping of the flow of events so as to realize desired public good': Christine Parker and John Braithwaite, 'Regulation' in P Cane and M Tushnet (Eds), The Oxford Handbook of Legal Studies (Oxford University Press, 2003, 119), 119; J W Thomas and M S Grindle, 'After the

governance decides what actions are needed to be taken to address a particular challenge and how decisions are taken and implemented. The governance system involves diverse governance approaches,[142] multiple themes[143] and socio-cultural factors as well as varied spatial scales.[144]

In Australia, invasive animal management operates within a complex natural resource governance structure,[145] comprising multiple institutions at the Commonwealth, state and local levels of government, private actors, and decision-making processes, as illustrated in Figure 1.6. The governance system must embrace not only ecological but socio-cultural, economic and political aspects. As described in section 1.4.2, the failures in invasive animal control can be partly attributed to the autopoietic characteristics of the invasive pests; however, the decision-making processes to implement control actions are also to blame since they are slow-paced and complex.[146] The decision-making process involves issues of capacity to pursue control action, for example, economic constraints may not allow a landholder to pursue control action that requires long-term resources; it also involves other human dimensions of control, for example, coordinated control action requires community consensus on the objectives and methods of control. The systems level interactions lead to diverse outcomes, including power dynamics, that can obstruct or accelerate the process of behavioural change required for the implementation of innovations.

Decision: Implementing Policy Reforms in Developing Countries' (1990) 18 (8), *World Development* 1163.

[142] The IUCN and *CBD* recommends four major types of approaches for governance diversity: governance by government, shared governance (governance by the government and stakeholders), governance by private individuals and organizations, and governance by indigenous peoples and/or local communities (IUCN Matrix): Garzia Borrini-Feyerabend, *The 'IUCN Protected Area Matrix': A Tool Towards Effective Protected Area Systems*, 2007 <http://www.sgpmongolia.org/upload/IUCN%20protected%20area%20matrix.pdf>.

[143] R Plummer and D. Armitage, 'A Resilience-Based Framework for Evaluating Adaptive Co-management: Linking Ecology, Economics and Society in a Complex World (2007) 61 *Ecological Economics* 62.

[144] G Winter (Ed), *Multilevel Governance of Global Environmental Change Perspectives from Science, Sociology and the Law* (Cambridge University Press, 2006).

[145] Commonwealth of Australia, 'Turning Back the Tide: The Invasive Species Challenge (Report on the Regulation, Management of Invasive Species and the Environment Protection and Biodiversity Conservation Amendment (Invasive Species) Bill 2002, 8 December 2004), 61-84; Invasive Plants and Animals Committee (2016), above n 49, 11.

[146] M Lubell L Jasny and A Hastings, 'Network Governance for Invasive Species Management' (2017) 10 *Conservation Letters* 699, doi:10.1111/conl.12311; Martin et al (2016) above n 24.
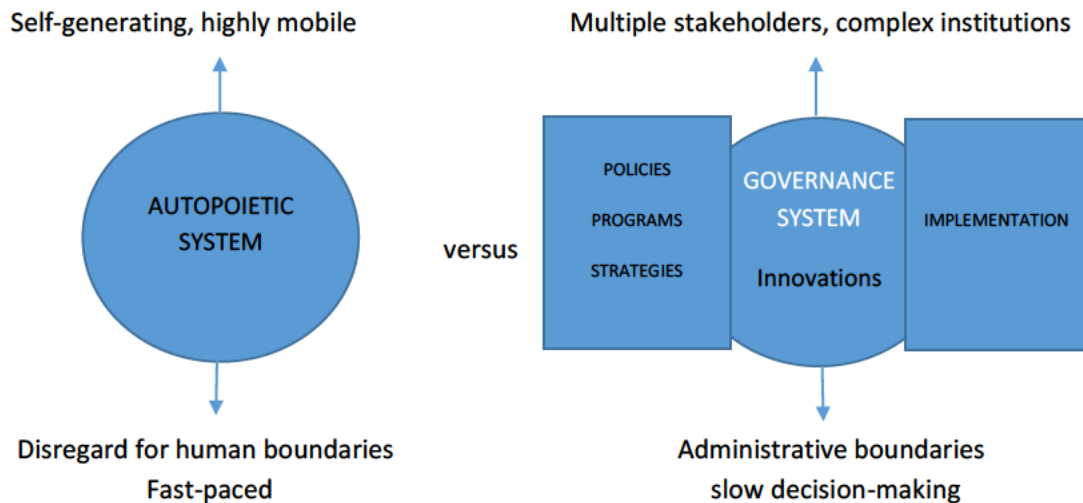
Figure 1.6: Systems context

The principle of 'shared responsibility' in Australian biosecurity policy and legislation formally supposes a connection between policy processes and governance structures,[147] providing a cogent argument for collaborative and collective action for effective invasive animal management. However, the concept is new and supporting institutional mechanisms are not yet in place.[148] In pursuing effective management, the task of the governance system is twofold: setting up clear objectives, strategies and programs; and implementing control. Pest management policies are regularly updated by incorporating control and management innovations. In order for innovations to contribute, policies and programs are required to facilitate and motivate adoption. The effectiveness in implementing innovations and the attainment of control objectives remains a key challenge for Australia's biosecurity.

Effective implementation of innovations at the domestic level is essential to fulfil the expectations enshrined in international instruments and ensure Australia's compliance under international law. The evidence in Australia from SOE Reports suggests that the implementation of invasive animal management policy has not been sufficiently successful. Considering invasive species as a top biodiversity threat world-wide,[149]

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[147] The context of the principle of shared responsibility in Australian Biosecurity and pest animal management is elaborated in chapter 2 (section 2.3) of the thesis.

[148] Craik, Palmer and Sheldrake (2017), above n 5.

[149] Evident from UN Sustainable Development Goals, 2015 and Aichi Biodiversity targets - Target 9: See *Biodiversity and the 2030 Agenda for Sustainable Sevelopment* <https://www.cbd.int/development/doc/biodiversity-2030-agenda-technical-note-en.pdf>; Secretariat of the Convention on Biological Diversity, 'Strategic Goal E, Global

countries are required to address 'the depth and level of compliance'[150] which includes effective implementation of law. To this effect, the *CBD* focuses upon enhancing implementation.[151] International environmental law and policy forums have recognised effective implementation as a key area in which improvements are needed.[152] Many documented strategies and initiatives address invasive species, but implementation efforts fall short of invasive species control objectives.[153]

1.4.7 The role of laws and institutional arrangements in implementation

Laws and institutional arrangements play an important role in implementation. The role of law is to guide behaviours of government and non-government stakeholders to achieve the control outcomes. Laws help to put restraints on those behaviours, which either limit effectiveness of control or facilitate the behaviours that help control action. Institutional arrangements, through the involvement of multiple stakeholders, are engaged in decision-making on policy processes and implementation for invasive animal management.

There is considerable variation in the way invasive animals are managed in Australia. Management is guided by the legal and institutional framework, which involves complex and overlapping laws, regulations, policies, private arrangements and non-binding instruments (eg, codes of practice and management plans) at the three levels of government: federal, state/territories and local (See Figure 1.7).

Biodiversity Outlook 4' *Global Biodiversity Outlook 2011–2020*, 2014 <https://www.cbd.int/gbo/gbo4/publication/gbo4-en-hr.pdf>.

[150] Sophie Riley, 'Rio +20: What Difference Has Two Decades Made to State Practice in the Regulation of Invasive Alien Species?' (2014) 38 *William and Mary Environmental Law and Policy Review* 371.

[151] Chris Mcgrath, *Does Environmental Law Work? How to Evaluate the Effectiveness of an Environmental Legal System* (Lambert Academic Publishing, 2010).

[152] Secretariat of the Convention on Biological Diversity, above n 149.

[153] United Nations General Assembly, *The Future We Want* (UN General Assembly Resolution 66/288, 27 July 2012) <http://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_66_288.pdf>; IUCN Natural Resource Governance Framework, <https://www.iucn.org/sites/dev/files/import/downloads/nrgf_2_pager_final_29oct_ceesp.pdf>.

Intergovernmental Agreement on Biosecurity
Establishes national goals and objectives for biosecurity. Aims to strengthen the working partnership between governments and improve the national biosecurity system. The schedules under the agreement identify priority areas for collaboration.

National Environmental Biosecurity Response Arrangements
Establishes the national arrangements for responding to significant pest and disease incursions where there are predominantly public benefits.

National related strategies

Australian Biodiversity Conservation Strategy
Guides biodiversity conservation policies and programmes and is Australia's National Biodiversity Strategy and Action Plan under the *Convention on Biological Diversity*.

Australian Animal Welfare Strategy
Guides the welfare of all animals in Australia

Australian Pest Animal Strategy
Translates higher level policies and strategies into nationally agreed principles, goals and priorities to guide pest animal management.
Implementing the strategy through the plans below will require leadership and commitment from landholders, industry, communities and governments.

State and territory governments
Biosecurity, pest animal (strategies/plans)
Each state and territory has relevant plans or strategies that outline their pest animal policy and legislation.

Nationally significant species action plans
(e.g. National Wild Dog Action Plan) These plans and strategies provide more detailed assessments of risks and impacts of pest animals. They specify priorities, targets, preferred strategies and indicators. They also identify key stakeholder partners

Threat abatement plans
These plans describe the research, management, and any other actions necessary to reduce the impact of a listed key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* on native species and ecological communities. Plans currently exist for rabbits, feral cats, foxes, goats, cane toads, rodents on islands <100,000 ha and feral pigs.

Regional
National Resource Management plans
Each NRM region and organisation has a plan or strategy that identifies local pest animal priorities and coordination and control approaches.

Local government
Pest animal plans
Local governments are responsible for the implementation of pest animal control on public lands they manage. They identify pest animal risks and control approaches at the local level.

Community groups
Local community groups and actions
Groups are present in many local communities that plan and drive collective action across landholders in their area.

Industry
Best practice and quality assurance programs
Industry best practices often specify pest animal species and preferred management approaches relevant to the industry.

Property
Property management plans
Landholders can draw on the relevant aspects of all of these plans to develop their own property level plans.
Includes all private and public landholders and keepers of exotic species.

Farm biosecurity plans
Landholders can utilise farm biosecurity measures to protect their properties from the entry and spread of pests and diseases.

Figure 1.7: Policy framework for pest animal management

The roles and responsibilities for management are not confined to a single entity. All levels of the governance system share responsibility for pest animal management along with the non-government stakeholders. Under the *Constitution of Australia*, the states and territories have retained colonial rights to govern their own natural resources,[154] which includes the responsibility to manage invasive animals. On-ground implementation (on-farm biosecurity, on-farm pest control, backyard management, public land management, on-ground control activities, diagnostics/identification, and training and engagement) of pest animal control is primarily the responsibility of public and private landholders with support from state

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[154] As per the agreement made at Federation in 1901.

and territory governments. This sub-section gives a broad overview of the legislative and institutional arrangements for invasive animal management in Australia. Multiple strategies and reviews have discussed the institutional arrangements for pest animal management.[155] For an IACRC project, this researcher was involved in the process of preparing a resource on institutional arrangements for pest animals. (see Appendix 1).

Federal level

The Australian Government[156] provides support and strategic investment for pest animal management. Where the Commonwealth legitimately deals with a subject matter, the *Australian Constitution* provides that Commonwealth law prevails over state law in the event of an inconsistency. The *Australian Constitution* does not give the Commonwealth explicit power to enact environmental laws; however, the Commonwealth has acquired legitimate power over many environmental matters through its other explicit constitutional powers; for example its external affairs powers,[157] which enables the Commonwealth to enter international conventions, the subject matter of which then becomes a legitimate Commonwealth interest. Therefore, the Commonwealth has acquired powers to deal with pest animal management matters through the international conventions already discussed in section 1.4.4 of this chapter.

The federal government has a primary responsibility to provide stewardship for the whole of the system at the national and international level with the help of regulatory and administrative agencies. Key federal institutions responsible for pest animal management include the Department of Agriculture and Water Resources, the Department of the Environment and Energy, and the Australian Pesticides and Veterinary Medicines Authority (APVMA). The federal government responsibilities include:[158]

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[155] Commonwealth of Australia (2004), above n 145, 61–84; Martin et al (2016), above n 24.
[156] Also referred to as the 'Commonwealth' and federal government'.
[157] *Australian Constitution* sec. 51 (xxix); *Commonwealth v Tasmania* ('*Tasmanian Dam case*') [1983] HCA 21; (1983) 158 CLR 1 (1 July 1983).
[158] Invasive Plants and Animals Committee 2016, above n 48, 16

- fulfilling international obligations under the WTO, *CBD* and other international agreements and strategies, and monitoring and reporting Australia's status to meet international obligations.[159]

- incorporating biosecurity risks into threat abatement and recovery plans for threatened species and ecological communities.

- promoting and developing partnerships between government, industry and the community, including for consultation, awareness raising, information dissemination and sharing leading to a biosecurity practice.

- managing pest animals on land under its responsibility.

- maintaining capacity to prepare for, detect and respond to invasive animal incursions, including training exercises.

At the national level, the *APAS* provides guidance for the management of pest animals. The *APAS* is guided by the Intergovernmental Agreement on Biosecurity (IGAB), the National Environmental Biosecurity Response Agreement (NEBRA),[160] and two other national strategies: *Australian Biodiversity Conservation Strategy*[161] and *Australian Animal Welfare Strategy*.[162] It complements national biosecurity and animal welfare strategies. The Department of Agriculture and Water Resources administers pest animal management through the *Biosecurity Act 2015* (Cth).[163] The *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (Cth) ('*EPBC Act*') deals with the conservation of biodiversity.[164] In the *EPBC Act*, a number of pest animals are recognised as threats to native species. 'Threatened species' is one of the 'matters of national environmental significance' under the *EPBC Act* which provides the Commonwealth government with the ability to step in and identify the causes that will, or are likely to, have a significant impact on a

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[159] Department of Agriculture and Water Resources, Australia's International Biosecurity Obligations <http://www.agriculture.gov.au/biosecurity/risk-analysis/conducting/international-obligations>.

[160] The National Environmental Biosecurity Response agreement 'sets out emergency response arrangements, including cost-sharing arrangements, for responding to biosecurity incidents that primarily impact the environment and/or social amenity and where the response is for the public good' <http://webarchive.nla.gov.au/gov/20130329090427/; http://www.coag.gov.au/node/74>.

[161] Natural Resource Management Ministerial Council (2010), above n 92.

[162] *Australian Animal Welfare Strategy*, http://www.agriculture.gov.au/animal/welfare/aaws

[163] *Biosecurity Act 2015* (Cth)

[164] *EPBC Act* s 3.1.C

threatened species.[165] The *EPBC Act* provides for the identification of 'key threatening processes'[166] and 'threat abatement plans'[167] to be made jointly with the state/territories or with agencies at the state/territory level. The impacts of some pest animals have been listed as 'Key Threatening Processes' under the *EPBC Act*.[168] Threat abatement plans have been developed for goats,[169] feral cats,[170] rabbits,[171] foxes,[172] cane toads,[173] feral pigs[174] and exotic rodents.[175] The feral camel is recognised as an established pest of 'National Significance' under the *APAS* for which a national action plan has been developed.[176] The states and territories have separate legislative regimes for the protection of threatened species. For example, The *NSW Biodiversity Conservation Act 2016* and *The Nature Conservation Act 1992* (Qld) provide for the protection of ecological communities in the states of (NSW) and (QLD) respectively. The designations 'key threatening process', 'threat abatement plans', and 'pest animals of national significance' trigger the release of Commonwealth resources for action against pest animals.[177]

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[165] *EPBC Act* ss 12-24E mention matters of national environmental significance that trigger Commonwealth Government involvement. These include: impacts on World Heritage areas, National Heritage areas, Ramsar Wetlands, listed migratory species, marine environment, the Great Barrier Reef Marine Park, Water trigger; and the protection of the environment from nuclear actions.

[166] Ibid 183.

[167] Ibid s 270B

[168] Key threatening processes under the *EPBC Act* <http://www.environment.gov.au/biodiversity/threatened/key-threatening-processes>.

[169] DEWHA, *Threat Abatement Plan For Competition and Land Degradation by Unmanaged Goats* (2008).

[170] DEWHA, *Threat Abatement Plan for Predation by Feral Cats* (2008).

[171] DEWHA, *Threat Abatement Plan for Competition and Land Degradation by Rabbits* (2008).

[172] DEWHA, *Threat Abatement Plan for Predation by the European Red Fox* (2008).

[173] Department of Sustainability, Environment, Water, Population and Communities, *Threat Abatement Plan for the Biological Effects, Including Lethal Toxic Ingestion, Caused by Cane Toads* (2011).

[174] Department of Environment and Energy, *Threat Abatement Plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)* (2017).

[175] DEWHA, *Threat Abatement Plan to Reduce the Impacts of Exotic Rodents on Biodiversity on Australian Offshore Islands of Less Than 100 000 Hectares* (2009).

[176] Natural Resource Management Ministerial Council *National Feral Camel Action Plan: A national strategy for the management of feral camels in Australia*, 2010 <https://www.environment.gov.au/system/files/resources/2060c7a8-088f-415d-94c8-5d0d657614e8/files/feral-camel-action-plan.pdf>.

[177] Environment and Communications References Committee, *Effectiveness of Threatened Species and Ecological Communities' Protection in Australia.* (The Senate (Cth), 2013).
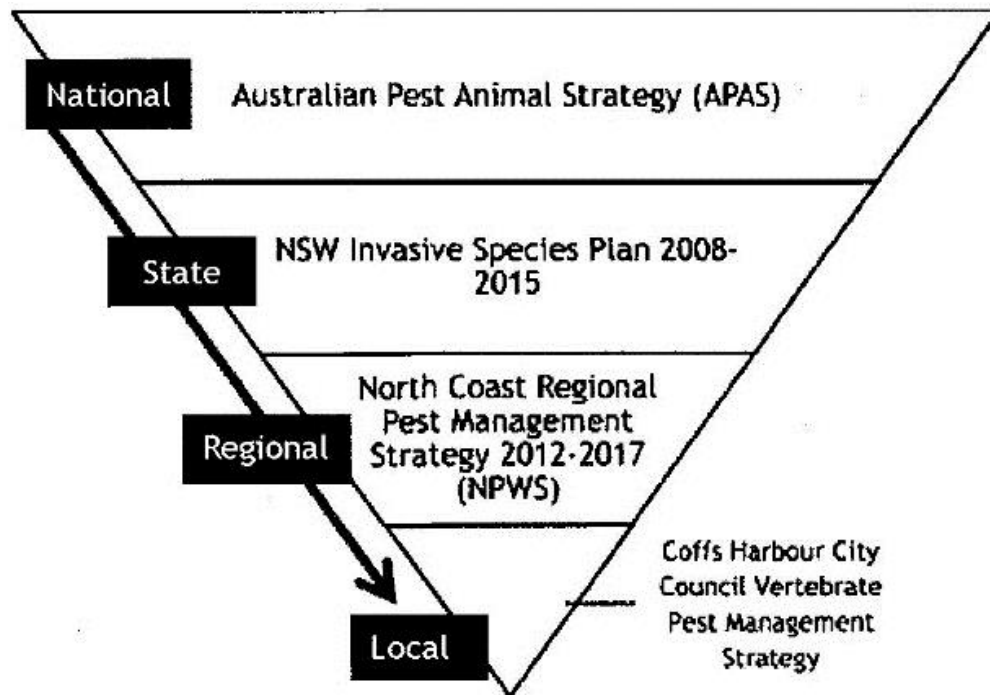
Figure 1.8: Legislative and institutional arrangements for pest animal management in New South Wales as an example
(Source: Legislation and management of pest animals in Australia, PESTSMART Publications, <https://www.pestsmart.org.au/legislation-management-of-pest-animals/>)

State/territory level

The states and the two self-governing territories have a primary responsibility to provide stewardship for the whole of a system at the state level with the help of regulatory and administrative agencies. Key government institutions at the state and territory level include primary industry and agriculture departments, biosecurity-specific agencies or divisions, natural resource management agencies, advisory boards or committees set up by the natural resource management or environment agencies, and the state government advisory groups. Non-government stakeholders at this level include community groups (eg, conservation councils), and the farmer and industry groups. Each state and territory in Australia has independent legislation, strategies and administrative arrangements for pest animal management. This leads to legislative and regulatory inconsistencies between jurisdictions. The responsibilities of state and/or territory governments include:[178]

- ensuring pest animal biosecurity within their borders, including enforcement actions and regulatory interventions.

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[178] Invasive Plants and Animals Committee (2016), above n 48, 15

- preparing for, detecting and responding to invasive animal incursions, including training.

- undertaking surveillance and diagnostics to support early detection and diagnosis of invasive animals.

- promoting and developing partnerships between government, industry and the community, including consultation, awareness raising, information dissemination and sharing leading biosecurity practice.

- managing eradication and containment programs.

- undertaking invasive animal biosecurity activities on public lands under their jurisdiction and on private land under certain circumstances.

- provide support to landholders and the community to manage established invasive animals.

- manage established invasive animals on land under its responsibility.

- regulate the keeping of invasive animals that pose significant risks.

- ensure public land management, stakeholder awareness, on-ground control activities, and training and engagement as part of its shared responsibility.

Local level

Local governments have an important role in peri-urban pest animal management since on-ground implementation of pest animal control takes place at this level. Local government is the first approachable level of government to communities. Key government stakeholders at the local level include local government officers, pest control officers, environment health officers, planners, advisory boards/committees set up by natural resource management and environmental agencies. Management at local levels is guided by regional and local pest animal management plans/strategies. The plans are administered by natural resource management agencies, catchment management authorities and local governments with assistance and input from key stakeholders and the local community (eg, volunteers, donors and philanthropists). Local government has a shared responsibility for the following:[179]

- manage local and regional incursion programs;

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[179] Ibid, 18.

- regional collaboration between local councils to deal with regional biosecurity issues;

- working in partnership with all governments, industry and the community;

- promote reporting;

- implementing state-based invasive animal management strategies and/or plans;

- providing support and information to the local community on invasive animal biosecurity issues;

- the management of invasive animals on local government-owned land; and

- backyard management, public land management, stakeholder awareness, on-ground control, diagnostics, identification, training and engagement.

Invasive animal problems rarely align with territorial boundaries. The problem challenges jurisdictional distinction between the national, state/territory and local levels. The administrative arrangements of multiple levels of government have to address this problem. The need for governance through multi-level mechanisms is reflected in decision-making and implementation for invasive animal management.[180] The multiplicity of roles within the governance structure compels governments to work with non-government stakeholders across administrative levels and sectors. The coordination requires arrangements between government and non-government stakeholders which blur traditional governance approaches such as jurisdictional control, subordination and power. This involves an interplay between individual institutions and their interactions with multiple institutions. Socio-economic, cultural and political influences impact on managerial action at the individual and collective levels. Institutional decisions at these levels determine provisioning, access and distribution of resources; allocation of responsibilities[181] and exercise of power[182] during implementation. A range of innovations can facilitate implementation of pest animal controls but institutional arrangements are identified constraints on adoption and implementation of innovations to achieve effective invasive species

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[180] This is particularly a case in peri-urban areas where intersection of jurisdictions lead to overlapping powers and authorities between state and local governments.

[181] The responsibility is shared; including the responsibilities of biosecurity agencies and the community comprising of people and businesses that are exposed to risks posed by the invasive animals.

[182] E Östrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (Cambridge University Press, 1990).

management.[183] Understanding these institutional factors is a pre-requisite for improved invasive animal management. The relevant literature on these issues is described in Chapter 2.

1.4.8 Peri-urban context

Peri-urban Australia is the transitional zone between rural and urban areas.[184] Key factors that distinguish peri-urban landscapes from other areas include unclear boundaries and their dynamic and transitional nature. Land fragmentation, diverse property uses and the process of peri-urbanisation[185] have significantly changed the Australian landscape.[186] The phenomenon of peri-urbanisation is influenced by the idea of 'livability' which comprised of inter-related and varying values.[187] The process of peri-urbanisation involves complex elements including conversion of rural land for new activities, in-migration of new landowners, formation of diverse communities, competing land uses, smaller land areas than in rural settings, high rates of population growth and development pressures.

The process of peri-urban development is evident through a continuous but uneven conversion of farmland, establishment of industry and population shifts.[188] The development of peri-urban areas is considered vital for economic growth. Peri-urban growth in Australia is characterised by cities which continue to expand into natural areas.[189] For example: encroachment of the threatened Grassy Eucalypt Woodland of the Victorian Volcanic Plain by the peri-urban zone in Melbourne; and encroachment on the Cumberland Plain Woodland in the Sydney Basin. Peri-urban areas pose

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[183] Sophie Riley 'Law is Order and Good Law is Good Order: The Role of Governance in the Regulation of Invasive Alien Species' (2012) 29 (16) *Environmental and Planning Law Journal*,16.

[184] Cecily Maller, Robert Kancans and Anna Carr, *Biosecurity and Small Landholders in Peri-urban Australia* (Australian Government Bureau of Rural Sciences, 2007) 11.

[185] Jenny Wadsworth, Darryl Low Choy, Peri-Urbanisation and Biosecurity, *A Planning Perspective* <http://soac.fbe.unsw.edu.au/2011/papers/SOAC2011_0235_final.pdf>.

[186] A Bryan et al, 'The Second Industrial Transformation of Australian Landscapes (2013) 5 *Current Opinion on Environmental Sustainability* 278.

[187] M Ruth and R S Franklin, 'Livability for All? Conceptual Limits and Practical Implications' (2014) 49 *Applied Geography* 18.

[188] Andrew Butt, Melissa Kennedy and Marco Amati, 'Peri-Urbanization "Beyond the Edge" or a Window into the Future?' in Melissa Kennedy, Andrew Butt and Marco Amati (Eds), *Conflict and Change in Australia's Peri-Urban Landscapes* (Routledge, 2016) 1.

[189] The literature describes this phenomenon in different ways. For example, in Europe and North America, it is described as 'shrinking cities': Manuel Wolff and Thorsten Wiechmann, 'Urban Growth and Decline: Europe's Shrinking Cities in a Comparative Perspective 1990–2010' (2018) 25(2) *European Urban and Regional Studies* 122.

unique challenges in terms of residential zoning,[190] food-producing land, urban
agriculture[191] and development rights.[192] The fragmentation of land in peri-urban
areas is facilitated by demands of affluent peri-urban dwellers interested in lifestyle or
hobby farming. This increases demands for natural resources and services.[193] Existing
residents may oppose such developments which often creates politically sensitive
conflicts in peri-urban areas.[194]

Peri-urban landholders tend to produce higher value horticultural products compared
with their non-peri-urban counterparts.[195] Considering market proximity, these
commodities include nursery, cut flowers, perishable vegetables and poultry. The
estimated value of agriculture in peri-urban areas accounts for 20 to 25 per cent of the
gross value of total agricultural production in Australia.[196] Peri-urban settlers have
diverse motivations and competing interests which leads to fragmentation of land,
multiple tenures and varied land uses.[197] The encroachment of human land uses puts
increasing pressure on biodiversity.[198] The transformation of ecological systems,
ecological diversity and ignorance of the value of natural systems in peri-urban areas
favours invasive animals. In peri-urban areas the frequent movement and density of
people, animals and vehicles facilitates the spread of invasive species.[199]

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[190] Wadsworth and Low Choy, above n 185.
[191] For eg: the idea of regional city garden in Penrith, Western Sydney; the idea of light and dark agriculture for the White Bay-Rozelle Bay precinct in the west of the Sydney Central Business District.
[192] Ben P Harman, Rick Pruetz and Peter Houston, 'Tradeable Development Rights to Protect Peri-Urban Areas: Lessons from the United States and Observations on Australian Practice (2015) 58(2) *Journal of Environmental Planning and Management* 357, doi: 10.1080/09640568.2013.859130.
[193] G Smith and J Scott, *Living Cities – An Urban Myth?* (Rosenberg Publications, 2006).
[194] Buxton et al, above n 20. For eg Sydney region: I Sinclair, R Bunker and D Holloway (2003) *From the Outside Looking In: Planning and Land*, 2003 <http://www.ruralplanning.com.au/library/papers/soac03.pdf>.
[195] Maller, Kancans and Carr (2007), above n 184.
[196] P Houston, 'Re-Valuing the Fringe: Some findings on the Value of Agricultural Production in Australia's Peri-Urban Regions' (2005) 43(2) *Geographical Research* 209. Houston 2005 examined agricultural production in Statistical Local Areas (SLAs) outside urban areas in five mainland states of Australia using ABS Census of population and Housing Data.
[197] Michael Buxton and Darryl Low Choy, *Change in Peri-urban Australia: Implications for Land Use Policies*, SOAC <http://soac.fbe.unsw.edu.au/2007/soac/changeinperiurbanaustralia.pdf>.
[198] Coleman (2017), above n 23, 5.
[199] Buxton, et al (2006), above n 20.

The presence of a range of pathogens in pest animals has a potential to spread diseases which can affect livestock, native species and humans.[200] Studies have pointed out the human health risks due to pathogens and parasites carried by dingoes in peri-urban regions,[201] and feral pigs (with numbers estimated at up to 24 million including in peri-urban areas of Australia) can act as reservoirs for zoonotic diseases.[202] Potential risks of invasive animals are likely to be higher in peri-urban areas than other areas due to concentration of people and multiple industries. These include the risks of invasive animal attacks on humans; for example in Queensland, wild dogs have reportedly attacked humans.[203]

Many peri-urban areas contain national parks in which are found native animals and wild introduced species. This proximity increases the likelihood of encounters between humans and wild animals in peri-urban areas.[204] The conflict situations primarily include: humans killed or injured by wild animals; livestock or other animals killed or injured by wild animals; damage to property by wild animals and wild animals getting killed or injured.[205] The intensity of conflicts increases with the economic losses of livestock and risks to humans.[206]

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[200] W R Henderson, *Pathogens in Vertebrate Pests of Australia* (IACRC, 2009).

[201] Ibid; B Brown and D B Copeman, 'Zoonotic Importance of Parasites in Wild Dogs Caught in the Vicinity of Townsville' (2003) 81(11) *Australian Veterinary Journal* 700; D Jenkins, L Allen and M Goullet, 'Encroachment of *Echinococcus Granulo-Sus* into Urban Areas in Eastern Australia' (2008) 86(8) *Australian Veterinary Journal* 294.

[202] Factsheet, Feral pigs in Queensland Distribution, Ecology and Impact <http://hcmif3k7kt343pwrn2ytkt39.wpengine.netdna-cdn.com/files/2013/02/IPA-Feral-Pigs-Qld-PA6.pdf>.

[203] *Gold Coast Bulletin* <http://www.goldcoastbulletin.com.au/news/gold-coast/wild-dogs-hunt-livestock-terrorise-ruralresidential-communities-on-gold-coast-in-broad-daylight/news-story/bc75f16093920655cc8c301bf3f68290>.

[204] M R Conover, *Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management* (CRC Press, 2001).

[205] B Raguse 'Doggone Scared – Children's Lives at Risk,' *Queensland Times* 14 March 2000, 1; S Ryan, 'Pet-mauling wild dogs spur urban fury' *The Courier-Mail*, 10 March 2000, 5; C A Marks, and T E Bloomfield, 'Distribution and Density Estimates for Urban Foxes (*Vulpes vulpes*) in Melbourne: Implications for Rabies Control' (1999) 26(6) *Wildlife Research* 763; C A Marks and T E Bloomfield, 1999, 'Bait Uptake by Foxes (*Vulpes vulpes*) in Urban Melbourne: The Potential of Oral Vaccination for Rabies Control' (1999) 26(6) *Wildlife Research*, 777.

[206] R Woodroffe, 'Predators and People: Using Human Densities to Interpret Declines of Large Carnivores. (2000) 3 *Animal Conservation* 165; A Treves and Karanath, 'Human-Carnivore Conflict and Perspectives on Carnivore Management Worldwide' (2003) 17 *Conservation Biology* 1491.

1.4.8.1 Invasive species problem in peri-urban areas

Peri-urban landscapes in Australia harbour key natural resources including, for example, 40 per cent of protected ecological communities, over 50 per cent of threatened species and internationally important wetlands.[207] Describing urban development pressures and their impact on environment, the *SOE* report states:

Cities are often located in areas with high biodiversity, and the process of urbanisation itself is likely to have led to many species that formerly occurred in these places now being threatened. In 2015, Ives et al. analysed the extent to which the distribution of 1643 species of national environmental significance under the EPBC Act overlapped with 99 Australian cities of more than 10,000 residents. They found that 25 per cent of listed plants and 46 per cent of listed animals had distributions that intersected with cities. The distributions of 8 threatened species (all plants) entirely overlapped with cities, whereas 51 (10 per cent) of the 503 threatened species found in cities had more than 30 per cent of their distribution in urban areas. The research showed that cities contain substantially more threatened species per unit area than non-urban areas.[208]

The number of invasive animal species is increasing throughout the peri-urban regions in Australia[209]. The increase in numbers is primarily due to the imbalances in ecological and social systems in these areas. A well-balanced ecological system requires undivided, undisturbed and extensively large areas of lands. Peri-urban development transforms ecological and socio-economic systems through division/sub-division of land involving farming land, new businesses and industries, urban areas and population growth.[210] The transitional zone invites animals from the rural space; for example, feral pigs, foxes or wild dogs migrate from bushland.

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[207] Buxton et al, (2006) , above n 20.
[208] Cresswell and Murphy (2017), above n 1.
[209] Biosecurity Queensland, *Wild dog management strategy 2011–2016* (QLD Department of Employment, Economic Development and Innovation, 2011); B L Allen, 'Urban Dingoes (*Canis lupus* dingo and hybrids) and human hydatid disease (*Echinococcus granulosus*) in Queensland, Australia' In R M Timm and J M O'Brien (eds), *Proceedings of the 22nd Vertebrate Pest Conference* (Berkeley, CA, 2011) 334; B L Allen and P West, 'The Influence of Dingoes on Sheep Distribution in Australia' (2013) 91 *Australian Veterinary Journal* 261; M S O'Keefe and C S Walton, *Vertebrate Pests of BuiltUupAreas in Queensland* (Queensland Department of Natural Resources and Mines, Land Protection, 2001).
[210] Low Choy et al (2007), above n 22.

The next sub-section describes the characteristics of Australian peri-urban areas that contributes to the invasive species problem.

1.4.8.2   Complexities in peri-urban invasive animal management

Peri-urban areas create a special set of problems in the management of invasive animals:

Population density: The *SOE* 2016 report identifies 'urban and peri-urban pressure jumping to a much higher level due to population growth and failure to manage human demands on the environment' as a major and almost certain risk to biodiversity.[211]

Globally, the numbers of people living in urban areas exceeds those living in rural areas.[212] This is evident in Australia. More than 80 per cent of Australia's population resides in urban areas.[213] The continuous increase in population in urban areas across Australia requires infrastructural and amenity support services. New infrastructure, such as construction of roads and buildings, involve fragmentation of the natural environment. Providing services requires new agencies. The decision-making process for peri-urban invasive animal control thus involves both urban and rural priorities. Urban priorities are often decided on the basis of socio-economic development whereas farming, environmental rules and production outcomes are expected from rural areas.[214] Peri-urban areas involve both sets of priorities, simultaneously.

Demographic diversity – Demographic heterogeneity is the distinguishing feature of peri-urban Australia. The peri-urban population involves more land owners, managers and occupiers than in rural areas. The classification of peri-urban residents as 'the seekers, the survivors, the speculators and the strugglers' describes the heterogeneous social composition of peri-urban communities.[215] Peri-urban areas generally enjoy a greater diversity of cultures, ethnicities and world views than rural areas.

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[211] Cresswell and Murphy (2017), above n 1, 173.

[212] *Population Distribution, Urbanization, Internal Migration and Development: An International Perspective* (UN Department of Economic and Social Affairs, Population Division, Publication no. ESA/P/WP/223, 2011) 363.

[213] *Australia Population 2018*, <http://www.population.net.au/>.

[214] M D Farrier, A H Kelly and A Langdon, 'Biodiversity Offsets and Native Vegetation Clearance in New South Wales: The Rural/Urban Divide in the Pursuit of Ecologically Sustainable Development. (2007) 24(6) *Environmental and Planning Law Journal* 427.

[215] Low Choy et al (2007), above n 22.

Demographic variations lead to greater cultural diversity, which has significant implications for public management.[216] The inter-section of multiple values and interests create conflicting situations for pest animal management in peri-urban areas.[217] For example, urban landholders may be unconcerned by rabbit populations since rabbits are not seen as pest animals by them, contrasting with the concerns of farmers sharing the same landscape.

Property size and intensive production practices: Division of land in the peri-urban space creates smaller property blocks, each individually owned. Thus, more properties and humans in peri-urban areas can experience negative impacts from a similar number of pest animals than the impacts would be on a piece of the same property size and similar number of animals in a rural environment. However, their response to the issues are likely to be more diverse than for a similar rural area.

In peri-urban areas, property size affects the nature of primary production, at multiple scales. Diversity in agricultural production creates differences in how a particular issue is valued by people engaged in each sector.[218] For example, wild dogs and foxes may be a problem for those engaged in a poultry sector or who have livestock on their properties but it is unlikely to be an issue for others who may be engaged in the production of cut-flowers and vegetables, and those who do not have livestock. Evaluation of cost and benefits also varies according to sectoral interests of people. For example, feral deer are a cost for primary producers engaged in horticulture but hunters value them as a trophy species – and for many people within a community deer have an aesthetic value. In addition to agriculture and agriculture-related sectors, other businesses contribute towards peri-urban employment and economic growth but many have no interest in invasive species issues or control.[219] Owing to the nature of

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[216] H Foster, B Towers and J Whittaker, 'Peri-Urban Melbourne in 2021: Changes and Implications for the Victorian Emergency Management Sector. 2013 28(3) *Australian Journal of Emergency Management* 6.

[217] Aslin et al (2004), above n 20; J Oliver and C Walton, *Pests in Queensland Baseline Survey 2003: A Survey of Primary Producers and Residents of Regional Centres and Large Country Towns* (Land Protection, Department of Natural Resources, Mines and Energy, 2004).

[218] P Klepeis, N Gill and L Chisholm, 'Emerging Amenity Landscapes: Invasive Weeds and Land Subdivision in Rural Australia' (2009) 26 *Land Use Policy* 380.

[219] David McLaren et al, 'Highlighting the Complexity of Interactions between Peri-Urban Environments and Weed Management Using Case Studies from Southern Victoria' in Melissa Kennedy, Andrew Butt and Marco Amati (eds), *Conflict and Change in Australia's Peri-Urban Landscapes* (Routledge, 2016) 189.

these businesses, invasive animals do not have a direct effect on their economic activity. The fragmentation of land use leads not only to cadastral boundaries but also 'socially constructed boundaries'.[220] Diversity in land-use pattern, habitats and human activities favours the establishment and spread of multiple invasive animal species in peri-urban areas[221] and social attributes add to the complexities of invasive animal control.

Attitudes towards control: In peri-urban space, the majority of the population lack an opinion on control due to lack of direct knowledge or interest or information on pest animal issues.[222] This is generally attributed to the disconnection of peri-urban producers from traditional agricultural networks in Australia.[223] This lack of an in-depth understanding and awareness of the invasive animal problem makes it difficult to implement controls. Peri-urban residents have varying experiences and attitudes towards pest animal management[224] and may even have varied attitudes towards domestic animals, which are often allowed to roam freely. Based upon such attitudes, peri-urban dwellers may generally object to production-related control in rural areas. An abundance of food, including livestock, plants, domestic animals, refuse and waste food, can support invasive animals. For the majority of population in peri-urban areas, interaction with wild animals are a positive experience, which varies with their conceived notions and expectations about wild animals and the control practices followed by rural communities may be perceived as a hurdle in the enjoyment of landscapes and amenity.[225]

Peri-urban individuals have varied perceptions about pest animal control methods. Often, these perceptions are negative about using control methods and techniques which involve application of chemicals or poisons to kill animals, which may cause painful death and suffering to the target animal. The perceptions are largely based on animal welfare concerns and cultural values and may receive support from animal

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[220] Wadsworth and Low Choy, above n 185.

[221] Heather J Aslin and Nicole A. Mazur, *Biosecurity Awareness and Peri-Urban Landholders: A Case Study Approach* (Australian Government Bureau of Rural Sciences, 2005); Low Choy et al, above n 22.

[222] Aslin and Mazur (2005), above n 221.

[223] Cresswell and Murphy (2017), above n 1, 171

[224] Maller, Kancans and Carr (2007), above n 184.

[225] D J Decker, S J Riley and W F Siemer (eds), *Human Dimensions of Wildlife Management* (Johns Hopkins University Press, 2nd ed, 2012) Ch 1.

welfare organisations, and may culminate in political campaigns, thus preventing the implementation of coordinated control programs.

The management of invasive animals in peri-urban areas thus assumes complexity due to the confluence of rural and urban institutional arrangements. Formal institutional arrangements coupled with human behavioural elements increase the complexity of peri-urban invasive animal management. The convergence of multiple roles and responsibilities, jurisdictions and divergent interests lead to conflicted framing of the invasive animal problem and solutions.[226]

To effectively manage this problem, it is crucial to improve our understanding of the dynamics of pest animal control in peri-urban areas. Until recently, peri-urban environments were not regarded as a separate 'context' of management by the biosecurity and other government agencies. The *SOE* report emphasised the need to address peri-urban specific biosecurity challenges.[227] The recent review of the IGAB,[228] identified the need for improved governance and institutional arrangements to address national biosecurity challenges, including the management of established pest animals.[229] The review report identifies increasing urbanisation as one of the leading causes of biosecurity risks.[230] It is crucial to overcome institutional challenges in implementing law and policy for an effective biosecurity system.[231]

1.5 Research question

The question this thesis seeks to answer is:

What are the legal and institutional impediments that need to be overcome for effective invasive animal control in peri-urban Australia?

This study aims to investigate the institutional complexities and dynamics of peri-urban invasive animal control, and suggest possible improvements for control. This thesis is concerned with the effective use of technological, managerial innovations and institutional processes for invasive animal control in peri-urban spaces. Finding

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[226] S S Batie, 'Wicked Problems and Applied Economics' (2008) 90 *American Journal of Agricultural Economics* 1176.
[227] Cresswell and Murphy (2017), above n 1, 171.
[228] Council of Australian Governments, *Intergovernmental Agreement on Biosecurity (IGAB) 2012*.
[229] Craik, Palmer and Sheldrake, (2017), above n 5, 86.
[230] Ibid 17.
[231] Ibid.

effective solutions to a 'wicked problem' is not easy.[232] To understand the dynamics of an invasive animal problem requires an understanding of complex systems.[233] An effective strategy for the management of this wicked problem has to consider not only biological but also economic, political and institutional structures.[234] The 'wickedness' of the invasive animal management problem and the recent political adoption of shared responsibility in biosecurity policy demands analysis of how the implementation dynamics of the law will unfold; particularly in the peri-urban context. Understanding the implementation of biosecurity legislation, policy and practice can contribute towards improved institutions for invasive animal control and management in peri-urban Australia.

This thesis provides a critical examination of the issues affecting shared responsibility, and the peri-urban institutional challenges to implementing control of invasive animals. One research focus is to understand how government and community stakeholders understand their responsibilities. Taking into account the nature of invasive animal management in peri-urban areas, this research has to consider many disciplinary areas, including technological innovation, natural resource management, law, governance and planning. Individual and collective efforts both determine the success or failure of control. Legal scholarship affirms such polycentric and scientifically uncertain problems as challenging environmental problems.[235] The research problem thus necessitates an interdisciplinary approach[236] that draws on a variety of 'concepts, assumptions, expectations, beliefs, and theories'.[237]

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[232] Australian Public Service Commission, *Tackling Wicked Problems, A Public Policy Perspective*, 2007 <https://www.apsc.gov.au/__data/assets/pdf_file/0005/6386/wickedproblems.pdf>; V A Brown, J A Harris and J Y Russell (eds), *Tackling Wicked Problems: Through the Transdisciplinary Imagination* (Earthscan, 2010).

[233] *Prioritising Adaptation Actions for Managing Invasive Animals Under Climate Change* <http://www.invasiveanimals.com/research/phase2/land-pests/forecasting-and-adaptive-management-and-planning/managing-invasive-animals-under-climate-change/>.

[234] Donella Meadows, *Thinking in Systems - A Primer* (Chelsea Green Publishing Co, 2008); Paul Martin, *Review of the National Landcare Program* (DAFF, 2003).

[235] Michel Callon, 'An Essay on Framing and Overflowing: Economic Externalities Revisited by Sociology' in Michel Callon (ed), *The Laws of the Markets* (Blackwell 1998) 260; Elizabeth Fisher, 'Environmental Law as "Hot" Law' 2013 25(3) *Journal of Environmental Law* 347, <https://doi.org/10.1093/jel/eqt025>.

[236] Dave Owen and Caroline Noblet, 'Interdisciplinary Research and Environmental Law (2015) 41(4) *Ecology Law Quarterly*.

[237] J A Maxwell, *Qualitative Research Design: An Interactive* Approach (Sage Publications, 2005).

This study adopts a problem driven approach to analysing complex institutional challenges 'to ask questions about the incumbent ways of doing things, and promote a search for alternatives that actually offer a solution (rather than just providing new ways of doing things)'.[238] Government studies and reports in Australia have highlighted the institutional issues. Recently completed studies[239] have provided recommendations for institutional reforms. This research is complementary to the prior institutional studies but has a focus on peri-urban specific institutional impediments.

1.6 Underlying assumptions

The identification of institutional impediments to improve pest animal management involves two inherent challenges. These challenges are rooted in philosophical and ethical perspectives relating to pest animal control and methods employed for pest animal control. Firstly, this thesis assumes that invasive animals must be controlled. Philosophical justification for killing animals is not the subject of this research; however, ethical considerations do form part of the challenge of control.

Secondly, the control technologies are prescribed on the basis of scientific research. Apart from purely scientific research, human perspectives play an important role in deciding the utility and risks of control techniques. Human perspectives reflect philosophical, ethical or cultural beliefs and verified or unverified experiences relevant to a particular technology. The second assumption within this thesis is that the best way of advancing pest animal control is by using technological control to control pest animals and so the focus of the work is on the institutional settings needed to achieve this. A plurality of views on animal killing or the utility of technological control is a reality. Some people would contest both of these assumptions. To restated, the researcher is aware of this reality but it is not within the scope of this research to evaluate these complex socio-political debates.

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[238] Matt Andrews, Lant Pritchett and Michael Woolcock, 'Doing Problem Driven Work' (Faculty Research Working Paper Series, CID Working Paper No. 307, Harvard Kennedy School, December 2015).

[239] Martin et al (2016), above n 4; Craik, Palmer and Sheldrake (2017), above n 5.

1.7 Structure

Chapter 1 introduced the nature of the invasive animal problem in Australia. It explained basic concepts used throughout the thesis. It described the complexities of invasive animal control and outlined the need for adoption and implementation of innovations for effective pest animal management. It also established the significance of the problem. The case is argued that the current regime for pest animal management neglects/overlooks the importance of institutions in successful adoption-implementation of innovations, particularly in the peri-urban context. Identifying how institutions constrain adoption-implementation of innovations and institutional improvements can contribute to effective pest animal management.

Chapter 2 describes innovations for invasive animal management; the relevance of technologies and their adoption in peri-urban invasive animal management; and describes the institutional issues of innovation-adoption theory. A set of criteria, comprising four variables, is established to facilitate the identification of institutional issues. This draws on the concept of innovation adoption/implementation applied in an institutional context, and on the concept of political economy and risks for pest animal control innovation. The chapter also outlines the boundaries of this research, describing specific technologies that were considered when investigating peri-urban institutional issues.

Chapter 3, describes the basis of methodology and the suite of methods used to identify institutional impediments to effective invasive animal management in peri-urban areas of Australia. The thesis uses an evidence-based policy approach to understand complex institutional issues involved in implementing innovations for pest animal management. Taking into account, the inter-disciplinary nature of this research, the methodological approach considers a number of variables relating to control innovations and their complex interaction with law and policy at the implementation level. The evidence-based policy approach facilitated a cluster of inter-related evidence on institutional issues:

The literature review covered theoretical aspects of adoption and implementation of pest animal control innovations. The literature review (Chapters 1 and 2) and a scoping study (Chapter 4) provided the basis for theoretical hypotheses about how

institutional issues that may impact on implementation of controls and the effective adoption of innovations considered in this research.

A case study approach examined two Australian peri-urban jurisdictions to examine institutional issues in implementing control innovations for selected pest animals in this research namely: feral deer management in peri-urban Sydney and wild dog management in peri-urban Brisbane (Chapter 5). Each case study was examined to uncover peri-urban specific institutional issues that arise during frontline control action using the desktop review of key policy documents and interviews with pest animal control experts.

The institutional issues obtained through the first two levels of evidence were analysed using the theoretical perspectives, to propose nine hypotheses on institutional impediments. The small sample survey provided a third level of evidence of the reasonableness of the hypotheses, and more details about the institutional impediments (Chapter 6).

Finally, the evidence-based hypotheses was compared with the findings from two other independent biosecurity policy reviews. The process of triangulating a body of evidence from four different perspectives cumulatively provided the basis to indicate the validity of hypotheses on nine peri-urban institutional impediments.

In summary, Table 1.4 outlines the context and type of evidence gathered during this research to derive an evidence-based inference on peri-urban institutional impediments. The evidence is gathered in four stages: familiarisation of issues (Chapter 1 and 2), scoping study (Chapter 4), Case studies and a small scale survey of expert stakeholders (Chapters 5 and 6), and triangulation and confirmation (Chapter 7).

Table 1.4: Description of evidence obtained in this research

Chapter	Title	Context of evidence	Type of evidence & evidence triangulation
1	Introduction	Institutional complexities in peri-urban invasive animal management	Literature on peri-urban institutions for pest animal control and management

Chapter	Title	Context of evidence	Type of evidence & evidence triangulation
2	Adoption and Implementation of Innovations: Practice and Institutional Theory in Pest Animal Management	Pest animal control and management innovations • Technological innovations • Managerial innovations • Innovations in law and enforcement • Resourcing innovations	Policy documents describing pest animal control innovations, National biosecurity legislation and policy, State-level biosecurity legislation, Pest animal control and management strategies
		Peri-urban regions, pest animal species and relevant innovations	National, State and local government websites, Demographic data on peri-urban regions in Australia, Policy documents, State and local government legislation, strategies and plans relating to pest animal management.
		Theoretical perspectives	Literature on innovation adoption and implementation, Literature from political economy, literature on risks
4	Legal and Institutional Issues – Scoping Study	Preliminary hypotheses on institutional issues in innovation-adoption and implementation for pest animal management	Observations during the Invasive Animals CRC workshops, Literature on invasive species management
5	Legal and Institutional Issues – Case Studies	Peri-urban specific institutional issues in practice, based on front-line pest animal control obtained through case studies in two Australian peri-urban jurisdictions: • Wild deer management in peri-urban Sydney • Wild dog management in peri-urban Brisbane	Policy documents, Legislation, reports, news articles, draft plans, minutes of the meeting, other articles and literature on case studies; Conversations and semi-structured interviews with the pest animal control experts.
6	Analysis and Discussion of the Research Findings	Final hypotheses about 9 peri-urban institutional impediments	Evidence on institutional issues obtained through previous stages; results of the small sample survey

Chapter	Title	Context of evidence	Type of evidence & evidence triangulation
7	Conclusion and Recommendations	Validation of final hypotheses about 9 peri-urban institutional impediments	Evidence from two recently conducted credible biosecurity policy reviews: Policy Review 1 - Priorities for Australia's biosecurity system, An independent review of the capacity of the national biosecurity system and its underpinning Intergovernmental Agreement Canberra. Policy Review 2 - Effective Citizen Action on Invasive Species: The Institutional Challenge. Invasive Animals Cooperative Research Centre: Canberra.

Chapter 4 explores key institutional issues in implementing innovations for invasive animal control. Taking into account the key elements of invasive animal management, it describes institutional constraints that hinder the process of implementing controls. The institutional issues outlined in this chapter serve as a basis to investigate two peri-urban specific issues in Chapter 5.

Chapter 5 describes the case study work conducted during this research. The case studies discuss innovations for wild deer and wild dog control in peri-urban areas of Sydney and Brisbane respectively. The case studies were chosen to illustrate broader facets of pest animal management that can arise in the peri-urban institutional context for an innovation.

Chapter 6 describes the findings of this research. In this chapter, the methodological approach and theories are applied to the evidence collected. It summarises the institutional impediments in implementing pest animal management innovations.

Chapter 7 concludes the thesis by synthesizing key research findings, and discusses the significance of the research and areas of further research.

Figure 9 provides an overall synthesis of the elements of the thesis.

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│              Chapter 1: Introduction                │
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│   Chapter 2: Adoption and Implementation of Innovations │
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│              Chapter 3: Methodology                 │
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│              Chapter 5: Case studies                │
│                                                     │
│   a)  Feral deer management in peri-urban Sydney    │
│   b)  Wild dog management in peri-urban Brisbane    │
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│  Chapter 6: Analysis and Discussion of the findings │
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│     Chapter 7: Conclusion and Recommendations       │
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Figure 1.9: Thesis structure

1.8 Conclusion

This thesis argues that to improve invasive animal management in peri-urban Australia there needs to be more emphasis on institutional dimensions of adoption and implementation of innovations. The following important themes relevant to this research have been articulated throughout Chapter 1:

• Management of invasive species in peri-urban areas is vital for biodiversity conservation and environment protection.

• Peri-urban areas are important for Australia's economic development, but it is equally important to address the problem of invasive animals in these areas.

- Invasive animal management is a complex endeavour because of the autopoietic characteristics of invasive animals. Peri-urban institutional arrangements add to the overall complexity in invasive animal management.

- The peri-urban context is unique. It is different from an entirely rural or an entirely urban context. Traditional invasive animal management has been designed around different sets of approaches for urban and rural contexts. For example, pest animal management in urban areas revolves around public health and sanitation whereas in the rural context it revolves around the protection of farms, agricultural and rural industries. Institutional structures and organisations for pest animal management have been designed around such contexts. Peri-urban spaces require a synthesis of these quite distinct approaches.

The remainder of this thesis describes an investigation of institutional impediments to adoption and implementation of innovations for effective invasive animal management in the peri-urban context.

CHAPTER 2: ADOPTION AND IMPLEMENTATION OF INNOVATIONS

2.1 Introduction

The previous chapter discussed the research question for this study, the relevance of the research and contextual issues, which included describing the laws and institutional arrangements for pest animal management. Chapter 1 also outlined the key objective of this research, which is to identify institutional impediments to adoption and implementation of innovations that determine the effectiveness of pest animal management in peri-urban areas.

This chapter describes relevant innovations and the process of investigation used to identify the institutional impediments.

This chapter has three purposes:

1. To describe the innovations used generally for pest animal management: For the purpose of describing innovations for pest animal management, the innovations are outlined in two major categories: technological and managerial. Chapter 1 (section 1.4.5) described the logic behind the need for technological and managerial innovations for strategic pest animal management. The innovations described in this chapter are drawn from literature, and research initiatives led by the IACRC.

2. To outline specific innovations that were considered in the empirical phase of this research project: A range of innovations are available for pest animal management. Given resource constraints, it was important to limit the scope of research. Specific innovations were considered on the basis of applicability, utility and the institutional context for the management of pest animals.

3. To describe institutional issues based on innovation-adoption theory: The identification of institutional impediments required a framework to examine issues in innovation adoption and implementation. The theoretical discussion on institutional issues in this chapter leads to an analytical framework comprising four theoretical variables used to interpret institutional issues. The variables-based analytical framework is informed by interdisciplinary theories.

This chapter has four sections. Technological and managerial innovations are described in sections 2.2 and 2.3 respectively. Section 2.4 articulates boundaries of the research by describing innovations, pest animals and peri-urban regions selected in this research. Section 2.5 discusses institutional issues of innovation adoption and implementation theory with an objective to develop an analytical framework to facilitate interpretation of institutional issues.

2.2 Technological innovations

This section describes technological innovations for pest animal management by categorising them into two types: a) technologies for effective control, and b) technologies for effective information and communication. Sub-section 2.1.1 describes innovations in poisoning, fencing, trapping, biological control and fertility control. Sub-section 2.1.2 describes innovative tools including FeralScan Pest Mapping, collars for tracking, genetic technologies, cameras/sensors and drones/remote sensing technologies.

2.2.1 Technologies for effective control techniques

Pest animal control technologies generally comprise the following elements: a technique (eg, coordinated control, trapping), an instrument or a mechanical device (eg, ejectors, tranquilizers, traps) and a chemical or biological product (eg, poison, Sodium monofluoroacetate, commonly referred as 1080, is the widely used poison for baits).[240] As per the *APAS* recommendation, an ideal control technique for feral animals should be humane, target-specific, efficient, cost-effective and safe.[241] For a control technique, the overarching goal of innovation is to improve the completeness and precision with which pest animals can be killed. Accuracy helps to achieve less impacts on non-target species and the environment. Innovations in control techniques are focussed on improving safety (to non-target species, environment or human health), ease in practical use, cost effectiveness and humane killing of the target species. Control measures used in the management of pest animals include lethal methods (eg, shooting, poisoning, trapping) and non-lethal methods (eg, exclusion

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[240] Department of Agriculture and Water Resources, *Control Tools and Technologies for Established Pest Animals and Weeds Programme: grant guidelines*, 2016 <http://www.agriculture.gov.au/SiteCollectionDocuments/pests-diseases-weeds/weeds-pests-guidelines.pdf>.

[241] Invasive Plants and Animals Committee (2016), above n 48, 13.

fencing, fertility control).[242] There are ethical and political questions about each method, but these are not the subject matter of this thesis.

The control techniques outlined below are poisoning, containment, trapping, biological control and fertility control.

Poisoning

Poisoning is the most commonly used technique for vertebrate pest animal control in Australia because it can achieve high levels of control at a minimal cost. The application of poisons is considered cost-effective for a wide range of species and is applied over large areas and for many species including rabbits, foxes, feral pigs and wild dogs.[243] The most commonly used poisons in Australia are 1080,[244] yellow phosphorous,[245] strychnine[246] and pindone.[247] These poisons are applied to a bait selected on the basis of its cost and effectiveness in deployment to the target species. For example, fresh meat baits laced with 1080 are supplied by state governments for the control of carnivorous pest animals. Application of poisons can have a disadvantage of poisoning native fauna and other non-target species, including humans. Poisons can have multiple effects on target animals and non-target species with severe animal welfare implications. For example, poisoning from 1080 leads to disturbance in the central nervous system, convulsions, hyper excitability and

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[242] T Sharp and G Saunders, (2011). A Model for Assessing the Relative Humanness of Pest Animal Control Methods (Australian Government Department of Agriculture, Fisheries and Forestry, 2nd ed, 2016).

[243] Humane Vertebrate Pest Control Working Group , 'A National Approach Towards Humane Vertebrate Pest Control' (Discussion paper arising from the proceedings of an RSPCA Australia/AWC/VPC joint workshop, 4– 5 August 2014, Melbourne, RSPCA Australia, Canberra).

[244] Australian Pesticides & Veterinary Medicines Authority (APVMA), *The Reconsideration of Registrations of Products Containing Sodium Fluoroacetate (1080)*, 2005, <https://apvma.gov.au/sites/default/files/publication/15051-sodium-fluororacetate-1080-prelim-review-findings.pdf>; APVMA (2008) Review findings, Sodium Fluroacetate, Technical Assessment, The reconsideration of registrations of products containing sodium fluoroacetate and approvals of their associated labels, 2008. <https://apvma.gov.au/sites/default/files/publication/15071-sodium-fluororacetate-1080-final_report-env-assessment.pdf>.

[245] T Sharp and G Saunders, *Model Code of Practice for the Humane Control of Feral pigs, PIGCOP* (IACRC, revised 03 September 2012).

[246] Government of Western Australia Department of Health Public Health and Clinical Services , 'Code of Practice for the Safe use and Management of Strychnine in Western Australia' (April 2013).

[247] T Sharp and G Saunders, Model Code of Practice for the Humane Control of Rabbits, RABCOP (IACRC, revised September 2012); National Registration Authority For Agricultural and Veterinary Chemicals, 'The NRA Review of PINDONE' (May 2002).

respiratory failure in target and non-target animals.[248] The regular use of poisons may lead to aversion for poison baits among the pest animals. Thus, innovations are needed to increase effectiveness and target specificity to reduce risks and to make control more humane.

Continuous innovations have been made in poisoning systems to minimise the likelihood of non-target impacts and their uptake of baits. Innovations relating to poisoning can be classified as product or process innovations. For example, a process level innovation in an instrument may improve the delivery technique; a product innovation may provide a more humane poison to facilitate its use in integrated pest animal management. Government organisations and private companies are engaged in introducing innovative control technologies. For example, Animal Control Technologies (Australia) Pty Ltd has registered several technologies and products for vertebrate pest animals.[249] Table 2.1 lists notable innovations and their benefits.[250]

Table 2.1: Examples of technical innovations

Pest animal	Product	Benefits
Wild dogs/Red foxes	DOGABATE FOXECUTE	PAPP – A new predacide, humane, Blue Healer antidote
Wild dogs/Red foxes	Mechanical ejectors	High target specificity and good field longevity
Wild dogs/Red foxes	Lethal trap device (LTD; green tube)	Contains cyanide which rapidly euthanizes trapped dogs and foxes, improving animal welfare and reducing labour requirements.
Wild dogs/Red foxes	Blue Healer – PAPP and nitrite antidote	Saves accidently poisoned dogs or wildlife
Feral pigs	PIGOUT	Feral pig bait, easy to use, shelf stable, high target specificity, internal 1080 core
Feral pigs	HogHopper	Target specific, reduced labour requirements, protects manufactured or grain bait
Rabbits	Carbon monoxide fumigator	Easy to use, portable, humane fumigant, smoke tracer, runs on readily available LPG or propane

(Source: Campbell, 2011)

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[248] Trudy Sharp and Glen Saunders, Model Code of Practice for the Humane Control of Foxes (FOXCOP) (IACRC, September 2012).

[249] *ACTA Broadcare Products for Foxes, Rabbits, Wild Dogs, and Feral Pigs* <http://www.animalcontrol.com.au/default.htm>.

[250] Andrew Campbell, *Towards a more durable institutional base for invasive animals R&D.* (IACRC, 2011); ibid.

Fencing

Fences are used to exclude or isolate pest animals within a defined area and reduce livestock predation by pest animals.[251] They are effective when used in conjunction with other control techniques such as baiting or trapping. The types of fences used to exclude pest animals include conventional netting fences and electric fences. Conventional fencing relies on placing a physical barrier (plain wire, barbed wire, woven wire nets) to isolate pest animals from livestock on a property.[252] The dingo barrier fence in Queensland is an example of a conventional fence.[253]

Electric fences require an electrical circuit instead of a physical barrier. Electric fence systems include a power source (energiser and an earthing system) and a fencing of conductors/wires, insulators and strainers. An electric fencing system sends a high voltage current through the conductors/wires. If the electric current is interrupted by an animal, an electric shock is received. The strength of an electric shock can be adjusted based on target animals. The shock leads to contraction of muscles and unpleasant feeling in a pest animal without causing physical harm. Electric fences are cost effective over long distances, require less maintenance, limited labour and installation can be done in a short period compared to the conventional netting fences.[254] The availability of electric fencing material has facilitated numerous innovations to increase the effectiveness of electric fences. The effectiveness depends on its design features. The design features vary for each pest animal species based on area to be covered and the presence of non-target animals in the area.[255] The

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[251] K Long and A Robley, 'Cost Effective Feral Animal Exclusion Fencing for Areas of High Conservation Value in Australia' (A report for the Australian Government, The Department of the Environment and Heritage, 2004); Australian Wool Innovation Limited, *Wild dog exclusion fencing, A practical guide for woolgrowers* (2017).

[252] *Wild dog control methods: Exclusion fencing, netting*, Moreton Bay Regional Council <https://www.moretonbay.qld.gov.au/uploadedFiles/common/forms/animals/Wild-dog-control-methods-exclusion-fencing-netting.pdf>.

[253] Parliament Agriculture and Environment Committee, *Barrier Fences in Queensland* (Report No 35, 55, June 2017) <http://www.parliament.qld.gov.au/Documents/TableOffice/TabledPapers/2017/5517T1037.pdf>.

[254] Invasive Animals CRC, *PestSmart Factsheet: Fencing for Fox Control* (2012).

[255] Kirstin Long and Alan Robley, *Catalogue of Fence Designs*, 2004 <https://www.pestsmart.org.au/wp-content/uploads/2012/05/fencing_catalogue.pdf>.

photograph (Figure 2.1) gives a basic idea of the use of fencing for pest animal management.[256]

Figure 2.1: Electric fencing to exclude pest species

Trapping

Trapping is one of the most commonly used control techniques as part of integrated pest animal management. It is useful in situations where other control techniques like poisoning cannot be used. Trapping is not considered a useful technique for large-scale control operations because it requires intensive labour. It is effective in areas with small isolated pest animal populations. The traps are used for feral animals

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[256] <https://www.beefcentral.com/production/stock-handling-and-animal-welfare/electric-fencing-underutilised-in-wild-dog-fight-industry-leaders/>

including cats,[257] dogs,[258] foxes,[259] rabbits[260] and pigs.[261] The effectiveness of trapping differs for each pest animal species. The use of soft net traps is particularly useful in urban/residential areas. Soft net traps comprise a flexible metal frame and netting and/or bag that collapses over the animal when triggered.[262] Trapping is often linked to fatal controls such as shooting.

Biological control (biocontrol)

Biological control involves introduction of a natural enemy, such as an insect, fungus or a virus to control pest animal species. Ideally, upon introduction the natural enemy attacks the target species without causing harm to other native or economically significant species. A successful example of biocontrol in Australia is the introduction of the myxoma virus for rabbit control during the late 1930s and 40s. The introduction of the myxoma virus or RHDV proved helpful in reducing rabbit population but over the time the introduced virus or strain became less effective. Subsequent innovations have introduced RHDV2 and RHDVK5 strains for rabbit biocontrol.[263] During the introduction of innovative biocontrol approaches, vaccines to protect non-target

[257] T Sharp, *Standard Operating Procedure, Trapping of Feral Cats Using Cage Traps*, 2016 <https://www.pestsmart.org.au/wp-content/uploads/2018/02/171215-SOP_CAT002_web.pdf>.

[258] T Sharp, *Standard Operating Procedure, Trapping of Wild Dogs Using Padded-Jaw Traps*, 2016 <https://www.pestsmart.org.au/wp-content/uploads/2018/01/171215_SOP_DOG001_web.pdf>; T Sharp, T, *Standard Operating Procedure, Trapping of Wild Dogs Using Cage Traps*, 2016 <https://www.pestsmart.org.au/wp-content/uploads/2018/01/171215_SOP_DOG002_web.pdf>.

[259] T Sharp, *Standard Operating Procedure, Trapping of Foxes Using Padded-Jaw Traps*, 2016 <https://www.pestsmart.org.au/wp-content/uploads/2018/02/180212_SOP_FOX005_web.pdf>; T Sharp, *Standard Operating Procedure, Trapping of Foxes Using Cage Traps*, 2016 <https://www.pestsmart.org.au/wp-content/uploads/2018/02/180212_SOP_FOX006_web.pdf>.

[260] *Standard Operating Procedure, RAB008: Trapping of Rabbits Using Padded-Jaw Traps*, 2018 <https://www.pestsmart.org.au/wp-content/uploads/2018/02/180226_SOP_RAB008_web.pdf>.

[261] Invasive Animals CRC, Trapping for feral pig control in Australia, 2014 <https://www.pestsmart.org.au/wp-content/uploads/2017/10/FPFS5_trapping_web.pdf>; T Sharp, *Standard Operating Procedure, Trapping of Feral Pigs*, 2012 <https://www.pestsmart.org.au/wp-content/uploads/2018/02/171221_SOP_PIG001_web.pdf>.

[262] T Sharp and L McLeod, *GEN003: Trapping Using Soft Net Traps, Standard Operating Procedure*, 2013 <https://www.pestsmart.org.au/trapping-using-soft-net-traps/>.

[263] T E Cox et al, *Benefits of Rabbit Biocontrol in Australia* (PestSmart Toolkit publication, IACRC, (2013).

domestic rabbit species have also been introduced.[264] New methods including genetic manipulation are being developed.

Fertility control

Fertility in pest animals is manipulated through surgical, chemical and immunological methods.[265] Chemical methods involve contraception encapsulated in baits whereas immunological methods aim to regulate proteins involved in the reproductive process to develop immuno-contraceptives.[266]

2.2.2 Technologies for effective information and communication

Information on the distribution and abundance of pest animals is required for many purposes. Due to pest animal mobility, direct physical surveillance and monitoring by humans may be an inefficient way to collect pest animal intelligence. Technologies facilitate pest animal intelligence through surveillance, detection, monitoring and information gathering/sharing and assessment and analysis of data. Technologies improve pest animal intelligence as well as communication for coordinated action. The following technologies are some examples:

FeralScan pest mapping

FeralScan is a national information management system – an integrated database – that facilitates pest animal surveillance,[267] through the recording of sightings, damage and control measures. The FeralScan program was developed by the IACRC with the support of the Australian Government, the NSW Government, catchment management organisations and landholder groups. FeralScan is a digital platform operated through purpose-built web and smart phone apps. It provides a platform for communities to document pest animal problems they encounter. FeralScan records information on Australia's 11 pest animal species of national significance, including feral cats, rabbits, wild dogs, introduced pest fish, foxes, mice, feral camels, feral pigs, Indian myna bird, feral goats and European starlings. It enables the delivery of

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[264] IACRC, *Rabbit biocontrol in Australia: Key facts (PESTSMART)* 2015 <https://www.pestsmart.org.au/rabbit-biocontrol-in-australia-key-facts/>.

[265] Giacomo Dell'omo and Maura Palmery, 'Fertility Control in Vertebrate Pest Species' (2002) 65 *Contraception* 273.

[266] For the literature on fertility control specific to pest animals see, IACRC, *Fertility Control* <https://www.pestsmart.org.au/tag/fertility-control/>.

[267] FeralScan <https://www.feralscan.org.au/>.

citizen science to monitor and manage pest animals. The recorded information can be accessed by anyone across Australia (see Figure 2.2).[268]

Figure 2.2: FeralScan landing page

Collars for tracking

Collars mounted with GPS data-loggers are used for tracking. Pest animals are fitted with tracking collars. Some examples of their use include[269]:

- Use of collars to study dingo/wild dog ecology.[270]

- Satellite tracking studies to monitor the seasonal movement and dispersal of wild dogs in Queensland.[271]

- Studies are being conducted to assess the use of human fitness technologies for tracking and controlling feral pests.[272]

Genetic technology

Innovations in genetic technologies involve the use of remotely-sourced DNA from a variety of sources, including hair and faeces. For example, one study has developed DNA detection technology to enable tactical monitoring of foxes in Tasmania.[273]

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[268] FeralScan <https://www.pestsmart.org.au/feralscan/>.

[269] P Fleming and D Jenkins (eds), *Proceedings of a Workshop on Remote Monitoring of Wild Candids and Fields* (IACRC, Australian National University, Canberra, 21-22 March 2007).

[270] Purcell et al (2006), above n 123.

[271] Fleming and Jenkins (2007), above n 269, 15.

[272] *The Land* <http://www.theland.com.au/story/4648718/fitbit-for-ferals/>.

[273] Stephen D Sarre et al, 'DNA Detection of Foxes to Prevent Establishment in Tasmania' (2007) 44 *Managing Vertebrate Invasive Species* http://digitalcommons.unl.edu/nwrcinvasive/44.

Potential approaches to use recombinant DNA technologies for pest animal management are being studied.[274]

Cameras/sensors

Cameras are used for monitoring purposes to conduct surveys or record observations for pest animal management. There is no standard terminology for using cameras for pest animal management. Some of the terms to describe these techniques include 'camera trap', 'remote camera', motion sensing camera', 'trail camera', 'game camera' and 'sensor camera'.[275] The use of camera trapping techniques for pest animal management requires a thorough understanding of its intended use, settings, and deployment and data analysis methods. Research studies are being conducted into the use of camera trapping for use in pest animal management.[276] Camera trapping is a technique in which remotely triggered cameras take photographs of target animals activated by movement.[277]

Drones/remote sensing

The recent pest animal management review conducted in NSW noted that drones can be used for monitoring pest animal management. The report recommends addressing privacy concerns associated with the use of this technology.[278] Trials have been conducted to assess the use of drones to monitor pest animals, particularly in inaccessible areas.[279]

2.3 Managerial innovations

Invasive animal control approaches ideally focus upon eradicating or managing the population of invasive animal species. This is achieved through technological or other

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[274] Ronald E Thresher, 'Genetic Options for the Control of Invasive Vertebrate Pests: Prospects and Constraints' (2007) 52 *Managing Vertebrate Invasive Species*.

[275] P D Meek, G Ballard and P Flemming, *An Introduction to Camera Trapping for Wildlife Surveys in Australia* (PestSmart Toolkit publication, IACRC, 2012).

[276] Meek et al (2016), above n 124.

[277] A S Glen et al, 'Optimising Camera Traps for Monitoring Small Mammals' 2013, 8(6) *PLoS One* 63.

[278] *State-Wide Review of NSW Pest Animal Management* (Issues paper, NSW, 2015).

[279] A Felton-Taylor and D Claughton, 2015. 'Drones Trialled to Help Reduce Billion-Dollar Invasive Pest Animal Problem. *ABC News*, 2015 <http://www.abc.net.au/news/rural/2015-07-22/drones-to-help-manage-invasive-pest-animal-species-in-australia/6639204>; https://www.cio.com.au/article/580125/drones-being-trialled-tackle-australia-pest-problem/; Griffith C. 'Drones patrol for feral animals' *The Weekend Australian*, 2015 <https://www.theaustralian.com.au/business/technology/drones-patrol-for-feral-animals/news-story/a88a60be88a0788849c666323136ce53>.

control techniques. Control technique implementation requires policy support through processes including decision-making and communication, strategic partnerships to perform on-ground control. Managerial innovations include a range of principles and processes to support the use of technological innovations.[280] For example, pest animal management planning guides describing control actions for pest animal management. It also involves human interactions governed by laws, regulations and institutions. This section describes five managerial innovations: Best Practice Management (BPM), Standard Operating Procedures (SOPs)/Codes of Practices (COPs), community engagement, and law and regulations.

Best Practice Management (BPM)

Priority 2.2 of the *APAS* emphasises improving best practice management and the adoption of these practices among landholders through research, development and extension.[281] The elements of BPM are summarised in the Figure 2.3.
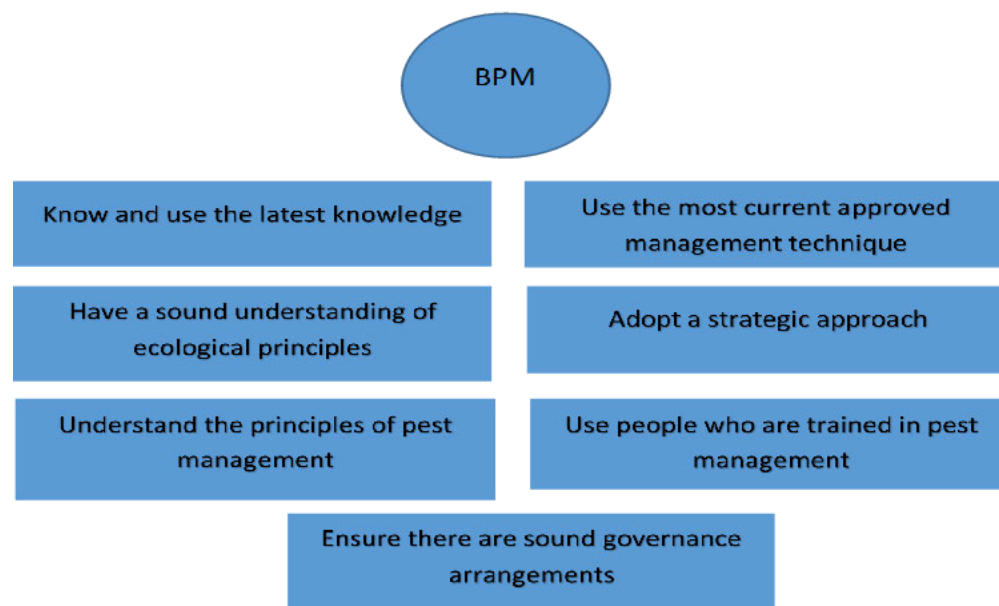
Figure 2.3: The elements of Best Practice Management
(Source: Braysher, 2017)

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[280] Principles Underpinning Best Practice Management of the Damage Due to Pests in Australia.

[281] Invasive Plants and Animals Committee (2016), above n 48, principle 4, priority 3.3.

Standard Operating Procedures (SOPs) and Codes of Practice (COPs)

Animal welfare and humaneness are key considerations in determining the acceptability of a control method. This includes animal welfare impacts for target and non-target species. What constitutes an animal suffering involves subjective interpretations and values-based evaluations. A model for assessing the relative humaneness of pest animal control methods[282] has been developed to examine the relative impact of different methods on animal welfare[283] and the intensity of suffering caused by the killing technique.[284] Recognising the sentience of animal species, the managerial standards for control approaches were developed by Sharp and Saunders to address animal welfare considerations and effectiveness of control techniques. SOPs and COPs partly aim to minimise animal welfare impacts on target and non-target species. SOPs describe control techniques, their implementation and welfare impacts. COPs describe best management practices, control strategies, science and impacts of pest animals. SOPs and COPs provide guidelines on a) selecting the most humane, target specific, cost effective and efficacious techniques for pest animal control; b) evaluating control methods for planning, and c) effectively administering control programs. SOPs and COPs do not replace or override legislation and are subject to the applicable legal requirements in a specific jurisdiction. Table 2.2 gives examples of SOPs and COPs for techniques used to control feral rabbits and foxes. The examples are adopted from Sharp and Saunders[285] and PESTSMART[286]. On similar lines, SOPs and COPs have been developed for pigs, dogs, cats, goats, deer, birds, hares and horses.

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[282] Sharp and Saunders, above n 243.

[283] D J Mellor and C S W Reid , 'Concepts of Animal Well-Being and Predicting the Impact of Procedures on Experimental Animals' in R.M. Baker, G. Jenkin and D.J. Mellor (eds) *Improving the Well-Being of Animals in the Research Environment* (Proceedings of a conference held at the Marriott Hottel, Sydney, October, ANZCCART, 1993) 3.

[284] D M Broom, 'The Welfare of Vertebrate Pests in Relation to their Management' in D.P. Cowand, C J Feare (eds), *Advances in Vertebrate Pest Management* (Fürth: Filander Verlag, 1999) 309.

[285] T Sharp and G Saunders, *Development of a Model Code of Practice and Standard Operating Procedures for the Humane Capture, Handling or Destruction of Feral Animals in Australia* (IACRC, 2004).

[286] *National Codes of Practice & Standard Operating Procedures* <http://www.pestsmart.org.au/animal-welfare/humane-codes/>; *Fox Standard Operating Procedures* <https://www.pestsmart.org.au/tag/fox-sop/>.

