



Evaluation of the Northern Illawarra Wild Deer Management Program

Final Report

Prepared for the
South East Local Land Services

Planning | Evaluation | Research



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Executive Summary

The Northern Illawarra Wild Deer Management Program was established in May 2011 to address the growing negative impacts of deer in the Northern Illawarra. Significant effort has gone into developing a safe and well regarded program that has won the support of residents and other land managers across the region in a challenging policy and landscape context.

Prior to the program, complaints about wild deer in the Northern Illawarra had increased from the early 2000s and were responsible for more than half of all animal-related complaints to Wollongong City Council. **The core problem was that the numbers and distribution of deer (a non-native species) were increasing, resulting in impacts including:**

- car accidents and other traffic hazards
- accidents and delays on the rail network
- damage to property, such as residential gardens and fences
- decreasing agricultural productivity through competitive foraging
- browsing, trampling and rutting damage to native species
- indirect impacts from illegal hunting.

The Northern Illawarra Wild Deer Management Program is facilitated by a South East Local Land Services program coordinator and receives operational funds sourced primarily from Wollongong City Council and other public and private land managers. The program engages a range of stakeholders and addresses impacts through a variety of activities, ranging from ground-shooting through to community awareness-raising. Central to the program is a regular process of contractors shooting deer on council and private land.

The program's objectives are to:

1. Develop a risk based operations plan which will establish and maintain a safe, integrated and cooperative control program targeting wild deer in the Northern Illawarra area.
2. Reduce the socio-economic impacts that wild deer pose to landholders in the Northern Illawarra area.
3. Improve community and stakeholder awareness relating to the negative impacts and management of wild deer.
4. Facilitate training to landholders enabling them to better undertake control of wild deer themselves and therefore helping to sustain the outcomes of this project post its completion.
5. Keep abreast of and where possible foster research on wild deer management, including exploring innovative and conceptual solutions to complex situations.

With the Management Plan for the NIWDMP expiring in mid-2016, South East Local Land Services commissioned this evaluation to understand the performance of the program against its objectives and to inform future initiatives. The evaluation draws on interviews with a selection of key stakeholders (including landholders), a review of program documents (including operational records and monitoring data), a review of other deer management programs and a summit workshop.

The key findings of the evaluation against its objectives are that:

1. The program has successfully developed a risk-based operations plan and, in turn, implemented a safe and integrated control program for deer in the Northern Illawarra. This allowed the program to gain the support of a range of landholders and access to their land for control operations.
2. The NIWDMP appears to be reducing the socio-economic impacts of wild deer on landholders in the Northern Illawarra, though a sustained, long-term reduction in impacts likely requires a longer-term program. Most evidence shows a stable or downward trend in impacts.
3. Landholders involved in the program appear to be highly satisfied with the quality of the communication from the program coordinator and contractors. However, both landholders and other key stakeholders suggested that the broader awareness-raising done by the program could be increased, particularly given the need for the program to be working across the landscape.
4. While the program originally aimed to facilitate training to landholders, enabling them to better control wild deer themselves, this component of the program was discontinued because of restrictions on firearms use and other logistical constraints.
5. The program coordinator, contractors and Wollongong City Council appear to have put considerable effort into trialling, testing and refining methods of deer control, though there are opportunities for more clearly documenting the approach to and findings from these research activities.

An unintended benefit of the Northern Illawarra Wild Deer Management Program is the development of a valuable set of processes, procedures and tools for conducting professional shooting operations in urban, peri-urban and rural private land. This includes work methods statements, site plans and the technology for real-time reporting of shooting operations. These are valuable outcomes that are being adopted in other pest animal management programs elsewhere, and have application for future initiatives in this space.

The key lessons from the program are that:

- It is important to gain the trust of and buy-in from landholders and other stakeholders; and that this takes significant time and effort.
- A dedicated program coordinator that is trusted by landholders and other stakeholders is required to communicate with landholders and stakeholders, to oversee and uphold safety standards and to drive other elements of the program.

The program has faced a range of challenges, including:

- a lack of legislative backing for managing the negative impact of deer, meaning landholders are not obligated to participate
- securing funding for the program was an ongoing and time consuming process
- establishment of a safe program with buy-in from landholders required an initial investment of time and effort
- engaging sufficient landholders to participate in the program across a landscape that has many land managers (both public and private)

A comparison with other deer control programs around the country found that the Northern Illawarra Wild Deer Management Program faces many of the same challenges as other programs. One of the key challenges is removing high enough numbers of deer to effectively control or reduce deer populations. The Northern Illawarra Wild Deer Management Program is typically much larger and compares favourably to other programs in terms of the number of deer removed per unit of effort. Other programs have successfully collaborated with volunteer shooters, which has been a challenge for the NIWDMP and there may be opportunity in the future for exploring collaboration between rural residents and accredited volunteers.

Recommendations

Based on the key findings, results and discussion contained within this evaluation, we recommend:

1. The Northern Illawarra Deer Management Program, or a similar program of control, **should continue to be supported and delivered** through the Local Land Services program coordinator.
2. **The program should be funded for an interim one-year period** while a new program is refined.
3. Future iterations of the program should seek to **reduce the environmental damage caused by deer**, particularly where there any key environmental assets at risk.
4. Future deer control in the area **should adopt a regional perspective**.
5. **Monitoring of the program should be continued**, including collecting data directly related to the outcomes/objectives of the revised program.
6. In developing a new program, **the role and value of community engagement should be carefully considered**.
7. Any future version of the NIWDMP should **consider maintaining an element of research**.
8. Relevant program stakeholders should **continue to advocate for deer to be declared a pest species**.
9. In any future program, staff should **continue to liaise with public land managers**, seeking opportunities to conduct operations on their land where strategic opportunities exist.
10. **Consider how the learnings from the NIWDMP can be shared more broadly**.

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1 Introduction

1.1 Overview

Wild deer have social, economic and environmental impacts throughout the Northern Illawarra region. In response, the Northern Illawarra Wild Deer Management Program (NIWDMP) was initiated in May 2011. The program engages a range of stakeholders and addresses these impacts through a variety of activities, ranging from ground-shooting through to community education.

The NIWDMP receives funding from several sources, including Wollongong City Council and private landholders, and is facilitated by South East Local Land Services (South East LLS). With the program due for completion in 2016, South East LLS commissioned this evaluation to understand the performance of the program against its objectives and to inform future direction in this area.

1.2 Objectives and scope of the evaluation

The evaluation has three broad objectives:

- assessing the performance of the program against its objectives
- comparing it to and learning from similar programs
- making recommendations on the program's future direction.

As detailed in the methodology (Section 3), the evaluation draws on interviews with a selection of key stakeholders, a range of documents and data supplied by South East LLS and a broader review of similar programs.

The evaluation and, in turn, this report, addresses six key evaluation questions. These questions are based on the needs of South East LLS staff and include:

1. What is the background to and rationale for the NIWDMP?
 - a. what are the impacts of wild deer in the region?
 - b. what is the policy context for wild deer management?
 - c. how has the NIWDMP worked to manage wild deer in the region?
2. How effective has the program been at achieving its objectives?
 - a. to what extent has the program developed a risk-based operations plan that establishes and maintains a safe, integrated and cooperative control program?
 - b. to what extent has the program reduced the socio-economic impacts of wild deer on landholders in the Northern Illawarra area?
 - c. to what extent has the program improved community and stakeholder awareness relating to the negative impacts and management of wild deer?
 - d. how has the program facilitated training to landholders enabling them to better undertake control of wild deer themselves and therefore helping to sustain the outcomes of this project post completion?
 - e. how has the program kept abreast of and, where possible, fostered research on wild deer management, including exploring innovative and conceptual solutions?
3. Have there been any unexpected outcomes from the program (positive or negative)?
4. What have been some of the challenges and lessons from the NIWDMP?

5. What can be learned from other deer or similar vertebrate pest control programs (i.e. involving ground-shooting in urban/rural areas) in Australia?
6. What recommendations are there for the program’s future direction?

1.3 Structure of this report

This report is structured around the key evaluation questions above and contains the following sections:

- **A summary of the NIWDMP**, including its objectives and key activities and **an overview of the broader context in which the program operates** (question 1).
- **An overview of the methods used in this evaluation and their limitations**. Details can be found in Appendix 1.
- **The main body of the report (Section 4) examines the extent to which the NIWDMP has achieved its objectives** (question 2) and any unexpected outcomes from the program (question 3).
- Section 5 outlines the **key challenges and lessons from the NIWDMP** (question 4)
- Section 6 explores **additional insights from other deer control programs** and the broader literature on deer management (question 5)
- The overarching **findings from the evaluation are summarised in Section 7**, together with **recommendations for future work in this space** (question 6).

2 Background to the Northern Illawarra Wild Deer Management Program

2.1 Overview

This section outlines:

- the impacts of wild deer in the Northern Illawarra region
- the policy context relating to deer control and the associated complexities of management
- the objectives and activities of the NIWDMP.

2.2 Impacts of wild deer in the Northern Illawarra region

Deer were first introduced into Australia in the late 1800s for their aesthetic value and their value as a game species. Subsequent introductions, translocations and releases from deer farms have seen six species become established in the wild¹:

- chital *Axis axis*
- hog *Axis porcinus*
- red *Cervus elaphus*
- rusa *Cervus timorensis*
- sambar *Rusa unicolor*
- fallow *Dama dama*

In 2004, Moriarty estimated the Australia-wide total population (across all species) to be in the order of 200,000 individuals. Since then, there is evidence that deer populations across Australia have expanded in both range and size.²

In the Northern Illawarra region, the key species of concern is the rusa deer, *C. timorensis* (see Box 1). Introduced into Royal National Park in 1906³, this population had spread south through to the Wollongong local government area by the 1980s.⁴ Both fallow deer *D. dama* and red deer *C. elaphus* are also known to exist in the region.⁵

Within the Wollongong local government area, **complaints about the impacts from deer grew from the early 2000s onwards**, with records (beginning in 2009) showing a spike in mid-2009 (Figure 2). Deer are now responsible for more than half of all animal-related complaints to council (Figure 3).

¹ Moriarty A. 2004. The liberation, distribution, abundance and management of wild deer in Australia. *Wildlife Research* 31: 291-299.

² Burgin S et al. 2015. Feral deer in the suburbs: An emerging issue for Australia? *Human Dimensions of Wildlife* 20:65-80.

³ Moriarty A. 2004. Ecology and environmental impact of Javan Rusa deer (*Cervus timorensis rusa*) in the Royal National Park. PhD Thesis, University of Western Sydney. *Cited in Eco Logical Australia 2015. Distribution and abundance of deer in the Wollongong LGA: 2015 Monitoring report. Prepared for Wollongong City Council.*

⁴ Eco Logical Australia 2015. Distribution and abundance of deer in the Wollongong LGA: 2015 Monitoring report. Prepared for Wollongong City Council.

⁵ Northern Illawarra Wild Deer Management Plan 2011-2015. n.d. South East Local Land Services.

Box 1. Rusa deer.

Rusa deer, *Cervus timorensis*⁶

Origin: Indonesia. Introduced to Royal National Park in 1906.

Habitat: Preferred habitat is grassy plains bordered by dense brush or woodlands

Size: Stags up to 140 kg and 120 cm at shoulder. Hinds up to 75 kg 100 to 160 kg.

Diet: Preference for grass; opportunistically browse on other vegetation.

Behaviour: Semi-nocturnal. Rest in dense vegetation during the day.

Breeding: Up to three calves in two years.



Figure 1. Rusa deer *Cervus timorensis* photographed near a residential property in the Northern Illawarra region. Photo supplied by Michael Knez.

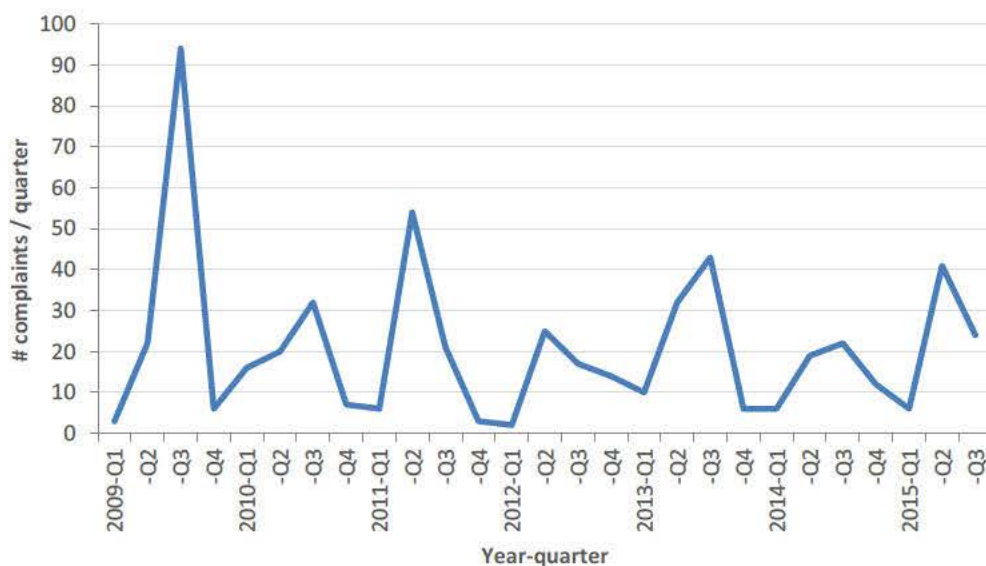


Figure 2. Logged complaints to Wollongong City Council about deer.

