An integrated assessment of the impact of wild dogs in Australia

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An integrated assessment of the impact of wild dogs in Australia

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Contents

Summary .................................................................................................................................................. 1
Integrated assessment of wild dog management ...................................................... 1
Estimated market impacts of wild dogs on sheep and beef producers in Australia: Results from three case studies ...................................................................................................................... 1
Estimated non-market impacts of wild dogs in Australia ........................................... 2
Psychological stress caused by wild dogs ................................................................. 3
Implications for wild dog management ................................................................. 3

1 Introduction ................................................................................................................................. 4

2 Wild dogs in Australia ................................................................................................................ 5
Economic, environmental and social impacts of wild dogs ....................................... 5
Current management of wild dogs .............................................................................. 6

3 Integrated assessment methodology ............................................................................. 8
Estimating market impacts ......................................................................................... 8
Assessing non-market impacts ................................................................................ 9
Choice modelling approach to value non-market impacts ...................................... 11

4 Awareness and attitudes to wild dogs in Australia .................................................. 12
Awareness of wild dog problems ............................................................................. 12
Management of wild dogs ....................................................................................... 14

5 Eastern Victoria .................................................................................................................... 16
Case study region .......................................................................................................... 16
Market impacts ............................................................................................................. 18
Non-market impacts ..................................................................................................... 20
Integrated assessment ................................................................................................. 25

6 South Australian Arid Lands ............................................................................................. 27
Case study region .......................................................................................................... 27
Market impacts ............................................................................................................. 28
Non-market impacts ..................................................................................................... 32
Integrated assessment ................................................................................................. 40

7 South Western Queensland ............................................................................................... 42
Case study region .......................................................................................................... 42
Market impacts ............................................................................................................. 44
Non-market impacts ..................................................................................................... 46
Integrated assessment ................................................................................................. 51

8 Measuring traumatic stress due to wild dog attacks ............................................... 53
Critical events .................................................................................................................. 53
Impact of Events Scale–Revised (IES–R) survey results ........................................... 54
Discussion ......................................................................................................................... 55

9 Conclusions and implications for wild dog management ......................................... 56

Appendix A: Bioeconomic livestock model .................................................................... 58
Revenue functions ........................................................................................................... 58
Cost functions ................................................................................................................. 62
Livestock growth equations .......................................................................................... 64
Algebraic representation of the cattle model ............................................................... 66
An integrated assessment of the impact of wild dogs in Australia

Algebraic representation of the sheep model .................................................. 68
Estimating benefits from wild dog control programs .................................. 69
Estimating costs of wild dog control programs ........................................... 70
Cost of kangaroo competition in the South Australian Arid Lands ............... 72
Appendix B: Participatory approach in case study regions .............................. 74
Appendix C: Impacts of Events Scale–Revised survey .................................... 75
Appendix D: Choice modelling to estimate non-market impacts .................... 77
Appendix E: Sensitivity of economic analysis to choice of discount rate ............ 82
Appendix F: Review of previous studies on the social impacts of wild dogs ....... 84
References ........................................................................................................ 87

Tables

Table 1 Selected results of national survey of landholders (per cent) .................. 12
Table 2 Responses to attitudinal questions from the choice modelling survey, average by responding group (per cent) .................................................................. 13
Table 3 Livestock numbers and gross value of production, Eastern Victoria (2010–11 dollars) ......................................................................................... 17
Table 4 Cost–benefit analysis measures for Eastern Victoria, by growth in livestock deaths over 20 years (2009–10 dollars) ........................................... 20
Table 5 Victorian households’ annual willingness to pay (for 10 years) to ameliorate adverse impacts of wild dogs in Eastern Victoria ......................................................... 22
Table 6 Assumed non-market benefits from management of wild dogs for different scenarios, Eastern Victoria ............................................................... 23
Table 7 Total non-market benefits from management of wild dogs, Eastern Victoria ($’000) ........................................................................................................ 24
Table 8 Net benefits of management of wild dog programs in Eastern Victoria over 20 years .......................... 25
Table 9 Cost–benefit analysis measures for the South Australian Arid lands, by growth in calf deaths (in 2009–10 dollars), over 20 years ................................................................. 30
Table 10 Annual cost of kangaroo competition in the South Australian Arid Lands ($m, valued in 2009–10 dollars) .................................................... 31
Table 11 South Australian householders’ willingness to pay (for 10 years) to ameliorate the adverse impacts of wild dogs in the South Australian Arid Lands .............................................. 37
Table 12 Assumed non-market benefits from the management of wild dogs for the different scenarios of wild dog attacks in the South Australian Arid Lands ................. 38
Table 13 Total non-market benefits from the management of wild dogs in the South Australian Arid Lands ($’000) ................................................................. 39
Table 14 Net benefits from the management of wild dog programs in the South Australian Arid Lands over 20 years ................................................................. 41
An integrated assessment of the impact of wild dogs in Australia

Table 15 Livestock numbers and gross value of production in South Western Queensland, in 2009–10 dollars

Table 16 Cost-benefit analysis measures for South Western Queensland, by growth in livestock deaths (in 2009–10 dollars), over 20 years

Table 17 Queensland householders’ willingness to pay (for 10 years) to ameliorate the adverse impacts of wild dogs in South Western Queensland

Table 18 Assumed non-market benefits from the management of wild dogs for the different scenarios of wild dog attacks in South Western Queensland

Table 19 Total non-market benefits from the management of wild dogs in South Western Queensland ($'000)

Table 20 Net benefits from the management of wild dogs in South Western Queensland

Table 21 Overview of studies employing the Impact of Event Scale (IES) and Impact of Event Scale-Revised (IES-R) with different population groups*

Table A1 Miscellaneous livestock parameters across case study areas

Table A2 Starting values for cattle model by age cohort (t=1), South Australian Arid Lands

Table A3 Starting values for cattle model by age cohort (t=1), South Western Queensland

Table A4 Starting values for cattle model by age cohort (t=1), Eastern Victoria

Table A5 Starting values for sheep model by age cohort (t=1), South Western Queensland

Table A6, Starting values for sheep model by age cohort (t=1), Eastern Victoria

Table A7 Quantity of wool by age cohort per year

Table A8 Wool price by age cohort

Table A9 Annual cattle maintenance costs

Table A10 Annual sheep maintenance costs

Table A11 Annual costs to transport slaughtered livestock

Table A12 Livestock mating and branding rates

Table A13 Livestock mortality rates

Table A14 Data to estimate annual baiting costs in the South Australian Arid Lands

Table A15 Average annual costs of wild dog control programs in South Western Queensland (2009–10 dollars)

Table D1 Non-market benefits from management of wild dogs after 10 and 20 years for four different scenarios about growth in wild dog attacks in the absence of control

Table E1 Cost–benefit analysis measure for Eastern Victoria by growth in livestock deaths, 5 per cent discount rate
An integrated assessment of the impact of wild dogs in Australia

Table E2 Cost–benefit analysis measure for Eastern Victoria by growth in livestock deaths, 10 per cent discount rate

Table E3 Cost–benefit analysis measure for the South Australian Arid Lands by growth in livestock deaths, 5 per cent discount rate

Table E4 Cost–benefit analysis measure for the South Australian Arid Lands by growth in livestock deaths, 10 per cent discount rate

Table E5 Cost–benefit analysis measure for South Western Queensland by growth in livestock deaths, 5 per cent discount rate

Table E6 Cost–benefit analysis measure for South Western Queensland by growth in livestock deaths, 10 per cent discount rate

Table F1 Summary of key social science literature on impacts of wild dogs in Australia

Table F2 Key issues and social consequences of wild dogs

Figures

Figure 1 Assessing the economic, environmental and social impacts of wild dogs ..........8
Figure 2 Benefits of wild dog control for beef and sheep industries, Eastern Victoria.... 19
Figure 3 Benefits of wild dog control for beef industry, South Australian Arid Lands: discounted net benefits, for calf death rates................................................................. 28
Figure 4 Breakeven curves for wild dog baiting programs, South Australian Arid Lands ........................................................................................................................................... 32
Figure 5 Benefits of wild dog control for beef and sheep industries, South Western Queensland ...................................................................................................................... 45
Figure A1 Proportion of calf deaths, by scenario, South Australian Arid Lands

Figure D1 Example of a choice set

Maps

Map 1 Distribution and abundance of wild dogs in Australia.............................................. 5
Map 2 Number of respondents per statistical local area that participated in the 2010 ABARES survey of wild dog and fox management....................................................... 10
Map 3 Eastern Victoria case study region........................................................................... 16
Map 4 South Australian Arid Lands case study region ..................................................... 27
Map 5 South Australian arid lands qualitative social impacts case study area............... 33
Map 6 South Western Queensland case study region ...................................................... 42
An integrated assessment of the impact of wild dogs in Australia

Boxes

Box 1 Wild dog management and its impact on kangaroo competition for grazing vegetation

Box 2 Effective wild dog management: perceptions of landholders
Summary

Wild dogs are a significant pest animal in Australia. They are widespread in Queensland, the Northern Territory and much of Western Australia and South Australia, as well as being present in parts of New South Wales and Victoria. Wild dogs are known to have a significant detrimental effect on the agricultural sector (market impacts), but they also cause non-market impacts in terms of adverse social impacts and environmental damage. These impacts are described in more detail below.