Table 2.2: Example of COPs and SOPs for pest animals

SOP Number	Title
GENERAL	
GEN001	Methods of euthanasia
GEN002	Care and management of dogs used in the control of pest animals
GEN003	Trapping using soft net traps
RABBITS	
RAB001	Inoculation of rabbits with RHDV
RAB002	Ground baiting of rabbits with 1080
RAB003	Aerial baiting of rabbits with 1080
RAB004	Ground baiting of rabbits with Pindone
RAB005	Diffusion fumigation of rabbit warrens
RAB006	Rabbit warren destruction using ripping
RAB007	Rabbit warren destruction using explosives
RAB008	Trapping of rabbits using padded-jaw traps
RAB009	Ground shooting of rabbits
RAB011	Bait delivery of Rabbit Hemorrhagic Disease Virus (RHDV1) K5 strain
FOXES	
FOX001	Ground baiting of foxes with 1080
FOX002	Aerial baiting of foxes with 1080
FOX003	Ground shooting of foxes
FOX004	Fumigation of fox dens
FOX005	Trapping of foxes using padded-jaw traps
FOX006	Trapping of foxes using cage traps
COP name	**Title**
RABCOP	Model code of practice for the humane control of rabbits
FOXCOP	Model code of practice for the humane control of foxes

Community engagement methods

The 'community' relevant to pest animal management includes stakeholders from local to national levels,[287] for example, local landholders, volunteer groups, regional groups, groups with shared interest in pest animal management or natural resource management, industry groups, groups associated with various political positions and specific interests such as non-government organisations.[288] In addition to formal and

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[287] Whitman, D. (2008). "Stakeholders" and the politics of environmental policymaking. The Crisis of Global Environmental Governance: Towards a new political economy of sustainability. J. Park, K. Conca and M. Finger. New York, Routledge: 163:193.

[288] Curtis, A., H. Ross, G. R. Marshall, C. Baldwin, J. Cavaye, C. Freeman, A. Carr and G. J. Syme (2014). "The great experiment with devolved NRM governance: lessons from community engagement in Australia and New Zealand since the 1980s." Australasian Journal of Environmental Management 21(2): 175-199.

informal community arrangements, virtual/online communities[289] participate in pest animal management. One of the key factors of community action in pest animal management is that the participation of stakeholders is voluntary.[290] The engagement of communities is considered important in pest animal management for coordinated and collective action to prevent political backlash (for example over animal cruelty claims) and, pre-dominantly, to fulfil resourcing requirements. Community engagement involves interactions between communities and institutional arrangements.[291]

The *APAS* principle for effective pest animal management suggests that the 'management of mobile pest animals requires a coordinated approach at the appropriate scale, which may need to be applied across multiple land tenures'.[292] The key reasons for prescribing coordinated and collective action are the need for collective recognition of pest animal threat, acceptance of the problem and the need for collective response to an identified threat.[293] The following points describe the reasons for the increasing role of community engagement in pest animal management.

- *Community impacts*: Pest animal impacts are not limited to an individual landholder. The entire community within a specific area is affected due to the negative impacts of pest animals. Coordinated approaches are more likely to be effective in addressing community impacts of pest animals.

- *Nil-tenure approach*: The mobility of pest animals challenges the effectiveness of management. Due to the mobility of pest animals, efforts taken by an individual landholder may not prove beneficial if neighbours are not managing the same pest animal on their lands. This negatively affects the overall investment and effort by an individual landholder to mitigate the problem. The landholders not actively participating in the management create

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[289] Wu, I. S. (2015). Forging trust communities. Baltimore, John Hopkins Press.

[290] Martin, P., D. Low Choy, E. LeGal and K. Lingard (2016). Effective Citizen Action on Invasive Species: the Institutional Challenge. Canberra, Invasive Animals Cooperative Research Centre.

[291] Martin, Paul, Amanda Kennedy and Jacqueline Williams, 'Creating next generation rural landscape governance: the challenge for environmental law scholarship' in Paul Martin et al (eds), Environmental Governance and Sustainability, IUCN Academy of Environmental Law Series (Edward Elgar, 2012).

[292] Invasive Plants and Animals Committee (2016), above n 48, Priority 2.3, Principle 3.

[293] A Ford-Thompson et al, 'Stakeholder Participation in Management of Invasive Vertebrates (2012) 26(2) *Conservation Biology* 345, doi:10.1111/j.1523-1739.2011.01819.x.

a refuge for pest animals on their properties. Pest animals travel across land tenures, including state forests and national parks. The characteristics of high mobility and adaptability of invasive animals require a coordinated approach at the appropriate scale, across multiple land tenures.[294] Coordinated and collective action are often vital for managerial effectiveness. A nil-tenure or landscape-scale approach should take into account the abilities of individual landholders and facilitate coordinated management. The nil-tenure approach helps in collective identification of the problem.[295]

- *Active engagement and consultation*: Stakeholders involved in pest animal management have different attitudes towards pest animals, their impacts and how they should be managed.[296] The consideration of these attitudes determines the overall success or failure of management programs. This requires consultations, discussions and trust between stakeholders which can be achieved only through coordinated and collective ways of addressing the problem.

Pest animal management requires the combined efforts of stakeholders. The literature indicates that top-down approaches where technical expertise from science and government is forced upon communities may be less effective in achieving managerial outcomes.[297] The focus needs to be upon facilitating approaches that trigger community leadership and local level action.[298] Government driven top-down approaches may not facilitate the adoption of pest animal management innovations.[299] This indicates the need to understand behavioural dimensions of stakeholders, to

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[294] Invasive Plants and Animals Committee (2016), above n 48, principle 6.

[295] R Hunt, *The Nil Tenure Approach to a Landscape issue (Wild Dogs)* (Paper presented at the Third NSW Pest Animal Control Conference, 4-7th July 2005, NSW).

[296] J Everts, 'Invasive Life, Communities of Practice, and Communities of Fate' (2015) 97(2) *Human Geography* 195.

[297] A Dickman, S Marchini and Manfredo, *The Human Dimension in Addressing Conflict with Large Carnivores. Key Topics in Conservation Biology 2*, (John Wiley & Sons 2013) 110–126; K K Miller, 'Human Dimensions of Wildlife Population Management in Australasia: History, Approaches and Directions' (2009) 36 *Wildlife Research* 48.

[298] Decker, Riley and Siemer (2012), above n 225.

[299] Lyndal Thompson et al, *Engaging in Biosecurity: Literature Review of Community Engagement Approaches* (Bureau of Rural Sciences, 2009) <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.477.2224&rep=rep1&type=pdf>.

facilitate effective community action.[300] Collective action involves multiple stakeholders potentially with differences of opinions on managerial solutions and values about pest animal management. This multiplicity may lead to conflict among stakeholders.[301] Understanding this dynamic of collective action involves the study of people's behaviours, attitudes, socio-cultural perceptions (human dimensions) of pest animals and pest animal control system. Understanding of human dimensions is crucial to address human-animal conflicts and conflicts during pest animal control efforts.[302] The use of science of the human dimensions has traditionally been lacking. Human dimensions research on pest animal management in the US is being examined and used for Australian pest animal management.[303]

Innovations in law and enforcement

A role of law in pest animal management is to establish clear obligations backed by enforcement measures for pest animal management. Law also provides supporting mechanisms that facilitate on-ground control action.

The biosecurity Act of 2015 (Cth) and legislation at the state/territory levels have introduced a legal obligation for landholders to control pest animals on their individual lands. It is pertinent to discuss the biosecurity policy framework which underpins legal obligations for pest animal management.

Until 2015, the preventative aspect of Australia's biosecurity system was managed under the *Quarantine Act 1908* (Cth) and related regulations at the national level. In 1996, a detailed ten-month review of quarantine issues was undertaken by the Australian Quarantine Review Committee chaired by M E Nairn. In its final report

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[300] S Lidstrom et al, 'Invasive Narratives and the Inverse of Slow Violence: Alien Species in Science and Society' (2015) 7 *Environmental Humanities* 1; G R Marshall et al, 'Collective Action in Invasive Species Control, and Prospects for Community-Based Governance: The Case of Serrated Tussock (*Nassella trichotoma*) in New South Wales, Australia' (2016) 56 *Land Use Polic*y100.

[301] F Madden and B McQuinn, 'Conservation's Blind Spot: The Case for Conflict Transformation in Wildlife Connservation.' (2014) 178 *Biological Conservation* 97.

[302] Martin et al (2016), above n 24.

[303] For example, Martin et al. (2016), above n 302; R M Niemiec et al, 'Landowners' perspectives on coordinated, landscape-level invasive species control: The role of social and ecological context' (2017) 59(3) *Environmental Management,* 477, doi:10.1007/s00267-016-0807-y; Tanya M Howard, Lyndal J Thompson, Paloma Frumento and Theodore Alter, Wild Dog Management in Australia: An Interactional Approach to Case Studies of Community Led Action, (2017) *Human Dimensions of Wildlife*, doi: 10.1080/10871209.2017.1414337; A Ford-Thompson et al (2012), above n 293.

titled *Australian Quarantine: A shared responsibility* ('*Nairn Report*')[304] the Committee suggested the need to incorporate: the biosecurity continuum approach (see Chapter 1, section 1.3 of this thesis), which is a science-based risk management approach; a shared responsibility;[305] and institutional improvements including new organisational structures, information systems and resources for effective biosecurity in Australia.[306] The control of established invasive species was then, as now, primarily a state/territory issue. The government endorsement of this report led to developments in institutional coordination through the establishment of new biosecurity agencies, including: Plant Health Australia, the Quarantine and Exports Advisory Council, the Eminent Scientists Group, Australian Biosecurity System for Primary Production and the Environment (AusBIOSEC) and the National Biosecurity Committee. These federal arrangements were loosely co-ordinated with the states.[307]

In 2008, the Quarantine and Biosecurity review, *One Biosecurity: A Working Partnership* ('*Beale Report*') indicated that the idea of shared responsibility envisioned in the 1996 *Nairn Report* had not been practically achieved and the goals of institutional cooperation remained far from achievable. The review suggested incorporating the word 'biosecurity' instead of 'quarantine' since quarantine connotes a narrow and defensive idea of diseases and disease agents with an emphasis on containment and exclusion whereas biosecurity widens the scope by including control of established pest animals and weeds. The report panel indicated that the term biosecurity should be a more pro-active concept, aligned with the biosecurity continuum. In terms of shared responsibility, the 2008 *Beale Report* emphasises a partnership between governments and clearer roles and responsibilities across the biosecurity continuum.[308]

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[304] M E Nairn et al (1996) *Australian Quarantine: A Shared Responsibility* (Department of Primary Industries and Energy, Canberra, 1996) ('*Nairn Report*').

[305] Ibid.

[306] The *Nairn Report* states that the idea of shared responsibility for biosecurity connotes joint ownership and involvement of the Commonwealth and state governments, between businesses, and the general community, ibid s 2.4, 34–35.

[307] Carolyn Tanner and Mike Nunn, 'Australian Quarantine Post the Nairn Review' (1998) 42(4) *The Australian Journal of Agricultural and Resource Economics* 445.

[308] R Beale, J Fairbrother, A Inglis and D Trebeck, 'One Biosecurity: A Working Partnership' (The independent review of Australia's Quarantine and Biosecurity Arrangements. Australian Government, Canberra, 2008) ('*Beale Report*').

The review of biosecurity revealed multiple constraints in terms of capacity of government and non-government stakeholders to manage invasive animals.[309] Declining government budgets and inadequate provisioning of resources for invasive animal management were identified as the reasons behind reduced capacity of stakeholders in implementing control.[310] The reports identified that governance is challenged to develop innovative strategies that can trigger the mobilisation of available resources and capacities by diverse stakeholders, and indicated that on-ground coordinated control actions and stakeholders' collaboration are crucial for effective invasive animal management.[311]

In response to the 2008 *Beale Report*, Australian federal, state and territory governments, excluding Tasmania, signed the IGAB, which aimed to strengthen relationships between governments and identify improved ways of working together to enhance biosecurity arrangements in Australia. The IGAB covers issues relevant to the whole biosecurity system, including pest animals, with shared responsibility 'between all governments, industry, natural resource managers, custodians or users, and the community'[312] and 'cost-effective, science based and risk management'[313]

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[309] *Nairn Report*, above n 306; Tanner and Nunn, above n 307; Agriculture and Food Policy Group, 'Creating Our Future: Agriculture and Food Policy for the Next Generation' (Australian Government, November 2006) ('*the Corish Report*') <http://www.agriculture.gov.au/SiteCollectionDocuments/about/corish-response.pdf>.

[310] Invasive Species Council, 'Barriers to Effective Climate Change Adaptation: Invasive Species and Biodiversity Conservation' (A Submission to the Productivity Commission, 2011); Australia's aging population and other public interests indicate that fiscal pressures are due to increase further. For further explanation, see, Productivity Commission, *An Ageing Australia: Preparing for the Future* (Commonwealth of Australia, 2013); The Treasury, 'Intergenerational Report 2015 – Australia in 2055' (Commonwealth of Australia, 2015); Woodburn (2013), above n 81.

[311] *Beale Report* (2008), above n 308. *Explainer: Why Australia needs biosecurity*, 15 November 2013 <http://theconversation.com/explainer-why-australia-needs-biosecurity-20105>.

[312] Council of Australian Governments (2012), above n 228, principle 1.

[313] Ibid, principle 5

approach for biosecurity. Figure 2.2 illustrates the policy developments that led to the integration of pest animal management into the biosecurity framework.

responsibility
[Biosecurity continuum approach, shared responsibility]

2008 – Beale review recommendations – 'One biosecurity: a working

Animal Strategy
[APAS as a vital part of Australia's integrated approach to national biosecurity system; shared responsibility]

Animal Strategy [APAS aims to be consistent with the biosecurity policy with IGAB as a guiding instrument; pest animal management as a shared responsibility between landholders,

Intergovernmental Agreement on Biosecurity

[IGAB aims to improve shared management of risks posed by pests and diseases entering,

[Replaced the Quarantine Act of 1908, aims to promote shared responsibility and prevent biosecurity risk as defined in clause 310 of the

Figure 2.4: Intersection of biosecurity and pest animal management

Based on these developments and through pragmatic policy deliberations, Australian governments via the Council of Australian Governments (COAG) decided to primarily direct limited government resources into preventative biosecurity, with a

strong focus on citizen and community action.[314] One of the recommendations of the *Beale Report* was to incorporate a legal framework for a national approach to biosecurity. The biosecurity legislative reform proposal adopted the principle of 'shared responsibility' addressing the recommendations proposed by the *Beale Report*.[315]

However, the concept of shared responsibility remains ill defined. Government agencies have generally taken this to mean that citizens will accept responsibility and accountability for controlling established harmful species. However, the two most recent studies[316] suggest that this is not yet an established social norm and there are many practical impediments to this being an effective model.

Nevertheless, the shared responsibility model is adopted in the *Biosecurity Act 2015* (Cth).[317] The *Act* reflects biosecurity as the shared responsibility between governments at all levels, business, industries and the community. The *Act* provides two definitions of biosecurity risk. The preliminary chapter includes the definition of biosecurity risk for its general application throughout the *Act*.[318] This definition has been modified in Chapter 6, section 310 to include the word 'emergence' of a disease or pest.[319] The word 'emerge' expands the meaning of biosecurity risk to include emerging pests and diseases that are found or already established in Australia. Section 310 should be read in conjunction with the definition of 'invasive pests' (described in the definition section of the chapter) which gives effect to the *CBD*[320] to cover the management of invasive species within the *Act*. For environment protection and biodiversity conservation, the biosecurity system includes the Department of

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[314] Department of Agriculture and Fisheries, 'Reform of Australia's Biosecurity System: An Update Since the Publication of One Biosecurity: A Working Partnership' (DAFF, 7 March 2012) <www.daff.gov.au/biosecurityreform>. National Biosecurity Committee, 'Modernising Australia's Approach to Managing Established Pests and Diseases of National Significance' (Australian Senate Environment and Communications References Committee, 2015).

[315] The *Beale Report* recommendations 2, 4, 6, 11, 35, 37, 40 and 43 proposed sharing of responsibility. These recommendations were considered in the *Biosecurity Reform Bill*: National Biosecurity Committee (2015), above n 316.

[316] Martin et al (2016), above n 4; Craik, Palmer and Sheldrake (2017), above n 5.

[317] *Biosecurity Act 2015* (Cth).

[318] Ibid, s 9 (Definitions).

[319] Ibid, s 310.

[320] *CBD*, arts 7 and 8.

Environment and Energy which administers environmental and biodiversity concerns through the *EPBC Act*.[321]

As part of the shared responsibility, three national agreements note the commitments of state/territory and industry for biosecurity. The Emergency Animal Disease Response Agreement (EADRA) and the Emergency Plant Pest Response Deed (EPPRD) postulates the requirement of a comprehensive legal structure at the state/territory level; and the National Environmental Biosecurity Response Agreement (NEBRA) includes a commitment to consistency between state/territory level legislation and the national approach. However these commitments, particularly of industry and NGOs, have not been explicitly agreed.

With shared responsibility as a key strategic theme, Australian state and territory governments are sequentially adopting the shared responsibility approach through relevant legislation.[322] Three states have specified the obligation to manage the biosecurity risk of pest animals in the form of 'General Biosecurity Duty' (GBD) or 'General Biosecurity Obligation' (GBO) which requires individual landholders to take action for pest animal control on their lands and to stop the spread of animals from their land.

To date, the Commonwealth, NSW and Queensland governments have enacted specific landholder duties of care in the biosecurity legislation and introduced regulations to support their respective Acts. *Biosecurity Act 2015* (NSW) includes a GBD which applies to any individual who deals with a biosecurity matter or is a carrier of biosecurity matter.[323] In Queensland, under *the Biosecurity Act 2014* (Qld) landholders have a primary responsibility for the control of invasive animals.[324] Individual landholders are identified as primary beneficiaries of invasive animal

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[321] At the Commonwealth level, the *EPBC Act 1999* (Cth) identifies invasive animals that are hazardous or threaten the extinction of native animals and plants. The mechanism of 'key threatening processes' is used to prioritise feral animals requiring immediate attention by developing 'threat abatement plans'. The Natural Resources Council also considers invasive animals issues but currently, no ministerial council has responsibility specific to invasive species issues.

[322] So far, three states have passed legislation to this effect: *Biosecurity Act 2015* (NSW) s 22, *Biosecurity Act 2014* (Qld) s 23; *Catchment and Land Protection Act 1994* (Vic) s.20 and its inclusion is under process in a few other states (eg, Northern Territory Government, 2016; Government of Western Australia, 2014).

[323] *The Biosecurity Act 2015* (NSW), s 22 (General Biosecurity Duty).

[324] *The Biosecurity Act 2014* (QLD) (General Biosecurity Obligation).

control and are expected to take control action along with the community and government stakeholders. Other states and territories: Tasmania, Victoria, the Northern Territory and Western Australia, have instituted legislative reviews with the intent of potentially developing and enacting 'single Act' legislation to better manage biosecurity within their jurisdictions. The state of Tasmania has also foreshadowed a GBD approach. Legislative developments relevant to biosecurity legislations in the states and territories across Australia are described in Table 2.3.

Table 2.3: Biosecurity obligations: Summary of Australian states approaches to GBO/GBD

State	Legislation and relevant biosecurity obligation
NSW	The NSW *Biosecurity Act 2015*: The Act introduced 'general biosecurity duty' (GBD) in s 22, pt 3. The GBD applies to 'anyone who deals with biosecurity matter or with a carrier of biosecurity matter, or carries out an activity in relation to biosecurity matter, and who knows or ought reasonably to know that the biosecurity matter or the carrier or activity poses or is likely to pose a biosecurity risk'. The aim in NSW is to introduce the GBD to recognise 'each person's role in preventing, eliminating or minimising biosecurity risks based on their level of knowledge and understanding.
QLD	*The Biosecurity Act 2014* (Qld): The *Act* introduced 'general biosecurity obligation' (GBO) in s 23. The *Act* describes GBO as: 'everyone is responsible for managing biosecurity risks that are: under their control and that they know about, or should reasonably be expected to know about'. The *Act* was designed to replace the existing overlapping, inconsistent and reactive approach to biosecurity regulation within Queensland comprised of a mixture of more than 15 different pieces of legislation and accompanying subordinate instruments. Regulations were published in 2016 to support the *Act*.
SA	In South Australia, there is no specific Biosecurity legislation. Biosecurity South Australia manages biosecurity issues under the policy framework guided by the *South Australian Government State Biosecurity Policy 2013–2016*.
WA	Western Australia has already adopted the *Biosecurity and Agriculture Management Act 2007* with a separate *Exotic Diseases of Animals Act 1993*. There is no one 'general biosecurity obligation' of the kind enacted in NSW and QLD.
TAS	The Tasmanian Government commenced a review of Tasmania's biosecurity legislation in 2016, with the aim to develop a new single entity Biosecurity Act via the introduction of framework legislation to Parliament in 2017. Public feedback was obtained in March/April 2016 on a Position paper for having a single Biosecurity Act.
VIC	In Victoria, the 'Invasive Plants and Animals Policy Framework' ('IPAPF') of 2002 provides an overarching approach to the management of existing and potential invasive species. The Victorian Department of Environment and Primary Industries (DEPI), in 2015, was developing new invasive species management legislation to replace the noxious weeds and pest animal provisions of the *Catchment and Land*

State	Legislation and relevant biosecurity obligation
	Protection Act 1994 and close the gaps in powers to deal with incursions of taxonomic groups currently not, or only partially, covered by Victoria's biosecurity legislation.
ACT	ACT is governed by Commonwealth legislation, there is no Territory specific/relevant legislation.
NT	Northern Territory has historically managed biosecurity issues within the context and regulatory framework of Commonwealth law e.g. *Quarantine Act 1908* and now the *Biosecurity Act 2015*. In July 2016, The Northern Territory Government released the *Northern Territory Biosecurity Strategy 2016-2026*, developed to address increasing biosecurity risks across the Territory. The *Strategy* includes a review of all current NT 'obligations under established agreements', review of existing biosecurity legislation and development of a new legislative framework 'consistent with best practice. Separate pieces of legislation currently manage biosecurity. There is no direct GBO/GBD provisions in NT.

In pest animal control, compliance and enforcement is defined with regard to the conformity with legal biosecurity obligations.[325] Compliance and enforcement involve government biosecurity managers, public officials, members of the public and law enforcement agencies as well as their employees, who monitor and investigate potential breaches of biosecurity obligations. In the regulatory community, the idea of 'responsive regulation' has been widely adopted as a set of principles. Ayres and Braithwaite[326] have summarised this idea as an enforcement pyramid in which the level of enforcement intervention is 'responsive' to the level of compliance and the nature of infringement. The idea suggests a greater role of voluntary compliance supported by social mechanisms, including the combination of incentives and disincentives rather than enforcement through command-and-control; biosecurity agencies then try to secure compliance using promotional and enforcement activities.[327] The biosecurity compliance for pest animal management obligations

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[325] For example, NSW Department of Primary Industries, *Biosecurity and Food Safety Compliance Policy 2017*, 1 <https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/713107/Biosecurity-and-Food-Safety-Compliance-Policy.pdf>; NSW Department of Primary Industries, *Biosecurity and Food Safety Enforcement Policy 2017* <https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0018/713106/Biosecurity-and-Food-Safety-Enforcement-Policy.pdf>.

[326] Ian Ayres and John Braithwaite. *Responsive Regulation: Transcending the Deregulation Debate* (Oxford University Press, 1992).

[327] Department of Agriculture and Water Resources, *Biosecurity Compliance Plan 2016-17: Our Plan for managing compliance* <http://www.agriculture.gov.au/biosecurity/legislation/compliance/biosecurity-compliance-plan>.

often focuses on raising awareness about biosecurity obligations to secure voluntary compliance and behaviour-based responses to non-compliance.[328] The compliance and enforcement policies often rest on the key assumption that, upon awareness, most people will comply with the biosecurity obligations.[329]

Resourcing innovations

The *APAS* states that 'the cost of pest animal management should be borne by those who create the risk and those who benefit from its management. Governments may co-invest where there is a net public benefit from any such intervention'.[330]

Resources for invasive animal control are investments in natural resource management through government and private channels. As highlighted in Chapter 1, resources for pest animal control activities are required on a continual basis because of the long-term nature of control and the uncertainties involved in recurrence of threat after completion of managerial action. The resource requirement depends upon two main factors: the goal of management and the strategies required to deliver outcomes in proportion to the envisioned goal. Currently, government, land managers and NGO programs provide funding for government and regional programs.[331] Because of the absence of a committed investment approach for invasive animals and declines in government's overall capacity to invest, several possible innovations in resourcing have evolved or are suggested,[332] as listed in Table 2.4.[333]

Table 2.4: Resourcing innovations

Resourcing innovation	Function
Payments for ecological services	Incentives can be paid to land managers who deliver a targeted environmental service by controlling invasive animals. For

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[328] NSW Department of Primary Industries, Biosecurity and Food Safety Compliance Policy 2017, Approach to compliance, 3. NSW Department of Primary Industries, Biosecurity and Food Safety Enforcement Policy 2017, enforcement response, 4.

[329] Compliance Posture GPAS 2016/10/001, http://www.agriculture.gov.au/about/commitment/practice-statements/general-practice-admin-statements/gpas-2016-10-001.

[330] Invasive Plants and Animals Committee (2016), above n 48, principle 8.

[331] Martin, Paul, Miriam Verbeek et al, "Measuring the Impact of Managing Invasive Species", Report number K112-25, May 13 2013 for the Australian Government Department of Agriculture, Forestry and Fisheries (contractors: Invasive Animals Limited, on behalf of the Invasive Animals CRC); Martin et al (2016), above n 4, 40-42.

[332] Ibid 28.

[333] In addition to specific references, see generally, Kip Werren (2015) Utilising taxation incentives to promote private sector funded conservation, a PhD thesis, School of Law, University of Western Sydney.

Resourcing innovation	Function
	example, the mandatory labelling scheme.[334] These programs can be financed by government as well as communities.[335] Incentive-based programs require adequate financial or in-kind resources to encourage participation; for example the 'Land alive and Conservation Partners Program' supported by the NSW Office of Environment and Heritage.[336]
Crowdfunding	In this mechanism, the people who support invasive species control can donate fund through an arrangement called 'crowdfunding platform'.[337]
Stewardship	Invasive species control can be included as a basic stewardship condition for land licenses, public funding or as a criterion for tax deduction.[338]
Risk-based instruments	Risk-based instruments in the form of invasive risk insurance scheme or industry collective responsibility. It is conceptually possible to create a legally binding mechanism whereby legal entities (individuals, companies and states) pool their risk to collectively address the costs generated during implementation. These entities can be private and/or public actors and can form partnerships to create and implement various forms of regulation and risk-management strategies.
Market instruments	This includes a mandatory financial guarantee (deposit or bio-bank) to fund the economic loss and environmental restoration. Biodiversity offsetting is one of the mechanisms that provides compensation for biodiversity loss. This mechanism has already been tried through biobanking and biodiversity credit schemes in natural resource management[339] and studied for its potential for invasive animal management.[340]

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[334] P Martin et al, 'The Costs and Benefits of a Proposed Mandatory Invasive Species Labelling Scheme' (A Discussion Paper Prepared for WWF, Australia, by the AgLaw Centre, 2005).

[335] For example, S K Swallow, C M Anderson and E Uchida, 'The Bobolink Project: Selling Public Goods from Ecosystem Services Using Provision Point Mechanisms' (Department of Agricultural and Resource Economics: Connecticut, 2012).

[336] *Aboriginal land management for biodiversity* <http://www.environment.nsw.gov.au/landalive/>; http://www.environment.nsw.gov.au/cpp/ConservationPartners.htm>.

[337] For example, *Chuffed* <https://chuffed.org.au>; *Greenfunder* <https://www.greenfunders.org/>.

[338] R Worrell and M Appleby, 'Stewardship of Natural Resources: Definition, Ethical and Practical Aspects' (2000) 12(3) *Journal of Agricultural and Environmental Ethics* 263.

[339] For Biobanking, see *NSW Government 2016 Biobanking: A Market –Based Scheme* http://www.environment.nsw.gov.au/biobanking/ ; For Biodiversity offsets see Government of Victoria, *Native Vegetation Offsets 2014* https://www.environment.vic.gov.au/native-vegetation/native-vegetation/offsets-for-the-removal-of-native-vegetation .

[340] For Biodiversity offsetting in invasive species see D A Norton and B Warburton, 'The Potential for Biodiversity Offsetting to Fund Effective Invasive Species Control' (2015) 29 *Conservation Biology* 5.

Resourcing innovation	Function
Fees and charges for services	Fee-for-service establishes a direct link between the task and monetary charge. It proves efficient in cases of private benefits to a specific stakeholder.[341]
Rate or levy	Rate or levy is useful in cases where a) the nature of activity is relevant to a general industry, b) it is difficult to decide the end-users of service, c) there are risks of creating perverse incentives rather than achieving stated objectives through fees, d) charging fees has many administrative complexities and challenges.[342]
Taxpayer funding	Taxpayer funding is an efficient way in cases where other options (fees, rates, levies) are not cost-effective or impractical.[343]
In-kind and voluntary contributions by landholders and industry participants.	These require strong individual motivation and a good trust relationship.

Summary

This section discussed innovations in pest animal management, highlighting new developments in pest animal management. These innovations are applicable to established vertebrate pest animals. Particular innovations are needed to enhance pest animal management in peri-urban areas that consider:

- Humane control options, with particular benefits on the peri-urban fringe.
- Improved intelligence on pest animal location and impacts.
- Meaningful citizen engagement in surveillance and monitoring.
- Strategic pest animal management.
- Enhanced capacity to implement pest animal control.
- Coordinated and collective action, community engagement and shared responsibility.
- Essential resources.

However, the fact that innovations are being developed, are available or possible does not mean that they will necessarily be successfully deployed. Institutional issues are pivotal to determining whether this will happen. Since Invasive animal issues in peri-

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[341] DAWR, *Cost Recovery Implementation Statement, Biosecurity 2015–16* (CC BY 3., 2015).
[342] Biosecurity levies <http://www.agriculture.gov.au/ag-farm-food/levies/biosecurity-levies>.
[343] Craik, Palmer and Sheldrake, above n 5, 127.

urban areas are embedded in broader natural resource management programs, some innovations are being experimented with in peri-urban areas. The next section narrows the scope of this research to case studies of specific innovations relevant to two pest animal species in two case study peri-urban regions in Australia.

2.4 Boundaries of the research – Innovations, species and peri-urban regions

The applicability and effectiveness of innovations varies considerably for pest animal species. The objective of this research was to identify institutional impediments for pest animal management in peri-urban areas. It was important to select specific innovations and applications in pest animal management to better understand peri-urban institutional issues.

Two case studies were selected to explore the adoption and implementation of pest animal management innovations. The case studies comprise three elements: a) a pest animal species, b) a peri-urban region in which the species exists and c) innovations for the management of selected species in the peri-urban region. Specific innovations and applications were considered for feral deer management in peri-urban Sydney (PUS) and wild dog management in peri-urban Brisbane (PUB). The pest animal species and peri-urban regions for case studies were chosen partly based on the IACRC project goals and access to information sources.

A variety of methods are traditionally used to designate specific area as 'peri-urban'; for example, in peri-urban planning studies, mapping techniques are used to identify and select peri-urban areas. For this research, the 'legal-institutional' characteristics of peri-urban areas and peri-urban as a political rather than geographical concept influenced the choice of PUS and PUB. The case example innovations were selected based on their relevance to management priorities in the *APAS*. The selected innovations are a significant departure from earlier approaches and are perceived as new by the stakeholders adopting those innovations.

This section describes the background of the case studies. It begins with an explanation of government administration, the Commonwealth government and the regional framework. The discussion then provides an explanation of peri-urban characteristics of PUS and PUB. It describes the problem of feral deer in PUS and the

problem of wild dogs in PUB before outlining the target innovations for their management.

2.4.1 Levels of government

Australia is geographically divided into regions to facilitate administrative and procedural aspects of governance; for example statistical,[344] natural resource management,[345] biological,[346] and meteorological issues.[347] For electoral purposes, the regions are grouped into states and territories.[348] The federal government divides the country into regions for the purpose of administering economic development.

A second tier of government, the states and territories, each with their own governments and (in the case of the states) constitution. The states of NSW and QLD classify regions within their respective states on the basis of spatial and socio-economic characteristics, though multiple approaches exist for their classification.[349] The classification based on administrative regionalisation is helpful in this research for understanding the institutional structure at various levels of state government.

A third tier of government is local government. NSW has 128 local government areas including cities, municipalities, shires and regions.[350] QLD is divided into 77 local government areas including cities, towns, and shires or regions.[351] The parliaments of NSW and QLD have legal power for established pest animal management.[352]

PUS in NSW comprises the area between the Sydney metropolitan area and the major regional town of Wollongong. PUB in QLD comprises the area north-east and south of the Brisbane metropolitan area, including the major regional centres of Sunshine Coast (north), Toowoomba (east) and Gold Coast (south). The areas between

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[344] <http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+ Statistical+Geography+Standard+(ASG)>.

[345] <http://nrmregionsaustralia.com.au>.

[346] <http://www.environment.gov.au/land/nrs/science/ibra>.

[347] <http://www.bom.gov.au/>.

[348] <http://www.aec.gov.au/profiles/index.htm>

[349] For example, Trade and Investment NSW, https://www.industry.nsw.gov.au/contact-us/nsw-trade-and-investment>; Trade and Investment Queensland <https://www.tiq.qld.gov.au/connect/about-us/regional-advisers/>.

[350] *Local Government Act 1993* (NSW) no 30; https://www.lgnsw.org.au/about-us/nsw-council-links

[351] *Local Government Act 2009* (Qld) and *Local Government Reform Implementation Act 2007* (Qld); Department of Local Government, Racing and Multicultural Affairs, Local government directory, <http://www.dilgp.qld.gov.au/local-government-directory/>.

[352] *Constitution Act 1902* (NSW); *Constitution of QLD 1901.*

metropolitan areas and regional centres (also called spatial centres) is occupied by smaller towns of varying sizes as well as national parks. In PUS and PUB there is an overlap at three (state, regional and local) scales of governance arrangements.
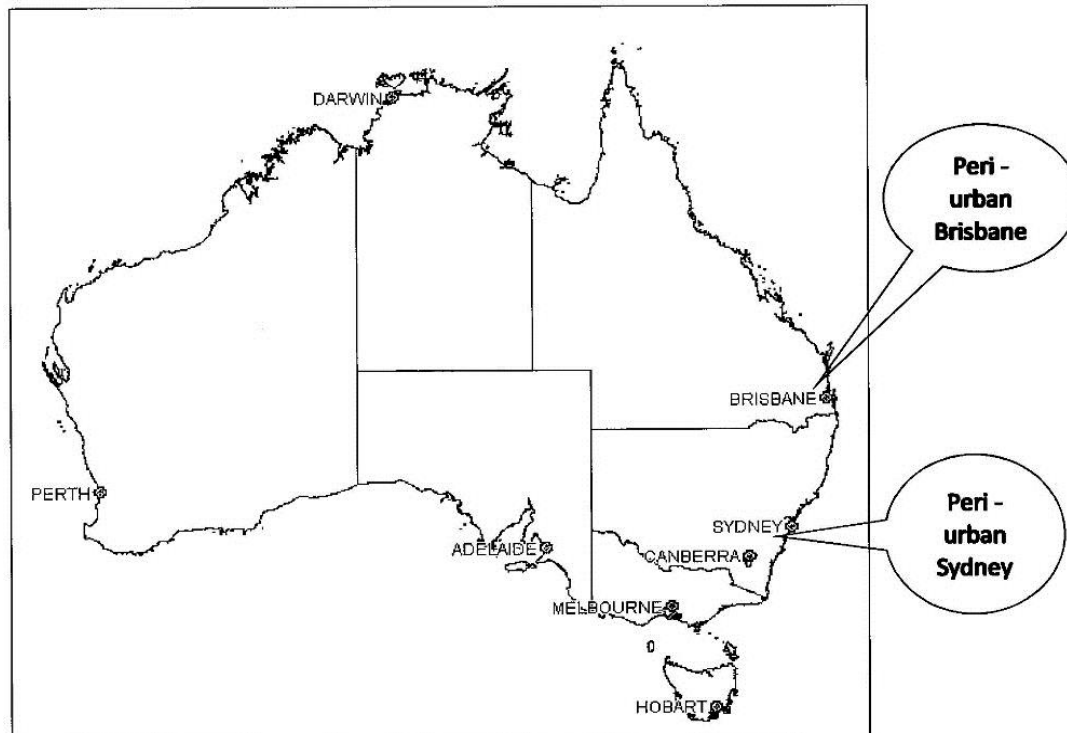
Figure 2.5: Map of Australia showing the location of case study areas

2.4.2 Characteristics of peri-urban Sydney and peri-urban Brisbane

The Following features describe the characteristics of PUS and PUB[353]:

- Overlapping governance processes with multiple agencies directly or indirectly overseeing pest animal control and management, and related issues such as land uses.

- Demographic and socio-economic indicators show consistent and continued strong growth.[354]

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[353] These excerpts have been drawn from local council/government examples and references including: *Wollongong Local Government Area Economic Development Strategy*; *Sutherland Shire Council Economic key findings report*; *Wollongong City Council Environmental Sustainability Strategy 2011-2014*; *Community Strategic Plan Shoalhaven 2023*; *Digital Economy Sector Strategy Shoalhaven City Council January 2012*; *Sutherland Shire Council Environmental Strategy 2013*; *Climate Change Adaptation Strategy and Action Plan Wollongong City Council 2009*.

[354] New South Wales Environment Protection Authority, *New South Wales State of the Environment* (2015) 1–8; Department of Infrastructure, Local Government and Planning, *The State of Queensland Shaping SEQ South East Queensland Regional Plan* (2017) 11.

- Agricultural production emphasises intensive agriculture. For example – the South East Queensland (SEQ) region makes up only 1.3 per cent of QLD but represents 9.8 per cent of the gross value of agricultural commodities produced in Queensland.[355]

- Continued fragmentation of agricultural land, with rezoning of land for residential purposes causing frequent changes in the institutional and governance processes followed by local governments.

- The areas are abundant in biodiversity. For example, the Royal National Park (located in PUS is the world's most biologically diverse national park. In PUB, the Gold Coast area holds 1737 species of vascular flora; 4,525 ha of world heritage-listed Gondwana Rainforest; 12, 630 ha of internationally recognised Ramsar sites, 54 flora and 48 fauna species listed under the *EPBC Act 1999* (Cth), and 113 flora and 86 fauna species listed under the *Nature Conservation Act 1992* (Cth). There are also: 56 regional ecosystems, 691 km of bush trails, 585 species of vertebrate fauna.[356] Table 2.5 describes the demography of PUS and PUB.

Table 2.5: Typologies of PUB and PUS

Population PUS and PUB have the highest percentage of population in their respective states. South Sydney region is experiencing exponential growth in population. For example, Sutherland Shire has the highest population growth rate in NSW. Sutherland Shire is the second most populous local government area in NSW. The Illawarra region ranks third in terms of population growth and density. PUB occupies the area along the coast and south-east of Brisbane where 71% of Queensland's population is concentrated.	
Service age group	The number of young workforce (age group 25–34) is almost equal to retirees (age group 60–69). The proportion of persons at post retirement age is growing.
Ancestry	Only 40% of the population in the case study areas are second generation Australians; the remaining 60% population is from overseas, of which more than 50% encounters difficulty in speaking the English language. For example, in Wollongong the top five countries of birth for people are: Australia, China, England, Macedonia and India; the top five languages (other than English) spoken are: Mandarin, Macedonian, Arabic, Serbian and Italian.

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[355] The State of Queensland, *Shaping SEQ South East Queensland Regional Plan 2017* (Department of Infrastructure, Local Government and Planning, 2017).

[356] City of Gold Coast, *Our Natural City Strategy* <http://www.goldcoast.qld.gov.au/documents/ps/our-natural-city-strategy.pdf>.

Industry sector of employment	Majority of the population works in manufacturing and services sector including healthcare & social assistance; professional, scientific & technical services; retail trade; construction; financial & insurance services; education & training. Few members of the population are employed in agriculture, forestry and fishing areas.
Occupation	Majority of people are professionals with a very few community and personal service workers. Majority of people do not work as a volunteers.
Income	There is a significant diversity in individual income as well as in the household income
Internet connection	Majority of homes in these areas have broadband internet connection.
Place of work	Majority of working residents commute to their workplaces.

2.4.3 Problem of feral deer in PUS

Feral deer are being recognised as an emerging pest animal threat in NSW and across Australia.[357] Particularly severe is the impact of feral deer in the area near the Royal National Park, and Wollongong and Illawarra regions.

Deer species were introduced to Australia from Europe for recreational purposes particularly as game animals.[358] In 1906, the trust authorities of the Royal National Park introduced deer species for exhibition purposes within a fenced enclosure called 'Deer Park'. Rusa deer was introduced into the Royal National Park in 1906.[359] The introduced deer escaped and established wild populations in the areas surrounding the Royal National Park and its adjacent areas (that comprise PUS). These also include deer escaped or released from farming operations as well as deer released for recreational hunting. By 1980s, their population spread south through to the Wollongong local government area.[360] Another major event which led to deer

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[357] P West and G Saunders, 'Pest animal survey: A Review of the Distribution, Impacts and Control of Invasive Animals Throughout NSW and the ACT' (NSW Department of Primary Industries, 2007); Natural Resources Commission, 'Shared problem, Shared Solutions: Pest Animal Management Review' (Final Report, Document No: D16/3146, Sydney, August 2016).

[358] A Bentley, *An* Introduction *to the Deer of Australia* (Bunyip Edition, Australian Deer Research Foundation Ltd, Melbourne, 1998).

[359] A Moriarty, *Ecology and Environmental Impact of Javan Rusa Deer in the Royal National Park* (PhD Thesis, University of Western Sydney, 2004).

[360] Eco Logical Australia, 'Distribution and Abundance of Deer in the Wollongong LGA' (Monitoring report. Prepared for Wollongong City Council, 2015).

dispersal were bushfires in 1994. The bushfires affected more than 90 per cent of the park and caused deer to disperse into areas adjoining the Park.[361]

Five deer species[362] are widespread in NSW. There is no estimate on wild deer population but there is an abundant deer population across the PUS landscape. In addition to Rusa deer, two other species, namely Fallow deer and Red deer, exist in the southern Sydney region.[363] Rusa and Fallow deer have established populations around the Royal National Park and southern suburbs of the Sutherland shire.[364] The most recent pest animal management review in NSW reported that the Illawarra region (in PUS) encountered major environmental and socio-economic impacts from deer.[365] The deer population has shown a 62 per cent growth covering 13 per cent of the NSW.[366]

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[361] D Keith and B J Pellow, (2005). *Effects of Javan Rusa Deer (Cervus timorensis) on Native Plant Species in the Jibbon-Bundeena Area, Royal National Park, New South Wales* (Linnean Society of New South Wales, 126 2005), 99-110.

[362] Except Hog deer (*Axis porcinus*), five species that are widespread in NSW are fallow deer (*Dama dama*), Red deer (*Cervus elaphus*), Sambar deer (*Rusa unicolor*), Chital deer (*Axis axis*) and Rusa deer (*Rusa timorensis*).

[363] New South Wales Local Land Services, *Northern Illawarra Wild Deer Management Program*, <https://southeast.lls.nsw.gov.au/our-region/key-projects/illawarra-wild-deer-management-program>.

[364] A Moriarty, 'The Liberation, Distribution, Abundance and Management of Wild Deer in Australia. (2004) 31 *Wildlife Research* 291.

[365] Natural Resources Commission (2016), above n 357.

[366] References include: For the presence, spread and impacts of deer – a) A. Moriarty (2004), above n 364; b) P West and G Saunders, 'Pest Animal Survey 2002: An Analysis of Pest Animal Abundance across New South Wales and the Australian Capital Territory' (New South Wales Agricultural Institute, Orange, 2003); c) West and Saunders, above n 357; d) T Pople, G Paroz and A Wilke, 'Management of Deer in Queensland' in S McLeod (ed) *Proceedings of the National Feral Deer Management Workshop* (IACRC, Canberra, November 2005). For economic impacts: a) S McLeod (ed) *Proceedings of the National Feral Deer Management Workshop* (IACRC, Canberra, November 2005). For production impacts, see a) K Jensz and L Finley, *Species Profile for the Fallow Deer, Dama* (Latitude 42 Environmental Consultants Pty Ltd. Hobart, Tasmania, 2013); b) *ABC Rural* 'Feral Deer Pastures on New South Wales South Coast, 28 Aug 2015 <http://www.abc.net.au/news/rural/2015-08-28/feral-deer-destroying-pastures-on-nsw-south-coast/6732498>; c) G Dryden, 'Wild Deer in SE Queensland – Graziers' Pest or Charismatic Megafauna?' in S McLeod S (ed) *Proceedings of the National Feral Deer Management Workshop,, Canberra* (IACRC, November 2005). For traffic impacts: a) P J Rowden, D A Steinhardt and M C Sheehan, 'Road Crashes Involving Animals in Australia' (2008) 40(6) *Accident Analysis and Prevention* 1865; b) R Attewell and K Glase, 'Bull Bars and Road Trauma' (Report CR200. Australian Transport Safety Bureau: Canberra, 2000); c) D Ramp and E Roger, *Frequency of Animal-Vehicle Collisions in NSW. Too Close for Comfort* (Royal Zoological Society of NSW, Mosman, Australia, 2008) 118; *Oh Deer: A Tricky Conservation Problem for Tasmania*, 7 January 2016 <https://theconversation.com/oh-deer-a-tricky-conservation-problem-for-tasmania-43702>.

2.4.3.1. Feral deer impacts

The available evidence on the impact of feral deer suggests that they have significant environmental, agricultural and socio-economic impacts.[367] Feral deer impacts in PUS include:

- Traffic hazards: road accidents, vehicle collisions including car accidents, delays on the rail network.[368]

- Damage to property including, for example, fences, house, motor vehicles.

- Major impact on threatened plant species and ecological communities. Deer extensively feed on grass and eat seedlings in the endangered ecological community of littoral rainforests, causing massive impact on regeneration of rainforest.[369]

- Agricultural productivity: Direct predation on native and cultivated vegetation (including agricultural crops, pasture, forestry plantations, gardens, shrubs, smaller plants and livestock).[370]

- Diseases: Deer are believed to be a potential vector for disease, parasites and weeds, although there is no available evidence to support this threat.[371] Wild deer may act as vectors for parasites and infectious diseases of livestock.[372] Wild deer are also susceptible to diseases such as foot-and mouth disease, rabies and brucellosis.[373]

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[367] D Forsyth et al (eds) *2016 National Wild Deer Management Workshop Proceedings* (IACRC, Adelaide, 17-18 November 2016); Naomi Davis et al, 'A Systematic Review of the Impacts and Management of Introduced Deer (family *Cervidae*) in Australia' (2016) 43 *Wildlife Research*, 515-<https://doi.org/10.1071/WR16148>.

[368] Sydney train data, unpublished report: 2015 Draft Illawarra Deer Management Program (obtained from one of the local government stakeholders involved in the program; received by e-mail communication after conversation in person during the AVPC Conference, 2017, Canberra, Australia).

[369] Iain J Gordon and Herbert H T Prins (Eds), *The Ecology of Browsing and Grazing* (Springer, 2008).

[370] Forsyth et al (2016), above n 367, 10–13.

[371] Unpublished report: 2015 Draft Illawarra Deer Management Program (obtained from one of the local government stakeholders involved in the program; received by e-mail communication after conversation in person during the AVPC Conference, 2017, Canberra, Australia).

[372] *Draft Hastings Wild Deer Management Strategy 2016-18* (LLS North Coast, NSW Government 2016).

[373] Ibid.

- Biodiversity impact: Impact on native Australian flora and fauna through trampling, rutting and browsing pressures. Sutherland shire littoral rainforest has lost 70 per cent of plant species due to deer populations. Reportedly, littoral rainforest, several local endangered ecological communities and threatened species are vulnerable to feral deer impacts and soil erosion.[374]

- Illegal hunting and shooting close to properties with potential concerns for people and animals to be injured, deer corpses left to rot, inhumane hunting (eg, use of arrows) and hunters causing damage to properties.[375]

The threat posed by deer has been assessed as extreme by the National Invasive Plants And Animal Committee.[376] The NLIS has introduced notification of the movement of domestic deer in its scheme to address disease related incidence.[377] The Vertebrate Pest Committee, under its nationally agreed guidelines, recommends that the states and territories should impose strict controls relating to extreme threat species, including deer.[378] High reproduction rates in deer species make it difficult to assess control.[379]

2.4.3.2. Feral deer management

Strategies for feral deer control vary based upon the objectives of control. Deer are an economic asset to deer owning landowners/farming enterprises. The priority of management is to address deer escaping from farms and forming new populations in the wild. Escape-proof enclosures are used to keep farmed deer in captivity. A deer that escapes from the farm or an enclosure is defined as a wild deer. Current wild deer population comprise deer that have escaped from captivity. Management strategies for wild deer include eradication and containment. The objective of eradication and

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[374] Davis (2016) above n 370, 8.

[375] *Deer Management Plan, Wollongong City Council 2013-14* (Wollongong City Council, 2012).

[376] Invasive Plants and Animal Committee (2016), above n 48.

[377] *Biosecurity Regulation 2017 – National Livestock Identification System* <https://legislation.nsw.gov.au/~/pdf/view/regulation/2017/231>; DPI-NSW, 'Discussion paper: Biosecurity Act 2015, Livestock Identification and Traceability' (December 2015).

[378] Department of Agriculture, *Guidelines for the Import, Movement and Keeping of Non-indigenous Vertebrates in Australia: 2014, Developed by the Vertebrate Pests Committee,* CC BY 3.0, <https://www.pestsmart.org.au/wp-content/uploads/2014/07/VPCGuidelinesJan14.pdf>.

[379] Current population reduction assessments call for 53% Hog deer, 34% Fallow deer and 46% Rusa deer removals: Invasive Species Council, 'Recreational Hunting NSW: Claims v Facts' (2012) 1.

containment is to minimise the impacts of wild deer, limit the spread of wild deer populations and prevent the establishment of new populations.[380] Current management in PUS primarily comprises shooting. Other options such as trapping, fencing and habitat corridor manipulation are being investigated.[381] Table 2.6 lists wild deer control techniques for eradication and/or containment that are generally effective in peri-urban areas. The techniques are drawn from the *Deer Management Plan 2017-2020 of the Wollongong City Council*.[382]

Table 2.6: Wild deer control technique

Control technique	Applicability		Effectiveness		
	Advantages	Disadvantages	Efficacy	Cost-effectiveness	Target specificity
Ground based shooting	Target specific control, Helps reduce deer population where they have the most impact	Difficulties in locating deer, herd gets dispersed while shooting which makes eradication difficult	Most effective method available	Expensive	Target specific
Fencing	Useful for protection of small areas/properties	Requires continuous maintenance	Limited effectiveness	Expensive	Non Target specific
Trapping	Useful when large deer population exists	Expensive, time consuming and labour intensive	Limited effectiveness	Expensive	Target specific

2.4.3.3 Deer control innovations considered in this research

Ground based shooting is the primary control technique used for wild deer control in PUS. Ground shooting is an effective and target-specific control method.[383] Despite

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[380] Moriarty (2004), above n 364.

[381] Wollongong City Council, *Pest Management Plan for Deer 2017-2020*, 2017 <http://www.wollongong.nsw.gov.au/services/sustainability/naturalareamanagement/Documents/Pest%20Management%20Plan%20Deer%202017-20.pdf >.

[382] Ibid.

[383] For the explanation on efficacy of ground shooting see: Andrew Bengsen, *A Systematic Review of Ground-Based Shooting for Pest Animal Control* (PestSmart Toolkit publication, IACRC, 2016); For Sedative darting as a control technique, see, *Hastings Wild Deer Management Strategy 2016-18* (North Coast Local Land Services, 2016) 7; *Pest Species*

the target specificity, ground shooting involves the risks of injuring or killing non-target species. To mitigate the risks of injuring or killing non-target species and to ensure animal welfare considerations, Standard Operating Procedure (SOP DEE001) provides extensive guidelines for humane shooting for deer management.

Shooting requires the user to obtain a permit/license. The requirement of permits/licenses instils a commercial approach to deer shooting in which hunting resources are used for feral deer control. The individual farmers or land managers who permit licensed shooters to kill deer on their lands can re-invest the money for other pest control activities. For example, the Farmer Assist Program by Sporting Shooters Association of Australia (SSAA) brings farmers into contact with qualified, licenced and experienced volunteer shooters. The focus of SSAA is on target shooting.[384] Standard shooting protocols and site plans ensure the safe implementation of volunteer shooting. Ground shooting is effective to control low density populations. For large numbers of deer, aerial shooting is a preferred technique. Aerial shooting is conducted by NSW government employees (members of the NSW Feral Animal Aerial Shooting Team) to control fallow, red and sambar deer populations. Aerial shooting is one of the most effective and humane techniques to control feral animal populations in national parks[385]. In NSW, the National Parks and Wildlife Service (NPWS) implements programmes to control feral animals in collaboration with local governments and other states as well as non-government organisations.

Community based deer management

Wild deer are more likely to be mobile and may graze across a large area. Implementation of control techniques is successful when it is conducted cooperatively with all landholders. Integrated deer management programs are conducted with the involvement of one or more councils and bodies, NPWS, and private landowners. The first step in deer management involves assessment of deer problem. The assessment is based on surveys and information on deer sightings. Currently there are no agreed

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Regional Management Plan: Fallow Deer and Red Deer (Eyre Peninsula Natural Resources, ND) 6.

[384] The Sporting Shooters Association of Australia (NSW) <ssaansw.org.au>.

[385] Aerial shooting is carried out by the experts accredited by the Feral Animal Aerial Shooting Team (FAAST) Training Program: Andrew Moriarty and Stephen McGilchrist, *FAAST Training and Reference Manual*, 2003 <https://snowybrumby.files.wordpress.com/2013/10/faast-training-manual.pdf>.

monitoring techniques available for deer. One of the potential innovations that may facilitate data availability of deer population is deer mapping. A pilot version of DeerScan is being tested for its utility in mapping deer population.[386]

Recreational hunting facilitates the involvement of community in wild deer management and provides a complimentary strategy to compensate for the drawbacks of 'co-ordinated control measures through the involvement of recreational shooters working on private and public lands,[387] as well as providing deer meat, which is a source of healthy food.[388] Recreational hunting is selective, which may not be adequate where heavy culling is required but has a potential to be a supplementary control and hunting clubs are playing a role in advancing and promoting recreational hunting;[389] for example, The Federation of Hunting Clubs Inc. (Federation) is an umbrella organization of 35 hunting clubs representing hunters from all parts of NSW. However, widespread use has not been proven.

Property owners are advised to manage deer using fences, but electric fencing is not allowed.[390] Careful driving, avoid feeding deer and aggressive deer management around breeding season are measures recommended by local governments.

Enforcement of laws for feral deer management:
The new *Biosecurity Act 2015* (NSW) and the *Game and Feral Animal Act 2002* (NSW) provide a legislative framework to effectively respond to feral deer threats. Under the *Biosecurity Act 2015* (NSW), landholders have a legal responsibility to control feral deer on their land. The responsibility is defined as a GBD. The role of local government is to take all reasonable steps to minimise biosecurity risks relevant

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[386] *DeerScan* <https://www.feralscan.org.au/deerscan/>.

[387] A Bengsen, J Sparkes and S McLeod, How Can Recreational Hunting Help Control Pests on Public Land, 2016 <http://event.icebergevents.com.au/uploads/contentFiles/files/2016-SUCON/Andrew%20Bengsen.pdf>; A J Bengsen and J Sparkes, 'Can Recreational Hunting Contribute to Pest Mammal Control on Public Land in Australia?' (2016) 46 *Mammal Review* 297, doi:10.1111/mam.12070.

[388] Invasive Species: If We Can't Beat Them, Maybe we Should Eat Them, 14 April 2014 <https://theconversation.com/invasive-species-if-we-cant-beat-them-maybe-we-should-eat-them-25244>.

[389] I Paronson, *The Australian Ark: A History of Domesticated Animals in Australia* (CSIRO Publishing, 1998).

[390] *Feral Animal Policy*, Sutherland Shire Council <http://www.sutherlandshire.nsw.gov.au/files/assets/website/temp-dms/policies-pdf/policy_feral_animals.pdf>.

to pest animals. The *Act* is read in conjunction with ten other Acts to achieve the goals of pest animal management.[391]

Innovations that have been considered for feral deer management in PUS include:

- Ground shooting
- SOPs for ground shooting
- Mapping technology: DeerScan
- Community engagement
- Enforcement of laws requiring wild deer management

2.4.4 Managing wild dogs in peri urban Brisbane

Wild dogs are prevalent and widely distributed throughout QLD.[392] The national study by ABARES of landholder perceptions relating to wild dogs indicates an overall increase in the severity of negative impacts across Australia, with Queensland experiencing the highest impacts.[393]

Wild dogs include purebred dingoes (*Canis Lupus dingo*), dingo hybrids and domestic dogs (*Canis lupus familiaris*) in the wild.[394] Dingoes evolved in Asia.[395] The scientific evidence relating to genetic diversity suggests the introduction of dingoes in Australia occurred up to 4600 to 18 300 years ago through trading routes.[396] Wild dogs are often dingo and domestic dog hybrids and difficult to distinguish from pure

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[391] The relevant legislation includes: *Local Government Act 1993* (NSW), *Local Land Services Act 2013* (NSW), *National Parks and Wildlife Act 1974* (NSW), *Threatened Species Conservation Act 1995* (NSW), *Forestry and National Park Estate Act 1998* (NSW), *Crown Lands Act 1989* (NSW), *Crown Lands (Continued Tenures) Act 1989* (NSW), *Native Vegetation Act 2003* (NSW), *Prevention of Cruelty to Animals Act 1979* (NSW) and *Game and Feral Animal Control Act 2002* (NSW).

[392] Department of Employment, Economic Development and Innovation, *Wild Dog Management Strategy 2011-16*, 2011, <https://www.daf.qld.gov.au/__data/assets/pdf_file/0016/62431/Wild-dog-strategy-2011-16.pdf>.

[393] Binks, Kancans, and Stenekes (2015), above n 115.

[394] WoolProducers Australia, 'National Wild Dog Action Plan: Promoting and Supporting Community-Driven Action for Landscape-Scale Wild Dog Management' (Wool Producers, 2014).

[395] B N S K Sacks et al, 'Y Chromosome Analysis of Dingoes and Southeast Asian Village' (2013) 30 *Molecular Biology and Evolution* 1103.

[396] C R Mattias et al, *Mitochondrial DNA Data Indicate an Introduction Through Mainland Southeast Asia for Australian Dingoes and Polynesian Domestic Dogs* (Proceedings of the Royal Society of Biological Science, 2011), doi: 10.1098/rspb.2011.1395; B P Smith and C A Litchfield, (2009). 'A Review of the Relationship Between Indigenous Australians, Dingoes (*Canis dingo*) and Domestic Dogs (*Canis familiaris*)' (2009) 22 *Anthrozoos* 111.

dingoes.[397] The dingo is a native species which has a key ecological and ecosystem function in Australian continent.[398] The requirement of food, water and shelter brings wild dogs closer to peri-urban areas. Food habits of wild dogs vary significantly, but domestic livestock and small and medium sized animals constitute a significant part of their diet. The free roaming of domesticated dogs increases the risk of them becoming wild and increases the risk of these dogs creating problems on adjacent properties.[399]

2.4.4.1 Impacts of wild dogs

Wild dogs cause significant economic, environmental and social impacts. In Australia, wild dog production losses are estimated at $89 million per year.[400]Agricultural losses particularly affect sheep and cattle producers. Domestic livestock, including lambs, calves, sheep and cattle, are vulnerable to wild dog attacks.[401] These attacks lead to significant stress, weight loss, low-quality meat, and poor wool growth in sheep.[402] Dingoes are considered as a problem for biodiversity conservation because they predate on species, including threatened fauna,[403]

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[397] IACRC, *PetSmart Factsheet: Frequently Asked Questions – Wild Dog Biology, Behaviour & Ecology* (2015); IACRC, *Distribution of Pure Dingoes and Dingo-Dog Hybrids in Australia* (2012); A W Claridge and R. Hunt, 'Evaluating the Role of the Dingo as a Trophic Regulator: Additional Practical Suggestions (2008) 9 *Ecological Management and Restoration* 116.

[398] S Healy, 'Deadly Dingoes: "Wild" or Simply Requiring "Due Process" (2007) 37 *Social Studies of Science* 443; P Fleming et al, *Managing the Impacts of Dingoes and Other Wild Dogs* (Bureau of Rural Sciences, 2001).

[399] A study conducted in Western Australia, indicates that the majority of dog attacks involve less than three dogs and, in most cases, these include the dogs owned by neighbours or dwellers in a vicinity of one kilometre; G Jennens, 'Dog Attacks on Livestock' in S. Hassett (ed), *Urban Animal Management* (Proceedings of the Seventh National Conference On Urban Animal Management in Australia, Australian Veterinary Association, 1998) 17.

[400] <https://www.theland.com.au/story/5008346/australias-staggering-89m-wild-dog-problem/?src=rss>; Natural Resources Commission, 'Cost of Pest Animals in NSW and Australia, 2013-14' (Report by Esys Development Pty Ltd, 2016).

[401] Fleming et al (2017), above n 15.

[402] B Mitchell and S Balogh, *Monitoring Techniques for Vertebrate Pests: Wild Dogs* (NSW Department of Industry and Investment, 2007); WoolProducers Australia (2014), above n 394.

[403] B L Allen et al, 'Dingoes at the Doorstep: Preliminary Data on the Ecology of Dingoes in Urban Areas' (2013) 119 *Landscape and Urban Planning* 131.

wallabies[404] and wombats.[405] The impact of dingoes in the reduction of native mammal species is based on anecdotal evidence and is contentious.[406]

In QLD, overall production loss due to wild dog activities is estimated to be $67 million, with beef producers incurring A$45 million in losses.[407]

Wild dogs can also act as a reservoir of parasites and diseases that affect livestock. For example, the transmission of hydatid disease and Neosporosis by dingoes results in the loss of livestock and decreased carcass value. This causes an estimated A$5 million of losses annually to the livestock producers in QLD.[408]

Dog attacks and nuisance caused by stray or roaming dogs are also issues in residential areas.[409] Close to human settlements, the majority of population comprises hybrid dogs.[410] Dingoes create a risk of diseases amongst domestic animals and humans[411] and there have been a few instances of wild dogs (including dingoes) attacking humans, with two documented instances in which humans were killed.[412] The attacks generally occur in peri-urban areas due to increased human-animal interactions.[413]

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[404] G Lundie-Jenkins and J Lowry, 'Recovery Plan for the Bridled Nailtail Wallaby (*Onychogalea fraenata*) 2005-2009' (Report to the Department of Environment and Heritage (DEH) and Environmental Protection Agency/Queensland Parks and Wildlife Service, 2005).

[405] A Horsup, 'Recovery Plan for The Northern Hairy-Nosed Wombat (*Lasiorhinus krefftii*) 2004-2008' (Report to the Department of Environment and Heritage, Canberra. Environmental Protection Agency/Queensland Parks and Wildlife Service, Brisbane, 2004).

[406] B Allen and P Flemming, Reintroducing the Dingo: The Risk of Dingo Predation to Threatened Vertebrates of Western New South Wales' (2012) 39 *Wildlife Research* 35.

[407] L Hewitt, *Major Economic Costs Associated with Wild Dogs in Queensland Grazing Industry, Bluprint for the Bush* (Queensland State Government, 2009).

[408] Ibid.

[409] J R Butler et al, 'Dog Eat Dog, Cat Eat Dog: Social-Ecological Dimensions of Dog Predation by Wild Carnivores' in M E Grompper (ed) *Free-Ranging Dogs and Wildlife Conservation* (Oxford University Press, 2014) 117.

[410] Department of Agriculture and Fisheries (QLD), *Wild Dog Facts: What is a Wild Dog?* (2016) <https://www.daf.qld.gov.au/__data/assets/pdf_file/0006/77451/IPA-Wild-Dog-Fact-Sheet-What-Is-A-Wild-Dog.pdf>.

[411] L Allen, 'Wild Dog Management in Queensland: An Issues Paper' (Biosecurity Queensland, 2008).

[412] <http://www.bbc.com/news/magazine-17129061.

[413] J Thompson, L Shirreffs and I McPhail, 'Dingoes on Fraser Island: Tourism Dream or Management Nightmare' (2003) 8 *Human Dimensions of Wildlife* 37; D Staines, 'A Legal Trauma, a Public Trauma: Lindy Chamberlain and the Chamberlain Case' (2006) 38 *Studies in Law, Politics, and Society* 153.

Wild dogs also have a social impact in peri-urban communities.[414] These include threats to the health and safety of community, stress due to wild dogs attacking humans and their livestock and potential threat of diseases.[415] Wild dogs have mixed impacts on the natural environment. On the positive side they reduce population of other feral animals, including rabbits, goats, pigs, cats and foxes.[416]

Strategic guidance for the management of wild dogs in QLD is provided by the *Wild Dog Management Strategy*.[417] The strategy prescribes for integrated management with the use of control techniques including fencing, trapping, shooting and ground or aerial baiting.[418]

Fencing can be effective in controlling the movement of wild dogs, returning to areas in which they are controlled. With local government support, wild dog barrier fences are erected to protect sheep grazing areas in southern and south-western QLD. The Wild Dog Barrier Fence (WDBF) was constructed in 1950s, with graziers having the responsibility to maintain the fence. The changing conditions of the wool market and drought brought in considerable changes in land use and the condition of WDBF significantly deteriorated. In 1984, the QLD State Government altered the fence by shortening it from 5600 km to 2500 km. Additional check fences have been constructed in the southern Darling Downs area of QLD to protect livestock. These are managed by the local governments. Currently the WDBF is about 2500 km long and protects 26.5 million hectares of sheep and cattle grazing area. It is administered by Biosecurity Queensland with assistance provided by the Queensland Department of Agriculture and Fisheries' WDBF Panel.[419]

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[414] C Sykes, *A Man from Gelantipy* (re-written and compiled by Colin Ferres, James Yeates & Sons Printing Pty Ltd, Bairnsdale, Victoria, 1982).

[415] C Lightfoot, *Social Benefit Cost Analysis: Wild Dog Management in Victoria* (Tyne Group, 2010).

[416] A S Glen, C R Dickman, M E Soule and B G Mackey, 'Evaluating the Role of the Dingo as a Trophic Regulator in Australian Ecosystems' (2007) 32(5) *Australian Ecology* 492; C Johnson, Australia's Mammal Extinctions: A 50 000 Year History (Cambridge University Press, 2007).

[417] Department of Employment, Economic Development and Innovation (2011), above n 392.

[418] *Queensland Wild dog management Strategy 2002*, <http://www.southwestnrm.org.au/sites/default/files/uploads/ihub/land-protection-2002-queensland-pest-animal-strategies-wild-dogs-dingo-canis.pdf>

[419] Queensland Government, Department of Agriculture and Fisheries, *History of the Wild Dog Barrier Fence*, <https://www.daf.qld.gov.au/business-priorities/plants/weeds-pest-animals-ants/pest-animals/barrier-fences/history-of-the-wild-dog-barrier-fence>; *Wild Dog Check Fences*, <https://www.daf.qld.gov.au/business-priorities/plants/weeds-pest-animals-

Despite these measures, the wild dog population in Queensland is expanding because of a reluctance of land managers to pursue wild dog control. The key reasons for this reluctance include:[420]

- The land managers who are not adversely affected by wild dog impacts do not take wild dog control seriously,
- A lack of resources,
- Concerns of accidental poisoning of non-target animals, and
- A lack of awareness of wild dog impacts.

Outside the WDBF, baiting is considered as the most economic, efficient, humane and effective method. Coordinated baiting programs conducted over smaller areas have proved effective in long-term wild dog control.[421]After baiting programs, other methods (shooting, trapping, and fencing) are employed to remove remaining population of wild dogs and to provide additional control. Taking into account the concerns about accidental poisoning of working dogs and non-target animals, research to investigate an antidote for 1080 was initiated by the QLD State Government in 2002.

Baiting with 1080 and strychnine is available throughout Queensland. 1080 is more humane than strychnine; it contains an odourless, tasteless white powder with a special dye to identify the toxin and which is incorporated into baits. Such baits are then distributed on the ground (ground baiting) or from the air (aerial baiting). The analysis of humaneness of 1080 by Sharp and Saunders[422] suggests that the animal experiences pain and suffering during the initial onset of signs. The suffering may not occur once the process of central nervous system dysfunction is over. Compared to strychnine, the animal suffers less pain and anxiety; therefore, strychnine is categorised as less humane. The National Consultative Committee on Animal Welfare has recommended the ban on the sale and use of strychnine in Australia and the use of strychnine in wild dog baits is being phased out in Australian states and territories. Integrated control (ground or aerial baiting, trapping, shooting and fencing) with a

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ants/pest-animals/barrier-fences/wild-dog-check-fences>; Wild Dog Barrier Fence Panel, <https://www.daf.qld.gov.au/business-priorities/plants/weeds-pest-animals-ants/pest-animals/barrier-fences/wild-dog-barrier-fence-panel>.

[420] Biosecurity Queensland (2011), above n 209, 17– 21.

[421] Ibid, 16.

[422] Sharp and Saunders (2011), above n 242.

primary aim to reduce livestock losses and interactions of wild dogs with domestic dogs is considered as an effective control strategy for wild dog management.[423] In peri-urban areas trapping is particularly useful. Trapping ensures quick death if used in conjunction with poison baits and also causes minimal impact on non-target species.

Table 2.7 lists control techniques for wild dog management in QLD.[424]

Table 2.7: Wild dog management techniques

Control technique	Applicability		Effectiveness		
	Advantages	Disadvantages	Efficacy	Cost-effectiveness	Target specificity
Baiting - 1080	Allows distribution of baits by land/air or buried/tied to reduce non-target impacts	Baiting in peri-urban areas is difficult due to population density, non-target impacts	Partially effective	Low cost	Non-target impacts
Baiting - Strychnine	Effective if used in conjunction with traps to ensure a quick death for captured wild dogs	Strychnine is a less humane poison than 1080	Partially effective	Expensive	Non-target impacts
Trapping	Effective as part of an integrated approach especially as a follow-up of baiting program, allows control of small populations	Time-consuming, labour intensive	Effective, Only padded, offset or laminated jawed traps are acceptable	Expensive	Minimal non-target impacts if used correctly
Shooting	Effective as part of an integrated approach, Allows the	Time-consuming, labour intensive	Effective, must be conducted in accordance	Expensive and highly regulated	No non-target impacts if used correctly

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[423] Binks, Kancansand Stenekes (2015), above n 115.
[424] Biosecurity Queensland 2016, above n 209.

Control technique	Applicability		Effectiveness		
	Advantages	Disadvantages	Efficacy	Cost-effectiveness	Target specificity
	control of small populations		with the Weapons Act 1990		
Fencing	Prevents wild dogs returning to areas where they have been controlled	Regular maintenance of fences is required	Partially effective	Expensive	Non-target impacts

2.4.4.2 Wild dog control innovations considered in this research

Use of PAPP in conjunction with mechanical ejectors:

Para-aminopropiophenone (PAPP) is an alternative to 1080. PAPP is an active ingredient in toxic baits for the broad-scale management of wild dogs and foxes. It is a humane poison with an antidote, methylene blue, which makes it particularly suitable for its application in peri-urban areas.[425] PAPP has been developed for wild dog control because of its target selectivity and humaneness.[426] PAPP is commercially available for wild dog control with the name DOGABAIT in PUB. The PAPP product DOGABAIT has following innovative attributes:

- an attractive and palatable bait for wild dogs
- reliable
- humane mode of action
- biodegradable
- effective antidote (chemical methylene blue) for use by vets and pet dog owners
- selectively toxic to wild dogs compared to non-target species

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[425] For detailed information on PAPP, see *PESTSMART – Frequently asked questions: PAPP for wild dog & fox control* <https://www.pestsmart.org.au/wp-content/uploads/2015/06/WDFS7_PAPP2016-june-2016.pdf>; Invasive Plants and Animals Committee (2016), above n 48, 'PAPP, A New Complementary Tool in the Fight Against Pest Animals', 28.

[426] P J S Fleming et al,(2006), above n 140; *Toxicology and ecotoxicology of para-aminopropiophenone (PAPP) - A new predator control tool for stoats and feral cats in New Zealand (PDF Download Available)* <https://www.researchgate.net/publication/261995774_Toxicology_and_ecotoxicology_of_para-aminopropiophenone_PAPP_-_A_new_predator_control_tool_for_stoats_and_feral_cats_in_New_Zealand>.

PAPP is available in addition to 1080 and is designed to allow poison baiting where the use of 1080 is restricted (eg, in peri-urban areas). PAPP is intended to complement 1080 baits to enable comprehensive regional wild dog management.

A mechanical ejector (M-44/Canid Pest ejector) is a device that once triggered by a wild dog, ejects a lethal dose of PAPP toxin into its mouth. The animal, pursuing a baited lure, pulls the spring activated device. This propels the poison directly into the mouth of the animal. It is a target-specific technique that does not require regular checking. The key features of Canid Pest Ejector (CPE) (see Figure 2.4) include:

- The upward pulling action of a device can be easily achieved by wild dogs, but much less so by most non-target species.
- The baited lure head ensures target specificity, since the lure head does not attract herbivores.
- CPE is staked to the ground by a sturdy metal peg, which cannot be easily removed.
- Devices are useful for long-term management.
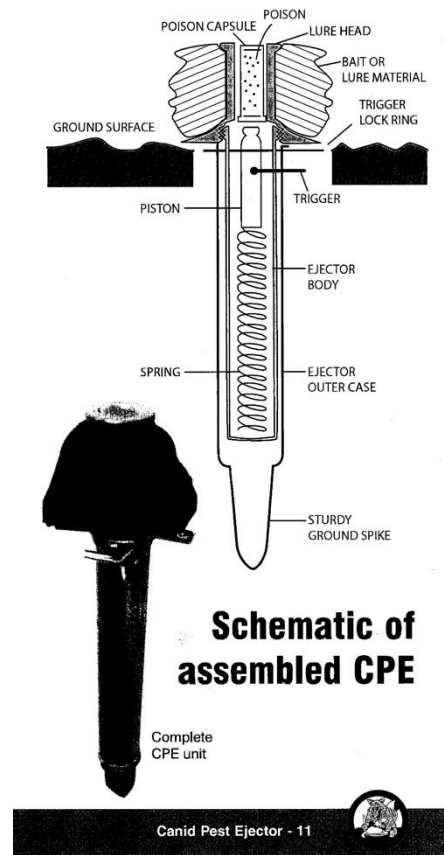
Figure 2.6: Canid pest injector
(Source: Animal Control Technologies Australia, *Booklet: Canid pest ejector, controlling foxes and wild dogs* <http://www.animalcontrol.com.au/pdf/ACTA_CPE_DL_Booklet.pdf>)

Traps

Innovations in traps allow more precise matching of the size of the animals' foot to the size of the traps. Foot hold traps hold the animal firmly, preventing the damage to underlying tissues. Foot-hold traps are commercially available in three major designs: padded jaws, offset jaws and laminated jaws. These traps are buried in the ground. When an animal steps on the plate, the plate frees the tongue from the notch and allows the jaws to shut. This holds the animals foot until it is released or moved by the trapper. Trapping is an effective method in situations where a small number of wild dogs must be controlled after a large-scale baiting program. This is particularly useful in peri-urban areas.

For efficiency and animal welfare reasons, the following operating procedures provide guidelines on wild dog management.

- Model code of practice for the humane control of wild dogs (DOGCOP)
- Trapping of wild dogs using padded-jaw traps (DOG001)
- Ground shooting of wild dogs with 1080 (DOG003)
- Ground baiting of wild dogs with 1080 (DOG004)
- Aerial baiting of wild dogs with 1080 (DOG005)
- The care and management of dogs used in the control of pest animals (GEN002)

Data gathering and analysis:

WildDogScan aids in reporting wild dog sightings. It maintains detail record of the date, species and number of animals reported.[427]

Collaborative control

Wild dogs traverse lands managed by a variety of stakeholders. In PUB, wild dogs have spread to areas of high human activity, including townships, refuge dumps, camping, and picnic areas and resorts. Wild dogs also inhabit certain PUB areas where residential land adjoins national parks. For effective management, landholders have to work together across the property boundaries, adopting a nil-tenure approach. The nil-tenure approach engages local communities in collaboration with government land managers to collaboratively address wild dog problems. This requires

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[427] *WildDogScan* <https://www.feralscan.org.au/wilddogscan/>.

coordinated community action. The coordinated action helps in pooling economic and human resources to conduct wild dog management. The approach depends upon engagement and participation of communities. It includes: acceptance and 'ownership' of the problem, participation of stakeholders, communication and sharing of information, and cultural change in terms of implementing coordinated control. In peri-urban areas, public awareness and knowledge of wild dog management is important to raise the capacity and willingness of landholders to take control action.

Enforcement of new and existing laws:

In QLD, the *Biosecurity Act 2014* provides a legislative framework to respond to pest animal threats. Landholders have a legal responsibility to control pest animals, including wild dogs, on their land. The responsibility is defined as a GBO. The role of local government is to take all reasonable steps to minimise biosecurity risks. Local governments have a responsibility for the enforcement of wild dog control where landholders fail to control wild dogs on their land or refuse to participate in control activities.[428] Education and voluntary compliance are the recommended strategies for enforcement of the *Biosecurity Act*.

The *Land Protection (Pest and Stock Route Management) Act 2002* (QLD) is the relevant legislation that governs the management of declared pest animal species in QLD and provides the right of government to enforce wild dog management.

Queensland Parks and Wildlife Service (QPWS) has a legal obligation to manage wild dogs, including dingoes, on the land managed by QPWS, under the *Nature Conservation Act 1992* (QLD), *Forestry Act 1959* (QLD) and *Recreation Areas Management Act 2006* (QLD). The QPWS is responsible for maintaining biodiversity through conservation of dingo populations on protected areas and managing wild dogs to mitigate threats to native wildlife. Authority holders carry out wild dog control on QPWS lands by securing approval from QPWS.[429]

Innovations in wild dog management in peri-urban Brisbane include:
- Use of PAPP in conjunction with the mechanical ejector
- Operating procedures for wild dog management

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[428] An individual landholder has a shared responsibility to manage wild dogs as per the GBO.

[429] *Management of wild dogs on QPWS Estate* <https://www.npsr.qld.gov.au/policies/pdf/op-pk-nrm-wild-dog-mgt.pdf>.

- Data gathering and analysis - Use of WilddogScan for monitoring
- Coordinated nil-tenure control and community engagement
- Enforcement of new and existing laws for wild dog management

2.4.5 Summary of discussion on cases

Table 2.8 summarises the technological and managerial innovations considered in this research.

Table 2.8: Innovations considered in this research

Innovations	Wild deer management in peri-urban Sydney	Wild dog management in peri-urban Brisbane
Technological	Ground shooting	Use of PAPP in conjunction with the mechanical ejector
	SOP for ground shooting	Operating procedures for wild dog management
	Mapping technology: DeerScan	Mapping technology: WilddogScan
Managerial	Community engagement	Coordinated nil-tenure control and community engagement
	Enforcement of laws requiring wild deer management	Enforcement of laws requiring wild dog management

2.5 Institutional theories of innovation adoption and implementation

Chapter 1 described the importance of adoption and implementation of technological and managerial innovations for pest animal control. The chapter also noted that substantial government and community resources in Australia are devoted to improving pest animal management. The return on investments in pest animal management depends on the extent to which stakeholders adopt and implement the innovations. Theories suggest that adoption and implementation of innovation involves overcoming institutional constraints. My objective in this thesis is to identify what institutions impede the effectiveness of pest animal management. The following theoretical perspectives suggest types of institutional impediments that can affect innovation adoption and implementation.

2.5.1 Innovation adoption

The adoption of pest animal management innovation requires the intention to use innovations 'on the ground'. Adoption involves a decision-making process about the

merits of innovations, including a consideration of available knowledge and information relevant to a specific innovation.[430]

Diffusion theory[431] explains how innovations spread through a social system[432] with an assumption that interactions between stakeholders within a social system influence the spread of innovation.[433] The theory describes diffusion taking into account three aspects of decision making: a) The decision-making process for innovation-adoption followed by individuals, b) categories of individuals involved in innovation-adoption c) characteristics of innovations influencing the rate of innovation-adoption.