⁶ Key Threatening Process Nomination – Environment Protection and Biodiversity Conservation Act 1999. n.d. Department of the Environment.

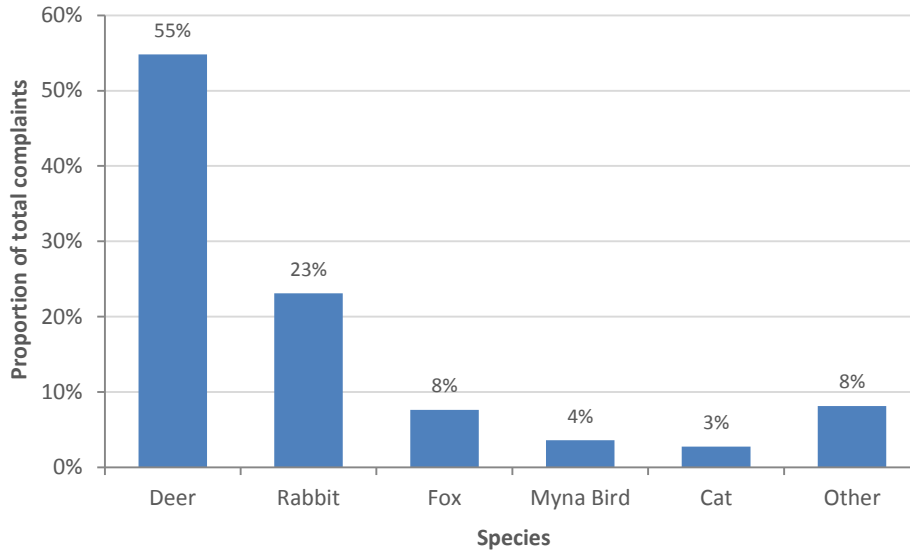


Figure 3. Complaints to Wollongong City Council, by species. Data aggregated between 2009-2015.

Residents and other stakeholders have identified a range of impacts from deer, including:

- Causing car accidents and other traffic hazards.** In surveys of urban residents in 2012 and 2014⁷, approximately 30% of respondents had experienced a ‘near miss’ with a deer and approximately 5% had collided one (Figure 4).

“Three of my friends have had accidents with deers in the Helensburgh area. One was critically injured and in hospital for a long time” (urban survey respondent).

Respondents to a similar survey of rural residents⁸ also highlighted incidents and ‘near misses’ while riding horses and motorbikes.

- Accidents and delays on the rail network.** Sydney Trains data shows substantial impacts from deer – both to trains (from collisions) and from the delays caused by deer in the rail corridor. Since the 2010-11 financial year, over 212 deer have been struck by trains in the Northern Illawarra region. The estimated cost per annum is in the order of \$145k for incident call-outs, \$242k in the economic costs of delays and an unquantified financial cost for repairing trains.⁹
- Damaging property.** Almost half of urban survey respondents noted that deer had damaged their fences, garden, house or car (Figure 4). As one urban resident described:

“It is hard to estimate the damage as it has been a constant problem for years - destruction of trees, shrubs and smaller plants ... apart from the physical damage to the garden, it is also

⁷ Data supplied by Wollongong City Council. Mail-survey sent to all residents within 100 m of a registered deer complaint. In 2012, council distributed 4428 questionnaires and received 1533 responses (35% response rate).

⁸ Data supplied by Wollongong City Council. Survey completed in 2011, 2012, 2013, 2014 with 423 responses in total over this period.

⁹ Data supplied by Sydney Trains – Unpublished report: 2015 Draft Illawarra Deer Management Program Business Matrix.

quite stressful because you get to the point where you think it is just not worth planting anything” (urban survey respondent).

More than half (58%) of rural respondents noted similar property or infrastructure damage (Figure 5). The reported value of this damage varied greatly between residents, ranging from estimates of less than \$50 to well over \$5,000 (Figure 6 and Figure 7). The mean damage in 2012 was \$354/urban respondents, dropping to \$255 in 2014 (Figure 6).¹⁰ The mean damage reported by rural residents has tended to be higher, ranging from \$578 per respondent in 2014, up to \$1780 per respondent in 2013 (largely driven by high fencing costs).

- **Decreasing agricultural productivity.** As has been documented elsewhere in Australia¹¹, rural residents in the Northern Illawarra have reported deer impacting on the productivity of their properties. Fifty-six per cent of respondents to the 2011 rural survey indicated that deer were competing with their livestock for food (Figure 5). As one respondent noted, “we have stock that we have to feed because deer eat all the ground feed”.

Other impacts on productivity related to deer damaging fences and the perceived threat of transmitting diseases and parasites. In this latter point, while deer are clearly a potential vector for disease, parasites and weeds, there is no evidence that the deer population around Wollongong currently carries any diseases of concern.¹²

- **Biodiversity impacts.** A nascent body of research is beginning to demonstrate the impact that deer can have on native Australian flora and fauna through trampling, rutting and browsing pressure¹³. These impacts have also been observed by residents of the Northern Illawarra (Figure 5), with environmental impacts (e.g. damage to trees and shrubs) being the most frequently cited impact of deer by rural residents. Community groups members working on environmental restoration projects have also observed impacts, one group member noting:

“I belong to a small Bushcare group and find it heart breaking to see the damage the deer do in rooting out native plants, ringbarking small trees and upsetting the logs we have so painstakingly installed” (urban survey respondent).

Similarly, a draft report prepared by Landcare Illawarra highlights the impact of deer on their revegetation work in the region. Protective fencing has been essential to any planting done by the group to protect it from deer browsing and rutting, the report authors observing that:

¹⁰ Note that this decrease was not statistically significant given the very high level of variability in estimates: $t=1.16$, $d.f.=2388$, $p=0.247$.

¹¹ Lindeman M and Forsyth D. Agricultural impacts of wild deer in Victoria. 2008. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Victoria.

¹² Northern Illawarra Wild Deer Management Program Annual Report 2015.

¹³ e.g. Bennett A and Coulson G. The impacts of Sambar, *Cervus unicolor*, on the threatened shiny nematolepis *Nematolepis wilsonii*. 2011. Pacific Conservation Biology 16, 251-260; Keith D and Pellow B. Effects of Javan Rusa Deer (*Cervus timorensis*) on native plant species in the Jobbon-Bundeena Area, Royal National Park, New South Wales. 2005. Proceedings of the Linnean Society of New South Wales 126, 99-110.

“Deer are also present on most sites ... their impact on plantings is catastrophic, so much so that in the absence of protection one must conclude that such work is feeding them hard-won funding for little result” (p. 2).¹⁴

- **Impacts from illegal hunting.** This is noted in Wollongong City Council’s Deer Management Plan and reflects residents’ observations and concerns about illegal deer hunting in the area.¹⁵ These concerns have been noted by both urban and rural survey respondents, with almost a two-thirds of rural survey respondents reporting issues with illegal hunting in 2011 (Figure 5) and six out of eight landholders interviewed for this evaluation noting problems. These problems include:
 - Concerns over illegal shooting close to their properties, with the potential for people and animals to be injured. One rural survey respondent noted “Illegal hunting is a problem. I had a horse shot in front of my house in 2008”.
 - Deer corpses, typically headless, being left to rot.
 - Inhumane hunting methods and behaviour, including observations of deer killed or injured by arrows (7 comments from rural residents).
 - Damage to property by illegal hunters, one landholder noting:
“I’ve got a revegetation program that I’m in the process of implementing, and it’s very difficult because of the amount of deer going through. It’s fully fenced, but unfortunately we’ve got deer hunters who keep cutting the fences [...] in the last 2 years, I’ve repaired the fences four times” (landholder interviewee).

There are thus a range of clear impacts from wild deer on deer on residents and the environment in the Northern Illawarra region. However, as outlined below, the policy context for managing wild deer is challenging.

¹⁴ Unpublished draft report *Natural and assisted native plant regeneration in Illawarra woodlands and rainforest*. Landcare Illawarra.

¹⁵ Deer Management Plan, Wollongong City Council. 2013-2014

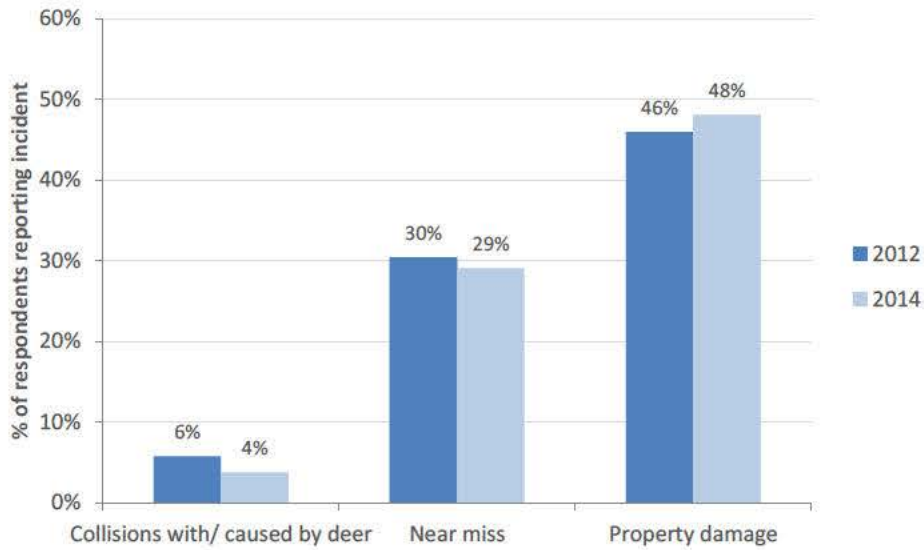


Figure 4. Percentage of urban residents reporting traffic incidents or property damage from deer based on Wollongong City Council survey in 2012 (n=1533) and 2014 (n=857). Property damage includes damage to fences, gardens, houses and cars.

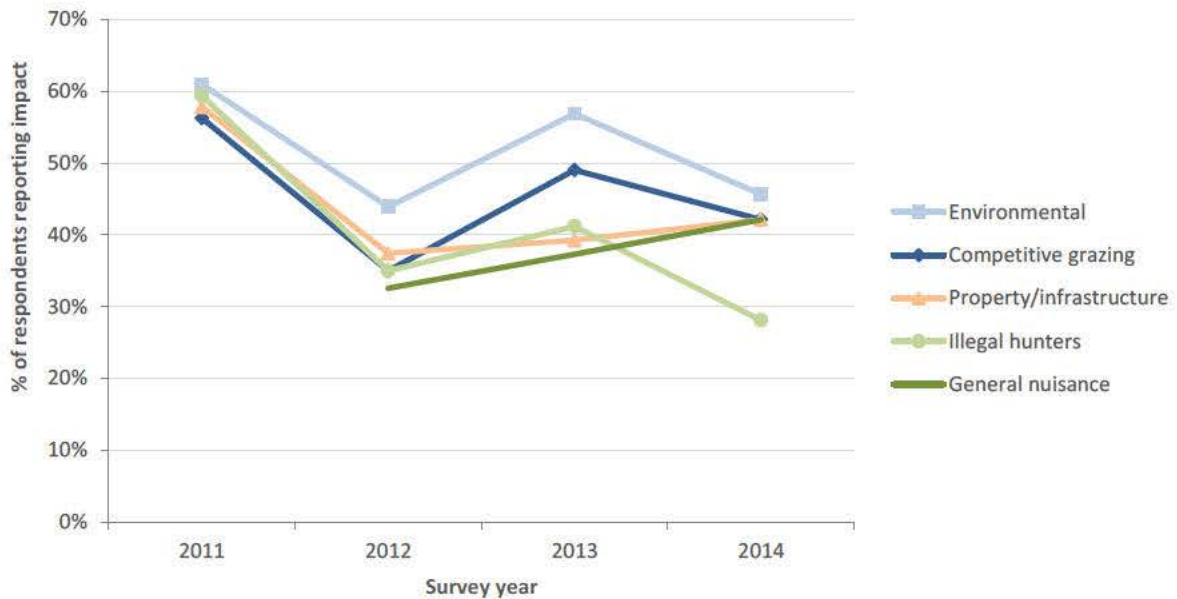


Figure 5. Percentage of rural residents reporting different types of impacts from deer through time. Data from Wollongong City Council survey of rural residents.