In general, wild dogs are considered pest animals because of their attacks on livestock and are subject to control. Their legal status varies across the states and territories, with the dingo regarded as a regulated native species under the Australian Government's Environment Protection and Biodiversity Conservation Act 1999. Most states and territories have a wild dog management strategy, either as a stand-alone strategy or as part of a broader vertebrate pest strategy. These strategies are based on both the individual state legislation and a national approach, aligning to the Australian Pest Animal Strategy over time.

Management of wild dogs is mostly conducted by landholders, who bear the cost of production losses from wild dog attacks. In some areas wild dog control is undertaken by the relevant state government or is financially supported by local government.

Improved wild dog management is a challenge because of the nature of the problem. It requires coordinated action by all landholders. No individual landholder can capture the full benefits of wild dog control if their neighbours are not taking similar action. The management of wild dogs is further complicated by different types of landholders with different objectives. Private landholders are generally seeking to run profitable farm businesses, while governments managing public land including national parks or state forests have other goals. Where private landholders share boundaries with public lands the management of wild dogs can be particularly difficult, with the public land becoming a home and potential 'refuge' for wild dogs.

The challenge facing government is to implement policies and programs that support coordinated wild dog management in order to ensure the benefits of control are fully realised, but to do this in a way that does not take over, or crowd out, the private investments that individual landholders have an incentive to make in wild dog control.

Integrated assessment of wild dog management

The evidence presented in this report indicates that there are positive net economic returns to wild dog management for the three case study regions under most assumptions about the rate of growth in attack rates. In addition to significant economic benefits of wild dog control, there are also significant non-market benefits associated with wild dog management. It is likely that private landholders are not taking these non-market benefits into consideration when deciding how much to invest in wild dog control. However, in the absence of a coordinated approach to wild dog management, there is likely to be significant under-investment by private landholders to control wild dogs.

Estimated market impacts of wild dogs on sheep and beef producers in Australia: Results from three case studies

Where wild dogs are present in Australia, sheep and cattle are vulnerable to wild dog attacks. These attacks can cause not only the death of lambs and calves but also severe injuries to
An integrated assessment of the impact of wild dogs in Australia

juvenile and adult sheep and cattle. In a national survey an estimated 66 per cent of landholders reported wild dog problems on their property in the 12 months prior to the survey, and around 55 per cent of landholders reported that the presence of wild dogs had reduced lambing and/or calving rates. In this study, on average, each landholder reporting attacks on their property suffered livestock losses of around 100 animals a year, with a further 65 to 70 animals injured. In response to wild dog problems, landholders reported changing the livestock composition of their farming enterprise and taking active management such as baiting, shooting, trapping and exclusion fencing.

The economic cost of these problems was not estimated explicitly in this study. Instead, the economic costs over 20 years were estimated under a plausible range of growth rates for wild dog attacks in the absence of management. It was estimated that, the economic cost over 20 years in Eastern Victoria, one of the three case study areas considered in this study, would range between $1.8 million and $31.6 million, in net present value terms, if wild dog attacks were to grow between 2 and 20 per cent a year respectively in the case study area in the absence of wild dog control. The case study region of Eastern Victoria represents only around 13 per cent of the state’s landmass and 1.7 per cent and 10.8 per cent of the states sheep and cattle population. For the South Australian Arid Lands, another case study area, the economic cost was estimated to range between $1.4 million and $34 million over 20 years, in net present value terms, depending on the assumed rates of growth in wild dog attacks in the absence of management. This case study area represents about 33 per cent of the landmass of the state of South Australia but 10.4 per cent of the cattle population of the state. For South Western Queensland, the third case study area that represents around 19 per cent of the landmass of Queensland and 22.6 per cent and 3.6 per cent of the state’s sheep and cattle population, respectively, the corresponding estimates were $2.4 million and $54 million. These results are based on livestock losses and the subsequent impact on the size of livestock herds and flocks over time.

Where information was available on the costs of wild dog control in the three case study regions, these were estimated and compared with the estimated benefits. In the majority of cases, the investment being made in wild dog controls generated significant benefits. The only exception was in South Western Queensland, where the estimated control costs outweighed the estimated benefits unless the rate of attack was 10 per cent or higher in the absence of control.

Estimated non-market impacts of wild dogs in Australia

The above results take into consideration only the adverse market impacts of wild dogs associated with livestock losses and injuries. Inclusion of the estimated non-market benefits of wild dog control was found to refine the ‘market’ assessment in all three case study regions under the assumed scenarios.

A choice modelling survey with respondents randomly selected within Victoria, Queensland and South Australia was used to estimate the willingness of individuals to pay for the management of wild dogs in order to reduce social and environmental impact in the three case study areas. The resulting estimated non-market benefits of the management of wild dogs were all positive and significant. Respondents in Victoria, Queensland and South Australia reported being willing to pay $0.035, $0.01 and $0.41 respectively to reduce the adverse impacts of wild dogs on householders. They also reported being willing to pay $3.98, $3.63 and $5.67 respectively to reduce the adverse impacts of wild dogs on native species. However, respondents in Victoria and Queensland reported being willing to pay $1.44 and $0.11 respectively to protect public areas from the adverse effects of wild dogs whilst respondents in South Australia were not willing to pay to protect public areas from the adverse effects of wild dogs.
An integrated assessment of the impact of wild dogs in Australia

The incorporation of these non-market impacts strengthened the estimated net social benefits of wild dog control in each of the three case study regions.

Despite a widespread perception of the adverse impact of wild dogs on the environment and a reported willingness of the community to pay to reduce these impacts on native species and public lands, the effect of wild dogs on Australia’s environmental assets is uncertain. There is some evidence that wild dogs are an ‘apex predator’ and have a positive impact by reducing the density of other feral animal populations. There is also a view that wild dogs have a negative impact through the reduction of native species populations. This was explored for the South Australian Arid Lands case study to investigate the conditions under which wild dogs limit kangaroo numbers and reduce competition for pasture for livestock. Realistic scenarios were identified where it is not economic for landholders to implement wild dog controls because of the corresponding increase in kangaroos competing with livestock for pasture.

Psychological stress caused by wild dogs

An estimated 35 per cent of landholders nationally reported that the presence of wild dogs left them feeling angry, while an estimated 21 per cent reported feelings of distress and anger. These issues were explored further through a series of semi-structured interviews with landholders in each of the case study regions. Some participants reported being constantly alert to the problem of wild dogs and one participant reported feeling like a failure because of an inability to control the problem adequately.

A quantitative survey—the Impact of Event Scale—Revised survey—was undertaken with 39 participants in the case-study regions who had been directly affected by wild dogs. The 22-item scale measured traumatic stress associated with wild dogs and found that these participants reported similar or higher levels of stress to people who had experienced other types of trauma. Psychological intrusiveness was a particular characteristic of the study, with potential implications for support and treatment.

Implications for wild dog management

This study highlights at least three key factors to improve the management of wild dogs in Australia.

- First, there are likely to be benefits associated with government or industry bodies providing a coordination role. Securing cooperation of all landholders, including private and government—the so called ‘nil tenure’ approach, is central to the effective management of wild dogs.

- Second, the psychological stress suffered by individuals with direct experience of wild dogs is significant and comparable to that suffered by individuals experiencing other traumatic events. There may be a role for governments to monitor the extent of this stress and ensure adequate support is available to those who require it.