Decision-making process:
Innovation diffusion theory comprises a five stage process of decision-making for adoption of an innovation:[434] awareness, persuasion, decision, confirmation and implementation. In the awareness stage, an individual is exposed to an innovation and develops a basic understanding of it. In the persuasion stage individuals obtain sufficient understanding to develop an attitude, either positive or negative, toward the innovation. In the third stage an individual will make a decision to accept or reject the innovation. In the fourth stage the individual seeks to confirm the decision. In the absence of confirmation, the individual may reverse the decision. Finally, in the fifth stage the innovation becomes operational through its implementation. This is the operative aspect of innovation during which individuals may require further information and knowledge to address problems they encountered during implementation.[435]

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[430] E M Rogers, 1995, *Diffusion of Innovations* (Free Press, 4th ed, 1995); S Chamala, 'Adoption Processes and Extension Strategies for Conservation Farming,' in S Chamala, P S Cornish and J E Pratley (eds), *Tillage - New Directions in Australian Agriculture* (Inkata Press, 1987) 400.

[431] D J Pannell et al, 'Understanding and Promoting Adoption of Conservation Practices by Rural Landholders' (2006) 46 (11) *Australian Journal of Experimental Agriculture* 1407; A F Baudisch and H Grupp, *Evaluating the Market Potential of Innovations: A Structured Survey of Diffusion Models* <http://www.ausicom.com/filelib/PDF/ResearchLibrary/innovation%20models.pdf>.

[432] E M Rogers and F. F. Shoemaker, *Communication of Innovations: A Cross-Cultural Approach*, (Free Press, 1971); E M Rogers, *Diffusion of Innovations* (Free Press New York, 3rd ed, 1983); Rogers (1995), above n 430.

[433] Rogers and Shoemaker (1971), above n 432.

[434] Rogers (1995), above n 430.

[435] Ibid.

Adoption:

Innovation diffusion theory provides two major reasons for the differences among individuals in adopting an innovation. The first reason reflects the variation in speed with which information, often described by mathematical models, [436] is disseminated in a society. The second reason is the influence of individual characteristics on adoption. The examples of individual characteristics relevant to pest animal management include the capacity of individuals to cope with uncertainty and to work in coordination with other stakeholders for innovation-adoption. Differences in individual characteristics reflect the classification of adoption into five phases:[437] innovators, early adopters, the early majority, late majority and laggards. Innovators have been described as alert information seekers with an ability to cope with uncertainty; they are typically the first adopters.[438] Early adopters are described as initial adopters who potentially influence other adopters by providing information and advice on innovations. The early majority provides a link between early and late adopters and will engage in interactions about an innovation with their peers. The late majority includes cautious individuals who would seek credible evidence on the utility of innovation. Laggards include the individuals who are either isolated from the social system or skeptical about innovations. These individuals are the last to adopt an innovation.

Characteristics of innovations influence the rate of adoption:

Rogers and Shoemaker proposed five broad characteristics relevant to innovation adoption: trialability, compatibility, complexity, observability and relative advantage.[439] In pest animal management, trialability involves the characteristics of stakeholders and how effectively they learn and accept pest animal management innovations; the compatibility of innovation depends upon the way it facilitates and improves on-ground pest animal management. An innovation should be easy to use for on-ground application. Observability refers to the visibility of the innovation among stakeholders; an innovation should be able to justify its relative advantage as

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[436] F Bass, 'A New Product Growth model for consumer durables' (1969) 15(5) *Management Science*, 215; Baudisch and Grupp, above n 439.

[437] Rogers and Shoemaker (1971), above n 431.

[438] V Mahajan, E Muller and Y Wind, 'New-Product Diffusion Models: From Theory to Practice' in V Mahajan, E Muller and Y Wind (eds), *New Product Diffusion Models* (Kluwer Academic Publishers, 2000) 3.

[439] Rogers and Shoemaker (1971), above n 432.

compared to the technology being replaced.[440] The relative advantages of control techniques and products in pest animal management are viewed differently by stakeholders. For example, during the process of decision-making for the use of PAPP as a pest animal control product, a peri-urban landholder may see relative advantage of PAPP based on avoided non-target effects with respect to domestic pets, whereas national park authorities may prioritise its use on the basis of cost-effectiveness.

Demographic characteristics including target population, age, education, income and cultural backgrounds affect the adoption of innovations by stakeholders.[441] During adoption, interpersonal communication among stakeholders has been identified as a key factor for effective adoption.[442] Blum prescribes the use of appropriate communication to avoid this constraint.[443] In pest animal management, this indicates the need for community engagement through extension. Top-down engagement approaches are often considered as less effective in terms of information exchange among stakeholders.[444] The effectiveness of engagement not only relies on communications to instill an understanding of innovations but also the involvement of potential adopters throughout the adoption process.[445] This indicates that the adoption of a technological innovation – for example, the use of mechanical ejector with PAPP baits – for wild dog control may require combined efforts of extension agencies to ensure understanding of innovation among potential adopters. Additional support provided by general media, agriculture specific media, and training activities can help adoption.[446] The applicability of innovation at a particular jurisdictional scale is also a determining factor in its adoption.[447]

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[440] Pannell et al (2006), above n 431.
[441] Ibid.
[442] M Wright and D Charlett, New Product Diffusion Models in Marketing: An Assessment of Two Approaches, (1995) 6(4) *Marketing Bulletin* <https://pdfs.semanticscholar.org/74d0/d9f2051c76c73f43b1df20ddcb1b818e68c5.pdf>.
[443] A Blum, 'Transfer of Biotechnological Information for Agricultural Development' in C A Taylor (ed) *Science Education and Information Transfer* (Pergamon Press, 1987) 165.
[444] Pannell et al (2006), above n 439, Thompson et al (2012), above n 293.
[445] H Kruger et al, *Biosecurity Engagement Guidelines: Practical Advice for Involving Communities* (Australian Bureau of Agricultural and Resource Economics and Sciences, 2010).
[446] M Oliver et al, *Farmers' Use of Sustainable Management Practices* (Australian Bureau of Agricultural and Resource Economics, 2009).
[447] T Greenhalgh et al, 'Diffusion of Innovations in Service Organizations: Systematic Review and Recommendation' (2004) 82(4) *The Milbank Quarterly*. For this research, the consideration is whether the innovation is appropriate for the peri-urban scale.

In summary, diffusion theory suggests that the 'innovation-decision making process'[448] affects adoption in its initial stages if the long-term benefits are not visible. Various studies have investigated the innovation adoption practices in agriculture and natural resource management[449] but the adoption of pest control techniques is a relatively less researched issue.[450] The acceptability of pest animal control and management method is also affected by the way it has been justified.[451] Rogers suggests that the role of change agent is important in the adoption of innovations. In the natural resource management literature, extension has been identified as an influential factor to improve the rate of innovation adoption. Since pest animal management is embedded within natural resource management institutions, the role of rural extension is important. The literature suggests that innovation adoption in pest animal management can be improved through extension services. This includes raising awareness regarding the contributions of potential innovation for addressing the problems that individuals encounter.[452]

2.5.2 Innovation implementation

Implementation is the process of putting innovations into practice. Institutions play an important role in the interaction between innovations and the institutional arrangements in which innovations are embedded.[453] Implementation indicates that attainment of outcomes and institutional issues can constrain the adoption and implementation of innovations. Toddi Steelman describes this phenomenon:

> [I]nnovative practices are embedded in larger institutional processes that affect innovations' effectiveness, especially during the periods during which implementation occurs … There are inherent tensions between innovation and

[448] Rogers and Shoemaker (1971), above n 432.

[449] Chamala (1987), above n 430; G Feder and D L Umali, 'The Adoption of Agricultural Innovations: A Review' (1993) 43(3-4) Te*chnological Forecasting and Social Change* 215; N I Fisher, H J Cribb and A J Peacock, , 'Reading the Public Mind: A Novel Approach to Improving the Adoption of New Science and Technology' (2007) 47(11) *Australian Journal of Experimental Agriculture* 1262; A K A Ghadim and D J Pannell, 1999, 'A Conceptual Framework of Adoption of an Agricultural Innovation' (1999) 21(2) *Agricultural Economics* 145; L J Guerin and T F Guerin, , 'Constraints to the Adoption of Innovations in Agricultural-Research and Environmental-Management: A Review' (1994) 34(4) *Australian Journal of Experimental Agriculture* 549.

[450] D Southwell et al, 'Understanding the Drivers and Barriers Towards Adoption of Innovative Canid Control Technologies: A Review. (ABARES, 2011),

[451] D J Mellor and K E Littin, 'Using Science to Support Ethical Decisions Promoting Humane Livestock Slaughter and Vertebrate Pest Control (2004) 13 *Animal Welfare* S127.

[452] Rogers (1995), above n 437.

[453] Pannell et al (2006), above n 430.

institutions. Innovations, by definition, are transitory. Institutions are not. How then do we establish new practices that can endure?[454]

While diffusion theory acknowledges the role of a change agent, it does not provide a sound basis to understand institutional aspects during implementation. Institutions can help accelerate the decision-making process by promoting awareness through knowledge and information of the innovation. This includes raising awareness about the beneficial characteristics of innovation and addressing values, needs and on-ground experiences of individuals. In other words, institutions play a fundamental role in providing information and resources for effective on-ground application of innovations. Since institutions are embedded in broader socio-economic and cultural logics, human decisions influence institutional support for implementation.

Institutions in peri-urban areas are entangled with socio-economic considerations, including identities and lifestyle issues (eg, population, age, family patterns, working conditions) and economic factors (eg, economic activities and their attractiveness). The analysis of peri-urban institutions thus requires legal-institutional and political approaches to understand the socio-economic characters of peri-urban regions. Four theories have been identified to analyse the process of innovation-adoption for peri-urban invasive animal management. This section provides a description of these theories, depicted in Figure 2.5.

Transaction cost theory:
Institutions serve the purpose of coordination by reducing uncertainties to provide a stable structure for improved human interactions.[455] Decisions involved in pest animal management are partly based on institutional arrangements, which shape the transactions between institutions and communities. The transactions include interactions sharing the flow of available information and resources and the process of decision making. The decision-making process reflects attitudes and beliefs that influence the interpretation of information and resources in a system. Martin and Verbeek, in the context of natural resource management systems, describe transactions as 'the means through which information and resources flow'.[456] Transaction costs are 'the costs of the resources used to define, establish, maintain,

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[454] Steelman (2010), above n 39, 6.
[455] North (1990), above n 30.
[456] Martin and Verbeek (2006), above n 7.

use and change institutions and organizations; and define the problems that these institutions and organizations are intended to solve'.[457] Transaction costs, particularly resource and information costs, can pose a challenge in designing and implementing innovations.[458]

The institutional origins of transaction cost theory can be traced through a systems perspective.[459] Formal and informal institutions are shaped by complex and interwoven natural and socio-economic systems. Transactions are the factors that regulate the flow of resources and information between and within the systems and have the potential to support or impede the flow.[460] The process of decision making and implementation involves a flow of resources;[461] in the institutional setting, they include administrative and resourcing costs.[462] Transaction costs, thus, can inhibit innovation adoption/implementation by reducing the effectiveness of institutional arrangements,[463] with information, belief systems and allocation of resources key variables that determine the effectiveness of natural resource management (NRM) institutions.[464] Specifically, in the Australian NRM context, transaction cost theory has been used to assess the effectiveness of institutional arrangements for water reforms through regulatory, market and social innovations.[465]

The adoption of innovations depends on the perceived advantages and disadvantage of innovations (characteristics of innovations) and on the flow of resources and information to support the implementation of the innovation. Stakeholders involved in

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[457] G R Marshall, 'Transaction Costs, Collective Action and Adaptation in Managing Complex Social-Ecological Systems' (2013) 88 *Ecological Economics* 185.

[458] L Hurwicz, Issues in the Design of Mechanisms and Institutions" in E T Loehman and M Kilgour (eds), *Designing Institutions for Environmental and Resource Management* (Edward Elgar, 1998).

[459] Paul Martin and Neil Gunningham, 'Improving Governance Arrangements for Sustainable Agriculture: Groundwater as an Illustration' (2014) 1(1) *Australian Journal of Environmental Law.*

[460] Martin and Verbeek (2006), above n 7.

[461] P V Martin, J A Williams and C Stone, 'Transaction Costs and Water Reform: The Devils Hiding in the Details' (CRC for Irrigation Futures Technical Report 08/08, 2008); K Kuperan et al, 'Measuring transaction costs of fisheries co-management in San Salvador Island, Philippines, Naga' (1999) 22(4) *ICLARM Quarterly* 45.

[462] Hurwicz (1998), above n 458.

[463] P Martin and M Verbeek, 'Cartography of Environmental Law' (Finding new paths to effective resource use regulation'. Report: Methodology for MRN Law in Context Studies. Project No. TPF 1, LWA, June 2000.).

[464] Martin and Verbeek (2006), above n 7.

[465] P Martin and J Shortle, Transaction *Costs, Risks and Policy Failure* (Paper presented at the 10th annual global conference on environmental taxation, Lisbon, 2009).

pest animal management require labour, education and skills to implement controls. Transaction cost theory points to the need to identify impediments to the flow of resources and information; in the peri-urban context, transaction costs often arise from the fragmented and complex peri-urban governance arrangements,[466] including information costs, coordination costs, resourcing costs and decision-making costs.

Theory of path dependence:

The theory of path dependence focuses upon the historical evolution of institutions, particularly the factors that repetitively influence and shape institutions over a period of time;[467] 'history matters' in the shape of institutional arrangements. Path dependence helps in analysing the role of institutions in creating specific patterns that broadly affect societal choices in the adoption or rejection of innovations, because the evolution of technologies is influenced by social, economic and cultural setting.[468] In other words, the path of technological innovation depends on the patterns created through political, social or educational influences.

Arthur argues that path dependence and increasing returns (positive feedback) to adoption of existing technologies leads to a situation of technological 'lock-in'.[469] Increasing returns to the adoption of existing technologies are described in four classes: scale economies, learning effects, adaptive expectations and network economics. Scale economies occur when a technology has a large set-up or fixed cost, features which discourage an enterprise from adopting innovations. Innovations require new investments and the costs and benefits of innovations remain uncertain for a long time. Learning effects (specialised skills and knowledge relevant to existing technologies) helps by improving the benefits of innovations and reducing their cost over time.[470] Network economics suggest the adoption of innovations by multiple

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[466] Martin and Verbeek (2006) above n 7.

[467] L Magnusson and J Ottosson, 'Path Dependence: Some Introductory Remarks' in L Magnusson and J Ottosson (eds), *The Evolution of Path Dependence* (Edward Elgar, 2009).

[468] Pier-Paolo Saviotti, 'On the Co-Evolution of Technologies and Institutions' in Matthias Weber and Jens Hemmelskamp (eds), *Towards Environmental Innovation Systems* (Springer, 2005).

[469] W B Arthur, *Increasing Returns and Path Dependence in the Economy* (Ann Arbor, 1994).

[470] K Arrow, The economic implications of learning by doing, (1962) 29 *Review of Economic Studies* 155.

individuals is made more likely as the advantages of innovations spread within the population.

Constraints developed by institutions over time shape human interactions. Institutional constraints include formal (eg, legislative, economic, regulatory) constraints or informal (cultural practices, behaviour) constraints. Some influences may not be conducive to innovation implementation; for example, the regulatory factors governing innovations in pest animal control technologies involve multiple regulatory approvals. Institutions have a broad responsibility to ensure that the process of research and development of innovations motivate innovators to invest and discover/invent new technologies but the rigours of the regulatory approvals process may negatively influence the decision of innovators to pursue innovations in control technologies.

The classes of increasing returns discussed by Arthur are also relevant to the institutions.[471] Technological and institutional lock-in prevents efficiency and effectiveness of implementation.[472] The theory helps in assessing how certain dominant trends facilitate or impede the reform processes.[473] In the Australian context, the prominent examples of these dominant trends are the impact of common law principles[474] and distribution of power in Australian natural resource management governance.[475]

For example, use of a new pest animal control technique may require specialised training and experience. It is the role of institutions to conduct training programs and educate individuals. If the existing institutional structure fails to provide for training and education in new control techniques, it affects the adoption and implementation of innovation.

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[471] North (1990), above n 30; P Pierson, 'Increasing Returns, Path Dependence, and the Study of Politics' (2000) 94(2) *American Political Science Review* 251.

[472] Jane Marceau, Karen Manley and Derek Sicklen, *The High Road or the Low Road? Alternatives for Australia's Future* (Australian Business Foundation, Sydney, 1997).

[473] Paul Martin and Jacqueline Williams, *The Missing Leg in Rural Innovation Research* (paper presented at the Primary Industries Innovation Centre Symposium New Pathways to the Adoption and Diffusion of Primary Industries Innovations, University of New England, 24-25 November 2008).

[474] Hathaway, Oona A, Path Dependence in the Law: The Course and Pattern of Legal Change in a Common Law System (2000) 86 *Iowa Law Review*.

[475] S Ryan et al, *Australia's NRM Governance System. Foundations and Principles for Meeting Future Challenges* (Australian Regional NRM Chairs: Canberra, 2010).

Public choice theory:

Public choice theory can be traced to the concept of the 'political marketplace', described in neo-classical economics.[476] Influential positions in a society give a few individuals the ability to steer economic and political arrangements to create institutional structures and processes that fulfil their self-interests. The theory highlights how the rent seeking of vested interests influences public investment in favour of some at the expense of others.[477] The processes of policy-making and implementation are often driven by such vested interests. Political and social power maintains the status-quo by influencing decisions which are beneficial to these interests and rulers tend to choose institutions that favour their own interests.[478] Also reflecting path dependent behaviour, public choice theory suggests that vested interests of some individuals can act as an impediment to action.[479] A dominant paradigm establishes a strong institutional pattern which privileges reforms that are favourable to powerful actors. The impact of dominant interests resists change or reform in the institutional system.[480]

Risk and risk perception:

Risk is a multi-dimensional concept that includes objective and subjective variables.[481] Risk is not independent from social context.[482] Based on perceived probability of risk and impact, subjective factors of risk evaluation include limits of knowledge, bias, personal beliefs and approvability of opinions.[483] Risk involves the

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[476] Edgar Kiser, 'Comparing Varieties of Agency Theory in Economics, Political Science, and Sociology: An Illustration from State Policy Implementation' (1999) 17(2) *Sociological Theory* 146.

[477] Philip Keefer and Stephen Knack, 'Boondoggles, Rent-Seeking, and Political Checks and Balances: Public Investment under Unaccountable Governments' (2007) 89(3) *The Review of Economics and Statistics* 566.

[478] North (1990), above n 30.

[479] Todd Sandler, ' Collective Action: Fifty Years Later' (2015) 164 *Public Choice* 195.

[480] Pablo del Rio and Xavier Laabdeira, 'Barriers to the Introduction of Market-based Instruments in Climate Policies: An Integrated Theoretical Framework' (2009) 10(1) *Environmental Economics and Policy Studies* 41.

[481] Jens O Zinn, *Social Theories of Risk and Uncertainty: An Introduction* (Wiley-Blackwell, 2009).

[482] Brian Wynne, 'Risk and Environment as Legitimatory Discourses of Technology: Reflexivity Inside Out?' (2002) 50 (3) *Current Sociology* 459.

[483] Mark Burgman, *Risks and Decisions for Conservation and Environmental Management* (Cambridge University Press, 2005); Mark A Burgman et al, 'Designing Regulation for Conservation and Biosecurity' (2009) 13(1) *Australasian Journal of Natural Resources Law and Policy* 93.

idea of 'uncertainty'. For pest animal management, risk studies are relevant to understanding how stakeholders engage in decision making on risk through evaluation of available risk choices and how institutions interact with risk management stakeholders in addressing risks. The extent to which Innovation is adopted is partly determined by how these risks are created and perceived by stakeholders.

Invasive animal risks involve the likelihood of a pest animal establishing itself or spreading in Australian territory or a part of Australian territory; and the potential for the pest animal to cause harm to human, animal or plant health; environment; and economic consequences associated with the establishment or spread of pest animals.

People perceive such risks differently. The conceptualisation of invasive animal risks and the risks of innovations in control[484] involves people's educational, professional, cultural background and values attached to the invasive animals or other values.[485] It is also affected by what interests might be influenced by different types of invasive species. The perceived risks are largely influenced by social considerations which include human behaviors, values and attitudes,[486] for example, in suburban environments, native wildlife is valued by some householders.[487] Attitudes to pest animals include empathy and values towards animals.[488] Human dimensions of wildlife management[489] include attitudes, norms, motivations and values embedded in

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[484] Karen F Hytten, 'Dingo Dualisms: Exploring the Ambiguous Identity of Australian Dingoes, (2009) 35(1) *Australian Zoologist* 18; Feral camels in Australian rangeland ecosystem cause menace by damaging key infrastructure but certain groups consider them as a resource for their monetary as well as dietary needs. For further description, see *National Feral Camel Action Plan: A National Strategy for the Management of Feral Camels in Australia*, above n 176.

[485] For eg, Sheep producers consider dingoes as a threat to their flocks from the economic perspective whereas Aboriginal people tend to protect dingoes for cultural reasons: G Fitzgerald, *Public Attitudes to Current and Proposed Forms of Pest Animal Control*. (IACRC, 2009).

[486] Department of Primary Industries and Fisheries, *Queensland Biosecurity Strategy: 2009-14*, 2008 <https://www.cabinet.qld.gov.au/documents/2008/dec/biosecurity%20strategy/Attachments/Qld-BiosecurityStrategy-2009-14.pdf>.

[487] S I FitzGibbon and D N Jones, 'A Community-Based Wildlife Survey: The Knowledge and Attitudes of Residents of Suburban Brisbane, With a Focus on Bandicoots' (2006) 33 *Wildlife Research* 233.

[488] J W Driscoll, 'Attitudes Towards Animals: Species Ratings' (1995) 3(2) *Society and Animals* 139.

[489] This overlaps with the social science research on wildlife and invasive species which is not the focus of this research. D G Nimmo and K K Miller, 'Ecological and Human Dimensions

human behavior relating to the acceptance of management practices.[490] Values and beliefs as well as emotions[491] influence social behavior of humans during their interactions with animals.

Invasive animal management risks involve the risks in using and implementing innovative control techniques. Risks in implementing pest animal control depend upon individual and socio-cultural perceptions of control techniques and their possible (including unintended) effects. Individual experiences, morals, judgements and assumptions[492] are also the crucial factors in defining risks. The formulation of prospective risk through values is based upon cognitive factors and public attitudes.[493] Risk perception involves the notion of valuing risks by the perceivers. Values are perceived subjectively as per socio-political as well as cultural considerations. The risks are governed by the institutions and institutional processes.[494] In the institutional context, the phenomenon of risk is related to the process of decision-making.[495] Decision making involves, the construction of risk by the government[496] and the role of media in construing social risks.[497]

An understanding of the socio-economic system is important to analyse risk. It involves the evaluation of trust and uncertainties. A single instance confirming or denying trust has consequential impacts on increasing or lowering risk.[498] Institutions

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of Management of Feral Horses in Australia: A Review' (2007) 34(5) *Wildlife Research* 408.

[490] Decker et al (2004), above n 225.

[491] H W Hudenko, 'Exploring the Influence of Emotion on Human Decision Making in Human-Wildlife Conflict' (2012) 17 *Human Dimensions of Wildlife* 16.

[492] J C Tulloch and D Lupton, *Defining Risk. Risk and Everyday Life* (SAGE Publications 2003) 197.

[493] Shawn J Riley and Daniel J Decker, 'Risk perception as a factor in Wildlife Stakeholder Acceptance Capacity for Cougars in Montana' (2000) 5 (3) *Human Dimensions of Wildlife* 50, doi: 10.1080/10871200009359187.

[494] Risk governance

[495] A Giddens, 'Risk and Responsibility' (1999) 62 *The Modern Law Review* 1.

[496] U Beck, *Risk Society: Towards a New Modernity* (Sage Publications, 1992).

[497] J X Kasperson, R E Kasperson, N Pidgeon and P Slovic, 'The Social Amplification of Risk: Assessing Fifteen Years of Research and Theory' in N Pidgeon, R D Kasperson and P Slovic (eds.) *The Social Amplification of Risk*, (Cambridge University Press, 2003) 13; D A Scheufeleand D Tewksbury, 'Framing, Agenda Setting, and Priming: The Evolution of Three Media Effects Models. (2007) 57 *Journal of Communication* 9.

[498] Zinn (2009), above n 481.

provide risk-related information.[499] For invasive animal control, stakeholders' action depends upon 'trust' in institutions conveying risk-related information about control technologies and programs. The risk society approach[500] prescribes a conscious and 'reflective' action from an individual as well as society to address risks.

Based on the theoretical approaches discussed above, Table 2.9 highlights their potential influence on decision making for adoption and implementation of innovations for pest animal management in the institutional context.

Table 2.9: Theoretical approaches in innovation adoption and implementation

Theory	Role of institutions	Impediments in decision-making	Key variable
Transaction cost theory	Provisioning of information and resources	Impeding flows of information and resources	Transaction costs
Path dependence theory	Provisioning of new pathways and structures	Maintaining institutional structures and resistance to change	Path dependence
Public choice theory	Facilitate change at the political and bureaucratic level	Vested interests that underpin political institutions	Political decision-making
Risk/Risk perception theory	Facilitate identification and management of risks	Invasive animal management risks including perceptions relevant to the use of control technologies	Actual and perceived risks

2.6 Conclusion

Understanding institutional impediments to the adoption and implementation of innovations in pest animal management requires investigation of how institutions facilitate or constrain the process of innovation-adoption and implementation. The first part of this chapter described a number of innovations for pest animal management. To facilitate the assessment of institutional impediments in peri-urban

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[499] Ibid. 'Recent Developments in Sociology of Risk and Uncertainty [36 paragraphs]' 7(1) *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research* art 30 <http://nbn-resolving.de/urn:nbn:de:0114-fqs0601301>.

[500] 'The Risk Society' approach developed by Beck and Gidden is concerned with how modernisation has led to the concerns of safety and uncertainty. In the context of risk management, the precautionary principle ignores the complexities of a) socio-cultural risks: Tulloch and Lupton (2003), above n 492, b) emotional risks: S Lash, 'Risk Culture', in B Adam, U Beck and J van Loon (eds) *The Risk Society and Beyond: Critical Issues for Social Theor* (Sage, 2000), c) institutional risks: Mitchel Dean, *Governmentality. Power and Rule in Modern Society* (Thousand Oaks, 1999).

context, it was necessary to identify innovations that are directly applicable to peri-urban Australia. This chapter identified specific innovations (for example, mechanical ejectors and PAPP as control techniques for peri-urban wild dog management) relevant to two pest animal species (wild dog and feral deer), which are the specific case studies in this research.

In the second part of this chapter, theories relevant to innovation-adoption and innovation-implementation have been outlined. Drawing on the approaches from political economy and risk theory, four institutional variables have been characterised as potentially relevant to the overarching research question. These variables potentially influence the adoption and implementation of innovations for pest animal management. The interaction between stakeholders and institutions shaped by these variables will partly decide the success or failure of innovation as well as the effectiveness of pest animal management.

The next chapter describes the methods, using the concepts and lessons discussed in this chapter, used to conduct this research. The chapters that follow Chapter 3 describe the study findings and conclusions.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The preceding chapter described technological and managerial innovations applicable to pest animal management. Considering peri-urban contexts as the focus of investigation, it narrowed the scope of this research by outlining specific innovations applicable in selected case studies. It also described theories relevant to the adoption and implementation of innovations. Innovation diffusion theory embodies innovation-adoption decision-making process but does not provide an approach to analysing institutional elements in innovation-implementation. These elements include strategies, resources, technologies and on-ground practices that shape effectiveness of innovation-implementation. Since this research is concerned with identifying institutional impediments to effective pest animal management; more particularly governance and informal arrangements that shape adoption and implementation of innovations for on-ground pest animal control, the discussion in Chapter 2 outlined four more pertinent theoretical perspectives on adoption and implementation of innovation.

This chapter describes how the theoretical approaches and findings concerning the context of peri-urban invasive animal management were utilized in the methodological approach of this research. It describes the need for multi-methods; and the role played by each method in providing evidence that enabled analysis of legal-institutional issues. The chapter also outlines the research and ethical framework for the research.

3.2 Research approach

The main research question underpins a sense of dissatisfaction with institutional arrangements for invasive species management, as described by the national environmental assessment reports, government biosecurity evaluations and independent reviews (see Chapter 1). The research question has been informed by the broad objectives of the IACRC project titled 'Reduction of Legal and Institutional Impediments to Community Action'.[501] One of the fundamental propositions of the

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[501] The overarching objectives of IACRC through this research was to understand peri-urban institutional issues that would facilitate inputs to a) improve understanding of the effects of legal and institutional arrangements on effective invasive species control, b) enable

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IACRC project is that the challenges in management of pest animals are derived partly from institutional factors and cannot be overcome without innovations in institutional arrangements. This research addresses the institutional dimensions of pest animal management, including laws and policies, program design and implementation and coordination.

The research question provided a direction to pursue a pragmatic outcome from this research.[502] Desktop research explored the essentials of 'effectiveness' in pest animal management and facilitated the articulation of key research components of innovation, adoption and implementation (discussed predominantly in Chapters 1 and 2). These components, in conjunction with the notion of institutional impediments referred to in the main research question, led to the following sub-research questions:

(1) What innovations are currently being implemented or have potential applicability for effective invasive animal management?

(2) What are the possible institutional reasons that inhibit the adoption of innovations for effective invasive animal management in peri-urban areas of Australia?

(3) What possible strategies, responses, actions can improve the uptake of innovations for effective invasive animal management?

As already stated, the underlying contention of this research is that there is a lack of effectiveness in invasive animal management. This research seeks to identify specific solutions instead of purely abstract answers. Therefore, it was necessary to both understand the problems in detail and, based on that understanding, formulate solutions within the existing legal and institutional framework.

A purely doctrinal legal research methodological approaches would, therefore fail to address the complexities, values, beliefs, practicalities as well as phenomenological aspects of this research.[503] Traditional legal research based in either values based enquiries or instrument-based enquiries prove helpful in suggesting law reforms, but these methodological approaches have significant difficulties in addressing and

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advocacy of law and policy reform proposals to improve the effectiveness of invasive species governance arrangements, and c) develop a policy briefing paper which provides input into government reviews of invasive species management.

[502] R Cooksey and G McDonald, *Surviving and Thriving in Postgraduate Business Research* (Tilde University Press, 2011).

[503] Paul Martin and Donna Craig, 'Accelerating the Evolution of Environmental Law Through Continuous Learning from Applied Experience' in Paul Martin and Amanda Kennedy (eds), *Implementing Environmental Law* (Edward Elgar, 2015) 27.

evaluating applied effectiveness of law.[504] Fisher et. al. have identified four methodological challenges for research in environmental law and governance issues: 'dealing with the speed and scale of legal/regulatory change, engaging with the interdisciplinary nature of the subject, addressing the heavy reliance in environmental law on a diverse range of governance arrangements and tackling the multijurisdictional nature of the subject'.[505] The presence of a multitude of stakeholders and fragmented institutional approaches signifies these methodological challenges in the peri-urban context.

It is a challenge for researchers to understand the intricacies involved in a 'wicked' problem.[506] In peri-urban areas, innovation adoption and implementation for pest animal management involves an intricate interplay of institutional factors. To reveal attributes of governance, a methodology needs to focus upon the institutional arrangements which can enable legal instruments to achieve stated outcomes.[507] It requires a method which balances both doctrinal and empirical approaches, involving a balanced integration of philosophical, instrumental and operational approaches to address the applied effectiveness of law.[508] Legal-institutional research, encompasses institutional evidence, methods and theories to facilitate analysis of the governance system within legal research framework.[509]

In this research, the objective is to understand 'complexity, uncertainty and value divergence'[510] of institutions involved in peri-urban pest animal management. Martin and Craig[511] recommend the use of 'evidence-based policy' approach in understanding such problems. While acknowledging the utility of this approach in understanding the effectiveness of policy strategies, Head states:

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[504] Richard A Posner, 'The Decline of Law as an Autonomous Discipline: 1962-1987 (1987) 100 *Harvard Law Review* 761; Michael G Faure, 'Instruments for Environmental Governance: What Works?' in Paul Martin et al (eds), *Environmental Governance and Sustainability* (IUCN Academy of Environmental Law, Edward Elgar, 2012).

[505] Elizabeth Fisher et al, 'Maturity and Methodology: Starting a Debate about Environmental Law Scholarship' (2009) 21(2) *Journal of Environmental Law* 213, 215.

[506] Rittel and Webber 1973, above n 62.

[507] Wang Xi et al, 'Assessing Environmental Governance of the Hudson River Valley: Application of An IPPEP Model' (2014) 1 *Pace Environmental Law Review*.

[508] Martin and Craig (2015), above n 503.

[509] Terry C Hutchinson, 'The Doctrinal Method: Incorporating Interdisciplinary Methods in Reforming the Law', (2015) 3 *Erasmus Law Review* 130.

[510] B W Head, 'Wicked Problems in Public Policy' (2008) 3(2) *Public Policy* 101.

[511] Martin and Craig (2015), above n 503.

Investment in more research to address gaps in knowledge is necessary, especially in relation to understanding causal links; since better knowledge can contribute both to 'evidence-informed' policy and to good processes for increasing the scope of consensus. Such knowledge should address institutional and social structures, processes and relationships as well as knowledge about attitudes, values and cultural expectations.[512]

Taking into account, the challenges in addressing the 'wicked' problem of invasive animal management and the necessity of an integrated methodology to analyse peri-urban institutions and processes; this interdisciplinary research adopts a strategic and pragmatic philosophical stance, it uses the evidence-based policy approach [513] involving the application of multi-methods to identify institutional impediments to the applied effectiveness of innovations for invasive animal management:

[A]n epistemology that is neither purely discursive (doctrinal/philosophical and inductive) nor scientific (empiricist and deductive). Rather a strategic epistemology that blends both forms of investigation and synthesis, focused on finding pragmatic solutions for real world human behaviour challenges.[514]

In other words, the philosophical influences that underpin evidence-based policy research are informed by an epistemology which can be described as strategic, pragmatic and pluralist.[515] The strategic investigation adopts 'the analytic structure of corporate and military intelligence gathering and decision-making'.[516] It comprises of objective facts and subjective beliefs as variables which are synthesised for pragmatic decision-making. The research process involves disciplined use of objective data, transparent use of methods and clear exposition of limitations.[517] The strategic approach, with its emphasis on applied effectiveness of environmental governance, is based on Ann Majchrzak's characterisation of policy research as pragmatic:

[T]he process of conducting research on, or analysis of, a fundamental social problem in order to provide policymakers with pragmatic, action-oriented recommendation for alleviating the problem.[518]

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[512] Head (2008), above n 510, 114.
[513] Martin and Donna (2015), above n 503.
[514] Ibid 30.
[515] Ibid 41.
[516] Ibid 45.
[517] Ibid 47-48.
[518] Ann Majchrzak, *Methods for Policy Research: Applied Social Research Methods* (SAGE, 1984) 12.

Pragmatic research is multi-dimensional[519] and involves a combination of multiple methods to understand complex policy problems.[520] Such an epistemology serves the objective of policy research to propose provisional solutions for institutional improvements by understanding difficulties in governance processes and the effectiveness of law and policy in the context of implementation.[521]

Figure 3.1: Methodological approach

Evidence-based policy research helps to determine 'what works' on the basis of the best available evidence.[522] The evidence can also be used for evaluating policies through a comparison of systemic reviews[523] and provides an input for policy makers in decision making to achieve better policy outcomes. The evidence-based approach to addressing biosecurity concerns in Australia involves 'hierarchies of evidence'.[524]

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[519] Ibid 18.

[520] Ibid 58

[521] Martin and Craig (2015), above n 503, 44.

[522] Paul Jensen, 'What is Evidence-Based Policy? (Policy Brief 4/13. Melbourne Institute of Applied Economic and Social Research, 2013) 3.

[523] Ray Pawson, 'Evidence-Based Policy: In Search of a Method' (2002) 8(2) *Evaluation* 157.

[524] Justin Parkhurst, *The Politics of Evidence: From Evidence-Based Policy to the Good Governance of Evidence* (Routledge Studies in Governance and Public Policy, Routledge, 2017) 4; G Banks, *Evidence-Based Policy Making: What is it? How do we get it?* (ANU Public Lecture Series, presented by ANZSOG, 4 February 2009).

The objective of the evidence-based policy approach in this study is to obtain the best available evidence on implementation of control innovations for effective pest animal management. Specifically: what is the nature of problem, what is required to address the problem, what impedes implementation, and how the solutions would impact effectiveness. The methodological assumption is that the evidence will help identify exiting gaps to enable better policy.[525]

This requires intelligence that can confirm, or reject the assumption in this research that institutional issues constrain the effectiveness of strategic pest animal management. Such evidence is 'qualitatively different'.[526] It seeks to understand the dynamics of policy implementation. The overarching aim while gathering data and information was to find and evaluate evidence on the institutional issues in effective pest animal management. This was achieved by triangulating the evidence gathered through a wide range of sources as possible. The synthesis of evidence from multiple sources helps to increase reliability and limits the effects of bias. In policy research, the appraisal of systemic reviews is helpful in ensuring rigour and scientific validity of findings. The evidence on peri-urban institutional issues in this research was obtained through academic and policy sources, and empirical evidence. It was then corroborated against previous reviews that also evaluated institutional effectiveness for pest animal management.

As explained in Chapters 1 and 2, peri-urban institutional complexity involves the confluence of structural and socio-cultural aspects. Analysis of the implementation dynamics of pest animal management innovations required a methodological approach that is adaptable and flexible, to allow the identification of institutional complexities and challenges. Policy research most often uses a qualitative approach to research design as the means of gathering data and information.[527] The qualitative information or data often comes from consultations with key stakeholders and research partners. This research used stakeholder consultations and supplementary

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[525] K Oliver et al, New Directions in Evidence-Based Policy Research: A Critical Analysis of the Literature' (2014) 12 *Health Research Policy and Systems* 34.

[526] N Black, 'Evidence based policy: proceed with care. (2001) 323(7307) *British Medical Journal* 275.

[527] Martin and Craig (2015), above n 503, 42.

evidence including policy documents and maps to obtain a nuanced picture of peri-urban institutions.

The understanding of institutional variables require that the research approaches be rooted in social policy science. The research required stakeholders to define the problem as well as propose solutions; such 'negotiated approaches to problem-solving' are an important feature of evidence-based policy research.[528] The research approach undertaken in 'IACRC project Program 4 Community Engagement' involved understanding the views and interests of invasive animal control stakeholders and practitioners, which allowed academic and community collaborative deliberation on the issues relevant to research while understanding the requirements of policymakers and practitioners by working 'with' them. This broader context of the larger program allowed the researcher to conduct empirical evidence gathering through participatory processes, including observation and conversations with the stakeholders to elaborate the institutional issues and solutions. Throughout the research process, engagement with stakeholder partners was ensured through project meetings, workshops, conversations with the project leaders and stakeholders. These processes provided valuable information on the problems experienced by the key stakeholders in implementing pest animal management strategies.

In summary, the use of multi-methods builds on the strategic philosophy and evidence-based approaches adopted in this thesis. It allowed data collection from desktop research and empirical research to understand stakeholders' views. The evidence-based research approach reflects the idea that multi-methods research is needed to address the multiple types of questions that are embedded in considering the applied effectiveness of environmental law and institutions.[529] Such research aims to investigate 'what works'.[530] Desktop research and initial conversations developed the researcher's understanding of possible collection methods to obtain evidence on institutional impediments. The central methodological intent was to obtain evidence on institutional issues from multiple sources to identify, on the balance of evidence, the institutional challenges for adoption and implementation of innovations.

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[528] Head (2008), above n 510.
[529] Martin and Craig (2015), above n 503, 43.
[530] Majchrzak (1984), above n 518; Head (2008), above n 510.

To address wicked problems, interdisciplinary approaches are most useful since these problems are not strictly aligned with the particular academic disciplines.[531] Interdisciplinary research helps in understanding complex real world problems through the convergence of disciplines and use of plural methods. In evidence-based policy research, inter-disciplinary approaches help in understanding policy problems and possibilities for improvement.[532]

> Various scientific disciplines may have different methodological approaches, and may offer complementary or sometimes competing perspectives on complex issues. It is perhaps not surprising that inter-disciplinary approaches have come to the fore in recent decades for addressing multi-layered social problems.[533]

Fleming et.al. state that the inter-relationship between science and humanities disciplines (including ecology, invasion biology, agricultural sciences, conservation science, and human dimensions) and inter-disciplinary collaboration is an essential aspect of research and practice for effective management of invasive species.[534] Interdisciplinary research in this study, which included animal science, law, political economy and institutional studies, was needed to understand peri-urban pest animal management from not only a legal but also institutional and scientific perspectives.

The evidence-based approach used qualitative participatory processes to collect data. Stakeholders drew on their personal experiences to interpret pest animal management institutions. This formed the basis of institutional analysis in which stakeholder participant's interpretation of the peri-urban institution cumulatively reflected to identify institutional impediments to adoption and implementation of innovations for effective pest animal management. In this type of policy analysis, the researcher's judgement is applied to the evidence to draw a probabilistic conclusion about what is happening, and to propose solutions within the context of policy priorities. Instead of pursuing a purely deductive, or a purely inductive approach, the research adopts an 'epistemology of implementation'.

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[531] G Bammer, 'Strengthening Interdisciplinary Research: What it is, What it does, How it Does it and How it is Supported' (Report for the Australian Council of Learned Academies) <www.acola.org.au>.
[532] Head (2008), above n 510.
[533] Ibid 6.
[534] Fleming et al (2017), above n 15, H-I.

3.3 Research design

As outlined in the previous section, the research is guided by the main and subsidiary research questions that considers elements of pest animal management policy (eg, innovations, strategies, procedures) in the context of institutional arrangements. The research is interested in understanding how pest animal management stakeholders experience institutional arrangements. The evidence-based approach enabled the use of multiple research methods that were suitable in terms of answering the research questions, the skills of the researcher and the underpinning epistemological position. This section describes the flow of research methods and their use during each stage of the research process.

3.3.1 Stages of research

The scope of this research was to understand institutional challenges for stakeholder participants while 'implementing' invasive animal control in peri-urban context. Akin to this scope, research methods focussed on understanding the process of implementation of law within the institutional context. Figure 3.2 illustrates the stages but note that some stages were carried out concurrently.

Figure 3.2: Stages of research

STAGE I – Familiarisation with the issues

The objective of this stage was to explore initial hypotheses concerning the research questions. This involved:

a) Conversations with the IACRC project leaders and partner stakeholders to understand the underpinnings of the research, its background and context.

b) Desktop research to review concepts relevant to innovation-implementation for peri-urban invasive animal control and management. A theoretical rationale used for analysing institutional issues was also investigated.

STAGE II – Scoping study

The objective of scoping study was twofold:

    a) To provide the basis for design of the empirical studies.

    b) To expand and refine the initial hypothesis obtained in the first stage.

This stage involved:

    a) Observational research of stakeholder workshops to verify and expand the literature based hypothesis.

    b) Conversations to better understand the relevant issues and questions.

STAGE III – Case studies

The objective of case studies was:

    a) To provide an in-depth examination of the issues associated with the hypothesis in specific settings.

    b) To refine the hypothesis and deepen understanding of the peri-urban institutional dynamics behind the issues.

    c) To examine the likely validity of the expanded hypothesis derived in stage 2.

This stage involved:

    a) Conversational interviews to understand the peri-urban institutional dynamics and to understand the historical background and context, the case study issues and areas.

    b) Semi-structured interviews to understand peri-urban-specific institutional issues that constrain adoption and implementation of control and managerial innovations. This was supported by a small-scale survey of invasive species frontline experts as an additional verification of preliminary conclusions.

    c) Institutional analysis of impediments to adoption and implementation of pest animal control innovations in the peri-urban context.

This stage synthesised material collected through desktop research and through empirical evidence to derive conclusions on the institutional impediments for invasive animal control and management in peri-urban context.

STAGE IV – Triangulation and confirmation

The objective of this stage was to evaluate the likely validity of hypotheses and to obtain a deeper knowledge of what happens in practice as an aid to interpretation of the qualitative findings. The use of multi-methods within a triangulation framework

provided confidence in the evidence-based reasonableness ('intuitive validity') of the research conclusions.

The next section describes the research stages in detail and methods used. These are summarised in table 3.1.

Table 3.1: Research methods

Stage	Purpose	Method	Chapter location
Familiarisation with the issues	To describe the background and context of the research To elaborate on the problem statement in the light of research questions	Desktop research Document analysis Stakeholder discussions	Chapter 1
	To describe pest animal management innovations generally To describe peri-urban-specific innovations To describe theoretical approaches	Desktop research (literature review) Document analysis Stakeholder discussions	Chapter 2
	To identify methodological approach and select research methods	Desktop research, Researcher discussions	Chapter 3
Scoping study	To identify institutional issues that impede pest animal management generally (hypothesis)	A scoping study - Observations - Conversations - Desktop research - Document analysis - Doctrinal research and analysis	Chapter 4
Case study	To identify peri-urban specific institutional issues	Case study approach - Desktop research - Document analysis - Interviews - Site visits	Chapter 5
	To identify institutional impediments	Institutional analysis based on the variables-based analytical framework	
Triangulation and confirmation	To comprehensively assess the institutional issues	Small sample experts survey	Chapter 6

3.3.2 Research methods

This research needed to unravel institutional intricacies in a complex problem of implementing innovations for pest animal management. This required a data gathering process to generate evidence on institutional challenges and an understanding of the perceptions and experiences of stakeholders involved in pest animal management. The thesis used the following research methods:

Desktop research

The desktop research aimed to aid the researcher to understand

a) The theoretical context of technological and managerial innovations; and

b) The operation of pest animal control and management in peri-urban Australia, including the innovations available to improve operations.

Desktop research involved collection, collation, reading and synthesising of published information relating to theory and practice of pest animal control and management. Desktop research was conducted at each research stage.

Table 3.2: stages of desktop research

Chapter 1	Chapter 2	Chapter 3	Chapter 4	Chapter 5	Chapter 8
Desktop research	Literature review	Desktop research	Literature review Document analysis	Literature review Document analysis	Desktop research
Background Context, Research questions	Innovations Peri-urban specific innovations, Theoretical approaches	Selection of research methodology and methods	Identification of institutional issues	Identification of peri-urban specific institutional issues	Future institutional reforms

The desktop research shaped the formulation of research questions (Chapter 1), understanding of innovations and theoretical approaches (Chapter 2), the selection of research methods (Chapter 3), the analysis of institutional issues (Chapter 4), elaboration of issue-specific case studies (Chapter 5), and the assessment of options for future reforms (chapter 8).

The literature review particularly reflected in Chapter 2 explored innovative control approaches, including technological, managerial, regulatory and policy innovations. It provided background on the process of implementation of law and policy and the institutional context, and introduced theories from political economy relevant to implementation of innovations within the institutional context. The literature review (further reflected in Chapter 4) explored institutional issues influencing the implementation of pest animal management innovations.

Documentation that was analysed includes: legislation, policy documents, strategies, pest animal control brochures, guidance documents, evaluation reports of the pest animal control programs and web-based information on pest animal management. In

addition, the case study data included meeting minutes and newspaper articles. Documents were useful in evaluating and interpreting the institutional context of pest animal management.

Doctrinal analysis involves identification of legislation, synthesis of legal issues and understanding of the rules and associated institutions. This facilitated

- The identification of legislation relating to pest animal control in Australia at the commonwealth, state/territory and local levels. The results of research at this stage underpinned a submission to the NSW Natural Resource Commission Review.[535]
- The identification of rules, policies and principles incorporated in various statutes governing pest animal control and management.

This research was conducted in three steps:
a) Step 1 - Within the IACRC Program 4, a summary of Australian laws, regulations, policies and programs was prepared in 2014. A desktop research was conducted by this researcher to incorporate changes as of June 2015.
b) Step 2 - During June – August 2015, the researcher contacted invasive animal experts within state and federal agencies in Australia to supplement desktop research. This 'direct inquiry' refined the correctness of this preliminary investigation.
c) Step 3 - In 2018, the researcher updated existing resource.

Legal analysis was used to evaluate laws and regulations.

Desktop research was challenged by the continuous innovations in pest animal control and multiple strategies for on-ground pest animal management practices. This challenge has been reiterated in the literature; Low Choy notes that shifts in on-ground practices occur more rapidly than change in theory.[536]

Conversations

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[535] Resource on Australian laws, regulations, policies and programs; and Submission to the NRC Review as an output of this research: Paul Martin and Vivek Nemane, *Review of Australian Invasive Animals Laws* (NSW Natural Resource Council, July 15 2015, unpublished)).

[536] D Low Choy, 'The SEQ Regional Landscape Framework: Is Practice Ahead of Theory?' (2008) 26 (1), *Urban Policy and Research* 111.

Many conversations were used to refine the researchers' understanding of the tacit aspects of issues in pest animal management. Conversations were used to expose the researcher to peri-urban institutional dynamics. Using the suggestions of project leaders, the institutional themes that emerged from desktop and observational research, the researcher was able to then pursue conversations with stakeholders.

In addition to unstructured conversations, the researcher participated in workshops and expert meetings held under the aegis of IACRC. These include:

- Invasive Animals CRC - Project 4E3 Stakeholder consultation workshop, Sydney (3 June 2015).
- Invasive Animals CRC - Project 4E3 Theme meeting, Sydney (17 November 2015).
- Invasive Animals CRC – Wild dog theme meeting, Armidale (19 January 2016).
- Invasive Animals CRC – Science Writers Workshop, Canberra (May 1-8, 2016).
- Invasive Animals CRC – Community Engagement Masterclass 2016 – Northam, Perth, Western Australia (May 9-14, 2016).

These meetings and workshops allowed the researcher to better understand and experience the intricacies of pest animal management. The representations allowed a more nuanced understanding of institutional issues in the Australian and international contexts and provided a chance for the researcher to interact with biosecurity and pest animal management experts.

During the research period, the researcher also attended conferences with an intention to gain detailed perspectives on multiple issues relating to invasive animal management. The participation in conferences and interactions with pest animal management experts throughout the research process enabled insights into multiple issues relevant to peri-urban institutions, which helped in specifying institutional impediments and understanding their implications. The presentations in these conferences and constructive feedback by the conference participants (researchers and practitioners in invasive animal management) facilitated the researcher's understanding of invasive species management. The researcher participated in and presented at the following conferences:

- **Invasive Animals CRC Theme Meeting (17 November 2015), Sydney, NSW.**
  - Presentation - *Improved Legal and Institutional Arrangements for Peri-Urban Invasive Animal Management*
- **UNE Post-graduate Conference (19 & 20 January 2016) Armidale, NSW.**
  - *Presentation - Improved Legal and Institutional Arrangements for Peri-Urban Invasive Animal Management*
- **17th Australian Vertebrate Pest Conference (1-4 May 2017) Canberra, ACT.**
  - Presentation - *What Impediments are you Facing in Peri-Urban Invasive Species Control? Institutional Expectations for Invasive Animal Management in Peri-Urban Australia.*
- **International Union for Conservation of Nature (IUCN) Academy of Environmental Law 15th Annual Colloquium (May 31 - June 3, 2017), Cebu, Philippines.**
  - Presentation - *Why is Implementation of Natural Resources Law Complex in Peri-Urban Areas?*
- **Workshop on governing mega-diversity in Brazil and Australia (11 November 2017), Coffs Harbour, NSW, Australia.**
- Presentation - Implementation of the Convention of Biological Diversity principles for invasive species management in peri-urban Australia.

Participant observation

During 2015-2018, a series of workshops were conducted as part of the IACRC Community Engagement program. As part of the process of scoping the issues, the researcher participated in four workshops as a participant observer.[537] The process of observation and relevant details are provided in Chapter 4. As an observer, the participation facilitated in understanding scenarios relating to invasive animal control and management.

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[537] The objective behind organising workshops was to understand current and future issues in invasive animal control and management. To this end, the workshops adopted the methodology of 'scenario planning'. These include: Consultation workshop, Sydney (June 2015); Scenarios workshop, Brisbane (August 2015); Scenarios workshop, Sydney (August 2015); Scenarios workshop, Brisbane (October 2015); Scenarios workshop, Sydney (October 2015).

Observation enabled the comparison of what is logically expected with what is the current scenario of pest animal management. The researcher observed the dichotomy between scenarios for pest animal management and expectations of institutions as a basis for understanding the contemporary institutional context. The observations were manually recorded. These observations also enabled the researcher to build on initial conversations and desktop research, providing many opportunities for unstructured questioning of people deeply engaged in invasive species management.

Case study

In this context, case studies are taken in the form of illustrative examples that depict institutional complexity.[538] As described by Yin: 'The distinctive need for case studies arises out of the desire to understand complex social phenomena'.[539] To investigate law and policy aspects of pest animal management and its interrelationship with on-ground implementation, it was important to understand stakeholder perspectives informed by real world cases. To this end, the case study approach was deemed suitable to explore the details and nuances of peri-urban institutions.[540] As noted by Yin, the approach involves 'an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used'.[541] This also facilitates an in-depth description of some social phenomenon.[542] The selection of case studies from two Australian States with different pest animal species as examples allowed this researcher to contrast different issues, technologies, governance arrangements and policy mechanisms.[543] Since pest animal management approaches are species-based, consideration of two pest animals as examples helped in understanding different contextual differences.

Two peri-urban case studies: wild deer management in peri-urban Sydney, and wild dog management in peri-urban Brisbane were used to uncover possible institutional issues. The contextual elements of these case studies were discussed in Chapter 2. The

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[538] R E Stake (ed), *The Art of Case Study Research* (Sage Publications, 1995); B Flyvbjerg, 'Five Misunderstandings About Case-Study Research' (2006) 12 *Qualitative Inquiry* 219; G Thomas, *How to do Your Case Study: A Guide for Students and Researchers* (Sage, 2011).

[539] R Yin, *Case Study Research: Design and Methods* (Sage, 4th ed, 2009) 4.

[540] Ibid 357.

[541] R Yin, *Case Study Research: Design and Methods* (Sage Publications, 1984) 23.

[542] Yin (2009), above n 539, 4.

[543] The details on the case studies are provided in Chapter 2 and 5.

two case studies helped to reveal multiplicity of 'variables of interest'.[544] The control and management approaches adopted for wild dog and feral deer are significantly different. The wild dog example highlighted the implementation of PAPP and ejector as an innovative control, whereas the example of feral deer provided a focus on community level control. Case studies were selected based on the specific criteria and their appropriateness was confirmed through stakeholder interactions. In selecting case studies, consideration was given to:

- Peri-urban specific institutional characteristics,
- Severity of invasive animal problems in the peri-urban context,
- Access to documents including policies, strategies, guidelines, reports; and
- Availability of key informants, representing private and government roles.

Each case study looked at institutional mechanisms and managerial practices associated with the selected innovations (as described in Chapter 2, section 2.4 of this thesis). Background data for the case studies was obtained through desktop research and interviews.

Interviews

Interviews were used to explore expert stakeholders' perspectives on control and management of pest animal species in the peri-urban institutional context. The interviews were conversational and semi-structured.[545] Conversations facilitated data-gathering on institutional issues and provided a richer understanding of issues identified through more formal mechanisms. Conversational interviews explored invasive animal control issues 'in practice'. These conversations covered themes relevant to pest animal control.[546] The following themes were covered:

- Control innovation dimension
- Scarcity of resources
- Funding
- Information

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[544] Yin (2009), above n 556, 2.

[545] Russell H Bernard and Gery W Ryan, *Analyzing Qualitative Data: Systematic Approaches* (SAGE, 2010), 29; ibid 106.

[546] List of themes: control innovation dimension; scarcity of resources; funding; information; institutional arrangements including government agencies, policies, laws and regulations, plans and strategies; capacity building; co-ordination and cooperation; peri-urban context; risk perception issues; animal welfare concerns

- Institutional arrangements including government agencies, policies, laws and regulations, plans and strategies
- Capacity building
- Co-ordination and cooperation
- Peri-urban context
- Risk perception issues
- Animal welfare concerns

The themes were based on the scoping research. A background document that was prepared for the conversations is provided in Appendix 2. During conversations, key participants were asked to elaborate on these themes with their personal and professional experiences. The researcher sought information on implementation challenges that provided insights into the peri-urban institutions, Conversations explored personal as well as professional experiences relating to pest animal management. The experiences explained by the key participants using stories and instances helped in understanding their values and beliefs as well as the way in which these interact with institutional norms.[547] Conversations helped in elucidating the 'invasive narrative'[548] and the complex institutional web.[549]

Semi-structured interviews were also used while exploring institutions through the lens of stakeholders who are involved in pest animal management in the peri-urban space. Of specific interest were the risks and challenges that key interview participants experience in the implementation of pest animal management innovations. The focus of semi-structured interviews was to understand the challenges involved in on-ground pest animal management. The exploration involved intensive questioning of specific (institutional) aspects and stakeholders' experiences, to understand challenges to effective pest animal management.

Open-ended questions were used to obtain detailed and comprehensive information[550] about institutional issues, derived through a scoping study. The open-ended questions

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[547] C Bold, *Using Narrative in Research* (Sage, 2012); D J Clandinin and F M Connelly, *Narrative Enquiry: Experience and Story in Qualitative Research* (Jossey-Bass, 2000); W Hollway and T Jefferson, *Doing Qualitative Research Differently: Free Association, Narrative and the Interview Method* (Sage, 2000).

[548] Lidstrom et al (2015), above n 300.

[549] J Saldana, *The Coding Manual for Qualitative Researchers* (SAGE, 2013).

[550] Z O'Leary, *The Essential Guide To Doing Research* (Sage, 2007).

allowed informants to elaborate on specific issues at a greater depth, if they wished to do so. The questions are included in the Appendix 3. The questions were based on the following themes:

- Perceptions of landholders and residents
- Ways to improve invasive animal management objectives
- Challenges in legal and regulatory compliance while implementing control
- Participatory constraints
- Involvement of stakeholders
- Capability limits
- Political leadership

Interview participants:

The participants for conversational interviews and semi-structured interviews were selected on the basis of their professional experience and expertise in pest animal management. A purposive sampling approach was used. A few participants reflected on institutional issues across both the case studies, based on their expertise. Pragmatic considerations affected the selection of key participants, considering the time and money at the researchers' disposal. However, the IACRC events provided opportunities to access many key informants. While reporting the interviews, precaution was taken to maintain the anonymity of participants.

Interview process

Interview participants were contacted through an introductory e-mail that provided: a) an overview of the nature and scope of the research, and b) a background document describing legal-institutional issues relevant to pest animal control. This helped to determine the interest of participants in being interviewed. Potential interviewees were asked to review the information sheet. The nature of interview questions and complexity of the institutional issues required such a procedure; particularly since the aim was not to obtain 'naïve' responses. All key informants were provided with research consent forms and research ethics approvals (obtained from the University of New England).

Interviews involved 30 minute- to 1.5 hour-long conversations in which invasive animal management challenges and opportunities facing peri-urban areas of Australia were explored. Interviews were conducted in English. Interviews were discerned to

'understand, discover, describe and interpret' the institutional phenomenon. Interviews were transcribed to expedite data analysis. The audio recording of the interviews were transcribed by 'SmartDocs', a transcription service provider. As a follow-up process, the researcher re-checked, and corrected the transcribed document wherever necessary while listening to the original audio recording.

Data analysis

The objective of the analysis was to understand expert stakeholders' perspectives on how institutions facilitate or impede pest animal control.[551] The responses of key informants were coded. The process of coding facilitated capturing key information featured in the data and categorising code, category, theme and theory.[552] Considering the volume of data set, the method of manual coding with pencil and paper strategies and Microsoft Word document as a tool was used.[553] The data was coded through inductive coding, with codes developed from segments of interview texts on each institutional theme, and through deductive coding based upon institutional themes explained in Chapter 6 and theoretical variables identified in Chapter 2. The list of codes is provided in Appendix 5.1.

The objective of interviews was not to obtain a statistically reliable result. Due to the complexity of institutional issues and the nature of research, it is difficult to expect that such an objective could be attained. The objective was to derive expert insights on institutional challenges in pest animal management, adding to a body of evidence. The results of the interviews are discussed in Chapter 6, which includes a synthesis of institutional issues.

Survey

A small sample survey was also used in this research

- To assess whether institutional issues derived through the scoping study (see Chapter 4) and case studies (see Chapter 5) were consistent with the views of a wider group of stakeholders.

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[551] Martin and Craig (2015), above n 503; J. Rogers Hollingsworth, 'Doing Institutional Analysis: Implications for the Study of Innovations' (2000) 7 (4) *Review of International Political Economy* 595.

[552] Pat Bazeley, *Qualitative data analysis; practical strategies* (SAGE, 2013).

[553] Ibid.

- To obtain additional stakeholder inputs, if any, on institutional impediments and to ensure that stakeholders' priorities on institutional issues were reflected in the analysis and recommendations for institutional improvements.
- To triangulate results across the three methods, providing greater confidence in the interview conclusions.

The survey was designed following the policy research approach promulgated by Ann Majchrzak. Such a survey is 'small and purposefully sampled' and it lacks a sample size needed for statistical analysis.[554]

The survey involved a written questionnaire to the survey participants. The participants were asked to provide:

- Their personal details, job role and general responsibilities.
- Their organisation.
- Any specific information (roles and responsibilities in pest animal management).

The questionnaire involved closed-answer questions (eg, yes/no responses, or level of agreement/disagreement) with a provision for additional comments.[555] The survey instrument covered institutional issues derived through scoping and peri-urban specific case studies. The issues relate generally to both case studies.[556] The details regarding survey data collection including a copy of the survey instrument are provided in the Appendix 4.1. Survey completion by the respondents was conducted in the presence of the researcher. During this process, respondents were attentive and diligent in responding the surveys. The researcher observed the process to avoid a risk of collusion or inattention.

The survey responses generated binary (yes/no responses) and categorical data. Exploratory data analysis was undertaken to obtain a single consistent form of the data.[557] The exploratory analysis showed that a few respondents did not comment on

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[554] Majchrzak (1984), above n 518, 63.
[555] O'Leary (2007), above n 550, 159.
[556] The institutional issues covered by the scoping study (Chapter 4) significantly intersect with issues derived through case studies (Chapter 5). The survey instrument avoided overlapping of issues while retaining the main objective of assessing the consistency between issues.
[557] *Approaches to the Analysis of Survey Data* (The University of Reading Statistical Services Centre, March 2001) 7.

an open-ended question. The data was then exported into Microsoft Excel. The survey data was qualitatively analysed to find out commonalities, differences, interpretations, narratives and relationships in responses. The exploratory analysis proved helpful in categorisation of the survey data. The responses were rated to form an ordered thematic sequence in the form of 'keys' having numerical meaning (see Chapter 6, section 6.3 of this thesis). Given the small sample, the purpose of the survey and the nature of the issues, only simple counts and reporting were used in the analysis.

Data triangulation:

Data triangulation[558] involves the use of multiple sources and methods for data collection. The use of multiple methods facilitated the collection of more comprehensive evidence and cross verification of the information, providing verifiable credibility and intuitive validity.[559] This approach offers more comprehensive data, allowing deeper insights into the problem being investigated, and recognition of inconsistencies in data sets.[560] Data triangulation assists in strengthening the findings.[561] In this research, data collected through desktop research, participant observations during the workshop, case studies and a survey facilitated understanding of the different perspectives of stakeholders, enabling confidence in the conclusions on institutional impediments in peri-urban invasive animal control and management (see Figure 3.3).

Triangulation helped to provide confidence in the reliability of qualitative data obtained from multiple methods. The complexity of qualitative data also required simplification and acceptance of the subjectivity in stakeholder opinions. The approach in this research acknowledges that the perspectives of stakeholders reflect their subjective views of the institutions. It is acknowledged that the researchers' own interpretation, at least to some extent, will be reflected. The final survey and

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[558] Campbell and Fiske discussed the idea of triangulation: D T Campbell and D W Fiske, 'Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix' (1959) 56(2) *Psychological Bulletin* 81; The use of triangulation for qualitative research in social sciences was facilitated by Eugene J Webb et al, *Unobtrusive Measures. Nonreactive Research in the Social Science*s (Rand McNally, 1966).

[559] Martina Yvonne Feilzer, 'Doing Mixed Methods Research Pragmatically: Implications for the Rediscovery of Pragmatism as a Research Paradigm' (2010) 4(1) *Journal of Mixed Methods Research* 6.

[560] M Q Patton, *Qualitative Research and Evaluation Methods* (Sage 3rd ed, 2002).

[561] W L Neuman, *Social research methods: Qualitative and Quantitative Approaches* (Allyn and Bacon, 3rd ed, 1991).

comparison of research findings with two other studies provide some assurance of the objectivity of the analysis.
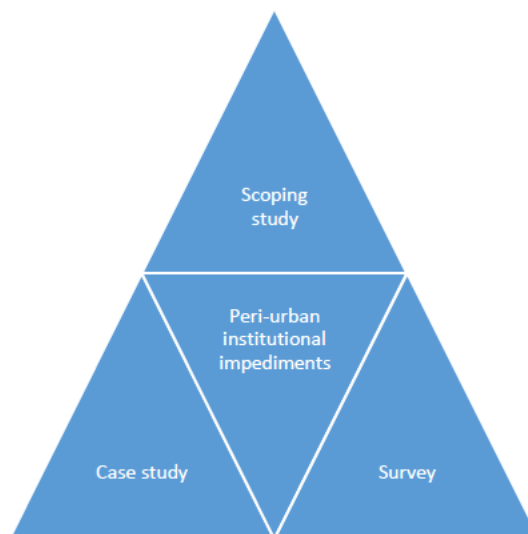
Figure 3.3: Data triangulation

3.4 Research ethical framework

The research followed research ethics requirements and processes as prescribed by the University of New England.[562] The research also followed best-practice research policies of the IACRC. A standard procedure of 'undertaking of confidentiality and informed consent' has been used throughout the process of this research. All participants were thoroughly informed about the purpose and nature of the research. The voluntary participation of key informants was assured through negotiation between the researcher and participants about the place, timing and duration of the interviews. Taking into account the professional standing of the key participants, the interview process assured substantial opportunities to clarify and explain the information in order to avoid any negative impact on individual professional careers. The interview recordings and questionnaires were stored in a secure storage and electronically protected by a password. The researcher adopted a neutral position throughout the data collection and analysis; including about the content of what stakeholders revealed.

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[562] Research ethics approvals: Approval Number HE15-287, Approval Number HE16-110.

3.5 Limitations of the research method

The institutional analysis required researcher's judgement to explore issues that are often subtle, unwritten and at times contrary to the official positions of formal institutions. The researcher took the position of 'reflexivity', which emphasises that the researcher is an integral part of the social context under investigation while being distinctly aware of his or her own values.[563]

3.6 Conclusion

This chapter presented an account of the methods used in this research. The chapter started by emphasising the need of evidence-based approach in designing this research, particularly to answer the main research question which falls under inter-disciplinary domain of strategic pest animal management, innovations, innovation-adoption and implementation in the institutional context. It described the research techniques used for data collection and the role of triangulation in confirming the research findings.

The next chapter describes the scoping study conducted to obtain an elaborate hypothesis comprising of a set of institutional issues.

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[563] M Hennink, I Hutter and A Bailey *Qualitative research methods* (SAGE Publishing, 2011).

CHAPTER 4: LEGAL AND INSTITUTIONAL ISSUES – SCOPING STUDY

4.1 Purpose

The previous chapter outlined methods used to identify institutional impediments to effective pest animal management innovations. This chapter discusses the first stage of the investigation. As preparation for the empirical work, and bearing in mind the need for reasonably clear hypotheses to frame that work, the objective of this stage was twofold:

- To identify institutional issues in innovation-adoption and implementation for pest animal management.
- From this exploration of issues, derive hypotheses about what issues are possibly relevant to adoption in the peri-urban context.

4.2 Exploration of institutional issues

To explore institutional issues in innovation-adoption and implementation for effective pest animal management, a scoping study was undertaken. The scoping study involved two stages: a) observations during the Invasive Animals CRC citizen and government stakeholder workshops, and b) a review of relevant literature through desktop research.

4.2.1 Observations during the Invasive Animals CRC workshops

Background and purpose of the workshops
The IACRC community engagement program conducted multiple workshops to realise the objectives of 'Project 4E3: Reducing Institutional Barriers to Citizen Action for Effective Pest Animal Management'. The workshop consultations on institutional issues affecting pest animal control were not limited to peri-urban areas but provided the opportunity for observational research on institutional issues which, when coupled with the relevant literature, would provide initial hypotheses for further investigation.
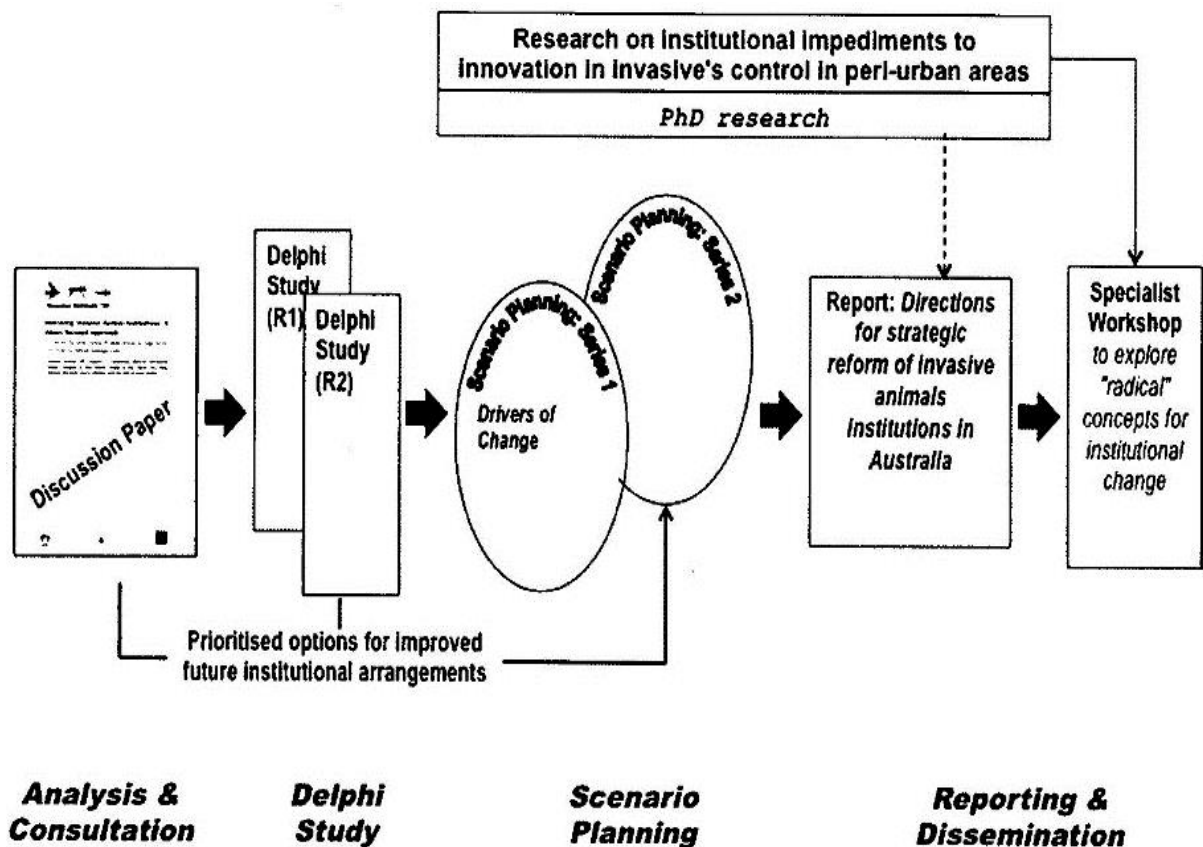
Figure 4.1: 4E3 Project pathway
(Source: Low Choy et al, 2017, 6)

The 4E3 project followed four phases (as shown in Figure 4.1). In the first stage, an extensive stakeholder consultation and citizen survey, was undertaken by the members of the 4E3 project team to review institutional arrangements for pest animal management. The outcome of this phase was a discussion paper titled 'Improving Invasive Animal Institutions: A citizen focused approach'.[564] The discussion paper outlined future institutional issues and options for pest animal management.

In the second phase, the options identified in the first stage were refined to identify key institutional issues that affect citizen action for pest animal management. In the third phase a process based on 'scenario planning' was undertaken to investigate institutional issues for effective citizen action for pest animal management. During this phase the institutional issues identified through scenario planning and the first two phases were combined to form a composite set of future options. The future

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[564] Improving Invasive Animal Institutions: A citizen focused approach, a report prepared by Paul Martin, Elodie Le Gal, Darryl Low Choy, Graham Marshall, and Katrina Dickson as part of the Invasive Animals CRC Program 4E3 "Facilitating Effective Community Action".

options were evaluated to provide directions for strategic reform of pest animal management institutions in Australia. During the last phase, project outcomes were delivered in the form of publications. The publications propose politically and economically feasible reform proposals to improve pest animal management institutions. The publications include:

- Discussion paper: Effective citizen action on invasive species, The institutional challenge.[565]
- Recommendations for the reform of invasive species management institutions.[566]
- Stakeholder views on pest management in Australia.[567]
- Scenario planning for institutional improvements to support citizen action in invasive animal management[568]

The objective of the PhD research was to identify institutional issues in pest animal management, specifically in peri-urban settings. Figure 4.1 shows the pathway followed to meet the objectives of the project 4E3 and the role of this research within the project. The observational study commenced at the beginning of the third phase of the project 4E3, when the process of scenario planning began.

> Scenario planning is a strategic tool that can be used to develop a science based decision-making framework in situations of high uncertainty and low controllability. It provides a systematic approach for the development and testing of future options for action (eg, plans, strategies and policies) in an uncertain environment through the creation of possible futures to test them in. Scenario planning creates possible futures to inform present decision-making.[569]

As part of the scenario planning process, stakeholder workshops were conducted to identify and assess future options for pest animal management. The objective was to identify current as well as future institutional challenges, and on that basis propose better institutional arrangements.

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[565] Martin et al (2016), above n 4.
[566] P Martin and D Low Choy, *Recommendations for the Reform of Invasive Species Management Institutions* (PestSmart Toolkit Publication, IACRC, 2016).
[567] P Martin and K Lingard, 'Stakeholder Views on Pest Management in Australia' (IACRC Report, 2017).
[568] D Low Choy, S Serrao-Neumann, G Schuch and P Martin, 'Report on Scenario Planning for Institutional Improvements to Support Citizen Led Action in Invasive Animal Management' (IACRC, 2017).
[569] Ibid

For the researcher, these workshops provided the opportunity to investigate institutional issues through stakeholders' perspectives. The researcher participated as an observer in four scenario workshops conducted as part of the IACRC Community Engagement program. These were: two in Brisbane (August 2015, October 2015) and two in Sydney (August 2015, October 2015). The workshops comprised two rounds. During the first round (August 2015) participants deliberated on a range of institutional issues to prepare scenarios or a vision for future pest animal management institutions. The participants explored possible alternative outcomes and management approaches. During the second round (October 2015) participants assessed the options that were identified in the first round to address institutional issues and to realise the vision for pest animal management. The participants explored possible strategies for achieving desirable pest animal management outcomes, and the institutional reforms required to make these feasible. Each workshop built on its own dynamic by developing future scenarios for invasive species issues in the Australian context and proposing institutional changes and innovations to achieve the stated improvements. Workshop discussions were triggered with guiding questions but were not limited to these questions. The workshop participants analysed issues both theoretically and strategically through guided discussions. The discussions addressed current as well as future institutional issues of invasive animal management and options to address these issues.

Who was involved in the workshops?

The workshops were attended by professionals from government agencies, regional NRM bodies, such as South East Queensland Catchments, university and research organisations, and NGOs such as community-based organisations, animal welfare organisations and industry bodies.

The participants were selected mainly by the partner organisations within the IACRC. The Project 4E3 had access to other stakeholders from the pest animal management 'community of practice' network. Participants (for the workshops attended by the researcher) were drawn from the states of Queensland and New South Wales. The participants represented different interests and knowledge about invasive species issues (see Figure 4.2).
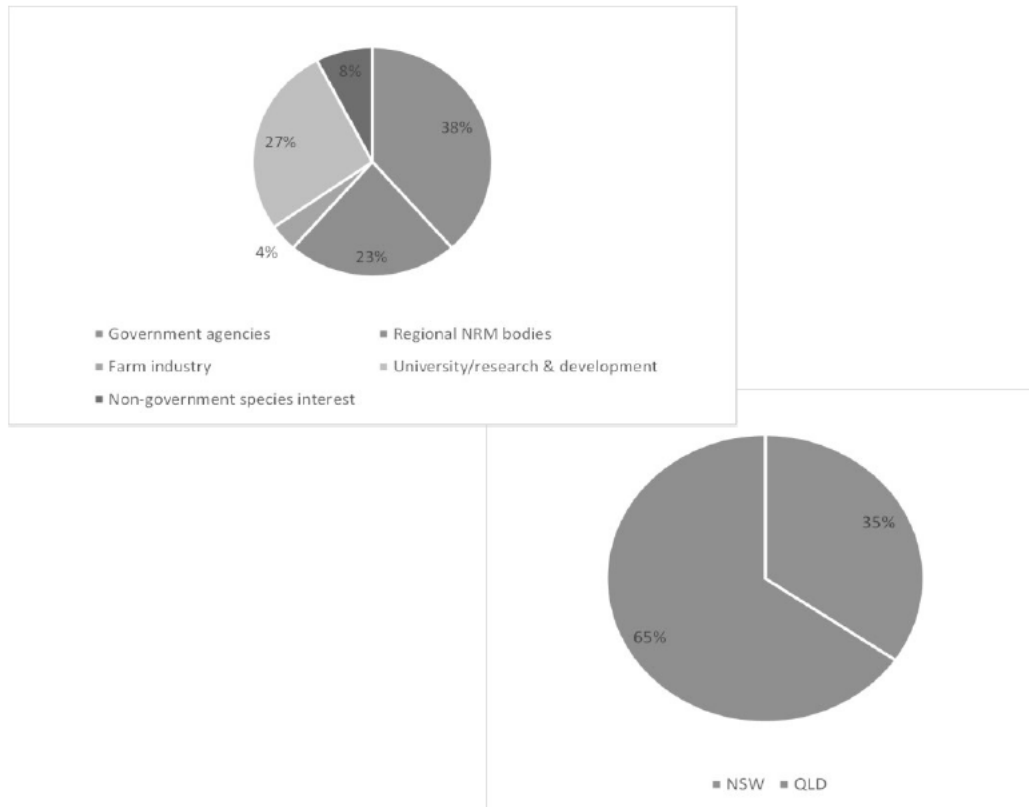
Figure 4.2: Stakeholder participation a) by location and b) by organisation

Process of observation

As already noted, the researcher participated in workshops with an objective to understand institutional issues in pest animal management and to develop preliminary hypotheses for further investigation. The workshops followed a deliberative process in which participants engaged in discussions on the nature of institutions and institutional processes for pest animal management. The researcher participated as a passive observer. The workshop process was led by Professor Darryl Low Choy and Professor Paul Martin. Workshop participants were encouraged to think about institutional issues and to put forward possible ideas to address those issues. The process involved intense deliberation on a range of institutional issues including, for example, pest animal policy objectives, the role of technologies and managerial options, clarification of the role of stakeholders, regulatory and legislative requirements, and involved multiple negotiations among participants while arriving at consensus. Situations arose when participants drifted away from the key discussion topics due to the diversity of pest animal issues. In these situations, the workshop leaders intervened to steer discussions and find a middle ground without eroding the value of multiple ideas that enriched deliberations. While recording observations, the

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researcher gave attention to the inherent diversity of views and the sensitivity with which different stakeholders expressed their opinions on a number of issues. The researcher recorded his observations manually.