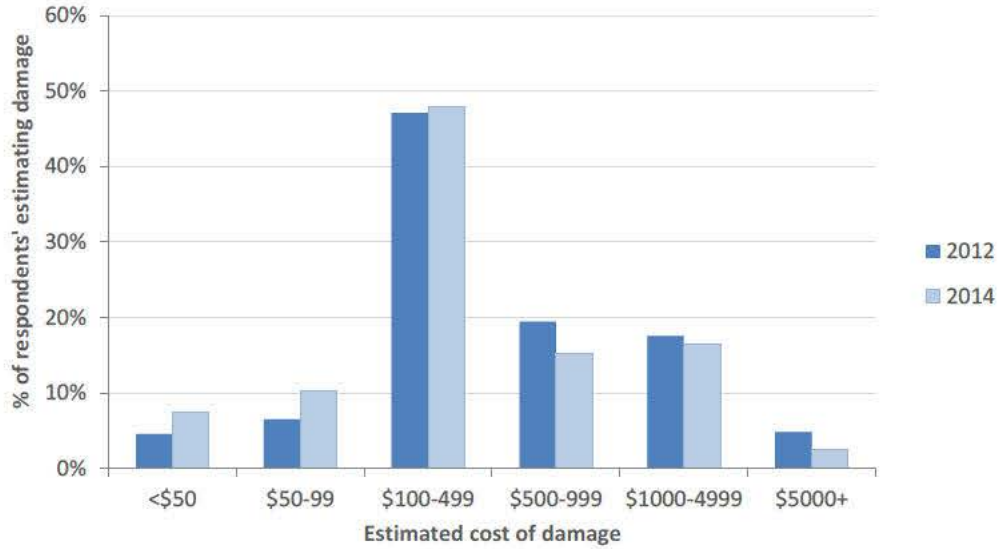


Figure 6. Reported value of damage to urban properties from deer. Based on survey of urban residents in Wollongong in 2012 (n=416 estimating damage) and 2014 (n=242 estimating damage).

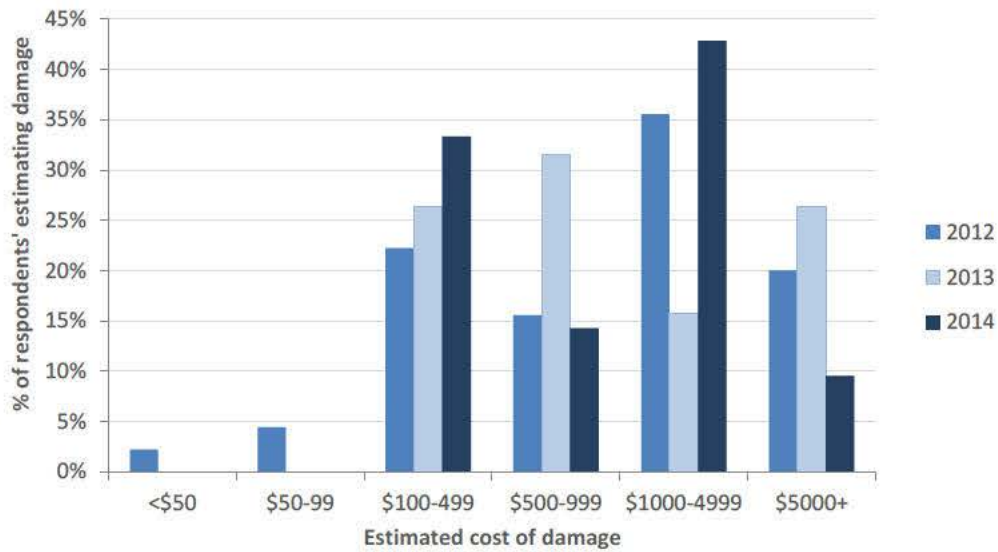


Figure 7. Reported value of damage to rural properties from deer. Based on survey of rural residents in Wollongong in 2012 (n=45 estimating damage), 2013 (n=19 estimating damage) and 2014 (n=21 estimating damage). Note that values were not provided in the 2011 survey.

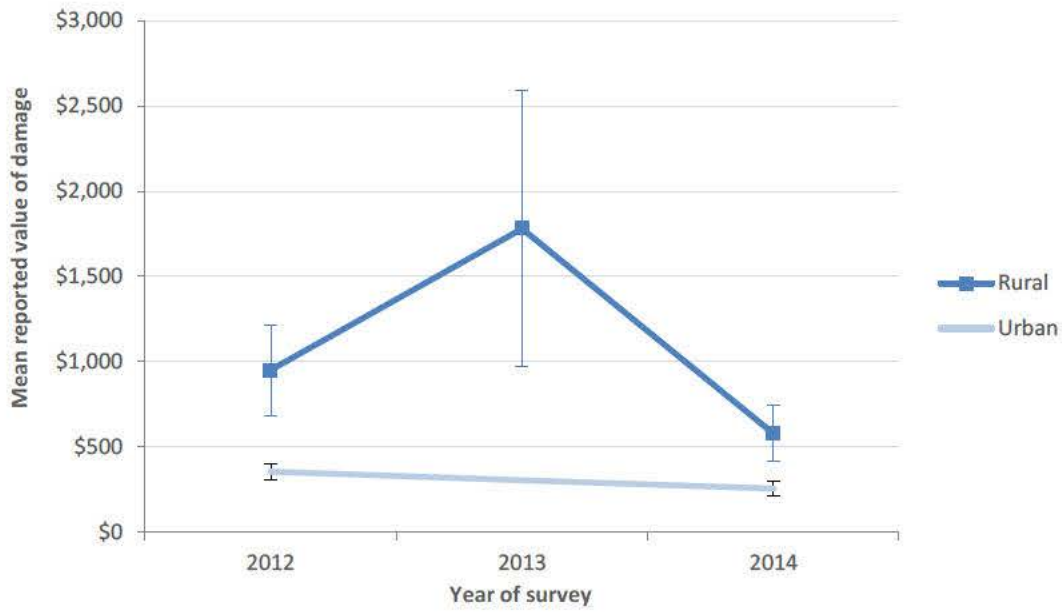


Figure 8. Mean estimated cost of deer impacts on property/infrastructure.

2.3 Policy context for wild deer management

Historically, the legislation relating to deer management has:

- tended to view them principally as a game species
- viewed their impacts as less severe than other feral species, such as goats, foxes and rabbits.

With the expansion of deer populations and the emergence of research on the environmental impacts of deer¹⁶, federal and state legislation and regulation (Table 1) relating to deer has received increased attention in recent years.

Table 1. Summary of legislation and policy relating to wild deer management in the Illawarra region.

Level	Policy/legislation	Notes
Federal	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Wild deer fall under the Key Threatening Process 'Novel biota and their impact on biodiversity' ¹⁷ . No Threat Abatement Plan exists for this process or deer specifically.
NSW	<i>Threatened Species and Conservation Act 1995</i>	'Herbivory and environmental degradation caused by feral deer' is a Key Threatening Process.
	<i>Game and Feral Animal Control Act 2002</i>	Deer are listed as a game animal and therefore have a range of restrictions on the conditions under which they can be shot or otherwise managed.
	<i>Local Land Services Act 2013</i>	Deer are not a declared pest - land managers are not obliged to control them on their property. Deer can, however, be managed as a 'nuisance animal'.
Local	Vertebrate Pest Animal Management Policy	Outlines policy and prioritisation process relating to vertebrate pest management, including deer.
	Wollongong City Council Deer Management Plan	2013-2014 management plan outlines key management actions and processes for deer in the Wollongong LGA.

At the federal level, 'Herbivory and habitat degradation by feral deer' was nominated as a Key Threatening Process (KTP) under the *Environment Protection and Biodiversity Conservation Act 1999* in 2011 and 2012. In 2013, this nomination was subsumed by the broader KTP 'Novel biota and their impact on biodiversity'.¹⁸

¹⁶ see Key Threatening Process Nomination – Environment Protection and Biodiversity Conservation Act 1999. n.d. Department of the Environment.

¹⁷ see <http://www.environment.gov.au/biodiversity/threatened/nominations/ktp-not-prioritised-assessment>

¹⁸ see <http://www.environment.gov.au/node/14591>

The problem with this listing, as argued by the Invasive Species Council, is that while the novel biota KTP is a more systematic approach, it has precluded “meaningful threat abatement action on specific threats such as feral deer species”. They noted that the value of KTP listings is in the associated development of threat abatement plans (TAPs) but, because of the broad nature of this listing, no TAP is planned—“recognition but no action”.¹⁹

Within NSW, ‘herbivory and environmental degradation caused by feral deer’ is listed as a Key Threatening Process under the *Threatened Species Conservation Act 1995*. The Office for Environment and Heritage has identified and prioritised 12 actions for addressing this threatening process, though progress on these actions is unclear.²⁰

Deer are not declared pests in NSW under the *Local Land Services Act 2013*. Unlike declared pests such as rabbits, wild dogs and feral pigs, this means that land managers do not have an obligation to control deer on their properties. Local Land Services are able to support land managers in controlling deer as a ‘nuisance animal’.

As a game animal under the *Game and Feral Animal Control Act 2002*, there are also a range of regulations limiting how deer can be managed on private and public land. These regulations:

- prevent hunting from vehicles
- prevent hunting at night/with spotlights
- limit the time of year and number of deer that can be shot (not applicable to rusa deer)
- require shooters to possess game hunting licences.

While exemptions are available, these restrictions simply make it more difficult to implement a landscape-scale, integrated approach to deer control.

At the local level, deer are considered a pest by Wollongong City Council under its Vertebrate Pest Animal Management Policy.²¹ The high level of complaints about and impact from deer (see Figure 3) have, in turn, led to deer being classified as a priority pest and the development of the Pest Management Plan – Deer. The overall aim of this plan is to “reduce deer numbers in key locations to reduce impacts on residents and natural areas”²², including the more specific objectives of:

- reducing damage to urban property from deer
- reducing danger from deer roaming onto roads
- reducing deer impacting on Council managed natural areas
- increasing community understanding of deer behaviour and management options
- reducing incidents of illegal hunting of deer in Wollongong LGA.

The key control effort identified in the plan is the NIWDMP, which is part-funded by Wollongong City Council.

¹⁹ Protecting threatened species and ecological communities from invasive species. 2012. Invasive Species Council. p. 9

²⁰ <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20012>

²¹ Vertebrate Pest Animal Management Policy, Wollongong City Council. n.d.

²² Pest Management Plan 2013-2014 – Deer. Wollongong City Council. p. 12.

2.4 The objectives and operations of the NIWDMP

The NIWDMP was established in May 2011 as a collaboration between the then Cumberland Livestock Health and Pest Authority (LHPA; now the South East LLS) and Wollongong City Council.

The program aims to:

“Manage wild deer populations to reduce the potential risk of further southern migration, to minimise the socio-economic impacts imposed on the Northern Illawarra community and to complement similar control programs already in place with other land managers in the Illawarra”²³

In turn, the program’s objectives are to:

1. Develop a risk based operations plan which will **establish and maintain a safe, integrated and cooperative control program** targeting wild deer in the Northern Illawarra area.
2. **Reduce the socio-economic impacts** that wild deer pose to landholders in the Northern Illawarra area.
3. **Improve community and stakeholder awareness** relating to the negative impacts and management of wild deer.
4. **Facilitate training to landholders** enabling them to better undertake control of wild deer themselves and therefore helping to sustain the outcomes of this project post its completion.
5. **Keep abreast of and where possible foster research** on wild deer management, including exploring innovative and conceptual solutions to complex situations.

The overarching aim of preventing further southern migration fits well with the principle of ‘containing’ established pests, identified in NSW’s biosecurity strategy (Figure 9).²⁴ Similarly, program staff and the management plan also highlight **the key risk of deer acting as a vector for new disease/invasive species outbreaks** from the port of Wollongong. While this is a yet-unrealised threat in the region, addressing this threat is clearly well-aligned with the principle of ‘prevention’ in the NSW biosecurity strategy.

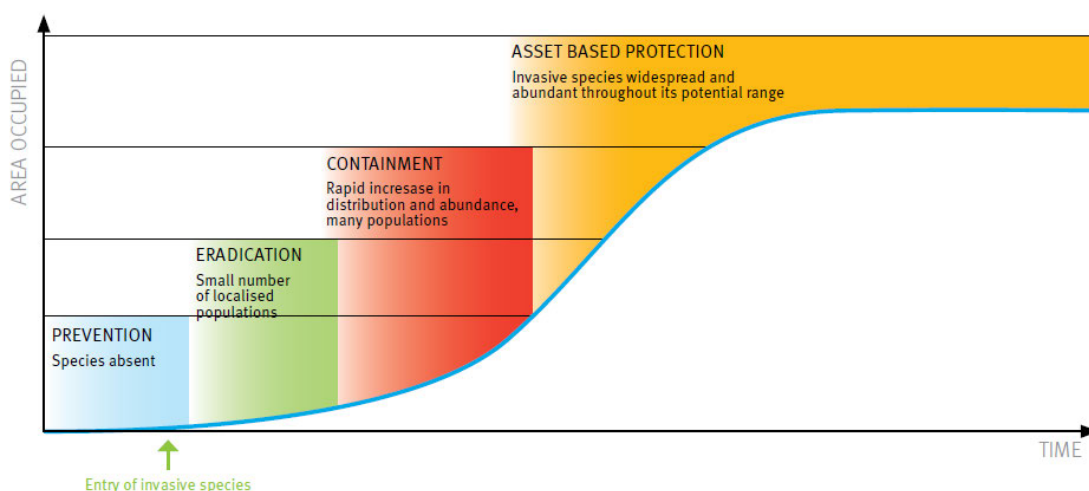


Figure 9. Invasion curve and prioritisation of invasive species management actions. Sourced from New South Wales Biosecurity Strategy 2013-2021, p. 19.