- Third, there may also be a role for governments to invest directly in wild dog management to capture the non-market benefits identified in this study. The magnitude of that investment is not known. The benefit–cost analyses show that there are positive returns to current investments. There are likely to be benefits to additional investment, but the level of investment that generates the greatest market and non-market returns cannot be determined using a benefit–cost analysis approach and requires further research.
1 Introduction

Wild dogs are one of the pest animals established in Australia that have had a significant detrimental impact on Australia’s economy, environment and communities. Previous studies on the impact of pest animals have estimated the economic impact of wild dog populations in Australia (Gong et al. 2009; McLeod 2004). While the social impacts of wild dogs on agriculture in Australia have long been acknowledged (Sykes 1982), prior to the recent surge of interest in this topic, there had been little systematic research into the social impacts of wild dogs and of invasive animals in general (Fitzgerald & Wilkinson 2007). More recently, a number of social science and social impact studies concerning wild dogs have been undertaken (Fenton 2009; Fitzgerald & Wilkinson 2009; Lightfoot 2010; Russell 2006). No previous studies have attempted to comprehensively estimate the market and non-market environmental and social impacts of wild dogs in Australia.

This paper evaluates the economic, environmental and social impacts of wild dogs in Australia and assesses the costs and benefits of investing in wild dog management to prioritise future investments. It uses a cost–benefit analysis framework applied to three case study regions. The work was funded by the Australian Pest Animal Research Program and contributes to the following program objectives:

- to develop integrated, strategic approaches to manage the impacts of nationally significant pest animals on agriculture
- to quantify the benefits of pest animal management.

This report is structured as follows. Chapter 2 provides some background to the issue of wild dogs in Australia. Chapter 3 describes the range of methodologies used to assess and quantify the social, economic and environmental impacts of wild dogs in Australia. Australians’ perceptions and attitudes to wild dogs are explored in Chapter 4. An assessment of the social, economic and environmental impacts of wild dogs—including quantification of the benefits of management—is presented in Chapters 5, 6 and 7. Chapter 8 presents a quantitative approach to measuring traumatic stress of people arising from wild dog attacks. The report concludes with a discussion of the implications for wild dog management.
2 Wild dogs in Australia

Wild dogs—including dingoes (Canis lupus dingo), feral domestic dogs (Canis lupus familiaris) and hybrids of the two—are considered one of the most significant pest animals problems affecting Australian agriculture, and in particular sheep and cattle producers. Wild dogs are widespread in Queensland, the Northern Territory and much of Western Australia and South Australia (Map 1). They are also present in parts of New South Wales and Victoria.

Map 1 Distribution and abundance of wild dogs in Australia

Source: NLWRA and Invasive Animals Cooperative Research Centre (2008).

Economic, environmental and social impacts of wild dogs

Where wild dogs are present in Australia, sheep and cattle are vulnerable to wild dog attacks. Wild dog attacks cause not only the death of lambs and calves but can also cause severe injuries to juvenile and adult sheep and cattle. The increased stress imposed on livestock through attacks can result in maimothing by sheep, reduced weight gain, poor wool growth and low-quality meat (Mitchell & Balogh 2007).

Wild dogs are also implicated in the spread of diseases to livestock. Wild dogs can carry the hydatid tapeworm, Echinococcus granulosus, which can be transmitted to both livestock and humans (Allen 2008; Lightfoot 2010). Wild dogs have also been identified as host animals of the protozoan parasite Neospora caninum, which may cause bovine abortion (NSW Agriculture 2004; Rural Management Partners 2004; Walker 2004, cited in Hewitt 2009).

Wild dogs not only have a significant detrimental impact on Australian agriculture, they have a social impact on landholders and those living in rural communities. They are also perceived to have an adverse impact on the natural environment.
An integrated assessment of the impact of wild dogs in Australia

The social impacts of wild dogs on agriculture in Australia have long been acknowledged (Sykes 1982). The impacts of wild dogs on society relate to the danger they impose to the health and safety of the community. This includes the psychological impact—such as stress, anxiety and depression—on individuals affected by dog attacks on their livestock, the spread of disease and the threat of physical attacks (Lightfoot 2010). People also feel concern for the potential environmental damage that wild dogs cause.

The effect of wild dogs on Australia’s environmental assets is uncertain. There is some evidence that wild dogs are an ‘apex predator’ and have a positive impact by reducing the density of other feral animal populations such as rabbits, goats, pigs, cats and foxes, thereby protecting some smaller native species (Glen et al. 2007; Johnson 2007; Queensland Rural Lands Protection Board 2002). However, there is also a view that wild dogs have a negative impact through the reduction of native species populations (Fleming et al. 2001; Lightfoot 2010; McLeod 2004).

Current management of wild dogs

The management of wild dogs in Australia varies between the states and territories, largely due to differences in state legislation and the definitions and distinctions between ‘wild dogs’ and ‘dingoes’. The legal status of dingoes and other wild dogs also varies within some states and territories. However, most legislation specifies that management of wild dogs is the responsibility of the landowner.

Wild dogs are seen as pest animals because of their attacks on livestock. However, the dingo is regarded as a protected native species under the Environment Protection and Biodiversity Conservation Act 1999. In general, wild dogs are considered pest animals and are subject to control.

Most states and territories have a wild dog management strategy, either as a stand-alone strategy or as part of a broader vertebrate pest strategy. These strategies are based on both the individual state legislation and a national approach, aligning to the Australian Pest Animal Strategy over time.

In the absence of a coordinated approach to wild dog management, there is likely to be significant under-investment to control the pest animal. The benefits to an individual landholder of controlling wild dogs on his or her property are influenced by the efforts of neighbouring landholders to also control wild dogs. If neighbouring landholders make little or no effort, then the benefits to an individual landholder are greatly reduced. Securing cooperation of all landholders, including private and government—the so-called ‘nil tenure’ approach, underpins effective management of wild dogs.

Management of wild dogs is mostly conducted by landholders, who bear the cost of production losses from wild dog attacks. In some areas wild dog control is undertaken by the state government or is financially supported by local government (for example, see Tully et al. 2011).

A variety of methods are used in Australia to control wild dog populations. Techniques include exclusion fencing, guardian animals, shooting, trapping and poisoning. The choice of control technique is largely dependent on the technique’s effectiveness in different environments (Southwell et al. 2013), as well as jurisdictional legislation.

Lethal baiting is considered to be one of the most cost-effective control methods available (Sharp 2012a). Ground baiting allows baits to be placed where they are most likely to be found by wild dogs, while minimising the chance of their uptake by non-target animals. Aerial baiting is
An integrated assessment of the impact of wild dogs in Australia

often used where the terrain makes ground baiting impossible or impractical (Sharp 2012b). The use of exclusion fencing is only relatively minor in comparison to the use of other management techniques (Southwell et al. 2013).

Gong and colleagues (2009) estimated that expenditure on management, administration and research on vertebrate pests in 2007–08, including but not limited to wild dogs, was around $122.7 million, split among the Commonwealth ($12.6 million), states and territories ($75.5 million) and landholders ($34.6 million). It was not possible to separate the wild dog component of this expenditure.
3 Integrated assessment methodology

An integrated approach has been adopted to quantify the economic, environmental and social costs and benefits of wild dog management. A combination of modelling and survey techniques was used to quantify the impact of wild dogs in Australia. Figure 1 provides an overview of the integrated approach to the analysis.

Figure 1 Assessing economic, environmental and social impacts of wild dogs

Cost-benefit analysis

Total benefits ($values) analysis

Non-market valuation

Market value

Environmental impacts

Social impacts

Agricultural production impacts

Qualitative and quantitative data

Quantitative data

Quantitative data

Total control costs ($values) analysis

Costs and impact of control methods

This approach integrates the economic impacts of wild dogs on Australian agriculture with non-market environmental and social impacts into a holistic assessment of the impact of wild dogs. This enables a more accurate estimation of the return to the entire Australian community of investments to control wild dogs.

A case-study approach was used to explore the impacts of wild dogs and associated management. Three case study regions were assessed, within Victoria, South Australia and Queensland. These areas were selected for several reasons. First, all case study areas are inhabited by wild dogs. Second, in these areas wild dogs affect the state of ecosystems, the profitability of livestock enterprises, and people living in the surrounding communities. Third, each case study area represents a different type of livestock production system.

Estimating market impacts

The market impacts of wild dogs are assessed through the estimation of the benefits from wild dog controls and the associated costs of those controls.

To estimate the benefits, two scenarios are examined: a baseline scenario where wild dog control measures are implemented, resulting in fewer livestock losses; and a no control scenario. The estimated benefits are the value of livestock losses avoided from wild dog controls, calculated as the difference between net revenues from livestock production in the baseline and
An integrated assessment of the impact of wild dogs in Australia

in the no control scenario. Given uncertainty about the growth in the wild dog population and associated impacts in the absence of controls, a series of no control scenarios are modelled to investigate the sensitivity of the estimates to assumptions about the rate of growth in livestock attack rates.

Costs are the expenditures in managing wild dogs, estimated using data on current control programs. Both benefits and costs are projected over a period of 20 years and discounted at a rate of 7 per cent.