4.2.2 Literature identified through desktop research

Desktop research was also conducted to corroborate and expand on the institutional issues from workshop observations with the available literature on pest animal management. The available literature falls short of describing the issues covered during the workshops. This is particularly due to the diversity and nature of pest animal issues discussed by workshop participants and to their practical experience. However, the literature proved useful in two ways: a) to interpret institutional issues observed during the workshops and b) to identify additional institutional issues in the peri-urban context that were not touched upon during the workshop discussions. Section 4.5 of this chapter describes the literature identified through desktop research. It covers only those issues for which further explanation beyond the observations from practitioners and stakeholders was needed.

4.3 The scoping study within this research

The scoping study was intended to help the researcher to quickly understand the institutional issues for pest animal management in practice. The combination of observations and desktop research provided an understanding of institutional issues, identified in this chapter. The study highlighted institutional issues that constrain on-ground implementation of innovations in pest animal management. It particularly highlighted institutional matters for which there is a paucity of research resources. The issues derived through this scoping study were the basis of investigation of peri-urban specific institutional impediments to the adoption of innovations for effective pest animal management.

4.3.1 Structure of this chapter

Section 4.4 of this chapter describes the observations from the IACRC workshops. Six themes emerged for institutional issues in innovation adoption and implementation for pest animal management (see Figure 4.3).
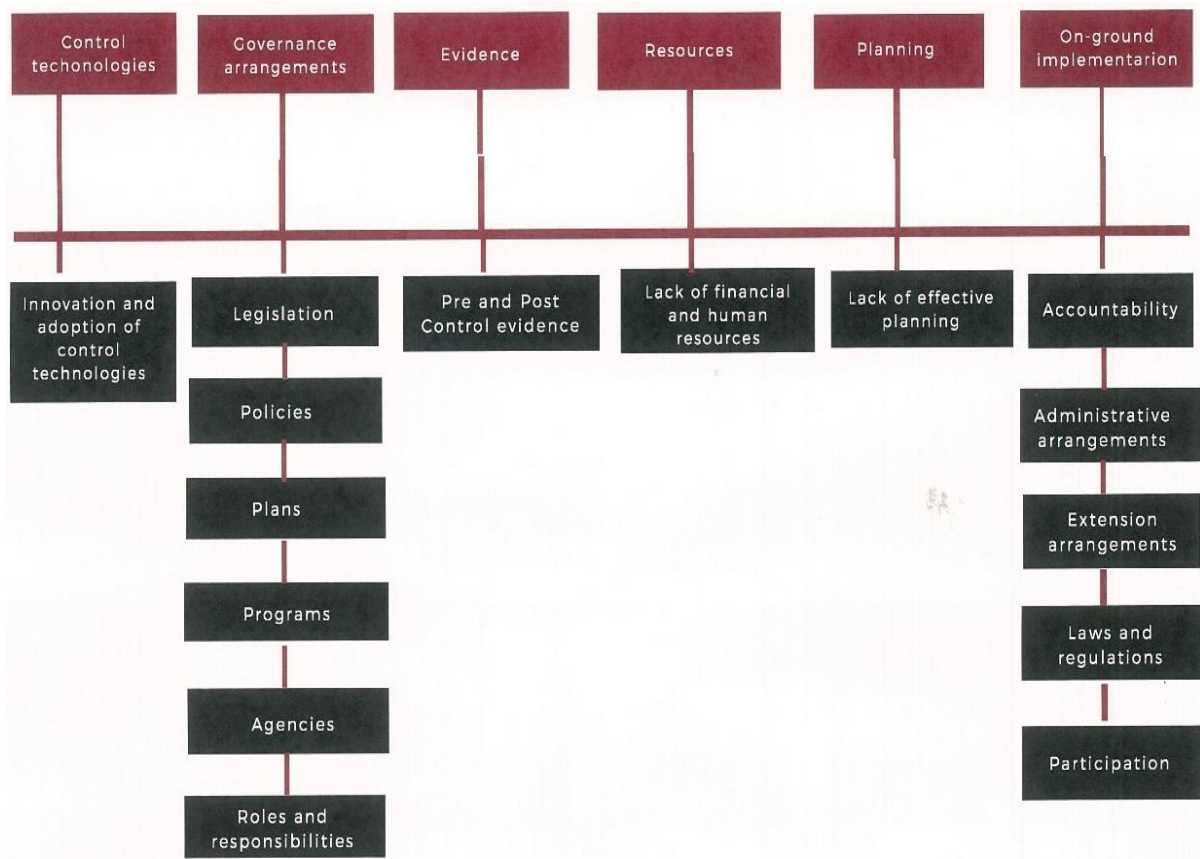
Figure 4.3: Themes from workshop observations

A theme here refers to an aspect in pest animal management that was discussed in the workshops. Each theme had multiple issues that further describe and elaborate on the institutional constraints. The observations are not reported in detail because a) the purpose of observations was limited only to deriving an initial hypothesis and research questions, and b) the observational methods with a limited sample are not sufficient as a basis for drawing generalised conclusions. In each theme, the workshop observations provide a summary of participants' views. The observations do not attempt to evaluate the views expressed by the workshop participants.

Section 4.5 describes the results of additional desktop research. The purpose of desktop research was to ensure that all issues around the institutional problem of pest animal management were identified. The section discusses only the elements that were not identified during the workshop discussions. In the case of three themes: evidence, resources and planning, the desktop research did not reveal insights additional to what was learned from observations. To avoid repetition, I have focused the description of desktop research outputs on control technologies, governance

arrangements and on-ground implementation where additional insights were found from the literature.

To avoid interrupting the flow of the description of workshop observations, I have described the institutional issues from desktop research in a separate section. Section 4.5 describes the institutional issues identified through literature, including policies for pest animal management.

4.4 Workshop observations

This section describes institutional issues in innovation adoption and implementation for pest animal management. From the scoping study, the following six themes emerged:

- Control technologies
- Governance arrangements
- Evidence
- Resources
- Planning
- On-ground implementation of control

4.4.1 Theme 1 – Control technologies

Participants discussed the importance of control technologies and the importance of easy access for stakeholders. In particular, participants acknowledged the increased importance of cost-effective control techniques and the facilitating role of technologies in information/data collection, monitoring and analysis for effective pest animal management. Participants stated that the science-based approach underpinning biosecurity policy requires continuous innovation in control technologies. Innovation driven by research and development was considered vital for new control technologies. Participants discussed four institutional issues relating to innovations in control technologies:

- Inadequate resources
- Inadequate research partnerships and coordination
- Difficulties in regulatory approvals
- Cost-effectiveness

Each of these elements is discussed in more detail below:

Inadequate resources

Participants identified the lack of resources as the key factor affecting research and innovation for pest animal management. Continuous decline in funding from the government and industry were stated as reasons for decreased financial investments in research and innovation. Participants pointed out that government investments in pest animal management research and development are primarily affected by competing political and research priorities. The reasons given for insufficient industry investments include fluctuating market demands, the credit crunch and low adoption rates of new technologies.

Research partnerships and co-ordination

Participants stated that innovations in control technologies for pest animal management require support from formal research as well as on-ground learning by stakeholders. Technological innovations require consistent policy approaches for Research Development and Extension (RD&E) and targeted long-term investments to fund creation to commercialisation. Innovations for pest animal management in Australia come from diverse sources including government research organisations, for example, Commonwealth Scientific and Industrial Research Organization (CSIRO) and CRCs, universities, industries, and community.[570] Collaborative partnerships among these and the other stakeholders involved in pest animal management research are needed for continuous innovations.

Participants identified a gap between innovation policy, and practices that hinder shared research for innovations in pest animal management. In this context, participants discussed current innovation policy[571] agendas and their relevance for pest animal management research. The collaboration between research agencies and industry has been recognised as a priority in Australian innovation policy framework but this collaboration was expressed to be rarely evident in practice.[572] Major innovations for pest animal management stem from industries working in silos. These

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[570] Department of Agriculture and Water Resources, *National Primary Industries Research, Development and Extension Framework* <http://www.agriculture.gov.au/ag-farm-food/innovation/national-primary-industries>; National Primary Industries Research, *Development and Extension Framework, Statement of Intent*, 2009.

[571] Commonwealth of Australia, *National Innovation and Science Agenda* (Department of the Prime Minister and Cabinet, 2015).

[572] Collaboration is identified as one of the four pillars for innovation in Australia's 2015 *National Innovation and Science Agenda*.

include, for example, *Grain Industry National RD &E Strategy*[573], *National Beef Production RD & E Strategy*[574], *National Sheep Meat Production RD &E Strategy*[575], *National Wool RD&E Strategy*[576]. For Australian specific NRM problems, tailor-made solutions must be derived within the country but poor levels of co-ordination negatively affects sustained support of innovations. Participants pointed out that lack of financial resources affects the ability of research institutes to hire and retain quality staff. The lack of resources drives governments' policy focus on short-term innovations. Such practices are not conducive for pest animal control innovations where implementation related risks should be taken into account for long-term viability of control measures.

Difficulties in regulatory approvals

Participants discussed institutional problems of regulatory approval by the APVMA. Regulatory agencies are involved in the approval of control technologies and products through a formal approval process. APVMA is the regulatory agency which governs approval of most innovations in pest animal management.[577] Participants acknowledged the need for strict regulations for use and application of agricultural chemicals and veterinary medicines (agvet) to prevent potentially harmful effects on health and safety of humans, animals and the environment, but stakeholders suggested the need for improved regulatory processes. Regulatory approval by the APVMA involves an assessment of new products and active constituents, amendment of

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[573] Grains Industry National Research, *Development and Extension Strategy 2017*, <https://www.npirdef.org/content/75/7afad8b6/Grains-Industry-National-RD-E-Strategy-2017.pdf>. The original strategy was developed in 2011

[574] Primary Industries Standing Committee – R&D Sub-Committee January 2010, *National Beef ProductionRD&E Strategy* <http://www.utas.edu.au/__data/assets/pdf_file/0008/349199/Beef-Industry-National-RD-and-E-Strategy.pdf>.

[575] Primary Industries Standing Committee – R&D Sub-Committee January 2010, *National Sheepmeat Production RD&E Strategy.*

[576] *Wool Industry National Research Development and Extension Strategy 2011*, <https://www.wool.com/globalassets/start/education-and-extension/national-wool-research-development-and-extension-strategy/strategy/2011-10-31_wool_rdne_strategy-sp-printable-version.pdf>.

[577] The role of APVMA in regulating agvet chemicals is governed by the *Agricultural and Veterinary Chemicals (Administration) Act 1992* (Cth). The APVMA follows an evaluation and registration process for the legal sale, supply and use of agvet products in Australia. The APVMA regulates products up to and including the point of sale. After the sale of products, the states and territories are responsible for controlling the use. The APVMA does not have any responsibility for monitoring the use of chemicals.

registered products or renewal of products. Innovations have to comply with risk-assessment and safety criteria designed by the APVMA. APVMA follows a risk-based assessment process[578] but the criteria for risk-assessment followed by APVMA reportedly differs from other agencies involved in similar assessments.[579] Conflicting risk assessment mandates between regulatory agencies lead to delays in approvals. Delays in regulatory approvals affect innovations and their uptake. Participants attributed the cause of delay in regulatory approvals to the institutional processes involving consultations with multiple advisory agencies, multiple risk-assessment frameworks, competing objectives of regulatory and advisory agencies, and a lack of consistency in approval processes. Multiple layers of administration affect decision-making for consideration and approval of technologies. A lack of transparency was identified as one of the impediments in institutional decision-making. It was suggested that current processes may create risks to regulatory integrity including undue influence by stakeholders. Participants cited the absence of performance pressure on regulatory agencies as a cause of delay in adoption of new technologies and their timely approval; another reason cited for delays was chronic and increasing under-resourcing of government departments that administer approval of control products.[580]

Participants stated that strict regulations for the on-ground use of technologies lead to their late adoption or non-adoption. While drafting regulations for on-ground use of control technologies, regulatory agencies take into account the stringent criteria of utility and efficiency based on animal welfare and humaneness. Strict regulations are perceived as impediments by stakeholders using technologies for on-ground implementation. Participants stated that better information on the problems faced by

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[578] For example, *APVMA – AgVet Code*, <https://apvma.gov.au/node/4131>.

[579] For example, APVMA makes administrative decisions for registration and regulation of new agvet products on the basis of veterinary medicine approach but as part of the assessment process it receives input from Department of Health, Department of the Environment, Food Standards Australia New Zealand, Office of the Gene Technology Regulator and Department of Biosecurity, <https://apvma.gov.au/node/4131>.

[580] Since 2014, the Department of Agriculture and Water Resources, with an objective to improve the efficiency of agvet chemicals regulatory system, has been engaged in extensive consultations with stakeholders including the chemicals industry, chemical users, state and territory governments and community members. Some of the issues discussed in workshops have been reflected in these consultations. For additional information, see discussion papers and a summary of reform measures *available at*: <http://www.agriculture.gov.au/ag-farm-food/ag-vet-chemicals/better-regulation-of-ag-vet-chemicals/streamlining#summary-of-reform-measures>.

on-ground implementers due to strict regulations and how it affects on-ground effectiveness of technologies could help research institutes in developing balanced regulations with the aim of effective on-ground implementation. Participants stated the need for increased communications with stakeholders involved in on-ground implementation for better regulations.

Cost-effectiveness

Participants pointed out to the costs of current technologies as an impediment for adoption. Cost effectiveness was stated as the primary consideration for stakeholders' selection of a specific control measure. Currently available control technologies reportedly have a high purchase and maintenance cost. These technologies require substantial labour which further increases the implementation cost. Participants observed that landholders and communities make their adoption decisions on the basis of short-term cost benefit approaches which require that innovations deliver low cost pest animal control technologies.

4.4.2 Theme 2 – Governance arrangements

The governance arrangements for pest animal management in Australia include a range of national and state government agreements, strategies, legislation, plans, programs and stakeholders with varied roles and responsibilities (See Chapter 1, section 1.7). No single entity can be expected to deliver the goals of pest animal management. To achieve the goals of pest animal management effectively, there is need to ensure that activities of many stakeholders are harmonised so that overall performance conforms to pest animal management plans. This can be achieved through proper coordination among all stakeholders. The challenge of co-ordination in pest animal management mainly arises from the fact that different stakeholders are needed as integral contributors to overall performance. Issues include:

 a) Due to the nature of pest animal control activities, the work performed by stakeholders often overlaps. Individual stakeholders (eg, government agency or NRM agency at the regional level) may consider their work and organisational goals as more important than the overall pest animal management plan.

 b) Multiple stakeholders tend to engage in pest management activities at different places and times. This does not often allow close coordination among stakeholders.

Without coordinated action, the work of some stakeholders may overlap or conflict with the other stakeholders, rendering the overall performance substandard.

Participants stated that governance of the pest animal management system requires formal arrangements that facilitate coordination. Participants identified the following elements of the current governance arrangements that impede innovation adoption and implementation:

- Legislation - Difficulties in designation of pest animals due to multiple laws, duplication of laws, spill-over effects from other legislation, lack of behavioural effectiveness of existing laws.
- Policies - Lack of clarity about shared responsibility, lack of policy integration, lack of policy performance indicators.
- Poorly coordinated plans.
- Different programs operating at various levels of government.
- Agencies having overlapping or competing mandates.
- Poorly coordinated roles and responsibilities and gaps in responsibilities.
- Lack of coordination, generally.

Each of these elements is discussed in more detail below:

Legislation

Participants discussed how multiple pest animal legislation across Australia creates difficulties in pest animal management. Definitions of pest animal species in legislation are not uniform. It is reportedly difficult to decide the status of some pest animals because of the lack of precision or multiplicity of legislation. Feral deer are the main concern. Within same states/territories, more than one agency has responsibility to manage a pest animal. These agencies sometime adopt different control practices for a similar pest animal. Variations in recommended control practices make it difficult for stakeholders to select the best amongst available control practices. Participants stated that 'spill-over' effects from other legislation affects pest animal management. For example, rules governing organic agricultural production restricts pest animal control on those lands. In such cases, the adjacent lands cannot optimise their control efforts. Participants observed that weak enforcement of legislation fails to effectively control undesirable human behaviours. Some social and moral norms influence human behaviour concerning pest animal management in ways

that are not helpful. This particularly relates to aversion to fatal controls. Participants stated the need for enforcement of legislation to control behaviours that encourage the spread of pest animals.

Policies

Participants stated that multiple policies, strategies and reference documents provide guidance for pest animal management. Policies comprise control and management strategies, action plans for priority species, guidance documents on operational aspects of control technologies, and specifications on animal welfare standards. These documents set a strategic and administrative direction for stakeholder action, but the participants identified the following constraints that inhibit outcomes:

Lack of integration – Participants stated that policy documents exist at different levels of government. At each government level, government agencies with distinct portfolios pursue their own control objectives. Government agencies follow diverse structures and processes. The overlap between structures and processes within government agencies constrains the realisation of integrated and uniform policy approaches for pest animal management.

Policy performance assessment – Participants suggested that the performance of government agencies involved in pest animal management should be assessed using clear performance criteria. The lack of performance evaluation affects integrated management of pest animals. For example, policy documents envision control outcomes in terms of the economic, social and environmental aspects of pest animal management. However, given the absence of performance assessment implementation is primarily driven by economic and/or human health concerns, leading to variable policy outcomes.

The notion of shared responsibility – Participants noted difficulties in incorporating a 'shared responsibility' approach for pest animal management in practice. Policy documents lack clarity about changes that are needed in the roles, responsibilities, relationships and practices to put the principle of shared responsibility into practice. Participants cautioned that, in the absence of clarity, stakeholders may pursue vague or abstract control objectives that are difficult to convert into realistic actions.

Poorly coordinated plans – Participants stated that pest animal management is pursued through plans prepared by many government agencies and non-government stakeholders. Participants particularly discussed the pest animal management policy framework in NSW and QLD. Pest animal management in these two states is influenced by the state government plans, regional plans (drafted by NRM regional organisations), local government plans (reflecting the local government's responsibility in NSW and QLD to implement pest animal control, risks and control approaches at the local level), community plans (prepared by the local community groups, for example good neighbour programs to help reduce the spread and impacts of high risk pest animal species), industry plans (to address pest animal concerns relevant to a particular industry) and property management plans (prepared by public and private landholders including relevant pest animal management). Participants stated that multiplicity of plans affects integrated action, due to a lack of uniformity.

Government agencies – Participants stated that it is difficult to cover all pest animal management roles and responsibilities in a single government portfolio. Pest animal management issues are intertwined within broader natural resource management in the governance structure. Federal, state and local levels of governments are involved in different capacities to oversee and coordinate invasive animal management. The government agencies follow separate mandates for different aspects of their control activities. Law and policy frameworks used by these agencies include multiple and fragmented instruments (laws, regulations, policies, strategies and plans). Participants observed that policy decisions at the higher levels of government lead to frequent changes in the agency portfolios, through consolidation or separation of agencies and changes in program priorities or strategies. Consolidation or separation leads to new agency structures and processes that affect the consistent long-term focus required for pest animal management.

Poorly coordinated roles and responsibilities

Participants highlighted the importance of contributions from, and cooperation between, multiple stakeholders engaged in managing pest animals on public and private lands. These stakeholders include landholders, governments and industry as well as community groups who perform intersecting roles in pest animal management. These stakeholders have diverse perspectives, interests and objectives. The involvement of multiple stakeholders can create confusion among stakeholders

over their roles and responsibilities in pest animal control. Government agencies adopt varied engagement approaches with landholders on many natural resource management issues. Pest management issues are generally entangled in broader natural resource management issues dealt with by government agencies, including, for example, water or catchment management agencies, landcare agencies and local councils. Landholders, being unaware of most of the NRM issues, tend to get confused about which government agency they should approach for pest animal problems. In certain cases, despite landholders' interest in pest control, lack of information about the appropriate agency constrains on-ground work.

Participants observed that the primary responsibility for pest management rests with the individual or community stakeholders but decisions regarding distribution of public financial resources are taken by federal and/or state level governments. This creates an apparent gap for implementation, since the stakeholders responsible for on-ground work have to depend upon decision-making by bureaucratic stakeholders who may or may not have a clear idea of what is needed for on-ground control. Local level governments have the most proximate opportunities to get involved in on-ground control but the resources and decision-making power generally rests with the Commonwealth or state level government. This leads to frictions within and across sectors and levels of stakeholders and counter-productive policy.

Lack of coordination, generally

Participants recognised a lack of co-ordination as the major problem in invasive animal control. The coordination problem persists throughout all the institutional levels, within and across different sectors and levels of industry, community and government. Participants stated that co-ordinated effort has a potential to bring greater focus and efficiency but poor clarity around roles and responsibilities among stakeholders retard their ability to manage invasive animals. This is evident through a reported lack of co-ordinated effort – at the government level (eg, between NRM bodies and local councils), between government and people on-ground, among local groups, and between different NRM agencies, and an absence of broad scale partnerships, among landholders, and between NGOs/private conservation groups and government.

4.4.3 Theme 3 – Evidence

Participants discussed the evidence needed for pest animal management in two categories:

a) Pre-control evidence, for assessing the pest animal threat; and
b) Post-control evidence for assessing the performance of stakeholders (at an individual and coordinated level) after control action.

Participants stated that at the pre-control stage, objective information about pest animal location, movement and threat is needed to devise an appropriate control strategy. Understanding invasive animal impacts is crucial to strategise the course of control action. Information can stimulate stakeholders to take actions that either support or negate desired outcomes of management. Objective intelligence facilitates decision-making about the need for control action, selection of control methods, feasible steps for implementing control and the resources required to control objectives. Pest animal intelligence involves information on various elements of the pest animal problem; for example, animal species, their characteristics, scale, presence, rate of dispersal, and impact. It helps provide evidence necessary to instigate control action. Once the control action begins, monitoring helps in assessment of the success achieved. Post control evidence helps in assessing the performance of control. Evaluation is conducted to assess the success of managerial actions in achieving the goals of controls. This evidence is useful to assess control requirements and to strengthen the course of future control actions.

Participants stated that obtaining objective evidence is constrained due to following elements:

- Problems in the availability of data and information
- Lack of effective systematic monitoring
- Difficulties in data collection, integration and analysis
- Difficulties in obtaining realistic estimates of populations
- Difficulties in measuring performance of control measures
- Difficulties in quantifying perceived impact of harmful species
- Inadequate reporting on projects and project performance
- Absence of tools to test the veracity of information that is provided
- Absence of tools and methods to assess the reliability of data

- Lack of adequate methodologies to evaluate project or program performance

Each of these elements is discussed in more detail below

Problems in availability of data and information

Participants noted that comprehensive information is required to devise an appropriate strategy for pest animal management. The availability of data (for example, about animals, their characteristics, scale, presence, rate of dispersal, and impact) helps provide evidence to derive a clear strategy. Pest animal strategy includes decisions about whether control actions are needed, selection of control techniques, feasible steps for implementing control and the resources required to achieve control objectives. Data can facilitate anticipation of risks as well as planning responses, and provide evidence and justification for control activities. Participants noted that pest animal threat assessment is not uniform nor reliable, due to inherent biases in assessing threats. Threat assessment involves social influences, values and motivations in perceiving pest animal problems. This affects the quality and objectivity of evidence used for decision-making. A lack of objective evidence creates difficulties in planning effective responses.

Inadequate reporting

Conversations about the damage caused by pest animals are common but objective data often does not get reported. For example, deer or dog sightings are rarely specifically reported. Data on vehicle collisions with deer is not well reported. A lack of information creates difficulties in formulating a baseline for native vis-à-vis pest animal populations and for assessment of control approaches. Unavailability of data on funding (particularly about in-kind contributions) makes it hard to calculate a realistic estimate of investments made by government, industry and the community for pest animal control.

Difficulties in quantifying perceived impact

It is possible to calculate damage caused by pest animals in terms of how many native/domestic animals were killed by pest animals; for example, the number of sheep killed by wild dogs and the economic impact on agriculture. The damage caused by wild dogs and costs per hectare gives an estimate of economic impact. It is harder to obtain data on risk perceptions. Risks that a wild dog might attack someone

in a park or scare someone or kill a pet is a perceived impact which is hard to quantify. It is also difficult to specify the environmental impacts of pest animal species at a local scale.

Lack of tools to test information

Use of new technology, like FeralScan, is useful for reporting, but participants suggest that ownership of smartphones does not mean that people will use mobile apps. People over 50 years of age may not prefer to use an app. Thus, for a proportion of the population, reporting through FeralScan may not be reliable. The FeralScan pest app may also be used to report animals that are not feral but simply strays. Access to information through mobile apps is thought to be restricted by information and data access laws. As a result of such factors, some workshop participants expressed the need for multiple ways of communication and reporting.

Lack of effective monitoring

Participants stated that monitoring is more likely to be effective if there is a clear objective for what needs to be monitored. This helps in defining scope and baseline indicators to assess information collected through monitoring. Current pest animal management objectives vary because of multiple sectoral policies, strategies and plans. Monitoring thus involves diverse elements (eg, biodiversity, land degradation, reduction in the quality of water, amenity value of ecosystem) according to the different objectives of policies. This diversity creates difficulties in quantifying pest animal data. For example, it is difficult to quantify the impact of pest animals on native species. Invasive species impact concerns not only involve extinction of native species due to predation but also destruction of native species habitat (including water and food supply) or diseases carried by invasive animals potentially causing infection and decline in populations of native animals. In the absence of baseline data it is difficult to define indicators. Valid baseline indicators are essential to enable time and location based comparisons. Some participants believe that the current monitoring system does not support valid, reliable, specific, measurable and time-framed indicators. Fragmentation in governance also affects our capacity to monitor as the expertise, infrastructure and technologies to monitor are used in many ways pursuing different objectives. The result is incoherent intelligence.

Data collection, integration and analysis

Participants discussed the institutional issues affecting integration and analysis of data. An enormous amount of data is collected and disseminated at various stages of control through pest mapping, citizen science and standardised data protocols. Data is generally obtained from reporting by multiple stakeholders pursuing control activities with varied objectives. A large amount of data is obtained from stakeholders but this data is spread across various government agencies, industries and non-government organisations. There are multiple data holders. The information is collected in different formats because of a lack of agreed standard data collection formats. A lack of agreement on data sets or a standard format for data-sharing affects data analysis.[581] Data that is sourced only through government institutions may leave gaps, omitting substantial information from other sources, including community stakeholders. There is no single institutional repository for relevant data.

Inconsistency between systems or methods for data collection and reporting makes it difficult for land managers and other stakeholders supervising properties in different regions to reliably compare impacts and resource inputs. Local governments often have incident reporting systems which collects some data. Data is also collected during implementation of control programs by public and private agencies. Since the information is not shared, it fails to provide a pool of information to assess overall performance of controls. Roles and responsibilities for managing and using the data are not clear. Many organisations are directly or indirectly involved in collection and collation of information, but it is not clear as to which organisations have primary responsibility for managing datasets. As a result of these institutional failings, potentially valuable intelligence is wasted.

Lack of realistic estimates

Participants explained difficulties in obtaining data on investments from public and private sources for pest animal control. Data on investments, particularly on private citizen in-kind contributions (eg, investment of time in writing grant applications and

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[581] Data analytics capability (Data analytics – What has happened, Descriptive analytics – Why something has happened, Predictive analytics (through modelling and data analysis) – What might happen in the future. For the meaning and literature on data analytics, see, Patrick Mikalef et al, 'Big Data analytics Capabilities: A Systematic Literature Review and Research agenda' (2017) *Information Systems for E-Business Management,* doi: 10.1007/s10257-017-0362-y.

installing control equipment) are not recorded. Even where some records are available, there are difficulties in quantifying in-kind investments because of a lack of a standard method to convert these inputs into an economic value.

Data on pest animal management involve many interrelated components, and intangible outcomes that are difficult to quantify. For example, quantitative assessment should cover: inputs (money), and outcomes (pest animals eradicated). Qualitative assessment should include: results in case studies, and expert opinions to fill gaps in quantitative assessments. Multiple sources of government funding make it difficult to quantify the investments made by each level of government. This restricts reliable evidence needed for an estimate of required future investments. The lack of a consistent framework for performance evaluation also makes it difficult to know the status of invasive animal control, the impacts of interventions or to estimate cost-benefits or future requirement of resources.

The absence of comprehensive data on community engagement limits reliable evaluation. For example, to measure the involvement of community stakeholders, two data sets are needed: a) the number of people who participated in creating a plan and b) the number of people who actively contributed and participated in implementation. It is easy to count the number of people who attended an event, but more difficult to assess their actual contribution. The lack of methods to collect information on people's actual contribution negatively affects objectivity of evidence about citizen action.

Performance measurement
Performance measurement is crucial for future investment decisions. To obtain objective performance evidence, the costs and benefits may have to be assessed for several years. There are difficulties in estimating the performance of the animal management system because of the involvement of multiple stakeholders across jurisdictions and agencies. Plans, strategies and annual evaluations report performance for local, regional and state level jurisdictions but they lack consistency. Participants in the workshops suggested that performance evaluation needs a comprehensive framework that evaluates the economic, environmental and social factors that influence pest animal management. Current frameworks used by agencies are not comprehensive enough to capture all the useful elements. Multiple sources,

including, agency corporate plans, strategies and annual reports, provide some information on performance but the formats are not consistent. The sources of these data and data formats vary, which makes it difficult to combine data to assess overall performance.

4.4.4 Theme 4 – Resources

Participants expressed serious concerns regarding the lack of resources for pest animal management. Resources for pest animal management come through government and private investments. The requirement for resources varies according to the goal of control and strategies required to deliver outcomes. Participants discussed the following two elements that constrain the availability of resources:

- Difficulties in securing government funds; and
- Inadequate human resources

Each of these elements is discussed in more detail below:

Difficulties in securing government funds

Participants stated that it is difficult to secure adequate funds from all the three levels of government. Government resources are based on funding models that target widespread pest species. The benefits of control operations may not be seen in the short-term but government funding criteria are based on demonstrating short-term outcomes. Short-term funding approaches result in 'shallow' outputs rather than managing invasive animal impacts.[582] Funding cycles were described as 'political or election based', with a duration of one to three years. The stop-start funding approaches are reportedly not effective for integrated pest control because of a) 'species-based' rather than integrated management approaches b) reactive rather than anticipatory approaches for managing impacts, and c) an excessive focus on new incursions rather than established pest animals. Owing to government's financial constraints these suboptimal approaches are expected to continue to drive funding. The emphasis of current arrangements is on meeting narrow funding criteria rather than whole-of-systems approach. The funding approach negatively affect capacity and commitment of stakeholders since it fails to induce confidence in stakeholders, because of a lack of assurance or guarantee of funds availability over the long-term.

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[582] One participant stated that the outputs are generally measured in terms of number of dead animals rather than addressing biodiversity impacts.

As pest animal management funds are generally made available as part of broader NRM funds, there is a risk that limited funds will be diverted into other NRM issues. A lack of political will for establishing and strengthening public-private relationships has been cited as a reason for the unavailability of long-term funds. Continued political will to support funding for invasive animal control and management was highlighted as an issue of critical concern.

Inadequate human resources

Participants expressed the need for competent and committed people, including control experts, facilitators and volunteers to address pest animal problems. The human resources requirement includes skilled staff with specific training (eg, training in implementing control techniques) and expertise (eg, managerial experience in 'nil-tenure approaches'). Participants stated that a lack of monetary resources affects the long-term availability of a skilled public service workforce (including facilitators and experts). Participants expressed concern about the decline in the available workforce for pest animal control activities, particularly pest animal management specialists and community volunteers.

The lack of resources for pest animal management is widely seen as a challenge.[583] The issue of resources has been consistently highlighted through policy documents and literature on pest animal management. Workshop participants were keen to see innovative approaches to address the problem through private funding strategies. It was considered important to identify the institutional issues that affect the availability of resources as a basis for more creative strategies to address the problem.

4.4.5 Theme 5 – Planning

The issues in planning that impede implementation of innovations were identified as:

- Lack of specific pest control objectives
- Lack of flexibility
- Lack of communications between the general community and invasive species control stakeholders

Each of these elements are discussed in more detail below:

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[583] Section 4.5 of this chapter indicates the policy documents that describe the lack of resources in pest animal management.

Lack of definite pest control objectives

Participants stated that the absence of clarity and consensus on control objectives create obstacles in planning. Defining a pest animal problem is the first stage in a solution-oriented agenda for action. The specific identification of the pest animal problem helps in determining the need for and guiding the flow of resources for control. The problem should be defined on the basis of available information (evidence) and rationality of arguments to justify control action. Participants expressed difficulties in finding control objectives that are agreeable to all stakeholders. Problems include: a) confusion over expected goals and approaches for pest animal management, b) lack of detailed scientific studies to determine control objectives, c) objectives based only on the control area and number of participants, d) lack of certainty about specific control approaches and actions, and e) 'narrow scoping' of the invasive animal problem and a lack of opportunity to 'redefine the scope during implementation.'

Lack of flexibility

Participants stated that current plans do not provide flexibility for adjusting actions. Plans do not adequately address long-term, short-term and emergency approaches to enable best management strategies. Plans rarely allow re-defining of the problem; to re-allocate responsibilities and resources to address events arising during implementation. 'Randomly adopted' short-term planning strategies affect community capacity and confidence for the period required for implementing effective plans. For example, when pest animals have already caused severe damage, control needs to shift to a crisis management exercise. In this situation, original plans with multiple social/environmental objectives should be redefined with short-term targets (eg, culling as many animals as possible). A change in objective does typically increase more cost and may have animal welfare implications as possible perverse outcomes.

Lack of community involvement

Participants stated that community involvement is not given sufficient consideration in planning processes. Planning is often driven by government stakeholders. During implementation, a government-led plan (objectives/outcomes) may conflict with the expectations of on-ground non-government stakeholders. The interests of stakeholders can deviate from the objectives/outcomes stated in a plan. Participants stated that a

lack of communication and involvement of community stakeholders negatively affects preparation of plans and their implementation.

4.4.6 Theme 6 – On-ground implementation

Implementation involves on-ground actions to achieve management goals that focus on reduction in number of pest animals or maintaining a reduced pest animal population. Control and management strategies significantly vary depending upon the context and goal of pest animal management. Participants noted that there are two particular contexts of on-ground implementation:

Individual implementation: Individual stakeholders who have invasive animal species on their lands are obliged to take control action. Individual stakeholders include public land managers, private landholders and landowners of private company. At the state/local levels individual stakeholders have an obligation to perform pest animal management control, and responsibilities under *the Biosecurity Acts*.[584] Landholders of both public and private lands have a primary role in the management of established pest animals:

- To detect and report new pest animal occurrences
- To control established pest animals, and to mitigate, as necessary, the impacts on their own assets, or as required by regulation.

Coordinated implementation: This context of on-ground implementation involves multiple stakeholders – based on the obligations as enshrined in the *Biosecurity Act 2015* (NSW)[585] as well as the *APAS*[586], these include;

- When an invasive animal population is widespread and well established, coordinated collective action by stakeholders is needed. Collaborative control approaches require effective stakeholder involvement and partnerships.
- Control actions in which individual stakeholders 'cooperate with and plan pest animal management activities jointly with neighbours, state, territory and local governments, industry within a landscape scale/cross-tenure approach'.[587]

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[584] *Biosecurity Act 2015* (NSW); *Biosecurity Act 2014* (Qld).

[585] The obligations vary by the state. In NSW, the obligation is, GBD as defined in *Biosecurity Act 2015* (NSW) pt 3, General Biosecurity Duty; In Queensland, the obligation is GBO as defined in *Biosecurity Act 2014* (Qld), ch 2, pt 1, General Biosecurity Obligation.

[586] Invasive Plants and Animals Committee 2016, above n 48.

[587] Ibid, prin 3.

- Control actions in which industry and community groups 'lead, promote and participate in collective action based on industry or community needs at a local, regional or national level to mitigate impacts of established pest animals on industry or community assets'.
- Control actions in which local governments 'manage pest animal problems on local government land in a responsible way, in co-operation with other landowners'.

Participants discussed the institutional difficulties that impede on-ground implementation of strategies involving pest animal management innovations:

- Accountability – Community's over-reliance on government, government's over-reliance on community/volunteers, a lack of coordination to ensure genuine shared responsibility
- Administrative arrangements – Regulatory and procedural requirements including licenses, training and satisfying complex procedures for funding
- Extension arrangements – Inadequate communications of best practices to stakeholders
- Participation – Lack of community engagement, inadequate political support, a lack of incentives, diverse attitudes, insufficient acknowledgement of citizen contributions, inadequate use of citizen science, and inadequate knowledge and awareness among stakeholders

Each of these elements is discussed in more detail below:

Accountability

Participants stated that implementation is significantly influenced by the resourcing capacity of stakeholders. Resourcing capacity affects the ability of government and non-government stakeholders to be effectively accountable for pest animal control. Historically, government has played a key role in pest animal management. Participants reported that this created an impression that it is government's responsibility to manage pest animals. There is a general tendency among non-government stakeholders to rely on government for investment and to lead or support on-ground action. 'Shared responsibility' and a more proactive role for land managers and community in implementing controls (with government as a coordinator) is a relatively new model of pest animal management. The shared responsibility approach

allows government managers to use both 'top-down' strategies and voluntary compliance approaches for pest animal control. In this approach, government delegates the control responsibility to community stakeholders and intends to impose liability on individuals in cases of inaction.

With adoption of the shared responsibility approach, participants believe that government has started moving away from its biosecurity obligations but without any consensus about how the resulting gap will be filled. Participants stated that the inherent problem with this approach is a lack of clarity and awareness amongst non-government stakeholders about the meaning of shared responsibility. The historical role of government in pest animal management means that non-government stakeholders are resistant to accepting pest animal control as their exclusive obligation. Government intends to steer on-ground action to rely more on non-government stakeholders. It is expected by stakeholders to lead to confusion among government and non-government stakeholders because they rely on each other to perform pest control. In this unresolved situation, stakeholders' expectations may not be realised in practice. This situation leads to two competing perspectives:

a) Non-government stakeholders claim that the government agencies do not provide adequate assistance for on-ground implementation. These include (for example) a lack of government support in the form of resources and extension services, non-willingness of local governments to get involved in control programs and the non-willingness of local governments to support communities in pest animal management.

b) Government stakeholders argue that a lack of cooperation and non-compliance by the broader community is a major barrier to effective implementation of pest animal control. Problems include a lack of cooperation from stakeholders in performing biosecurity obligations (sharing information about pest animals and pest control measures on their land or properties, providing access to inspect properties, non-fulfilment of responsibilities by pet owners to confine pets to their properties).

Administrative arrangements

Participants stated that processes of the administrative agencies constrain on-ground implementation of control. These problems include:

a) Procedural requirements

Administrative and procedural requirements make it difficult to access institutional support and flexibility for effective on-ground action. An example is the requirements for licenses and training for the use and application of poisons. Mandatory procedural requirements for funding are time consuming and labour intensive. The government departments administering them are reportedly understaffed and under resourced. Coordination requires effective planning and better communication with stakeholders. Complex regulations and bureaucratic processes also make it difficult for agencies to explain control processes to landholders. Complicated forms are not often filled-out properly by landholders, owing to confusion in understanding intricate information or questions. The processes impose substantial transaction costs on all stakeholders.

b) Permissions to secure emergency resources for emergency control

Local government staff are reportedly not allowed to use public money without a formal application process. This involves permissions and approvals at various levels. This delays provisioning of resources for urgent on-ground operations. Local government relies on fees and charges to raise financial resources for pest animal control activities, and levying fees and charges requires regulatory approval from local council. Many regulatory requirements have to be fulfilled at every stage for generating or utilising financial resources. This institutional issue retards urgent control actions.

Participants supported procedural regulations in devolving government grants for pest animal control (eg, compliance with financial instruments was considered as an important aspect of due diligence) but report that the paperwork demands lots of information. Compliance processes also create difficulties including employing additional staff for implementation of control programs. Participants stated that multiple layers of administration at local and state government levels delay the availability of resources for on-ground action.

c) Complex procedures for funding

Participants stated that non-government stakeholders have to go through bureaucratic processes that are in-efficient. For example grant and funding applications involve lengthy paperwork. These processes are perceived as overtly strict measures

inhibiting 'speedy control' and they can lead to community antagonism to Government officials. Excessive bureaucracy reportedly reduces people's motivation to initiate control. Other difficulties include restricted access to control techniques, for example the non-availability of baits in feed stores, lack of facilities to hire traps, and lack of access to cameras for monitoring.

    d)   Inadequate communications by extension services

Participants stated that landholders are often unaware of the seriousness of the pest animal problem. Lack of awareness is typically more pronounced in urban and peri-urban areas because small-scale producers, hobby farmers and citizens in these areas are generally disconnected from traditional agricultural networks and lack understanding of invasive animal problems. Because of a lack of understanding (eg, the severity and urgency of invasive animal control action, and of the best control approaches including integrated pest control), these stakeholders can have an attitude of carelessness towards pest animal issues. It was opined that the majority of peri-urban dwellers adore invasive animals (eg, wild deer) rather than recognising them as pests. This leads to inaction and opposition to those who are proactive in implementing control. The role of extension services should be to create awareness amongst these stakeholders through information. The following issues relevant to extension services were identified through workshop observations:

    i)   Knowledge and information about pest control exists only in silos. It is dispersed within organisations and groups (for example within research organisations or local baiting groups). Inadequate transfer of knowledge at national-state/territory-regional-local levels inhibits on-ground innovation.

    ii)   Extension services increasingly emphasise communication through digital and social media. (For example information on invasive animal impacts, scientific research findings and best practice management; and online video series on rabbit control on best practice rabbit control). Over-reliance on digital communication and reduced face-to-face interactions between extension personnel (including facilitators) and the community negatively affects knowledge transfer of practical knowledge and information on how to use control techniques, their effectiveness, applicability, selection criteria, access, and use. A lack of precise information on control techniques leads to

misconceptions, creating a knowledge gap about the use of available technologies.

iii) Communication strategies are used to educate, create awareness and understanding among stakeholders to achieve the involvement of stakeholder groups. Both electronic and social media platforms are used. These platforms sometimes spread biased or misleading information about control techniques, which can create outrage over a control action (particularly during a large-scale control program coordinated by the government). Examples include animal welfare 'scares' about the control of feral horses, wild dogs or feral cats.

Participation

Participants stated that stakeholder participation is necessary for pest animal management given the increasing role of non-government stakeholders in funding and conducting on-ground action, and the limited role of government as coordinator (the shared responsibility approach). The following institutional issues were said to constrain participation:

a) Community engagement

Participants identified the following reasons for the lack of effective community engagement in pest animal management:

i) Community engagement is considered as a strategy prescription by government agencies. The notion of community engagement is often discussed in policy documents but, in practice, inclusive forms of governance and broader social participation have been largely ignored. Current pest control policies use the rhetoric of 'engagement' but programs are based on 'top-down' philosophies and 'science push' models of communication where information-based traditional extension (eg, delivery of information through digital technologies and social media tools) is most often practised.

ii) Community engagement is not governed by any legal principle or standards.

iii) Implementing innovations in community engagement is difficult because of multiple and incoherent terms and varied methods and approaches used for engagement.

iv) The lack of institutionalisation of participatory norms and expectations (eg, clear administrative and procedural mechanisms to share power) makes it difficult to reliably implement community engagement in practice.

b) Inadequate political support for community-led actions. This includes political support for ill-informed animal welfare 'scares'.

Participants stated that the capacity of stakeholders to implement control primarily depends upon socio-economic resources. Political support plays a key role in increasing the capacity of communities by directing resources and raising awareness and concern about invasive animals. Political commitment is essential to achieve invasive animal management but support is insecure, sporadic and volatile depending on often competing socio-economic interests. This limits the continuity of control programs and negatively affects stakeholder participation.

c) Lack of incentives

Incentives play an important role in encouraging stakeholders to participate in control. A lack of resourcing makes it difficult for government to provide financial incentives. Additionally, government decisions can have an adverse effect on the availability of incentives (eg, ban on rabbit or fox fur trade and the absence of bounty system has reduced the incentives of recreational shooters).

d) Diverse attitudes

The requirement of context-specific control and the varied priorities of stakeholders create complexities for individuals as well as for coordinated control. Social and psychological dynamics (values, interests, motivations) and the resultant social conflicts[588] negatively affect community participation. The motivations of individual groups are different and require appropriate strategies for behaviour management.[589] Current community engagement approaches fail to effectively address the increasingly complicated social and psychological dynamics among stakeholders.

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[588] In the case of invasive animal management, social conflict can be characterised as the conflict between animals and landholders as well as conflict between and among stakeholders – social conflicts inherent in conservation issues.

[589] Orbits of stakeholder participation suggested for wild dog management by Greg Mifsud, the National Wild dog facilitator. The orbit suggests six categories: Defeatists, Storytellers, Experts, Cynics, Activists, and Withdrawers of stakeholder groups; Reference - Notes from Community of Practice Meeting, A project under the National Wild Dog Action Plan (25th February 2016, Armidale, NSW).

e) Citizen contributions

Invasive animal control programs demand a long-term commitment from stakeholders. Trust building among stakeholders requires consistent dialogues and good-faith negotiations that motivate and persuade stakeholders to implement control. Current approaches are reported to often configure pest animal problems as transactional. Approaches are usually negotiated for short-term control outcomes. The language of pest animal management policy may evince contention rather than inclusion (eg, some members of the community are identified as risk creators) which affects the spirit of 'true engagement' in control programs.

f) Use of citizen science in pest animal management

Community involvement brings knowledge and information for formulating policies and plans. It also helps raise awareness about invasive animal issues. According to participants, current institutions do not effectively optimise community knowledge and experience. The experience of land managers in dealing with pests is a valuable resource but government programs reportedly adopt top-down approaches that ignore community resources and skills. Citizens feel they are not treated as a valued partners in implementing control. Community information is not being adequately channelled and utilised. This is evident from the following issues:

i) Inadequate mechanisms for citizen reporting: An absence of a community reporting system was identified as a major hurdle for meeting data and informational requirements.

ii) Participation without decision-making powers: Efforts to involve communities through public consultation processes at the local government levels are limited. The objective of communication platforms (eg, consultations, meetings, discussion forums, negotiation committees) should be to facilitate discussion between communities and government, to create shared understanding and to develop shared action plans, but the decision-making power rests with the government. A lack of community involvement in decision making affects perceived legitimacy and transparency of decisions.

4.5 Additional issues – invasive species

This section describes the outputs from desktop study for each theme discussed

4.5.1 Theme 1 – Control technologies

In Australia, there is an overall push for innovations through national policies, but pest animal management innovation is not addressed in the national innovation agenda.[590] Pest animal management innovation requires research capabilities in science, technology and regulatory approaches.[591] The literature highlights that innovative research to improve mechanisms for adoption of knowledge is required for effective pest animal management.[592] Stakeholders in pest animal control innovation include research organisations, industry, universities and individual researchers.[593] Innovation models for pest animal management research emphasise partnerships among research stakeholders, particularly industry and businesses.[594] Collaboration between research agencies and industry is not strongly evident in practice.[595] Amongst the OECD countries, the rate of collaboration between industry and researchers is the lowest in Australia. Australia also lags on OECD measures for industry collaboration in research.[596] A lack of emphasis on shared governance practices leads to failures in delivering appropriate research to regulators and policy-makers.[597] Institutional issues relevant to research and innovation identified by workshop participants were consistent with the findings of the IGAB Review.[598]

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[590]Commonwealth of Australia (2015), above n 571.

[591] Campbell (2011), above n 250.

[592] Ibid; Kate Andrews, *Knowledge for Purpose – Managing research for Uptake – A Guide to a Knowledge and Adoption Program* (Australian Government, Department of Sustainability, Environment, Water, Population and Communities, 2012).

[593] Department of Agriculture and Water Resources, above n 588; National Primary Industries Research (2009), above n 570.

[594] Campbell (2011), above n 250.

[595] Department of Agriculture and Water Resources, above n 588; National Primary Industries Research (2009), above n 570.

[596] OECD (2014), The Governance of Regulators. In *OECD Best Practice Principles for Regulatory Policy* (OECD Publishing, Paris) <http://dx.doi.org/10.1787/9789264209015-en>; Australian Research Council reports give an overview of research performance by Australian Higher Educational Institutions <http://www.arc.gov.au/era-reports>.

[597] M A Burgman, 'Governance for Effective Policy-Relevant Scientific Research: The Shared Governance Model' 2015 *Asia and the Pacific Policy Studies*.

[598] Craik et al 2017, above n 5.

4.5.2 Theme 2 – Governance arrangements

Workshop observations revealed a multiplicity and fragmentation of institutional arrangements. Desktop research was conducted to explore this multiplicity of institutional arrangements using a three-step process (as described in Chapter 3, section 3.3.2). The desktop research on institutional arrangements covered new biosecurity legislation, The *Biosecurity Act 2015* (Cwth) and the relevant legislative changes in Australian states/territories and roles and responsibilities for pest animal management. The introduction of new biosecurity legislation has not substantially changed the nature of institutional issues identified through workshop observations.

The research involved identification of agencies, agreements, laws, policies, strategies, private or non-binding arrangements and plans relating to invasive animal management at the commonwealth, state/territory and local levels of government. The cumulative three-step process led to the preparation of 'Resource on Australian Laws, Regulations, Policies and Programs'. The final copy of this resource is included in Appendix 1.1. The research contributed was provided to the NSW Natural Resource Commission review: Paul Martin and Vivek Nemane, *Review of Australian Invasive Animals Laws*, NSW (Natural Resources Commission, July 15 2015 (unpublished)). A copy of this submission is included in Appendix 1.2.

4.5.3 Theme 3 – On-ground implementation

The regulatory issues for on-ground implementation of innovations identified through the desktop study are:

- Liability
- Community expectations
- Animal welfare

Each of these elements is discussed in more detail below:

Liability

The accountability for pest animal management involves fulfilling responsibilities by stakeholders. Managerial responsibilities can be shared or devolved to specific stakeholders'.[599] Owing to multiple interpretations, 'responsibility' lacks conceptual

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[599] D J Decker and L C Chase 'Human Dimensions of Living with Wildlife: A Management Challenge for the 21st Century' (1997) 25(4) *Wildlife Society Bulletin* 788.

clarity and uniform definition[600] in law[601] and more broadly in governance.[602] *APAS* describes responsibility in pest animal management as shared when land holders need to work together and partner with industry and community groups, and with local and state governments, to effectively reduce the impacts created by pest animals.[603] It is described as a collaborative effort which 'brings multiple stakeholders together in common forums with public agencies to engage in consensus-oriented decision making'.[604] To this end, roles and responsibilities are created within the framework of legislation which create obligations for stakeholders to perform certain duties. However, stakeholders are unclear about the specifics of this responsibility sharing. Workshop participants discussed how limited capacity (resources) leads to a conflict between government and non-government stakeholders about who should be accountable for pest animal management.

Pest animal management is currently regulated by the GBO in NSW and QLD.[605] Devolving the biosecurity duty to landholders, presumes that landholders would be largely responsible for the control of established invasive animals, allowing government to direct the resources towards new invasions. But such a presumption may not prove to be effective for invasive animal control.

Where supervision is difficult, it is hard to establish accountability and expect the fulfillment of the control obligations. On-ground pest animal control lacks moral and legal standards that clearly define obligations and liabilities. The legal principle helps in articulating obligations and liabilities but the effectiveness of legal principle depends on risk accountability and values. Accountability can be described as the liability for unexpected results from any action[606] which gives rise to legal

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[600] Giddens (1999), above n 495.

[601] A E Auhagen and H W Bierhoff, 'Responsibility at the Beginning of the Third Millennium' in A E Auhagen, and H W Bierhoff (eds) *Responsibility. The Many Faces of a Social Phenomenon* (eds.) (Routledge, 2001) 179; P Cane, *Responsibility in Law and Morality* (Hart publishing, 2002).

[602] L Pellizzoni, 'Responsibility and Environmental Governance (2004) 13 *Environmental Politics* 541.

[603] Invasive Plants and Animals Committee (2016), above n 48, prin 5.

[604] Chris Ansell and Alison Gash, 'Collaborative Governance in Theory and Practice' 2008 18(4), *Journal of Public Administration Research and Theory* 543 <https://doi.org/10.1093/jopart/mum032, page number 543>.

[605] See table 2.3 in chapter 2.

[606] Pellizzoni (2004), above n 602; L A Witt, *Responsibility in Work Organisations* in A E Auhagen and H W Bierhoff (eds), *Responsibility. The Many Faces of a Social Phenomenon* (Routledge, 2001) 139.

liability[607]or social liability[608]. Martin highlights the problem of relying on a biosecurity duty to allocate legal liabilities for pest animal management.[609] The problem is rooted in the framing of the biosecurity duty akin to a civil liability. A biosecurity duty is a regulatory approach based on a broader framework of duty of care in the common law. The common law of Australia is built on the foundation of protection of private property rather than sustainable management of natural resources.[610]

In Australia, the Productivity Commission proposed an Environment Duty of Care (EDOC) as an environmental management instrument.[611] The Commission recommended that the EDOC be defined in legislation to 'require everyone who influences the management of the risk to the environment to take all reasonable and practical steps to prevent harm to the environment that could have been reasonably foreseen'. QLD, Victoria, South Australia and Tasmania have legislated an EDOC in the form of a statutory duty of care.[612] Shepheard notes that, in common law, the statutory 'duty of care' does not create higher standards of behaviour.[613]

In pest animal management, the new legal obligation is upon landholders who have a responsibility for managing pest animal species that can impact on their assets (or those of other landholders) or those pest animals they are required to manage by regulation. This suggests that there is no wider public EDOC requiring landholders to manage nationally significant pest animal species. This lacuna may provide an escape from the biosecurity duty by landholders who are not directly affected by pest

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[607] Cane (2002), above n 601.

[608] K G Shaver and D A Schutte, 'Towards a Broader Psychological Foundation for Responsibility: Who, What, How' in A E Auhagen and H W Bierhoff (eds), *Responsibility. The Many Faces of a Social Phenomenon* (Routledge, 2001) 35.

[609] Paul Martin, Decision Rules and the Implementation of Innovative Regulation, (draft article, unpublished).

[610] G Bates, 'A Duty of Care for the Protection of Biodiversity on Land' (Consultancy Report to the Productivity Commission. AUSInfo. 2001).

[611] Ibid.

[612] M Shepheard and P Martin, 'The Multiple Meanings and Practical Problems with Making a Duty of Care Work for Stewardship in Agriculture' (2009) 6(1) *Macquarie Journal of International and Comparative Environmental Law* 191.

[613] M Shepheard, *The Duty of Care, an Ethical Basis for Sustainable Natural Resource Management in Farming? Defending Social License Farming* (CSIRO Publishing, 2011). For eg, in QLD, a duty of care for the environment has been incorporated in Environmental Protection Act 1994 (Qld) s. 319 General Environmental Duty; and Land Act 1994 (Qld) s. 199 Duty of Care Condition.

animals. In the absence of a wider obligation, it may be difficult to compel landholders to perform their biosecurity obligations for pest animal management.[614]

The duty of care has its roots in the common law, specifically with the law of tort.[615] In pest animal management, the landholder harbouring pest animals on their property and not taking any action theoretically has a statutory liability. The law provides a mechanism for civil liability of landholders who fail to control pest animals on their lands[616] but landholders are not clearly accountable for omissions. The liability for negligence in tort law is based on: a) Liability cannot arise until it is established that the person owed a duty to someone for that negligence (existence of a duty), and b) there was a failure to observe the standard of care and that failure has caused harm which was reasonably foreseeable.[617] For civil liability, a proven link between the action and harm is required to establish responsibility. The involvement of multiple actors create problems in proving individual failures of responsibility. Due to the 'wicked' nature of invasive animal problem, it is difficult to establish a link between the specific stakeholder's inaction and its effect or to link accountability to a specific individual whose decision or negligence has caused problem. This shifts responsibility either to another citizen who suffers loss or to the community as a whole.

In peri-urban areas the problem may span different land titles and land uses. A duty of care approach may fail to provide clear accountability in practical terms for landholders' inaction.[618] Individual landholders or peri-urban dwellers who neglect their biosecurity duty to control invasive animals or do not participate in coordinated control, may not be held liable owing to enforcement difficulties in proving their inaction.

The application of polluter pays principle is problematic in pest animal management. It is a duty of the local authority to detect the presence of a pest animal causing a

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[614] Martin (unpublished), above n 609.

[615] Shepheard and Martin (2009), above n 612; M Shepheard and P Martin, *A Statutory Duty of Care and Farmers' Natural Resource Management* (Paper presented at the XXV European Congress and Colloquium of Agricultural Law, 2009).

[616] Marc L Miller and Robert N Fabian (eds), *Harmful Invasive Species - Legal Responses* (SR, 2004); Shine et al (2000), above n 14.

[617] *Donoghue v Stevenson* [1932] AC 562, 618–619.

[618] Department of Sustainability and Environment, 'Land and Biodiversity at a Time of Climate Change' (Green Paper, Melbourne VIC Australia, 2008).

significant harm or posing a significant risk of harm. A local authority is entitled to demand that landholders who haven't taken any action despite the presence of pest animals on their land and landholders who are temporary occupiers or owners of the land where invasive animals are present to take action. Allocation of costs rather than imposing liability is the original objective of the polluter pays principle. As per the polluter pays principle, the landholder is exclusively liable for managing invasive animals on their land. The constant mobility of pest animals suggests that the neighbouring landholders can be indirectly responsible for allowing pest animals to escape from their land. In principle, these landholders should share the burden of pest animal management. The effectiveness of control and managerial action depends upon the weakest link in the management system and institutions are an integral part of it. One of the major problems is poorly coordinated cross-tenure action in which non-participation by a few private property owners leads to the re-establishment of surviving pest animal populations in adjoining properties once the control program is over.[619] Establishment of appropriate standards through legal reform is the solution but the legal enforceability of biosecurity obligation as a regulatory approach has not been evaluated so far.[620]

Animal welfare regulations

Pest animal control is influenced by animal welfare regulations. Animal welfare regulations are based on two categorisations of animals. According to the first category, animals as objects of property should be managed in humane ways that minimise the pain and suffering while implementing control. The second category seeks to impart legal rights to animals on the basis of animals akin to legal persons.[621]

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[619] For example see A Bengsen, 'Effects of Coordinated Poison-Baiting Programs on Survival and Abundance in Two Red Fox Populations' (2014) 41(93) *Wildlife Research* 194.

[620] Shephard and Martin (2009), above n 612; Bates (2001), above n 610; A Gardner,' The Duty of Care for Sustainable Land Management' (1998) 5 *Australasian Journal of Natural Resources Law and Policy* 5 29; Productivity Commission, *Constraints on Private Conservation of Biodiversity.* (2001).

[621] Animal rights argument seeks to secure fundamental rights for animals on the basis of their needs and capabilities, see David Glasgow, 'The Law of the Jungle: Advocating For Animals in Australia' (2008) 13(1) *Deakin Law Review* 181; David Fagundes, 'What We Talk About Persons: The Language of a Legal Fiction' (2001) 114 *Harvard Law Review* 1745; Animal welfare arguments proposes that animals should be treated humanely despite their current categorisation as property in Australian Law: Derek W St Pierre, 'The Transition From Property to People: The Road to the Recognition of Rights for Non-Human Animals' (1998) 9 *Hastings Women's Law Journal* 255.

Animal welfare regulations seek to reduce unnecessary pain and suffering of animals.[622] Despite innovations in control techniques, animal welfare risks are prevalent in control techniques. For example poisons/chemicals can lead to suffering in target/non-target animals. Animal welfare regulations therefore put limits on the use of control methods against pest animals.[623] Regulations are inadequate in addressing the diversity of values and interests involved in pest animal management. Despite the animal welfare and humane control guidelines, stakeholders may have ethical objections to the use of control methods. These values influence law and policy of pest animal control.[624] Animal welfare issues are also politically contentious, which is evident through political lobbying, media criticism[625] and action over animal welfare issues. Individuals as well as animal welfare groups may oppose control measures because of uncertainties and controversies, including scientific uncertainties, regarding the welfare effects of control measures. Examples from the literature include:

- The RSPCA's opposition to pig hunting in Queensland.[626]

- Wool Producers of Australia's opposition to the ban on 1080.[627]

- Restrictions on gun use for pest animal control.[628]

- Participation.

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[622] For eg, anti-cruelty legislations.

[623] RSPCA, Policy E02 Management of Wild Animals (2010) [2.3] <http://kb.rspca.org.au/rspca-policy-e02-management-of-wild-animals_422.html>; Australian Animal Welfare Strategy (AAWS) and National Implementation Plan 2010-14, For exemptions, see *Animal Welfare Act 2002* (WA) s 24; Codes of practice (Agvet Codes – *Agricultural and Veterinary Chemicals Code Act, 1994* (Cth) Agyet Codes, provides statutory powers to the APVMA for the regulation of agricultural and veterinary chemicals in Australia for animal welfare and provide limited protection to the invasive animals; House of Rep. (2005), above n 79, recom 46.

[624] *Animal Liberation v Conservator of Flora and Fauna* [2009] ACAT 17; *The Australian Society of Kangaroos v the ACT Conservator of Flora and Fauna* (AT13/00041); *Animal Liberation ACT v Conservator of Flora and Fauna* (Administrative Review) [2014] ACAT 35.

[625] M Fyfe, 'In Wild Dog Country, all Death is Merciless' 7 December 2008 *The Age (Australia)*; RSPCA Victoria, *Victoria's Shame – Wild Dog Trapping*, 2009.

[626] A Edwards, *RSPCA Urges Queensland Government to End 'Gruesome' Illegal Pig Hunting. ABC News* <http://www.abc.net.au/news/2015-10-25/rspca-calls-for-end-to-illegal-pig-hunting-central-queensland/6858646>.

[627] Wool Producers Australia, *WPA Continues Support for 1080*, 2011 <http://www.woolproducers.com.au/media-releases/?news=179>.

[628] I Townsend, 'Guns Are Back (audio)' *ABC Radio National*, 2012 <http://www.abc.net.au/radionational/programs/backgroundbriefing/guns-are-back/3725866>.

The APAS priority 2.3 recognises the role of citizen participation in coordinated management.[629] Coordinated action for on-ground implementation of control requires the support of stakeholders who often hold different views about pest animal management.[630] It requires the support of the 'right people, at the right time and place, motivated and able to do the right thing'.[631] Participation of stakeholders is critical for the adoption and implementation of innovations. Participatory approaches recognise the pivotal role of citizens and communities.

Stakeholders' participation in pest animal management varies according to their level of interest. Stakeholders in pest animal control can be categorised as: stakeholders who are aware of pest animal problems, watchers, reviewers, advisors, creators, deciders.[632] Institutions play an important role in facilitating participation of each of these stakeholders.

Transparency, accessibility and integrated communication are essential for creating awareness. Reviewers are more likely to engage and respond based upon the set of available options. For example, the availability of control measures may quicken the response of reviewers. Advisors are active in implementation but from a distance. Genuine advisors provide key advice and suggestions during the engagement process. During the implementation process, knowledge and ideas are created directly or indirectly by the people interested and passionate about the work. Institutions are supposed to optimise and facilitate this creativity by rewards or by incentives to these creators. Successful outcomes depend not only upon the participation but also the way in which decisions and actions are taken by the stakeholders. Decision-making thus shapes the outcome and impacts future implementation. Regular consultations between multiple stakeholders (including managers and social scientist and ethicists) have been recommended to foster understanding on pest control issues and thus to improve management decisions for invasive animal control. Active involvement of communities requires true partnership between government and communities through recognition of capacities, mutual respect for expertise and equity in sharing power.

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[629] Invasive Plants and Animals Committee (2016), above n 48, prin 2;
[630] Ibid, prin 1.
[631] Paul Martin et al, 'Improving Invasive Animal Institutions: A Citizen Focused Approach, (report prepared by as part of the Invasive Animals CRC Program 4E3 Facilitating Effective Community Action Project) 24.
[632] Orbits of stakeholder participation, Greg Mifsud

Community organisations and volunteers play an important role in monitoring and generating knowledge through citizen science,[633] An example is the *Atlas of Living Australia* (ALA)[634] and *Biodiversity Volunteer* portal[635] which capture data from community monitoring programs. ABARES, however, notes there are constraints to volunteer participation: maintaining volunteer interest and commitment, provision of resources, the objectivity of citizen science and knowledge, risks relating to health and safety of volunteers, as well as the absence of a well-planned, cautious, scientifically rigorous and training based approach.[636]

When the participation demands ongoing action and investment, commitment and result-oriented action from stakeholders, it implies engagement instead of mere consultation.[637] Engagement in pest animal management is based on the idea of collaboration that 'brings multiple stakeholders together in common forums with public agencies to engage in consensus-oriented decision making'.[638] Figure (4.4) illustrates the types of engagement and the role of institutions in facilitating participation in pest animal management.

In 'small-scale, low risk' control programs, the participation of a few stakeholders is required, where there are less chances of conflicts and disagreements among the participants. For such control programs, engagement requires information, consultation, involvement and partnerships (See Figure 4.4 - type of engagement a,b,c and d). For 'large-scale, high risk' control programs, the involvement of multiple stakeholders without whose participation it is impossible to realize the control objectives is required. There are high probabilities of conflict between stakeholders

[633] T Kadoya, 'Using Monitoring Data Gathered by Volunteers to Predict the Potential Distribution of the Invasive Alien Bumble Bee *Bombus terrestris'* (2009) 142(5) *Biological Conservation* 1011; J Silvertown, 'A New Dawn for Citizen Science' (2009) 24(9) *Trends in Ecology and Evolution* 467; J Cohn, 'Citizen Science: Can Volunteers do Real Research?' (2008) 17 *Society and Natural Resources* 1; D Brossard, B Lewenstein and R Bonney, 'Scientific Knowledge and Attitude Change: The Impact of a Citizen Science Project' (2005) 27(9) *International Journal of Science Education* 1099.

[634] *Atlas of living Australia* (ALA) <https://www.ala.org.au/>.

[635] *Biodiversity Volunteer portal* <https://volunteer.ala.org.au/>.

[636] R Clarke et al, 'Volunteer Monitoring in Biosecurity: An Issues Paper, (Research Report 12.9, CC BY 3.0, ABARES, 2012) <http://data.daff.gov.au/data/warehouse/9aas/2012/vmibsd9aaps20120803/RR12.09VolunteerMonitoring_v1.0.0.pdf>.

[637] H Aslin and V Brown, 'Towards Whole of Community Engagement: A Practical Toolkit' (Murray-Darling Basin Commission, Canberra, 2004).

[638] Ansell and Gash (2008), above n 604, 543.

where the engagement process requires mobilisation and empowerment (Figure 4.4: e). The literature on community engagement recognises the importance of community mobilisation and empowerment;[639] for example, community-led planning approaches, in which communities develop management plans along with the government facilitators. Community engagement is made more difficult because of multiple and incoherent terms for and methods of engagement.[640]

	Type of engagement	Description	Examples of tools	Level and longevity of engagement	
Shallow	a. Inform: one-way communication Message giving	Advertising, education	Newsletters, media, brochures, letters, websites	Passive	Non-ongoing
	b. Consult: one- or two-way communication with decision-making not resting with community	Information gathering, reporting	Toll-free numbers, public meetings, surveys, focus groups, panels	Increasing level of engagement	Increasingly self-sustaining nature of engagement
	c. Involve: creating shared understanding and solutions pursued by one partner only	Community consultation and involvement	Community advisory groups, joint planning groups, forums		
	d. Partner: developing shared action plans through collaboration	Community participation and negotiation	Community management committees, workshops, negotiation processes		
Deep	e. Mobilise and empower: people take independent initiatives and develop contacts with external institutions for resources and advice	Self-direction planning with limited support through governance arrangements	Action plans developed and implemented by the community with access to experts and resources available through government	Proactive	Ongoing

Figure 4.4: The engagement continuum
(Source: Braysher, 2017)

4.6 Conclusion

In this chapter, IACRC workshop observations followed by desktop study helped in identification of institutional issues for innovation adoption/implementation. Drawing on the scoping study, Table 4.1 consolidates the list of institutional issues identified.

The institutional issues identified in this chapter form the basis of peri-urban specific investigation. The next stage of this thesis is to explore peri-urban specific institutional issues through selected case studies.

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[639] Thompson (2009), above n 299.
[640] T Howard, 'The "Rules of Engagement": A Socio-Legal Framework for Improving Community Engagement in Natural Resource Governance' (2005) 5 (5) *Oñati Socio-legal Series* [online] 1209.

Table 4.1: List of institutional issues for scoping study

Theme	Issues	Elements
Control technologies	Innovation/adoption of control technologies	Inadequate resources Inadequate research partnerships and coordination Difficulties in regulatory approvals Cost-effectiveness
Governance arrangements	Legislation	Difficulties in identification of pest animal species Duplication of laws Spill-over effects from other legislations Lack of human behavioural considerations
	Policies	Lack of clarity on shared responsibility Lack of integrity among policies Lack of policy performance indicators
	Plans	Multiple plans
	Programs	Multiple programs
	Agencies	Multiple agencies with separate mandates
	Roles	Diverse roles and responsibilities affecting collaboration Gap in responsibilities and allocated resources
Evidence	Pre and Post control evidence	Problems in availability of data and information Lack of effective monitoring Difficulties in data collection, integration and analysis Difficulties in obtaining realistic estimates Difficulties in measuring performance Difficulties in quantifying perceived impact Inadequate reporting Absence of tools to test veracity of received information Absence of tools and methods to assess data Lack of adequate methodologies to evaluate performance
Resources	Lack of financial and human resources	Lack of adequate government investment Lack of clear estimates Lack of transparency in investments Inadequate human resources
Planning	Lack of effective planning	Lack of definite pest control objectives Lack of flexibility Lack of communications with general community/stakeholders
On-ground implementation	Accountability	Community's overreliance on government Government's overreliance on community/volunteers Lack of coordination for shared responsibility

Theme	Issues	Elements
	Administrative arrangements	Regulatory and procedural requirements including licenses, training, complex procedures for funding
	Extension arrangements	Inadequate communications with stakeholders
	Laws and regulations	Liability Enforcement and compliance Community expectations Animal welfare
	Participation	Lack of community engagement Inadequate political support Lack of incentives Diverse attitudes Acknowledgement of citizen contributions Inadequate use of citizen science Inadequate knowledge and awareness among stakeholders

CHAPTER 5: LEGAL AND INSTITUTIONAL ISSUES – CASE STUDIES

5.1 Introduction

The previous chapter identified institutional issues that constrain adoption and implementation of innovations for pest animal management. This scoping work was not specific to peri-urban areas. This chapter focuses on the specific context of peri-urban areas

a) To identify legal and institutional issues affecting adoption and implementation of pest animal management innovations;

b) To determine whether the broader set of institutional issues from the scoping study in chapter 4 match peri-urban specific institutional issues; and

c) To better understand the peri-urban institutional impediments and issues in practice, based on frontline experience

To develop this context-specific understanding, the researcher developed two case studies: wild deer management in PUS and wild dog management in PUB. Chapter 2 (section 2.4) described the background of these case studies. This chapter explores the two case studies, describing the pest animal management approaches and governance arrangements in PUS and PUB respectively. These explorations discuss relevant institutions, drawing on perspectives from those involved in and affected by the institutions. The focus of these case studies is to present evidence of 'how things are' in terms of pest animal management, and the ways in which institutional frameworks affect adoption and implementation of innovations. Recapping from Chapter 2, the innovations considered in each case study are summarised in Table 5.1. The case study evidence includes policy documents, news articles, legislation, regulations and interviews to explore the institutional issues. Section 5.2 and 5.3 encapsulate the discussion on selected case studies.

I begin each case study with an overview of the relevant pest animal management approaches and governance structure. I then draw on desktop research,[641]

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[641] Desktop research – legislation, policy documents, reports, news articles, other articles

documentary evidence from data collection[642] and interviews[643] to describe the institutional issues in each case study.

Table 5.1: Innovations considered in each case study

Innovations for wild deer management in peri-urban Sydney	Innovations for wild dog management in peri-urban Brisbane
• Control technique: Ground shooting • SOP for ground shooting: DEE001 • Data gathering and analysis - Mapping technology: DeerScan • Community engagement • Enforcement of the *Biosecurity Act 2015* and other existing laws for wild deer management	• Use of PAPP in conjunction with the mechanical ejector • Operating procedures for wild dog management • Data gathering and analysis - Use of WilddogScan for monitoring • Coordinated nil-tenure control and Community engagement • Enforcement of new and existing laws for wild dog management

Throughout the case study discussion, I provide evidence and quotes from stakeholders (see Table 5.2) I interviewed to illustrate their views on the institutional aspects of pest animal management.

Table 5.2: Key informants

Name	Role/expertise
Key informant 1	Committee member of an NGO interested in the management of wild deer in Royal National Park
Key informant 2	Government biosecurity and wild dog management expert employed by a local government in peri-urban Queensland
Key informant 3	Government biosecurity and wild dog management expert employed by a local government in peri-urban Queensland.
Key informant 4	Pest animal management expert for an agriculture industry
Key informant 5	Senior Pest Management Specialist employed by a local government in peri-urban Queensland.
Key informant 6	Biosecurity consultant/ Ex - pest animal management facilitator
Key informant 7	Government biosecurity expert employed by the State government in Victoria (Department of Economic Development, Jobs, Transport and Resources, Casterton, Victoria).
Key informant 8	Government biosecurity expert employed by the State government in Victoria (Department of Economic Development, Jobs, Transport and Resources, Casterton, Victoria).

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[642] Policy documents, draft plans, minutes of the meeting
[643] These involved conversations and semi-structured interviews with the key informants (see table 5.2).

Key informant 9	Government biosecurity and pest animal management expert employed by the State government in NSW.
Key informant 10	Government biosecurity and pest animal management expert employed by the State government in WA.

5.2 Case study 1 – Wild deer management in peri-urban Sydney

5.2.1 Overview of management

This section gives an historical overview of deer management approaches. It summarises the legislation, strategies, structures and organisations involved in deer management in PUS. The exploration of this study was initiated through a conversation with the key informant 1, who provided background documents and many contacts relevant to deer management in peri-urban Sydney and had been deeply involved in the wild deer management issues for more than two.

The case study area of PUS includes the Royal National Park (RNP) and its surrounding areas. The description of PUS has been provided in Chapter 2. The RNP was originally managed by the National Park Trust. Its objective was to create a place for recreation.[644] To achieve this purpose, the Trust infused various improvements by planting trees, developing gardens and introducing animals, particularly in the area surrounding Audley, Southern Sydney. Deer were introduced to the RNP in 1906 by the then Park trustees for aesthetic purposes. From the introduced species, Rusa Deer adapted extremely well to the environment in the RNP and its surrounding areas.[645] By the late 1970s the deer population had increased significantly and the impact was a concern. While accurate figures are not available, estimates are that the deer population increased to several thousand within the RNP and its surrounding areas (see Figure 5.1). Simultaneously, because of the visibility of deer in the RNP, the community located in adjacent areas developed an affinity with the deer. Deer were considered as an integral part of the RNPs landscape by the community. Lack of awareness of the negative consequences of deer and their socio-economic impacts contributed to an unmanaged increase in the deer population.

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[644] P Adam, 'Royal National Park, Lessons for the Future from the Past' (2012) 134 *Proceedings of the Linnean Society of New South Wales* 134, B7-B24.

[645] Moriarty (2004), above n 364.
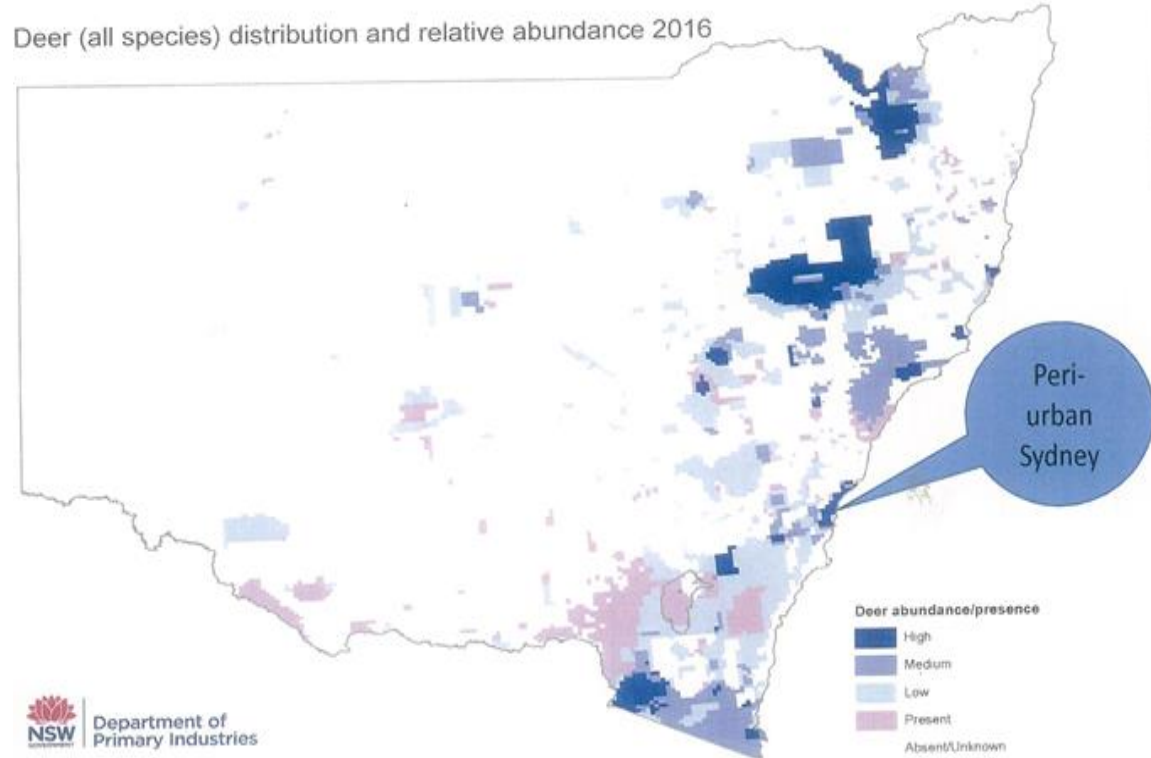
Figure 5.1: Deer distribution in peri-urban Sydney case study area
(Adapted from: NSW Government, Department of Primary Industries, Distribution maps for vertebrate pests, 2016 survey maps, <https://www.dpi.nsw.gov.au/biosecurity/vertebrate-pests/publications/distribution-maps-for-vertebrate-pests>)

During this period, the National Park Trust was overseeing management of the deer. The Trust also managed excavation of primary materials required for road and rail construction and tree stumps from logging to raise money for funding recreational activities. These activities led to sharp criticisms of the Trust over conservation issues leading to the transfer of Park management to the NPWS in 1967.[646] After considering the impact of deer, the NPWS commenced deer culling programs in the 1970's. Because of a lack of a consistent and agreed control approach to deer population management, the programs had limited success. Community perceptions evoked a strong response against NPWS when it attempted to implement control programs. This led to the suspension of programs. In 1994, bushfires reduced the number of deer to about 150. However, deer populations recovered very quickly. The opportunity to eradicate the deer was lost.