²³ Northern Illawarra Wild Deer Management Plan 2011-2015. n.d. South East Local Land Services. p. 5.

²⁴ New South Wales Biosecurity Strategy 2013-2021. 2013. Department of Primary Industries.

As well as the legislative challenges noted in Section 2.3, the design and implementation of NIWDMP activities also had to accommodate:

- the relatively broad-ranging behaviour of deer and, in turn, the need to coordinate control across multiple landowners
- the presence of deer in rural, peri-urban and urban areas
- the low availability of public land suitable for control operations.

Figure 10 below shows the key activities and expected outcomes of the program, including the link between these elements and program objectives.

Central to the program is a regular process of contractors shooting deer on council and private land. This involves contractors visiting a range of sites 1-3 nights per week (an average of 5.4 nights per month over the program; Figure 11). At each site the contractors observe the deer present and, when safe, shoot one or more individuals. They then remove and process the deer carcasses (Figure 12), with the meat donated to the local zoo.

In turn, this has required extensive:

- development of policies, procedures and appropriate approvals
- liaison with private landholders, including both residents and commercial operators
- collaboration with other relevant stakeholders, particularly members of the NIWDMP Stakeholder Committee, with representatives from:
 - South East LLS
 - National Parks and Wildlife Service
 - Firearms Safety and Training Council
 - Sydney Trains
 - NSW Police
 - RSPCA
 - Wollongong City Council
 - Sutherlands Shire Council
 - Private land managers.
- experimentation with other control methods, including trapping and deterrents.

The program is resourced through a range of cash and in-kind contributions from land managers and government agencies.

With funding for the program expiring in mid-2016, South East Local Land Services and the Wollongong City Council commissioned this evaluation of the NIWDMP to assess its performance and consider its future direction.

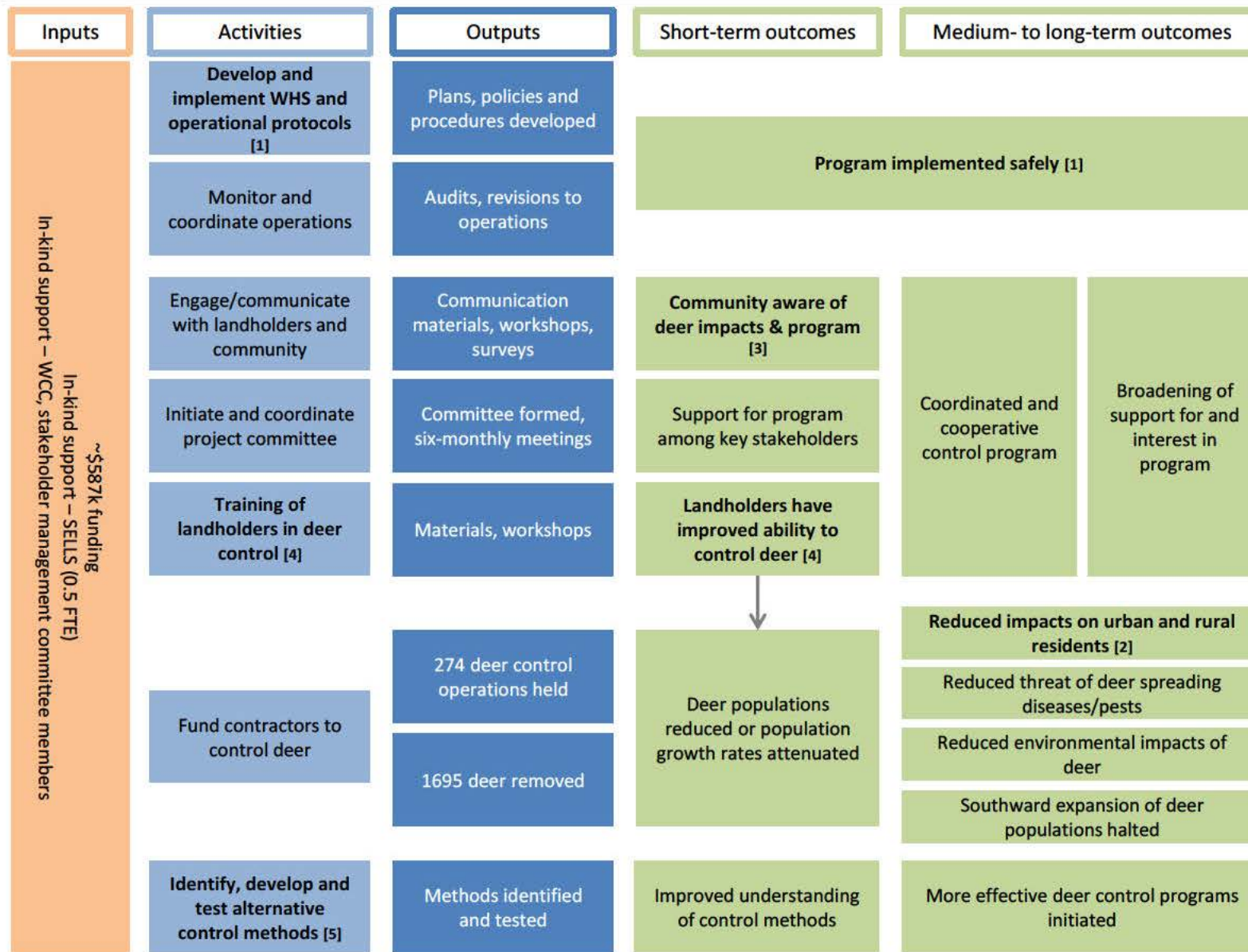


Figure 10. Underlying logic of the NIWDMP. Bold text and number references the program objectives as per Section 2.4. Funding estimates from annual program report (December 2015).

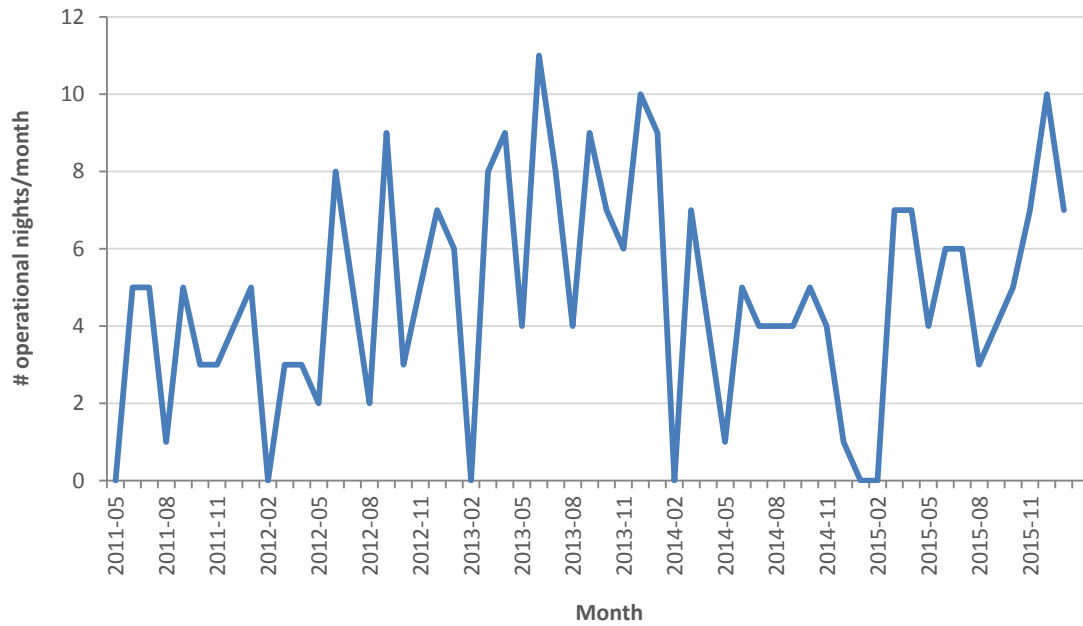


Figure 11. Number of nights contract shooters operated each month throughout the NIWDMP. Note that no operations occurred during school/public holidays.

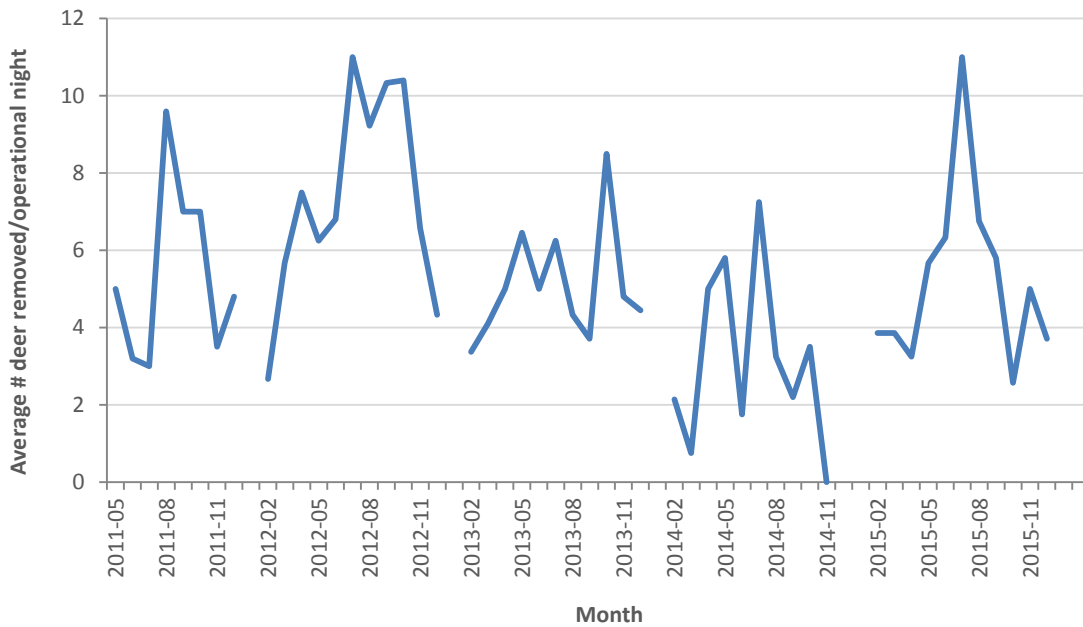


Figure 12. Average number of deer removed per operational night over the course of the NIWDMP (average shown for each month).

3 Summary of methodology

The approach to this evaluation included:

- An **engagement meeting** to source key documents, discuss timing and agree on logistics and the approach to the evaluation.
- **Face-to-face meetings with the NIWDMP coordinator, Michael Knez, and the Wollongong City Council project officer, Damian Gibbins.**
- **Review, collation and analysis of documents and data supplied by South East LLS and Wollongong City Council**, including program documentation, survey results and shoot data.
- **Semi-structured phone interviews with other key stakeholders**, including contractors (1), landholders (8) and stakeholder committee members (3).
- A **review of literature and other programs of relevance to the NIWDMP**, including interviews with program managers (4).
- **Analysis, synthesis and development of a draft report.** This includes presenting the findings to key stakeholders through a summit workshop/meeting, before integrating feedback into a final report.

Each of the steps is discussed in more detail in Appendix 1.

While this evaluation has sought to qualify and triangulate data where possible, the results and findings should be interpreted with the following factors in mind:

- Much of the information and analysis below relies on data collected by program stakeholders (e.g. resident surveys). We assume that these methods have been applied reasonably well and in ways that have not created any unexpected biases.
- We interviewed only a small number of landholders involved in the program. Others may have different views to those documented here. Nevertheless, their perspectives were closely aligned and assessed in the context of other data.
- We did not audit any of the work practices or workplace health and safety procedures. Judgements around the program's safety rely on reviews of planning documents and feedback from relevant stakeholders (including a member of the Firearm Safety and Training Council).

4 Achievements against the NIWDMP's objectives

4.1 Overview

This section explores how effective the NIWDMP has been at achieving each of its five objectives (as outlined in Section 2.4). Each objective is discussed in turn in the sub-sections below, together with an assessment of any unexpected positive or negative outcomes from the program.

4.2 A safe, integrated and cooperative control program

4.2.1 Summary

The program appears to have largely delivered on its first objective of developing a “risk-based operations plan that establishes and maintains a safe, integrated and cooperative control program”.²⁵ Key points relating to this include:

- Developing a comprehensive set of documentation and procedures relating to Health, Safety and Environment planning.
- Active monitoring and adaptation of the program to ensure standards are maintained—e.g. in addressing potential performance issues relating to fatigue management.
- Endorsement by relevant agencies (NSW Police, Firearm Safety and Training Council) and the support of key stakeholders, including large corporate land managers who have low levels of tolerance to risk.
- Agreement by a range of land managers to have control operations on their land, allowing for deer management beyond council land alone.

The two key elements of this objective—safety and having an integrated, cooperative program—are discussed in more detail below.

4.2.2 Safety

Safety has clearly been of paramount importance to the operation of the NIWDMP. Its primacy is reflected in safe implementation being the first objective of the program. This emphasis relates to the program's operating environment—using firearms to control deer in rural, peri-urban and urban areas. This includes:

- parcels of council land, typically adjacent to residential areas
- private land in peri-urban and rural areas, including farming/agricultural land
- private land owned by corporations for commercial operations (e.g. mining).