A bioeconomic livestock model was developed to estimate the net revenue from livestock production activities, with and without wild dog controls. The model is dynamic and decisions in one period affect returns to production in future periods. It includes a net revenue function, livestock growth equations and damage functions. Net revenue is estimated as the difference between revenues and costs valuing the returns to land, labour and capital. Revenue is estimated as the returns from livestock slaughtered—meat production—plus the returns from wool production for sheep. Two categories of costs are included in the estimation of net revenue: maintenance costs and slaughter costs. Livestock growth equations keep track of births, deaths and slaughter numbers within the herd each year. Damage functions estimate the effect of wild dog attacks on livestock numbers in each scenario. The model is based on one previously developed by ABARES to estimate the cost of a foot and mouth disease outbreak in Australia (Cao et al. 2002). Separate models are developed for cattle and sheep production and applied to the three case study regions: Eastern Victoria, the South Australian Arid Lands and South Western Queensland. For further detail on the modelling refer Appendix A.

Assessing non-market impacts

The non-market impacts of wild dogs have been assessed using a variety of techniques. A national survey of landholders about wild dog and fox management in 2010 provided some information about how landholders feel about the presence of wild dogs in their area. A participatory approach to identifying the social impacts of wild dogs was also employed in the three case study regions. An Impacts of Event Scale survey was used to assess the psychological stress on individuals known to have been directly affected by wild dogs. This approach was adopted to address some of the gaps in knowledge—putting a significant focus on personal, psychological, emotional and stress impacts and attempting to quantify the stress impacts to provide hard data for key decision makers. A choice modelling survey was also used to estimate the willingness of individuals to pay to manage wild dogs in order to reduce social and environmental impacts. Each of these techniques is described briefly below.

National survey of social impacts of wild dogs

In 2010, ABARES undertook a national survey for the project 'Understanding the drivers of barriers to participation in wild canid management in Australia: Implications for the adoption of a new toxin, para-aminopropiophenone' (Southwell et al. 2013). The survey focused on better understanding current attitudes to wild dog and fox management from a broader national perspective and across state boundaries; it also measured financial, environmental and social impacts.

Relevant questions from this national survey provide insights into the proportion of farmers with fears for the safety of their family or workers, and those reporting feeling very distressed, anxious and angry as a result of wild dogs.
An integrated assessment of the impact of wild dogs in Australia

A total of 525 private land managers were surveyed by telephone. Respondents were randomly selected from a database of property owners obtained from the Australian Bureau of Statistics within statistical local areas known to contain wild canids. All the mainland states and territories in Australia were surveyed, with the exception of the Australian Capital Territory. Landholders in Tasmania were excluded from the survey. Map 2 highlights the number of respondents per statistical local area that participated in the survey.

Map 2 Number of respondents per statistical local area that participated in the 2010 ABARES survey of wild dog and fox management

![Map of Australia showing number of respondents per statistical local area](image)

Legend
SLA10eAust
Number of samples per SLA
0
1 - 4
5 - 10
11 - 14
15 - 19

Participatory approach in case study regions

A participatory approach to identifying the social impacts of wild dogs involved face-to-face, in-depth, semi-structured interviews (with some telephone interviews) and informal focus groups in the three case study areas: Eastern Victoria, South Australian Arid Lands and South Western Queensland. Forty-seven people were interviewed in total across the three regions, including landholders, community members, some government agency staff and other key stakeholders.

The aim was to identify the main social and psychological impacts of the wild dog problem from the perspective of landholders and other key stakeholders. Key questions guiding the interview process included:

- What are the main characteristics of the wild dog attack event(s)?
- What were/are the impacts of the wild dog attack event(s)?
- Do you have any wild dog management? What type?
- In your view, what constitutes effective management?
An integrated assessment of the impact of wild dogs in Australia

- What support would assist you with the social-psychological impacts of the wild dog attack event(s)?

- Do you have any key messages to send to government?

The textural data acquired from the interviews and focus groups were analysed for key themes with the assistance of NVivo software (QSR International), a text analysis tool. The findings provide a broad context for the impacts on individuals, businesses and communities reflecting the situation at the time of the study in the three case study regions.

The social impacts were subsequently validated by land managers, experts on wild dog management and other stakeholders. For further detail on this participatory approach, refer Appendix B.

Impact of Event Scale survey to assess psychological stress

This inquiry into social impacts also considered the psychological impacts of wild dogs amongst a sample of individuals known to have been directly affected by wild dogs.

A quantitative survey was undertaken with 39 participants in the case study areas to assess the level of traumatic stress they experienced as a result of attacks. This 'Impact of Event Scale-Revised survey' contained a 22-item scale which measures traumatic stress associated with a critical incident or event in terms of intrusive thoughts, avoidance thoughts and thoughts associated with hyperarousal. The response format asks people to answer using a five-point (0 to 4) scale where 0 equates to 'not at all' and 4 to 'extreme impact'.

The findings were compared with the findings from other studies using this survey tool. The other studies examined traumatic response to events that include motor vehicle accidents, war service in Vietnam veterans, and life threatening events such as a sudden cardiac arrest or an acute myocardial infarction. For further detail on this survey, refer Appendix C.

Choice modelling approach to value non-market impacts

A choice modelling approach was used to estimate the value of the social and environmental benefits associated with wild dog management in the three case study areas. Respondents were asked to trade off the environmental, economic and social attributes of alternative wild dog management scenarios to estimate the relative values of each attribute. Specifically, respondents were surveyed to determine their willingness to pay over a 10-year period to protect households, native species and public areas from the negative impact of wild dogs.

The web-based choice modelling survey was conducted in early 2012. The respondents were randomly selected within Victoria, South Australia and Queensland. In total, 1817 responses were collected from six split samples. Two samples for each state were selected to distinguish between the rural and urban population. In addition to questions designed to elicit respondents' willingness to pay for wild dog management to protect households, native species and public areas, other questions were asked—about awareness of wild dog issues and socio-demographic information—to understand better the views of the general community.

The choice modelling framework is consistent with the principles of cost-benefit analysis and can be directly incorporated into the assessment of the market impacts of wild dogs, allowing for a more complete comparison of the benefits and costs of management options. For more information about the choice modelling survey and methodology, refer Appendix D.
4 Awareness and attitudes to wild dogs in Australia

The attitudinal questions asked as part of the choice modelling survey provide insights into the perceptions of both rural and urban Australians about the impact of wild dogs. The national survey of landholders also provided information regarding landholders’ awareness, attitudes and experiences with wild dogs in Australia. Selected results from these surveys are presented in this chapter.

Awareness of wild dog problems

An estimated 72 per cent of landholders nationally reported they were aware of wild dog attacks occurring in their area (Table 1). The majority of landholders reported they were aware of these attacks through the media, although a significant proportion also reported observing attacks on their own property. Landholders in close proximity to a national park or state forest were more likely to report being aware of wild dog attacks in their area.

Table 1 Selected results of national survey of landholders (per cent)

<table>
<thead>
<tr>
<th>Landholders aware of wild dog problems</th>
<th>NSW</th>
<th>Vic.</th>
<th>Qld</th>
<th>SA</th>
<th>WA</th>
<th>NT</th>
<th>Aust.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>68</td>
<td>52</td>
<td>95</td>
<td>44</td>
<td>92</td>
<td>94</td>
<td>72</td>
</tr>
<tr>
<td>Landholders reporting wild dog problems</td>
<td>69</td>
<td>52</td>
<td>72</td>
<td>44</td>
<td>73</td>
<td>83</td>
<td>66</td>
</tr>
<tr>
<td>Landholders with wild dog problems:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– reported the problem as severe</td>
<td>22</td>
<td>37</td>
<td>51</td>
<td>23</td>
<td>52</td>
<td>31</td>
<td>34</td>
</tr>
<tr>
<td>– reported the problem getting worse</td>
<td>36</td>
<td>36</td>
<td>62</td>
<td>15</td>
<td>62</td>
<td>54</td>
<td>45</td>
</tr>
<tr>
<td>– reported undertaking management action</td>
<td>86</td>
<td>91</td>
<td>93</td>
<td>86</td>
<td>94</td>
<td>93</td>
<td>90</td>
</tr>
<tr>
<td>– reported wild dog management as effective</td>
<td>39</td>
<td>29</td>
<td>71</td>
<td>63</td>
<td>28</td>
<td>16</td>
<td>47</td>
</tr>
</tbody>
</table>

An estimated 54 per cent of people in rural areas of Victoria, South Australia and Queensland who responded to the choice modelling survey reported that wild dogs were a problem in their state (Table 2). Rural-based survey respondents in Queensland were more likely to report that wild dogs were a problem than their counterparts in Victoria and South Australia.