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[646] *National Parks and Wildlife Act 1967 (NSW).*

In 1997, community organisations (eg, Hacking River Catchment Management Committee) requested the then Minister for Environment to avoid delays in making a decision on deer control. In their requests, the community organisation recognised the challenges in implementing deer control. The challenges included: pressure from certain sections of the community to retain deer at the RNP, and ensuring that options for deer removal do not involve stress or cruelty to animals.[647] Recognising the continuous problems caused by deer and upon community requests, the then Minister for the Environment approved a two-year program to be administered by the NPWS to capture deer by trapping and relocating them to deer farms. The control program proved of a limited success because of: a) lack of adequate demand for farm stock, b) difficulties in deer trapping, and c) adverse public reactions evoked because of injury to the deer while deer trapping. Traps were also sabotaged. The NPWS initiated program was finally suspended because of the objections raised by some sections of the community.[648] Because of a lack of clear decisions by the government and concerns raised by certain sections of the community on control methods, the deer population continued to grow. In 1999, it was estimated that the deer population was at least 5000 in RNP.[649]

In 2000, organised culling of deer was planned to control the deer population. Documents indicate that the culling operation was the result of community concerns on the increasing problem of deer.[650] This move was opposed through a court action led by animal rights groups. The opposition had its basis in the animal-welfare concerns and aesthetic values of deer. Based on the court's decision, the NSW

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[647] Documents provided: Communication to Minister Pam Allan by the Hacking River Catchment Management Committee dated 14 July 1997; Rusa Deer Management Meeting, Royal National Park, Minutes of Stakeholder Meeting dated 25 November 1997; Newspaper - Jenny Stokes, 'Future of deer Depends on Study', *The LEADER* 21-10-1999.

[648] Document provided: Communication Strategy for Deer Management Plan dated 10-1-2002.

[649] Document provided: National Parks Association of NSW, Southern Sydney Branch, *The Ethics of Conserving Cute and Furry aliens in National Parks*, Media release dated 23-10-1999; 'Deer Study Row Erupts' *St. George and Sutherland Shire Leader*, dated 16-11-1999; Newspaper - 'Fury on Deer Plan Delay' *The LEADER*, dated 16-11-1999; Newspaper - 'New Plan to Control Feral Deer' *ILLAWARRA MERCURY*, dated 22-3-2000.

[650] Documents provided: Public meeting – 'The Deer problem, Royal National Park, Bundeena Community Centre', 5 August 2000; Communication by the President of the Bundeena Progress Association to the Minister for NPWS, NSW; Newspaper - *Jenny Stokes*, Deer Me, Animals Run Amok in Town' *LEADER* dated 25-7-2000; NPA Communication to the Minister for the Environment, 10 July 2000.

Minister of the Environment ordered suspension of culling until community support could be demonstrated.[651]

The literature on deer impacts indicates that deer cause severe degradation of the herbivory and environment within the RNP and its surrounding areas. Rusa Deer cause considerable environmental modification through their grazing habitats. In 2000, there was very little scientific documentation to illustrate the extent of deer impacts on natural biodiversity. Anecdotal, photographic and general landscape appraisal were the only ways to assess deer impacts. Nevertheless, these methods confirmed that deer were having a major impact on the natural biodiversity in PUS. Another bushfire in 2001 burnt more than 50 per cent of the RNP, which led to the dispersal of deer in and around the park, with an estimated population of approximately 3000 deer in the PUS area.[652]

The NPWS has a complex challenge in attempting to manage deer. While it was important to address increasing negative impacts, the historical opposition by the community due to divided opinions on deer control and animal welfare concerns made it difficult to implement control. The NPWS considered it essential to develop a deer management strategy. The RNP management plan also required the preparation of such a strategy. The RNP established a deer working group in conjunction with the NPWS.[653] The working group involved NPWS, NSW, local government agencies of Sutherland and Wollongong, Rural Protection Boards, the Australian Deer Association, RSPCA, other conservation groups (eg, Nature Conservation Council (NCC), National Park Association (NPA), and For Australian Wildlife Needing Aid (FAWNA)[654], deer industry and recreational shooters.[655]

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[651] C Shephard, 'A Case Study for Managing Controversial Pest Animals: Rusa Deer in Royal National Park' in S Balogh (ed), *Proceedings of the Second NSW Pest Animal Control Conference: a practical pest animal management* (New South Wales Agriculture, Orange, NSW, 2002). pp 56-58.

[652] Moriarty (2004), above n 364; Document – Official communication by the then Secretary of the Oatley Flora and Fauna Conservation Society to the then Minister for the Environment NSW, dated 22 June 2001.

[653] Document - Deer Management Working Party, Meeting 1, 26 July 2000, RNP.

[654] FAWNA) is a government approved non-profit organisation that works for wildlife rescue and rehabilitation of injured animals.

[655] Management of pest animals in NSW National Parks - Andrew Leys, Pest Management Coordinator – NSW National Parks and Wildlife Service, Hurstville; Proceedings of NSW Pest Animal Conference, Orange, 25-27 October 2000; Document – Deer Working Group –

The task of the working group was to make recommendations on the management approach to be adopted by the NPWS. The initial meetings of the deer working group focussed on understanding the positions of stakeholders involved in the working group. The meeting points indicate that stakeholders had an agreement on the objective of reducing the number of deer but it was difficult to determine the level of reduction because of the lack of quantified/objective data. The working group was aware of two community issues: a) the community would oppose total eradication of deer and b) any control option that is not consistent with animal welfare may invite a community backlash. The members of the working group considered it necessary to have a deer injury protocol along with the Deer Control Plan.[656]

The working group considered that, without community involvement, it would be difficult to implement control. Newspaper coverage indicates that the community had varied opinions on deer management. For example, one animal welfare organisation indicated that deer killing was not necessary and deer should be allowed to live in the RNP without any measures to control.[657] Other opinions suggest that community expected urgent action to control deer.[658] To address community perceptions on the impact of deer and animal welfare concerns, the working group steered community awareness through publication of articles in local newspapers[659] and held two community consultation workshops. Public meetings and consultations were held to discuss the proposed management plans.[660] The NPWS also received public

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Terms of Reference, dated August 2000; Document – Deer Working Party, Meeting No. 2, dated Thursday 31 August 2000.

[656] Document – Deer Working Party, Meeting No. 3, dated 23 October 2000.

[657] Document – Newspaper – 'The Deer Kill in the Royal National Park, What they didn't tell you' *LEADER,* dated 29 January 2002.

[658] Document – Newspaper – Frank Formby, Greys Point, 'Deer: the harm they do'*, St. George and Sutherland shire LEADER* dated 24 January 2002; Document – Newspaper - Kathie Van Barneveld, Grays Point, 'Deer must go', *St. George and Sutherland shire LEADER* dated 29 January 2002; Document – Newspaper – Patricia Callaway, Heathcote, 'They're not Bambi', St. George and Sutherland shire LEADER, dated 31 January 2002.

[659] Document – Deer Working Party, Meeting No. 7, dated 18 December 2001. The document indicates that the articles on deer issues were published in the local newspaper 'The St. George and Sutherland Leader'.

[660] Document - Draft Deer Management Plan for Royal National Park, dated 12 Dec. 2000, 20 August 2001, 29 December 2001; Document - Draft Deer Control Communication Plan, dated 12 April 2001; Document – Draft deer management plan for Royal National park Community Workshop Program, 2001 at Audley and Corrimal; Document – Official communication by the director of the NPWS to the then Secretary of the Oatley Flora and Fauna Conservation Society, dated 23 July 2001; Document – Official communication by

submissions that were considered to finalise the plan[661]. The objective of workshops was to create awareness among communities about the severity of the deer problem in the RNP and surrounding areas and to involve them in the planning process. The involvement of politicians was considered essential to negotiate with the animal welfare organisations.[662] The community consultation and planning process led to the development of first RNP deer management plan in 2002.[663]

Since then, deer management in the peri-urban Sydney has been implemented through collaborative planning and institutional arrangements. For the deer management, the PUS case study area can be broadly classified into two: a) The area administered by the NPWS that includes the RNP and NPWS reserves outside the RNP and b) the area administered by the local councils.

The processes and actions for deer management in PUS case study area are described in the Table 5.3.

Strategies for wild deer control vary based on the objectives of control. The objective of deer management in peri-urban Sydney case study area is to maintain accepted levels of deer population rather than to achieve zero densities of deer.[664] Deer management mainly takes two forms: hunting or stalking for shooting, and fencing to exclude deer from specific areas. These strategies are not mutually exclusive. Adaptive management for deer control is practiced. Figure 5.2 outlines adaptive deer management and its elements within peri-urban Sydney case study area.

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the then Secretary of the Oatley Flora and Fauna Conservation Society to the Director of the NPWS NSW, dated 31 August 2001.

[661] Document - Managing deer in Royal National Park and other Sydney reserves, NSW National Parks & Wildlife Service, nature and conservation, 2001; Document – Official communication by the NSW NPWS Senior Ranger Community Relations to the NPA, dated 15 January 2002; Document – Submission on the Deer Management Plan of the Royal National park by the Convener, Park Management Committee, NPA, dated 31 January 2002, Document - Draft Deer Management Plan for the Royal National Park and NPWS Reserves in the Sydney South Region, Community Consultation responses to submissions report, 2002.

[662] Document – Personal e-mail communication – from a member of Deer Working Group to Key Informant 1 (members of the Deer Working Group) – dated 2 January 2002; Document – Deer Working Party, Meeting Agenda, dated 6 February 2002.

[663] Document – Deer Management Plan, published by the NSW National Parks and Wildlife Service in conjunction with the Royal National Park Deer Working Group, February 2002; Injured Deer Protocol, NPWS Deer Working Group Publication, dated 8 January 2002.

[664] IACRC, *2016 National Wild Deer Management Workshop Proceedings,* (Adelaide, 17-18 November 2016).

Table 5.3: Deer management in peri-urban Sydney case study area

Area administered by the NPWS	Area administered by the local councils
Objective	
Reduce the number of deer in populations which impact negatively on the natural environment of Royal National Park and other reserves managed by the NPWS Sydney South Region	Reduce the number of deer in populations which impact negatively on the natural environment; reduce socio-economic impacts, ensure safety of people in peri-urban Sydney.
Approaches	
Deer management plans	Deer management included in the broader pest animal management framework/separate policy framework for deer management.
Cooperative approaches for the management of deer on and adjacent to the reserves managed by the NPWS Sydney South Region	Local council led approaches through community cooperation
Efforts to improve community and stakeholder appreciation of the issues related to deer management	Efforts to improve community and stakeholder awareness on deer issues and to receive inputs/information on deer
Control techniques	
Ground shooting	Ground shooting, hunting, fencing
Research on deer including studies on other effective, humane and safe methods of population control	Support the research endeavours of NPWS and other stakeholders
Monitoring and evaluation	
Attempts to use technologies for monitoring Review the operation of the deer management program through annual reports	

In the NPWS administered area, deer are managed through ground shooting by trained NPWS staff.[665] A strict protocol for shooting is followed. The protocol is reviewed by the NSW Firearms Safety and Training Council, Local Council and the NSW Police. Shooting is conducted at night, when deer are active and public safety can be appropriately managed. Integrated deer management programs are conducted with the involvement of one or more councils and bodies, NPWS, and private landowners. For some community groups, deer represent part of the history of the RNP. The community members recognise a need for deer control but also oppose their eradication because of animal welfare concerns. Some community members adjacent to and within the RNP feed and befriend deer, which makes implementation ineffective. The deer management plan is prepared with community involvement. It

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[665] Document – Draft of a manual for a training course for NPWS and Council Rangers, 21 January 2002.

enshrines goals and objectives of deer management. Targeted communication with key stakeholders regarding their obligations (and the penalties for non-compliance) plays a role in deer management in these areas.
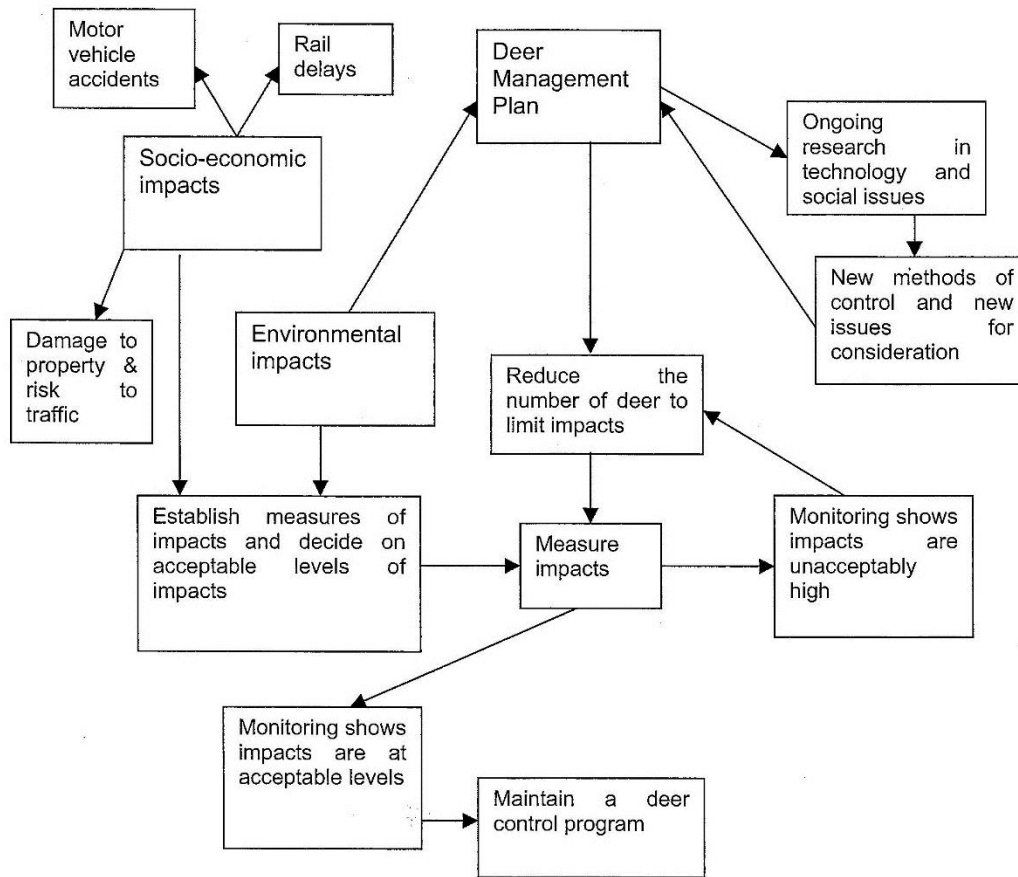
Figure 5.2: Adaptive management for deer control program
(Source: Deer management plan for the Royal National Park and its surrounding areas 2005-2008)

On the council administered areas, the wide variety of landholders have diverse objectives for their land. This influences local government approaches to deer management. Objectives include management for hunting, where deer populations are managed to provide recreation and sports; and to manage deer for socio-economic and safety reasons. Since deer are not declared as a pest in NSW, the mandatory deer control measures in place in the NPWS administered area are not applicable in the council administered areas. Based on these objectives, deer are managed in different ways:[666]

- Shooting/hunting to manage the deer population for sport or recreation.

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[666] NRC 2016, above n 357, 73-79.

- Deer owners and farmers have an obligation to prevent escape of deer. The control strategy to prevent such an escape is through fencing. As per the *Game and Feral Animal Control Act 2002* (NSW), primary producers and their employees do not require a hunting licence to shoot deer on their own properties. Other individuals require a hunting licence.

- Property owners have a responsibility to avoid damage to others' property. Outside the area of national parks, for the protection of hobby farms, gardens and backyards, people have put fences around houses to deal with the deer problem.

- Residents are advised to avoid feeding deer and to take general precautionary measures including safe driving, especially during breeding seasons.

- Local councils have a responsibility to manage deer upon individual requests from the community. These generally include: requests to remove dead, injured or troublesome deer. Deer are removed using shooters contracted by the councils. In these areas deer are spread across landholdings, often appearing at different times of year, which makes their management complex.

Figure 5.3 shows an example of deer management by the Sutherland Shire Council.

Despite government efforts, the deer population shows continuous growth in PUS case study area. It is not confined to the RNP. The deer population has extended to the South Sydney region, with approximately 70 per cent of the total population outside the park. In PUS, deer are found in groups of up to 40 animals. Deer seek alternative food sources especially grass and other plants, which is available in large amounts in urban gardens and reserves.[667] The damage is most pronounced in the coastal and littoral rainforests.[668] There are no direct predators of deer in NSW, thus unmanaged deer can increase in numbers causing damage to agricultural interests and the environment, and impacting on public safety through road accidents. The NRC recommended for change in deer management approaches to make control more feasible.[669]

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[667] Moriarty, A. (2004). The liberation, distribution, abundance and management of wild deer in Australia. *Wildlife Research*, 31:291-299.

[668] Keith, D. and Pellow, B 2004. Effects of Javan rusa deer (Cervus Timorensis) on native plant species in the Jibbon-Bundeena area, Royal National Park, New South Wales. Proceedings of the Linnean Society of New South Wales).

[669] NRC (2016), above n 357.
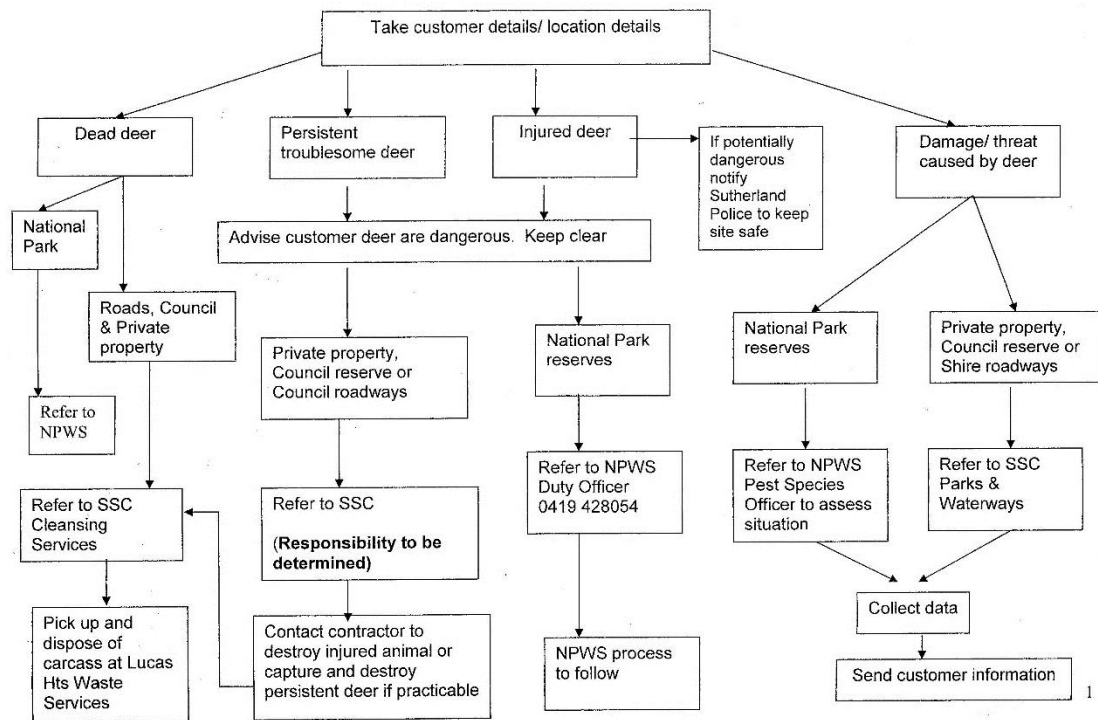
Figure 5.3: Process of local council's response to deer issues
(Source: NRC, 2016)

5.2.2 Legislation for wild deer management

The legal framework for feral deer management in the PUS case study area is influenced by the law of NSW, under which the right to kill deer is associated with the ownership of land. Wild deer in PUS are managed by management interests including individuals, businesses, recreational and community organisations across private, voluntary and public sectors.

The specific statute protecting and regulating wild deer in NSW is the *Game and Feral Animal Control Act 2002* (NSW). Under the *Act*, wild deer is considered a game animal.[670] Deer can be legally hunted in NSW on private and some public lands.[671] For hunting on private land, permission is required from the landowner or manager. For hunting on public land, permission is required from the state government. The *Act* administers deer management through two types of hunting licence: Restricted (R-licence) and General (G-licence).

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[670] *Game and Feral Animal Control Act of 2002* (NSW), pts 1 and 2, Deer as a non-indigenous game animal.
[671] Ibid.

- The R-licence allows restricted hunting by licensed volunteer hunters on public lands that are declared for hunting which include some State Forests and Crown Lands; and on private property with the landholders' permission.

- The G-licence allows hunting by licenced volunteer hunters on private property with the landholders' permission.

Schedule 1 of the *Game and Feral Animal Control Regulation 2012* (NSW) sets out the mandatory conditions of NSW Game Hunting Licences.[672] A hunting licence must be obtained from the NSW Game Council (exceptions include farmers and government personnel). The cost of obtaining licence is A\$75 per annum, A\$325 for five years. For hunting licences, additional documentation, including the NSW firearm licence number (for both R and G licences), and membership of an approved hunting organisation and training (for R licence) is mandatory. The Game Council administers hunting restrictions; for example, a closed season for some species. Game hunting is prohibited in the national parks. As an exception to the general biosecurity duty, landholders do not have an obligation to remove deer under the *Act*.

Under the *Local Land Services Act 2013* (NSW), the minister can declare particular animal species to be a pest[673] through public notification.[674] The pest control order is made by the Minister after consultation with a LLS, or at the request of a LLS. The Minister must consult with persons or organisations prescribed in the regulation before making a pest control order for a game animal.[675] The owners and occupiers of private land have an obligation to comply with general or limited destruction obligation under the pest control order.[676] Occupiers of the private land also have an obligation to notify the presence of the pest on the land.[677] In case of non-compliance, private occupiers are liable for penalties.[678] The occupiers of public land have similar obligations, without any penalties applicable.[679] In certain situations when urgent

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[672] *Game and Feral Animal Control Regulation 2012* (NSW), no 428, sch 1, Conditions of game hunting licences

[673] *Local Land Services Act 2013* (NSW), s 130(5) of the LLS Act 2013.

[674] Ibid s 133; the requirement of notification and publication can be waived by the Minister in special circumstances as per Section 135 of the LLS Act 2013.

[675] Ibid s 132.

[676] Ibid s 142.

[677] Ibid s 142(3).

[678] Ibid s 142.

[679] Ibid s 143.

action is needed or if there is a serious risk of harm being caused by the pest, the *Local Land Services Act 2013* (NSW) allows the LLS to give eradication orders to be served on owners or occupiers, in relation to a pest on controlled land.[680]

In 2015, the NSW Government passed the *Biosecurity Act 2015* (NSW). Under the *Biosecurity Act*, landholders have a shared responsibility to manage the biosecurity risk.[681] Deer are considered a biosecurity risk because of their potential to carry weeds and transmit diseases but the *Act* does not cover feral deer in its regulations on pest animals and is not clear on how the shared responsibility to manage deer as a biosecurity risk will operate. This is an example of the type of overlap and confusion of legal arrangements for pest animal management.. Table 5.4 summarises the legislation affecting deer management in the PUS case study area.

Table 5.4: Deer management legislation in the peri-urban Sydney case study area

Legislation	Regulated area
Game and Feral Animal Control Act 2002 Game and Feral Animal Control Regulation 2012	Hunting/shooting of deer
Animal Diseases and Animal Pests (Emergency Outbreaks) Act 1991 Animal Diseases and Animal Pests (Emergency Outbreaks) Regulation 2012	Animal disease outbreaks
Prevention of Cruelty to Animal Act 1979 Prevention of Cruelty to Animals Regulation 2012	Handling and destruction of pest animals
Non-indigenous Animals Act 1987 Non-indigenous Animal Regulation 2012	Keeping and movement of controlled species
Local Land Services Act 2013 Local Land Services Regulation 2014	Control of pest animals across NSW, Support to landholders to eradicate pests, Community led pest planning, Inspection of properties
National Parks and Wildlife Act 1974 National Parks and Wildlife Regulation 2009	Pest animals on public land
Threatened Species Conservation Act 1995 Threatened Species Conservation Regulation 2010	Impacts of pest animals on nature
Firearms Act 1996 Firearms Regulation 2006	Use of firearms
Work Health and Safety Act 2011 Work Health and Safety Regulation 2011	Workplace health and safety
National Livestock Identification Scheme	Management of deer as a game and livestock animal
Biosecurity Act 2015 (NSW)	General Biosecurity Duty to manage biosecurity risk

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[680] Ibid ss 144-150.
[681] *Biosecurity Act 2015* (NSW) no 24 pt 3 s 22.

Landholders, hunters, animal welfare organisations/groups, conservation groups, government agencies and political parties have different views on the legislative status of deer as both a pest and a protected species. These views can be broadly divided into two segments:

a) Stakeholders supporting the recognition of deer as a pest animal:

This view recognises deer as an immediate threat because of its socio-economic and environmental impacts. Stakeholders supporting this view argue that the current law protects deer purely for the sake of recreational hunters, who cannot control deer sufficiently. Under this view, the non-pest animal status of deer negatively affects its management because of the following reasons:[682]

- In the absence of a legislative back up, the support of stakeholders for deer management remains fragmented. The legal status undermines community participation.

- It is difficult to create a clear legal obligation for landholders' deer management.

- It has a limited influence on landholders' participation.

- It creates scope for interest groups to protect deer on the basis of claimed cultural significance. The declaration of deer as a pest animal in South Australia has helped in implementing integrated pest management programs.

- It creates limitations on the availability of funding and the cost-benefit ratio of control investments.

b) Stakeholders supporting the recognition of deer as a game animal:

This view recognises deer as an economic asset that can be managed as a game for recreational hunting. For these stakeholders, deer as a game animal provide income to farmers and landholders through deer farming, deer-based tourism, deer harvesting and recreational hunting.[683] It also helps state governments to earn revenue from

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[682] These observations are drawn from: NRC (2016), above n 357; Patrick Gilmour, Robyn Bowden and Rebecca Dennis, 'Evaluation of the Northern Illawarra Wild Deer Management Program' (Report, Final v03; , Client: South East Local Land Services; First person Consulting Pty Ltd ABN 98605466797, 09-05-2016).

[683] Document - Newspaper – Amanda Cariln, 'Deer would be fair game' *LEADER* 1 August 2006.

regulations including fees for R-licenses.[684] Another argument put forth by the supporters of deer as a game animal is that this helps control illegal poaching. According to these stakeholders, farmed deer occasionally escape from paddocks naturally or through malicious practices. Deer farmers attempt to recapture those but are not successful in all cases. Escaped deer are considered as 'wild' and may be destroyed by poachers. This can lead to illegal poaching with perceived risks of harm to deer farmers and their livestock.[685] In PUS, for example, recreational hunting is not allowed in the national park area but unauthorised hunting has often been notified in the RNP.[686] A significant increase in illegal hunting has been also recorded in the Wollongong area.[687]

5.2.1.2. Current legislative status of deer and its effectiveness

At the Commonwealth level, 'Herbivory and habitat degradation by feral deer' has been identified as a key threatening process in 2011 and 2012.[688] In 2013, it was added as a key threatening process under 'Novel Biota and their impact on biodiversity.[689] The *Threatened Species Conservation Act 1995* (Cth) identifies 'Herbivory and environmental degradation caused by feral deer' as a Key Threatening Process. The significance of any particular species being added as a Key Threatening Process is that it triggers the requirement of prohibitive action through threat abatement plans.[690]

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[684] DPI-NSW: Game Hunting Guide, Game Licensing Unit, April 2017 <http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/711658/nsw-game-hunting-guide.pdf>.

[685] Submission by the NSW Deer Industry Branch to NRC Review, http://www.nrc.nsw.gov.au/PDF/State-wide%20review%20of%20pest%20animal%20management/Submissions%20-%20Draft%20report/Deer%20Industry%20Association%20of%20Australia%20NSW%20Branch%20-%20Tim%20Hansen.pdf.

[686] Hunting in National Parks – Summary of Public Service Association Survey, http://www.psa.asn.au/Oldsite/news/files/2012%20Summary%20NP%20Survey%20Sept%202016.pdf.

[687] Illegal hunting targeted in the Wollongong area; http://www.dpi.nsw.gov.au/about-us/media-centre/releases/2016/illegal-hunting-targeted-in-the-wollongong-area.

[688] Key Threatening Process Nomination - EPBC Act 1999.

[689] See http://www.environment.gov.au/node/14591.

[690] NSW Office of Environment and Heritage, How key threatening processes are listed, http://www.environment.nsw.gov.au/committee/HowKeyThreateningProcessesAreListed.htm.

Under the *Biosecurity Act 2015* (NSW), deer are not specifically listed as a pest animal but in the areas where deer have an adverse impact, they may be identified and managed as pest animals through the regional pest animal plans. For this purpose, NSW DPI, in collaboration with local stakeholders will have a responsibility to develop deer management plans. According to the plans, deer management actions will be undertaken with the assistance of landholders. This illustrates the fragmentation of pest species control. As deer are mobile, the fragmentation undermines control action over overlapping jurisdictions in the peri-urban context.

Feral deer are not a declared pest but an exemption allows control programs to take place in locations where deer are excessive in numbers.[691] Under the supervision of the Game Council, deer control programs have been organised to reduce their numbers (eg, in the Illawarra region) but these programs, including the current Supplementary Pest Control (SPC) programs run by NPWS have not been effective.[692]

5.2.3 Roles and responsibilities

A range of stakeholders influence deer management in PUS. These include public landowners, such as NPWS, local councils, and state government departments, and private landowners. Throughout the NPWS administered area, coordinated deer management is practised. In the rest of the PUS areas, a different approach is required because of the fragmented pattern of land ownership, diversity of land uses and attitudes towards land management. Multiple plans at various levels influence pest animal management in NSW as illustrated in Figure 5.3. This section deals with the most important and relevant stakeholders for feral deer management.

NSW Government

The role of the NSW Government is to provide the legislative and policy frameworks for deer management. The NSW Department of Primary Industries (NSW DPI) has responsibility for pest animal management at the state-level. It administers wild deer

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[691] NSW Department of Primary Industries, Ecological Deer Management in NSW: Suspending the Regulations, May 2017, Prime fact 1461, 2nd edition, DPI Game Licensing Unit, Orange, <https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/718519/primefact-1461-edm-suspending-the-regulations.pdf>.

[692] Supplementary Pest Control Trial: Interim Evaluation February 2016 <http://www.nrc.nsw.gov.au/pest-animal-management>.

management through legislation, policy, training and education. Under *the Game and Feral Animal Control Act 2002* (NSW), the DPI NSW regulates licensed hunting through the Game Licensing Unit. The NSW DPI also administers the *Prevention of Cruelty to Animals Act 1979* (NSW), but it has no enforcement powers.

LLS operates under the *Local Land Services Act 2013* (NSW). The LLS is responsible for the management of travelling stock reserves in NSW for which it must manage pest animals.[693] The LLS participates in on-ground detection and control of deer, provides information and advice on pest animal management techniques, assists land managers to reduce deer through the coordination of group control programs, conducts inspections, and regulates compliance with the *Act*.

Figure 5.4: NSW biosecurity framework for pest animal management
(Source: NRC 2016, 7)

The Office of Environment and Heritage (OEH) is responsible for administering the *National Parks and Wildlife Act 1974* (NSW) which aims to protect NSW's environment and heritage, and to manage national parks/nature reserves. The OEH also administers the *Threatened Species Conservation Act 1995* (NSW) which treats deer as a key threatening process. The OEH works with other government agencies and the community to protect biodiversity and agriculture on neighboring private lands, provides advice and undertakes species recovery, threat abatement using threat abatement plans, community engagement programs and research.

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[693] Part 10 of the LLS Act 2013.

The Royal Society for the Prevention of Cruelty to Animals (RSPCA), Animal Welfare League, and the NSW Police provide animal welfare services in incidences of neglect or abandonment of pets. The RSPCA is politically active in relation to perceived cruelty to animals during control actions. In the past, they have prevented deer control work on certain occasions because of animal cruelty issues.

State level community includes state/territory conservation councils, farmer and industry groups that facilitate deer control on land used for production and trade.

Local government

The local councils relevant to the PUS case study area include Sutherland Shire Council and Wollongong City Council. Local councils have a shared responsibility in deer management. This is the initial contact level of government for communities. In residential areas, local councils attempt to ensure that people are not affected by deer issues. Local councils within the NSW legislative framework provide control services through pest management officers and agencies. Local government officers, including pest animal control officers, environment health officers, planners, advisory boards/committees set up by NRM and environmental agencies, facilitate deer management around properties. However, they have limited power and few resources.

Private occupiers, including individual landholders have a primary responsibility under the *Local Land Services Act 2013* (NSW) to manage pest animals on land they own, occupy or manage. Their tasks include on-farm biosecurity, on-farm pest control, backyard management, public land management, on-ground control activities, diagnostics/identification, training and engagement. The legal and political status of deer, community attitudes, and practical difficulties severely limit their capacity.

Local stakeholders share the responsibility in deer management but often without any legal obligation. These include:

- Volunteers and special interest groups provide assistance in the management of private and public lands through on-ground management tasks, including pest control and monitoring activities.
- Donors and philanthropists provide monetary help for implementing control.
- Crown Lands (part of NSW DPI) administers Crown land which is under its direct control; it provides support to control activities undertaken by community

groups and other stakeholders that manage land on their behalf, but also 'hosts' hunting.

- The obligation of public land managers, including local and county councils under the *Local Land Services Act 2013* (NSW) is to manage deer on land they own, occupy and manage.

5.2.4 Political dimension of deer management

The management of deer is considerably influenced by the involvement of political stakeholders. In NSW, state legislation allows deer management through hunting. Hunting is considered as a complementary strategy that facilitates selective taking of deer. Recreational hunting is the main control method used for deer management[694] except in the NPWS administered area. Recreational hunting is controlled by the NSW Game Council which imposes bag limits to ensure availability of deer. Hunting is justified on the basis of its effectiveness in achieving target-specific deer control. Land managers who permit shooters to kill deer on their lands can re-invest the money for other pest control activities. Government benefits from hunting through permit/license fees.

Recreational hunting is promoted in NSW. One of the conditions to receiving an R-licence is that the applicant must be a member of a government approved hunting organisation. The approval of hunting organisations is managed by DPI. Hunting clubs have played a key role in promoting recreational hunting.[695] The hunting clubs support members by providing training, accreditation and insurance coverage. The Federation of Hunting Clubs Inc (Federation) is an umbrella organisation of 35 hunting clubs, representing hunters from all parts of NSW. The SSAA brings farmers into contact with qualified, licenced and experienced volunteer shooters. The focus of SSAA is on target shooting.[696] These programs have been used in NSW. Standard shooting protocols and site plans ensure the safe implementation of volunteer shooting resources. Outside of these institutional boundaries, substantial 'unofficial' hunting reportedly does occur.

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[694] Bengsen and Sparkes (2016), above n 387; M Braysher, 'Taking Aim', (2013) 117 *Australian Geographic,* 36.

[695] Paronson (1998), above n 389.

[696] The Sporting Shooters Association of Australia (NSW) <ssaansw.org.au>.

Recreational hunting is popular in NSW. The support of recreational hunting has assumed a political dimension with an ideological support to manage deer as a resource. This ideological stance is sometimes allowed with other public interest groups, including RSPCA and animal rights groups. Political lobbying in NSW promotes it as a sport or recreational pursuit.[697] In 2010, the Shooters Party in NSW sought the support of the Labor Government for its Shooters Bill. The support for the Bill from the Labor Government was in exchange for votes in the Upper House. The Shooters Bill allowed for pest animal hunting by the use of methods that were not widely accepted by the community (use of guns, bows and arrows, packs of dogs and black powder – on all public land including national parks). Due to public outrage, the Bill was not passed. However the issue of 'hunters rights' in national parks and on public lands had now become a serious area of political contest.

In May 2012, the NSW Premier, Barry O' Farrell announced a deal with the Shooters and Fishers Party to gain support to pass electricity privatisation legislation through the NSW Upper House. The deal allowed sporting shooters to hunt in 79 national parks and nature and conservation reserves across the state.

Such recreational hunting has been criticised for many reasons. The arguments against recreational hunting include[698]:

- Recreational hunters cannot remove large number of pest animals. It is not an efficient form of control.
- The motivation of hunters is not to eliminate deer populations but to keep them as a resource for hunting. Hunters sometimes sabotage control actions.
- Recreational hunting may involve injury or killing of non-target animals and humans.
- Use of dogs for recreational hunting is considered an act of cruelty to animals. However, animal cruelty is also a claim made against public deer control programs.

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[697] The Submission of Invasive Species Council to the Review of the Game Council, 2013 <https://invasives.org.au/wp-content/uploads/2014/02/sub-review_NSW_Game_Council_May_2013_with_att2.pdf>; Invasive species, above n 388.

[698] Carol Booth, Is Recreational Hunting Effective for Feral Animal Control, 2009 <https://invasives.org.au/wp-content/uploads/2009/01/EssayProject_RecHunting_FeralControl.pdf>.

5.2.5 Institutional issues in wild deer control

This section describes institutional issues for wild deer management in the PUS case study based on the six themes identified through the scoping study (Table 4.1).

5.2.2.1. Theme 1 - Control technologies

Political impediments in adoption of control technologies

In the NPWS administered areas, aerial shooting at night is considered as more effective method than ground shooting, but the adoption of aerial shooting in the NPWS administered areas is constrained by opposition from animal welfare organisations.[699] Key informant 1 stated that there are different opinions among stakeholders on the effectiveness of aerial shooting because of animal welfare issues. This is partly because of widely published claims of cruelty in aerial shooting of wild horses. Politicisation of animal welfare impedes the adoption of aerial shooting.[700]

> Lack of political will to implement aerial culling due to fear of electoral backlash from the community.

As discussed, there is a heated conflict of opinions on managing deer as a pest or as a sustainable resource. The political difficulties combined with the action of the Game Council to keep the status of deer as a game animal instead of pest animal impedes decision-making on culling.

> Taking into account the social perception of deer, aerial shooting has been ruled out by the government; since the government places public pragmatism ahead of wildlife management.

5.2.2.2. Theme 2 - Governance arrangements

Legislations adopting different regulatory approaches

Deer management is influenced by many pieces of legislation adopting different regulatory approaches. Different approaches undermine feral species management. The legislation includes:

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[699] Key informant 1; Document – Media release by the National Parks Association of NSW, Feral Control Programs at Risk Across NSW, dated 27 May 2003.

[700] Document – Official communication NPA of NSW to the Parks and Wildlife Division, Department of Environment and Conservation, dated 1 October 2004; Document – Review of supplementary control options for the RNP Deer Management Program, Draft Discussion Paper (relevant policy on aerial shooting by DEC, NPA, RSPCA, Australian Veterinary Association, Nature Conservation Council on page 9 and 10), Royal National Park Deer Working Group, December 2004.

- *Game and Feral Animal Control Act 2002* (NSW) which regulates hunting of feral deer as a protected game animal.[701]

- The *Threatened Species Conservation Act 1995* (NSW) which promotes deer control to manage key threatening process.[702]

- Classification under the *Non-indigenous Animals Act 1987* (NSW)[703] is different to that adopted in the *Threatened Species Conservation Act 1995* (NSW);[704]

- The *Native Vegetation Act 2003* (NSW) separately regulates farm management practices including the management of pest animals.[705]

- The *Biodiversity Conservation Act 2015* (NSW) uses a risk-based approach to regulate human interactions with wildlife (including deer).[706]

- Land managers do not have an obligation to control deer under the *Local Land Services Act 2013* (NSW), since the *Act* does not define deer as pests. Thus, LLS manage deer as a 'nuisance animal' rather than a pest animal.

These complex and contradictory approaches limit the effectiveness of legislation as a tool to manage deer. According to some interviewees, this results in inefficient use of resources.

Multiple policies/plans/strategies/agencies

Pest species (including deer) management requires a clear and coherent policy framework. In the PUS case study area, deer management is influenced by multiple policies, strategies and plans at the state, regional and local levels. It is particularly influenced by the NSW NPWS Regional Strategies, deer management plans for RNP and NPWS Reserves in the Sydney South Region and deer management frameworks and protocols (eg, COPs and SOPs, methods of euthanasia, protocols for ground Shooting of Feral Deer). The Regional Pest Animal Committees provide regional pest animal management plans. Regional pest animal management plans prescribe the priority areas to reduce the worst impacts of wild deer. Local councils, through

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[701] *Game and Feral Animal Control Act 2002* (NSW) no 64 pt 1 s 5; *Game and Feral Animal Control Act 2002* (NSW) no 64 sch 3 pt 1.
[702] *Threatened Species Conservation Act 1995* (NSW) sch 3.
[703] *Non-indigenous Animals Act 1987* (NSW) (6A).
[704] Threatened Species Conservation Act 1995 (NSW) pt 2.
[705] *Native Vegetation Act 2003* (NSW) no 103 pt 2, s 11.1.b.
[706] *Biodiversity Conservation Act 2015* (NSW) no 63 pt 1, s 1.3 (g).

community led planning processes, prepare plans to accommodate local variations (eg, Feral Animal Policy, Sutherland Shire Council).[707] The essential component of a local pest management plan is to focus on the adverse invasive animal impacts rather than reduce the number of invasive animals.[708] Based on the NRC Review recommendations, the NSW Government will develop a NSW Wild Deer Management Strategy.[709] The objective of a separate strategy is to provide managerial guidance (eg, on impacts, approaches, best practices) on deer control to stakeholders. DPI provides an overarching direction for pest management through the State Pest Animal Planning Committee, which has a responsibility to prepare plans at the state level (eg, Invasive Species Plan).[710] LLS provide strategic plans incorporating landscape scale and cross-tenure approaches (eg, LLS Plans).

As has been stated a number of times, it is difficult to implement any deer management plan because of the competing approaches and varied frameworks. Efforts in achieving synergies and cooperation are evident. For example, Sutherland Shire Council, in its Feral Animal Policy (June 2005), is committed to take steps for feral animal control in cooperation with other agencies and the community. It acknowledges the costs of feral animals to the community. It has acted in control programs as a coordinator of the North Illawarra Wild Deer Management Program with involvement in the Royal National Park Deer Management Committee, but following institutional reasons impeded progress:

a) Lack of synergies between legislation and government policies: For example, the NSW State legislation identifies deer as a game animal, but Vertebrate Pest Animal Management Policy of the Wollongong City Council considers deer as a priority pest animal,[711] which aims to 'reduce deer numbers in key locations to

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[707] Document – Public Exhibition Response to the Draft Feral Animal Policy, dated 14 June 2005; Document – Control of Feral Deer, Reaffirmation of Council's Feral Animal Policy, dated 17 August 2009.

[708] NSW DPI 2014 – NSW DPI 2014. Vertebrate pest control manual. NSW DPI.

[709] Wild deer, Wild deer policy and planning in NSW <https://www.dpi.nsw.gov.au/biosecurity/vertebrate-pests/pest-animals-in-nsw/wild-deer/wild-deer>.

[710] NSW Department of Primary Industries, *NSW Invasive Species Plan 2008-15* <https://www.pestsmart.org.au/wp-content/uploads/2014/12/nsw-invasive-species-plan.pdf>.

[711] *Vertebrate Pest Animal Management Policy*, Wollongong City Council, Adopted by the Council on: 3 August 2015.

reduce impacts on residents and natural areas'.[712] The state-level Invasive Species Plan states that wild deer is a localised rather than state-wide problem. The NSW Government response to the NRC Review states that in regional pest animal plans, deer will be identified as a pest where they have adverse impacts on economy, environment and community.

b) Lack of uniformity in words used in policy documents, for example *The NSW Invasive Species Plan 2015-22* uses both 'strategy' and 'plan' to describe various policy documents.

c) The absence of a lead agency with clear responsibility for deer management.[713]

5.2.2.3. Theme 3 - Evidence

Data collection revealed the following issues with the pre-control and post-control evidence concerning deer:

Stakeholders lack clarity on deer numbers or actual prevalence of the deer population in RNP and surrounding areas. Deer population estimates are made on the basis of scat (dropping) counts and aerial surveys.[714] There are no precise arrangements to receive information from the community. One of the documents obtained during data collection showed the type of intelligence on deer distribution collected based on a 'random' basis from communities:

> Deer have migrated beyond Dharawal (near Campbelltown … western Sydney), beyond the upper Georges River, and are now to be found behind the scout camp at Glenfield near Campbelltown. I expect they have gone north and south as well.[715]

The data collection approaches do not have mechanisms to verify such reports. Because of the problems in availability of data and information, it is hard to obtain pre and post control evidence on deer management issues. It is thus not possible to evaluate the status of problems or the effectiveness of controls.

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[712] Document - Pest Management Plan 2013-2014 – Deer. Wollongong City Council, page number 12.

[713] Key informant 1.

[714] Document - An aerial survey of deer numbers in 2009, MINUTES – Royal National Park Deer Working Group 14 June 2011.

[715] Document – Personal e-mail communication – from a member of Deer working Group to Key Informant 1 (members of the Deer Working Group) – dated 2 January 2002; Document – Deer Working Party, Meeting Agenda, dated 6 February 2002.

For monitoring in NPWS administered areas, scat analysis is used as a standard approach. Other approaches include vegetation monitoring;[716] deer versus non deer affected areas especially, explicit or anecdotal data on shifts in deer distribution or numbers; status of culling numbers; and records of accidents. Use of hidden cameras is considered but further research is needed to make it specific to deer by excluding other mammals.[717] Further research on monitoring techniques is constrained because of lack of resources.[718]

In council administered areas, council collects information on deer through community surveys. The council also keeps a record of customer reports. Customer Request Management Systems are used to record the reported number, distribution and impacts of feral animals.[719] These are used for management decisions. Evaluation is conducted on the basis of records of control operations.[720]

The problem of unreliable evidence on deer management was described by a number of interviewees.

Key informant 1 expressed the problem simply:

> How do we know if we are effective [in deer control efforts]?

The lack of precise information and useful monitoring methods create difficulties in assessing the effectiveness of management. The importance of monitoring and evaluation is recognised by stakeholders, as complexities in determining the effectiveness of control affects decision-making during implementation (if the control program is long-term) or for devising strategies for future control programs.

Current approaches to data collection on deer impacts include hiring an ecological consultant or recruiting students to collect data on the presence and impacts of deer. Informants[721] stated that these approaches are not adequate to assess performance of

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[716] Document – Official communication from Craig Shephard to the Deer Working Group, dated 28 January 2003.
[717] Document – Notes from the meeting of the working group on deer held at Audley on 14 June 2011
[718] Document – Personal e-mail communication – from Key informant 1 to a member of Deer Working Group (members of the Deer Working Group) – dated 23 May 2011.
[719] Document – Sutherland Shire Council's Feral Animal Policy.
[720] Office of Environment and Heritage. 2011. Draft Memo South West Regional Pest Management Strategy Part B: 2012-2015, OEH, Sydney, NSW.
[721] Key informant 1, 4, and 5.

control programs and cannot deliver strategic information required to determine a strategy for feral deer control. Key informant 1 argued that monitoring technologies like FeralScan are useful but that the information available may be used for pursuits that are not aligned with the objectives of control, including, for example, to support unauthorised hunting.

Key informant 5 stated that data and information is not useful unless it is accessible. One informant highlighted that legislation constrains access to data:

> When you have reporting, you've also got to be aware that there's legislation around accessibility.

Key informant 5 stated that evaluation of the deer problem is very difficult because of lack of clear methodologies for assessing impacts as well as a lack of 'reporting systems'. Current frameworks may not be reliable for measuring performance in specific contexts,[722] particularly since information is gathered from multiple and, often, anecdotal sources.

5.2.2.4. Theme 4 - Resources

In addition to the resources provided by the Commonwealth, the NSW government generates its own resources for natural resource management including pest animal control. In NSW, government funding for pest animals comes through multiple sources.

Aiming for shared funding arrangements for emergency services, including biosecurity issues, the NSW Government has established an Emergency Services Property Levy (ESPL). The ESPL is a property-based model that supports all property owners in need of emergency services as opposed to insurance-based ESL model which was restricted to the property owners having insurance.[723]

The LLS under the *Local Land Services Act* 2013 (NSW) extracts rates paid by landholders. The funds received through rates ($32.6 million in 2015-16) are also used for biosecurity services, including on-ground programs (eg, state-wide wild dog

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[722] Key participant 5 described the problem of performance measurement taking Monitoring, Evaluation, Reporting and Improvement (MERI) Framework as an example. For further information on the MERI Framework, see New South Wales Natural Resources Monitoring, Evaluation and Reporting Strategy 2010–2015.

[723] NSW Government Insurance Monitor <https://www.eslinsurancemonitor.nsw.gov.au/emergency-services-levy>.

management programs). The current ratable area is 10 hectares. This excludes small landholders who pose biosecurity risks in peri-urban spaces, but there is a proposal to reduce the minimum ratable area to two hectares.[724]

In NSW, seven different conservation funding arrangements (bio banking agreements, conservation agreements, nature conservation agreements, registered property agreements, incentive property vegetation plans, conservation property vegetation plans, and wildlife refuges) provide a mechanism for private land conservation.[725] Owing to duplication and inadequate incentives, landholders resist from entering into long-term private land conservation which is required for effective pest animal control.[726] The current set of invasive animal laws and more recent reforms, including investment in private land conservation and improved land use planning (biodiversity certification, biodiversity offsets policy), have the potential to deliver effective pest animal control, but inconsistencies in the statutory framework create uncertainty and impede decision-making.

These is a problem of financial and human resources for deer management in the NPWS administered area. It was reported that the budget allocated for deer management is not sufficient. The resources for deer management within national parks come through government grants as well as through a park visitor's charge. Government funding is only available to help maintain the population of deer below 1000. Given limited resources, it is hard to achieve the recommended deer population in littoral rainforest areas.

Securing human resources is another problem. The low budget does not allow continuous availability of skilled managers,[727] with one interviewee reporting a deer control problem of:

[724] NRC Recommendation through its submission to Pest Animal Management Review Draft Report: NRC (2016), above n 357.

[725] NSW Biodiversity Conservation Trust (2018), *Biodiversity Conservation Trust 2017-18 to 2020-21 Business Plan* <https://www.bct.nsw.gov.au/sites/default/files/2018-03/BCT-Business-Plan.pdf>.

[726] H F Smith et al, 'Evaluating Incentives for Biodiversity Conservation on Private Land: Informing the Development of Lismore City Council's Rural Landholder Initiative' (Report prepared by Southern Cross University and Lismore City Council, Lismore, 2015).

[727] Key informant 1; Newspaper – ABC Illawarra 'NSW National Park's 50th birthday overshadowed by staffing cuts, biosecurity fears', by Gavin Coote, dated 19 Oct 2017.

Lack of continuity and permanence of people working on certain positions in Royal National Park affects [deer] management.

As trained personnel are not available on a continuous basis in national park, pest control practitioners are hired temporarily, including expert shooters used by Sutherland Shire Council and Wollongong Council.

5.2.2.5. Theme 5 - Planning

The analysis of deer management plans[728] indicated difficulties in reaching agreement on fundamental of coordination, including:

- Clear objectives and priorities
- Measurable targets
- Allocating roles and responsibilities
- Timeframes for deer management

Interviewees acknowledged the importance of plans and strategies in pest animal control. While elaborating on their utility, key informant 8 stated that:

Strategies can be flexible as they allow institutional flexibility during implementation but there must be a concrete action plan.

Informants highlighted issues that affect coordinated planning: government agencies follow different mandates and have different objectives for pest animal control. For example, in NSW, the OEH regulates deer on public land with the objective of biodiversity conservation whereas the regulatory efforts of the DPI on deer hunting reflect population management and an economics approach that recognises hunting as a legitimate recreational activity. The policy objectives of feral deer control are affected by political and group-based interests.[729] There is a conflict of opinion about eradication versus lowering the number of deer. Eradication is opposed by hunters and, to a certain extent, their case is justified and supported by the government because of political interests:

There were reports of insufficient involvement of multiple stakeholders in decision making. According to one interview, interventions by government in control and

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[728] Deer management plans and documents received from key informant 1, the NPWS Library and desktop research.

[729] Document – NSW Legislative Assembly Hansard, Sutherland Shire Feral Deer Control which discusses the concerns expressed by the community and the need for political level agreement on feral deer control action in peri-urban Sydney case study area, dated 26 October 2004.

management are viewed as one sided due to lack of diversity and multiple voices in decision-making. While commenting on the role of information to create a constructive dialogue on issues in invasive animal control and management, an informant[730] stated:

> Asymmetry of information is a big deal. How can we get a more level playing field to enable deliberation at the community level?

Local community voices about the nuances at a local level reportedly failed to be strategically incorporated in higher level planning. In the local level plans, community involvement is reportedly restricted to those having strong vested interests rather than the community in general. This interviewee suggests this affects equitable outcomes from the drafting of plans.

5.2.2.6. Theme 6 - On-ground implementation

Regulatory restrictions:

For ground shooting, use of silencers in firearms is not permitted. This creates control problems. In populated areas, despite following procedural requirements (providing information to police), the noise of a gunshot may create fear. Also, a gun-shot frightens deer, leading to a danger of deer run through populated areas (regulations allowing the use of silenced firearms could reduce the risk of this damage). Although recognised as a best practice for feral deer control, ground shooting cannot be implemented because of these regulatory constraints.[731]

One informant[732] stated:

> The requirement of firearms accreditation for operators implementing deer control [and regulatory restrictions in peri-urban areas] affects control operations.

Hunting may be useful to reduce numbers to within the carrying capacity of the land. This would also satisfy the expectations of hunting lobby. They desire a constant resource to pursue hunting from a social amenity perspective. However, hunting is not effective for lowering the population to low levels.[733] The RSPCA opposes recreational hunting on the grounds of significant animal welfare concerns and

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[730] Key informant 6.
[731] Key informant 1.
[732] Key informant 5.
[733] Key informant 6.

expects stringent shooting regulations to be enforced in this regard.[734] Regulatory constraints for recreational hunting include:

- Mandatory compliance with the Hunters' COP which is a part of the Game and *Feral Animal Control Act 2002* (NSW)[735] and the *Game and Feral Animal Control Regulation 2012* (NSW)[736]. The Hunter's COP is intended to ensure ethical, safe and responsible hunting that complies with the principles of 'fair chase'. The licensed hunters in NSW have an obligation to follow the mandatory COP.

- Clauses 5, 6, 8, 9 and 10 of schedule 1 of the *Game and Feral Animal Control Regulation 2012* (NSW) (for public and private lands) by the Game Licensing Unit are considered as an obstacle for the effective use of volunteer hunting resource.

- These constraints are waived in places where deer are excessive in numbers. For example in NSW: a) clauses 5-13 of schedule 1 of the NSW *Game and Feral Animal Regulation 2012* (NSW); b) *The Biosecurity Act 2015* (NSW) section 62, control orders can be issued; c) *The Biosecurity Act 2015* (NSW) provisions carrying mandatory obligations including section 62, control measures (section 68), and General Biosecurity Directions (s. 126) and individual Biosecurity Directions (s. 128) can be used to control deer despite its game status.

Taking into account the increase in the deer population and severity of feral deer impacts, regulatory restrictions on deer hunting were suspended for nine local government areas including Wollongong Local Government Area in June 2017. This removes both seasonal and time restrictions on hunting. The results of this reduced constraint are not known.

Lack of accountability

All informants supported the view that, it is hard to secure accountability from government as well as community stakeholders. Because of inadequate resourcing, government relies on voluntary compliance but a lack of landholders complying with

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[734] RSPCA, Recreational hunting, Australia information paper, March 2013 <https://www.rspcawa.asn.au/perch/resources/recreational-hunting-rspca-australia-information-paper-march-2013.pdf>.

[735] *Game and Feral Animal Control Act 2002* (NSW) no 64 div 4, 24.

[736] *Game and Feral Animal Control Regulation 2012* (NSW) no 428, sch 1, Conditions of game hunting licences.

the regulations leads to severe problems. Control and management is thus perceived as a government-led activity, with the general community failing to respond to the concept of 'shared responsibility'.

Ineffective administrative processes

It was reported that current administrative and management processes are not effective in engaging stakeholders.[737] The RNP created a deer Working Party and Deer Working Group for the RNP[738] to address deer problem through stakeholder interaction and engagement. But, in the absence of any legislative power, the Deer Working Group's recommendations have no legal validity. This new group failed to effectively engage external stakeholder groups and adds a new administrative layer to an already cumbersome bureaucratic structure. This has resulted in difficulties in laying out a well drafted and precise plan for implementation.

Lack of effective use of law to facilitate deer management

It was reported that existing law is not used as an effective instrument to promote deer management. The following examples were highlighted:

- In 2005, deer were listed as a key threatening process in NSW. Herbivory and environmental degradation caused by feral deer is a key threatening process under schedule 3 of the *Threatened Species Conservation Act 1995* (NSW). The *Act* provides for the listing of key threatening processes under part 2 of the *Act*. It was suggested that the UN World Heritage Committee evaluates pest animal control efforts, including for feral deer management. Should the RNP be designated as a World Heritage Area, recognition as a World heritage site could be pre-cursor for more effective initiatives for controlling feral deer.

- This may allow non-government stakeholder groups (eg, the Environmental Defenders office) to hold government accountable in the Land and Water Court for its failure to effectively manage pest animals.

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[737] Informant 1

[738] The Deer Working Group of RNP comprises of representatives from local government as well as NGOs. The Working Group is responsible for the preparation of RNP's deer management plan.

Perceptions

Informants (1, 4, 5 and 6) stated that perceptions about deer play an important role in peri-urban pest animal management. However, these perceptions are not well understood.

Government stakeholders have their own impressions on how landholders or non-government stakeholders perceive pest animals and their management. Informants supported that in peri-urban areas, people see animals as a part of recreation or social amenity. While describing people's affection, another interviewee stated that:

> People actually purchase blocks of land (in peri-urban areas) because there's deer there. They can sit around and have their cuppa in the morning or the afternoon. [With affection and love towards deer, these property owners and their family members including kids would call deer by names] hey look at my deer, that's Fred – that's Sam – that's Daisy"

Informants 1 and 5 stated that a lack of resources, skills, knowledge and awareness are the factors responsible for all levels of government not pursuing control action.[739] Animal welfare concerns are a consideration that creates polarised views on control. Stakeholders that support animal welfare (eg, RSPCA) have been considered as a major influence limiting control of deer.

Varied ideas on 'humane control' and 'humane' ways of killing have become the basis of objection to government action. While describing this issue, one informant (8) stated that:

> [The peri-urban community] perceives it as a rural issue. Perceptions of farmers towards the Government has been extremely negative. It's slowly starting to change but a lot of negative perceptions.

Diverse attitudes

Peri-urban landholders have small landholdings and a major proportion of landholders depend upon off-farm income. Land is neither a primary source of income to these landholders nor do they expect it to be so. As a result, they can have a carefree attitude towards pest animal issues on their or surrounding properties. This is reflected in the following statement:[740]

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[739] Document - Neighbour Attitudes to Deer Management Program Effectiveness 2004.
[740] Key informant 5.

Diversity of land uses and different attitudes is a problem. Diverse land use makes it harder to implement control. Also, it is challenging to capture diverse landholder attitudes.

Animal welfare

The community understands the importance of pest animal control, but people are also very concerned about animal welfare. Implementation of government assisted control programs can be politically difficult without co-operation from animal welfare organisations. While explaining the intricacies of implementing control program, Informant 5 explained his own experience in implementing a feral deer control program:

> The RSPCA specified the calibre to be used in a rifle as a criterion of humaneness in ground shooting. There was enough evidence to indicate that a calibre doesn't make control program inhumane.

While explaining the need for engaging animal welfare organisations in peri-urban pest animal control programs, he went to explain

> (It is vital to) recognise the importance of engaging with animal welfare organisations in peri-urban areas. Without the support of RSPCA, it is hard to convince community particularly since there are more RSPCA members in urban and peri-urban areas (caring) about the validity and satisfactory fulfilment of humaneness criterion in the selected control method. Effective negotiations with RSPCA (or other animal welfare organisations like PETA) in selecting a proper control method may help in carrying out control. The support of key stakeholders including animal welfare organisations helps in building trust and motivation among community. It helps in lifting the spirits of stakeholders who may initially oppose control program on animal welfare grounds.

Due to animal welfare concerns, new control innovations can create political risks and hence become a politically disputed issue. Dominant interests are represented by politicians, hunting lobbies and animal welfare groups who influence policies, which create difficulties in making controls politically feasible. For example, The Animal Justice Party secured a seat in a recent election in the NSW Government.[741] The party seeks a new legal status for animals and stringent regulatory and enforcement actions

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[741] Legislative Council 2016 General purpose standing committee No 5. Parliament House, Sydney.

for the protection and well-being of animals while repudiating 'ag-gag' laws.[742] These may make future deer control even more difficult.

The stakeholder organisations adopt different views on control measures and best practice depending upon their 'interests' rather than pure research-based claims. For example, organisations that support hunting or shooting see criticisms of some control methods (eg, hunting with a G-licence) by animal welfare organisations as manipulating legitimate control measures and best practice for their own interests. If there are divided opinions among stakeholders about any contentious issue, the chances of getting that issue politicised increase, particularly if a stakeholder group has concerns about the way the program is being conducted. In such situations, landholders approach local councillors, expecting these politicians to take actions in their favour. Decisions taken by political leaders in such situations can ruin a pest control program. It is difficult to justify program decisions to urban and peri-urban councillors who lack understanding of pest animal issues as compared to rural councillors who are more attuned to these issues. For example:

- Political intricacies over SPC trials in NSW National parks are discussed in the submission by Valleybrook Hunting Club which opposed SPC trials in NSW National Parks on the grounds of politics, cost-effectiveness and efficiency over ground or helicopter shooting.
- The influence of politics in decision-making is well documented. For example, the NSW State premier's negotiations with the Shooters and Fishers Party for opening selected national parks in NSW to hunting and subsequent reversal after public outrage.
- A single incident can create a media backlash and public outcry.

When implementing a control program, consistent efforts are needed to make sure that local politicians are aware of the pest animal problem, its context and the efforts being taken to address the problems. In peri-urban areas, local politicians are a mix of urban and rural councillors. Rural politicians generally have a background awareness of pest animal control issues compared with less so among the urban counterparts.

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[742] Animal Justice Party <http://animaljusticeparty.org/policieslist/humans/animal-law/>. The charter of the party reflects its objective: 'Support the development and adoption of non-invasive and non-lethal methods to control native and introduced animal populations, including fertility control and more appropriate land management methods' <https://animaljusticeparty.org/about/charter/>.

This can make it challenging to convince politicians of the need to address pest animal problems. The knowledge and awareness of politicians also impacts on allocation of funds for pest animal issues.

Informant 5 described his way of creating awareness among peri-urban councillors on pest animal issues:

> I make an effort to actually take them (councillors) around and show them (pest animal) issues, especially ones that we know that in the past have been an issue so that when it comes up again they (councillors) understand it. And if you do that properly it saves me a lot of work because the community will go to the councillor, wanting the councillor to get up me to do what the community wants them to do. Whereas if I can educate the council about why we made a decision; s/he will have that conversation with the community, which is great.

Informant 6 stated that the voice of the hunting lobby in deer control and management has historical significance. Hunting is one of the possible solutions to manage deer population up to certain levels, and it is helpful in providing financial resources to the state government through licences. While commenting on the game status of deer and the effectiveness of hunting as a method of deer management, the informant took a cautious and neutral position:

> If you are wanting to manage [deer] down to about half the carrying capacity of the land, hunting is a solution. But if you want to manage [deer] down to extremely low to very low levels, hunting is not a solution. Thus [the role and effectiveness of hunting] varies as per the management goal. Hunting becomes appropriate in certain cases and may prove counterproductive in other scenarios.

While commenting on the strong political voices on hunting, the informant (6) noted the role of other stakeholders in achieving a balanced position depending upon the context of problem and goals of management:

> You've got a loud hunting voice, but there are other voices as well. I think you have got to boost the other voices through other organisations like Landcare groups or farming groups.

5.3 Case study 2 – Wild dog management in peri-urban Brisbane

5.3.1 Introduction

The peri-urban Brisbane case study includes the area of SEQ as shown in Figure 5.5. PUB has been experiencing sustained urban growth over the past four decades. The

growth is characterised by a 'dynamic urbanizing process that involved close sub-division, fragmentation and land use conversion of formal rural lands'.[743] Currently available estimates indicate that the population in the SEQ region is expected to grow from 3.5 million to 5.3 million in next 25 years, which will require around 80 000 new dwellings.[744]

The population growth in peri-urban Brisbane has resulted in 'land use activities with a high degree of heterogeneity, continual change and conflicting values'.[745] The land use in PUB includes the intersection of urban area, rural living area and rural production areas. This has also resulted in pest animals, particularly wild dogs, becoming more widespread.

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[743] Low Choy (2007), above n 22, xvi.

[744] Department of Infrastructure, Local Government and Planning (2017), above n 354.

[745] Patricia M Please et al, 'Prioritizing Community Behaviors to Improve Wild Dog Management in Peri-Urban Areas' (2017) *Human Dimensions of Wildlife*, doi: 10.1080/10871209.2017.1385877.
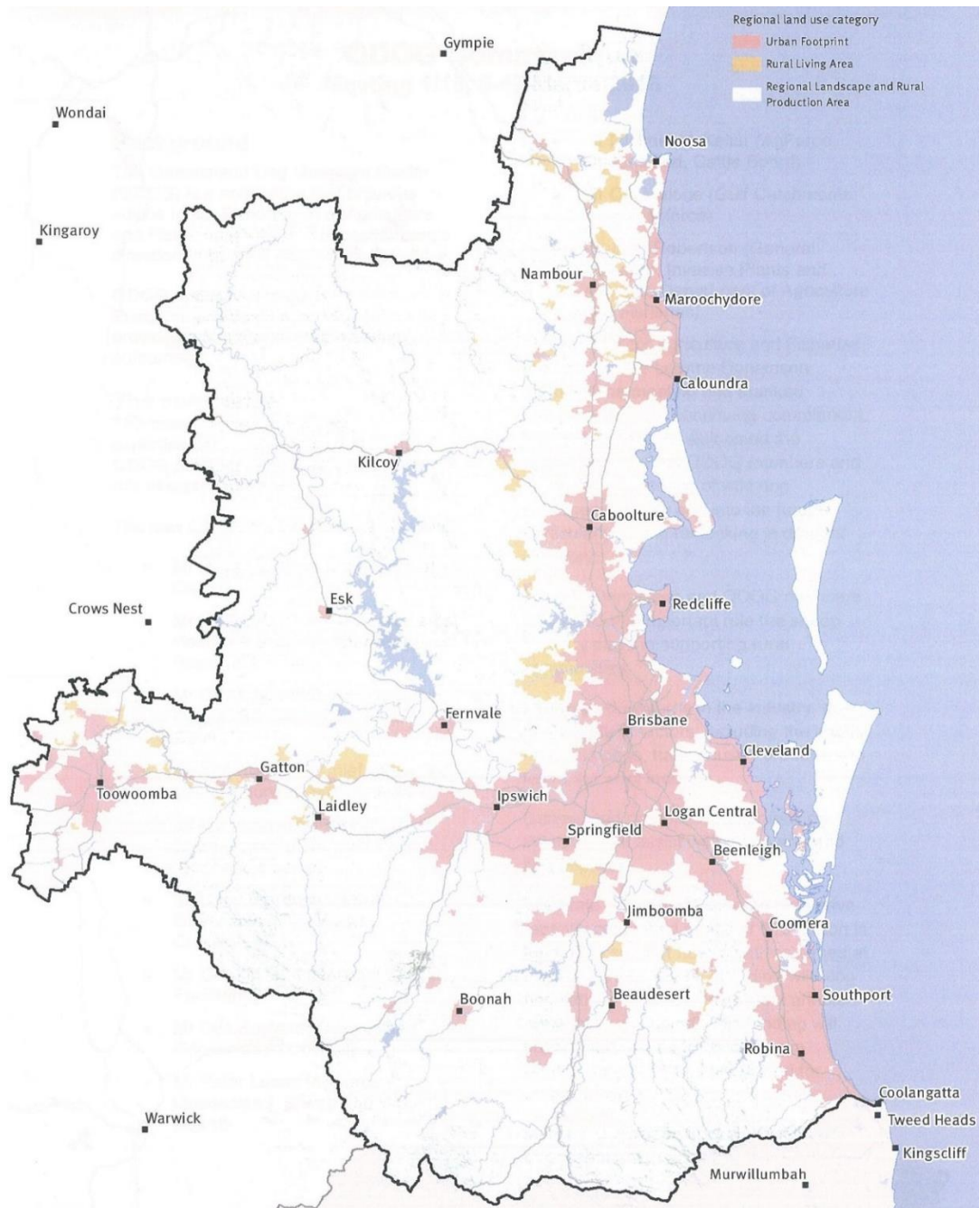
Figure 5.5: Land use in peri-urban Brisbane case study area
(Source: The State of Queensland, Department of Infrastructure, Local Government and Planning (2017) Shaping SEQ, South East Queensland Regional Plan 2017, page number 9).

Continued peri-urbanisation and rural lifestyle residents are likely to increase the

interactions between domestic and wild dogs, resulting in a further increase of wild

dog population.[746] Figure 5.6 shows the estimated distribution of wild dogs in Australia.
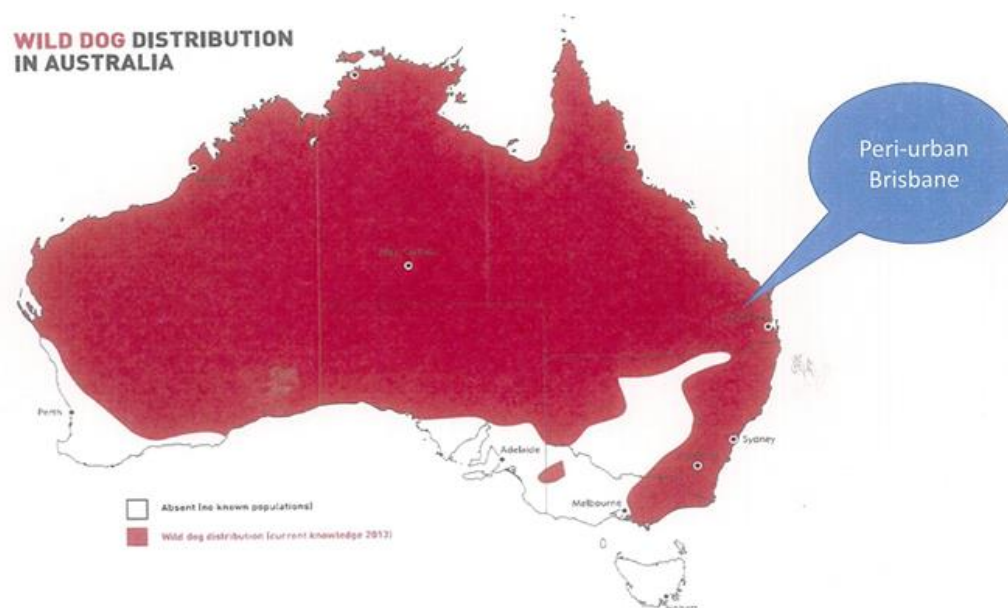
Figure 5.6: Wild dog distribution overlapping the peri-urban area of Brisbane
(Adapted from Wool Producers Australia, *National Wild dog action plan 2014*, 11)

Scientific studies relevant to PUB indicate that wild dogs are often found in backyards, school grounds and parks. Because of a lack of research, specific estimates of wild dog impacts in PUB are not available. Based on the information collected on PUB areas, wild dogs have diverse impacts, including attacks of domestic livestock, physical threats to humans and psychological impacts on humans due to stress and fear within the peri-urban communities. The recent report by the Centre for Invasive Species Solutions (CISS) on the peri-urban wild dog project states that a number of wild dogs have been found in the PUB area with high potential to spread diseases among humans and livestock.[747] Because of limited data, it is difficult to quantify the impact of wild dogs on the environment and biodiversity. The research indicates substantial negative impact of wild dogs on native wildlife.[748]

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[746] A T McNeill et al, Dingoes at the Doorstep: Home Range Sizes and Activity Patterns of Dingoes and Other Wild Dogs Around Urban Areas of North-Eastern Australia' (2016) 6(48) *Animals* 1, doi:10.3390/ani6080048.

[747] Matt Gentle et al 'Dingoes, Domestic Dogs, or Hybrids? Genetics of Peri-urban Wild dogs in NE Australia' (2016). In *Proceedings of 5th Queensland Pest Animal Symposium: Options, Obstacles and Outcomes*, 7-10 Nov, Townsville, Australia.

[748] G Mifsud, *When Does Predation Upon Native Species Move from Natural to a Threatening Process? Observations from Wild Dog Control Programs and the Potential*

5.3.2 Wild dog management

The objective of wild dog management in PUB is to reduce wild dog impacts through community action. As described in Chapter 2, baiting with poisons is the most efficient method for wild dog management, but there is a variety of technologies and management approaches that can be (or are being) used.

The publicly available strategy for wild dog management in QLD outlines the following strategic actions (Table 5.5) for wild dog management in peri-urban areas, which includes PUB.

Table 5.5: Strategic management of wild dogs in peri-urban Brisbane

Strategic actions	Responsible stakeholders
Implement local community-based programs for impact management and reduction of wild dog numbers using nil-tenure management	Land managers, local government and Biosecurity Queensland
Establishment and continuation of local wild dog committees, linkages between the committees	Biosecurity Queensland, Queensland Dog Offensive Group (QDOG), Natural Resource Management agencies
Nil-tenure planning process	All land managers
Implement control	Land managers, government agencies
Local government pest management plans	Local government
Facilitate networking between stakeholders	Local government pest management officers
Promote the implementation of nil-tenure approach for wild dog control	QDOG members
Landholder and community engagement	Wild dog committees, local government
Eradication to prevent the establishment of new wild dog populations	Local government, Biosecurity Queensland
Policy and procedures to support enforcement of wild dog management	Biosecurity Queensland
Enforcement of wild dog control	Local government
Education and awareness of peri-urban landholders	QDOG, Biosecurity Queensland, Local government and NRM agencies

The management of wild dog in PUB is particularly challenging because of:

a) The involvement of multiple institutions and stakeholders. This fragmentation makes it difficult to coordinate wild dog management activities.

Impacts on Koala Populations from Western and South East Queensland (Paper presented at the 15th Australasian Vertebrate Pest Conference, Sydney, 2011).

b) Stringent regulatory restrictions on baiting with poisons, particularly near urban areas.

c) Major challenge for wild dog management arise from land tenure arrangements. The majority of land in PUB is freehold. In QLD, local government is responsible for invasive species enforcement. Local councils do not have control over private lands and lack control over the management of wild dogs on private properties. The local councils encourage and support private land owners to seek funding for pest animal management but the process of funding is complicated, involving considerable paperwork. It is considered as a time and resource consuming process. The councils generally provides limited financial support to community groups involved in pest animal management.

d) The PUB area continuously attracts new residents.[749] Their lack of awareness and experience on invasive species issues negatively affects wild dog control.[750]

In PUB, local councils undertake collaborative wild dog baiting programs several times per year. The wild dog and dingo populations near the national park boundaries are largely controlled by the QPWS staff, working with landholders neighbouring the parks, as well as with Biosecurity Queensland and the council.[751]

5.3.3 Legislation for wild dog management

In Queensland, the *Biosecurity Act 2014* (Qld) governs the management of wild dogs.[752] It is a legal responsibility of public and private land holders to control wild dogs on their lands. The *Biosecurity Act 2014* (QLD) contains the GBO which requires every individual to take reasonable and practical steps to minimise biosecurity risks associated with pest animals under their control. Non-compliance with the GBO is an offence. Biosecurity Queensland encourages voluntary compliance with the GBO and provides services to support management of pest animals. Local governments have an obligation to prepare pest management plans to manage pest animal impacts in their local government areas and to enforce those laws. Prior to the *Biosecurity Act 2014* (QLD), wild dogs were declared class 2 pest

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[749] Low Choy et al (2007), above n 22, 111.
[750] Please et al (2017), above n 745.
[751] Department of National Parks, Sport and Racing – Operational policy – Management of Wild Dogs on QPWS Estate.
[752] *Biosecurity Act 2014* (Qld), Schedule 2, restricted matters and categories.

animals under the *Land Protection (Pest and Stock Route Management) Act 2002* (QLD) with land managers, private individuals, industry and local and state governments having the legal responsibility to control wild dogs on their lands.

As discussed in the scoping study (section 4.3), wild dogs and dingoes are both implicated in wild dog problems. However, their legal status reflects their native/exotic status. The *Nature Conservation Act 1992* (QLD) prescribes the protection and conservation of dingoes within protected areas (eg, national parks). QPWS is responsible for the management of wild dogs within protected areas under its administration. Wild dog includes purebred dingoes, hybrid dingoes and escaped as well as deliberately released domestic dogs. Since dingoes are considered a natural resource under this Act, QPWS is obliged to manage dingoes in a manner that is consistent with their conservation. This includes application of a current understanding of dingo (genetics, identification and population ecology) and prevention of hybridisation between wild dogs and dingoes. Other legislation that influences wild dog control in PUB are listed in Table 5.6.

Table 5.6: Legislation for wild dog management in peri-urban Brisbane case study area

Legislation	Regulated area
Exotic Diseases in Animals Act 1981 Exotic Diseases in Animals Regulation 1998	Exotic animal diseases
Stock Act 1915 Stock Regulation 1988	Stock disease
Land Protection (Pest and Stock Route Management) Act 2002 Land Protection (Pest and Stock Route Management) Regulation 2003	Pests, pest declarations, pest plans, Wild dog fences This legislation governs the action to be taken to control wild dogs and other declared invasive animal species; bestows power to local government to enforce the management of pest animals.
Animal Care and Protection Act 2001 Animal Care and Protection Regulation 2012 Animal Welfare Program	Animal care and protection Act 2001 (Qld) places a legal duty of care on people in charge of animals. Without a permit, wild dogs cannot be moved, fed, given away, sold or released into the environment. A dingo cannot be kept without a permit. GBO is also applied to dingoes. Humane trapping, handling and destruction of animals
Nature Conservation Act 1992 Nature Conservation (Wildlife) Regulation 2006 Nature Conservation (Wildlife Management) Regulation 2006	Impacts of pest animals on nature

Legislation	Regulated area
Forestry Act 1959	Impacts of pest animals on nature, Dingo is protected as a 'forest product' within State forests.
Health Act 1937 Health Regulation 1996 Health (Drugs and Poisons) Regulation 1996	Use of poisons
Pest management Act 2001 Pest management Regulation 2003	Pest control measures
Weapons Act 1990 Weapons Categories Regulation 1997 Weapons Regulation 1996	Use of firearms
Local Government Act 2009	Local pest animals, Local pest animal control plans; Under the Local Government Act Local councils have power to declare pest species that is not declared under the class 1, 2 and 3 of the Act, through the adoption of local law or a subordinate local law that deals with the control of pests for the local government region.
Work Health and Safety Act 2011 Work Health and Safety Regulation 2011	Workplace health and safety, including pesticide use
Biosecurity Act 2014	Control and management of pest animals Mechanisms for local governments to enforce the management of high priority pest animals
Agriculture and Veterinary Chemicals (Queensland) Act 1994	The Act empowers APVMA to carry out its functions in Queensland; and allows the controls relating to the approval and registration of agricultural and veterinary chemicals to apply in Queensland.
Animal Management (Cats and Dogs) Act 2008	Identification and registration requirements for cats and dogs; regulating dogs that pose a risk to public safety
Biological Control Act 1987	Biological control of agricultural pests

5.3.4 Roles and responsibilities

A wide range of stakeholders influence wild dog management in PUB. Institutions for wild dog management exist at the local and state levels of governance. Regional governance arrangements influence wild dog management through NRM planning but in the absence of formal coordinating institutions at the regional scale, it is difficult to achieve effective collaboration between local, regional and state level governance. This section deals with the most relevant stakeholders for wild dog management:

QLD Government

The role of QLD Government is to provide legislative and policy framework for wild dog management.