The key risks when operating in this environment are clear:

- loss of life or significant injury as a result of the incorrect use of firearms
- injury to people or animals should shots miss targeted deer.

²⁵ Northern Illawarra Wild Deer Management Plan 2011-2015. n.d. South East Local Land Services. p. 5.

There is also an important element of public perception that the program has had to deal with – that is, it not only has to be safe, but it also has to be understood to be safe by community members and other stakeholders. This was further complicated at the outset of the program because of the challenges in working with the Game Council New South Wales—the statutory body responsible for managing introduced game species (including deer), which has since been dissolved.

With these issues in mind, the program coordinator Michael Knez, and the original program manager Daniel Shaw, have spent considerable time developing, documenting and maintaining the Health, Safety and Environment (HS&E) system for the program (Figure 13).

The Health, Safety and Environment Management Plan for the NIWDMP sets the high level framework for managing safety and includes a clear governance structure that identifies the roles and responsibilities of individuals involved. It also describes the two-dimensional risk assessment process (likelihood by consequence), the risk register for documenting these hazards and their associated control measures (e.g. Work Methods Statements (WMS), Standard Operating Procedures (SOPs) and policies and procedures). Hazards (and control measures) include:

- handling and transporting carcasses (WMS)
- working in remote areas (WMS)
- driving vehicle and 4WDs off road (WMS, training)
- use of Category A, B and D Firearms (WMS, training, licencing)
- operating from a utility (WMS)
- fatigue management (policy and procedure)

The program has also required **extensive work by the program coordinator to liaise with and the approval of corporate land managers** (i.e. industrial sites) for operating on their properties. In some cases this required individual, standalone risk management plans to be developed in line with those organisations' own national or international HS&E systems.

Points of note in relation to the planning and delivery of shooting operations include:

- Each shoot site is assessed during daylight hours and a site-specific operations plan developed. This includes identifying risks, hazards and safe shooting zones (where bullets will hit a safe background if they miss their target).
- Detailed, real-time monitoring data is collected about shoot activities on portable electronic devices (e.g. sites visited, deer observed, shots taken, deer killed, staff present).
- Operations are not conducted on Friday nights, weekends or school or public holidays.
- Shooters are accredited with the Firearms Safety and Training Council and have all relevant qualifications and licences.
- Program staff/contractors are continually trialling new equipment to improve the safety of operations, such as night-vision and thermal imaging equipment.

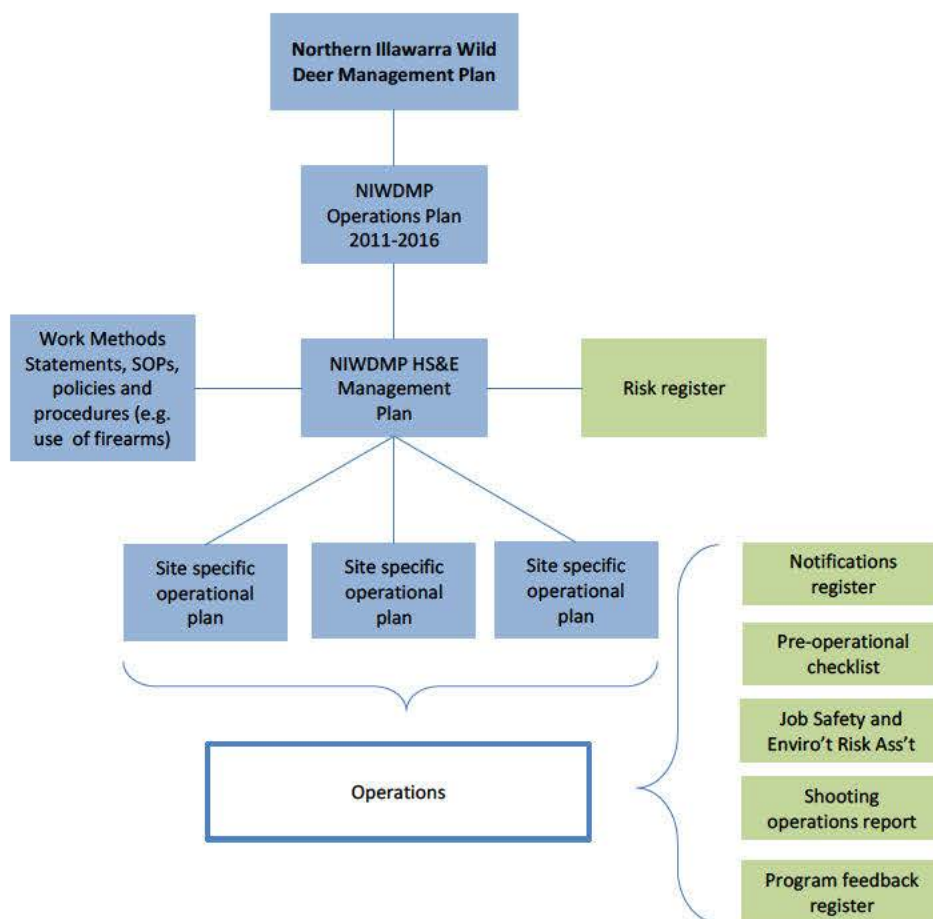


Figure 13. Key elements of the risk-based operational planning elements for the NIWDMP.

The program coordinator and other committee members noted that there have been no incidents during the program’s lifetime. Furthermore, Table 2 shows that the program’s operations have also been comprehensively audited or reviewed on-site by representatives from a range of organisations. Indeed, out of 274 operational nights, more than a third were observed by third-party stakeholders.

Table 2. Number of audits of NIWDMP operations by different stakeholder groups.

Organisation	Number of audits
LHPA / South East LLS	72
NSW Police	6
RSPCA	8
Wollongong City Council	22
Sutherland Shire Council	4
Industry stakeholders	8
Members of Parliament	1
LHPA / South East LLS Board Members	3

There was also evidence of the program being monitored and adapted to ensure operations continued to be run safely. This involved observed issues with fatigue among contract shooters, which led to the program being temporarily stopped, a new contracting arrangement made and new processes implemented around fatigue management (i.e. that shooters can't have worked in the hours preceding an operation).

All interviewed stakeholders considered the program to have been well planned and safely delivered, with good processes and procedures in place for managing risks. One stakeholder committee interviewee noted, for example:

"The procedures—the OHS documents and safeguards—are extremely good. I believe the LLS is auditing them enough that they're making it as safe as possible – one in every 10 times. For other high-risk contractors [in our organisation] it's not nearly as much as that".

Similarly, all eight land managers interviewed expressed high levels of satisfaction with safety procedures (see Box 2). Involvement of large corporations in the program (e.g. mining/engineering firms), who tend to have strict approaches to occupational health and safety, is further support for the robustness and professionalism of the program's documentation and staff/contractors.

Box 2. Safety.

Safety

"From our perspective, [what works well is] that they use professional shooters and they have a lot of governance around the operation" (interviewed landholder).

All landholders interviewed for this evaluation expressed high levels of satisfaction with safety regarding how the program is implemented. Interviewees emphasised the communication around contractors accessing their property as one of the key features that made them feel comfortable about participating.

"I'm very satisfied, they always very courteous, they let me know when they are coming and what's happening" (interviewed landholder).

Most interviewees also emphasised the safety precautions of the program compared to what they perceived to be the other option to control deer on their property, which was inviting recreational shooters to come out. Many had tried this method before getting involved in the program, and described issues with recreational hunters accessing their property without permission or notification; multiple groups coming onto the property at one time; unsafe shooting practices such as shooting around their house; dumping of carcasses; and damage to property.

The other option is for recreational hunters to come up. We were having 2-3 groups up at any one time which is very dangerous, as they don't know the others are there.

We did have some private hunters come onto our property, which we allowed, but it got out of hand, with them bringing their friends and at times we didn't want them.

4.2.3 Integration and cooperation

As well as setting out to be a safe program, the NIWDMP also aimed to provide integrated and cooperative control of deer in the region. We take this to apply to:

- integration and cooperation with other deer control efforts in the region, as per the overarching aim of the program (see Section 2.4)
- having deer control across the landscape and, therefore, across multiple tenure types, including both council and private land.

On this latter point, the program has certainly been successful. In December 2015, 347 individual landholdings were part of the program²⁶, with **a steady increase in the number of sites visited through time** (Figure 14; where sites might comprise one or more landholdings).

That said, the distribution of effort across sites is not equal, with **more effort (as indicated by number of visits through the program) directed at a few key sites** (Figure 15). Indeed, variation in the accessibility and prevalence of deer in different areas has meant that three sites account for almost half (43%) of the total deer removed under the program.

While the program has built working relationships with its current set of land managers, numerous land managers in the region have not signed on to the program. As described by a key program interviewee:

“It’s not fair that a farmer on one property is involved and the deer just end up banking up on their neighbour’s property [who is not involved], meaning the problem comes right back”.

Feedback from program staff/contractors suggests this issue is becoming more problematic as deer appear to be modifying their behaviour in response to the program and are ‘seeking shelter’ in areas where they are unable to be shot. An alternative may be that, as deer abundances drop (see Section 4.3), these deer are becoming more noticeable. In either case, these properties remain an important source of or refuge for deer; a potential issue for future deer control in the region.

In terms of integration with other deer control efforts in the region, there are few other active programs and none of the size or scale of the NIWDMP:

- The Office for Environment and Heritage has a (through the National Parks and Wildlife Service [NPWS]) control program in Royal National Park and areas in the Illawarra escarpment. A representative from NPWS sits on the NIWDMP stakeholder committee to help promote coordination between these two groups, though the size and scale of NPWS operations is relatively limited due to budget constraints.
- The Sutherland Shire Council runs a similar deer control program that is well-integrated with the activities in the NIWDMP, using many of the same procedures and processes. A member of the council sits on the stakeholder committee.
- Sydney Catchment Authority’s (now Water NSW) Feral Animal Control Program, which uses ground shooting to control deer. NIWDMP staff indicated that this program has been irregular, with activities only a few times a year and none over the last year. Engagement

²⁶ NIWDMP Meeting Minutes, December 2015.

with this body is progressing only relatively recently, with the NIWDMP team likely to begin accessing parts of the Woronora Catchment.

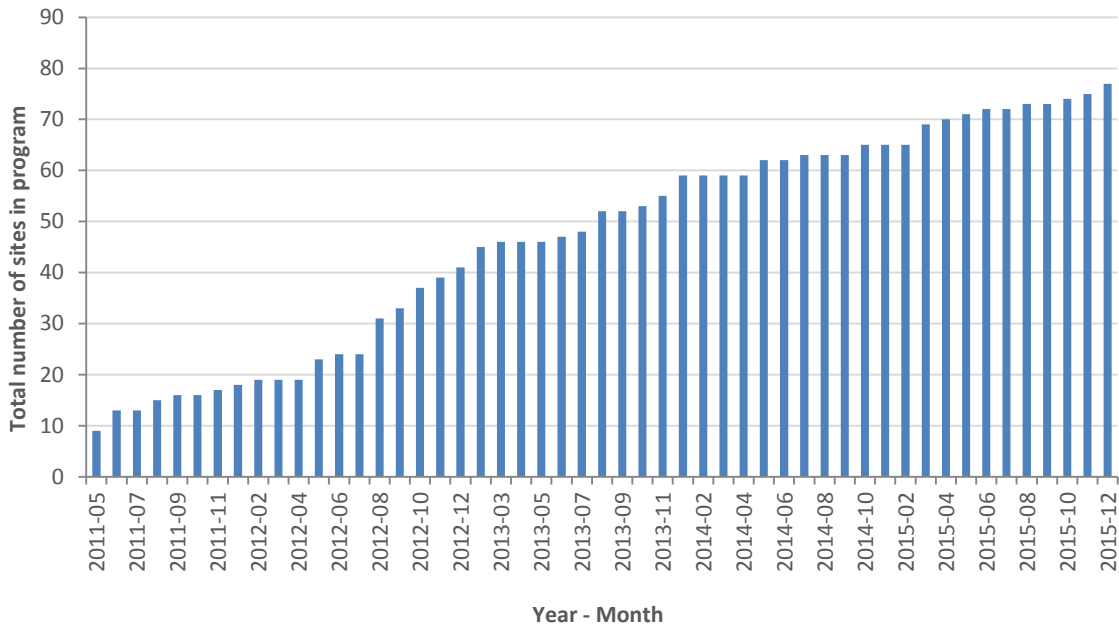


Figure 14. Total number of sites involved in the program through time. Note that a site might include one or more properties.