In contrast, an estimated 41 per cent of people in urban areas of Victoria, South Australia and Queensland who responded to the choice modelling survey reported that wild dogs were a problem in their state (Table 2). Urban-based survey respondents in Queensland were more likely to report that wild dogs were a problem than their counterparts in Victoria and South Australia.
An integrated assessment of the impact of wild dogs in Australia

Table 2 Responses to attitudinal questions from the choice modelling survey, average by responding group (per cent)

<table>
<thead>
<tr>
<th></th>
<th>Urban</th>
<th>Victoria Rural</th>
<th>South Australia Urban</th>
<th>South Australia Rural</th>
<th>Queensland Urban</th>
<th>Queensland Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wild dogs are a problem in my state</td>
<td>38</td>
<td>49</td>
<td>35</td>
<td>50</td>
<td>50</td>
<td>61</td>
</tr>
<tr>
<td>Wild dogs pose a significant risk of attacks to farm livestock</td>
<td>64</td>
<td>72</td>
<td>65</td>
<td>73</td>
<td>65</td>
<td>76</td>
</tr>
<tr>
<td>Wild dogs pose a risk of attacks on humans</td>
<td>41</td>
<td>41</td>
<td>31</td>
<td>39</td>
<td>51</td>
<td>57</td>
</tr>
<tr>
<td>Wild dogs pose a risk of attacks to pets</td>
<td>58</td>
<td>62</td>
<td>51</td>
<td>58</td>
<td>62</td>
<td>66</td>
</tr>
<tr>
<td>Wild dogs can significantly contribute to some native species becoming endangered</td>
<td>62</td>
<td>67</td>
<td>61</td>
<td>68</td>
<td>67</td>
<td>73</td>
</tr>
<tr>
<td>Wild dogs limit the spread of feral animal populations</td>
<td>42</td>
<td>36</td>
<td>44</td>
<td>44</td>
<td>42</td>
<td>43</td>
</tr>
<tr>
<td>Wild dogs maintain balance among wildlife species</td>
<td>20</td>
<td>12</td>
<td>18</td>
<td>16</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Dingoes maintain balance among wildlife species</td>
<td>39</td>
<td>32</td>
<td>40</td>
<td>40</td>
<td>41</td>
<td>48</td>
</tr>
</tbody>
</table>

Perceived and reported impact on farm businesses

More than 60 per cent of both urban and rural respondents to the choice modelling survey in Victoria, South Australia and Queensland reported that wild dogs pose a significant risk of attack to farm livestock in their state (Table 2).

An estimated 66 per cent of landholders reported wild dog problems on their property in the 12 months prior to the survey being conducted. A higher proportion of landholders reported wild dog problems on their property in the Northern Territory (83 per cent), Queensland (72 per cent) and Western Australia (73 per cent). Of those reporting wild dog problems on their property in the 12 months prior to the survey, an estimated 34 per cent said the problem was severe. More than half the landholders in Western Australia reporting problems with wild dogs indicated the problem was severe. In contrast, around half of landholders in New South Wales reported their problems with wild dogs as minor.

Around 55 per cent of landholders reported that the presence of wild dogs in their area had reduced lambing and/or calving rates. In Queensland and Western Australia, more than two-thirds of landholders reported a reduction in lambing and/or calving rates as a result of wild dogs. An estimated 17 per cent of landholders nationally reported changing their livestock composition or that they had left the industry. In Queensland, 25 per cent of landholders reported changing their livestock composition or leaving the industry.

On average, landholders reporting wild dog attacks on their property reported livestock losses of approximately 65, with approximately a further 72 injured. In all states the reported number of sheep killed per farm was greater than the number of cattle killed. In the Northern Territory the losses were all cattle, reflecting the lack of sheep in this jurisdiction. The states reporting the greatest number of sheep losses were Western Australia, South Australia and Queensland.

On average, around 45 per cent of landholders with wild dog problems reported that the problem was becoming more severe. An estimated 38 per cent reported it stayed the same, and 11 per cent reported it was less severe. Landholders in Western Australia, Queensland and the Northern Territory were more likely to report an increase in severity, while landholders in South Australia were more likely to report that the problem had stayed the same or become less severe.

Landholders’ awareness of wild dog attacks in their area, and their experiences of wild dog problems on their property, were higher for those in close proximity to a national park or state
forest. Landholders in these areas were almost twice as likely to report a severe problem with wild dogs (64 per cent as against 34 per cent), and were slightly more likely to report the problem as becoming more severe.

**Perceived and reported impact on individuals**

An estimated 43 per cent of respondents to the choice modelling survey reported that wild dogs pose a risk of attacks on humans (Table 2). Respondents in Queensland were more likely to report this than those in South Australia. In Victoria there was no difference in this view between rural and urban-based survey respondents. In contrast, rural-based respondents in Queensland and South Australia were more likely to report that wild dogs pose a risk of attacks on humans, compared with their urban-based counterparts.

A consistently higher proportion of respondents to the choice modelling survey, almost 60 per cent, reported that wild dogs pose a risk of attacks to pets in their state (Table 2). There were no significant differences in the responses of rural and urban-based survey respondents.

Around 35 per cent of landholders reported that the presence of wild dogs in their area had left them feeling angry, with around 21 per cent reporting feelings of distress and anxiety.

**Perceived impact on the environment**

Around 60 per cent of respondents to the choice modelling survey reported that wild dogs can significantly contribute to some native species becoming endangered in their state (Table 2). There was little reported difference in the views of respondents in different states or between the rural and urban-based respondents.

An estimated 42 per cent of respondents reported that wild dogs limit the spread of feral animal populations, such as rabbits and foxes (Table 2). The views of urban and rural-based respondents did not differ significantly. These views were also reasonably consistent among respondents in Victoria, South Australia and Queensland.

Around 17 per cent of respondents reported that wild dogs maintain balance among wildlife species in their state (Table 2). Again, there were few differences in the views of respondents in different states or between rural and urban-based respondents.

A higher proportion of respondents, around 40 per cent, reported that dingoes maintain balance among wildlife species in their state (Table 2). Respondents in Queensland, particularly rural-based respondents, were more likely to report this view than those in Victoria and South Australia.

**Management of wild dogs**

An estimated 22 per cent of landholders reporting problems with wild dogs on their property had made changes to the livestock composition of their farming enterprise as a result of wild dog attacks.

An estimated 90 per cent of landholders reporting problems with wild dogs on their property undertook active management of wild dogs. Actions taken by landholders included aerial and ground baiting, shooting, trapping and exclusion fencing. Shooting and ground baiting were the most common forms of wild dog management undertaken by farmers, although aerial baiting was reported by a significant proportion of landholders in Western Australia and Queensland. Trapping was also reported by almost half of all landholders with wild dog problems in South Australia and Western Australia.
An integrated assessment of the impact of wild dogs in Australia

Landholders with wild dog problems on their property also reported on government initiatives to manage wild dogs in their area, with ground baiting being the most common management technique. Again, aerial baiting was reported as a relatively more common management technique by landholders in Queensland and Western Australia.

Landholders with wild dog problems on their property reported a number of coordinated wild dog management actions in their area. These included coordinated ground and aerial baiting as well as shooting.

At the national level, an estimated 47 per cent of landholders with a wild dog problem on their property believed that management actions undertaken in their area were effective (Table 1). Landholders in Queensland and South Australia were considerably more likely to report that wild dog management actions in their area were effective (around two-thirds). In contrast, just 16 per cent of landholders in the Northern Territory with a wild dog problem on their property reported that management was effective in their area (Table 1).

An estimated 87 per cent of landholders with a wild dog problem nationally reported that more management on public land would improve the overall management of wild dogs in their area. More than two-thirds of landholders with a wild dog problem reported that more effective baiting programs and more government support to apply different technologies would improve management. An estimated 36 per cent of landholders with a wild dog problem reported that greater accessibility to baits would improve management in their area. Around 40 per cent of landholders with a wild dog problem reported that relaxed legislation on trapping would improve management in their area, although responses varied significantly by state. In Victoria, 83 per cent of landholders with a wild dog problem on their property reported that relaxed legislation on trapping would improve management.
5 Eastern Victoria

Case study region

The Victorian case study area includes the town of Orbost and the statistical local area of Balonne within East Gippsland Shire and a number of statistical local areas in north-east Victoria, including East and West Alpine Shire, Towong Shire, Falls Creek Alpine Resort and Mount Hotham Alpine Resort (Map 3).