- *Biosecurity Queensland*

Biosecurity Queensland administers invasive species and biosecurity legislation, policy, training and education. It also administers the *Animal Care and Protection Act 2001* (Qld); Biosecurity Queensland RSPCA share responsibility for enforcing the *Act*. It works with local governments, communities and other stakeholders to minimise the impacts of wild dogs.

- *Queensland Dog Offensive Group (QDOG)*

QDOG provides leadership and advocacy for wild dog management at the state and local level.

- *Department of National Parks, Sport and Racing - QPWS*

QPWS manages national parks and nature reserves, development and implementation of regional pest management strategies, control of wild dogs (as a declared pest animal) under the *Biosecurity Act 2014* (QLD), works with the rural community, supports Landcare and Integrated Catchment Management initiatives and participates in the preparation of local government area pest animal management plans to facilitate coordinated pest management on the QPWS estate.

Regional governance

In Queensland, regional governance arrangements including NRM bodies (SEQ Catchments, Moreton Bay Waterways and Catchments) and the *SEQ Regional Plan 2017*,[753] cover socio-economic and environmental issues of urban growth; but no organisation specifically addresses wild dog management in peri-urban areas.

Local management

Local government and its authorised officers, public and private land managers, local wild dog committees, community and conservation groups. The role of Pest Animal

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[753] *SEQ Regional Plan 2017* <https://planning.dilgp.qld.gov.au/planning/better-planning/state-planning/regional-plans/seqrp>.

Control Officers is to protect the health and production interests and perform the duties allocated by the respective local councils.

5.3.5 Institutional issues in wild dog management

As with the PUS case study, institutional issues are analysed using the six themes as listed in Table 4.1.

5.3.2.1. Theme 1 - Control technologies

Difficulties in regulatory approvals

Innovations in control technologies and products face difficulties because of a complex regulatory approval processes in the use of PAPP in conjunction with mechanical ejectors innovation for peri-urban wild dog management.

Available documents indicate that the APVMA approval process for PAPP began in 2008. In 2012, the APVMA sought updated information on the active chemicals being used in PAPP. The updated application was accepted for full assessment in 2014. The approval process for PAPP and products containing PAPP was completed in 2015. The Therapeutic Goods Administration approved PAPP as a scheduled S7 poison. The category S7 puts PAPP in the dangerous poisons category equivalent to 1080 products. Despite approval by the APVMA in January 2016, the availability of the PAPP product, DOGABAIT, was delayed because of regulatory restrictions. The IACRC also reported concerns about delay in regulatory approvals to the Productivity Commission.[754] The Productivity Commission, in its final report on the regulation of Australian agriculture, confirmed that this problem existed.[755]

Informant 2 stated that the approval of control products and technologies is delayed because of regulatory requirements of the animal welfare and humaneness criteria. Different agencies involved in the analysis of a control product follow varied frameworks to analyse animal welfare and humaneness. This creates gaps in decision-making on regulatory approvals. Commonwealth agencies, for example, the APVMA follow different rules depending on the states and territories that are involved.

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[754] Submission by the IACRC to the Productivity Commission Inquiry on the Regulation of Australian Agriculture <https://www.pc.gov.au/__data/assets/pdf_file/0017/207341/subdr240-agriculture.pdf>.

[755] Productivity Commission 2016, *Regulation of Australian Agriculture* (Report no. 79, Canberra) 25.

Commonwealth agencies involved in regulatory approval processes have different expectations and criteria for their decision-making. For example, the regulatory concerns of the APVMA are different to those of health agencies. The different processes of Commonwealth and state agencies lead to further confusion and miscommunications. Since the procedures for approval of control products are not formalised, personal relationships and contacts can be important in getting approvals.

Another informant[756] shared his views on how institutions facilitate or constrain innovations in control measures. He expressed scepticism about the role of administrative and regulatory agencies in facilitating new inventions in control techniques. In his view, regulatory institutions are vulnerable to a lobbying culture that has developed over the years. Effective lobbying is a determining factor in approval of innovations. He suggests that a ground-breaking invention may get suppressed just because of inadequate lobbying. Public research and development bodies cannot lobby on their own, which limits their efforts in advancing the technologies developed through scientific research. Citing the example of innovation supported by the wool industry, key informant 4 explained how institutional structures limit innovations:

> The Wool industry supported the development of PAPP which is useful for pest animal control in closer to urban areas. Registering S7 for PAPP was difficult as the registration agency thwarted efforts. The wool industry as a research and development body cannot lobby, so it has to take the help of other groups for effective lobbying.

Another informant[757] stated that government is steering the wheel of decision-making on regulatory aspects of control. Lack of ownership in the regulatory space makes it difficult to create an enabling environment for innovation and the dispersal of control technologies. Governance issues, like a lack of accountability and transparency in the approval of technologies, constrain efficiency in decision-making.

While commenting on regulatory hurdles facing innovative technologies, a participant pointed out the need for effective leadership and 'ownership' of issues for speedy and efficient regulatory approvals:

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[756] Key informant 4.
[757] Key informant 6

Someone somewhere in the government should say that the review of new technologies and their timely approval or disapproval [should be given priority].

High costs

Desktop research shows that the retail cost of PAPP baits is higher than other available poisons (1080 and strychnine). According to informant 4, this is because:

- PAPP baits involve a 'synthesizer aniline', the preparation of which involves high costs. This is coupled with the cost of institutional issues.

- The regulatory approval process to register PAPP involved high investment costs through IACRC, Australian Wool Innovation and Animal Control Technologies (Australia) Pty Ltd.

5.3.2.2. Theme 2 - Governance arrangements

The following observations have been derived through the review of policy documents for wild dog management in peri-urban Brisbane:

Multiple instruments (policies/strategies/plans/frameworks)

- Multiple instruments enunciating different objectives and approaches indicate differing priorities among landholders and biosecurity groups pursuing control action.

- Multiple instruments at various administrative levels governed by different organisations lead to difficulties in coordination between and within local governments. Each local government has different pest management plans and targets). In cross jurisdictional areas, implementing control becomes difficult because two local governments rely on their competing agendas.

- Local government plans which are not directly related to pest animals also influence control processes.

Lack of clear roles and responsibilities

Wild dogs are spatially distributed throughout the PUB case study area. Multiple stakeholders, including agencies of both state and local governments, are involved in wild dog management. The involvement of multiple stakeholders creates problems for coordinating wild dog control activities, for example:

- Distribution of wild dog management across multiple portfolios administered by state, regional and local agencies and departments leads to scattered control

approaches. This makes it difficult for government to achieve and facilitate coordination for communities to pursue on-ground control.

- The involvement by industry varies depending on the business sector and agricultural products being affected by wild dogs. Thus control efforts are not well aligned with the cumulative efforts as per government's expectations.

- Control outcomes are evaluated by each agency based on their own approaches. This does not give a uniform picture of wild dog control action.

- Decision-making for peri-urban development is largely influenced by economic priorities rather than environmental objectives. This sidelines wild dog control issues from being a top priority at the institutional level.

- Organisations (eg, IACRC) are helpful in bridging the gap by in-depth research of extension and control requirements across the system. Currently such organisations do not focus on peri-urban engagement.

In 2016, a government audit to examine whether Biosecurity Queensland has been achieving its pest animal management outcomes indicated that a lack of clear roles and responsibilities for managing wild dogs impedes the implementation of strategies in wild dog management. This strategy includes peri-urban-specific outcomes for wild dog management.[758]

Informant 2 stated that it is important to clarify the duties and obligations of government and community stakeholders relating to pest animal control in peri-urban areas. This is consistent with recent reports.[759] One of the ways to achieve this is through peri-urban planning instruments that categorically specify the duty of peri-urban residents to manage the pest animal problem with the assistance of local council and implementing agencies.

Lack of ownership of pest animal problem
Informant 6 identified a gap between governance arrangements and new principles of shared responsibility. He stated that shared responsibility requires innovative and evidence-based governance arrangements but that current arrangements have not transitioned to shared responsibility in practice. In his words:

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[758] Queensland Audit Office, 'Biosecurity Queensland's Management of Agricultural Pests and Diseases (Report 12 2016-17, The State of Queensland, 2017) 30.
[759] Craik, Palmer and Sheldrake (2017), above n 5; Martin et al (2016), above n 4.

The government have got an intent and a belief but they are using old governance structures which haven't caught up with the intent of community led action.

Centralised policy decision-making processes fail to capture the institutional intricacies of pest animal control and management at the local levels. While reflecting upon this issue, informant 2 stated:

Policies to resolve the problem and relevant laws are crafted by a few people without the buy-in of the affected communities. This is where the institutional conflict starts."

5.3.2.3. Theme 3 – Evidence

Key participants described a number of problems relevant to obtaining reliable evidence for wild dog management.

Difficulties in the assessment of problem

The mix of environments create difficulties in assessing the distribution (size and complexity) of wild dogs. This creates difficulties in planning control operations.

Informant 4 cited the lack of data as a problem for objective decision-making on control. In his view, the non-availability of adequate information from different sources creates difficulties in understanding how wild dogs have become invasive in a region, to predict threat levels, or to design control approaches. Because of the involvement of multiple stakeholders in wild dog management, information comes from heterogeneous sources and from multiple levels. This information is often a subjective conceptualisation of particular event or situation.

Informant 2 stated that lack of effective monitoring and evaluation methods is a barrier in wild dog control. According to the informant, reporting facilitates assessment of the wild dog threat but local councils are usually lackadaisical in reporting information collected by them. Citing Gold Coast Council's reporting process on pest animal control as an example of better practices, the key participant emphasised the utility of good reporting.

5.3.2.4. Theme 4 - Resources

Financial resources for pest animal management in QLD come through federal and state level funding. The Queensland Government and the federal government provides funding to support regional level projects for community pest animal management.

Federal government funding of A$2 million is allocated to control established pest animals. The QLD Government provided approximately A$2 million funding over three years to local governments.[760] The Queensland Feral Pest Initiative provided A$4 million over three years for wild dog control starting from 2015.[761]

In QLD, the prioritisation of financial investments and human resources based upon biosecurity risk is an objective of the *Queensland Biosecurity Strategy 2018-23*.[762] To this end, the QLD Government has invested in developing a risk based investment allocation model to understand the need for resources and the returns on investment.[763] Local governments have a legal obligation to collect and administer a levy using rate notices.[764]

Despite these efforts, peri-urban management:

- The environment levy are used exceptionally by some but not all the local governments for wild dog management. For example, the Sunshine Coast Council's Environment Levy Report (2014-15) notes that the council used a levy to monitor pest animals including wild dogs by using remote monitoring cameras on private properties.

- For peri-urban biosecurity, the flow of resources from state to regional and local levels is important but, state agencies with their own priorities (e.g. National Parks) compete against other state agencies for resources. Local governments also have to compete with state government agencies for funding and resources.

- Adequate resourcing remains a major constraint at both state and local levels. The report assessing the capability of biosecurity system in QLD found a lack

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[760] Conservation Partnerships, Conservation and Sustainability Services, *Community Sustainability Action Grants* (Department of Environment and Heritage Protection, 2017) 5.

[761] Queensland Government *Queensland Feral pest Initiative*, 2015 <https://www.daf.qld.gov.au/business-priorities/plants/weeds-pest-animals-ants/queensland-feral-pest-initiative>.

[762] Department of Agriculture and Fisheries, *Queensland Biosecurity Strategy 2018-23* (2018) 16.

[763] Model for investment allocation <https://www.daf.qld.gov.au/business-priorities/biosecurity/about-biosecurity/enhancing-biosecurity-capability-and-capacity-in-queensland/model-for-investment-allocatiom>.

[764] Emergency management levy <https://www.qfes.qld.gov.au/about/Pages/EmergencyManagementFireandRescue-Levy.aspx>.

of capacity to respond to incursions and inadequate staffing as key issues constraining effective biosecurity responses.[765]

- Lack of diversity in funding flows at the state, regional and local levels affects peri-urban pest animal control.[766]

- A lack of long-term funding and limited flexibility in funding grants (to suit on-ground changes or variations that happen during control) constrain on-ground control. A lack of continuous funding affects the momentum of control efforts and negatively impacts on relationships with stakeholders.

Informant 4 stated that a lack of resources affects the capacity to implement control. Government agencies cannot employ enough staff because of restricted budgets. This constrains their pest control despite a willingness to advance control. In peri-urban areas, hobby farmers are engaged in concurrent employments. Because of the non-commercial nature of their farming, limited time availability and lack of knowledge and awareness of pest control issues, these stakeholders have a limited engagement in wild dog control programs.

5.3.2.5. Theme 5 – Planning

Informants highlighted the following concerns with the planning processes for wild dog management:

Lack of coherent planning

Informant 2 stated that there is no coordination between and within local government plans. Each local council has a different pest management plan and different targets. In the peri-urban area, implementing control becomes difficult as different local governments pursue their different agendas. The industry sectors affected by wild dog issues have their own plans. Informant 4 stated that pest animal threats vary for industries depending upon their business product. Hence control efforts of industries remain sector-specific.

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[765] R Brooks, R Glanville and T Kompas, Queensland Biosecurity Capability Review, (Final report to Queensland Government, Brisbane, 2015).

[766] Who Should Fund Wild Dog Control? Government or Industry? <http://www.abc.net.au/news/rural/2015-08-25/wild-dog-government-funding/6721994>.

Preparation and administrations of plans

Informant 3 stated that planning documents elucidate a patchy and inconsistent approach to wild dog management. The documents lack specific control objectives because of the inability to use measurable performance criteria or specific outcomes. This is partially because of the unavailability of precise data, and weak evaluation. The plans lack enforceable mandates. The landholders enrolled in the plan are usually free to drop out at will since participation is voluntary. This distorts the balance between planning and action.

Assumption-based plans

Informant 4 stated that plans are generally prepared based on unverified assumptions regarding stakeholders' support. The key assumption is that the community will engage to deliver programs. These assumptions may or may not prove right during implementation, leading to success or failure in control. The plans are usually framed using phrases that assume perfect engagement of stakeholders. Such assumptions are rarely based upon experience. It is difficult to realise these expectations.

5.3.2.6. Theme 6 – On-ground implementation

Regulatory and procedural requirements for implementing control

In the PUB case study area, the application of poisons is restricted by stringent regulatory and procedural requirements. This includes compulsory licences and mandatory training for use of poisons. Regulatory requirements discourage landholder action. Informants highlighted the following regulatory restrictions[767]:

- Restriction on individual landholder's use of canid ejector

For the use of a canid ejector, a landholder can dig a hole and put the ejector inside the hole but the regulation allows only local government staff to position the cartridge, replace or service it. This discourages individual landholder action in implementing control.

- Warning signs

Warning signs are required to be displayed at property entrances and boundary posts along roads before the start of baiting program and must remain in place until four

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[767] Document - Toowoomba wild dog baiting program 2018.

weeks after the end of approved programs, or until residual baits are recovered. The installation of warning signage boards is a time consuming activity, and can discourage involvement.

- Distance restrictions

Poison baits are not allowed to be placed a) within 150m of a dwelling, b) within 20m of a watercourse, c) within 5km from town boundaries or roads. If baits are to be laid within 5km of town, the prior approval of Biosecurity Queensland is required. This imposes significant restrictions in more closely settled areas.

- Notification requirements

Following notification processes can be an obstacle in implementing wild dog control

- All neighbours whose boundary falls within 1km of bait sites must be notified. This regulation is applicable for National Parks and Forestry reserves as well as private landholders.
- Written notification must be given to all occupiers of dwellings within 2km of the bait sites.
- All the immediate neighbours must be notified 72 hours before the application of baits.
- Detailed safety requirements, though arguably justified, are complex and do discourage participation in control programs.
- Poison baits must be transported in marked and sealable containers.
- Unauthorised access to bait must be prevented.
- Baits should be used only on the properties identified on the indemnity form. The form must be sent to landholders participating in a baiting program approximately two weeks before the implementation.
- Landholders who are unable to receive baits can request someone else as a representative) to pick up baits on their behalf. For this, the landholders are required to sign authority forms.
- Indemnity forms are required to be signed by landholders or their representatives before collection of baits.
- Baits cannot be stored for future use nor used/supplied to other properties.

- All meat baits must be 250 grams in size, fresh, without bone/fat/skin, and must be tied/buried.
- Domestic pet animals (dogs/cats) need to be restrained during the control program.

- Regulatory restrictions on the use of PAPP

Due to different contexts of control, managers of baiting programs may prefer to use DOGABAIT in conjunction with 1080 products. For this, landholders need the access to both DOGABIAT and 1080 products. The access to each of these products is restricted by government regulations. For example:

- The Department of Natural Resources, Mines and energy (QLD) along with the local governments are the traditional suppliers of 1080 or strychnine. Only these agencies are eligible to provide PAPP baits due to the Restricted S7 regulation.[768]
- Only local shire councils and accredited rural merchants (within a limited area) are authorised to provide PAPP baits.
- Only licensed, Biosecurity Queensland officers and local government operators can provide 1080 poison or fresh meat baited with 1080 (eg, manufactured 1080 baits – Doggone, DK-9).
- A Strychnine permit approved by Queensland Health Department is required to purchase strychnine from chemists and the purchase of 1080 solution is prohibited.

Informants expressed the need for greater flexibility in the rules for implementing poisons to facilitate control implementation in peri-urban areas:

Informant 2 agreed that regulations are essential to ensure safety and to reduce accidental non-target impacts while implementing control. However because of concerns over non-target harm, the rules are very stringent for control in peri-urban areas. Constantly changing land use patterns and the juxtaposition of different land uses constrains pest animal control in peri-urban areas. Legislative and administrative decisions at the Commonwealth level are taken without understanding of the

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[768] *Health (Drugs and Poisons) Regulation 1996* (QLS) app 7, regulated poison.

overlapping requirements at the state or local levels. Informant 3 stated that these regulatory requirements and processes for implementing control programs are cumbersome and time-consuming. These include notification, processes involved in obtaining consent from local people by collecting their signatures, and the preparation of list of non-targets as mandatory requirements.

Informant 5 stated that in addition to ensuring safety, the objective of notification is to instil ownership of the problem amongst land managers but notification requirements makes control a tedious process.

> As part of notification requirements, it is hard to get information about residents staying [within the vicinity of two kilometres] of the property where baiting is being conducted. You can't get that information out of a phone book. That's not readily available. And it is [not easily accessible] considering privacy and freedom of information laws which put restraints on local governments [in disclosing that information].

Participant 3 described these procedural activities as complex and time consuming. For on-ground control facilitators, travelling long distances for control operations involves substantial amount of time. After reaching the control site, regulatory and procedural requirements can create further uncertainties (eg. if the required number of signatures are not received), delaying the commencement of control operations.

- Lack of sufficient information and skills required to use control products:

Although information on technologies is readily available through websites, lack of operative and procedural knowledge and technological limitations constrain their use. The basic skills required for the use of PAPP in conjunction with ejectors are:

- In-depth knowledge of baiting including of prime times for baiting, co-ordinated baiting, place of baits, replacement of baits, establishment of bait stations, clustering of baits, marking bait sites, methods to use and protect working dogs during baiting, and the use of ejectors including techniques to make lures attractive to cautious wild dogs.
- The operative aspect of ejectors involve precautionary measures for example: lure heads require periodic checking and replacement as they may attract non-target species, including working and domestic dogs.

- Animal welfare issues

Legislation strictly prohibits measures that may contravene provisions relating to the prevention of animal cruelty.

In QLD, the inhumane killing of an animal is defined as an offence of cruelty, with stringent punishment. The maximum penalty for an individual convicted of cruelty to animals is A\$243 800 or three years imprisonment under the *Animal Care and Protection Act 2001* (QLD). There are also offences for severe animal cruelty under the *Criminal Code Act 1899* (QLD) with a maximum penalty of seven years imprisonment. *The Animal Care and Protection Act 2001* (QLD) permits poison baits for pest animals and allows killing of pest animals in a humane way. It is an offence under sections 34 and 35 of the *Act* to possess and use certain traps and spurs.

One participant stated that the lack of consistent laws (eg, laws relating to domestic pets) and expectations of voluntary compliance rather than enforcement lead communities to ignore regulations. For example, the registration of pet dogs is a requirement but many dogs are not registered.

Informant 2 stated that ejectors with PAPP as a poison could prove a very useful control technique particularly in peri-urban areas. However 'lethal vs humane' control[769] is a major consideration in stakeholders' selection of control methods. Lethal control options are perceived as inhumane, which affects their adoption.

Informant 3 described the problem of lack of regulatory compliance by peri-urban landholders. Animal microchipping and registration is compulsory to facilitate differentiation between pet and pest dogs. There is no charge to register assistance animals and working dogs, but pet owners do not view this as a serious obligation. A lack of regulatory compliance by pet dog owners creates difficulties for pest managers in differentiating between pet and wild dogs. Moreover, the expectations of voluntary compliance lead peri-urban communities to ignore regulations. A lack of responsibility in managing domestic dogs by peri-urban pet owners contributes to the breeding of wild dog population and to increased attacks on livestock. Difficulties in distinguishing domestic dogs from wild dogs makes it difficult for the government managers to enforce regulations.

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[769] For example toxins, lethal poisons are not perceived as humane.

- Participation

Informants discussed the following reasons for lack of community participation in implementing wild dog control:

- Misperception of control programs

- Weak motivations for control

- A lack of effective enforcement

- Divided community opinions about controls

Each of these elements is discussed in detail below:

Perception of control programs

Informant 2 noted that landholders who are aware of pest animal problems may take up control activities but control is effective only if all the landholders actively participate and cooperate. According to this informant, perception of control programs plays a major role in participation. He cited his own experience of wild dog control in national parks. For any control program, signs and warnings were erected about the closure of the national park. Despite closure, people ignored the signs and warnings and continued to use the national parks with their pet dogs. Incidentally, a domestic dog was killed and the community perceived the control program as inhumane and contacted the media, which made it a controversial issue. People's perceptions and the media's generation of public antagonism prevented further control activity. Such perceptions are strong whereas perceptions favouring pest animal control (eg, wild dogs may attack small children) are typically weak.

Informant 3, supporting this observation, stated that the role and support of media in providing access to rational and 'true' information on control measures and the need of fulfilling legal responsibilities by community stakeholders (for eg, confining domestic pets) should and can play an important role in wild dog management programs.

Motivations of control

Informant 2 stated that the interest of community stakeholders in wild dog control varies depending on the impacts. In peri-urban areas, producers who suffer the impacts are interested in pursuing control, while others who do not experience impacts are not concerned, and may have positive interests in pest animals. The peri-

urban community involves citizens who are, in general, inquisitive about policy issues but lack understanding of invasive animal issues. Their curiosity makes them expectant that government agencies will take preventative or responsive actions. Due to a lack of personal experience in control, this group of citizens is forgiving in the event of inaction or the slightest failure on the part of government agencies. Hence public scrutiny compels relevant government stakeholders to carefully review each and every action, becoming ultra-cautious about control programs.

Lack of effective enforcement

Informants 3 and 5 stated that government policy relies on voluntary approaches for wild dog control. Voluntary compliance is generally triggered only if educational and communication strategies are pursued aggressively to create awareness among the diverse peri-urban population and to disseminate knowledge on pest animal controls in peri-urban environments. Currently, weak implementation of community engagement approaches means that they are often not effective.

Division of opinions on control

Informant 3 stated that government and community stakeholders are divided in their opinions, approaches and control efforts. For example, control processes vary among local government councils.

> For wild dog control, despite well-recognised standard operating procedures, the RSPCA may raise concerns about traps as cruel and barbaric. These confrontations are major obstacles in proceeding with any control program.

Informant 5 noted that in the peri-urban context, whether people have urban or rural backgrounds influence people's control choices. The presence of multiple stakeholders with varying individual perceptions, with some perceptions formulated or supported by social media, creates the risk of misconceptions about the use of poisons and their effects. Despite well-selected control approaches there are risks and uncertainties during implementation, such as the possibility of domestic pets being killed. Political intervention can lead to further difficulties in such a scenario. The diversity of stakeholders and a lack of a balanced approach thus limits control.

To address such complexities in peri-urban control efforts, informant 3 suggests that on-ground practitioners need to adopt an approach that effectively balances multiple

stakeholders' views in the given context of control. This is a further institutional constraint on the use of potential innovations.

Another key informant[770] emphasised the need for consistent efforts to make local politicians aware of the pest animal problem, its context and efforts taken to address these problems. In peri-urban areas, there is a mix of urban and rural councillors. Rural councillors generally have a background awareness of pest animal control issues, unlike their urban counterparts. This makes it challenging to convince politicians of the need to address pest animal problems. The knowledge and awareness of politicians impacts the way financial resources (funds) are allocated for pest animal management issues.

5.3.2.7. Additional perspectives by the key informants

Regulatory compliance

Informants 2, 3 and 7 discussed the problem of a lack of regulatory compliance in peri-urban areas. Peri-urban landholders enjoy living in the bush but do not understand their responsibilities. Absentee landholders and other peri-urban dwellers often do not cooperate in coordinated pest animal control programs. Regulatory compliance is considered a necessary tool to achieve frontline outcomes but

> In urban or peri-urban areas, we do come across people who do not have the skills or knowledge or awareness and that can be more difficult for the people that are not going to do the work anyway. I don't think it's [about] changing their behaviour. It's making them do the work [through effective enforcement].

Governance arrangements

All the key informants expect a change of culture within the government organisations at all levels because of changes to laws and policies, and because of the many barriers to long-established approaches.

Informant 6 stated that the government agencies increasingly perform their roles as enablers instead of being responsible for tangible pest animal control outcomes. This leads to significant misunderstandings among private landholders about the policy of shared responsibility. Government as an enabler aspires to achieve a balance between stakeholder roles and responsibilities. If stakeholders do not understand the logic

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[770] key informant 5

required for the implementation of a control program, those stakeholders may view legal and policy based roles and responsibilities as 'deficient' and believe their participation is not vital for pest animal control. This observation about shared responsibility is consistent with the conclusions of other institutional analyses.[771]

Informant 6 suggests a change of culture in government requires effective leadership grounded with highly visible action instead of mere political or bureaucratic statements. This leadership is not yet evident.

Informants 9 and 10 described fragmentation at government and community levels. In the view of the informant 9, each government agency has different motivations and interests in controlling pest animals, which also brings in varied opinions on impacts and decisions on how resources would be utilised. Thus, the problem of pest animals is viewed differently through the legal frameworks of government agencies. Since control efforts vary depending upon agency priorities, it is hard to assess real progress. Agencies contradict each other's goals, leading to finger-pointing and conflicts amongst agencies. In general, priorities are divided between economic and environmental interests.

In the rural-urban fringe, land use has encountered a sea change. It is a resources rich environment but competing values relating to animals, negative perception of lethal control methods, and welfare concerns make it difficult for government to implement control.

Informant 10 reflected upon the impact of fragmented governance on the capacity to implement innovations. In his view, pest animal management has multiple competing goals depending upon the interests on stakeholders from government and the community. Thus, a lack of specific and consistent goal leads to fragmented action. It also distributes resources and capacities in different directions, pursuing results which may or may not lead to effective outcomes. Roles and responsibilities in pest animal control are not clear. Scattered management processes (planning, monitoring, evaluation, and extension) and capacity (inequity in capacity) lead to suboptimal outcomes on any potential goal.

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[771] Craik et al (2017), above n 5; Martin et al (2016), above n 4.

Structured bureaucracy and top-down approaches make it difficult to innovate in government itself.

Informant 10 stated that capacity building/capacity development is the best solution to align pest control efforts. In capacity building, he stresses the principle of equity among stakeholders and equity in channelising capacities. The government stakeholders should have the capacity to organise communities of action setting rational and realistic goals (about what can be done/what can't be achieved). This type of systematic support for shared responsibility and landholder biosecurity obligations has not yet emerged.

5.4 Conclusion

In this chapter, two case studies have been described to explore institutional dynamics for the adoption and implementation of innovations. The case studies included wild deer management in PUS and Wild dog management in PUB. The case studies covered innovations with different characteristics ranging from control techniques, such as shooting or baiting, to innovations that were applicable for collective action. The case studies illustrated the ways in which institutional dimensions varies from species to species, and the nature of innovation. In conclusion, the empirical investigation through two case studies helped in the identification of institutional issues for innovation-adoption and implementation. These issues are further summarised in Chapter 6 (Table 6.1).

The next chapter of this thesis describes the analysis of peri-urban institutional issues with the help of four theoretical approaches and variables discussed in Chapter 2 of this thesis. It also describes the results of a survey conducted to verify the relevance and consistency of institutional issues derived through a scoping review (Chapter 4) and case studies (Chapter 5). The survey instrument covers themes, issues and elements derived through general scoping (Chapter 4) as well as peri-urban specific investigation (Chapter 5).

CHAPTER 6: ANALYSIS AND DISCUSSION OF THE RESEARCH FINDINGS

6.1 Introduction

This chapter has three purposes:

a) To synthesise legal and institutional issues based on the research findings.

b) Using the variables identified in Chapter 2, categorise legal and institutional impediments to innovation adoption and implementation for more effective pest animal management in peri-urban Australia.

c) To examine the hypotheses of institutional issues derived through the investigation and obtain more interpretive information through analysis of a small sample survey results.

The scoping study identified six institutional themes containing multiple issues and elements that constrain innovation adoption and implementation. Based on these six themes, further investigation through the peri-urban case studies led to a more detailed understanding of how institutional issues impact on implementation of legal duties to control harmful invasive species and, in particular, the deployment of novel technologies and management methods. The details from stakeholder interviews facilitated particular insights into specific institutional issues of pest animal management and broader challenges of implementing invasive species management innovations.

The cumulative evidence from the scoping study (Chapter 4) and peri-urban case studies (Chapter 5) revealed two sets of institutional issues. These institutional issues are synthesised in Table 6.1. They comprise 6 themes, 15 issues, 49 general elements, and 33 peri-urban specific elements. The table illustrates that general institutional issues identified through a scoping study remain relevant in peri-urban areas but the peri-urban areas contain additional elements arising from the unique features of peri-urban institutions: innovation and adoption of control technologies in the peri-urban context is substantially constrained by the political impediments and difficulties in securing regulatory approvals; the complexity of governance arrangements and lack of clarity on roles and responsibilities leads to an ownership problem; lack of access to available data and difficulties in quantifying the problem to have a clear assessment constrains the availability of objective evidence on the pest animal management

problem; and, in addition to lack of financial and human resources, lack of time considerably affects the ability of peri-urban stakeholders to implementing pest animal control. The table shows there are multiple institutional issues relevant to planning because of the dominance of government in planning processes in spite of a policy prescription of community-led planning approaches. The table also shows that regulatory restrictions, lack of enforcement-based compliance and behavioural as well as perception-based issues negatively affects on-ground implementation of control.

Table 6.1: Peri-urban institutional issues

Theme	Issues	Elements	Peri-urban elements
Control technologies	Innovation/ adoption of control technologies	Inadequate resources Inadequate research partnerships and coordination Difficulties in regulatory approvals Cost-effectiveness	Political impediments in adoption of control technologies, Difficulties in regulatory approvals, High costs
Governance arrangements	Legislation	Difficulties in identification of pest animal species Duplication of laws Spill-over effects from other legislations Lack of human behavioural considerations	Legislations adopting different regulatory approaches, Multiple instruments including policies, plans, strategies, agencies, frameworks, Lack of clear roles and responsibilities, Lack of ownership of pest animal problem
	Policies	Lack of clarity on shared responsibility Lack of integrity among policies Lack of policy performance indicators	
	Plans	Multiple plans	
	Programs	Multiple programs	
	Agencies	Multiple agencies with separate mandates	
	Roles	Diverse roles and responsibilities affecting collaboration Gap in responsibilities and allocated resources	

Theme	Issues	Elements	Peri-urban elements
Evidence	Pre and Post control evidence	Problems in availability of data and information Lack of effective monitoring Difficulties in data collection, integration and analysis Difficulties in obtaining realistic estimates Difficulties in measuring performance Difficulties in quantifying perceived impact Inadequate reporting Absence of tools to test veracity of received information Absence of tools and methods to assess data Lack of adequate methodologies to evaluate performance	Lack of objective data and information, Access to data and information, Difficulties in the assessment of problem
Resources	Lack of financial and human resources	Lack of adequate government investment Lack of clear estimates Lack of transparency in investments Inadequate human resources	Lack of financial and human resources, Lack of time
Planning	Lack of effective planning	Lack of definite pest control objectives Lack of flexibility Lack of communications with general community/stakeholders	Difficulties in having agreement, Lack of community involvement in planning, Lack of coherent planning, Preparation and administrations of plans, Assumptions-based plans
On-ground implementation	Accountability	Community's overreliance on government Government's overreliance on community/volunteers Lack of coordination for shared responsibility	Regulatory restrictions, Lack of accountability, Ineffective administrative processes, Lack of effective use of law to facilitate pest management,

Theme	Issues	Elements	Peri-urban elements
	Administrative arrangements	Regulatory and procedural requirements including licenses, training, complex procedures for funding	Perceptions, Diverse attitudes, Animal welfare, Political issues
	Extension arrangements	Inadequate communications with stakeholders	
	Laws and regulations	Liability Enforcement and compliance Community expectations Animal welfare	Regulatory and procedural requirements for implementing control, Lack of sufficient information and skills required to use control products, Animal welfare, Participation, Perception of control programs, Motivations of control, Lack of effective enforcement, Division of opinions on control
	Participation	Lack of community engagement Inadequate political support Lack of incentives Diverse attitudes Acknowledgement of citizen contributions Inadequate use of citizen science Inadequate knowledge and awareness among stakeholders	

6.2 Peri-urban institutional impediments

Based on theories for innovation adoption and implementation, four variables were identified that were hypothesised as likely sources of legal and institutional impediments to innovation adoption and implementation for effective pest animal management in peri-urban Australia. These are listed in Chapter 2, Table 2.9, of this thesis. The four variables help categorise how institutional issues impede innovation adoption and implementation, allowing the researcher to develop a list of institutional impediments.

Following is the list of hypothesised institutional impediments that the evidence suggests help to explain problems with innovative control of invasive species and the satisfaction of legal obligations to carry out that control.

- Hypothesis 1 – Fragmented governance arrangements in conjunction with community-level fragmentation affects decision-making.

- Hypothesis 2 – Fragmented governance arrangements affect the availability of resources for innovation adoption and implementation.

- Hypothesis 3 – Ambiguous standards of legal liability do not facilitate implementation of innovations.

- Hypothesis 4 – Enforcement measures are not capable of fully securing compliance with pest animal management obligations.

- Hypothesis 5 – Regulations fall short of balancing government and community objectives for pest animal management.

- Hypothesis 6 – Complex bureaucratic arrangements do not adequately facilitate implementation.

- Hypothesis 7 – Political barriers impede implementation efforts.

- Hypothesis 8 – Lack of motivation constrains the participation of government and non-government stakeholders.

- Hypothesis 9 – Risks or perception of risks affects the adoption and implementation of innovations

Though, for reasons discussed in Chapter 3, empirical proof of complex policy hypotheses is not generally feasible, an accumulation of evidence from different sources can build up an objective justification for policy proposals. This chapter adds to that evidence. Section 6.2 provides the results of data analysis. The process followed for analysing interview data has been described in Chapter 3. Documents describing the results of interview data analysis are provided in Appendix 5.2.

This section comprises four sub-sections. Each sub-section describes the findings from empirical investigation focussed on a theory-based variable.

6.2.1 Synthesis of findings reflecting transaction cost theory

The governance arrangements in peri-urban areas comprise multiple and overlapping legislation and government agencies overseeing pest animal management. These have different objectives and approaches, evident through multiple policies, plans, strategies and frameworks. The multiplicity of rules and interpretations can create difficulties in deciding the 'pest' status of an animal. Lack of clear control roles and responsibilities undermines the ability of community stakeholders to pursue pest animal control. Current roles and responsibilities have a hierarchical structure as prescribed by the government but in the two jurisdictions examined in detail this is

not structurally consistent with the new 'shared responsibility' paradigm. The hierarchical structure becomes problematic given many overlapping public roles in peri-urban areas. There is no mechanism to ensure an alignment of governance arrangements that overlap in peri-urban areas. Both case studies showed that governance arrangements are overlapping and very fragmented. The fragmentation of governance arrangements also leads to disintegration of human and economic resources in peri-urban areas. The empirical evidence shows that the governance arrangements are fragmented and fragmented institutional arrangements lead to transaction costs which, in turn, impede the effective implementation of control innovations and the implementation of laws and policies requiring control of harmful animals.

Information costs

Stakeholders require information on pest animal management at various stages of control. Partly due to fragmented governance, information pertaining to pest animal control technologies and management is dispersed. Fragmentation inhibits the flow of information needed to support innovation adoption and implementation. It constrains the ability of institutions to provide clear and explicit information and stronger incentives. A traditional top-down extension model is used to govern flow of information on pest animal management. The top-down communication and extension services do not elicit sufficient broad support from non-government stakeholders and communities in peri-urban areas primarily because of their inability to deliver persuasive opinions on animal welfare issues. Government communications are intrinsically compromised by the need to avoid advocating 'partisan' positions on contentious issues.

Decision-making costs

Fragmented governance and competing views on control approaches lead to a failure of consensus on the use of control technologies. A fragmented institutional framework creates administrative challenges when government agencies take decisions on similar pest animal issues. Inter-governmental arrangements for decision making processes are not well coordinated. Multiple control and management approaches make it difficult to have a specific set of rules that provide uniform guidance supporting pest animal management. The fragmented processes often

requires constant restructuring of decisions. In terms of structural institutional elements, pest animal management agencies are organised within a strict hierarchy of rules, procedures and tasks. This institutional structure connotes concentration of decision-making power at the top levels, with limited real participation of stakeholders down the hierarchy. Such a structure inhibits fair distribution of resources and participatory decision-making for pest animal management. The institutional structures and working procedures convey that hierarchical decision-making controls pest animal management. Also, the distribution of authority and resources are highly unequal. The roles and responsibilities are not clearly defined. There is no formal decision-making framework that ensures participation of all the stakeholders involved in pest animal management. While policy decisions are made at the top-levels of government, implementation is the responsibility of local government and non-government stakeholders at the lower levels. This hierarchical model perpetuates a top-down model of information and resources flow. These institutional issues negatively influence shared responsibility and the participation needed for on-ground pest animal control.

Co-ordination costs

The case studies reinforce the general understanding and the views identified in the scoping study that it is difficult to reduce the impacts of pest animals without coordinated control action by stakeholders. The case studies also showed that coordinated control is difficult in peri-urban areas for many reasons. Fragmentation at the institutional level makes it more difficult to coordinate action across public and private lands. The problems of securing nil-tenure management include competing objectives of public and private land management and common boundaries between public and private land managers with different interests. The control efforts taken by public land managers may not ensure the full range of benefits if pest animals take refuge on private lands where no control efforts are being taken or vice-versa. This is ample evidence that the problem is widespread. It is particularly institutionalised for deer control. Coordination costs also include the costs of securing participation of stakeholders, who may avoid participation because of lack of incentives, lack of time, lack of knowledge and awareness, and varied land uses that are not perceived as being affected by the pest in question. 'Shared responsibility' rhetorically suggests close co-ordination but institutional arrangements act against this.

Resourcing costs

Resources required for pest animal control can be divided into tangible and intangible resources. Tangible resources comprise: a) control technologies, and b) financial and human resources. Intangible resources include: a) evidence on pest animals, b) knowledge of pest animal control application, and c) relationships among stakeholders. All of the evidence gathered reinforces the view that there are insufficient resources and that the available resources are not allocated efficiently. They also suggest that significant innovation in funding strategies is essential.

Institutional issues impede innovation and adoption of control technologies

Peri-urban control dynamics require control technologies that are cost-effective, humane and facilitate coordinated control. Both in PUS and PUB, the available control technologies do not assure that control would be humane and avoid non-target impacts. In PUS, both ground and aerial shooting involves animal welfare concerns and possible non-target impacts. In PUB, the use of PAPP does not fully avoid the risk of non-target impacts. The findings suggest that, to find control technologies that fully comply the humaneness and animal welfare criteria, further innovation is necessary. In both the case studies, it was observed that monitoring technologies need further development so that it is easier to get species-specific evidence. Innovations require sustained research and development support, which is constrained by the inability of institutions to provide financial and human resources and co-ordinated research partnerships. The fragmentation and insufficient resourcing of existing institutions is partly a cause of these problems.

The adoption of control technologies is limited because of the high costs of these technologies. The PUS case study showed that obtaining shooting licences involves both licence fees and membership fees (for R-licences). The PUB case study showed that the purchasing cost of PAPP is higher than for other available poisons. Both the case studies indicated that the availability of pre- and post-control evidence is constrained by high costs involved in using monitoring technologies. Over and beyond economic expense, administrative issues impose significant true costs and frustrations. The empirical investigation confirmed that the administrative and regulatory agencies fail to provide sufficient support and decision-making to facilitate efficient user approval of innovations. The PUB case study indicated the existence of

a lobbying culture which impedes an efficient regulatory approval process. This reflects theories that political agents can impede innovation.

Limited information affects decision-making

Data from empirical investigation suggests that non-rural stakeholders in peri-urban areas often lack adequate understanding of pest animal management issues. New control technologies are introduced with the assumption that stakeholders are well-aware of the benefits of pest animal management and the use of new control technologies. However, technologies are made available but the lack of adequate understanding and animal welfare or humaneness concerns frustrate the use of the technological innovations. Due to a lack of knowledge and awareness on control technologies and their benefits, some peri-urban stakeholders make their decisions on the basis of inadequate information or limited experience. In the literature, this phenomenon is described as the problem of bounded rationality.[772] Lack of information and a lack of institutional mechanisms to compel the use of control technologies impedes the adoption of innovations in peri-urban areas.

Institutional issues impede the availability of financial and human resources

In peri-urban areas (with overlapping jurisdictions with rural areas), the concerns about lack of resources due to a continuous decline in government funding and inability of landholders to invest resources over a long time are particularly valid. The empirical investigation indicated that, despite the availability of some financial resources, there are no sufficiently exclusive resources available for pest animal control. A lack of efficient and trained human resources and time are major constraints in peri-urban areas. Some financial resources may be available but they are often scattered over multiple priorities. Pest animal management gets neglected relative to other socio-economic and development priorities. Because of fragmentation at the community level, it is difficult to take advantage of resources to conduct coordinated pest animal management in peri-urban areas.

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[772] Till Grüne-Yanoff, 'Bounded Rationality' (2007) 2(3) *Philosophy Compass*, doi 10.1111/j.1747-9991.2007.00074.x.

Objective evidence

The study findings show that there are difficulties in obtaining pre- and post-control evidence for pest animal management. The key problem is a lack of reliable data. Findings from the case studies also indicate many constraints in evaluation of data and information. One of the major issues is lack of a clear estimate on pest animal issues necessary for configuring the nature of potential control action. Overall, lack of objective evidence impedes pest animal management. Pest animal management methods, processes and planning is often based on selective evidence which constraints the effectiveness of pest animal management. The systematic improvement in innovations requires that each innovation for pest animal management needs to have evidence of performance. Multiple evaluation frameworks and weak criteria limit the methodological ability to assess the effectiveness of each innovation. The evaluation of effectiveness is further complicated by the context-dependent nature of the performance of pest animal management.

Decision-making

For peri-urban pest animal control, the fragmented structure of governance fosters administrative layers and inadequate provisioning of services for pest animal management. Overlapping institutions in peri-urban areas represent different sectoral interests, often with either an urban or rural focus. This diminishes the overall capacity of institutions to address peri-urban concerns in a coordinated manner. The absence of institutions bridging pest animal issues at the intersection of urban and rural areas and a lack of peri-urban specific governance arrangements, leads to uncertainties in administrative roles and responsibilities for pest animal management.

Governance fragmentation exists in conjunction with community level fragmentation. Peri-urban landholders have different values and interests concerning pest animal management depending upon the land-titles and objectives with which land is managed. These include differences in opinions about control technologies and animal welfare. While fragmentation of governance arrangements impede the flow of resources and information, diversity at the community level creates difficulties in establishing consensus over pest animal management issues because of diverse values and interests. This supports the hypothesis that: *Fragmented governance*

arrangements in conjunction with the community-level fragmentation affects decision-making for adoption and implementation of innovations.

Owing to fragmented institutional arrangements in peri-urban areas, resources are tied to multiple structures. It is clear from the evidence assessment in this thesis that provision of coordinated resources (including services by trained personnel, extension service officers and volunteers) remains a major concern. Dispersed information and data among various agencies leads to a lack of precise evidence for pest management investment. The hierarchical top down institutional structure perpetuates unequal distribution of resources, particularly at the local levels. The competition between local governments and within communities over resources negatively affects coordinated pest animal management. Resources at the community level remain divided because of diverse interests animal management. This supports the second key hypothesis: *Fragmented governance arrangements affect availability of resources for innovation adoption and implementation.*

6.2.2 Findings in the context of path dependence theory

The adoption and implementation of innovations is influenced and shaped by the institutions in pest animal management. The evidence reviewed in this thesis indicates that these include formal governance arrangements and informal institutions. Path dependence theory suggests that the historical pattern of institutions facilitates or inhibits adoption and implementation of pest animal innovations and strategies. The evidence indicates that the following institutional issues describe a historical pattern for pest animal management that constrains adoption and implementation of innovations in peri-urban areas.

Governance arrangements

Governance arrangements for pest animal control have historically evolved with the co-operative federal system of natural resource management governance of Australia. Many of the opinions provided by stakeholders suggest that fragmented governance arrangements do not facilitate coordinated resourcing and decision-making on pest animal management.

Legal liability

Under biosecurity legislation, prevention of biosecurity risk is a shared responsibility and the cost of biosecurity risk should be borne by those who are responsible for damage. The legislation prescribes voluntary measures as a preferred mode for compliance with the pest animal management obligations. However, there are many ambiguities and practical problems of accountability concealed within these simplistic principles.

In the scoping study discussed in Chapter 4, several difficulties in the application of legal liability to pest animal management were identified; the network of public and private tenures, varied interests in managing these properties, and a lack of knowledge and awareness of pest animal management issues substantially affects the control efforts undertaken by government agencies and landholders. Due to the autopoietic characteristics of pest animals, it is hard to tie down the individual liability of landholders who may be responsible for generating or harbouring pest animals on their properties, and it is difficult to generate legal evidence to prove that liability. Conventional standards of legal liability fail to ensure accountability of landholders in peri-urban context. This supports to the third hypothesis of this research: *Standards of legal liability do not facilitate implementation of innovations.*

Enforcement of law and regulations

Traditionally regulatory enforcement is tied to responsibility within a specific jurisdiction. In pest animal management, it is difficult to confine the harm caused by pest animals to a specific land title or jurisdiction. In peri-urban areas, the harm often exceeds legal boundaries created by governance arrangements. This creates difficulties in enforcing obligations enshrined in the biosecurity legislation. In peri-urban areas, political and media interference creates further complexities in attempting to achieve stringent regulatory enforcement.

This is partly why enforcement agencies prefer voluntary compliance approaches to ensure pest animal management. Because of a lack of adequate knowledge and awareness and the absence of coordinated resources, it will be difficult to enforce a duty of care for landholders to fulfil pest animal control obligations. This supports the fourth hypothesis: *Enforcement measures are not capable of securing pest animal management obligations.*

Lack of balanced approach

The investigation shows that the current regulatory system falls short of providing a balanced approach by which both government and community expectations are addressed. This is particularly evident from the PUS case study. In PUS, deer hunting for recreation is seen as a cultural activity. Professional hunting and shooting clubs support this endeavour through club memberships. Historically, the *Game Animals Act* supported recreational hunting as a conservational and recreational activity. On the other hand, other stakeholders have a legitimate demand to manage deer as a pest animal. The conflict of stakeholder opinions on deer as a game animal or a pest animal is irreconcilable. The proposal for change of deer status from game animal to pest animal is perceived as a hostile measure against an established legal-cultural activity. A similar conflict of values and politics is also evident in the PUB case study where conservation of dingoes is considered as important, both culturally and legally, despite the inclusion of dingoes in the control definition of wild dogs.

The case studies show that stringent regulation of control methods constrain the implementation of control technologies (shooting for deer management in PUS, and use of PAPP for wild dog management in PUB). Stakeholders have consistently stated that regulatory flexibility is needed to facilitate better pest animal management in these areas. The current approach follows the traditional regulatory approach that requires stringent controls on the use of total technologies in populated areas, due particularly, to animal welfare and non-target concerns. But, without regulatory flexibility, it is increasingly difficult to manage the impacts of pest animals in peri-urban areas. This provides support for the hypothesis: *Regulations fall short of balancing government and community objectives for pest animal management.*

Overtly complex bureaucratic arrangements

The findings show that bureaucratic processes are not efficient in facilitating information or resources for pest animal management. The bureaucratic culture follows a top-down approach of 'government as a manager', creating delays in implementation. This is increasingly inconsistent with the shared responsibility setting of invasive species policy. Path dependence theory suggests that formal institutional elements (eg, governance arrangements) devised on the basis of a 'rational institutional model' can be co-opted through the informal institutional

arrangements including administrative complexities. This supports the sixth hypothesis: *Complex bureaucratic arrangements do not facilitate implementation.*

6.2.3 Synthesis of findings on public choice theory

With its roots in positivism, public choice theory attempts to answer 'what is' rather than 'what ought to be'. The theory has proved useful in reflecting upon the political dimension of pest animal management. The empirical investigation showed that multiple influential actors, including political parties and animal welfare organisations, strongly and frequently influence pest animal management. A lack of trust in innovations because of credibility and reliability issues as well as potential risks in implementation creates an ideal platform for conflicting voices likely to be entangled with dimensions of power. The requirement for coordinated action through partnership is jeopardised in proportion to the magnitude of conflict created by political actors. Logics of profit and reputation may inhibit the industrial sector from investing in further research and innovations in this area if political factors consistently frustrate control action. Thus, political conflicts may prevent objective consideration of the innovations and the engagement essential for effective implementation.

Public choice theory explains political behaviour in the context of aggregate individual interests, welfare or votes. 'Political irrationality', political decision-making (because of an inadequate understanding of pest animal issues at the political level) and the political power of animal welfare organisations or lobbies negatively affects the implementation of control programs. Due to animal welfare concerns, promoting control innovations can create political risks. Dominant interests like hunting lobbies and animal welfare groups influence policies in different directions but counter to controls, making it difficult to implement controls which might otherwise be feasible. Politicians respect the pragmatism of the principle and logic of shared responsibility but political support of the shared responsibility notion entirely depends upon the context. Key informants stated that the support of political stakeholders is a key determining factor in adoption and implementation of innovations. The risk of political opposition from animal welfare interest groups was particularly emphasised. Different views and opinions of stakeholders can trigger political conflicts, supporting the hypothesis that: *Political barriers impede implementation efforts.*

Lack of motivation for on-ground implementation

On-ground implementation involves deployment of available technologies through coordinated efforts of government and non-government stakeholders. The study suggests that institutions can undermine stakeholder's action.

Reasons for lack of motivation among government stakeholders:
The role of government stakeholders in a shared responsibility setting is to facilitate community involvement in pest animal management. For on-ground implementation, one mechanism to ensure the action of landholders is through regulatory enforcement. However enforcement of it is not attractive to public authorities because of:

- A lack of consensus about legal and practical responsibility
- A lack of resources
- Difficulties in formulating a basis for legal accountability
- A lack of effective prosecution, due particularly to requirements of legal evidence
- Difficulties in imposing penalties due to a lack of resources and capacities of landholders
- The likelihood of negative perceptions about stringent enforcement by the government
- Political interference in favour of political pragmatism

Reasons for lack of motivation among non-government stakeholders:
Pest animal management reportedly fails to consider landholders' perspectives in deciding control objectives. This does not allow landholders to include their interests in broader planning processes. Institutions thus fail to adequately encourage landholders' opinions in governance processes at all the levels. Institutions also fall short of ensuring participation by landholders (regardless of their personal capacity) because of issues of land tenure. For pest animal management in peri-urban areas, landholders are not keen to expend time and efforts, particularly in the absence of strong incentives or even social appreciation. A lack of incentives for implementing control negatively affects participation of community stakeholders. The wild dog and feral deer management examples suggest that the structure for some private incentives exists, but it is weak. Because of diverse land use and management approaches, private incentives vary. Where public incentives are present, they are often reported to

be poorly designed and/or promoted. Incentives are too rigid to attract wide engagement. Incentives provide a motive for a particular course of action or reflect a preference for one choice but no other alternatives. A few incentives through markets (biodiversity offsets) are being experimented with for invasive animal control in peri-urban areas but innovative strategies where social or moral incentives are provisioned through civil society are not evident. The use of incentives does not always have the desired effect in peri-urban areas because the behaviour of the peri-urban community is influenced by many factors, including personal norms and values. Relevant information to understand and manage these human dimensions is limited.

The rationale for shared responsibility is to use a range of actors and stakeholders to facilitate pest animal management. The origin of shared responsibility for biosecurity and pest animal management was in 2015,[773] and is, thus, a recent legal innovation. The empirical investigation indicates that shared responsibility has been incorporated into public governance processes. This is evident through strategies and plans for pest animal management in PUS and PUB. However, stakeholders and institutions haven't made the required behavioural changes. In practice, 'real' engagement and power transfer remains a distant reality. Instead of community-led decision making, decision making power remains with the government. The concept of shared responsibility is not understood amongst non-government stakeholders. A lack of clarity and resultant misunderstandings is one of the reasons for their slow acceptance of new responsibilities.

In general, if they are to share responsibility, stakeholders should have a shared understanding about pest animal management. Theoretically, a shared responsibility underpinned by a sound understanding of human behaviours should see stakeholders engage in pest animal management, but institutions impede motivations for participation. This points to the eighth hypothesis of this research: *Lack of motivation constrains the participation of government and non-government stakeholders*

6.2.4 Findings of risk and risk perception theory

Perceptions of risk coupled with socio-cultural biases plays an important role in the psyche of peri-urban stakeholders. As evidenced in the PUS and PUB cases, the perception of risk associated with control measures is a major factor affecting

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[773] National Biosecurity Committee (2015), above n 315.

invasive animal control. Risk perception does not have to be objectively based. Human population density promotes perceived hazards of risks to human or animal welfare. Owing to this risk perception, stakeholders may be constrained from implementing controls.

Technological innovations facilitate efficient control of invasive animals in peri-urban areas but the perceived risks in these technologies lead to varied expectations among stakeholders about who will lead and take responsibility for on-ground actions. Community stakeholders have an expectation that government agencies and authorities should continue to take primary responsibility since they have immediate access to technologies. This expectation leads to two major problems for government stakeholders:

a) Community expectations fail to comprehend the complexity of public administration which include, for example, compliance with control regulations, formal procurement processes and approvals to obtain funds, and safety and security protocols for implementing control.

b) Implementation of technologies by trained government personnel is likely to mean effective response and successful outcomes. This leads community stakeholders to expect 'non failure' by government agencies. They expect government to fulfil the control expectations envisioned by them with little or no effort on their part. In the event of non-target injury or loss of life or property, there is immediate media criticism.

The precautionary principle translated in the form of 'biosecurity risk' forms the basis of biosecurity legislation at the Commonwealth as well as selected state and territory levels. The principle has been incorporated into governance processes. Difficulties in assessing the risks make it difficult for institutions to incorporate required behavioural changes. Risks relevant to invasive species and control are subjective. Also, the risks in implementing control vary based on stakeholders' perception. In the peri-urban space, people have varied perceptions of invasive animal risks because of demographic and social diversity. Along with the invasive animals risks, the risks or perceptions about future consequences of control add complexities in implementing control innovations.

For on-ground implementation of control, the research revealed six types of risks, as outlined in Table 6.2. The risks are categorised for government and community stakeholders. These risks are speculative in nature and it is a first daring attempt by the researcher to think about potential risks along the lines of implementation. This section provides a brief explanation of researcher's meaning of these risks with hypothetical examples.

Table 6.2: Risks/contingencies in implementing control

Risks/Risk perception	Government	Community
Accidental damage	Yes	Yes
Legal liability	Yes	Yes
Bureaucratic	Yes	-
Moral	-	Yes
Neighbourly conflict	-	Yes
political	Yes	-

Risk of accidental damage

The risk of accidental damage involves unexpected and unintentional damage as an outcome of control. For example, an injury to a non-target animal species while shooting a deer.

Risk of legal liability

The risk of legal liability can arise from any action that is contrary to pest animal control regulations. The issue of how lack of evidence creates difficulties in deciding who is liable for pest animal control is already discussed in Chapter 4. Here, the issue of liability concerns how control action may lead to different liability issues. For example, while implementing a deer control program, an injury caused to a non-targeted domestic dog can lead to multiple liability issues in tort law or criminal law.

Bureaucratic risk

Bureaucratic risk can arise for a government employee. For example, a pest animal control officer involved in a government-run control program, out of negligence, injures or kills a non-target species. The act of negligence incurs legal liability as a consequence of which the government stakeholder may have to lose job (referred to as a bureaucratic risk).

Neighbourly conflict risk

The risk of neighbourly conflict is a perceived risk where adjacent property owners may raise an objection to control action initiated by the property owner who is experiencing pest animal problem on his/her property and wants to address the same. The neighbourly conflict can arise for a number of reasons. For example, deer shooting involves a shot noise which may not be acceptable for some property owners. Such a disturbance can lead to conflict among neighbours, negatively affecting the control action.

Political risk

Politically powerful groups have vested interests (such as animal welfare concerns or recreation) which can be a disincentive to controlling pest animals; this is identified as a political risk.

Overall, these six risks are not legally defined in the context of pest animal control. A lack of objective assessment of risks and inadequate institutional support in communicating these risks to stakeholders limit the adoption of innovations for pest animal management. Risk/risk perception theory suggests that risks in implementing control can prevent coordinated action, particularly in the absence of a strong incentive to accept that risk. This supports the hypothesis*: Risks or perception of risks affects adoption and implementation of innovations*.

6.3 Further verification through survey results

This research relies on the accumulation of evidence from multiple perspectives and sources, to provide evidence-based support for inferences about policy improvement. This section presents the results of a survey of stakeholders involved in pest animal management, specifically focused on peri-urban institutional issues. This small scale survey was an additional step to check the credibility of the findings presented in Chapters 4 and 5. In addition to testing the reliability of the findings, the objective of this extra step was to expand the researcher's understanding of the institutional issues that have been analysed. The methodology adopted for this survey has been described in detail in Chapter 3. Specifically, the survey's objectives were:

- To test whether issues and elements identified through findings described in Chapters 4 and 5 are consistent with the preliminary conclusions about the hypotheses.

- To identify whether there are differences in the issues or elements compared to those derived from earlier investigations, and to obtain interpretive information on institutional issues.

In summary: the survey questions were designed to verify institutional issues and elements identified in Chapters 4 and 5 and as listed in Table 6.1. The survey questions were based on the following aspects of peri-urban control identified, particularly, through the scoping study:

- Control technologies
- Data and information
- Resources
- Planning
- Governance arrangements
- Bureaucratic arrangements
- Accountability
- Laws and regulations
- Participation
- Political issues

A small-scale survey of experts considering complex issues cannot be conclusive, nor was it intended to be. It can, however, provide additional interpretative support and add to the weight of evidence in support of hypothesis. It is in this restrictive light that these data are presented. Numerical counts are not provided to avoid misleading inferences. Table 6.3 provides nine keys that were used to weigh the responses of survey participants into various categories.

Table 6.3: Keys for describing the survey

Key	Description
1	Strong majority (60% or more) overall agree this issue is a major problem
2	Slim majority (51% - 59%) overall agree this issue is a major problem
3	Majority overall agree this issue is a problem, and of those respondents, most agree it is a major problem
4	Majority overall agree this issue is a problem, and of those respondents, evenly weighted between those who agree it is a minor problem and those who agree it is a major problem
5	Majority overall agree this issue is a problem, but of those respondents, most agree it is a minor problem
6	Majority overall agree this issue is a minor problem.
7	Evenly weighted overall agree-disagree issue is a problem
8	Slim majority (51% - 59%) overall agree this issue is not a problem (neither major nor minor)

Key	Description
9	Strong majority (60% or more) overall agree this issue is not a problem (neither major nor minor)

6.3.1 Results

Twenty-seven people from five Australian states participated in the survey; the states being: NSW, QLD, Victoria, Western Australia and South Australia. The participants represented organisations at the state, local, regional and industry levels. One respondent represented the IACRC. One respondent did not enter any valid response to identify the type of organisation represented. The survey participants each had a specialised knowledge in different areas of pest animal management. The group of survey participants were particularly involved in community engagement for pest animal management in Australia. The main features of participants' professional expertise in pest animal management is summarised below (see Table 6.4 and Figure 6.1) providing an indication of their relevant expertise.

The rest of this section discusses survey results relevant to each theme. A document describing survey analysis is included in Appendix 4.2.

Table 6.4: Background of the survey participants

State	Professional expertise in peri-urban and local pest animal management with government and non-government agencies
NSW	Invasive species extension officer Wild dog control coordinator
QLD	Senior pest animal management specialist at the local council Wild dog control coordinator/facilitator Regional coordinator/technical officer
Western Australia	Incursion response facilitators Invasive species response manager Wild dog control coordinator Biosecurity manager working with the government Feral pig management specialist Community engagement specialist
South Australia	Wild dog control project officer Natural resource management facilitator
Victoria	Community engagement officer Community wild dog control coordinator Rabbit control facilitator Biosecurity officer
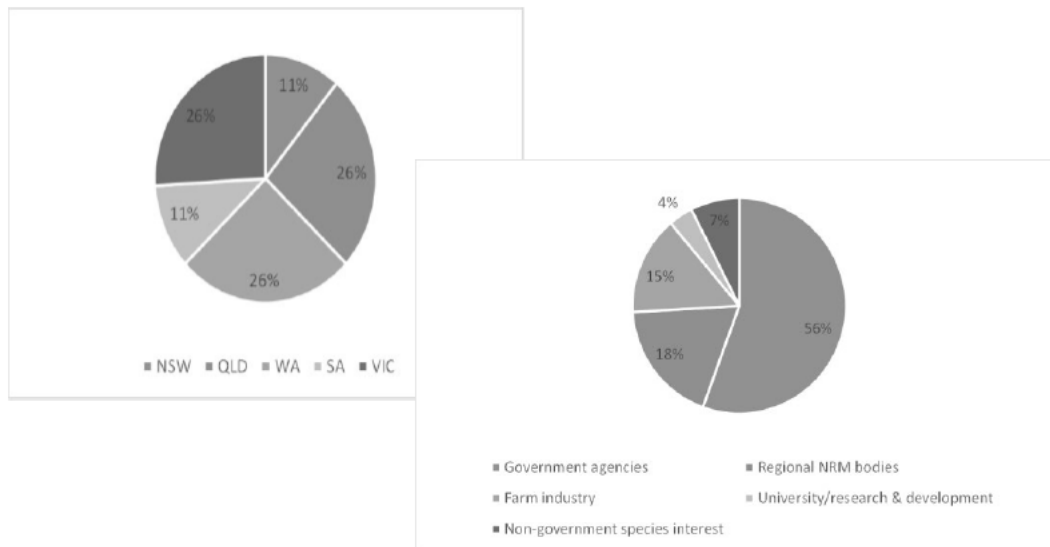
Figure 6.1: Survey respondents a) by location and b) by organisation

Theme 1 - Control technologies

The earlier investigations revealed that inadequate resources and inadequate research partnerships and coordination are major impediments for innovations in control technologies. Furthermore, they suggest that difficulties in regulatory approvals and cost-effectiveness of control impedes adoption of technologies. The survey questionnaire used six questions to assess participants' views on these institutional issues in innovation and adoption of control technologies.

A majority of the respondents overall agreed that the complexities or delays with approval procedures create difficulties for the availability of control technologies. Out of those who agreed, most considered that this was not a major problem affecting frontline programs.

One respondent from Western Australia stated that 'It is very difficult to change things. Processes are so risk adverse that innovation in this (pest animal control technologies) space is stopped'. One respondent from South Australia involved in wild dog management stated that effective pest animal control techniques are not available for organic certified properties. One respondent from NSW stated that procedural complexities are a barrier to releasing innovations such as those developed by the IACRC. One respondent from Western Australia stated that delays with approval procedures for control measures will become more problematic because of the chronic under resourcing of the government departments that administer these

procedures. A respondent from Western Australia stated that political decisions about which type of control program to fund can be controversial, illustrated by contention over a wild dog bounty trial.

A majority of the respondents believed that: a) the requirement of compliance with animal welfare regulations, b) technological risks of injuring non-target species and humans, and c) lack of cost-effective technologies create difficulties in implementing control technologies. Of those who agreed, most believed that these are not major issues affecting their frontline work. A strong majority of the respondents stated that getting information on how to use control measures is not a problem. Amongst the few respondents who stated that it is a problem, most thought it was not a major problem for frontline projects.

Amongst the overall respondents, a slim majority agreed that access to control measures is not a problem. Amongst the respondents who stated that it is a problem, the number of respondents acknowledging it as a major problem was higher than those who agreed that it is not a major problem. One respondent from Victoria stated that difficulties in getting access to contractors creates an impediment for landholders to treat pest animals. One respondent from QLD involved in wild dog management stated that 'government regulations in Queensland tend to make it difficult for landholders to access control tools'. The responses show that access to controls varies by state and by species.

The survey responses add weight to the evidence that the institutional issues in innovation and adoption of control technologies (identified in Chapters 4 and 5) are also relevant in varying degrees to the peri-urban regions across Australia.

Theme 2 - Data and information
The assessed evidence indicates that institutional issues impede the availability of reliable and objective information. Access to available information is partly constrained because of fragmented governance arrangements. This creates difficulties in the assessment of the pest animal management problem. The lack of intelligence on the pest animal problem and the absence of clear evidence on costs and benefits from pest animal control efforts also poses problems in deciding the strategic direction for future control efforts. The survey questionnaire assessed participants' views about data and information issues in implementing pest animal control.

A majority of the respondents agreed that issues, including: a) lack of reliable information about the presence, number and impact of invasive species impedes pest animal control, b) a lack of public information about the impacts of invasive species, b) unreliable data and analysis methods for designing control and control programs, c) the absence of a community reporting system, d) a lack of harmonisation between local, regional and state control programs, and e) difficulties in program performance evaluation do create difficulties in establishing clear evidence for pest animal management.

One respondent from Queensland stated that community reporting systems are not widely used despite their availability. Two respondents from Victoria acknowledged the availability of a comprehensive data system in Victoria, but reported that it is relatively new. One respondent from Western Australia stated that limited resources are a major constraint in obtaining evidence on pest animals, particularly because of their wide distribution across the large state. Therefore, wild dog programs are particularly hard to evaluate because they are carried over vast areas and the dogs are hard to find (whether alive or dead). Poisoned dogs are rarely found, so it is hard to evaluate baiting programs.

The survey responses add weight to the conclusion that data and information issues impede the implementation of pest animal control. The survey responses also indicate that community engagement in obtaining pest animal intelligence is crucial to improve the amount and quality of evidence.

Theme 3 – Resources
The body of evidence indicates clearly that financial and human resources constrain pest animal management in peri-urban areas. Although private investment and the role of volunteer and community are generally considered important, pest animal control remains very dependent on government resources. Fragmentation of formal institutions and varied community perceptions limit the availability of resources for peri-urban pest animal management. The survey questionnaire assessed participants' responses on funding issues in implementing pest animal control.

Respondents generally agreed that both government and non-government stakeholders' capacity to implement pest animal control is decreasing. A majority of

respondents agreed that the lack of government financial resources and stop-start funding are major problems.

The need to avoid duplication of efforts and provide more certainty about government resources was highlighted. A few participants pointed out that the availability of funding itself does not guarantee the effectiveness of pest animal management arrangements. One respondent from Victoria stated that industry funding (from Australian Wool Innovation) was crucial in significantly reducing the funding problem for wild dog management.

A majority of the respondents agreed that: a) a lack of financial resources with volunteers and private landholders, b) difficulties of securing public money, c) reporting about the spending of public money, and d) lack of political will to support pest animal control are impediments to pest animal management.

Theme 4 - Planning

The weight of evidence suggests that planning is not sufficiently effective in delivering pest animal control outcomes. In addition to technical aspects of planning, such as lack of flexibility in adapting plans to frequently changing situations during pest animal control, the key problem reported is the absence of clear objectives because of competing interests and expectations of stakeholders.

A majority of the respondents stated that there is little alignment between the objectives of government and non-government organisations in their plans, communications with general community are not adequately planned and other communication with stakeholders is not adequate. Out of those who agreed with these issues, most believed that the issues are not a major problem for frontline control. A majority of respondents stated that objective-setting in plans is not a major problem and presumably believe the planning objectives are clear or not significant in practice. Respondents were evenly divided on the effectiveness of processes for developing plans. While half of the respondents stated that this is a problem, the remainder said that it is not a problem.

One respondent from Western Australia stated:

> Investment in communication is often much lower than what is needed. In fact the power of proper communication is often not understood by many (stakeholders) and the focus is on other activities.

One respondent from Victoria stated that annual planning through community consultation plays an important role in pest animal management. Other evidence does suggest that the approach to plan preparation is quite different between states.

Theme 5 - Governance arrangements

A strong majority of the overall survey respondents agreed that: a) inconsistent policies and programs between government and non-government agencies, and b) conflict between invasive species and other laws and regulations is an impediment to pest animal control. A majority of the respondents also agreed that inconsistent policies and programs across levels of government or across government agencies is an impediment to pest animal control.

The survey results add to the evidence that the problem of fragmented governance arrangements is a major impediment in implementing innovations. The theory of transaction costs suggests that fragmented governance arrangements 'tax' coordinated pest animal management efforts in the peri-urban context.

Theme 6 - Bureaucratic arrangements

The earlier reported evidence identified the problem of bureaucratic arrangements, including licences and training requirements, as impediments in implementing technological control. The regulatory and procedural requirements particularly constrain the use of poisons and shooting methods in peri-urban areas. The survey responses confirmed the problem of these bureaucratic issues in implementing pest animal control.

A majority of the respondents stated that regulatory and procedural requirements make it difficult to implement control. However of those who agreed that it is a problem, most believed that it is a minor problem for them running frontline projects. Respondents were evenly divided on the requirement for compulsory training to implement control measures. While half of the respondents stated that this training requirement is a problem, the remainder believed that it is not. Out of those who believed that it is a problem, most stated that it is not a major problem. A slim majority of the respondents stated that, in relation to licences for control, frequent changes in administrative arrangements and responsibilities impede control implementation.

One respondent from NSW stated that difficulties in being able to carry funds forward from one financial year to another is a major impediment. The respondent also stated that it is extremely difficult to employ staff for pest animal control activities. According to the respondent, the inability to carry forward the available funds and difficulties in employing staff to control pest animals are a big disincentive to pest animal management.

Theme 7 - Accountability

Lack of coordination among stakeholders for project implementation was identified as a priority issue by a majority of overall respondents. Of those respondents who agreed that it is a problem, most believed that it is a major problem.

A majority of the respondents highlighted that community's over-reliance on government, government's over-reliance on landholders and the absence of coordination among stakeholders during project implementation all impede pest animal control. Out of those who agreed, most believed that these issues are major problems.

A majority of the respondents agreed that government's over-reliance on volunteers to undertake control activities and lack of clear roles does impede pest animal control. Out of those who agreed that it is a problem, most believed that this is not a major problem. A majority of the overall respondents agreed that a lack of rapid response capability for new incursions impedes pest animal control. Of those respondents, half believed that it is a major problem and the remainder believed that it is a minor problem.

These survey results are consistent with the other evidence that identified unclear accountability as a major impediment for stakeholders' participation and coordinated action. The findings also indicate the influence of factors including the availability of resources and limited willingness to take up control activities as impediments.

Theme 8 - Laws and regulation

A majority of respondents agreed that a lack of enforcement and a lack of compliance are major impediments for pest animal management.

A majority of respondents agreed that: a) liability risks are involved in implementing control, b) animal welfare regulations interfere with control, c) regulations

excessively limit control in populated areas, and d) community expectations to implement pest animal control are not adequately satisfied by existing laws/regulations. Of those who agreed, most believed these are not major problems in practice for their frontline operations.

A majority of overall respondents believed that: a) administrative costs imposed on landholders/residents are not excessive, and b) regulations for recreational hunting are not too restrictive.

Theme 9 - Participation

The majority of respondents agreed that community participation is a top priority for pest animal management. A large majority of respondents agreed that diverse attitudes of landholders is a major issue that impedes participation of stakeholders. A majority of respondents agreed that diverse land uses impede stakeholders' participation. A majority of respondents agreed that a lack of knowledge and awareness among landholders and residents is an impediment to participation of stakeholders. Of those respondents who agreed, most agreed that it is a major problem. One respondent from Victoria identified that multiple means of information, including local newspapers, community information boards and newsletters, are not used to create awareness of pest animal issues. A majority of respondents stated that a lack of monetary incentives and undervaluing citizen contributions for control lead to non-participation. Of those who agreed that this is a problem, most believed that it is not a major problem for their frontline activities.

Theme 10 - Political issues

The substantial majority of respondents stated that a lack of political understanding of the costs or risks of non-control is an impediment for pest animal management.

A majority of respondents agreed that political decisions often prevent implementation of pest animal control programs. Of those respondents, most believed that this is a major problem. A majority of respondents agreed that the political power of the animal welfare lobby impedes implementation. Of those who agreed, most believed that this is not a major problem for their frontline control projects.

6.3.2 Reflection on survey objectives

As stated earlier, the purpose of survey was to assess the congruence of evidence of institutional issues identified through empirical investigation using the survey responses. This was an effort to test the weight of evidence through deeper verification. The survey results confirmed that the findings of the research reflect institutional issues that are consistently indicated by multiple evidence. The survey also helped ensure that the analysis took into account the opinions of stakeholders involved in frontline pest animal management. The survey objectives were achieved to the following extent:

a) The additional survey findings gave confidence that the issues and elements identified through the other methods of empirical investigation discussed in Chapters 4 and 5 are consistent.

b) The survey evidence did not indicate drastic variations in the issues or evidence compared to that derived from earlier investigations.

c) The small sample survey did provide more interpretive information on institutional issues.

The scoping study outlined in Chapter 4 provided hypotheses about possible institutional issues that impede pest animal management. The elaborations by observations of a large group of workshop participants and complementary literature helped in refining the issues. The objective of Chapter 5 was to test the relevance of the institutional issues identified through the scoping study and better understand peri-urban specific issues that impede pest animal management. Through case studies and interviews, specific institutional issues for wild deer and wild dog management in peri-urban contexts were identified. Based on the set of issues discussed in Chapters 4 and 5, institutional hypotheses were drawn. The survey results suggest that every hypotheses raised by the survey was identified as a major problem by some participants. A small percentage of respondents agreed that every issue was a major problem. This indicates the likely validity of the hypotheses about institutional issues included in the survey questionnaire and helps to validate the institutional issues identified in Chapters 4 and 5.

The next section concludes this chapter by describing the relevance of triangulation in identifying institutional impediments in this research.

6.4 Conclusion

This chapter used theoretical perspectives to provide context to the findings of the current research. The chapter began by presenting the set of institutional issues identified through peri-urban case studies – wild deer management in peri-urban Sydney and wild dog management in peri-urban Brisbane. The analysis of institutional issues by reference to theoretical variables revealed hypotheses about nine institutional impediments to the adoption and implementation of control innovations in the peri-urban context.

The research suggests that peri-urban institutions are a distinct 'space' where urban and rural institutions come together; and formal and informal institutions influence the process of innovation adoption and implementation. Due to the 'wicked' nature of the pest animal problem and the institutional complexity, adoption and implementation is often grounded in the preference of the influential stakeholders, with a great influence of informal institutions in shaping pest animal management effectiveness. Fragmented governance arrangements do not facilitate co-ordinated decision-making in the peri-urban context. In addition to the governance arrangements, informal institutions influence motivation, beliefs, attitudes and risk perceptions, and can be responsible for constraining on-ground implementation of innovations. The institutional impediments do negatively affect the adoption and implementation of innovations for pest animal management in peri-urban areas.

The chapter then proceeded to test the congruence between the evidence on institutional issues with the specific hypotheses. The discussion of survey results confirmed that the findings of the research are consistent with the views of those working at the coalface of invasive species control. The survey results did not point to any inconsistencies in the institutional issues previously identified.

The overall body of empirical research indicates that the set of institutional issues identified from the scoping study are consistent with the evidence. The process of triangulation, with data collected from three types of empirical investigation (general institutional issues from Chapter 4, peri-urban specific institutional issues from Chapter 5, and survey results from Chapter 6) suggest that the findings of this research are based on congruent evidence of institutional issues. The challenge of assembling a body of evidence also suggests that institutions in the peri-urban space

do present a unique, intricate mix of formal and informal institutional challenges. The results from this study indicate that the multi-methods used in this thesis have merit.

The next chapter summarises and concludes the thesis with reference to its research questions and objectives. The chapter discusses alternative approaches that may improve peri-urban institutions for pest animal management. It also provides suggestions for future research, along with the limitations encountered in conducting the current research.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This research aimed to identify legal and institutional impediments to effective invasive animal management in peri-urban Australia. It used an evidence-based policy approach to address three intertwined research questions that essentially explored the effects of institutions involved in implementing pest animal management innovations in practice. The evidence-based approach using multi-methods allowed for triangulation from a number of perspectives to provide cumulative support for conclusions about the effects of institutions on the capacity of those involved in control to use various innovations. This is consistent with good practice in legal policy research where purely deductive methods are rarely feasible given the number of variables and the nature of the issues involved.

It explored how the current institutional arrangements prove inadequate in re-enforcing and sustaining stakeholders' behaviour to implement pest animal control. Within the limits of resources and time, the evidence in this research demonstrated that many institutions play a crucial role in determining the effectiveness of pest animal management. The evidence forms the basis to suggest options for institutional reforms to facilitate implementation of control innovations. Further research is recommended to fully develop a detailed set of options to address the institutional complexities of peri-urban pest animal management as an aspect of natural resource governance in Australia.

The purpose of this chapter is to summarise the research, by describing the process of the research, and to propose recommendations for future investigations and possible reforms. The chapter comprises five further sections:

Section 7.2 describes the background to the study, including the challenging context of peri-urban governance and the critical need to implement strategic pest animal control innovations for effective management of pest animals.

Section 7.3 discusses the rationale or the methodology adopted in this research, summarizes research steps and the evidence obtained to help answer each research question. It discusses the conclusions from each step and their significance in terms of

the cumulative weight of evidence. It also describes the limitations of this research method and elaborates on lessons learnt during the research.

Section 7.4 discusses the resulting hypotheses and elaborates on their likely validity as well as implications on law and policy.

Section 7.5 provides directions for policy development and recommendations for future theoretical and practical research.

Section 7.6 sums up the chapter and provides concluding notes to the thesis.

7.2 Background

The research objectives were informed by a review of the literature, summarised in Chapter 1, which investigated the problem of pest animal management in Australia and, particularly, peri-urban Australia. Stakeholders involved in pest animal control are faced with complex biophysical and social systems problem that requires strategic management. Effective management of pest animals in a peri-urban setting requires the use of control innovations, both technical and managerial. The need for innovations to provide more effective control has received greater impetus by the adoption of a government policy for 'shared responsibility' for carrying out pest animal management. This approach forms the backbone of the current biosecurity law, which in QLD and NSW has the particular feature of a legal duty of care to control invasive species. While innovations undoubtedly hold a great potential to improve pest animal control outcomes, a substantial body of research indicates that institutions largely shape the process of adoption and implementation of innovations. The full potential of many innovations to achieve better control outcomes remains speculative because of institutional impediments to the process of adoption and implementation of innovations. The IACRC identified a need to enhance institutional capability for implementation of control innovations through research to identify institutional impediments and to propose reforms. Within the broader context of this IACRC project, this study provides evidence on institutional issues which should be addressed in order to improve peri-urban pest animal management.