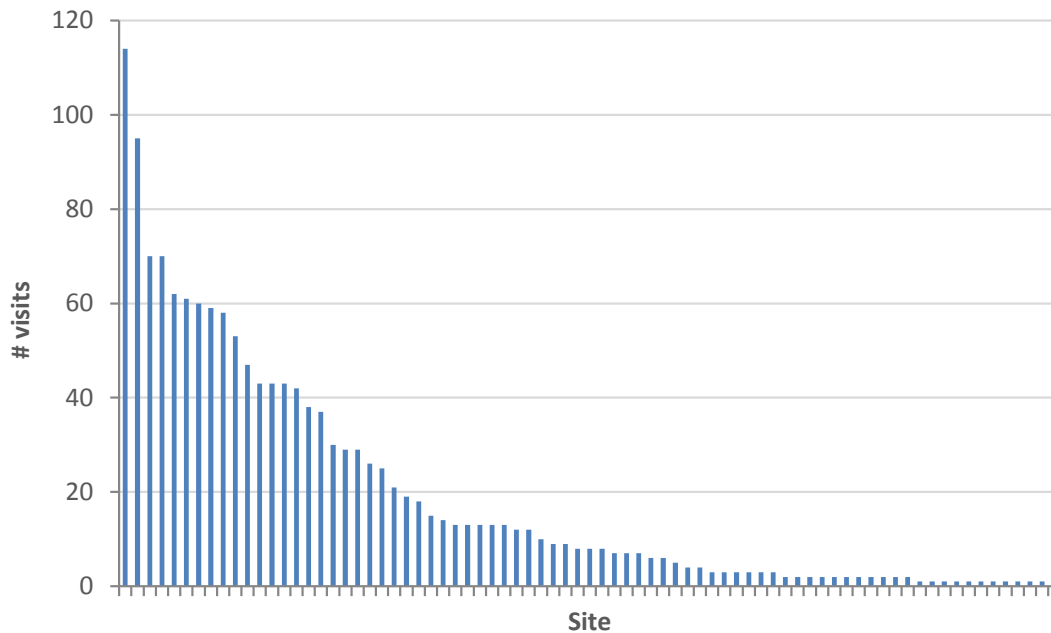


Figure 15. Effort at different sites (as measured by number of visits throughout program).

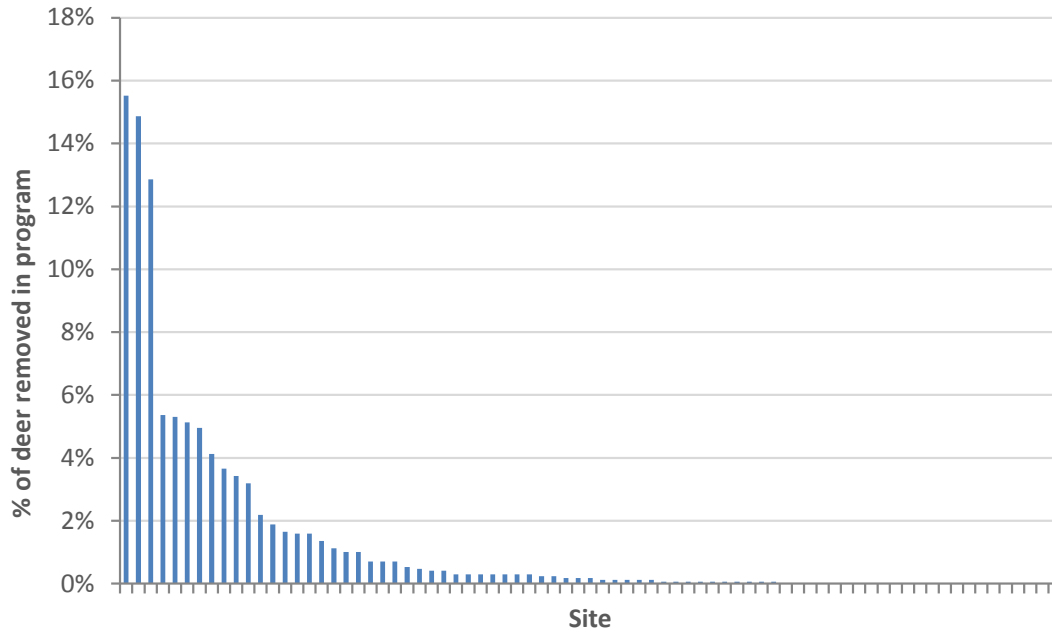


Figure 16. Amount of deer removed from different sites (as a percentage of the overall number of deer removed under the program).

4.3 Reducing in the socio-economic impacts of wild deer

4.3.1 Summary

One of the key objectives of the NIWDMP was to “reduce the socio-economic impacts that wild deer pose to landholders in the Northern Illawarra area”.²⁷ The available evidence suggests that the program is positively contributing to this objective, but that a long-term reduction in impacts is likely to require a longer-term program.

There are two broad lines of evidence of relevance to this objective:

- the reported impacts from and complaints about wild deer
- observations relating to wild deer abundance.

4.3.2 Reported impacts and complaints about wild deer in the Northern Illawarra

Insights on changes to the socio-economic impacts from deer come from a range of sources, most of which show stable or downward trends (but not statistically significant decreases) in impacts:

- a register of animal complaints kept by Wollongong City Council
- surveys of urban (2012 and 2014) and rural (2011-2014) residents
- feedback from landholders interviewed for this evaluation (8)
- collision data from Sydney Trains.

²⁷ Northern Illawarra Wild Deer Management Plan 2011-2015. n.d. South East Local Land Services. p. 5.

The number of complaints to Wollongong City Council shows a strong seasonal trend, with more complains in the second and third quarters of each year (Figure 2). **Complaints peaked in 2009, with a very slight (and statistically non-significant) downwards trend through to 2015.**

The surveys of residents in urban areas there is little meaningful change in how many people reported collisions, near-misses or property damage from deer between 2012 and 2014 (Figure 4). These data do not shed any light on whether there have been any changes to the frequency of incidents with deer. However, **the reported value of the damage done by deer appears to be decreasing**, dropping from \$354/respondent in 2012 to \$255/respondent in 2014 (Figure 8; though the high variability in estimates means the decrease is not statistically significant).²⁸

Surveys of rural residents need to be interpreted more carefully because of the much lower number of respondents in later surveys (192 in 2011, 57 in 2014). This issue aside, there appears to be a decreasing trend in the number of respondents reporting different types of impact since 2011 (Figure 5). Just focusing on the direct impacts of deer (i.e. damage to the environment, production or property), **residents reporting at least one type of impact have declined from 79% in 2011 to 58% in 2014** (Figure 17). The percentage of residents reporting more than one impact dropped even more noticeably (Figure 17) and those reporting impacts from illegal hunting have decreased from 81% to 43% in 2014.

As with urban survey respondents, rural survey respondents estimate that the monetary costs of deer damage is also lower in 2014 compared to 2012 (Figure 8). A few individual respondents in 2013 reported very high levels of impact associated with fencing, leading to the high variability in the data for that year.

The survey data above suggests that **while there are not overwhelming changes, there are improving trends.** This is further supported by the observations and reports of landholders interviewed as part of this evaluation (Box 3).

²⁸ Averaged across respondents who provided an estimated value and those that did not report any damage. (t=1.11, d.f.=1920, p=0.266).

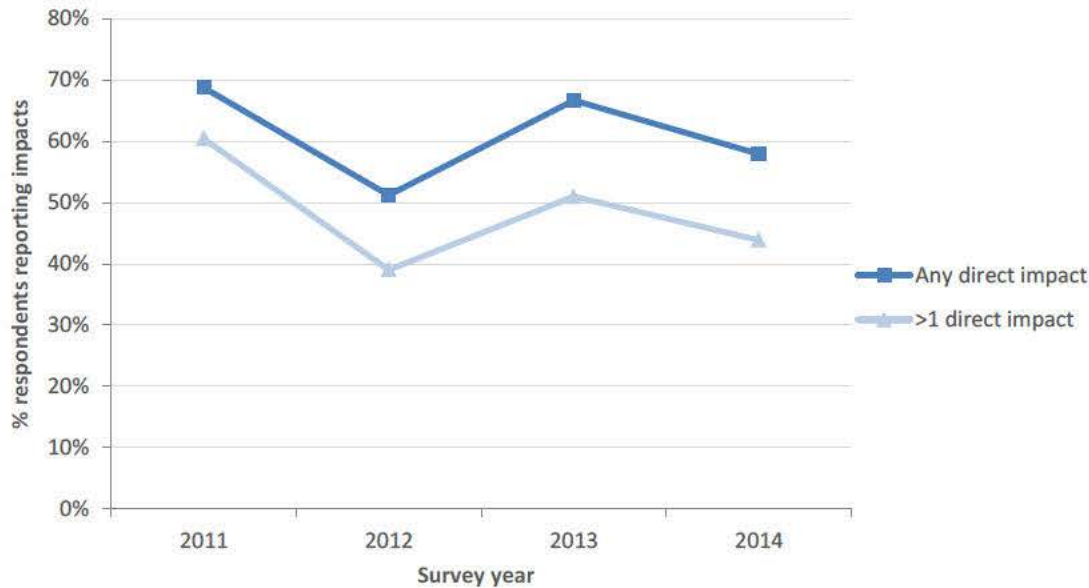


Figure 17. Percentage of rural survey respondents reporting direct impacts from deer (environmental, production or property).

Box 3. Landholder perspectives on program impacts.

Impacts of the NIWDMP – landholder perspectives

Landholders who were interviewed for this evaluation described varied impacts of the shooting program. Six of the eight respondents interviewed described reductions to deer sightings or abundance on their property, although for some this was not permanent (with numbers reduced temporarily after the shoots).

I've seen big changes in the number of deer and the availability of deer on the property.

The size of mobs have come down, but the frequency of the deer is the same.

Most landholders (5) felt the impacts of deer had lessened, citing a reduction in property damage, grazing pressure, car accidents and illegal hunting.

The best thing of all is that these guys have culled down the numbers, and the local Rambo types don't exist now, I haven't seen them for a long time.

Some landholders believed that while the numbers on their property had been reduced, the deer were simply learning to avoid the shoot locations and may be more heavily impacting nearby land as a result.

It's done well, but you get the odd landholder who won't let the shooters on, and then the deer get smart and stick to the places where they don't let them on.

Most respondents felt that the program had likely avoided growth of the deer population and associated increased impacts. All wished to see the program expanded, with more frequent shooting and involvement of more landholders to ensure geographic coverage

Adding to the trends above, data from Sydney Trains show a clear downward trend in collisions between the 2010-11 and 2014-15 financial years (Figure 18). Deer sightings are lower, more variable and do not show a clear trend through time. This is most likely because such sightings do not have to be reported in the same way as incidents where trains collide with deer.

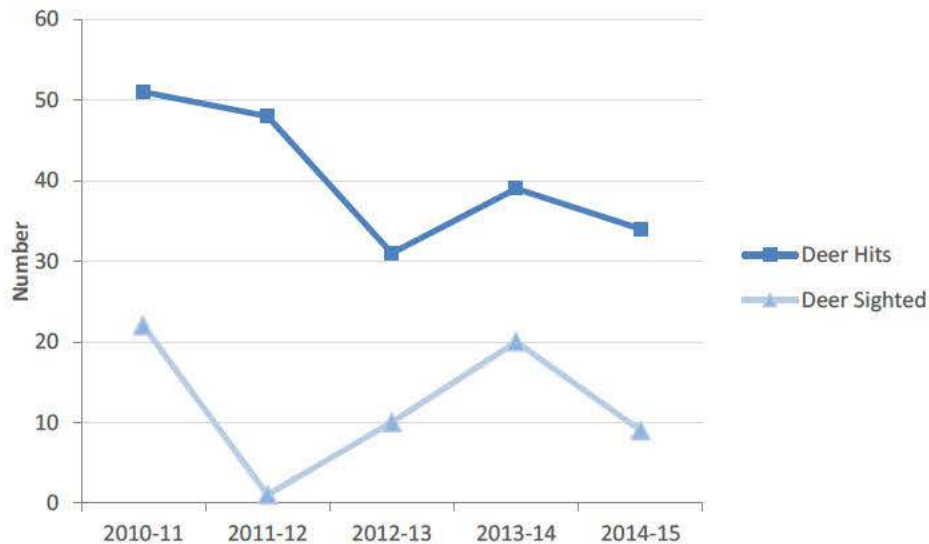


Figure 18. Deer sightings and hits on the Sydney Trains network. Note the years on the x-axis refer to financial years (i.e. the data go up to July 2015)

4.3.3 Reductions in population

The other line of evidence that provides insights on how the program has influenced the impacts of deer simply relates to how deer populations are changing (see Figure 10). The key question here is whether deer populations are:

- decreasing because of the program
- remaining stable, where they otherwise would have increased without the program
- growing, but at a lower rate than they would without the program
- growing at a rate that is un-impacted by the program (i.e. shot deer are simply replaced by better survival among others).