The area covers 30,000 square kilometres and the major population centres include Shepparton-Mooroopna, Wangaratta, Wodonga, Moe-Yallourn, Morwell and Traralgon. In 2009, the total population of this area was approximately 358,000 (ABS 2010).

Map 3 Eastern Victoria case study region

There are a number of different land uses including agriculture, state and national parks and forestry. Nature conservation covers an estimated 46 per cent of the area. Map 3 depicts the complex integration of public and private land, which increases the difficulties of managing wild dogs in this area. Further, the rugged landscape limits accessibility and provides wild dogs access to public lands where they are afforded protection. Wild dogs are generally found in and near forested areas of the north-east and Gippsland regions, and some areas of the north-west.

Production characteristics

Livestock production in this area consists of both cattle and sheep (Allen et al. 1998; Lightfoot 2010). In 2011 there were an estimated 264,000 sheep and 260,000 cattle in the case study area (Table 3). The Victorian breeding herd consists of 37 per cent Merino ewes, with the remainder used in cross breeding activities to produce slaughter lambs (Barker 2011). The gross value of production of wool in the region was $18.8 million in 2010-11, and sheep meat was valued at
$9.7 million. The gross value of beef production in the region was much higher, at around $96.9 million.

Table 3 Livestock numbers and gross value of production, Eastern Victoria (2010–11 dollars)

<table>
<thead>
<tr>
<th>Statistical local area</th>
<th>Sheep numbers</th>
<th>Sheep (including lambs) GVP of sheep slaughtered ($)</th>
<th>GVP of wool ($</th>
<th>Cattle numbers</th>
<th>Meat cattle GVP of cattle slaughtered ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine East</td>
<td>1 091</td>
<td>47 330</td>
<td>2 743 310</td>
<td>18 975</td>
<td>8 774 451</td>
</tr>
<tr>
<td>Alpine West</td>
<td>1 932</td>
<td>55 258</td>
<td>2 171 603</td>
<td>18 153</td>
<td>6 780 008</td>
</tr>
<tr>
<td>East Gippsland – SW</td>
<td>51 853</td>
<td>2 764 988</td>
<td>4 407 416</td>
<td>58 633</td>
<td>22 306 742</td>
</tr>
<tr>
<td>East Gippsland – Balonne</td>
<td>141 890</td>
<td>3 915 833</td>
<td>2 688 248</td>
<td>42 484</td>
<td>15 265 686</td>
</tr>
<tr>
<td>Towong Part A</td>
<td>27 081</td>
<td>1 000 708</td>
<td>1 694 512</td>
<td>24 751</td>
<td>9 222 990</td>
</tr>
<tr>
<td>Towong Part B</td>
<td>40 282</td>
<td>1 872 072</td>
<td>5 046 211</td>
<td>94 795</td>
<td>34 539 825</td>
</tr>
<tr>
<td>Total</td>
<td>264 129</td>
<td>9 656 189</td>
<td>18 831 300</td>
<td>257 791</td>
<td>96 889 702</td>
</tr>
</tbody>
</table>

Source: Australian Bureau of Statistics, Agricultural commodities cat. no. 7121.0 and Value of agricultural commodities.

Management of wild dogs

In Victoria wild dogs are declared ‘established pest animals’ under the Catchment and Land Protection Act 1994. All landowners—including state, local government and private landowners—have responsibility under the Act to take all reasonable steps to prevent the spread of, and as far as possible eradicate, established pest animals (VIC DEPI 2013).

It was reported that wild dog management in Eastern Victoria has a long history that goes back more than 75 years to the Chestnut Wild Dog Destruction League in the north-east of the state. Twenty years ago the first wild dog community meeting was held at Swifts Creek, located on the Great Alpine Road between Omeo and Ensay in East Gippsland, to encourage the state government to respond on wild dog management.

The Victorian Government has responsibility as a public land manager to manage wild dogs on its land. This role is largely undertaken by the Victorian Department of Environment and Primary Industries.

The Victorian Government has a Wild Dog Control Program, with community representation to government provided through a Wild Dog Management Committee. Wild Dog Controllers undertake the on-ground work. When field work for this study was undertaken the Victorian Department of Environment and Primary Industries was reportedly focusing its management program on protecting livestock by working in the buffer zone between public and private land.

At the time of undertaking the field work, there were representatives to the Wild Dog Management Groups in the north-east and in East Gippsland, appointed by the Victorian Minister for Agriculture, to liaise between the community and government on wild dog management. At the time of writing this report, the organisation has slightly changed. There were mixed opinions from participants about the effectiveness of the Wild Dog Management Groups. Their terms of reference did not include control over the on-ground action which led to criticism—particularly in relation to effective on-ground action. Some participants saw the groups as providing useful local area representation, while others were not sure the government was ‘listening to them’ as it was perceived that the wild dog problem was not improving.
An integrated assessment of the impact of wild dogs in Australia

The Victorian Government has 24 Wild Dog Controllers—most commonly referred to as ‘doggers’—who undertake the on-ground work for wild dog control. In Gippsland, one of these positions focuses on baiting activities. Some participants had issues with the ‘doggers’, highlighting that they tend to be of variable quality. It was reported that some were excellent and responsive while others did not communicate well or respond to landholders’ needs. This was very frustrating for the landholders, and one landholder said that complaints tended not to be reported because landholders think nothing will happen. In terms of indicators of success for the effectiveness of the wild dog program, complaints were not considered to be useful. It was suggested that a better indicator would be to account for the number of sheep restocked to previously excluded area(s) or to use the number of attack free days.

It was reported that the wild dog control culture in Victoria has been undergoing radical change over the last few years, with an increasing emphasis on getting communities and government staff to work together on the issue. The state government is making efforts to give more control to the communities, providing them with opportunities to learn new skills in the area of wild dog control. One indicator of this change was the government’s move to change the title of one of their trapper positions from ‘dogger’ to ‘community baiting officer’. As with many changes, some people were ‘for it’ and some ‘against’.

The character of the natural environment in Eastern Victoria and how it affects the wild dog issue

The public–private land interface is a key issue in Eastern Victoria in relation to the wild dog problem. The rugged, high-relief landscape with large tracts of forested public land alongside the less densely vegetated agricultural land means that it is a very different type of environment from the flatter, more open country of South Western Queensland or the South Australian Arid Lands. These features of the Eastern Victorian landscape mean that the salient wild dog issues are slightly different from those found in the other case study regions.

This type of terrain and associated ecosystems were thought to lead to some particular wild dog issues and impacts:

- public land as home and ‘refuge’ for wild dogs
- wild dog impacts on native fauna
- impacts of fires on natural ecosystems and flow-on effects to wild dog behaviour
- other issues, for example, concern about the safety of visitors to national parks, blackberry infestations, cross-breeding of different kinds of dogs
- large areas of plantation and absentee landowners generally equating to less wild dog control by the land managers.

As well, the different state government legislation and policies in the case study areas also affect the issue.

Market impacts

The market impacts of wild dogs and the potential benefits of wild dog control are estimated by comparing the economic costs and benefits under scenarios with and without control. Given uncertainty about the likely increase in wild dog attack rates in the absence of control, several scenarios are presented.
Revenues and benefits

Annual estimates of discounted benefits—for each rate of growth in livestock deaths—are presented in Figure 2(a) and 2(b) for cattle and sheep respectively. The discounted benefits are represented by the curves in Figure 2 and the areas under these curves are the present value of benefits. The sharp downward slope of the discounted net benefits commencing in year 14 results from discounting of constant net benefits (in nominal terms) from year 14 onwards. For a 20 per cent growth in livestock deaths the present value of benefits to cattle producers from wild dog control measures in Eastern Victoria are approximately $31.7 million over 20 years (Table 4).

Figure 2 Benefits of wild dog control for cattle and sheep industries, Eastern Victoria

(a) Discounted net benefits from wild dog controls for the cattle industry, for calf death rates

(b) Discounted net benefits from wild dog controls for the sheep industry, for sheep death rates

Cost–benefit analysis measures

The present values of benefits from control measures for Eastern Victoria are presented in Table 4 and increase with the growth in wild dog attack rates.