7.3 Methods

The rationale for the research methodology stems from the fact that understanding 'wicked' problems in environmental law and governance requires a research approach

which is able to deal with many intersecting and complicated variables in order to arrive at evidence-based insights. Methods labelled 'evidence based policy' research rely upon the accumulation of evidence to support reasonable and transparent inferences.

Being concerned with 'what works', this approach requires sufficient evidence to allow for explanation on 'what actually exists'. This also requires consideration of plausible accounts of the operation and effect of institutions relevant to invasive species management. By conducting a number of different inquiries using different methods, a body of evidence can be accumulated that together support the conclusions from the research. This approach is generally referred to as triangulation.

The key question addressed throughout this thesis was:

What legal and institutional impediments need to be overcome to achieve effective invasive animal management in peri-urban Australia?

The research question in this thesis required that the researcher identify institutional impediments to effective pest animal management in peri-urban areas of Australia. It reflects the proposition of the *APAS* that innovations are necessary for strategic pest animal management. This was the basis for the foundational assumption that the effectiveness of pest animal management depends on the adoption and implementation of innovations.

7.3.1 The four-step process

To conduct an evidence-based approach through this research, four steps were taken:

1. Familiarisation with the issues using desk research and exploratory discussions. This provided a theoretical framework and indications of likely institutional impediment issues.

2. Conduct of a scoping study to deepen understanding of the institutional issues and to further develop initial hypotheses about the operation and effect of these issues in practice.

3. The use of case studies to investigate how institutional factors interact in practice in the field. This also provided evidence related to the initial hypotheses.

4. The development of preliminary conclusions based on these various sources of evidence and further confirmation by comparison with the findings of other evidence based policy research.

At each step, multiple methods were used to understand the research problem. During the first step, conversations with the peri-urban pest animal management stakeholders developed the researchers' preliminary understanding of institutional issues. A key concern of the research was to understand the peri-urban institutional context in ongoing pest animal management in Australia. Understanding how Australia's continuously changing peri-urban institutional landscape influences invasive species management helped in refining the research objectives and approach.

The literature review further reinforced the need for peri-urban specific control using more advanced methods and technologies. The literature review also identified legal and institutional innovations that are potentially applicable for invasive animal control and management, with particular relevance to the peri-urban areas. While explaining peri-urban complexity in implementing invasive animal control and management innovations, the literature reflected upon institutional constraints. Taken together, the literature indicates that the research question could involve a wide range of innovations and institutions. To accommodate these in one research project, given the limitations of resources and time, is an ambitious task for any researcher. Taking this into account, the scope of this study was limited to specific innovations relevant to the management of pest animals in selected peri-urban case study areas.

The literature review also identified that this type of policy investigation requires a pragmatic methodology because of the inability to acquire sufficient definitive evidence for a purely deductive approach across such a large number of issues. Good practice was identified as being the use of separate lines of inquiry to produce evidence which mutually supports the policy conclusions, being transparent about the evidence and the limits to the evidence, and making the investigators' judgement explicit.

It was necessary to understand the institutional context and the type of issues to be studied so that the subsequent investigation could be designed. Chapter 4 describes, the scoping study involving workshop observations and desktop research through which preliminary hypotheses on institutional issues were developed.

Based on a preliminary understanding of the potential institutional issues, the researcher conducted peri-urban investigation, described in Chapter 5. This used a case study approach to explore two peri-urban instances (feral deer management in PUS and wild dog management in PUB) through conversations and semi-structured in-depth interviews. In conversations, the researcher set a general direction and followed specific topics raised by the stakeholders. During in-depth interviews, open ended questions and probing allowed participants to express their views in detail on specific peri-urban topics. The case studies uncovered a number of peri-urban specific institutional issues that undermine support for implementing controls, many of which were consistent with what were found from the literature review.

The evidence from the case studies was interpreted in the light of the literature, the preliminary scoping study, and by comparing the evidence from the two case studies. The analysis suggested the relevance of both formal and informal institutional elements which affected innovation-adoption in the two case studies. These included social, legal and political issues which intersected to create a complex context for control.

The identified peri-urban institutional issues were further tested with a broader group of stakeholders through a survey. The survey used a uniform questionnaire with a small sample of experts involved in frontline control of pest animal species from across Australia to test the researchers' understanding of the issues and to identify whether significant matters had been missed. The final step was to consider the researchers' conclusions relative to two other studies about institutional issues affecting the control of invasive species. Each of the studies derived inclusions based on different types of empirical evidence, and neither was specific to peri-urban issues although the diagnosis and the recommendations were strongly consistent with the research findings.

The process of triangulation of evidence provides the transparent basis for the researchers' conclusions on institutional impediments, which are presented as hypotheses for further investigation; this is because of the number of complicated issues involved in achieving successful institutional change, suggesting the need for more in-depth detailed analysis before recommendations could be implemented.

7.3.2 Lessons about the research method and process

The study of implementation dynamics from the perspective of institutional analysis is a relatively new development within inter-disciplinary research in law. Pragmatism as an overarching basis of research suggests multiplicity in terms of methods and disciplinary perspectives. The challenges and limitations of multidisciplinary, multi-method research are well known. This research faced limitations, many of which are inherent in interdisciplinary legal research.

The foremost limitation was to comprehensively address multiple institutional constraints, including scientific, political, economic and legal, that are involved in implementation of natural resource management innovation. It was difficult to distinguish between the formal natural resource governance institutions, biosecurity/pest animal management institutions, and the dynamics of informal (cultural and behavioural) institutions and the interplay between these institutions. For the purposes of this research biosecurity and pest animal management remained a key focus. These were also issues which were beyond the scope of the current investigation; for example the research did not investigate the influence of cultural issues and Aboriginal land management issues.

The second limitation is a result of the number and types of innovations which were potentially relevant to this study of the adoption and implementation of innovations. The innovations investigated were selected based on factors unique to peri-urban pest animal management of specific species. The case studies were intrinsically limited to the specific regions and the control of particular species, though these were selected with care taking into account the preliminary evidence from the scoping study.

Due to the limitation of time and resources, it was not feasible for the researcher to collect primary data from the many peri-urban institutions that were identified through the literature, the interviews and case studies. It was not also feasible to interview a large sample of community stakeholders, though many non-government workers involved in invasive species control took part in the workshops which were observed and the scoping discussions that were conducted. Secondary data also provided evidence from this perspective. Because of the scope of this study, a certain level of comprehensiveness, nuance and detail has been forgone in the law and policy analysis, which might have involved further unpacking of policy instruments,

policies, and strategies (for instance, in-depth analysis of differences between policies at the state and local levels and between various states). This would have provided a richer understanding of institutional impediments from the bureaucratic perspective.

BPM for peri-urban pest animal control emphasises landscape scale and nil-tenure approaches. These approaches reflect a form of governance systems thinking, highlighting the need to understand connectivity and to overcome fragmentation. However, there is a degree of legal and political naiveté implicit in these approaches because they underplay the significance of the types of institutional issues explored in this thesis. The issue of multiple laws and policy approaches in dealing with pest animal species was consistently raised by the stakeholders, and the concern was demonstrated in the case studies. Due to interaction of administrative jurisdictions (hierarchy, boundaries and role specialisation) in peri-urban areas, each agency attempts to tackle the problem based on their own approach. In peri-urban areas, behavioural aspects, including those related to multiple private tenure and land uses, add further complexity for the assessment and management of pest animal issues.

7.4 The bases of the hypotheses

Within the above-discussed limitations, the evidence presented in this thesis made it possible to systematically identify final hypotheses about the impediments to adoption and implementation of innovations for peri-urban pest animal management. The evidence obtained through four steps point to nine hypotheses. Each stage cumulatively adds to the evidence in support of the hypotheses discussed below:

Step 1 - The discussion on innovations for pest animal management, generally and the peri-urban specific innovations, established the link between potential innovations and the role of institutions in the adoption and implementation of innovations. It outlined four theory-based institutional constraints for the adoption and implementation of innovations. This formed the conceptual basis to explore institutional issues.

Step 2 - As part of the scoping study in Chapter 4, the literature and workshop observations enhanced the researchers' awareness of the institutional issues relevant to pest animal management. The scoping study provided a preliminary understanding of the potential institutional issues which could impact the implementation of

innovations in peri-urban regions. This knowledge was used to identify topics for further investigation in two case studies.

Step 3 - In Chapter 5, the case studies explored peri-urban specific institutional issues. An extensive analysis of policy documents and interviews with pest animal control experts helped to assess peri-urban institutional arrangements and the extent to which these facilitate or frustrate on-ground control. In order to 'ground truth' the peri-urban specific issues, the evidence derived through case studies was reviewed against the information from the scoping study.

Step 4 - The cumulative evidence on institutional issues was used to develop a set of hypotheses. To provide validation and to obtain additional insights, a small sample survey of invasive species expert practitioners was conducted. This confirmed the reasonableness (intuitive validity) of the nine hypotheses that were distilled from the evidence.

The hypotheses were assessed against two recent studies on the effectiveness of biosecurity policy for pest animal management which considered institutional arrangements. These policy assessments were conducted against the backdrop of the new biosecurity policy enunciating shared responsibility as its basis and the promulgation of the *Biosecurity Act 2015* (NSW). Neither of these studies were specific to peri-urban areas, but both gathered substantial evidence about institutional issues affecting the control of invasive species.

Policy assessment 1

W Craik, D Palmer and R Sheldrake, 'Priorities for Australia's biosecurity system, An independent review of the capacity of the national biosecurity system and its underpinning' (Intergovernmental Agreement, Canberra, 2017).

At the request of the Australian governments' Agriculture Ministers' Forum, authors Wendy Craik, David Palmer and Richard Sheldrake undertook an independent review of the capacity of Australia's biosecurity system and the underpinning IGAB. The review was conducted to fulfil the requirement of review as stated in the 2012 IGAB: *to review the progress of its implementation within five years, and to provide direction for effective national biosecurity system*. The 2012 IGAB provided a list of 40 priority areas for reform. The assessment of implementation was undertaken by the National Biosecurity Committee in 2015. The assessment helped in re-prioritising the

40 areas in which further work was needed. Based on these earlier assessments, the 2017 review identified gaps in implementation of IGAB and suggested priorities for reforms.

Evidence was gathered from multiple stakeholders (including from government, industry, community groups, researchers, businesses and other individuals) who provided written submissions, participated in consultations and targeted discussions and assisted with research and advice.

The review considered the biosecurity system of Australia as a 'trade and economic asset' primarily taking into account its relevance for agricultural and tourism industries. IGAB provides 'a framework for governments to coordinate and identify priority areas of reform and action to build a stronger and more effective national biosecurity system'. The review identified the following challenges for governments and biosecurity agencies in steering and maintaining the effective national biosecurity system:

- The roles and responsibilities of stakeholder participants are not clearly articulated. This affects the realisation of shared responsibility in practice, including problem ownership and participation.
- The need for greater emphasis on the connection between trade and biosecurity is needed to facilitate market access for primary industries; this requires the alignment between agendas of trade, market access, biosecurity and biodiversity.
- The need for more emphasis on environmental biosecurity issues to control negative impacts on natural environment (natural ecosystems, biodiversity) and the social environment (human health, social amenities).
- A lack of uniform approach to prioritise risks; multiple policy instruments adopt different approaches.
- The absence of a lead agency to identify priorities for research and innovations in biosecurity; the lack of resources for continuous research and innovation; the lack of cross-sectoral research (research that benefits multiple industries and/or stakeholders including community) and system-level research.
  - Governance arrangements are fragmented because of a lack of collaboration between institutions and agencies. There is a problem of commitment, accountability and transparency.

- The lack of financial and human resources.
- The lack of objective data and information.

Many of these issues are consistent with the findings from this research's detailed investigation of peri-urban institutional issues.

Policy assessment 2

P Martin, D Low Choy, E Le Gal and K Lingard, *Effective Citizen Action on Invasive Species: The Institutional Challenge* (Invasive Animals Cooperative Research Centre: Canberra, 2016).

The objective of this study was to identify key institutional areas that affect invasive species management, particularly major vertebrate pest management, and to suggest priorities and proposals for improvements. The evidence supporting the final set of recommendations was presented in the form of a discussion paper based on three years of research on 'improving institutional arrangements' for pest animal management as part of the IACRC Program 4 titled 'Facilitating Effective Community Action'. The discussion in this report is premised on the fact that community action is fundamental to effective invasive animal management. This is the policy premise for the national and state adoption of a shared responsibility approach for established invasive species.

The research used a participatory approach to identify institutional elements. It proposed 'top-down, bottom-up' performance criteria to evaluate invasive species institutions. The report identifies the following institutional challenges:

- Weak accountability of landholders and agencies responsible for managing invasive species.
- Gaps in the availability of resources.
- Gaps in community engagement.
- Weak coordination between different agencies and programs.
- The lack of 'institutionalised respect for citizens'.
- Administrative barriers in pursuing control actions.

These investigations were conducted while the biosecurity law and policy reforms based on shared responsibility were being pursued. The shared responsibility model suggests 'smart' regulatory approaches where both public and private actors have a combined role. It is a policy vision; theoretically its formalisation through laws and

institutional responsibilities should result in on-ground coordinated, collective action but putting this principle into practice is fraught with institutional difficulties. The investigation indicates a disconnection between the rhetoric of shared responsibility and the institutional arrangements needed for community-led frontline action required for invasive animal control and management. The policy assessments identified that the standard of shared responsibility has a mere advisory significance in the context of implementation.

7.4.1 The significance of findings from this research in the light of above-mentioned policy assessments

The three studies, conducted independently of one another, drawing on different evidence, and analysed by different experts, support the same general conclusions about institutional arrangements for the control of invasive species. They suggest, among other things, public institutional arrangements are not well aligned to the needs of a shared responsibility framework. They indicated that institutional fragmentation and complexity adds to the difficulties of insufficient resources, and the fundamental challenges of achieving a whole of landscape approach. Though there are differences in emphasis between the studies, they point in the same general direction and provides a basis for confidence in the conclusions of this thesis.

The research makes a unique contribution to knowledge in the field of biosecurity. The uniqueness is partly the specialised focus on the peri-urban institutional dynamics for Australia's biosecurity. It adopts an evidence-based policy approach to investigating what might be required for more active control in peri-urban areas. Using the innovation adoption and implementation literature, as well as theories centred on political economy and risks, the research applies institutional perspectives to pest animal management in peri-urban areas. Using documents and evidence gathered from stakeholders, the research applied a series of theoretical perspectives to the data that enabled the specific identification of peri-urban institutional impediments, providing institutional insights that was not previously available. This critical evidence confirms the important role of institutions to the adoption and implementation of innovations in pest animal management. This research uncovered many institutional constraints and risks that undermine the effectiveness of pest animal management in peri-urban areas.

From the analysis, two findings have particular significance in the peri-urban context: a) the significant role of political barriers, and b) the contribution of risk perception in creating impediments in implementing innovations. On-ground implementation of innovations in peri-urban context is likely to often hinge on resolving these impediments.

The overall findings underpin two conclusions:

a) The peri-urban context is distinct. The intersection between rural and urban communities draws in institutional arrangements from both directions, creating a great deal of institutional complexity and competition. The political context can be intense. To align institutional arrangements to public goals, such as shared responsibility, requires a sophisticated approach.

b) The current institutional arrangements for invasive species management, whether in peri-urban or rural areas, exhibit a number of deficiencies which are likely to impede the implementation of national and state policy. Institutional reform is badly needed.

The evidence-based approach highlighted some important impediments that current biosecurity law and policy may struggle to address. This is particularly with regard to the political barriers and risks in implementing pest animal management innovations in peri-urban areas. Invasive animal control action is insufficiently coordinated across the government because of institutional fragmentation. The process and practice of realising shared responsibility is particularly difficult in peri-urban areas. In a peri-urban context, both formal and informal attributes of institutions[774] create a 'super-wicked' policy and management problem for implementing the seemingly simple idea of coordinated, collective action as well as the principle of shared responsibility. Wicked problems involve uncertainties, conflicting socio-economic values that do not have a straightforward and simple solutions;[775] in fact, owing to their diabolical

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[774] Formal: for example, fragmented and often conflicting nature of institutional responsibilities in invasive animal management. Informal: for example, different views and perceptions on what invasive animal management should achieve and how.

[775] Rittel and Webber 1973, above n 62; Australian Public Service Commission (2007), above n 232; Head (2008), above n 510.

nature, any attempt to solve these problems generates further issues.[776] These characteristics have been demonstrated for peri-urban invasive species control.

Despite limitations and constrains (such as time and resources) elaborated earlier in this chapter, the research is significant and meaningful for the following reasons:

a) It has begun to widen the horizons of natural resources law and governance scholarship through an evidence-based policy approach to implementation of innovations in the institutional context. Studies of effectiveness of environmental law are beginning to emerge as important, given the unfortunate history of insufficient outcomes from laws and policies.

b) It has attempted to begin filling critical gaps in understanding 'shared responsibility' for pest animal management in the peri-urban Australian context through evidence-based investigation. Given that invasive species are identified as one of the central national challenges in protecting biodiversity, and for farming, understanding what is needed to make this new policy arrangement effective, is important.

c) It does affirm that improved institutions is a pre-requisite to realising the potential of innovations for effective pest animal management in peri-urban Australia. The research helped in understanding the specific legal and institutional gaps that need to be addressed to improve pest animal management in peri-urban Australia.

7.4.2 Research implications:

Implications for regulatory effectiveness

While addressing 'wicked' problems, institutions operate in an environment of goal multiplicity, struggle for resources and face difficulties in coordination, which affects decision-making. This research examined the extent to which institutions facilitate or impede regulatory effectiveness in invasive species management. The evidence on peri-urban institutions suggests that the effectiveness of new legal duties of care is subject to government's implementation choices. The policy aims to reinforce biosecurity obligations, and motivate non-government stakeholders towards public interest outcomes, but institutions are not well designed to facilitate the behaviours

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[776] V A Brown, P M Deane, J A Harris and J Y Russel, 'Towards a Just and Sustainable Future' in VA Brown, J A Harris, J Y Russell (eds), *Tackling Wicked Problems: Through the Transdisciplinary Imagination* (CSIRO Publishing, 2010) 3.

that are required. This raises the question regarding how institutions can create regulatory conditions needed to secure participation of non-government stakeholders. Traditional law and regulation thinking may not adequately consider the importance of the behavioural effects of institutional arrangements. Moreover, a lack of clarity on shared responsibility leads to differences between government and non-government stakeholders in their understanding of roles and responsibilities, and their willingness to engage in implementing control.

Implications for peri-urban governance and research

Peri-urban case studies highlighted the specific focus of this research while simultaneously revealing its increasing importance in natural resource management. In the peri-urban context, pest animal management is influenced by the opinion of community stakeholders. It significantly involves political interference, particularly because of animal welfare issues. This context indicates the importance of stakeholders' management as an important priority for pest animal management. For successful participation of peri-urban stakeholders in pest animal control, it would be expected that the regulators will seek a balanced approach that could pave the way for implementing pest animal control while safeguarding animal welfare concerns. This may include a traditional regulatory approach that makes it mandatory for peri-urban community stakeholders to abide by the pest control obligations. In a peri-urban environment, where continuous population growth and economic development will likely raise conflicting issues for environment and natural resource management, institutional and regulatory mechanisms that encourage market-based investments, non-government resources and individual stakeholder motivation to pursue control could be more useful. This requires the implementation of resourcing innovations (outlined in Chapter 2).

Implications for environmental law research and practice

Environmental law researchers typically use doctrinal approaches with a focus on legal instruments. This thesis demonstrates the value of using interdisciplinary research approaches and multi-methods to understand the effectiveness of environmental law and policy. The thesis reinforces the emerging understanding that interdisciplinary research may inform environmental law studies, particularly where the answer is for 'real-world' outcomes.

7.5 Recommendations for law and policy reform

The findings of this thesis indicate that current efforts may not significantly improve strategic control and management outcomes in peri-urban areas unless reforms are undertaken. To address institutional issues requires a co-ordinated, multi-level effort to remedy weaknesses at the structural and operational levels. The peri-urban institutional challenges are seemingly technical but they have deep economic, managerial, behavioural, political and legal dimensions. Hence, the institutional reforms, in part, should be technical; but it will also need the re-evaluation of rules governing formal and informal institutions that influence stakeholder actions. The remainder of this section suggests institutional improvements worthy of more detailed investigation.

1. ***Consolidate and coordinate the governance arrangements for implementing pest animal management strategy***

Governance arrangements for pest animal management, including agencies, laws, policies, programs and plans should be coordinated. This involves harmonisation of laws, policies, programs and plans, and unified agencies to improve operational efficiency. Better coordination is needed across horizontal and vertical levels of government, and with the non-government sector. The governance arrangements should enable coordinated efforts in identifying priorities and responses for peri-urban pest animal management. This also includes coordination in sharing evidence on pest animal management. An integrated response should strive to align administrative arrangements based on ecological scales. One of the examples of such an effort is the *Resource Management Act 1991* of New Zealand.

To fulfil peri-urban specific control objectives, a separate strategic institutional framework that enables more decision-making powers and resources at the local levels is needed. This requires reform that avails more powers to the local government. However, it should be noted that localism carries the risk that local politics will unduly interfere with implementation of pest animal control. Merely delegating authority, or even resources, to local government will not be a sufficient response.

Within the existing governance set-up, clearly defined commitments of local, regional and state/territory institutions to coordinated action can help in improving on-ground

action.[777] The existing regional mechanisms should treat peri-urban specific pest animal issues as a key priority, requiring distinct institutional arrangements. This requires improved communication between neighbouring local councils in a peri-urban area. One of the recommendations proposed by the IACRC review is to set up formal instruments, for example, agreements or Memorandum of Understanding (MoU) to specify clear roles and responsibilities of the institutions, and to articulate the procedures to implement coordinated services in peri-urban areas. The allocation of responsibilities should be based on an assessment of capacity of stakeholders to initiate and sustain control action.

To ensure the accountability of government, a comprehensive and transparent system of performance review should be established. The system should be based upon agreed commitments for performance.

2. *Establish an investment strategy for peri-urban areas to avail coordinated resources for pest animal management*

The Australian Natural Resource Management model for pest animal management relies on investments by governments, landowners and volunteers. The current funding model has been identified as increasingly insufficient for biosecurity management.[778] In this regard, the IACRC review has recommended the use of financial responsibility instruments as a way to increase private investments for pest animal control activities.[779]

For peri-urban areas, the researcher recommends a separate investment strategy. The strategy should be an integral part of the national investment strategy proposed by the Australian Government.[780] The strategy should focus upon increasing government investment of public funds and improving the distribution of funds for pest animal control activities, including training of human resources. This will require distinct

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[777] Allyn O Lockner *Steps to Local Government Reform: A Guide to Tailoring Local Government Reforms to Fit Regional Governance Communities in Democracies*. (iUniverse, 2013).

[778] Craik, Palmer and Sheldrake (2017), above n 5, 102-131.

[779] Martin and Low Choy (2016), above n 4, 15; Low Choy et al (2017), above n 568, 15.

[780] The NBC has proposed a national investment strategy to guide investment in biosecurity-related activities. A working draft of this strategy was discussed during the NBC's sixth strategic workshop held in Canberra (5 November 2015): Department of Agriculture and Water Resources, National Biosecurity Committee Strategic Workshop 6 <http://www.agriculture.gov.au/biosecurity/partnerships/nbc/nbc-strategic-workshop-6>.

peri-urban funding mechanisms and may also require a peri-urban specific cost-sharing and cost-distribution framework. Financial support with clear conditions and guidelines should be made available to local government with clear demarcation of control outcomes. The peri-urban investment strategy should also include ways to advance private funding options (as discussed in Chapter 2) including pathways to creation of markets. This includes incentives to encourage private sector and citizen/community investment. The strategy should be supported by a measurable performance indicators.

3. *Strengthen the institutional support for adoption of control technologies*
The peri-urban areas should formulate a separate regional committee comprising an expert group to suggest research and innovation priorities for control technologies applicable in the peri-urban context. In the peri-urban context, effective adoption hinges on social acceptability of technologies which involves human behavioural elements. The compulsory use of control technologies through legal mechanisms can also be considered as an option, but there are political risks. Adoption also depends upon the ability of institutions to facilitate stakeholders' decision-making in selection of technologies, and in particular to address problems with community support for control programs.

4 *Establish a strategy for compliance and enforcement of laws in peri-urban areas*
The GBD or GBO as a guiding legal instrument is a new concept, subject to uncertainties and qualifications. For invasive species management, multiple stakeholders perform varied intersecting roles and responsibilities. The legal instrument does not ensure clear accountability of individual stakeholders in invasive species control. In peri-urban areas, one of the key problems is access to private properties. The IACRC review indicates a change in private property rights to allow compulsory access to properties for pest animal control purposes.[781] The IGAB review indicates that because of a lack of awareness on pest animal issues, the legal instrument may not prove useful in the short-term. The IACRC review discussed a three-pronged approach to secure compliance: a) a system of penalties to those who do not fulfil pest animal obligations, b) education for those who are willing to

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[781] Martin et al (2016), above n 4, 13.

implement obligations, and c) remuneration for those whose actions are creating difference on ground.[782]

This thesis proposes a separate compliance and enforcement strategy for peri-urban areas. In addition to the recommendations stated by the IACRC review, the strategy should consider the inclusion of 'peri-urban citizen' obligations for pest animal management and deterrent actions for compliance failures.

In regional development, planning plays an important role in aligning processes, resources and formal institutions.[783] Land use planning is one of the important approaches that affect functioning of peri-urban areas and values. Zoning through statutory requirements designates agricultural and non-agricultural uses. Controls over peri-urban rural sub-division are in place but the critical issues of urban expansion, rural residential sub-division and commercial uses remain problematic for state and local governments. Planning has not been effectively explored as a possible mechanism for pest animal management. Instead, the previous planning efforts have been curtailed in the debates of power distribution among the three levels of government[784] which has reduced the efficiency of existing institutional mechanisms to address the 'wicked problems'. In peri-urban areas, the wickedness of the problem requires the planners to balance invasive species management without interfering the prospects of economic development. This research suggests the use of land planning approaches for the management of pest animal problems.

5. *Establish an engagement strategy to secure stakeholders participation for implementing controls*

In peri-urban areas, due to the diversity of landholders and other stakeholders who should be involved in pest animal management, a more realistic approach may be to focus on inclusive governance. In this framework, stakeholders would collectively negotiate and engage to achieve pest animal control outcomes. An inclusive

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[782] Ibid 26-29.

[783] Jeremy Buultjens, Kim Ambrosoli and Brian Dollery, 'The Establishment of Regional Development Australia Committees in Australia: Issues and Initiatives for The Future' (2012) 18(2) *Australasian Journal of Regional Studies*.

[784] Michael Buxton, Rachel Carey and Kath Phelan, 'The Role of Peri-Urban Land Use Planning in Resilient Urban Agriculture: A Case Study of Melbourne, Australia' in B Maheshwari et al (eds), *Balanced Urban Development: Options and Strategies for Liveable Cities* (Water Science and Technology Library 72, 2016 Springer Open 153, doi 10.1007/978-3-319-28112-4_10.

governance framework would have to address behavioural dynamics among stakeholders. The shared responsibility approach suggests the need for more inclusive governance but, to date, arrangements have not been determined.[785]

The use of deliberative democracy principles may facilitate more inclusive governance in practice. This would require the reconciliation of two factors: a) democratic participation of citizens, and b) adherence to deliberative processes including, for example, information, cooperation, reflectiveness and capacity. These strands of deliberative democracy can be explored in designing improved institutions for pest animal management.[786]

Animal welfare issues pertaining to the use of control technologies are a critical obstacle to securing the participation of stakeholders. Despite the scientific evidence on efficiency and humaneness, current technological measures can be, or appear to be, cruel and may affect non-targets. Dismissing animal welfare concerns can aggravate difficulties in implementing technological control measures, further fuelling conflict. Hence, there is a need for involvement of organisations with an animal welfare mandate and a constructive dialogue. It may be necessary to ensure that this dialogue is at a local level, because it is at this level that activists operate.[787]

For effective stakeholder participation, institutional mechanisms to regulate public involvement are important. The underlying power structures and incentives or disincentives shape the motivations of stakeholders. The incentives should be focussed upon those stakeholders from whom the response (control action) is very likely.[788] This requires more emphasis on incorporating human behavioural strategies in devising incentives for pest animal control.

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[785] Council of Europe, 2011. Draft Recommendations of the Committee of Ministers to Member States on the Council of Europe's Charter on Shared Social Responsibilities.

[786] See, eg, Mark E Warren and Hilary Pearse (eds), *Designing Deliberative Democracy: The British Columbia Citizens' Assembly* (Cambridge: Cambridge University Press, 2008); Cass Sunstein, *Designing Democracy: What Constitutions Do* (Oxford University Press, 2001); Bruce Ackerman, *We the People* (The Belknap Press of Harvard University Press, vol 1 (Foundations), 1991).

[787] J W Enck and D J Decker, 'Examining Assumptions in Wildlife Management: A Contribution of Human Dimensions Inquiry' (1997) 2(3) *Human Dimensions of Wildlife* 56.

[788] Michael G Faure,' Designing Incentives Regulation for the Environment' (Maastricht Faculty of Law Working Paper No. 2008-7, 27 October 2008) <https://ssrn.com/abstract=1290523 or http://dx.doi.org/10.2139/ssrn.1290523>.

The participatory approaches adopted for one area or project may or may not work in other areas. Even within one specific area or program, different approaches may be needed at different times. The diversity of peri-urban populations requires a multiple engagement approaches based on in-depth understanding of stakeholders and their motivations for participating in control. This study recommends separate engagement strategies will be needed to secure participation of peri-urban stakeholders. The strategy would comprise of following two approaches:

(a) A top-down approach, emphasising communication and services

In this approach, innovative communication would be used to deliver pest animal control information to the peri-urban population. This includes, for example, the use of social media networking to provide general information and personal advice on control, aiming for engagement of community in decision-making on policies, plans and processes for pest animal control. The institutions need mechanisms to address potential negative messages. The principles from behavioural sciences can be used to create communications that may be effective to secure public confidence in control activities.

In terms of services, administrative agencies should streamline processes where control participants and government institutions interact. These include, for example, access to control technologies at local levels, access to government funds, and access to resources for government stakeholders. The administrative processes for pest animal management should be user-friendly if they are to maximise control.

(b) A bottom-up approach to enrich relationships between government and non-government stakeholders

In this approach, the emphasis would be on building trust to help develop a shared vision and action on pest animal issues. This approach would involve targeted efforts, for example, to recognise and use citizen science in pest animal management and community led regional planning approaches. This would need to acknowledge the perspectives of citizens in defining the problem with due recognition to their value systems. This will require sophisticated engagement approaches to create a culture of mutual trust between government and non-government stakeholders. Evidence in this research suggests that in peri-urban contexts, people's perception determines the course of action for invasive animal management. Understanding these perceptions

and using planning approaches to secure community involvement throughout the management process (from planning to implementation) can support community-led action that is envisioned in pest animal management strategy. For example, an ongoing research project in PUB (SEQ) initiated by Professor Darryl Low Choy attempts to investigate the dynamics of peri-urban community involvement in planning for invasive animal management.[789]

6. *Strengthen the political support*

To address political barriers to adoption of control innovations, consistent efforts are needed to educate politicians about the pest animal issues and the need of new technological measures. To support implementation of technologies, the pest animal management strategy should incorporate a conflict management approach for potential conflicts in implementing controls.

Political leadership needs to enable a partnership between government and non-government stakeholders. This requires leaders who can position themselves 'above the battle of discourses'[790] enabling a constructive dialogue among stakeholders to facilitate the attainment of stated policy objectives. The development of such leaders in the invasive species management sector is an important, but a very long term, challenge.

7. *Develop an integrated risk management strategy for implementation of control innovations*

The research identified potential risks to the implementation of innovations. Present institutions do not have a clear risk management approach to potential risks encountered during each stage of implementation.

The research findings suggest that stakeholders configure risks according to their background, expertise, knowledge and awareness. The risks are understood differently by different stakeholders. The perception of risks is fragmented, because

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[789] IACRC, Research Programs 2012-2017, Community Engagement, Self-Empowered Peri-urban Community Led Planning for Invasive Animals, <http://www.invasiveanimals.com/research/phase2/community-engagement/self-empowered-peri-urban-community-led-planning-invasive-animals/>; Low Choy, Darryl, *Self-Empowered Peri-Urban Community Led Planning for Invasive Animal Management* (Paper presented at the 17th Australasian Vertebrate Pest Conference, 4 May 2017).

[790] M R Uhl-Bien, R Marion and B McKelvey, 'Complexity Leadership Theory: Shifting leadership from the Industrial Age to the Knowledge Era' (2007) 18 *The Leadership Quarterly* 298.

of cognitive and behavioural elements, to the extent that it is hard to derive an objective approach to risks. Socio-economic and cultural aspects affect perception of risks among peri-urban stakeholders. Effective responses to risks (risk management) would ideally be based upon a thorough study of framing of risks. This requires the knowledge of drivers – cognitive and behavioural – of risk perception, as well as the relationship between perception, attitudes and behaviours. Such an integrated approach would require inputs from disciplines, including from the behavioural sciences and sociology.

7.6 Areas of future research

The research demonstrated the importance of institutional approach, which may open avenues for further research in examining:

a) The interaction between formal and informal institutional elements and its influence in shaping the action of government and non-government stakeholders; and

b) The role of each formal institution on the informal institutions and how it shapes the relationship between all the stakeholders.

This thesis by no means suggests that an exhaustive view of peri-urban institutional impediments for effective pest animal management has been obtained. There are many empirical questions identified above where further investigation is required. This research investigation derived a hypotheses on institutional impediments. Further research to verify the nine institutional impediments would be useful.

The thesis also provided a set of broad recommendations for institutional improvements; their implementation should be based on more extensive verification research and consultations with the stakeholders and communities involved in invasive species management.

The research also suggests the need for theoretical development in the following areas:

- *Risk assessment and risk management approaches to understanding legal, social and political dimensions of risks.*

This research outlined significant risks associated with the implementation of technologies for pest animal management. In addition to technological risks, implementation is challenged by institutional risks (discussed in section 6.2.). New

approaches in risk assessment are needed to understand the legal, social and political dimensions of risks. The systematic approach to categorising institutional risks can facilitate improved risk governance. This would involve further interdisciplinary research combining theories in political economy (eg, theory of path dependence, theory of public choice) and risk-based theories.

- *An eco-governmentality approach to understanding peri-urban natural resource management.*

Looking at the wicked problem of pest animal management, a theoretical concept of eco-governmentality may be useful to enhance our understanding of structural and political issues at various levels of governance. The concept of eco-governmentality, drawn on the basis of Michael Foucault's concepts: biopower and governmentality has been used to analyse the governance of social interactions with nature.[791] The concept has been used to understand the role of government in articulating climate change debate as an economic issue to propagate market-based regulations.[792]

Further research to examine the applicability of the eco-governmentality approach to peri-urban natural resource management issues may facilitate an improved understanding of governance and policy issues. This also involves a solution-oriented discourse in Australian administrative constitutionalism to empower local government institutions for better administration of natural resource management issues in peri-urban context.[793]

- *Science, technology and society approaches for the management and dissemination of scientific knowledge.*

The capacity of government to implement invasive animal control technologies is affected by the constantly shifting notions of public reason and perceptions shaped by formal and informal institutions about control technologies. It is crucial to understand

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[791] Michael Goldman, 'Constructing an Environmental State: Eco-Governmentality and Other Transnational Practices of a 'Green' World Bank' (2001) 48(4) *Journal of Social Problems*, 499.

[792] Angela Oels, Rendering Climate Change Governable: From Biopower to Advanced Liberal Government?' (2005) 7 (3) *Journal of Environmental Policy and Planning*, 185.

[793] For example, the 'societal goal' as a foundation for designing future environmental law of Australia, reflects the use of eco-governmentality approach. See, Australian Panel of Experts on Environmental Law, *The Foundations of Environmental Law: Goals, Objects, Principles and Norms* (Technical Paper 1, 2017); Australian Panel of Experts on Environmental Law, *Environmental Governance* (Technical Paper 2, 2017).

the role of political power and its influence on public reason and perceptions for the adoption of control technologies and implementation of invasive animal control.

The Science, technology and society (STS) studies is an inter-disciplinary approach to understand the influence of social institutions on science and technology and vice-versa. The theoretical concepts in STS have been used to understand the processes of participatory decision-making about the use of scientific and technological innovations.[794] The STS approaches may be useful for understanding how scientific and technological knowledge relevant to invasive species management is governed by the states. It may also improve our understanding of the capacity of states to use scientific knowledge by creating and maintaining a political order that is favourable to address 'wicked problems'.

7.7 Concluding remarks

This research pursued evidence-based approach and identified institutional impediments to peri-urban invasive animal management. The focus was on issues which would affect the implementation of new biosecurity policy. The broader theme of the research was more effective pest animal management through adoption and implementation of innovations. The research concludes that the optimal use of many innovations to manage pest animal problem in peri-urban context will require overcoming institutional challenges in adoption and implementation. It seems unlikely that peri-urban stakeholders will sufficiently adopt and implement invasive species management innovations without changing its institutions. This requires a series of institutional innovation alongside the innovations in technologies and managerial practices for pest animal management. The preliminary proposals discussed in this chapter are intended to stimulate further deliberation.

Successive reforms in Australian biosecurity system indicate an aspiration to institutionalise 'shared responsibility'. The new biosecurity law and policy has provided a foundation for further developing the national biosecurity system and the institutions that underpin it. However, implementation will occur through a number of government and private institutions, which together significantly shape the behaviour of peri-urban citizens. Presently, institutional arrangements are not sufficiently

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[794] S Jasanoff, 'Technologies of Humility: Citizen Participation in Governing Science' (2003) 41 *Minerva* 223 <https://doi.org/10.1023/A:1025557512320>.

supportive for this researcher to be confident of the outcome. The researcher hopes that the study and its recommendations will assist policymakers – in partnership with other stakeholders – to address the Australian invasive species management challenges, by translating the aspirations embodied in law and policy documents into practical results within peri-urban communities.

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APPENDICES

Appendix 1: Australian rules impacting invasive species management

Appendix 1.1: Australian laws, regulations, policies and programs

Resource D – Australian laws, regulations, policies & programs

A summary of national, state and territory legislative and regulatory arrangements, policies and strategies

The Australian institutional framework for invasive animal control/management is characterised by complex and overlapping laws, regulations, policies, private arrangements and non-binding instruments (e.g. codes of practice, management plans).[795] It is also influenced by international legal instruments. Documenting Commonwealth and state/territory legal systems for invasive animal control/management required a decision about the boundaries of relevant law. Arguably, relevant laws and regulations include those addressing animal welfare and animal health, biological and chemical control, aspects of land tenure, biodiversity protection, the development of species management plans, land use planning laws, management of alien species, some emergency management, some water pollution prevention, animal research and teaching, and the keeping, sale and movement of specific species. Also relevant are laws that impose obligations for control of specified species. We have aimed for a reasonable balance.

With the cooperation of the small group of expert stakeholders we consulted (mainly within State and Federal agencies), we have identified key legislative and regulatory arrangements mainly relying on:

- Commonwealth, state and territory administrative documentation;
- Commonwealth, state and territory legislation and regulatory databases;
- work carried out by Wool Producers Australia in collaboration with key industry stakeholders as reported in the National Wild Dog Action Plan (see particularly table B1: Relevant Australian legislation for the management of wild dogs, pp. 45-49).[796]

Naturally any remaining errors or misinterpretations are our responsibility.

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[795] The study is focused upon terrestrial vertebrate pests

[796] Available at http://www.woolproducers.com.au/national-wild-dogs-action-plan.

Table A1.1: Commonwealth laws and regulations

MINISTER	AGENCY/ DEPARTMENT	ROLES/RESPONSIBILITIES	ACT	RELEVANCE
Minister for the Environment	Department of the Environment	Environment protection and conservation of biodiversity – Natural heritage – Co-ordination of sustainable communities policy – Environmental information and research; Regulation of the importation of live specimens; Listing of key threatening processes and development of threat abatement plans.	Environment Protection and Biodiversity Conservation Act 1999 and Environment Protection and Biodiversity Regulations 2000	Protection of environment and conservation of biodiversity
Minister for Agriculture	Department of Agriculture	Agricultural, pastoral, fishing, food and forest industries – Rural industries inspection and quarantine – Food security policy and programmes	Agricultural and Veterinary Chemicals Code Act 1994 and Agricultural and Veterinary Chemicals Code Regulations 1995	Control of agricultural and veterinary chemical products
			Quarantine Act 1908[797] and Quarantine Regulations 2000	Regulate biosecurity risks and the importation of animals and plants in Australia
			Biological Control Act 1984	Regulates the importation of biological control agents in Australia

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[797]   To be replaced by the Biosecurity Bill 2012 and Inspector-General of Biosecurity Bill 2012.

Key policies, strategies and frameworks

Intergovernmental Agreement on Biosecurity (IGAB) sets the broad policy parameters.

National categorisation system for invasive species

A list of exotic vertebrate animals already in Australian and a noxious fish list have been developed jointly by the Vertebrate Pest Committee and the Australian Weeds Committee in accordance with schedules under the Intergovernmental Agreement on Biosecurity (IGAB).

For a list of diseases to be declared, see http://www.daff.gov.au/animal-plant-health/pests-diseases-weeds/animal

Biosecurity national agreements

Biosecurity national agreements, based on cost-sharing agreements, provide emergency response plans for disease and plant pest incursions, including plans for outbreaks in disease in livestock and poultry (AUSVET), plants and crops (PLANTPLAN) and aquatic animals (AQUAVETPLAN). Other biosecurity national agreements include:

- Intergovernmental Agreement on Biosecurity (IGAB).[798]

- Emergency Animal Disease Response Agreement (EADRA)

- Emergency Plant Pest Response Deed (EPPRD)

- National Environmental Biosecurity Response Agreement (NEBRA)

Intergovernmental Agreement on Biosecurity (IGAB) is the national policy statement, the rest are more operational agreements on response to incursions or outbreaks.

Australia biodiversity and invasive species policies

Australia's Biodiversity Strategy 2010-2030

Australian Pest animal strategy

Australian Animal welfare strategy

National Plant Biosecurity Strategy

Recent or pending institutional changes

Biosecurity Act, 2015: The biosecurity Bill along with supporting legislation was passed by the Parliament on 14 May 2015. The new legislation is now awaiting royal assent from the Governor-General of the Commonwealth of Australia. This is expected in the coming weeks at which time the Biosecurity Act 2015 will become Australia's new biosecurity legislation.

One of the key things to be aware of is that, although the *Bill* will be a law, it will not fully commence until 12 months after receiving royal assent. The 12 month delay is to allow for clients, staff and stakeholders to understand their rights and obligations

under the new biosecurity legislation and to enable a smooth transition. Some parts of the legislation have a further delayed commencement date and additional transitional arrangements. Until commencement, the Quarantine Act 1908 remains the primary piece of biosecurity legislation in Australia.

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Vertebrate Pest Committee (2007). List of Exotic Vertebrate Animals in Australia, http://www.feral.org.au/list-of-exotic-vertebrate-animals-in-australia/

Institutional contacts

No specific contact nominated

Table A1.2: Australian Capital Territory Laws and regulations

MINISTER	AGENCY/ DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
Minister for Territory and Municipal Services	Territory and Municipal Services Directorate	Land management and stewardship - Roads Services	Animal Diseases Act 2005 and Animal Diseases Regulation 2006	Prevention and control of outbreaks of animal diseases
			Pest Plants and Animals Act 2005	Pest animal management – wild dogs are for example a declared pest animal under this Act
			Animal Welfare Act 1992 and Animal Welfare Regulation 2001	Trapping, handling and destruction of animals
Minister for the Environment	Environment and Planning Directorate	Environmental sustainability policy - Environment protection policy - Heritage - Planning, development and building control - Strategic land use and transport planning - Support to the Conservator of Flora and Fauna - Water policy	Nature Conservation Act 2014	Conservation of native flora and fauna
			Environment Protection Act 1997 and Environment Protection Regulation 2005	Regulate use of hazardous substances, coordinate environment protection. The Environment Protection Regulation 2005 is currently being revised under the new Act and has not yet been released.
			Planning and Development Act 2007 and Planning and Development Regulation 2008	Land management agreements for rural leases
Minister for Health	Health Directorate	Health policy	Medicines, Poisons and Therapeutic Goods Act 2008 and	Regulate use of poisons Medicines, Poisons and Therapeutic Goods Act 2008 is now the responsibility of the Minister for Planning but it is

			Medecines, Poisons and Therapeutic Goods Regulation 2008	still administered by the Environment and Planning Directorate.
Minister for Police and Emergency Services	Justice and Community Safety Directorate	Legal policy and services - Administration of justice	Firearms Act 1996 and Firearms Regulation 2008	Regulate possession and use of firearms
Minister for Workplace Safety and Industrial Relations	Chief Minister and Treasury Directorate Attorney-General—Justice and Community Safety Directorate	Chief minister and Treasury Directorate are responsible for Government strategy and policy - Sustainability policy and coordination Attorney General/Justice and Community Safety Directorate is responsible for legal policy and services - Administration of justice	Work Health and Safety Act 2011 and Work Health and Safety Regulation 2011	Secure health, safety and welfare of employees at work

Key policies, strategies and frameworks

This strategy is owned by the Environment and Planning Directorate.

1. ACT Pest Animal Management Strategy 2012-2022
    - http://www.environment.act.gov.au/cpr/conservation-strategies/pams2

Recent or pending institutional changes

The Pest Plants and Animals (Pest Animals) Declaration 2005 (No 1) Disallowable Instrument DI 2005-255 is forecast to be reviewed in the year 2016.

References

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ACT Government, Legislation Tables- Legislation Update 2014 (Cut-off date 7 February 2014), www.legislation.act.gov.au/updates/latest.pdf

EDO (ACT) (2009), ACT Environmental Law Handbook, http://www.edo.org.au/edoact/publications/handbook.html

Institutional contacts

Canberra Connect Contact Centre 13 22 81

Table A1.3: New South Wales Laws and regulations

MINISTER	AGENCY/ DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
Minister for Primary Industries	Department of Primary Industries	Biosecurity NSW: protecting the economy, environment and community from the negative impacts of pests, diseases and weeds.	Animal Diseases and Animal Pests (Emergency Outbreaks) Act 1991 and Animal Diseases and Animal Pests (Emergency Outbreaks) Regulation 2012	Control of outbreaks of animal diseases
Minister for Primary Industries	**Department of Primary Industries**		Local Land Services Act 2013 (Part 10 – pests) and Local Land Services Regulation 2014	Pest animal management on private and agricultural land (for example wild dogs are declared as a pest animal in NSW under this Act and landholders are required to cull them)
			Game and Feral Animal Control Act 2002 and Game and Feral Animal Control Regulation 2012	Regulate hunting of game animals and some pest species on public land
			Wild Dog Destruction Act 1921 and Wild Dog Destruction Regulation 2009	Wild dog management in Western Division only – wild dogs including dingoes, are declared as a pest animal under this Act and landholders are required to cull them.
			Prevention of Cruelty to Animals Act 1979 and Prevention of Cruelty to Animals Regulation 2012 Deer Act 2006 and	Promotes the welfare of animals including trapping, handling and destruction

			Deer Regulation 2008 Non-indigenous Animals Act 1987 and Non- Indigenous Animals Regulation 2012	Legislation covering the ownership, regulation and release of captive deer. Keeping and movement of controlled category non-indigenous species with potential to become a new invasive threat
Minister for the Environment	Office of Environment and Heritage	Conservation of nature including i) conservation of habitat, ecosystems and ecosystem processes ii) biological diversity	National Parks and Wildlife Act 1974 No 80 and National Parks and Wildlife Regulation 2009	Pest animal management on public land, non-native liberation.
			Threatened Species Conservation Act 1995 and Threatened Species Conservation Regulation 2010	Native flora and fauna conservation – the fox is declared as a threatening process under this Act.
			Pesticides Act 1999 and Pesticides Regulation 2009	Regulate use of pesticides and poisons
Minister for Police and Emergency Services	NSW police force	Police services	Firearms Act 1996 and Firearms Regulation 2006	Possession and use of firearms
Minister for Finance and Services	Workcover NSW	Work and Health Safety	Work Health and Safety Act 2011 and Work Health and Safety Regulation 2011	Safe working environment

Key policies, Strategies and Frameworks

NSW Invasive Species Plan 2008-2015

NSW Animal Biosecurity and Welfare Strategic Plan 2013-2015

NSW Biosecurity Strategy 2013-2021

Recent or pending institutional changes

Institutional changes in New South Wales are taking place within a broader political context, with the intention of reducing red tape as highlighted in NSW 2021.

- From January 2014, creation of statutory semi-autonomous regionally-based Local Land Services (LLS) which

    o brings together functions previously managed by Livestock Health and Pest Authorities (LHPA), Catchment Management Authorities (CMA) and agriculture advisory services of Agriculture NSW

    o will be accountable for delivering substantial pest animal control/management services including in compliance activities.

- Biosecurity strategy 2013-2021 and new forthcoming consolidated biosecurity legislation from early 2015. It is expected that the objects of this new legislation will be consistent with the biosecurity strategy. It will also consolidate existing legislation (e.g. NSW Local Land Services Act 2013 and NSW Wild Dog Destruction Act 1921).

Game and Feral Animal Control Amendment Act 2013 and abolition of the Game Council NSW. Following a governance review of the Game Council of NSW ("Dunn Report") commissioned by the NSW Minister for Primary Industries early 2013, the NSW government has disbanded the Game Council and transferred its responsibilities to NSW DPI..

NSW Invasive Species Plan 2008-2015. This plan which provides the guiding principles for invasive species management in New South Wales will be replaced in 2015. The new plan will consider all recent institutional changes including formation of the LLS system. There are also planned institutional changes in the NSW planning system. For an overview, see:

References

New South Wales Government, Allocation of the Administration of the Acts, http://www.legislation.nsw.gov.au/inforcepdf/2001-338.pdf?id=501ac8dc-d129-c8d2-8535-fb063e30ea19

New South Wales Government, New South Wales legislation, www.legislation.nsw.gov.au

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NSW Government, NSW Department of Primary Industries - Livestock Health and Pest Authorities, NSW Animal Biosecurity and Welfare Strategic Plan 2013-2015, http://www.dpi.nsw.gov.au/biosecurity/animal/strategic-plan

NSW Department of Primary Industries (2014), 67h edition, Vertebrate Pest Control Manual,

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/439201/Vertebrate-pest-control-manual-2014.pdf

Institutional contacts

Jane Frances, Manager Invasive Species Strategy and Planning, Port Stephens 0249163904

Nathan Cutter, Technical Specialist Vertebrate Pests, Orange 0263913174

Table A1.4: Northern Territory Laws and regulations[799]

MINISTER	AGENCY/DEPARTMENT	ROLES/RESPONSIBILITIES	ACT	RELEVANCE
Minister for Primary Industry and Fisheries	Department of Primary Industry and Fisheries	Primary industry biosecurity – Primary production (including pastoral, agricultural and horticulture industries) – interstate agricultural quarantine	Livestock Act No. 36 2008 and Livestock Regulations	Detection, prevention and control of stock diseases
			Biological Control Act	Regulate the release of agent organisms in order to control target organisms, such as invasive animals
			Agricultural and Veterinary Chemicals (Control of Use) Act 2004 and Agricultural and Veterinary Chemicals (control of use) Regulations	Regulate sale, use and application of chemical products
			Animal Welfare Act and Animal Welfare Regulations	Trapping, handling and destruction of animals
Minister for Parks and Wildlife/Minister for Land	Parks and Wildlife Commission of the Northern Territory Department of Land Resource Management	Management and Territory parks and reserves – Wildlife management	Territory Parks and Wildlife Conservation Act 2006 and Territory Parks and Wildlife Conservation Regulations	Feral animal management, use of pesticides

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[799]   In 2008, the Desert Knowledge CRC released a review of legislation and regulations relating to feral camel management in Northern Territory. The listed laws and regulations are to a wide extent relevant to other invasive animals. For further information, please see Carey R, O'Donnell M, Ainsworth G, Garnett S, Haritos H and Williams G. 2008. Review of legislation and regulations relating to feral camel management, DKCRC Research Report 50. Desert Knowledge CRC, Alice Springs, available at http://www.nintione.com.au/resource/DKCRC-Report-50-Review-of-legislation.pdf.

Minister for Police, Fire and Emergency Services	Police Civil Employment Unit (Administration only). Approval with OIC Firearms Policy and Records Unit.	Police	Firearms Act and Firearms Regulations	Regulate possession and use of firearms. Also regulates licensing for the shooter and controls the types and categories of firearms used.
Minister for Business	Department of Business	Safety regulations	Workplace Health and Safety (national uniform legislation) Act 2011 (No 39 of 2011) and Work Health and Safety (national uniform legislation) regulations	Health and safety of workers

Key policies, strategies and frameworks

Key strategies for invasive animal control in Northern Territory are summarised in Natural Resource Management Ministerial Council (2007), Australian Pest Animal Strategy 2007 - a National Strategy for the Management of Vertebrate Pest animals in Australia (see also appendix for a list of national, State/Territory and local strategy and policy documents relevant to feral/pest animal management in Australia)

National Feral Camel Action Plan

Northern Territory Agribusiness Industry Strategy 2011-2015

Framing the Future

Recent or pending institutional changes

No comment provided

References

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Northern Territory, Department of Primary Industries and Fisheries, Direction for the Use of 1080 for Wild Dog Management, available at

http://www.nt.gov.au/d/Primary_Industry/index.cfm?newscat1=Chemical%20Services&news cat2=&header=1080%20Baiting%20Information

Northern Territory Government, A to Z Government (list of the 33 agencies in Northern Territories), http://www.nt.gov.au/ntg4/Subject?documenttitle=*&myLevel=2&myRefPoint=cn=A-Z%20Government%20Listing&opt=6&layout=hide

Northern Territory Government of Australia (Land and Planning Services/ Department of Lands Planning and the Environment), The Northern Territory Planning System, http://www.lands.nt.gov.au/planning/planning-system

Parks and Wildlife Service, Department of Natural Resources, Environment and the Arts, A Management Program for the Dingo (*Canis lupus dingo*) in the Northern Territory of Australia – 2006-2011

http://www.lrm.nt.gov.au/__data/assets/pdf_file/0019/10765/dingo_management.pdf

Dionne Walsh (Greening Australia) (February 2008), From Cane Toads to Camels - Evaluating Northern Territory Pest Animal Management Through Community Consultation, http://www.greeningaustralia.org.au/uploads/Our%20Resources%20-%20pdfs/NT_Ferals_web.pdf

Institutional contacts

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Table A1.5: Queensland laws and regulations

MINISTER	AGENCY/DEPARTMENT	ROLES/RESPONSIBILITIES	ACT	RELEVANCE
Minister for Agriculture, Fisheries and Forestry	Department of Agriculture, Fisheries and Forestry	Agricultural chemicals – Agriculture, Fisheries and Forestry Research, Development and Extension - Animal Welfare – Biosecurity – Plant and Animal Diseases	Biosecurity Act 2014 (and subordinate legislation and associated regulations). [800]	Regulate biosecurity risks, including those that relate to biological infestations from invasive species. (remaining provisions to commence on or before 1 July 2016)
			Exotic Diseases in Animals Act 1981 and Exotic Diseases in Animals Regulation 1998	Control of animal diseases (to be repealed on or before 1 July 2016)
			Stock Act 1915 and Stock Regulation 1988	Stock disease management (to be repealed on or before 1 July 2016)
			Land Protection (Pest and Stock Route Management) Act 2002 and Land Protection (pest and Stock Route Management) Regulation 2003	Pest animal management – Landholders have a legal responsibility to control animals that have been declared pests. (Pest management provisions to be repealed on or before 1 July 2016)
			Animal Care and Protection Act 2001 and Animal Care and Protection Regulation 2012	Trapping, handling and destruction of animals
Minister for Environment and Heritage Protection	Department of Environment and Heritage Protection	Environmental protection policy – Environmental planning – Ecologically sustainable development – Nature conservation	Nature Conservation Act 1992 and Nature Conservation (Protected areas) Regulation 2006	Conservation of nature, permitted uses of protected areas
Minister for Health and Minister for Ambulance Services	Queensland Health	Public health	Health Act 1937 and Health Regulation 1996 Health (Drugs and Poisons) Regulation 1996	Regulate supply and use of poisons

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[800] For an overview of the biosecurity Act framework, please see http://www.daff.qld.gov.au/__data/assets/pdf_file/0004/117283/biosecurity-bill-framework.pdf.

			Pest Management Act 2001 and Pest Management Regulation 2003	Protect public health from pest control and fumigation activities
Treasurer, Minister for Employment and Industrial Relations and Minister for Aboriginal and Torres Strait Islander Partnerships	Department of Justice and Attorney-General	Workplace Health and Safety	Work Health and Safety Act 2011 and Work Health and Safety Regulation 2011	Protection in the workplace
Minister for Police, Fire and Emergency Services and Minister for Corrective Services	Queensland Police Service	Police Services	Weapons Act 1990 and Weapons categories Regulation 1997 Weapons Regulation 1996	Possession and use of weapons, including firearms
Deputy Premier, Minister for Transport, Minister for Infrastructure, Local Government and Planning and Minister for Trade	Department of Infrastructure, Local Government and Planning	Local pests	Local Government Act 2009	Enables declaration of locally significant species

Key policies, strategies and frameworks

Queensland Pest Animal Strategy (currently under review)

Queensland Wild Dog Management Strategy 2011 – 2016

Queensland Feral Deer Management Strategy 2013 – 2018

Regional Pest Management Plans – e.g. Central Highlands Pest Management Plan, Capricorn Pest Management Plan

Local Pest Management plans – e.g. Brisbane Invasive Species Management Plan 2013-2017

Recent of pending institutional changes

A new biosecurity Act was passed in Parliament on 6 March 2014 and should come into effect by 1 July 2016. For further information, visit http://www.daff.qld.gov.au/biosecurity/about-biosecurity/proposal-for-a-new-biosecurity-bill.

The *Biosecurity Act 2014* proposes a more flexible approach to declared pests. As an example, the general biosecurity obligation will minimise the need for prescriptive regulation about what a landholder must do. However, if a person was not achieving an adequate level of control, an authorised officer would be able to issue them with a biosecurity order requiring them to take specific steps to minimise the risks posed by feral animals.

References

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Queensland Government, Our Structure, http://www.cabinet.qld.gov.au/ministers.aspx, (last updated 16th august 2013)

Queensland Government, Department of Agriculture, Fisheries and Forestry, Weeds, Pest Animals and Ants, Legislation, http://www.daff.qld.gov.au/plants/weeds-pest-animals-ants/legislation-policies-permits/legislation

Environmental Defenders Office (EDO Qld), Pesticide Use in Queensland (current as at June 2011), http://www.edo.org.au/edoqld/wp-content/uploads/2012/05/Pesticide-Use-in-Queensland-JUNE-2011.pdf

Queensland Government, Environmental Health Branch, A Guide to what Pest Management Technicians in Queensland Need to Know (version 1 February 2012), www.health.qld.gov.au/ph/documents/ehu/20479.pdf

Institutional contact

Department of Agriculture, Fisheries and Forestry (Biosecurity Queensland). Dr John Robertson 07 3087 8065. John.Robertson@daff.qld.gov.au

Table A4.6: South Australian Laws and regulations

MINISTER	AGENCY/DEPARTMENT	ROLES/RESPONSIBILITIES	ACT	RELEVANCE
Minister for Agriculture, Food and Fisheries	Department of Primary Industries and Regions SA	Biosecurity – Chemical use legislation - Agriculture, Fisheries and Forestry Research, Development and Extension	Livestock Act 1997 and Livestock Regulations 2013	Regulate livestock matters, including exotic disease control
			Agricultural and Veterinary Products (Control of Use) Act 2002 and Agricultural and Veterinary Products (Control of Use) Regulations 2004	Regulate the use of chemicals
Premier	Various agencies are involved in the administration of the emergency management act 2004	Emergency management	Emergency Management Act 2004 and Emergency Management Regulations 2009	Emergency responses to invasive species incursions.
Minister for Sustainability, Environment and Conservation	Department of Environment, Water and Natural Resources	Natural Resource Management, Environment policy, biodiversity conservation, heritage conservation, environmental sustainability and animal welfare	Natural Resources Management Act 2004 and associated regulations	[in relation to pest plants and animals] Provides for the prevention or control of impacts caused by pest species of animals and plants that may have an adverse effect on the environment,

				primary production or the community
			National Parks and Wildlife Act 1972 and associated regulations.[801]	Conservation of Wildlife
			Animal Welfare Act 1985 and Animal Welfare Regulations 2012	Trapping and/or destruction of animals[802]
Minister for Sustainability, Environment and Conservation	Dog Fence Board		Dog Fence Act 1946	Owners of the dog fence must maintain the fence in dog-proof condition and take all reasonable steps to destroy wild dogs in the vicinity of the fence.
Minister for Mental Health and Substance Abuse	Department of Health, Environmental Health Service	Health policy	Controlled Substances Act 1984 and Controlled Substances (poisons) Regulations 2011	Sale and use of poisons

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[801]   For further details, please see http://www.austlii.edu.au/au/legis/sa/consol_reg/toc-N.html.

[802]For an overview of animal welfare legislation, please see http://www.environment.sa.gov.au/managing-natural-resources/plants-and-animals/Animal_welfare/Animal_welfare_legislation.

Minister for Police	Police	Police services	Firearms Act 1977 and Firearms Regulations 2008	Control possession, use and sale of firearms
Minister for Industrial Relations	Safe Work SA	Workplace Health and Safety	Work Health and Safety Act 2012 and Work Health and Safety Regulations	Health, Safety and welfare of workers

Key policies, strategies and frameworks

Key policies and strategies relevant to invasive species management are:

Our Place Our Future – State Natural Resources Management Plan South Australia 2012-2017 (available at http://www.environment.sa.gov.au/about-us/our-plans)

NRM plans for each of the eight Natural Resources Management regions (available via http://www.naturalresources.sa.gov.au/home

No Species Loss - A Nature Conservation Strategy for South Australia 2007-2017

PIRSA State Biosecurity Policy 2013-2016

Policies under the *Natural Resources Management Act 2004* guide actions at the state and regional level on particular declared plants and animals:

http://www.pir.sa.gov.au/biosecurity/weeds_and_pest_animals/animal_pests_in_south_australia/pest_animal_policies

http://www.pir.sa.gov.au/biosecurity/weeds_and_pest_animals/plant_pests_in_south_australia/plant_policies

Declarations are periodically updated and posted at:

http://www.pir.sa.gov.au/biosecurity/weeds_and_pest_animals

Recent or pending institutional changes

- There are no pending institutional changes to the status quo.
- The Minister for Sustainability, Environment and Conservation (MSEC) has the statutory responsibility under the *Natural Resources Management Act 2004* (NRM Act) for the prevention or control of impacts on the environment, primary production or the community caused by pest species of animals (currently excluding fish and invertebrates by regulation) and plants. Under this Act, strategic natural resources management biosecurity priorities are identified in State and regional plans. Eight regional NRM Boards work with landholders to administer coordinated control programs. NRM Boards have been integrated into regional services of Department of Environment, Water and Natural Resources (DEWNR).
- Biosecurity SA, a Division of the Department of Primary Industries and Regions (PIRSA), is accountable to the Minister for Agriculture, Food and Fisheries (MAFF) for providing advice, developing policy and delivering government services on matters relating to biosecurity in general. However, the NRM Biosecurity Unit of Biosecurity SA, which includes the Dog Fence Board, reports through PIRSA and the NRM Act's Chief Officer (Chief Executive of DEWNR) to the MSEC on vertebrate pest management.
- Pest fish and aquatic invertebrates are managed by Biosecurity SA under the Fisheries Management Act 2007, reporting to MAFF.

References

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Government of Australia, Biosecurity SA, Animal Pests of South Australia – What you need to know (http://www.pir.sa.gov.au/__data/assets/pdf_file/0020/154631/NRM_Animal_pests_broch_29042013.pdf)

Primary Industries and Regions SA (PIRSA, 2013), State Biosecurity Policy 2013-16

Primary Industries and Regions SA (PIRSA, 2012), Prohibited Exotic Animals Pets – Factsheet

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Government of South Australia, Primary Industries and Regions SA (PIRSA,2008), Agricultural and Veterinary Chemicals Legislation - Factsheet FS05/05

Government of South Australia, Primary Industries and Regions SA (PIRSA,2012), Agricultural Chemical Products - Permitted and Prohibited Uses - Factsheet 07/06

EPA South Australia (2005), EPA Guidelines for Responsible Pesticide Use

Government of South Australia, Jay Weatherill, Premier of South Australia (list of ministers with their portfolios) http://www.premier.sa.gov.au/ministers/

Key institutional organisations

Biosecurity SA, Primary Industries and Regions SA (http://www.pir.sa.gov.au/biosecuritysa) State level coordination of pest management including technical advice, policy development and research. Pesticide regulation.

Department of Environment, Water and Natural Resources (http://www.environment.sa.gov.au/Home) Provide services to the NRM Boards to deliver regional pest animal and weed management programs. Animal welfare.

Natural Resources Management Boards (http://www.naturalresources.sa.gov.au/home)

Statutory role to develop and oversight the implementation of regional NRM plans, including pest animal management programs

University of Adelaide (www.adelaide.edu.au). Pest animal research and training (Phill Cassey, Phil Stott)

Weed Management Society of South Australia (http://www.wmssa.org.au/) Professional and community-based membership providing information and advocacy for weed management

Table A1.6: Tasmanian Laws and regulations

MINISTER	AGENCY/DEPARTMENT	ROLES/RESPONSIBILITIES	ACT	RELEVANCE
Minister for Primary Industries and Water	Department of Primary Industries, Parks, Water and Environment	Agricultural chemicals – Animal Welfare – Biosecurity – Plant and Animal Diseases – Agriculture, Fisheries and Forestry Research, Development	Animal Health Act 1995 and Animal Health Regulations 2006	Prevention, detection and control of animal
			Cat Management Act 2009 and Cat Management Regulations 2012	Some provisions relate to feral cats
			Vermin Control Act 2000	Provides provisions for the control of vermins (e.g. classification of rabbits as vermins)
			Animal Welfare Act 1993 and Animal Welfare (general) Regulations 2013	Use of traps and poisons, destruction of animals
Minister for Primary Industries and Water	Department of Primary Industries, Parks, Water and Environment		Plant Quarantine Act 1997 and Plant Quarantine Regulations 2007	provides provisions in relation to the importation of material potentially contaminated with pests and diseases of plants with the potential to degrade primary production
			Seeds Act 1985 and Seeds Regulations 2010	provides provisions in relation to the importation of seeds of plants with the

				potential to degrade primary production.
			Agricultural and Veterinary Chemicals (Control of Use) Act 1995 and Agricultural and Veterinary Chemicals (control of use) Regulations 2012 Agricultural and Veterinary Chemicals (Tasmania) Act 1994 and Agricultural and Veterinary Chemicals (Tasmania) Regulations 2004	Control the use of agricultural and veterinary chemicals
Minister for Environment, Parks and Heritage	Department of Primary Industries, Parks, Water and Environment	Environmental protection policy – Environment planning – Ecologically sustainable development – Nature conservation	National Parks and Reserves Management Act 2002 and National Parks and Reserved Land Regulations 2009	Protection of national parks and wildlife against introduced species and diseases
			Nature Conservation Act 2002	Provides provisions for the conservation of and protection of the fauna, flora (e.g. specific controlled species including some of the introduced species)

| Minister for Local Government | Department of Premier and Cabinet | Local government | Dog Control Act 2000 and Dog Control Regulations 2010 | Control and management of dogs – the control of feral and commensal dogs preying upon livestock is covered under this Act. The Act does not specifically cover 'feral' dogs which are in the legislative black hole. It does cover 'dogs at large – essentially wandering owned dogs. |

Minister for Workplace Relations	WorkSafe Tasmania	Workplace Health and Safety	Work Health and Safety Act 2012 and Work Health and Safety Regulations 2012	Health, Safety and welfare of workers
Minister for Health	Health and Human Services	Health	Poisons Act 1971 and Poison Regulations 2008	Regulate sale, supply and use of poisons
Minister for Police and Emergency Management	Department of Police and Emergency Management	Police services – Emergency management	Firearms Act 1996 and Firearms Regulations 2006	Regulation and use o firearms
			Police Offences Act 1935 and Police Offences Regulations 2007	Illegal use of poisons

Key policies, strategies and frameworks

Tasmanian Biosecurity Strategy 2013-2017

Actions relating to invasive animals from Implementation Plan

The Tasmanian Biosecurity Strategy describes the approach taken to deliver the Tasmanian Biosecurity Policy. The Objective of Tasmania's Biosecurity Policy is to protect and enhance Tasmania's biosecurity status for the benefit of Tasmania's industries, environment and public well-being, health, amenity and safety.

There are a number of actions with the Implementation Plan for the Tasmanian Biosecurity Strategy that relate directly to invasive animals management. These are listed below:

Strategic actions

- ***Consistently applying Tasmania's risk analysis framework when making biosecurity related decisions***

  - Nationally agreed risk assessment process adopted for invasive species

  Development and delivery of training and information sessions for all biosecurity stakeholders on ALOP and the biosecurity risk decision making process used by the Tasmanian government

  - Plan and organise a biosecurity forum in collaboration with industry.

  Developing a partnership approach to survey and surveillance work using available advanced trapping technologies and digital capture of survey data

  - Develop new monitoring and trapping technology for invasive animals in corroboration with local stakeholders.

  Using nationally consistent approaches to survey and surveillance activities that meet national standards and allow for data aggregation

  - Adoption of nationally agreed 'data' attributes' for invasive species distribution information.

  - Data sharing at a national level of incursion and eradication activities.

  Communication programs that inform stakeholders of their biosecurity responsibilities and obligations.

  - Support Invasive Species Community Partnership to discuss priorities, roles and projects

  Maintaining a mechanism for the reporting of unusual biosecurity events and diseases

  - Maintain invasive species reporting hotline plus other (email, Facebook) reporting mechanisms

  Developing and implementing a review program for biosecurity related legislation to ensure laws and regulations supporting the Tasmanian Biosecurity System are contemporary and current

- Provide input to review of Tasmanian biosecurity legislation under National Biosecurity Response Agreement (NEBRA)

- Review of Tasmanian legislation relating to invasive species management and incursion response.

Review of current survey and surveillance activities to ensure such activities are contemporary, apply available technologies, and consistent with State and national standards for data collection

- Invasive Species Monitoring Strategy developed in collaboration with key stakeholders to improve and standardise data collection, storage and sharing.

Development and delivery of a State Biosecurity Communications plan of activities and developments that target biosecurity stakeholders with an objective of influencing behaviours and improving understanding

- Invasive Species Branch Community Engagement and Communications Strategy

Alignment of biosecurity communication activities amongst stakeholders such as government, industry, and Natural Resource Management groups

- Establish and maintain mechanisms such as the Invasive Species Community Partnership and Tasmanian Primary Industries Biosecurity Consultative Committee to ensure biosecurity communications messages are consistent and appropriately targeted.

- Invasive Species Branch Community Engagement and Communications Strategy maintained and communications plans developed and implemented where necessary. Recent or pending institutional changes

Invasive Species Branch (ISB)

Invasive animal management initiatives

The Invasive Species Branch (ISB) was established on 1 July 2012 with the task of addressing the threats and minimising the impacts of existing and emerging invasive animals and weeds. The ISB brought together the Fox Eradication Branch, Weed Management Unit and a number of individual specialist staff into a single business unit. This centralised invasive species knowledge and resources within one management structure.

In May 2014, the role of the ISB changed with the creation of Biosecurity Tasmania. Operational elements of invasive species management activities moved into a new Operations Branch with other operational biosecurity staff. The role of the ISB became focused solely on policy and legislative development, risk assessment, provision of specialist advice on management internally, research and program design.

The Biosecurity Tasmania has responsibility for administering Tasmania's *Weed Management Act 1999, Vermin Control Act 2000 and Cat Management Act 2009*.

The following are ISB initiatives since its formation:

Invasive Species Community Partnership: An Invasive Species Community Partnership group has been created to ensure that key stakeholder groups representing a broad community interest base have input into ISB priorities and activities. Represents an institutional emphasis on promoting with stakeholders the concept of 'shared responsibility' and a cooperative approach to management of invasive species that identifies community concerns and issues and ensures a regular formalised feedback loop.

Incursion Response Framework: An Incursion Response Framework has been developed and is now applied by the BT to ensure effective workflow and planning, execution and review of incursion responses.

Eradication Project Framework: A planning and management framework has been developed and is being applied to manage the scoping, planning, execution and monitoring of eradication projects.

Management framework: The ISB has adopted the Generalised Incursion Curve as the basis for decision-making with respect to individual species. Where a species is classified as a potential risk of entry, but not present in the State, and presents an extreme risk (e.g. Indian mynas), a Biosecurity Plan is prepared to outline the preventative, surveillance and public awareness efforts undertaken in conjunction with border biosecurity (inspection) measures to minimise the risk of entry and ensure early detection of incursions. Where a species has been detected in the State but not widespread or not established (e.g. the European Red Fox) and eradication is deemed feasible, an Eradication Plan is developed and executed. Where a species is established in the State and considered to present a level of impact or cause significant community concern (e.g. feral cats) a Management Strategy is developed to identify priority actions for government, land managers, community groups and researchers to address those impacts.

Review of Legislative Framework: A review of the legislative framework for invasive species management (both animals and weeds) was commenced but has now been incorporated into a wider review of all biosecurity legislation. Currently the Tasmanian legislative framework for invasive species includes the *Weed Management Act 1999*, *Vermin Control Act 2000*, *Animal Health Act 1995, Cat Management Act 2009, Plant Quarantine Act 1997, Seeds Act 1985* and *Nature Conservation Act 2002* and associated Regulations. Additional legislation regulates activities involving the use of firearms and toxins and the destruction of animals.

The Invasive Species Branch has identified a need to address existing gaps and inconsistencies in the current invasive species legislative framework, including the ability to undertake monitoring, control incursion response and eradication activities and effectively manage the risks presented by invasive species. It was also apparent that that legislative framework was dated and unnecessarily complex and contained inconsistencies.

A review of the legislative framework is addressing these issues. It will consider the powers required to effectively manage species present in Tasmania under the ambit of the Invasive Species Branch and review the existing statutory powers to identify any apparent inconsistencies or gaps. This project will also consider contemporary statutory powers and approaches being applied in other Australian States to manage invasive species, and assess whether any of these could be applied in Tasmania. This latter aspect will consider the application of a 'white' (permitted) list approach in full

or in part and the use of 'duty of care' principles for land managers and 'risk creators' to take responsibility for invasive species.

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Institutional contacts

Manager, Invasive Species (Michael.askey-doran@dpipwe.tas.gov.au) – terrestrial vertebrate invasive species, marine invasive species and declared weeds policy

Director, Biosecurity Operations (craig.elliott@dpipwe.tas.gov.au) – Operational activity in pre-border, border and post-border environments for all biosecurity (and animal welfare and product integrity) activities including terrestrial, aquatic and marine invasive animals and weeds

Director, Inland Fisheries Service (john.diggle@ifs.tas.gov.au) – freshwater invasive species

Table A1.7: Victorian Laws and regulations

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
Minister for Agriculture	Department of Economic Development, Jobs, Transport and Resources	Plant and animal diseases – Biosecurity - Agriculture, Fisheries and Forestry Research - Emergency management	Livestock Disease Control Act 1994 and Livestock Disease Control Regulations 2006	Prevention, monitoring and control of livestock diseases and to provide compensation for losses caused by certain livestock diseases
			Agriculture and Veterinary Chemicals (Control of Use) Act 1992 and associated regulations[803]	Imposes controls in relation to the use, application and sale of agricultural and veterinary chemical products, fertilisers and stock foods and the manufacture of fertilisers and stock foods. It also imposes controls in relation to agricultural spraying, contamination and in relation to transport, handling and other dealings
			Livestock Management Act 2010 and Livestock Management Regulations 2011	Provides the legislative framework for integrating, nationally agreed Standards relating to aspects of livestock management (e.g. biosecurity and management of pests)
			Drugs, Poisons and Controlled Substances	Transportation of baits

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[803] For a list, please see http://www.austlii.edu.au/au/legis/vic/consol_reg/toc-A.html.

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
			Act 1981 and associated regulations[804]	
Minister for Agriculture	Department of Economic Development, Jobs, Transport and Resources		Biological Control Act 1986	Provides provision for the biological control of pests in Victoria
Minister for Agriculture	Department of Economic Development, Jobs, Transport and Resources		Prevention of Cruelty to Animals Act 1986 and Prevention of Cruelty to Animals Regulations 2008	Trapping, handling and destruction of animals
Minister for Environment, Climate Change and Water	Department of Environment, Land, Water and Planning	Biodiversity conservation – Environmental sustainability	National Parks Act 1975 and National Parks Regulations 2013	Management of natural environment in designated parks. Provides for the protection of indigenous fauna and the control of exotic fauna

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[804]   For an overview, please see http://www.austlii.edu.au/au/legis/vic/consol_reg/toc-D.html.
  Please note that part IVA is administered by the Minister for Agriculture and Food Security. Part XI is jointly and severally administered with the Minister for Health and the Minister for Mental Health.

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
			Parks Victoria Act 1998 Forests Act 1958	This Act provides powers, duties and functions relating to metropolitan, national and state parks. Section 62A gives the Secretary power to use fire to control pest animals in State forest, National Parks or protected public land
Minister for Environment, Climate Change and Water	Environment Protection Authority Victoria		Environment Protection Act 1970 and associated regulations[805]	Provides the legislative framework in Victoria for protecting environmental assets.
Minister for Environment Climate Change and Water	Department of Environment, Land, Water and Planning	Responsibility for setting invasive species policy sits with the Minister of Agriculture	Catchment and Land Protection Act 1994 and Catchment and Land Protection Regulations 2012 Catchment and Land Protection (Register of Interest) Regulations 2006	The Act under Part 3 – Duties of the Secretary and Land Owners s20 General duties of and owners – (1) in relation to his or her land a land owner must take all reasonable steps to (f) prevent the spread of, and as far as possible eradicate, established pest animals. More broadly, the CaLP Act provides the overarching legislative framework for managing noxious weeds and pest animal in Victoria. It provides the power to declare animals as 'pests' (as well as

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[805]　For an overview of these regulations, please see http://www.austlii.edu.au/au/legis/vic/consol_reg/toc-E.html

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
				certain species of plants as 'noxious). It also regulates the control, importation into the State, keeping, movement, trade and release of pest animals (and noxious weeds) in Victoria. The CaLP provides a framework for integrated management and protection of catchments, establishes processes to encourage and support community participation in the management of land and water resources. It provides a system of controls on pest animals (and noxious weeds). It also establishes the Victorian Catchment Management Council and the ten Catchment Management authorities
Minister for Environment, Climate Change and Water /Minister for Agriculture and Food Security	Department of Environment, Land, Water and Planning Department of Economic	Minister for Environment, Climate Change and Water – Except:	Conservation Forests and Lands Act 1987 and associated regulations[806]	Provides the head of power to the Catchment and Land Protection Act 1994 (as well as other Acts relevant to invasives, such as aquatic invasive species.

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[806]   For an overview of associated regulations, please see http://www.austlii.edu.au/au/legis/vic/consol_reg/toc-C.html.