Without long-term monitoring and control/reference sites, these outcomes are difficult to tease apart conclusively:

- **Surveys of urban residents** show a clear change in perceptions of deer abundance in 2014 compared to 2012 (Figure 19). Many more respondents considered deer numbers were decreasing in 2014 (32%) as compared to responses in 2012, when just 9% considered deer to be decreasing.²⁹
- **Data collected by contractors as part of their operations** shows:

²⁹ (Z=-13.30, p<0.001)

- There are no clear trends in the number of deer removed per operational night, other than a dip in 2014 (Figure 12). Observations from the contractor, however, indicates that prior to the program (on other control works), they would remove 10-20 deer per night. It is currently “five to ten, if we’re lucky”.
- Counts of deer on shoot operations (i.e. recorded for each site through time) show a downwards trend over the course of the program (Figure 20). This trend is still evident at the three sites that have been visited most regularly (Figure 21), suggesting the trend is not just a result of visiting different sites through time.
- The apparent rise in deer observations in 2015 from the low in 2014 may relate to a low period in operations at the end of 2014. Interviews with program staff indicate this low point was due to revision of the contract with shooters and meant there was only one operational night over three months. This may have provided deer a window in which to ‘bounce back’.
- **Ecological surveys in 2012 and 2015** (green squares in Figure 20) used pellet counts and rapid assessment indices to estimate the relative abundance of deer at different locations. Analysis of pellet counts indicated that deer densities increased between 2012 and 2015 and that the “current deer management program is suppressing the rate of growth of the deer population but that population growth is still positive”³⁰
The results from rapid assessments are less clear, with more than half of sites indicating no change or decreasing deer densities.

Weighing up the evidence above is difficult. What evidence is available suggests that deer are being observed less and are likely to be causing less damage (Section 4.3.2). At the same time, the ecological surveys indicate that deer abundances may have increased between 2012 and 2015. This may be because:

- The timing of the surveys did not capture the larger drop in abundance/observations from early on in the program, or longer term trends were masked by the second survey being run after a low-point in activity (Figure 20).
- Deer abundance may have increased between surveys, but that deer have moved into more cryptic/sheltered habitats where they are being observed less (and potentially causing less damage because of this).

At minimum, the ecological surveys suggest that the deer program is at least suppressing population growth, with a more positive interpretation of the data indicating a longer-term downward trend in deer abundance.

³⁰ Eco Logical Australia 2015. Distribution and Abundance of deer in the Wollongong LGA: 2015 Monitoring report. Prepared for Wollongong City Council. p. 18.

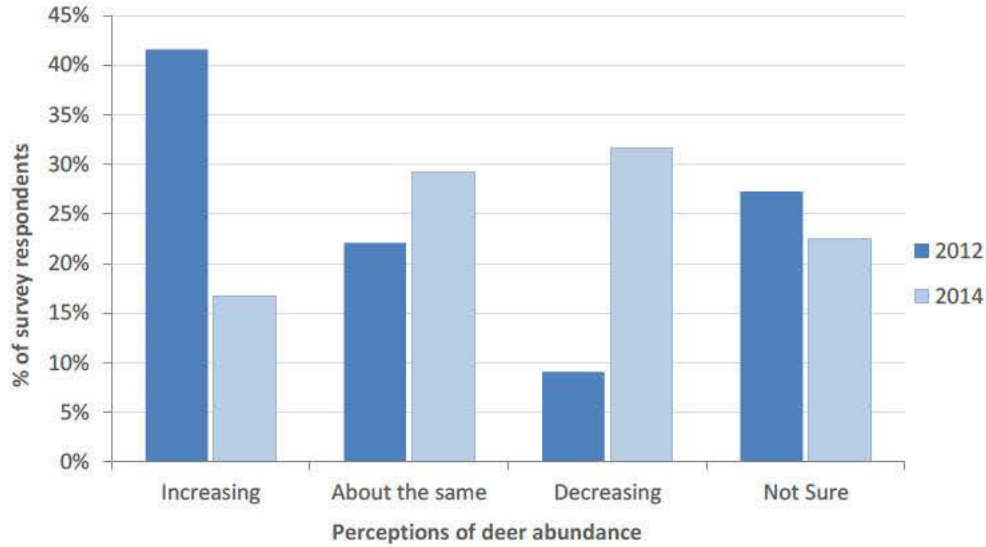


Figure 19. Urban survey respondents' perceptions of deer abundance over the preceding 12 months, as reported in 2012 and 2014.

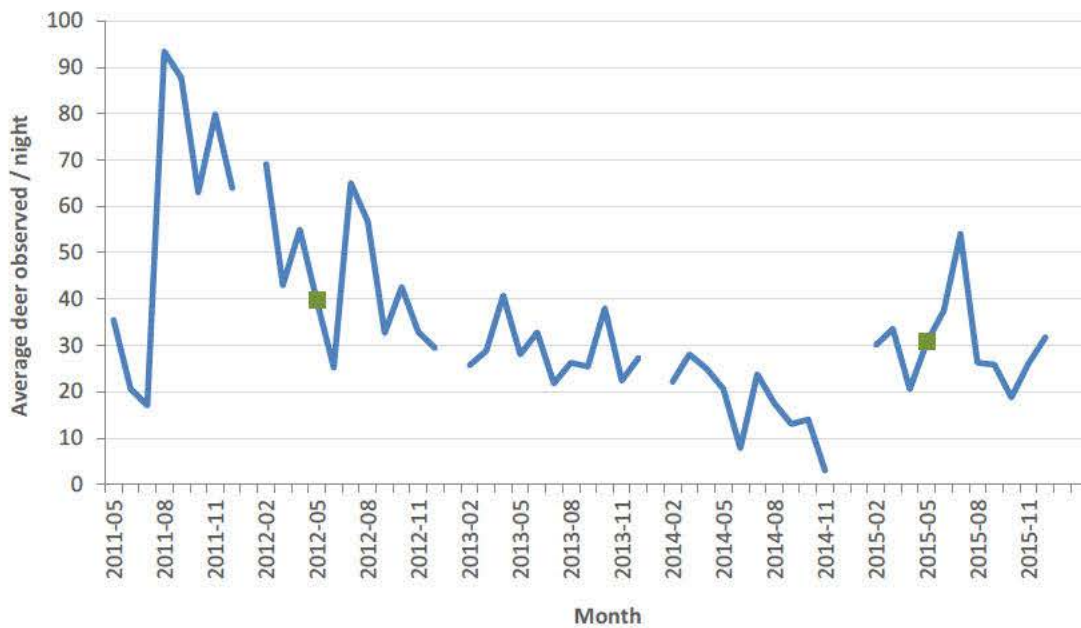


Figure 20. Average number of deer observed by contractors per operational night throughout the NIWDMP (data averaged for each month). Green squares indicate timing of Eco Logical Australia deer abundance surveys.³¹

³¹ Eco Logical Australia 2015. Distribution and Abundance of deer in the Wollongong LGA: 2015 Monitoring report. Prepared for Wollongong City Council.

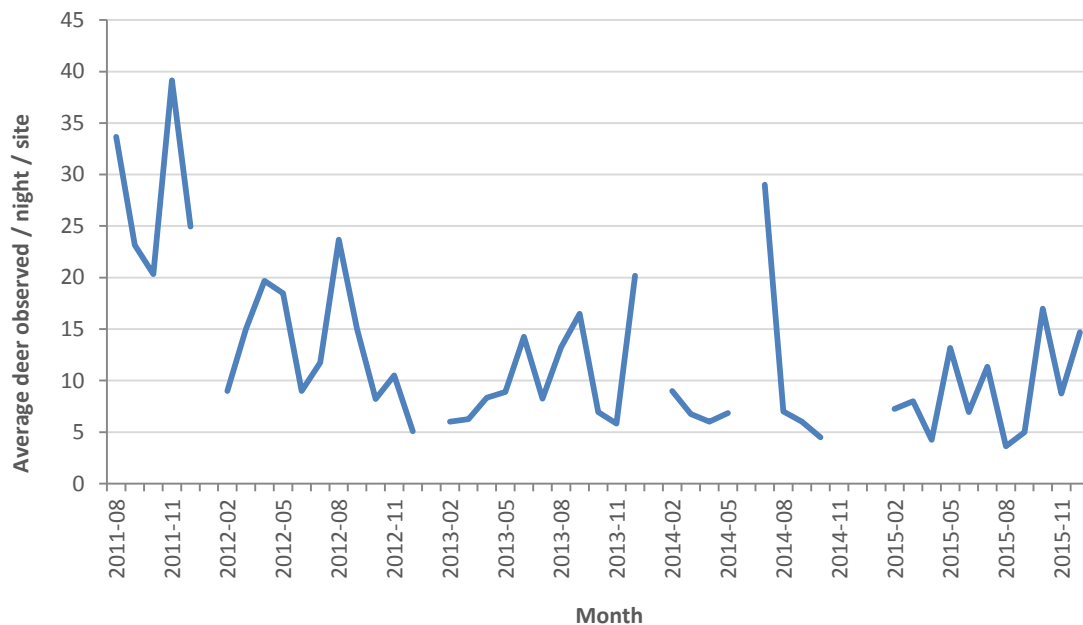


Figure 21. Average number of deer observed by contractors per operational night per site for the three longest, most consistently visited sites in the NIWDMP (data averaged for each month).

4.4 Community and stakeholder awareness

The third objective of the NIWDMP was to “improve community and stakeholder awareness relating to the negative impacts and management of wild deer”.³² The management plan itself does not articulate why this is an objective of the program. However, as outlined in Figure 10, the underlying logic is likely to be that awareness-raising will ultimately lead to greater levels of interest in and support for the program and greater levels of coordinated control. This was well-supported by participants in the summit workshop.

The program has implemented a range of activities that are all broadly linked to awareness-raising among community members and other stakeholders, including:

- general community members through:
 - fact sheets published on the Wollongong City Council website
 - letterbox dropping of information around new control sites
 - urban and rural surveys of landholders
 - an annual mail-out to landholders signed up to the program
 - direct liaison with landholders involved in the program to maintain their engagement and support (e.g. by the program coordinator, by the contractor when notifying of operations, through an annual newsletter)
 - direct liaison with potential landholders to make them aware of the program and seek their involvement
 - funding road signs to alert motorists to collision hot-spots

- other stakeholders through:
 - coordination of the NIWDMP stakeholder committee
 - direct liaison with other agencies and authorities, including councils and water authorities
 - presentations to other agencies and groups, including the Natural Resources Commission and the DPI Vertebrate Pest Management course

As with the safety-related aspects of the program, participants in the summit workshop emphasised the significant amount of effort the program coordinator, Michael Knez, and Wollongong City Council project officer, Damian Gibbins have put into this aspect of the program. In particular, the high level of effort to initiate and maintain relationships with a variety of landholders, including residents, primary producers and industry.

All landholders interviewed for this evaluation (8) indicate strong support for the quality of the communication they had received around the program, mainly citing the professionalism and reliability of the contractors. As one noted:

³² Northern Illawarra Wild Deer Management Plan 2011-2015. n.d. South East Local Land Services. p. 5.

“I'm very satisfied, they always very courteous, they let me know when they are coming and what's happening” (landholder interviewee).

However, **most interviewees (5) were unsure about what broader engagement had taken place** within the community, one noting

“I don't think the community has engaged well with the program, because I don't think it has been marketed well enough” (landholder interviewee).

Key stakeholders noted that there had been a deliberate decision not to advertise or market the program broadly, which conflicts somewhat with the intent of this objective as it is currently articulated. **Two committee members noted that broader communication of the program to the community may be a positive change**, one noting:

“Personally think it's much better that people know what's going on. That people know the options and if it's a collaborative effort... they need to be aware of what's happening and need to have confidence if shooting is involved that it will be well controlled”.

There are no data regarding broader community awareness of the program (and indeed, it was not promoted as such). **However, results from the urban survey suggest that (at least among this deer-affected part of the community) there were increasing levels of support for deer control in the region:**

- in 2012, 74% of respondents noted that they thought deer control was necessary in the Wollongong local government area
- in 2014, 84% of respondents considered deer control necessary.³³

4.5 Training to landholders

This objective related to facilitating “training to landholders enabling them to better undertake control of wild deer themselves and therefore helping to sustain the outcomes of this project post its completion”.³⁴ **While this objective is positive in terms of its consideration of the sustainability and long-term impact of the program, it has not been delivered.**

As noted by one of the committee members:

“The intention was to run training courses ... to bring them [landholders] to an understanding of how to conduct those particular activities to make them efficient and safe”.

Had this worked, the program may have been able to reduce deer densities to a level where landholders could maintain control by themselves, removing (or at least reducing) the need for an ongoing program of professional shooting.

For a range of reasons this training did not eventuate:

- landholders considered themselves too old, were not resident on the land, or were corporations without qualified staff

³³ Statistically significant difference (Z=-5.37, p<0.001)

³⁴ Northern Illawarra Wild Deer Management Plan 2011-2015. n.d. South East Local Land Services. p. 5.

- use of/coordination with recreational hunters became problematic, with issues around minimum qualifications, appropriate procedures and a history of illegal hunting in the area making landholders wary
- the legislation surrounding firearms, with many properties unsuitable for recreational-based licences given their residential zoning
- the legislation surrounding deer – i.e. controls over shooting at night, licence requirements etc.

As noted by one landholder interviewee, the professional program was simply a safer, more straightforward approach:

“I wouldn't do it until I [...] understand what the risks and issues are, you really need to go through it with a professional... I've got 30 years' experience with guns and shooting, but I've not conducted it in this environment before, so my concern is with the risk and safety issues”.

Given these constraints and issue, the NIWDMP has instead appeared to support landholders through the contract shooting program, rather than through training and management by landholders. The implication, however, is that because the majority of landholders are unable to undertake control efforts themselves, the program has become essential to any ongoing control of deer in the region.