Estimates of the cost of wild dog controls for Eastern Victoria are currently unavailable. As a result, a threshold analysis approach has been used. Under the threshold approach, wild dog control programs will break even if the present values of costs and benefits (Table 4) over the 20-year period are equal. For example, if the growth in attack rates is 10 per cent, the present value of wild dog control costs across 20 years must not exceed $12.42 million for this investment to be economically feasible.
An integrated assessment of the impact of wild dogs in Australia

Table 4 Cost–benefit analysis measures for Eastern Victoria, by growth in livestock deaths over 20 years (2009–10 dollars)

<table>
<thead>
<tr>
<th></th>
<th>Increase in livestock deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present value of benefits – cattle ($’000)</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>857</td>
</tr>
<tr>
<td>Present value of benefits – sheep ($’000)</td>
<td>996</td>
</tr>
<tr>
<td>Total present value of benefits ($’000)</td>
<td>1853</td>
</tr>
<tr>
<td>Present value of costs of control program ($)</td>
<td>na</td>
</tr>
</tbody>
</table>

Note: na = not available.

Sensitivity of results to choice of discount rate

These results are based on an assumed discount rate of 7 per cent, as recommended by the Department of Finance and Deregulation. The sensitivity of these findings to the choice of discount rate was assessed by assuming a discount rate of 5 per cent and 10 per cent. The effect of the sensitivity analysis focused on the present value of the benefits as the costs of wild dog control were not available. A higher discount rate reduces the present value of the benefits, while a lower discount rate increases the present value of the benefits. The results of this analysis are presented in Appendix E. Overall, the impact of the sensitivity analysis on the results is not large.

Non-market impacts

The non-market impacts of wild dogs in Eastern Victoria were assessed in several ways. The social impacts of wild dogs, as reported through semi-structured interviews, were qualitatively assessed and are presented below. The non-market impacts were also quantified through a choice modelling study. These results are also presented in this section.

Qualitative assessment of social impacts

Public land as home and ‘refuge’ for wild dogs and wild dog impacts on native fauna

It is considered to be common knowledge in this part of Victoria that the wild dogs live, take refuge and breed in the vast tracts of public land in north-east Victoria and East Gippsland. Because of the wild dogs’ close connection with public land there was also a substantial amount of information being reported from the participants about the impacts of the wild dogs on native fauna. One participant reported that two weeks earlier he found dog scat at Falls Creek that was full of possum fur.

... impact on agricultural production is one thing, but the impact on biodiversity is the bigger issue. We have people with their heads in the sand, not appreciating that. The hybrid dog is different to dingoes. They are not dingoes. (key stakeholder in wild dog management)

The impact of wild dog attacks on native fauna is an issue that concerns many of the landholders living close to public land. But it is not only the public land that the dogs inhabit—they are also in forested areas and private bush blocks. One landholder reported that over the past two decades the dogs have been getting more used to living closer to landholders.

Many of the landholders were also very aware that the public is more likely to provide support on wild dog management in relation to the safety of native fauna than in relation to the safety of agricultural livestock such as sheep and cattle.

Key stakeholders reported seeing evidence of wild dogs killing red back wallabies, black wallabies, koalas, goannas, emus and possums, with wombats, wallabies, kangaroos and
An integrated assessment of the impact of wild dogs in Australia

echidnas being a main component of their main diet. One participant commented that a lot of
dog faeces seem to have wombat hair in them.

Fire impact on natural ecosystem and flow on to wild dog behaviour

Several participants reported that wild dog problems had been much worse since the 2003 fires
in the eastern Victorian high country and associated farm land. The fires changed the local
vegetation and hence the ecosystem. Prior to these major fires there was a substantial network
of tracks for wildlife. This network was wiped out overnight and it is believed that the wildlife
and local ecosystem have not yet recovered.

The understanding is that, because the fires ‘opened up the country’, native wildlife (particularly
kangaroos) left the bush for the farms to obtain food. The wild dogs then followed to the farms.
Since that time the bush has developed very thick undergrowth that is not suitable for some
of the native animals (for example, wallabies), but suitable for wild dogs. It was acknowledged
that the decade of drought had also contributed to native animals looking for food on private
land, but the impact of the fires was very significant.

Since the fires two invasive species have been observed to have increased in population in the
bush/high country: dogs and deer. The deer population ‘has just exploded’. With the opening up
of the bush and the changes in the landscape, it appears that the dogs have become more
dispersed and developed new behaviour patterns. It is reported that this has made it more
difficult for the trappers who need to learn these new patterns of dog behaviour. The increase in
the number of feral deer has also had an impact on the wild dog population as it is believed that
deer are a new link in the food chain for wild dogs. It is considered that wild dogs now have
access to feed on deer carcasses and the occasional brumby carcass. The availability of the deer
carcasses is thought to be contributing to the good health and survival of wild dog pups. Their
high rate of survival is an observed trend that emerged several decades ago.

The fires also burned down some fences, giving the dogs greater access to private land. One
participant reported shooting and trapping 50 dogs in a three-month period since the fires, with
no apparent decline in the rate of dog attacks.

There is a sense that there is no official understanding or acknowledgement of the fires as a
contributing issue to the wild dog problem.

The impact of the fires has emphasised the need for integrated management of fencing (for wild
dog management) at the interface of public and private land and access to public land for fire
management. Evidence from cameras placed on a dog fence has shown that the fences keep out
not only the dogs, but also many kangaroos and other native as well as feral animals. This is of
great benefit to the landholder. The challenge is to keep the fences maintained as many of the
animals can damage them.

Other issues

A key issue raised, in connection with visitors to the public lands, was a concern that they may
become the target of attacks as a result of the increasingly aggressive behaviour observed in the
wild dog population. There have been some dog attacks and threats of attacks on landholders;
however, these landholders are competent with guns and know how to deal with the situation.
But they are very aware that many tourists are not equipped or skilled in this way and could end
up being a target for a dog, or pack of dogs, attack. National survey data indicates concern
amongst some of the farmers for family and worker safety. Although the percentages were low,
the fact that some people are were concerned about the human safety aspect of the wild dog
issue in Victoria—be it family, farmers or visitors—makes this an issue worth noting.
An integrated assessment of the impact of wild dogs in Australia

On a different subject, effective management of wild dogs can have beneficial flow-on effects for weed management. A couple of landholders commented that land stocked with sheep provided an effective control of blackberries because the sheep would eat them. For one landholder, since they removed the sheep due to the wild dog problem, the blackberries have ‘taken over’. They now have to pay an extra $5000 per annum to spray the blackberries.

Another concern was around the management (or lack) of domestic dogs and their contribution to the wild dog problem. Increased cross-breeding of domestic dogs with dingoes/wild dogs is considered to be contributing to the increased aggressive behaviour of the wild dog population.

Quantitative assessment of non-market impacts

The estimated non-market benefits of the management of wild dogs in Victoria were positive and significant. Respondents in Victoria reported being willing to pay $3.98 a year (for 10 years) per household to protect one native species from becoming threatened as a result of wild dog attacks in the Eastern Victoria case study region (Table 5). Victorian respondents also reported being willing to pay $1.44 per household a year to protect 1000 square kilometres of public area from the adverse effects of wild dogs, and $0.035 per household a year to protect one household in the case study region. These values were significantly different from the values reported by respondents in other states (and summarised in the following two chapters of this report).

Table 5 Victorian households’ annual willingness to pay (for 10 years) to ameliorate the adverse impacts of wild dogs in Eastern Victoria

<table>
<thead>
<tr>
<th>Protection</th>
<th>Annual marginal values per household</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households protected (per household)</td>
<td>$0.035** (0.004–0.066)</td>
</tr>
<tr>
<td>Native species protected (per species)</td>
<td>$3.977*** (2.910–5.028)</td>
</tr>
<tr>
<td>Public area protected (per 1000 km²)</td>
<td>$1.436*** (0.001–0.002)</td>
</tr>
</tbody>
</table>

Note: Significance levels indicated by: * 0.1, **0.05, ***0.01; 95 per cent confidence interval in brackets calculated using the bootstrapping procedure from Krinsky and Robb (1986).

Given considerable uncertainty about the rate of growth in wild dog attacks in the absence of controls, the non-market benefits of control have been estimated for four scenarios (Table 6). These scenarios were developed using a logarithmic damage curve that assumed the impact of wild dogs on non-market goods would be similar to the assumed percentage change in calf deaths used to estimate the market impacts.