MINISTER	AGENCY/DEPARTM ENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
	Development, Jobs, Transport and Resources	• In so far as it relates to the exercise of powers for the purposes of the *Fisheries Act 1995* (these powers are exercised by the Minister for Agriculture) • • Sections 11(1), 12, 28, 83, 88A, 91, 95A and 96 and Schedule 2 in so far as they relate to the exercise of powers for the purposes of: a. Sections 40 and 52AA of the *Forests Act 1958* (these powers are exercised by		

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		the Minister for Agriculture)		
		b. Sections 1,2,3(1), 3B,4-7(1), 7(3), 18, 19-22, 26A, 52, 53-55, 57,75,78-84,94-100,101,102 and 103 of the *Forests Act 1958* (these powers are jointly and severally exercised with the Minister for Agriculture)		
		c. The *Safety on Public Land Act 2004*, in so far as that Act relates to declaring, managing and enforcing public safety zones for the purposes of timber		

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		harvesting operations (these powers are jointly and severally exercised with the Minister for Agriculture)		
		d. The *Sustainable Forests (Timber) Act 2004* (these powers are exercised by the Minister for Agriculture) except:		
		i. Sections 3,22,23(1) and 24 and Part 9 (these powers are jointly exercised with the Minister for Agriculture)		
		ii. Part 2, section 45, Division 1 of Part 6 and Part 8		

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		(these powers are exercised by the Minister for Environment, Climate Change and Water) • Sections 11(1), 28, 31-40, 83, 88A, 91 and 96 in so far as they relate to the exercise of powers for the purposes of: a. Section 5, Parts 3 and 5 and Divisions 1 and 2 of Part 6 of the *Flora and Fauna Guarantee Act 1988* (these powers are jointly exercised with the Minister for Agriculture) b. Section 3 of the *Land*		

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		Conservation (Vehicle Control) Act 1972 (these powers are jointly exercised with the Minister for Agriculture) c. Part I (except section 4B), Parts III, IIIA, VIII and IX, Sections 16, 35, 41-44, 47D, 48-48C, 53-58B and 86-86C and, in so far as it relates to the effective management of hunting, including preserving good order among hunters of wildlife, section 87 of the *Wildlife Act 1975* (these		

MINISTER	AGENCY/DEPARTMENT	ROLES/RESPONSIBILITIES	ACT	RELEVANCE
		powers are jointly exercised with the Minister for Agriculture) d. Part IIIB in so far as it relates to the hunting of game and sections 58C, 58D and 58E of the *Wildlife Act 1975* (these powers are exercised by the Minister for Agriculture) • Section 12 and Schedule 2 in so far as they relate to the exercise of powers relating to hunting or game for the purposes of the *Wildlife Act 1975* (in so far as they relate to		

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		those matters, these provisions are administered by the Minister for Agriculture) • Section 99 in so far as it relates to: a. Sections 40 and 52AA and sections 1, 2, 3(1), 3B, 4-7(1), 7(3), 18,19-22, 26A, 52, 53-55,57,75,78-84,94-100,101,102 and 103 of the *Forests Act 1958* b. The *Safety on Public Land Act 2004*, in so far as that Act relates to declaring, managing and enforcing public safety zones for		

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		the purposes of timber harvesting operations c. The *Sustainable Forests (Timber) Act 2004* d. Part I (except section 4B), Parts III, IIIA, VIII and IX, sections 16,35,41-44,47D,48-48C,53-58B and 86-86C and, in so far as it relates to the effective management of hunting, including preserving good order among hunters of wildlife, section 87 of *the Wildlife Act 1975*		

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		e. Part IIIB in so far as it relates to the hunting of game, Part VIIA and sections 58C, 58D and 58E of the Wildlife Act 1975 (in so far as it relates to those matters and provisions, this provision is jointly and severally administered with the Minister for Agriculture) f. Section 5, Parts 3 and 5 and Divisions 1 and 2 of Part 6 of the *Flora and Fauna Guarantee Act 1988* g. Section 3 of the *Land Conservation*		

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		(Vehicle Control) Act 1972 (in so far as it relates to those matters and provisions, this provision is jointly administered with the Minister for Agriculture) • • •		
Minister for Environment, Climate Change and Water/Minister for Agriculture	Department of Environment, Land, Water and Planning Department of Economic Development, Jobs, Transport and Resources	Minister for Environment, Climate Change and Water – Except: • Section 5 • Parts 3 and 5 and Divisions 1 and 2 of Part 6 These provisions are jointly administered with the Minister for Agriculture	Flora and Fauna Guarantee Act 1988 and Flora and Fauna Guarantee Regulations 2011	Management and control of native fauna and flora.

MINISTER	AGENCY/DEPARTM ENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		Minister for Environment, Climate Change and Water – Except: • Part I (except section 4B), Parts III, IIIA, VIII and IX • Sections 16,35,41-44,47D,48-48C,53-58B and 86-86C • Section 87 in so far as it relates to the effective management of hunting, including preserving good order among hunters of wildlife These provisions are jointly administered with the Minister for Agriculture	Wildlife Act 1975 and Wildlife Regulations 2013	Wildlife protection and management

MINISTER	AGENCY/DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
		• Part IIIB in so far as it relates to the hunting of game • Sections 58C, 58D and 58E		
Minister for Agriculture	Department of Economic Development, Jobs, Transport and Resources	Division 2 provides for the declaration of noxious aquatic species	Fisheries Act 1995	Noxious aquatic species
Minister for Police and Emergency Services	Victoria Police	Police services – emergency services	Firearms Act 1996 and Firearms Regulations 2008	Regulation and use of firearms
Minister for Finance	WorkSafe Victoria	Workplace Health and Safety	Occupational Health and Safety Act 2004 and Occupational Health and Safety Regulations 2007	Health, Safety and welfare of workers

Policies, strategies and frameworks

For an overview of key policies and strategies of invasive species management in Victoria, see

State Government of Victoria, Department of Primary Industries, Invasive Plants and Animals Policy Framework (IPAPF), http://www.depi.vic.gov.au/agriculture-and-food/pests-diseases-and-weeds/protecting-victoria-from-pest-animals-and-weeds/invasive-plants-and-animals

The Invasive Plants and Animals Policy Framework outlines the case for government investment in invasive species and the Victorian policy approach to management across the invasion curve from prevention to asset based protection

- Victorian Biosecurity Strategy
- Invasive Plants and Animals Policy Framework

Recent or pending institutional changes

Machinery of Government Changes following 2014 election resulted in new departments and ministerial responsibilities.

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State Government of Australia, Department of Environment and Primary Industries, Victoria's 1080 Pest Animal Bait Framework Review (Review of Victoria's regulatory framework for the manufacture, supply and sale of 1080 pest animal bait products by authorised 1080 bait users, http://www.depi.vic.gov.au/agriculture-and-food/farm-management/chemical-use/agricultural-chemical-use/bait-use-and-1080/review-of-victorias-regulatory-framework-for-the-manufacture-supply-and-sale-of-1080

State Government of Victoria, Department of Environment and Primary Industries, Chemical Use Legislation, http://www.depi.vic.gov.au/agriculture-and-food/farm-management/chemical-use/agricultural-chemical-use/chemical-use-legislation

Institutional contacts

Customer Service Centre 136 186

Table A1.6: Western Australian Laws and associated regulations

MINISTER	AGENCY/ DEPARTMENT	ROLES/ RESPONSIBILITIES	ACT	RELEVANCE
Minister for Agriculture and Food	Department of Agriculture and Food, Western Australia (DAFWA)	Biosecurity and quarantine - Pests, weeds and diseases – Primary production protection	Exotic Diseases of Animals Act 1993 and Exotic Diseases of Animals Regulations 2011	Prevention and control of exotic diseases
			Animal Welfare Act 2002 and Animal Welfare (general) Regulations 2003	Humane handling and destruction and control techniques
			Biosecurity and Agriculture Management Act 2007 and associated regulations[807]	Control of declared pest or disease, use of chemicals
Minister for Environment	Department of Parks and Wildlife	Management of parks and reserves – Wildlife management	Wildlife Conservation Act 1950 and Wildlife Conservation Regulations 1970	Protection of fauna and flora, illegal use of traps – in this Act a subsidiary notice lists dingoes as 'unprotected fauna'
Minister for Health	Health Department of Western Australia	Public health	Poisons Act 1964 and Poisons Regulations 1965	Sale and use of poisons
			Health Act 1911 and Health (Pesticides) Regulations 2011	Use, storage and transport of certain pesticides
Minister for Police	Police Service	Police	Firearms Act 1973 and Firearms Regulations 1974	Regulate use of firearms
Minister for Commerce	Department of Commerce	Safety of workers and consumers	Occupational Safety and Health Act 1984 and Occupational Safety and Health Regulations 1996	Improve standards of occupational safety and health

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[807] For a comprehensive overview, please see http://www.austlii.edu.au/au/legis/wa/consol_reg/toc-B.html

Policies, strategies and frameworks

The primary document driving invasive species management in Western Australia is the Invasive Species Plan for Western Australia 2015-2019. This Plan outlines Western Australia's approach to managing existing and potential invasive species that can harm the state's economy, environment and people.

Other Key NRM, invasive species management plans and strategies for Western Australia are listed in De Milliano et al (2010), Ecologically Significant Invasive Species: A Monitoring Framework for Natural Resource Management Groups in Western Australia. Report prepared for the Natural Heritage Trust 2 Program, Department of Agriculture and Food, Western Australia, South Perth, p 21. These include for example:

A 100-year Biodiversity Conservation Strategy for Western Australia: Phase One: Blueprint to the Bicentenary in 2029 (Draft)

State Natural Resource Management Program

Good Neighbour Policy 2005 (Draft)

Cane Toad Strategy for Western Australia 2014-2019

- The Department of Agriculture and Food Western Australia 9DAFWA) currently has eight eradication plans in place for ragwort, praxelis, parthenium weed, Mimosa pigra, gamba grass, skeleton weed, bedstraw and hoary cress.

Recent or pending institutional changes

Governance

The Biosecurity Council of Western Australia (the Council) was established under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) as a specialist advisory group to the Minister for Agriculture and Food and the Director General of the Department of Agriculture and Food WA (DAFWA) on any matter related to biosecurity.

The Council membership is drawn from people who are experienced or actively involved in agriculture, fishing, aquaculture, pearling or related commercial activities; or natural resource management, environmental protection and/or regional communities.

The Biosecurity Senior Officers Group (BSOG) was set up to develop cross Government strategies for biosecurity management within the state and to resolve issues. The BSOG provides regular reports of its activities to the Council and will investigate and report on specific issues referred to it by the Council.

It was also set up to provide a whole of Government coordinated response to the Commonwealth for biosecurity. The BSOG provides advice on issues related to biosecurity to the Minister for Agriculture and to other Minister's as required (through the Minister for Agriculture's Office).

Six departments are represented at the BSOG: Department of Agriculture and Food WA (DAFWA), Department of Parks and Wildlife, Department of Fisheries, Forest Products Commission, Department of Premier and Cabinet and Department of

Defence. The BSOG is chaired by DAFWA. Some BSOG members also represent the State on sub-committees of the National Biosecurity Council.

Community biosecurity groups

Five biosecurity groups in the pastoral regions – Kimberley, Carnarvon, goldfields, Meekatharra and Pilbara were recognised by the Minister under the BAM Act on 1 July 2010. One biosecurity group in the agriculture region – Eastern Wheatbelt Biosecurity Group – was recognised by the Minister on 16 April 2015. These groups, formally known as Recognised Biosecurity Groups, provide leadership and direction on controlling declared pests in their region. Other biosecurity groups are forming in agricultural areas for coordinated control of declared pests.

Funds from the Declared Pest Account, consisting of a rate raised in the area matched by the State Government, are available to the Recognised Biosecurity Groups. Rates can be applied to affected lands within the RBGs area of operation. The Minister consults with affected landholders prior to imposing the Rate.

References

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Appendix 1.2: Review of Australian Invasive Species Laws

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REVIEW OF AUSTRALIAN INVASIVE ANIMAL LAWS

Professor Paul Martin
Vivek Nemane

This report provides a review of pest animal management in Australia, based upon desktop information and contact with relevant government agencies, under the agreement *Review of pest animal management* dated May 8 2015. Under that agreement a first stage report was to be delivered drawing on existing information updated through direct enquiries of relevant agencies, with some additional matters related to invasive animal control (welfare issues and hunting) incorporated. On this basis the NRC will determine if more investigation is needed. Whilst the NRC work is focused around hunting, our brief was not to specifically focus in on this issue.

The project approach was to update the existing Invasive Species / Invasive Animal reports and data from the Australian Centre for Agriculture and Law as follows:
1. Updating through direct enquiry the information (previously current as at May 2014) on national, state and territory legislative and regulatory arrangements
   The updated report
2. Extension (by direct enquiry) of that information to consider controls over hunting. The information provided in response to our enquiries is embedded in the updated report3
3. Updating the information from the Bios report on New Zealand, by direct enquiry
4. Investigating relevant animal welfare rules and issues. The Bios report contains information on legal and institutional arrangements for invasive species from a number of countries.

Direct enquiries yielded responses from the Federal Government, Australian Capital Territory, The Northern Territory, South Australia, Queensland, Tasmania, Western Australia and New South Wales.

The following limitations should be borne in mind:
1. Despite multiple requests no responses were obtained from Victoria and New Zealand.

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2. As indicated, defining the boundaries of relevant law is difficult because there are many areas of law (including common law and property rights) that intersect to affect invasive species control (including hunting issues.

3. The intention is that the NRC and the Australian Centre for Agriculture and Law will review what additional information beyond this report is desirable, and the most efficient way to meet this need.

I have attached to the covering email an invitation to the NRC to participate in two scenarios-based institutional reform workshops on community involvement in invasive animals control, which might be useful. The focus of these is not specifically hunting, but this issue will inevitably arise, and involvement could provide a rich understanding of the legal and institutional issues

Rather than provide an excessively long document, and bearing in mind the purposes for which the NRC wants this information, I have "loaded" the updated information and other potentially relevant information into the Invasive Animals CRC dropbox – the NRC can use whatever is in there, and it will be updated as we progress our invasive animals institutional reform consultative processes. The folder contains the following material, in PDF form.

1. Scoping Study- Improving Invasive Animal Institutions- A citizen--focused approach V1.2 including feedback
2. Australian laws, regulations, policies etc. updated (July 2015)
3. Key studies and reports (May 2014)
4. Media issue reporting (May 2014)
5. Resourcing community action (May 2014)
6. Selected international comparisons (May 2014)
7. Stakeholder policy positions (May 2014)
8. Country assessments of Invasive Species institutions
9. Innovations in institutions to improve weed funding, strategy and outcomes
10. Invasive Species Council Community Engagement report
11. Invasive Species Council Submission on Environmental Biosecurity
12. National Farmers Federation Submission on Environmental Biosecurity

The dropbox link is https://www.dropbox.com/sh/7tjbuvlohp8sr2l/AADieU-7XvNtf1eMNcQEX_FIa?dl=0

Animal welfare law is well covered on the RSPCA website. We have not had to do anything on that aspect other than some commentary included in the overview document that follows.

The link is http://kb.rspca.org.au/what-is-the-australian-legislation-governing-animal-welfare_264.html

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Discussion: Framing the issues

European settlement, which occurred only two centuries ago, has significantly impacted Australia's unique biology and ecology. Not least of the impacts has been the introduction of diseases, fungi, parasites, vertebrate animals (including birds), fish (marine and freshwater), insects and weeds (aquatic and land). Native species can also be harmful invasives, partly due to the substantial modification of the natural environment. Climate change is likely to contribute to increasing the harm from invasive species.

Australia now hosts more than 400 invasive species including weeds, diseases, insects, and animals[1]. The identified invasive vertebrate pests in Australia are amphibians (2), birds (16 species), fish (21 species), mammals (22 species), and reptiles (5). 44 species of birds, fish and mammals are most likely to be feasible or attractive targets for private trapping and killing, legally or illegally. for a variety of reasons. These include some not listed as invasive species[2].

1. Cyprinus carpio (fish) – Carp
2. Oncorhynchus mykiss (fish) – Rainbow Trout
3. Oreochromis mossambicus (fish) - Tilapia
4. Perca fluviatilis (fish) - European perch
5. Salmo salar (fish) - Atlantic salmon
6. Salmo trutta (fish) - brown trout
7. Salvelinus fontinalis (fish) - brook trout
8. Acridotheres tristis (bird) - Indian myna
9. Anas platyrhynchos (bird) - Mallard
10. Branta canadensis (bird) - Canada geese
11. Bubulcus ibis (bird) - Ibis
12. Columba livia (bird) - carrier pigeon
13. Corvus splendens (bird) - Crow
14. Gallus gallus (bird) - wild chicken or junglefowl
15. Gallus varius (bird)- domesticated chicken
16. Passer domesticus (bird) - house sparrow
17. Sturnus vulgaris (bird) -European starling
18. Cygnus olor (bird)- Mute swans
19. Gymnorhina tibicen (bird)- Australian magpie
20. Axis axis (mammal) – chital or Indian spotted deer
21. Bubalus bubalis (mammal) - water buffalo
22. Camelus dromedarius (mammal)- Camel
23. Canis lupus (mammal) – Dog
24. Capra hircus (mammal) - Goat

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[1] Global Invasive Species Database http://www.issg.org/database/welcome

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25. Equus asinus (mammal) – Donkey
26. Equus caballus (mammal)- Horse
27. Felis catus (mammal) - Cat
28. Lepus europaeus (mammal) - Hare
29. Mus musculus (mammal) - Mouse
30. Mustela furo (mammal)- Ferret
31. Oryctolagus cuniculus (mammal) –Rabbit
32. Ovis aries (mammal) - Sheep
33. Rattus exulans (mammal) - Pacific rat
34. Rattus norvegicus (mammal) - Brown rat
35. Rattus rattus (mammal) - Black rat
36. Rusa unicolor (mammal) - Sambar Deer
37. Sus scrofa (mammal) – Pig
38. Vulpes vulpes (mammal) - Fox
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39. Petrogale inornata (mammal) – Rock wallaby
40. Trichosurus vulpecula (mammal) - Brushtail possum
41. Macropus rufus (mammal) - Red kangaroo
42. Macropus giganteus (mammal) - Grey kangaroo
43. Crocodylinae – (amphibian) – Saltwater crocodlie
44. Crocodylus johnstoni (amphibian) – Freshwater crocodile

The legal architecture

Constitutionally, land management issues are the responsibility of the states (with local government sharing this responsibility in different ways in different states), but the combination of federal responsibilities under international conventions, the fiscal power of the Commonwealth, and various negotiated arrangements emerging over many years has resulted in a 3 level hybrid public governance.[3] The focus of this report is on the control of established vertebrate pest species. Reform of preventative biosecurity has received substantial attention in recent years. [4]

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[3] See 2012 Council of Australian Governments National Agreement on Biosecurity

[4] For further background see Australian Senate Environment and Communications References Committee. (2015). Environmental Biosecurity. Canberra ACT. Retrieved from http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/biosecurity/Report, Beale, R., Fairbrother, J., Inglis, A., & Trebeck, D. (2008) with an update of implementation in DAFF Biosecurity. (2012). Reform of Australia ' s biosecurity system An update since the publication of One Biosecurity : a working partnership. Canberra ACT. See also

State and National governments are reconsidering their role and that of private citizens. There are significant challenges for federated natural resource governance that are illustrated by invasive animal management, including a very complex link between government and private stewardship. Federal and state governments have signalled a desire to shift the boundaries between private and public responsibility to emphasise landholder responsibility[5]. The Commonwealth is refocusing its efforts on preventative biosecurity and reducing its involvement in the control of established species [6] aiming to limit federal activities to those that are specifically its responsibility under the Australian Constitution. This policy direction has significant practical and policy implications for invasive species control and for future regional natural resource management.

The practical considerations

Australia is a very large country, with around 61% used for farming, and large areas of Native Title and environmental protection uses. Many properties cover thousands of hectares with very small labour forces and, often, earn little income per hectare. The result is that the resource that can be effectively brought to bear upon invasive species control or other landscape conservation and restoration actions is far less than would be expected given our per capita wealth. Controlling invasive species under these conditions, within a biodiverse but very vulnerable environment, is a fundamental environmental challenge.

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and Cox, A. (2014). Stopping New Invasive Species: Primary Submission. Melbourne Australia: Invasive Species Council. Retrieved from http://invasives.org.au/files/2014/08/ISC-Submission-AS-SENT-with-Exec-Summary.pdf
[5] National Biosecurity Committee. (2015). Modernising Australia's approach to managing established pests and diseases of national significance: Discussion paper, Australian Government Department of Agriculture Forestry and Fisheries (July 2015). http://daff.gov.au/SiteCollectionDocuments/biosecurity/epdns-discussion-paper.pdf ; also NSW Government. (2014). Proposed Framework for a NSW Biosecurity Act. Sydney Australia NSW Dept of Primary Industries. NSW Government. (2014). Sydney Australia, NSW Dept of Primary Industries. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/518134/proposed-framework-nsw-biosecurity-act.pdf
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Many invasive species can spread naturally across boundaries, carried by their legs, wings or fins, wind, water, vehicles, or other animals. They will contaminate places even if citizens maintain high standards of stewardship, and will continue to do so for so long as a 'seed' population of the invasive species remains. They continue to be present over time. Simple notions of private responsibility for invasive animals control accountability are challenged by the ability of species to frustrate control by evolution, mobility or intelligence (as well as by issues of landholder capacity and social equity).

The Invasive Animals CRC estimates the economic cost of invasive animals and plants at $4.7 billion each year. The agricultural losses from invasive animals exceed $A1b per year. Invasive species also cause environmental damage that is not counted in dollar terms: rabbits not only harm pastures, they have a harmful impact on 156 threatened species; wild dogs and foxes not only predate upon livestock they also impact on 76 threatened species; and feral pigs not only cause major losses to sugar cane and grain they also destroy up to 70 per cent of sea turtle nests in north Queensland.

If the economic price of risks was included these estimates would be larger in economic and in environmental terms. A recent study considering only six potential invasive plants and animals [7] suggests that biosecurity is worth an average of $12 000 p.a. to $17 500 p.a. per annum for each broad-acre farms. This estimate only accounts for a very small sample of threats and it does not consider risks to nature. The serious risk of human, plant and animal disease is illustrated by bird flu, and the potential for rabies to enter Northern Australia along with dogs or other animals. The ongoing risk of other invasions is illustrated by the cane toad and by insects such as the Argentine, fire and crazy ants, or Africanised bees. Where there is an economic reason for landholders to control a species then action is more likely than when the harms are purely environmental. However when a problem is substantial and ongoing the response may be to abandon the affected enterprise. This is reported to be a frequent reaction to dog depredation on sheep, with uncounted economic cost from the shift from an economically optimal land use to a less profitable one.

Because impacts and invasion processes differ between invasive species, they need to be managed differently. Established species are managed and regulated differently to new introductions. Invasive animals control poses particular legal and operational challenges because their management involves species that move easily and adapt, lethal methods and chemicals, and difficult community

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[7] Hafi, A., Addai, D., Zhang, K., & Gray, E. M. (2015). The value of Australia's biosecurity system at the farm gate An analysis of avoided trade and on-farm

attitude and animal welfare issues. A number of reports provide information on the control of new infestations[8].

Management of invasive species is struggling to cope with the combined pressure of established and new invasive species. The Australian 2011 *State of the Environment Report* (*SoE 2011*) indicated that the impact of invasive species on inland waters is 'high' and conditions are deteriorating; and for biodiversity that the impact is 'high' to 'very high' and conditions are deteriorating. Farmers point to the increasing impact of species such as wild dogs, feral pigs, even carp, on their livestock and crops, in some instances making some agricultural activities non-viable.

Whilst most Australians would probably prefer a country free of invasive species (other than species that satisfy our human needs without further degrading the environment) this is not possible. When the first people landed upon our continent, a process of species invasions began. The fact that we have been able to prevent the introduction of, or control the spread of, very many harmful species indicates the successes that are the other side of evidence of the failures to control invasive species. Whilst a lot more can and should be done, this does not mean that the excellent work that has been done by governments, landholders, researchers and volunteers should be discounted.

Why does Invasive Species law struggle?

There are four aspects to invasive species governance. These are (1) biosecurity to prevent new invasions (2) responses to invasive species before they become naturalised (3) control of established invasive species, to minimise their harm; and (4) coordination, to optimise effectiveness and investment. Each of these areas involves specialised institutions and laws. Effective efforts rely upon science, education and extension, financial support, public works, voluntary action, and peer group pressure and support, as well as the law.

The effectiveness of legal instruments depends upon having enough public and private resources; the commitment and capacity of government agencies and citizens; and the ability to overcome many barriers. Better laws will not necessarily lead to far better outcomes unless many other requirements are also met. For this reason environmental law reform for invasive species management also needs to address support for citizen action, resources, efficient coordination and administration, and accountability for the performance of all aspects of the system.

Many apparently unrelated rules also affect invasive species management. These include

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1. Animal welfare rules, which can limit what control method can be used[9]. Political action over animal welfare can also limit invasive animal control, particularly by government agencies.
2. Human health and safety laws affect invasive species control, through operator and poisons licensing and protocols, and restricting practices in particular situations (for example, close to residences). [10]
3. The general rules governing natural resource management (NRM) programs affect invasive species management, which is often a part of broader landscape conservation and restoration projects.
4. Rules controlling access to and activities on private lands, including hunting and the obligations of both public and private landholders to control invasive species on their land. This report does not address the obligations of public landholders, which is a complicated political and economic issue.
5. Rules to control hunting, including on public land. Whilst research on the role of hunting generally indicates that it is neither an effective nor efficient strategy, it is nonetheless a strategy that can be used by private citizens without government support, and there is a section of the public who are committed to it. Relevant rules considered in this report, concern animal welfare and weapon control. We have not considered recreational fishing laws.

All three levels of government have responsibilities for aspects of invasive species control, resulting in many laws. Whilst there are common features, states use different terms, have varied organisational and administrative structures and implement their laws in different ways. For example in Queensland local government is responsible for enforcement of invasive species regulation whereas in other jurisdictions this is a state-level responsibility. This complex jurisdictional and management structure is similar to the state of regional natural resource management generally. Following other biosecurity reforms, the Australian government and some states are increasing their emphasis on the responsibility of the landholder responsibility for managing established pests, and focusing government resources on prevention and early response. For the commonwealth government this partly reflects the intention that government natural resource management activities be constrained by commonwealth responsibilities under the Australian constitution. 'Front-line' management of invasive species also occurs at the local government level, particularly for the protection of human welfare (e.g. control of rodents and insects at food premises and waste disposal facilities).

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[9] For a listing of relevant laws see RSPCA http://kb.rspca.org.au/What-is-the-Australian-legislation-governing-animal-welfare_264.html

There is a fundamental challenge of economic and human capacity in some parts of rural Australia to manage these issues. Two maps will serve to illustrate the challenge.
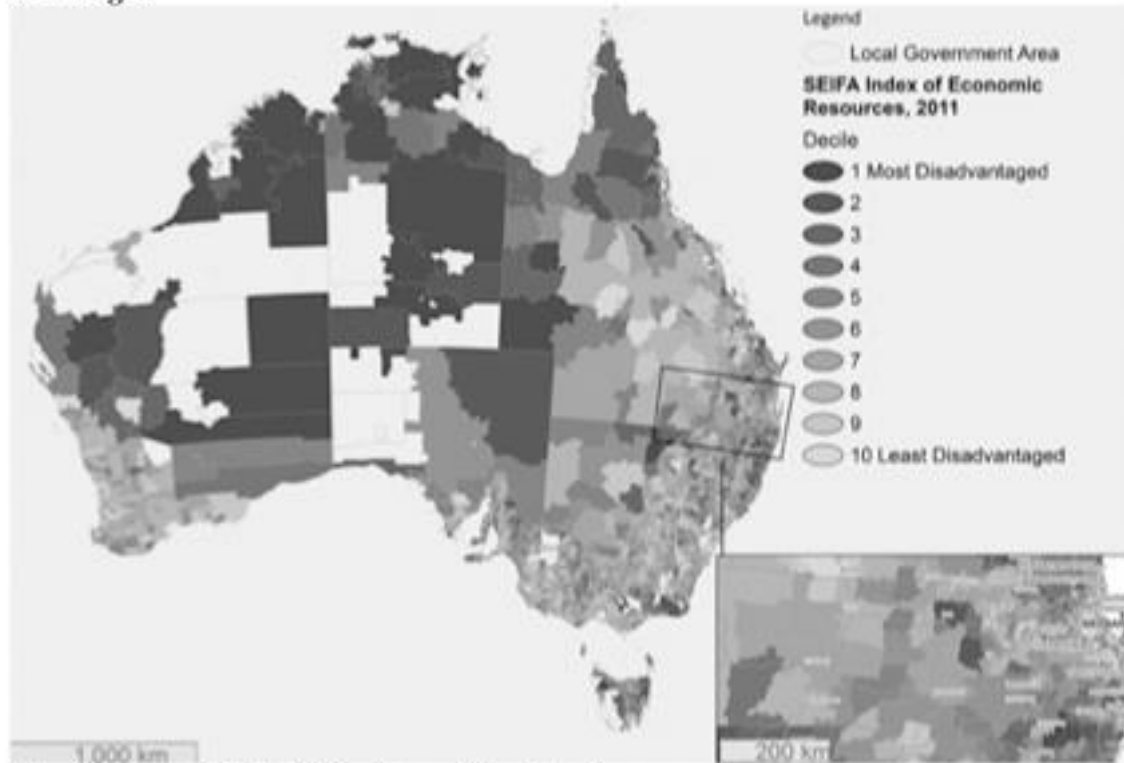
Map 1: The spatial distribution of disadvantage
Blackley RM (2014) Peri-Urban GIS series. Queensland Murray-Darling Committee Inc., Toowoomba, QLD AU

Indicators of variability in capacity to address target
pest species

Depth of shading is a 3 way function of
1.   Number of the 4 pest species present.
2.   Population sparsity; and
3.   Index of social disadvantage

Map 2: Indicators of variability in capacity to address target pest species.
Martin, LeGal et al 2014.

The involvement of the community in invasive species issues is mostly in
detecting invasions (e.g. community reporting of fire ant colonies in Queensland
or outbreaks of starlings in Western Australia); or controlling established
disease, weed and pest animal problems as land stewards or as volunteers.
Because those close to the land have the best opportunity to understand what is
happening and to take early action, there is a strong argument for citizen
responsibility. Citizens are often in a position to take effective action at lower
cost than government, not least of all because of the contribution of volunteers.
Where invasive species cause economic harm or risk of economic harm, citizens
also have a direct incentive to control them effectively and efficiently. As well as
the many practical limitations on the ability of government to supervise and
intervene on private lands, property rights and citizen rights limit the power of
government to force people to take action on their own land. Regardless of what
the law might be, effective management of invasive species will inevitably rely on
the voluntary work of citizens, but this work will be limited to what is feasible
and most likely to take place when there is an economic incentive for action.

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The increasing emphasis in government on citizen responsibility for control of established pests (with its implication of the use of regulation and enforcement coupled with citizen engagement as the main instruments for management) is consistent with norms like 'polluter pays' and 'good stewardship'. However there are significant complications. A mixture of regulated accountability and citizen engagement is essential, but it is not likely that it can be sufficient.

1. The most problematic invasive species are self-generating and adaptive; difficult to detect and remove; and span or traverse large areas or spread rapidly (and thus involve many land tenures and different land uses). The management of invasive species calls for sustained action and investment by land stewards over a large area. Differing interests, capabilities and attitudes make achieving this very hard. Private property rights limit the capacity of the law to force sustained cooperation, and the practical challenges of attempting to do so are daunting.

2. As noted above Australia is very large and sparsely populated. Whilst Australia' has a high wealth per person our GDP per hectare and population per hectare is similar to poor countries like Mongolia. Statistically, the further people are from urban centres, the less economic or human capacity they have. A lack of knowledge, funds or manpower for effective control can mean that a compliance problem is a social justice and feasibility problem. Strong enforcement can then be seen as heavy-handed and perceived unfairness of environmental laws can result in community opposition including general non-compliance.

3. Difficult arguments arise over control methods (including trapping and shooting or poisons); the obligations of landholders or the government, or legal responsibilities or performance. Political and evidentiary difficulties affect the enforcement of regulations. Agencies in different jurisdictions have different approaches to enforcement. For example Victoria uses an enforcement program in which prosecution is contemplated (though as a last resort), whereas in Queensland local government has enforcement responsibility and prosecution is generally considered not to be politically (or practically) feasible. Political issues of landholder rights, regulation, the environment and animal welfare, complicate relying on the law.

4. Voluntary cooperation is made difficult by social perceptions of invasive species: such as affection for problem animals as pets or because of animal welfare or ethical concerns; some invasive species have economic value to some land stewards, for example for recreational or paid hunting; and landholders with different enterprise types and land uses have different incentives to control (or not) particular harmful species. A grain-grower, for example, has few reasons to control foxes or feral cats.

5. The ecological interactions between invasive and native species, between invasive species and between humans and invasive species, can be complex. Complicated predator/prey relationships can result in unexpected results from managing a species in a modified natural system; and 'rebound effects' after control efforts can lead to increased invasive species harm rather than

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to its reduction. Invasive species laws have traditionally focused upon the control of particular harmful species and the behaviour of the individual land steward, rather than managing complex systems, though laws such as the federal Environmental Planning and Biodiversity Conservation Act use a more systems based approach. Environmental science and natural resource management practice focus increasingly on managing systems, but invasive species law has not fully embraced these approaches.

Invasive species laws interact with other laws that have no obvious connection. As noted earlier private property rights limit the power of government to drive sustained control on private lands, or to supervise what happens on those lands. Animal welfare and human health and safety laws restrict control methods. Natural resource management ("NRM") and land stewardship requirements are institutionally complex. "Stop/start" funding in NRM, the contracting and management of projects on site basis and frequent changes to programs can frustrate sustained citizen coordinated action.

There are possibilities for other institutional approaches but all face difficulties. Industry self-regulation and private incentives have emerged in areas like pollution control but not for the management of invasive species. The common laws of nuisance and negligence could create private incentives for land stewards to control invasive species that can affect their neighbours, but technical issues of law, evidence and causation limit the role of civil liability. Large parts of Australia are held under lease tenures whose terms could require good stewardship, including controlling invasive species. The short-lived Delbessie Agreement in Queensland (which reverted to the State Rural Leasehold Land Strategy) had a duty of care for land stewardship, with broad-ranging provisions[11]. Stewardship standards in industry codes and the environmental requirements of some purchasers of agricultural products impose good management requirements, but invasive species management does not seem to feature. More exotic 'non-government' possibilities include invasive species risk insurance as conditions of approval of risky activities, whole of industry invasive risk strategies and funding mechanisms, invasive species status inspections prior to property transfers, more emphasis on invasive species within market-based conservation schemes, or taxation incentives and new financing structures for connected-landscape conservation.

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[11] For a list of legal duties of care, and issues of implementation see Shepheard, Mark L. and Martin, Paul V. 2009. 'The multiple meanings and practical problems with making a duty of care work for stewardship in agriculture' Macquarie Journal of International and Comparative Environmental Law Volume (6):191. pp191-215. See also Natural Resources Management Act 2004 (SA), s 9; Catchment and Land Protection Act 1994 (Vic), s 9; Environmental Protection Act 1994 (Q), s 319.

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How improve the effectiveness of invasive species law?

It is tempting to propose simple-sounding solutions to complex problems, but this is not likely to succeed. Many people might agree that "we need stronger regulation that is enforced" but there are practical and social justice problems with a blanket approach to enforced regulation, and regulation alone is unlikely to force the necessary sustained private cooperation and investment. Others might say that the answer lies in community engagement, but in many parts of Australia this is not likely to be sufficient because there are not enough people with enough resources to do the job. It would be tempting to say that we need a more coherent national invasive species law (and I believe we do), but no legal instrument will in itself tackle the insufficiency of resources, limits to government power, and community norms discussed in this essay. Addressing the 'vicious' system problem of achieving better outcomes will require reshaping the system that drives invasive species harms and our attempts to control them. It will require a lot of innovation, and legal arrangements will have to support and encourage this, not merely rely upon long established concepts. Whether a particular mix of interventions will work in practice will depend upon the consensus that can be achieved to support it and upon its day-to-day implementation.

With colleagues I have previously suggested 6 approaches to improved management of weeds that I think are broadly applicable to invasive species. I summarise five of these below. Many of these issues are relevant to natural resource governance more broadly than for invasive species issues alone.

1.   *An ideal governance system would reflect the principle that those who are responsible for the introduction or the spread of a weed would be held responsible for controlling or remediating the harms that they have triggered. Our weed institutional arrangements do not reflect this principle. The costs of* [invasive species] *are largely borne by either those who are adversely affected (mostly primary producers), by the environment, by volunteers who work to control* [invasive species], *and by the general public (principally through bearing the costs of public* [invasive species] *control initiatives).*

2.   *... there will still be many situations where there is no person, or no person with sufficient resources, to control or remediate* [invasive species] *problems. To a very large degree the problem of established* [invasive species] *falls into this set of circumstances, where it is not possible to identify which agents ought be held accountable and even if it were the scale of the problem is such that mere accountability would be an insufficient response. Ultimately the 'solution' is to find more funds and human resources, and to deploy them more effectively, Current arrangements rely heavily upon some private land managers, the public purse and well-motivated volunteers. None of these have sufficient resources available to address the scale of the challenge, and the incentives for further investment by the*

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public or the private sector are insufficient to overcome this insufficiency.

3.   *For most* [invasive species] *problems a key requirement for control is a sustained programme across a sufficiently large area of landscape to address the issue. How large this landscape is varies with the nature of the* [invasive species] *and the degree of its establishment. .. What is needed in all cases is well-designed and sufficiently resourced action across the relevant landscape, overcoming the limitations imposed by individual tenure and the variety of land manager motivations.*

4.   *Confusion and administrative complexity 'tax' the flow of available resources to take action, and also 'tax' the flows of information for good decision-making... [T]here is a degree of unavoidable complexity due to the diversity of roles and unresolved issues about the purposes of* [invasive species] *control. However even taking this into account the institutional system for* [invasive species] *governance is excessively complex and confusing. The effects include: diverting limited human and financial resources for* [invasive species] *control into coordination and administration; wasteful confusion or paperwork impacting on the 'front line'; and diffusion of responsibility.*

5.   *Some complexity, competing motives and differing capability is inevitable in* [invasive species] *governance, and more so the case when resources and authority are spread across three levels of government and many organisations. Coupled with this, effective* [invasive species] *management often requires coordinating many actors across large areas, sometimes over long periods.*

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Appendix 2: Background document explaining various themes of conversation

Improved Legal and Institutional Arrangements for Peri-urban Invasive Animal Management

Invasive animal species are serious threats to Australia's native animals and plants. Policy responses are inevitable considering economical, ecological, agricultural and cultural losses caused by the invasive animals. The economic resources allocated for invasive animals control and management are under a significant strain. The Invasive Animals CRC strives to come up with effective control methods that are cost-effective and environmentally efficient but there are many impediments to the effective adoption of these control technologies & methods.

This document briefly provides key issues relevant to the adoption of invasive animal control methods. The objective of this document is to facilitate conversation that will help me in identifying various 'issues in practice'. The objective of my research project is to investigate the potential for legal and institutional changes to facilitate the application of invasive animal pest control in peri-urban Sydney & Brisbane using the control of wild dogs and feral deer as the detailed examples. The research aims at suggesting actionable proposals to advance the implementation of controls of invasive animals in peri-urban areas.

Key issues relevant to the adoption of invasive animal control methods are:

a) The Control Innovation Dimension: Lethal control methods are commonly employed for invasive animal control although fertility control and migration monitoring are available options. Control innovation aims at achieving a balance between pursuance for eradication with a strong emphasis on humanness. There are inconsistencies in laws governing control methods. Innovation itself faces institutional impediments. Managerial innovations are being encouraged in Australia for the peri-urban natural resources management but their adoption hinges on the institutional arrangements to facilitate implementation.

b) The scarcity of resources and lack of good management practices in channelizing resources for the invasive animal control and management.

c) Funding: Non-availability of enough money or lack of funding, short-term funding, lack of effective methods to analyse the value of funding outputs, high costs of materials and labour.

d) Information: Information helps in triggering the motivation for further communication, co-operation and co-ordination. The Lack of information, insufficient information and difficulties in obtaining information is the major problem for government as well as communities.

e) Policy, Laws and Regulations: Lack of well-designed laws and regulations, inconsistencies in environmental and biosecurity laws, lack of enforcement and effective implementation of laws and regulations, lack of self-obligation to follow laws and regulations, failure to balance private and public goods including failure to implement the polluter pays principle for invasive species, lack of uniform policy approaches.

f) Capacity Building: Lack of community knowledge and awareness on the issues of damage caused by vertebrate pests & knowledge about animal control methods, lack of knowledge prevalent in the government on the issues at ground level, lack of effective communication between government & community, lack of skilled human resources for pest control.

g) Co-ordination & Co-operation: Lack of co-ordination & co-operation between government agencies, non-government agencies and community.

h) The Peri-urban context: Peri-urban areas pose particular institutional difficulties. These difficulties include the heterogeneity of peri-urban communities, complications from the intersection of rural and urban regulatory and administrative structures, responses & risks to humans which might arise from the use of control mechanisms (particularly lethal controls), and the politics of animal welfare and pest animal control. The peri-urban institutional complexities relevant for this research are
   - Invasive animal control methods pose particular problems to the humans, plants and animals including the issues of actual and perceived risks and moral opposition.
   - The intersection of institutional jurisdictions and development related issues in peri-urban areas.
   - Population dynamics which make it difficult and a costly affair to administer control methods that may trigger socio-legal/socio-economic risks.
   - Peri-urban landholders can be classified into two major groups, namely life stylers and producers. The lack of awareness amongst peri-urban small tenure land holders about land and pest management issues pose difficulties in pest control methods.
   - Despite rules and programs for invasive animal management, the implementation process may face administrative transaction costs coupled with the problems of inadequacy of funds, dynamics of community relationships and politics as well as risk communication.

i) Risk perception: Risk is perceived in various ways. For the purposes of my research, any adverse possibility that impacts upon adoption of control methods is considered as a risk. Risk perception includes social perception of animals, perception of control methods and perception of government. This strongly affects an individual's decision to adopt control methods (for e.g. decision to use direct control methods like poisoning, culling, baiting, trapping). The perception of risk is subjective and varies according to political, social and cultural values (for e.g. biased opinions towards certain invasive animals). Effective risk communication strategies may help in changing these perceptions.

j) Animal welfare concerns: Animal welfare regulations prescribe both constraints as well as exemptions on the use of control methods against invasive animals. Lack of uniformity in animal welfare regulations prevents the effective adoption of control methods. These issues are politically contentious which is evident through political lobbying, media criticisms and actions over animal welfare issues (for e.g. pro-hunting lobbies suggesting that hunting based on scientific approach is sustainable versus anti-hunting lobbies suggesting that hunting is unnecessary and morally unacceptable despite of scientific approaches).

Relevant legal and institutional issues:

The legal and institutional issues that are expected to be relevant in this research include

1. Legal constraints upon the use of lethal or potentially lethal controls, in populated areas;
2. Institutional difficulties in achieving coordinated action across a number of distinct public and private titles;
3. Actual or perceived issues of potential legal liability, for landholders, government agencies, and local government;
4. The actual or perceived risk of political or medial criticism or attack, based upon human health or animal welfare concerns

Appendix 3: Semi structured interview questions

What do landholders and residents in your area think about invasive animal control?

How could objectives for invasive animal management be improved?

What challenges do you face in trying to comply with rules relating to invasive animal control?

What prevents or limits your involvement in invasive animal control?

How could other stakeholders help you more to achieve invasive animal management outcomes (without compromising animal welfare and human health)?

What capability limits, of what stakeholders, most affect your management of invasive species?

How does political leadership affect invasive animal controls?

Appendix 4: Qualitative survey questionnaire:

Appendix 4.1: Background information

Your name:

Your Occupation	
Your role and title	
Location	
State, Postcode	
Invasive species specialization (if any)	
Regions where you work (Please tick those applicable)	
Urban		
Peri-urban		
Rural		

Type of your organisation?

- [ ] Federal Government
- [ ] State Government
- [ ] Local Government
- [ ] Regional Organisations
- [ ] Industry Association
- [ ] Other

Additional information about your role and responsibilities (if any):

……
……
……
……

Issue 1: Control technologies Have you encountered any of the following difficulties in implementing control measures	No	Yes, but not a major problem	Yes, a major problem
• Complexities or delays with approval procedures for control measures	1+1+1+1+1+1 - 6	1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1 - 8
• Compliance with animal welfare regulations	1+1+1+1+1+1+1+1+1 - 9	1+1+1+1+1+1+1+1+1 - 11	1+1+1+1 - 4
• The risk of injuring non-target species and humans	1+1+1+1+1 - 5	1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 16	1+1+1 - 3
• Lack of cost-effective technologies	1+1+1+1+1+1+1+1+1 – 10	1+1+1+1+1+1+1 - 8	1+1+1+1 - 4
• Getting access to control methods	1+1+1+1+1+1+1+1+1+1+1+1+1 – 14	1+1+1+1+1 - 5	1+1+1+1 - 4
• Getting information on how to use control methods	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 – 17	1+1+1+1+1 - 6	1 - 1
• Political problems in implementing control programs	1+1+1+1+1+1 - 6	1+1+1+1+1+1+1+1+1+1 - 12	1+1+1+1+1+1 - 6

Issue 2 - Data and information: Have these issues limited you implementing invasive species controls?	No	Yes, but not a major problem	Yes, a major problem
• Lack of reliable information about the presence, number and impact of invasive species	1+1+1+1+1 - 5	1+1+1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1+1+1+1 - 10
• Lack of public information	1+1+1+1+1+1+1+1 - 8	1+1+1+1+1+1+1+1+1+1 – 10	1+1+1+1+1+1+1 - 8

	No	Yes, but not a major problem	Yes, a major problem
about the impact of invasive species			
• Unreliable data and analysis methods for designing controls and control programs	1+1+1+1+1+1 - 6	1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 14	1+1+1+1+1 - 5
• Lack of system for community reporting	1+1+1+1+1+1+1 - 7	1+1+1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1 - 7
• Lack of harmonisation of local, regional and state control programs	1+1 - 2	1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 14	1+1+1+1+1+1+1+1 - 8
• Complexity and difficulties of program performance evaluation	1 - 1	1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 14	1+1+1+1+1+1+1+1+1 - 9

Please explain other data and information issues which limit your implementation of invasive species controls

Issue 3: Accountability What accountability issues impede your implementation of invasive species control?	No	Yes, but not a major problem	Yes, a major problem
• Over-reliance on government by the community	1+1+1 - 3	1+1+1+1+1+1+1 - 7	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 15
• Over reliance on landholders	1+1+1 - 3	1+1+1+1+1+1+1+1 - 8	1+1+1+1+1+1+1+1+1+1+1 - 12

	No	Yes, but not a major problem	Yes, a major problem
by the Government			
• Over reliance on volunteers by the Government	1+1+1+1+1+1+1+1 - 8	1+1+1+1+1+1+1+1 - 9	1+1+1+1+1 - 6
• Lack of clear roles & responsibilities	1+1+1 - 3	1+1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1+1 - 9
• Lack of coordination among stakeholders for project implementation	1 - 1	1+1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1+1+1+1+1 - 12
• Lack of rapid response capability to respond to new incursions	1+1+1+1+1+1+1+1+1 - 9	1+1+1+1+1+1 - 7	1+1+1+1+1+1 - 7

Please explain any other accountability issues which limit your implementation of invasive species controls

Issue 4: Institutional arrangements What institutional arrangements impede your implementation of invasive species control?	No	Yes, but not a major problem	Yes, a major problem
• Conflict between invasive species and other laws	1+1+1+1+1+1+1+1+1+1 - 10	1+1+1+1+1+1 - 7	1+1+1+1+1+1+1 - 8

	No	Yes, but not a major problem	Yes, a major problem
and regulations			
• Inconsistent policies and programs across levels of government or across government agencies	1+1+1+1+1+1 - 6	1+1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1+1 - 9
• Inconsistent policies and programs between government and non-government agencies	1+1+1+1+1+1+1 - 7	1+1+1+1+1+1+1 - 7	1+1+1+1+1+1+1+1+1+1 - 11
Identify any further institutional issues that impede your implementation of invasive species control			

Issue 5: Planning What planning issues impede your implementation of invasive species control	No	Yes, but not a major problem	Yes, a major problem
• Lack of clear objectives	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 17	1+1+1+1+1+1+1+1 - 8	1 - 1
• Poor processes for developing plans	1+1+1+1+1+1+1+1+1+1+1+1+1 - 13	1+1+1+1+1+1+1+1+1 - 9	1+1+1+1 - 4
• Lack of alignment between the	1+1+1+1+1+1 - 6	1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 14	1+1+1+1+1+1 - 6

objectives of government and non-government organisations			
• Inadequate preparation of communications with general community	1+1+1+1+1+1+1 - 7	1+1+1+1+1+1+1+1+1+1+1 - 12	1+1+1+1+1+1 - 6
• Inadequate communication with stakeholders	1+1+1+1+1 - 5	1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 14	1+1+1+1+1+1+1 - 7

Please explain any other planning issues which limit your implementation of invasive species controls

Issue 6: Resources What funding issues impede your implementation of invasive species control	No	Yes, but not a major problem	Yes, a major problem
• Lack of financial resources of volunteers and private landholders	1+1+1+1 - 4	1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 14	1+1+1+1+1+1+1+1 - 8

	No	Yes, but not a major problem	Yes, a major problem
• Lack of government financial resources	1+1+1 - 3	1+1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1+1+1+1+1+1 - 12
• Difficulties of securing public money and reporting against public money	1+1+1+1+1+1+1 - 7	1+1+1+1+1+1+1+1+1+1 - 10	1+1+1+1+1+1+1+1 - 8
• Stop-start funding	1+1+1+1+1+1 - 6	1+1+1+1+1+1+1+1 - 8	1+1+1+1+1+1+1+1+1+1+1+1 - 12
• Absence of political will to support funding	1+1+1+1+1+1+1+1 - 8	1+1+1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1 - 7

Please explain any additional resourcing constraints which limit your implementation of invasive species controls

Issue 7: Red tape/Green tape What bureaucratic arrangements impede your implementation of invasive species controls?	No	Yes, but not a major problem	Yes, a major problem
• Regulatory and procedural requirements to implement control measures	1+1+1+1+1+1+1+1+1+1 - 10	1+1+1+1+1+1+1+1 - 8	1+1+1+1+1+1+1 - 7
• Difficulties in obtaining licences for	1+1+1+1+1+1+1+1+1+1+1+1+1 - 13	1+1+1+1+1+1+1+1 - 8	1+1+1 - 3

	No	Yes, but not a major problem	Yes, a major problem
pest animal control			
• Compulsory training required to implement control measures	1+1+1+1+1+1+1+1+1+1+1+1 - 12	1+1+1+1+1+1+1+1+1+1 - 11	1 - 1
• Frequent changes in administrative arrangements and responsibilities	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 15	1+1+1+1+1+1+1+1 - 8	1+1 - 2

Please explain any other bureaucratic issues which limit your implementation of invasive species controls

Issue 8: Laws and regulations What regulatory arrangements impede your implementation of invasive species controls?	No	Yes, but not a major problem	Yes, a major problem
• Excessive administrative costs imposed on landholders/ residents	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 20	1+1+1 - 3	1+1 - 2
• Liability risks involved in implementing controls	1+1+1+1+1+1+1+1+1+1 - 10	1+1+1+1+1+1+1+1+1+1+1 - 11	1+1+1 - 3
• Animal welfare regulations interfering with controls	1+1+1+1+1+1+1+1+1+1+1+1 - 12	1+1+1+1+1+1+1+1+1+1+1+1 - 12	1 - 1
• Laws that do not adequately meet	1+1+1+1+1+1 - 6	1+1+1+1+1+1+1+1+1+1+1+1 - 12	1+1+1+1+1+1+1 - 7

community expectations			
• Lack of compliance with regulations	1+1+1+1 - 4	1+1+1+1+1+1+1+1+1 - 10	1+1+1+1+1+1+1+1+1 - 10
• Lack of enforcement of regulations	1+1+1 - 3	1+1+1+1+1+1+1+1 - 9	1+1+1+1+1+1+1+1+1+1+1+1 - 12
• Regulations excessively limit control application in populated areas (e.g. peri-urban areas)	1+1+1+1+1+1+1+1+1 - 9	1+1+1+1+1+1+1+1+1+1+1+1 - 12	1+1+1+1 - 4
• Regulations for recreational hunting are too restrictive	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 22	1 - 1	1 - 1
• Laws impede potential market for animal products (e.g. fur, skin, meat)	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 20	1+1 - 2	1+1 - 2
Please explain any additional legal and regulatory issues which limit your implementation of invasive species controls			

Issue 9: Stakeholder's participation What non-participation issues impede your implementation of invasive species controls?	No	Yes, but not a major problem	Yes, a major problem
• Lack of monetary incentives to participate in control	1+1+1+1+1+1+1+1+1 - 9	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 16	1 - 1

	No	Yes, but not a major problem	Yes, a major problem
• Undervaluing citizen contributions for control	1+1+1+1+1+1+1+1 - 8	1+1+1+1+1+1+1+1+1+1+1+1 - 12	1+1+1+1+1 - 5
• Lack of knowledge and awareness among landholders and residents	1 - 1	1+1+1+1+1+1+1+1+1+1+1+1 - 12	1+1+1+1+1+1+1+1+1+1+1+1+1 - 13
• Diverse land uses	1-1	1+1+1+1+1+1+1+1+1 - 9	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 17
• Diverse landholder attitudes to invasive species control		1+1+1+1+1+1+1+1 - 8	1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1+1 - 18
Please explain any additional issues which limit participation of stakeholders in invasive species control programs			

Issue 10: Politics What political issues impede your implementation of invasive species controls?	No	Yes, but not a major problem	Yes, a major problem
• Political decisions preventing implementation of control programs	1+1+1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1 - 7	1+1+1+1+1+1+1+1 - 8
• Political power of animal welfare lobby	1+1+1+1+1+1+1+1+1+1+1 - 11	1+1+1+1+1+1+1+1+1+1+1 - 11	1+1+1 - 3

	1+1+1 - 3	1+1+1+1+1+1+1+1+1 - 9	1+1+1+1+1+1+1+1+1+1+1 +1+1 - 14
• Lack of political understanding of the costs or risks of non-control			

Please explain any additional political issues which limit your implementation of invasive species controls

From the issues that you have discussed so far, which are the most important impediments? (rate 1 to 5)	1 (least)	2	3	4	5 (most)
• Availability and access to control technologies	+++++ 5	++++++ 6	++++++ 6	++ 2	+++ 3
• Lack of objective data and information	0	++++++++ 8	+++++ 5	+ 1	++++++++ 8
• Lack of accountability	0	++++ 4	+++++ 5	++++++++ 8	+++++ 5
• Complex legal and administrative arrangements	++ 2	+++ 3	++++++++ 8	+++++ 5	+ 1
• Lack of effective planning	+ 1	++++ 4	+++++ 5	+++++ 5	++++++ 6
• Lack of capacity	+++ 3	+++ 3	+++ 3	+++++++ 7	+++++ 5
• Lack of resources	+ 1	++++ 4	+++++ 5	+++++++ 7	++++ 4
• Complex bureaucratic arrangements	+ 1	++++++ 6	+++++++ 7	+++++ 5	+ 1

• Complex regulatory arrangements	++ 2	+ 1	++++++++++ 10	++++++ 7	++ 2
• Lack of effective participation	++ 2	++ 2	+++ 3	+++ 3	+++++++++++ 11
• Politics	++++ 4	++++ 4	++++++ 6	+++ 3	+++ 3

Appendix 4.2: Survey results

Key	Description
1	Strong majority (60% or more) overall agree this issue is a major problem
2	Slim majority (51%-59%) overall agree this issue is a major problem
3	Majority overall agree this issue is a problem, and of those respondents, most agree it is a major problem
4	Majority overall agree this issue is a problem, and of those respondents, evenly weighted between those who agree it is a minor problem and those who agree it is a major problem
5	Majority overall agree this issue is a problem, but of those respondents, most agree it is a minor problem
6	Majority overall agree this issue is a minor problem
7	Evenly weighted overall agree-disagree issue is a problem
8	Slim majority (51%-59%) overall agree this issue is not a problem (neither major nor minor)
9	Strong majority (60% or more) overall agree this issue is not a problem (neither major nor minor)

Issue	Element	No problem	Yes problem, but not a major problem	Yes problem, a major problem	Total respondents	% overall no problem	% overall yes problem (minor+major)	% overall yes problem, but minor	% overall yes problem, and major	% of those who said yes a problem, and major	% of those who said yes a problem, but minor	Description (see key below table)	RANK by top % overall major
9	· Diverse landholder attitudes to invasive species control		8	18	26	0%	100%	31%	69%	69%	31%	1	1
9	· Diverse land uses	1	9	17	27	4%	96%	33%	63%	65%	35%	1	2
10	· Lack of political understanding of the costs or risks of non-control	3	9	14	26	12%	88%	35%	54%	61%	39%	2	3
8	· Lack of enforcement of regulations	3	9	12	24	13%	88%	38%	50%	57%	43%	3	equal 4

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#	Item				Total								Rank
3	· Lack of coordination among stakeholders for project implementation	1	11	12	24	4%	96%	46%	50%	52%	48%	3	equal 4
9	· Lack of knowledge and awareness among landholders and residents	1	12	13	26	4%	96%	46%	50%	52%	48%	3	equal 4
6	· Stop-start funding	6	8	12	26	23%	77%	31%	46%	60%	40%	3	equal 5
6	· Lack of government financial resources	3	11	12	26	12%	88%	42%	46%	52%	48%	3	equal 5
4	· Inconsistent policies and programs between government and non-government agencies	7	7	11	25	28%	72%	28%	44%	61%	39%	3	6
8	· Lack of compliance with regulations	4	10	10	24	17%	83%	42%	42%	50%	50%	4	7
3	· Lack of clear roles & responsibilities	3	11	9	23	13%	87%	48%	39%	45%	55%	5	
2	· Lack of reliable information about the presence, number and impact of invasive species	5	11	10	26	19%	81%	42%	38%	48%	52%	5	
2	· Complexity and difficulties of program performance evaluation	1	14	9	24	4%	96%	58%	38%	39%	61%	5	
4	· Inconsistent policies and programs across levels of government or across government agencies	6	11	9	26	23%	77%	42%	35%	45%	55%	5	
2	· Lack of harmonisation of local, regional and state control programs	2	14	8	24	8%	92%	58%	33%	36%	64%	5	
4	· Conflict between invasive species and other laws and regulations	10	7	8	25	40%	60%	28%	32%	53%	47%	3	
6	· Difficulties of securing public money and reporting against public money	7	10	8	25	28%	72%	40%	32%	44%	56%	5	
1	· Complexities or delays with approval procedures for control measures	6	11	8	25	24%	76%	44%	32%	42%	58%	5	
10	· Political decisions preventing implementation of control programs	11	7	8	26	42%	58%	27%	31%	53%	47%	3	

2	· Lack of public information about the impact of invasive species	8	10	8	26	31%	69%	38%	31%	44%	56%	5
6	· Lack of financial resources of volunteers and private landholders	4	14	8	26	15%	85%	54%	31%	36%	64%	5
3	· Lack of rapid response capability to respond to new incursions	9	7	7	23	39%	61%	30%	30%	50%	50%	4
7	· Regulatory and procedural requirements to implement control measures	10	8	7	25	40%	60%	32%	28%	47%	53%	5
2	· Lack of system for community reporting	7	11	7	25	28%	72%	44%	28%	39%	61%	5
8	· Laws that do not adequately meet community expectations	6	12	7	25	24%	76%	48%	28%	37%	63%	5
6	· Absence of political will to support funding	8	11	7	26	31%	69%	42%	27%	39%	61%	5
5	· Inadequate communication with stakeholders	5	14	7	26	19%	81%	54%	27%	33%	67%	5
1	· Political problems in implementing control programs	6	12	6	24	25%	75%	50%	25%	33%	67%	5
5	· Inadequate preparation of communications with general community	7	12	6	25	28%	72%	48%	24%	33%	67%	5
5	· Lack of alignment between the objectives of government and non-government organisations	6	14	6	26	23%	77%	54%	23%	30%	70%	5
9	· Undervaluing citizen contributions for control	8	12	5	25	32%	68%	48%	20%	29%	71%	5
2	· Unreliable data and analysis methods for designing controls and control programs	6	14	5	25	24%	76%	56%	20%	26%	74%	5
1	· Lack of cost-effective technologies	10	8	4	22	45%	55%	36%	18%	33%	67%	5
1	· Getting access to control methods	14	5	4	23	61%	39%	22%	17%	44%	56%	8
1	· Compliance with animal welfare regulations	9	11	4	24	38%	63%	46%	17%	27%	73%	5
8	· Regulations excessively limit control application in populated areas (e.g. peri-urban areas)	9	12	4	25	36%	64%	48%	16%	25%	75%	5

5	· Poor processes for developing plans	13	9	4	26	50%	50%	35%	15%	31%	69%	7
8	· Liability risks involved in implementing controls	10	11	3	24	42%	58%	46%	13%	21%	79%	5
1	· The risk of injuring non-target species and humans	5	16	3	24	21%	79%	67%	13%	16%	84%	5
7	· Difficulties in obtaining licences for pest animal control	13	8	3	24	54%	46%	33%	13%	27%	73%	8
10	· Political power of animal welfare lobby	11	11	3	25	44%	56%	44%	12%	21%	79%	5
8	· Laws impede potential market for animal products (e.g. fur, skin, meat)	20	2	2	24	83%	17%	8%	8%	50%	50%	9
7	· Frequent changes in administrative arrangements and responsibilities	15	8	2	25	60%	40%	32%	8%	20%	80%	8
8	· Excessive administrative costs imposed on landholders/ residents	20	3	2	25	80%	20%	12%	8%	40%	60%	9
7	· Compulsory training required to implement control measures	12	11	1	24	50%	50%	46%	4%	8%	92%	7
8	· Regulations for recreational hunting are too restrictive	22	1	1	24	92%	8%	4%	4%	50%	50%	9
1	· Getting information on how to use control methods	17	6	1	24	71%	29%	25%	4%	14%	86%	9
8	· Animal welfare regulations interfering with controls	12	12	1	25	48%	52%	48%	4%	8%	92%	5
9	· Lack of monetary incentives to participate in control	9	16	1	26	35%	65%	62%	4%	6%	94%	5
5	· Lack of clear objectives	17	8	1	26	65%	35%	31%	4%	11%	89%	9

From the issues that you have discussed so far, which are the most important impediments? (rate 1 to 5)	1 (least)	2	3	4	5 (most)	Total respondents	% of 1s (least)	% of 2s	% of 3s	% of 4s	% of 5s (most)	% of 4+5
Lack of effective participation	2	2	3	3	11	21	10%	10%	14%	14%	52%	67%
· Lack of accountability		4	5	8	5	22	0%	18%	23%	36%	23%	59%
· Lack of capacity	3	3	3	7	5	21	14%	14%	14%	33%	24%	57%
· Lack of effective planning	1	4	5	5	6	21	5%	19%	24%	24%	29%	52%
· Lack of resources	1	4	5	7	4	21	5%	19%	24%	33%	19%	52%
· Lack of objective data and information	0	8	5	1	8	22	0%	36%	23%	5%	36%	41%
· Complex regulatory arrangements	2	1	10	7	2	22	9%	5%	45%	32%	9%	41%
· Complex legal and administrative arrangements	2	3	8	5	1	19	11%	16%	42%	26%	5%	32%
· Complex bureaucratic arrangements	1	6	7	5	1	20	5%	30%	35%	25%	5%	30%
· Politics	4	4	6	3	3	20	20%	20%	30%	15%	15%	30%
· Availability and access to control technologies	5	6	6	2	3	22	23%	27%	27%	9%	14%	23%

Appendix 5: Coding

Appendix 5.1: List of codes

List of codes developed through the segments of interview data:

- Information
- Resources
- Power
- Risk
- Institutions
- Participation
- Fragmentation
- Planning
- Resource distribution
- Regulations
- Regulatory compliance
- Red tape
- Fragmented decision-making
- Perception
- Evaluation
- Accountability
- Political risk
- Community engagement
- Bureaucratic risk
- Organisational risk

List of codes developed from theoretical approaches described in chapter 2 in conjunction with the institutional themes:

Codes from theoretical approaches in conjunction with the institutional themes:

- Lack of technological resource
- Decision-making on control technologies
- Regulatory decisions on control technologies
- Values and beliefs relating to control measures
- Values and beliefs relating to animal killing
- Values and beliefs relating to humaneness
- Decision-making on control and management approaches
- Trust and credibility in the government
- Ambiguous policy and action
- Knowledge and information

- Inadequate planning
- Participatory planning
- Planning objectives
- Resource and knowledge
- Resource distribution
- Relationships
- Regulatory risk
- Complex regulations
- Monitoring, enforcement, compliance
- Regulatory structure
- Collective decision-making
- Performance evaluation
- Evaluation
- Accidental risks
- Accountability
- Government accountability
- Resources
- Decision-making at the organisational level
- Politics
- Political risks
- Flexibility in planning
- Power relationships
- Institutions and power relationships
- Institutional culture
- Media

Institutional themes:

- Formal institutional arrangements
- Planning
- Resources
- Data and information
- Effective control technologies
- Effective stakeholder participation
- Lack of accountability
- Bureaucratic arrangements
- Lack of effective law and regulatory arrangements
- Politics

Appendix 5.2: Coding – Phase 1

Responses			
Lack of technologies that are effective & require minimal or no experts assistance	Control technologies - minimal or no-assistance - user-friendly - Lack of effective technologies	Information - Resources	Resources
There is no unified approach to acceptable control technique	Control technologies - Diverse views – lack of uniformity in standards - Lack of standards in technology	Resources	Decision-making
Different organisations influence the use of control techniques It is important to get backing from animal welfare organisations (RSPCA, PETA) to defend control methods It is important to get government and private organisations backing to facilitate use of certain control techniques (use of gun silencer for shooting deer) in peri-urban areas.	Organisational Influence - Lobby - power dynamics – relationships	Power	Decision-making (Path-dependence, Public choice)
Humanness	Humane - technology	Risk	Risk - Technological
Consideration of new technologies and their timely approval.	Technology - Level of trust - power relations – Institutional support – Leadership - governance	Institutions	Decision-making (Path-dependence, Public choice)
Subjectivity in invasive animal control efforts by landholders and government	Subjective Values – beliefs – perception - participation	Participation	Decision-making

Subjectivity among stakeholders and community in weighing animal welfare for implementing control programs	Subjective values and beliefs	Participation	Decision-making
Perception about killing of invasive animals gets slightly negative in peri-urban areas	Negative perception - participation	Participation	Information Risk perception
Humaneness aspect leads to varied perceptions	Humaneness - perception	Participation	Information Risk perception
Different voices on control and management. Leading those voices to suit the objective is an important task	Diverse approaches - management	Fragmentation/participation	Decision-making
Low level of trust in community with the government	Trust	Participation	Trust Decision-making
Disconnect between the rhetoric and community led action on invasive species and the government of the resources	Awareness and understanding	Participation	Decision-making
It is important to have clear understanding among the stakeholders about the overall control program and its utility	Understanding	Participation	Information
killing or making landscape better which means taking up control as a whole-of-landscape issue Tendency of government is to create small box objectives (instead of targeting it as a landscape issue) without focussing on outcomes.	Diverse objectives and approaches within government Diverse objectives and approaches within government - planning	Fragmentation Planning	Decision-making Decision-making
Paradigm shift in government objectives must be how to align them broadly and work together with communities to achieve realistic outcomes. (Eg, getting more people on field day is not an objective; how many active participants you get for further action helps in realising the objective of communicating science to community).	Diverse objectives and approaches within government – planning - participation	Planning/participation	Decision-making

Is it community led, is it government led, is it short term, is it long term, is it technically driven, is it holistically driven? Is it systems focus? Is there a process focus? Is it outcome driven? We've just got to be really explicit about what's guiding decisions around implementation.	Diverse objectives and approaches - planning	Fragmentation - planning	Decision-making
Constraints of the cost, time and lack of skills or knowledge relevant to control materials	Financial resources, human resources, technological resources, time	Resources Participation	Resources
Resource distribution: If it's meant to be for community led action, the community leaders should be at the decision making table when it comes to taking decisions about the allocation of resources. Solution: Tapping into existing arrangements or it might mean creating new structures and new institutions	Diverse and complex distribution approaches	Resource distribution Participation	Resource distribution
Distribution mechanisms also depend upon what level of intervention it is being focussed upon (for e.g. training – can be at state level)	Diverse and complex distribution approaches	Resource distribution Participation	Resource distribution
Diversity of funding flows that accommodate the stuff that could be best coordinated or effected at a state wide level.	Diverse and complex distribution approaches	Resource distribution Participation	Resource distribution
Boundary organisations (for e.g. IACRC is research domain) for other connectivity and networking - facilitation/extension are absent	Diverse and complex distribution approaches - relationships	Fragmentation Participation	Resource distribution Decision-making
Regulatory decisions (particularly for poisons, use of silencer in guns) limit use of a control technique	Control technologies - technology regulations	Regulations	Decision-making Regulatory risk for smart regulation (Public choice)

Accessibility of digital data is governed by regulations which constrains reporting by government.	Data related regulations	Regulations	Resources Regulatory risk for smart regulation
Improvements in notification processes (ways and mechanisms of serving notices and interactions) are needed	Complexity and over-regulated control program compliance requirements	Regulatory compliance/Red tape	Monitoring-enforcement and compliance
Because of Notification and compliance requirements, government pest managers/facilitators are portrayed in negative	Arbitrary rules	Regulatory compliance/Red tape	Complex regulations Monitoring-enforcement and compliance
Regulations in different spheres (including for control application, training requirements, funding procedures) limit control	Complexity and over-regulated control program compliance requirements	Red tape	Complex regulations
Regulations affect capabilities of community and government to implement control	Complexity and over-regulated control program compliance requirements	Red tape	Complex regulations
Legal rules surrounding use of poisons (pindone for rabbit & 1 hectare criteria) are arbitrary.	Arbitrary rules	Regulations	Complex regulations
Formal and informal rules may clash negatively affecting compliance	Clash of regulations	Regulations/red-tape	Decision-making (Path dependence)
Regulations are different in states	Diverse regulations	Fragmentation	Complex regulations Decision-making

Decisions taken at the higher level (about poisons) may not reflect intricacies of use or application from both technical and facilitators' perspective – but there is a development in that direction	Levels of decisions	Fragmented decision-making	Decision-making
Financial rules and instruments involved in funding pest animal control are complicated (both for government and community).	Administrative complexity	Red tape	Resource Distribution
Requirement and impact of invasive animals control is perceived subjectively.	Subjective information	Perception	Information Decision-making
Different approaches.	Diverse information	Fragmentation	Information Decision-making
Mobile apps may not be used despite of their availability.	Digital information - motivation	Participation	information
Lack of effective tools to measure and evaluate control program performance	Measuring performance	Evaluation	Resources
Lack of measurement tools affect planning	Measuring performance	Evaluation	Resources
Perceived accidental risk prevent stakeholders from taking responsibility of control	Perception - liability	Risk	Risk (accidental)
It is hard to find who had the responsibility to control	Perception - liability	Accountability	Decision-making Free riding
Perception of city people that pest animal control is a rural issue – ownership with the problem in peri-urban areas is needed	Perception - liability	Accountability	Decision-making Free riding
Within government agencies, Roles and responsibilities are not clear	Roles and responsibilities	Fragmentation	Decision-making
There is a competition for resources	Competition for resources	Fragmentation	Resources Decision-making

Local government has to lead on-going control but resources are less (reprioritisation is essential).	Local government resources	Resources	Resources Resource distribution
Pest animal problem may be subdued within different government organisational priorities (instead of getting a clear focus)	Priorities of government organisations	Fragmentation	Resources distribution
Control innovations are being done at different local government levels (deer traps, which is good) but this differs as per resource availability and it's not leading to healthy competition as all of them work in their own silos rather than co-operating with each other.	Control measures - Different levels, approaches, objectives and resources	Fragmentation	Decision-making
Convincing political leadership and maintaining rapport with them throughout control program is a challenge that can't be ignored; requires teaching and directing them (like AFL)	Political leadership	Risk	Political risk
Political decisions can affect policy and action in a big way – State level – varies as per issue. Labour government is big on community engagement Federal level - like any politics, create a polarised story around invasive species which is frustrating Local level – relationships with other levels and community is essential.	Political	Political risk	Political risk
Community will engage to deliver the programs; There is innovation already happening with community at a local level to come up with new ideas to be able to manage a problem.	Assumptions - government	Community engagement	Decision making
Older people with skills but how to engage younger people and gender	Demography	Community engagement	Decision-making
Flexible plan but how? Strategy can be flexible not plan.	Planning	Planning	Decision-making Administration

Institutional flexibility also plays an important role in this.	Organisational flexibility in planning	Bureaucratic	Administration (Path dependence)
Community representatives involved in planning may be those having vested interests which affects equitable outcomes	Vested interest - planning	Power	Administration (Public choice)
Local community voices and the nuances at a local level gets failed to be incorporated into higher level planning which creates distance between planning and action.	Community involvement and action	Planning/participation	Administration Decision-making (Public choice)
Organisational culture either prevents or supports at different stages.	Organisational culture	Organisational risks	Administration (Path dependence Public choice)
Deer – social amenity, hunting (resource) Data on deer, deer Control evaluation is not hard to get. Media (bambies) – images, news can change the whole perception and reverse reaction to control efforts. Depending upon what level of management you want to get hunting can be productive or counterproductive (lobbies)			

Appendix 5.3: Coding – Phase 2:

1. **Formal Institutional arrangements**
2. **Planning**
3. **Resources**
4. **Data and information**
5. **Effective Control technologies**
6. **Lack of effective stakeholder participation**
7. **Lack of accountability**
8. **Bureaucratic arrangements (Red tape/Green tape)**
9. **Lack of effective law and regulatory arrangements**
10. **Politics**

Review of Interviewee Responses	FIA	PL	R	D&I	ECT	ESP	A	BA	L&RA	P	
Lack of technologies that are effective & require minimal or no experts assistance			×		×						Lack of technological resource
There is no unified approach to acceptable control technique	×				×						Decision-making on control technologies
Different organisations and stakeholders influence the use of control techniques	×				×					×	Decision-making on control technologies
Humane control techniques					×						Technological Risk
Consideration of new technologies and their timely approval.	×				×			×			Regulatory decisions on control technologies

Theme												Category
Subjectivity in invasive animal control efforts by landholders and government	×					×						Values and beliefs relating to control measures
Subjectivity among stakeholders and community in weighing animal welfare for implementing control programs	×					×						Values and beliefs relating to animal welfare
Perception about killing of invasive animals gets negative in peri-urban areas	×					×						Values and beliefs relating to animal killing
Humaneness aspect leads to varied perceptions					×	×						Values and beliefs relating to humaneness
Different voices on control and management (Leading those voices to suit the objective is an important task)	×					×						Decision-making on control & management approaches
Low level of trust in community with the government	×					×						Trust and credibility in the government
Disconnect between the rhetoric and community led action on invasive species	×	×				×						Ambiguous policy and action
It is important to have clear understanding among the stakeholders about the overall control program and its utility - killing or making landscape better which means taking up control as a whole-of-landscape issue	×					×						Knowledge and information

Statement	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Category
Tendency of government is to create small box objectives (instead of targeting it as a landscape issue) without focussing on outcomes.	×	×									Inadequate planning
Paradigm shift in government objectives must be how to align them broadly and work together with communities to achieve realistic outcomes (E.g. getting more people on field day is not an objective; how many active participants you get for further action helps in realising the objective of communicating science to community).	×	×			×						Participatory planning
Is it community led, is it government led, is it short term, is it long term, is it technically driven, is it holistically driven? Is it systems focus? Is there a process focus? Is it outcome driven? We've just got to be really explicit about what's guiding decisions around implementation.	×	×			×						Planning objectives
Constraints of the cost, time and lack of skills or knowledge relevant to control materials			×								Resources and knowledge
If it's meant to be for community led action, the community leaders should be at the decision making table when it comes to taking decisions about the allocation of resources. Solution: Tapping into existing arrangements or it might mean creating new structures and new institutions	×	×	×		×						Resource distribution

Statement	1	2	3	4	5	6	7	8	9	Category
Distribution mechanisms also depend upon what level of intervention it is being focussed upon (for e.g. training – can be at state level)	×		×							Resource distribution
Diversity of funding flows that accommodate the stuff that could be best coordinated or effected at a state wide level.	×		×							Resource distribution
Boundary organisations (for e.g. IACRC is research domain) for other connectivity and networking - facilitation/extension are absent	×					×				Relationships
Regulatory decisions (particularly for poisons, use of silencer in guns) limit use of a control technique					×				×	Regulatory risk
Accessibility of digital data is governed by regulations which constrains reporting by government.				×					×	Complex regulations
Improvements in notification processes (ways and mechanisms of serving notices and interactions) are needed	×						×	×		Monitoring-enforcement-compliance
Because of Notification and compliance requirements, government pest managers/facilitators are portrayed in negative	×						×	×		Monitoring-enforcement-compliance
Regulations in different spheres (including for control application, training requirements, funding procedures) limit control							×	×		Complex regulations
Regulations affect capabilities of community and government to implement control						×	×	×		Complex regulations
Legal rules surrounding use of poisons are arbitrary.					×				×	Complex regulations
Formal and informal rules may clash negatively affecting compliance	×					×	×	×		Monitoring-enforcement-compliance

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Statement									Category
Regulations vary in states	×							×	Regulatory structure
Decisions taken at the higher level (about poisons) may not reflect intricacies of use or application from both technical and facilitators' perspective	×	×			×				Collective decision-making
Financial rules and instruments involved in funding pest animal control are complicated (both for government and community).			×				×		Resource distribution
Requirement and impact of invasive animals control is perceived subjectively.	×				×				Decision-making on control and management approaches
Different approaches.	×				×				Decision-making on control and management approaches
Mobile apps may not be used despite of their availability.					×	×			Knowledge and information
Lack of effective tools to measure and evaluate control program performance			×		×				Performance evaluation
Lack of measurement tools affect planning		×	×						Evaluation
Perceived accidental risk prevent stakeholders from taking responsibility of control						×	×		Accidental risks

It is hard to find who had the responsibility to control						×	×			Accountability
Perception of city people that pest animal control is a rural issue – ownership with the problem in peri-urban areas is needed						×	×			Accountability
Roles and responsibilities are not clear within government agencies	×						×			Government Accountability
There is a competition for resources	×		×							Resources
Local government has to lead on-going control but resources are less (reprioritisation is essential).	×		×							Resources
Pest animal problem may be subdued within different government organisational priorities (instead of getting a clear focus)	×									Decision-making at the organisational level
Control innovations are being done at different local government levels (deer traps, which is good) but this differs as per resource availability and it's not leading to healthy competition as all of them work in their own silos rather than co-operating with each other.	×		×		×					Power relationships at the organisational level
Convincing political leadership and maintaining rapport with them throughout control program is a challenge that can't be ignored; requires teaching and directing them (like AFL)							×		×	Politics
Political decisions can affect policy and action in a big way State level – varies as per issue. Labour							×		×	Political risks

government is big on community engagement; Federal level - like any politics, create a polarised story around invasive species which is frustrating; Local level – relationships with other levels and community is essential.										
Older people with skills but how to engage younger people and gender	×					×				Knowledge and information
Flexible plan but how? Strategy can be flexible not plan.		×								Flexibility in planning
Institutional flexibility also plays an important role in this.	×									Institutional culture
Community representatives involved in planning may be those having vested interests which affects equitable outcomes		×		×						Power relationships
Local community voices and the nuances at a local level gets failed to be incorporated into higher level planning which creates distance between planning and action.	×	×		×						Institutions & Power relationships
Organisational culture either prevents or supports at different stages.	×									Institutional culture
Media news/images can change the perception and reverse reaction to control efforts.						×				Media