As the long-term (10 and 20 years) non-market impacts of wild dogs are difficult to predict, the estimates (Table 6) are hypothetical. These estimates were used only as an example to estimate the potential total net benefits of the management of wild dogs in the case study area. Therefore, it is estimated that, with controls, 25 households in Eastern Victoria are protected from the adverse impacts of wild dogs over 10 years if the rate of growth in wild dog attacks is 2 per cent in the absence of control. In contrast, it is estimated that controls protect 579 households in Eastern Victoria from the adverse impacts of wild dogs if the rate of growth in wild dog attacks is 10 per cent in the absence of control. It is estimated that the number of households, native species and public areas protected in Eastern Victoria increases when a 20-year period is considered, noting considerable uncertainty over a longer time horizon.
An integrated assessment of the impact of wild dogs in Australia

Table 6 Assumed non-market benefits from the management of wild dogs for the different scenarios of wild dog attacks in Eastern Victoria

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2%</th>
<th>5%</th>
<th>10%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of households protected</td>
<td>25</td>
<td>86</td>
<td>209</td>
<td>579</td>
</tr>
<tr>
<td>Number of native species protected</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Public area protected (1000 km²)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>20 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of households protected</td>
<td>86</td>
<td>209</td>
<td>497</td>
<td>805</td>
</tr>
<tr>
<td>Number of native species protected</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Public area protected (1000 km²)</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

Aggregate non-market values were calculated using the marginal values reported in Table 5, the number of non-market goods protected reported in Table 6 and the estimated population. Estimated non-market values for 10- and 20-year periods, in present value terms using a 7 percent discount rate, are reported in Table 7.
Table 7 Total non-market benefits from management of wild dogs, Eastern Victoria ($’000)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2%</th>
<th>5%</th>
<th>10%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>10 years</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>4431</td>
<td>15 507</td>
<td>37 661</td>
<td>104 121</td>
</tr>
<tr>
<td>protected</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI</td>
<td>479</td>
<td>8 273</td>
<td>1 675</td>
<td>4 068</td>
</tr>
<tr>
<td>Native species</td>
<td>745</td>
<td>3 244</td>
<td>2 607</td>
<td>11 354</td>
</tr>
<tr>
<td>protected</td>
<td>6 442</td>
<td>42 893</td>
<td>115 794</td>
<td>314 154</td>
</tr>
<tr>
<td><strong>Total benefits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI</td>
<td>1 224</td>
<td>11 516</td>
<td>19 168</td>
<td>66 024</td>
</tr>
<tr>
<td><strong>20 years upper bound</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>23 391</td>
<td>56 806</td>
<td>134 774</td>
<td>218 312</td>
</tr>
<tr>
<td>protected</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI</td>
<td>2 527</td>
<td>43 673</td>
<td>106 062</td>
<td>55 057</td>
</tr>
<tr>
<td>Native species</td>
<td>22 452</td>
<td>38 789</td>
<td>67 357</td>
<td>116 368</td>
</tr>
<tr>
<td>protected</td>
<td>6 497</td>
<td>174 658</td>
<td>410 775</td>
<td>654 990</td>
</tr>
<tr>
<td><strong>Total benefits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI</td>
<td>3 933</td>
<td>17 125</td>
<td>9 552</td>
<td>41 590</td>
</tr>
<tr>
<td><strong>20 years lower bound</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>15 507</td>
<td>37 661</td>
<td>89 352</td>
<td>144 736</td>
</tr>
<tr>
<td>protected</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI</td>
<td>1 675</td>
<td>28 954</td>
<td>4 068</td>
<td>70 317</td>
</tr>
<tr>
<td>Native species</td>
<td>14 885</td>
<td>25 716</td>
<td>4 4656</td>
<td>77 149</td>
</tr>
<tr>
<td>protected</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI</td>
<td>2 607</td>
<td>11 354</td>
<td>6 332</td>
<td>27 573</td>
</tr>
<tr>
<td><strong>Total benefits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI</td>
<td>19 168</td>
<td>66 024</td>
<td>55 057</td>
<td>175 039</td>
</tr>
</tbody>
</table>

Note: CI = confidence interval.

Respondents to the choice modelling questionnaire were asked their willingness to pay over 10 years to protect households, native species and public areas from the impact of wild dogs. To extend this analysis to a 20-year period for consistency with the market impacts, an assumption needed to be made regarding the willingness of those respondents to pay for an additional 10 years. In the absence of other information, an upper and lower bound are presented in Table 7 for the 20-year scenario. The upper bound represents the non-market benefits assuming that respondents were willing to continue to pay the same amount per household per year for the full 20 years. The lower bound represents the non-market benefits assuming that respondents were...
An integrated assessment of the impact of wild dogs in Australia

not willing to spend any more to protect households, native species and public areas from wild dogs between years 10 and 20.

The total non-market benefits from the management of wild dogs in Eastern Victoria over 10 years were estimated to range between $6.4 million and $314 million depending on the assumed rate of growth in wild dog attacks in the absence of control. When the rate of growth in wild dog attacks was assumed to be 2 per cent in the absence of control, the non-market benefits were dominated by those associated with the protection of households. As the assumed rate of growth in wild dog attacks increases, the non-market benefits associated with the protection of native species became relatively more important.

The non-market benefits in Eastern Victoria over 20 years were estimated to range between $43 million and $655 million depending on the assumed rate of growth in wild dog attacks in the absence of control and the assumption regarding respondents' willingness to pay to protect households, native species and public areas between years 10 and 20. The protection of native species made the greatest contribution to the total non-market benefits over a 20-year period regardless of these assumptions.

The total non-market benefits in Eastern Victoria were the highest of all the case studies, driven mostly by the larger population/number of households and native species within the region. It should be noted that there is considerable uncertainty regarding the number of non-market goods adversely affected by wild dogs and that, with improved information, the marginal non-market values reported in Table 5 could be used to derive revised estimates.

Integrated assessment

The total net benefits of the management of wild dogs in Eastern Victoria were estimated by combining the market and non-market benefits and costs over a 20-year period (Table 8). The non-market benefits were larger than the market benefits of wild dog control. As mentioned previously, in the absence of data on control costs, a threshold analysis approach is used for this case study region. The results indicate that if attack rates grow at 2 per cent a year in the absence of control then investments in wild dog controls in Eastern Victoria in the range $44.7 million to $66.5 million over 20 years will generate positive returns, depending on the assumed willingness of respondents to pay to protect households, native species and public areas between years 10 and 20. If the rate of wild dog attacks grows faster than this, then greater investments in wild dog control will generate positive returns.
Table 8 Net benefits of the management of wild dog programs in Eastern Victoria over 20 years

<table>
<thead>
<tr>
<th>Variable (upper bound estimate)</th>
<th>Growth in attack rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenarios</td>
<td>2%</td>
</tr>
<tr>
<td>Present value of market benefits ($'000)</td>
<td>1 853</td>
</tr>
<tr>
<td>Present value of costs of control program ($'000)</td>
<td>na</td>
</tr>
<tr>
<td>Net present market value ($'000)</td>
<td>1 853</td>
</tr>
<tr>
<td>Present non-market value ($'000)</td>
<td>64 697</td>
</tr>
<tr>
<td>Present value of total net benefits ($'000)</td>
<td>66 550</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable (lower bound estimate)</th>
<th>Growth in attack rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenarios</td>
<td>2%</td>
</tr>
<tr>
<td>Present value of market benefits ($'000)</td>
<td>1 853</td>
</tr>
<tr>
<td>Present value of costs of control program ($'000)</td>
<td>na</td>
</tr>
<tr>
<td>Net present market value ($'000)</td>
<td>1 853</td>
</tr>
<tr>
<td>Present non-market value ($'000)</td>
<td>42 893</td>
</tr>
<tr>
<td>Present value of total net benefits ($'000)</td>
<td>44 746</td>
</tr>
</tbody>
</table>

Note: Values in 2011–12 dollars; na = not available.
An integrated assessment of the impact of wild dogs in Australia

6 South Australian Arid Lands

Case study region

The South Australian Arid Lands case study area comprises two natural resource management groups: Maria–Oodnadatta and Marree–Innaminka. These groups are located in the northern arid zone of South Australia (Map 4) and cover an area of 320 000 square kilometres with a population of 1500.

Map 4 South Australian Arid Lands case study region

Production characteristics

Cattle production is the primary agricultural enterprise in this area, with 38 properties on 23 million hectares stocking an average of 114 500 head of cattle each year between 1999–2000 and 2007–08 (C Turner, Department of Environment and Natural Resources’ Pastoral Board, pers. comm. 16 May 2011). Approximately 70 per cent of the study area is used for grazing, with nature conservation covering approximately 20 per cent.

Wild dog management

In South Australia, the term ‘dingo’ is used for both wild dogs and dingoes. The government policy objective on the management of dingo populations is to protect the livestock industry to the degree necessary to ensure its economic survival, while at the same time recognising that continued survival of the dingo as a wildlife species is ensured (Biosecurity SA 2011).

The Natural Resources Management Act 2004 has the broad objective of protecting agriculture, the environment and the public from the impact of pest animals and plants. Under the Act, dingoes (including dingo crosses) are declared pests south of the South Australian Dog Fence.