4.6 Research and innovative solutions

The final objective for the program was to “keep abreast of and where possible foster research on wild deer management, including exploring innovative and conceptual solutions to complex situations”.³⁵ Throughout the NIWDMP, **program staff and contractors appear to have put considerable effort into trialling, testing and refining methods of deer control.** In this regard, this objective appears to have been successfully delivered on.

Program documents and interviews revealed a range of ways in which the NIWDMP explored or refined deer control methods:

- trials of tiger scat and chilli powder as deterrents to deer³⁶
- monitoring of potential diseases and parasites on deer that might pose a biosecurity threat³⁷
- trials of trapping methods
- testing of night vision and thermal imaging equipment
- development and use of electronic, real time operational reporting using tablets.

The program (through Wollongong City Council) also supported research by University of Wollongong student, Zoe Diment³⁸. The focus of her research was on the ecological and social dimensions of deer in the Wollongong region; a key finding being a positive correlation between

³⁵ Northern Illawarra Wild Deer Management Plan 2011-2015. n.d. South East Local Land Services. p. 5.

³⁶ Northern Illawarra Wild Deer Management Program Habitat Modification and Deterrent Trial Project Final Report. 2013. Feral and Game Management Pty Ltd.

³⁷ Annual Report 2015 – Northern Illawarra Wild Deer Management Program

³⁸ Diment, Z. 2011. Ecological and social dimensions of introduced animals: with a focus on deer on the urban interface in Australia. Honours Thesis, The University of Wollongong.

Lantana camara (a Weed of National Significance) and deer density—the *Lantana* was acting as a harbour or refuge for deer to shelter in. In response (and in line with the habitat manipulation work slated in the NIWDMP plan), Wollongong City Council removed *Lantana* from an urban bush reserve in an effort to make the deer more accessible to the control program.

What is lacking in this area is a documented research strategy/plan outlining what project funds have been allocated to what research, the different research projects in place and their relative priorities. It is unclear exactly what has been invested where. Similarly, a plan for documenting and disseminating findings from various trials would help broaden the impacts of the program beyond the Northern Illawarra.

4.7 Unexpected outcomes

The key unexpected or unplanned outcome from the NIWDMP is the development of a valuable set of processes, procedures and tools for conducting professional shooting operations in urban, peri-urban and rural private land. This includes the work methods statements, site plans and the technology for real-time reporting of shooting operations.

As noted by one committee interviewee, the program has:

“... raised the quality of safety and risk management. I’ve changed my procedures to mirror theirs as much as possible. For example, trying to catch up with the technological innovations. ... The whole idea is to raise the quality of the program and of ground-shooting contractors and their capability”.

5 Key challenges for and lessons from the NIWDMP

5.1 Challenges

As noted in Section 2, the NIWDMP faced a range of contextual challenges in achieving its objectives. Other challenges have been identified or inferred throughout Section 4 above.

These challenges provide important insights for future programs and include:

- **The lack of legislative backing for pest control.** As deer is not a declared pest, the program was more limited in the influence it could have on landholders and on the funds it could mobilise for control works. Similarly, as noted by a key program stakeholder, the legislation relating to deer meant they were not part of either the council's or the South East LLS' core operations, making it more difficult to justify and support the program internally.
- **Gaining full participation by landholders.** While the program effectively built relationships across a range of private landholders, participation was voluntary. As such, non-participating properties provide opportunities for deer to seek refuge. It also creates an unequal burden among landholders—something that itself has the potential to harm levels of participation.
- **Funding.** As noted by several program interviewees, securing funding for the program was an ongoing process. Funding remains tenuous, despite high levels of community support for the program. Importantly, as highlighted by three key stakeholders, if the program were to stop for more than a few months there is the potential for
 - a loss of momentum in control efforts
 - impacts on relationships with landholders, some of whom may be wary of buying in to a different, unproven program

“The worst thing that could happen is that the program shuts 1st of July. There are probably 100s of hours of stakeholder recruitment and management in setting it up” (committee member).

- **Illegal hunting and interference.** Program staff/contractors and documents pointed to a range of incidents where operations were interfered with by illegal hunters or vandals. This included interference with trapping and deterrent trials and equipment.
- **Balancing program promotion with maintaining a low profile.** Although there was largely good support within the community for the program, attitudes remain diverse. Although one of the objectives was community awareness, the NIWDMP also had to avoid raising unwanted attention, such as the vandalism noted above. Finding the right balance between promotion and awareness raising and profile is a challenge some stakeholders considered warranted greater attention.
- **Integrating systems between organisations.** The program required coordination across a range of organisations, including the South East LLS and councils. There were occasional instances noted by interviewees where differences in organisational systems prevented tighter integration of the program. For example, procurement arrangements in Sutherland Shire Council prevented the same contractors being used as in the NIWDMP.
- **The size and complexity of the problem.** The program operates in a difficult mix of environments. It also faces an abundant deer population with limited resources. The

objective of the program itself is, therefore, difficult, and calls for a long-term perspective. As noted by one landholder:

“It’s one of those things, this is going to be a long hard road to get this under control, and when you look at the number that are killed on my property alone - and there are properties on both sides of me that have big properties [the scale of the problem becomes clear]”.

- **The difficulty of getting clear estimates of deer density or changes to impact through time.** Understanding and demonstrating how effective the program has been requires good monitoring of deer densities and overall abundance through time. Such monitoring can be difficult.³⁹ The NIWDMP has a very good base of survey data, operational data and the beginnings of an ecological monitoring program—these will need to be continued and refined as part of any future management program(s).

5.2 Lessons

In addition to the challenges above, interviews and program documents also pointed to a range of lessons that are worth documenting for this and other programs. These lessons all essentially relate to **gaining the trust of and buy-in from landholders and other stakeholders**. Because of where deer are located in the Northern Illawarra, the entire success of the program relied on getting landholder support for control activities. This has been achieved on properties throughout the region, many of whom are now staunch advocates of the program. This appears to relate to:

- **Good communication from the program coordinator.** As noted elsewhere, significant effort was invested in liaising with landholders and other stakeholders to ensure they understood the program and its underlying plans and procedures. One committee member noted that having an on-ground coordinator assist greatly in this :
“It’s paramount to have someone with their feet on the ground. It [the program] needs to have that connection. Someone out there speaking to people, building that liaison with the clients that you’re dealing with so that they’re comfortable with you’re coming on to that property. That’s critical. You can’t buy that”.
- **Oversight of operations and driving of other program elements by the program coordinator.** Again, part of the smoothness of the operational aspects of the program appears to be related to the close oversight of the program coordinator. This helped maintain and continually improve quality and safety standards (for example, through regular tool-box safety talks or in relation to actions following issues with fatigue management). Other elements of the program, such as deterrent and trapping trials or liaison with external agencies, revolved around and were led by the central role of the program coordinator. While the stakeholder committee helped steer the project, this on-ground role appeared to be important in ensuring there was a clear driver of and contact point for program activities and communications, particularly given the cross-tenure nature of the program.

³⁹ Amos M et al. “I just want to count them” Considerations when choosing a deer population monitoring method. 2014. Wildlife Biology 20: 362-370.

- **Good communication from contractors.** Contractors followed-through with this, ensuring landholders were individually notified of operations and ‘kept in the loop’ with program activities.
- Similarly, landholders involved in the program praised **the professionalism and consideration shown by contractors**—noting it to be a key point of difference to their experiences with volunteer shooters. This professionalism included following through with plans, being mindful of farm operations and ensuring that carcasses are removed, gates shut and downed fences reported.

Landholders and other key stakeholders interviewed for this evaluation had **few suggestions for improving the program**, other than:

- increase the frequency of shoots, including introducing daytime shooting
- garnering greater financial support from key stakeholders (e.g. councils and state government)
- having deer declared a pest species
- greater control efforts by public land management agencies such as NPWS
- having a greater geographic coverage.

6 Insights from other deer control programs

6.1 Deer management

In response to the increasing impacts of growing deer populations, government agencies and natural resource management authorities around Australia have implemented a range of deer management strategies, programs and control methods. **This section briefly reviews a selection of these programs and, together with insights from the literature on deer management, draws out insights and points of comparison for the NIWDMP** (Section 6.4. below).

As experienced in the NIWDMP, various trials, programs and strategies around Australia and from overseas show **there are complex and consistent challenges associated with deer management**.

Some of these challenges include:

- high population control thresholds for deer species (see Table 3)
- conflicting interests among the community, stakeholders and land owners/managers
- difficulty in monitoring deer populations and their impacts over time
- complex legislative, policy and regulatory environment
- safety concerns
- limited control methods
- scarce resources.

One of the major challenges with reducing populations of invasive species such as wild deer is that the reproduction rates of such species can be high (Table 3). This means that the percentage of the population that must be removed to halt population growth ranges between 53% for Hog deer and 34% for Fallow deer—46% for rusa deer.⁴⁰ A larger proportion of the population would need to be removed annually to get an overall decline in the local population.⁴¹

These figures are complicated by the local meta-population dynamics—i.e. the extent to which relatively isolated populations exist and the level of interaction between those groups. For these reasons, deer control efforts have tended to be more successful when dealing with small, concentrated deer populations.

⁴⁰ 'Recreational hunting NSW: claims v facts', Invasive Species Council, 2012, p. 1.

⁴¹ 'Hastings Wild Deer Management Strategy 2016-18', North Coast Local Land Services, 2016, p. 27.

Table 3. Population growth rates and population reduction thresholds. Sourced from 'Recreational hunting NSW: claims v facts', Invasive Species Council, 2012, p. 1.

Deer species	Maximum annual rate of population growth	Threshold to halt maximum population growth
Hog deer (<i>A. porcinus</i>)	85%	53%
Chital (<i>A. axis</i>)	76%	49%
Rusa deer (<i>C. timorensis</i>)	70%	46%
Sambar (<i>C. unicolor</i>)	55%	40%
Fallow deer (<i>D. dama</i>)	45%	34%

6.2 Control techniques

There are various methods available for controlling populations of pest deer species, including:

- ground based shooting (daytime stalking and spotlight shooting)
- aerial shooting (platform and helicopter)
- trapping and relocation
- exclusion fencing
- habitat manipulation
- aversion techniques
- sedative darting.⁴²

The appropriateness and effectiveness of each method depends on contextual and environmental factors. It also involves consideration of safety and animal welfare. Each method also differs in its resource intensiveness and financial cost.

In Australia, ground shooting appears to be the most appropriate and effective method of deer control in rural and peri-urban areas, and in many cases is the only viable option available.⁴³

Aerial shooting has also been used effectively to control deer populations, for example, in the south east of South Australia helicopter shooting has been successful. However, aerial and helicopter shooting as methods of deer control appear to only be effective in areas where deer density is very high and cannot be used in areas with thick vegetation.⁴⁴ Aerial shooting presents significant safety concerns and is not appropriate in proximity to urban areas.⁴⁵

⁴² 'Hastings Wild Deer Management Strategy 2016-18', North Coast Local Land Services, 2016, p. 7; 'Pest Species Regional Management Plan: Fallow Deer and Red Deer', Eyre Peninsula Natural Resources, no date, p. 6.

⁴³ 'Deer Control Program Question and Answers', Parks Victoria, 2014, p. 1; 'Hastings Wild Deer Management Strategy 2016-18', North Coast Local Land Services, 2016, p. 7.

⁴⁴ 'Pest Species Regional Management Plan: Fallow Deer and Red Deer', Eyre Peninsula Natural Resources, no date, p. 6.

⁴⁵ 'Hastings Wild Deer Management Strategy 2016-18', North Coast Local Land Services, 2016, p. 7.

Trapping wild deer is difficult due to their ‘flight’ instinct, and using traps and darting with sedatives are only effective for managing targeted problematic individual deer.⁴⁶ Capture and relocation methods present significant animal welfare concerns, with high rates of deer mortality after relocation.⁴⁷ There are no poisons currently available in Australia for the use of deer control.⁴⁸

The paucity of research on effective control methods in the Australian context means that many of the programs currently operating in Australia involve research, trial methods and pilot approaches alongside control operations.⁴⁹

6.3 Summary of select programs

Table 4 summarises the key features of a selection of other deer control programs in Australia. These programs primarily use ground shooting methods, in rural, peri-urban and urban areas. The key points of relevance are drawn out in Section 6.4 below.

⁴⁶ ‘Hastings Wild Deer Management Strategy 2016-18’, North Coast Local Land Services, 2016, p. 7.

⁴⁷ ‘Deer Control Program Question and Answers’, Parks Victoria, 2014, p. 1

⁴⁸ ‘Hastings Wild Deer Management Strategy 2016-18’, North Coast Local Land Services, 2016, p. 7.

⁴⁹ Government agency stakeholder interviews (North Coast LLS, Parks Victoria, GMA).

Table 4. Summary of select deer programs reviewed as part of the evaluation of the NIWDMP. Information has been sourced from a combination of program documentation and interviews with program staff.

Program name and status	Species	Operating environment	Program deliverers / partners	Methods	Outcomes	Monitoring
Wilsons Promontory National Park Hog Deer Control Program 2015 (complete) ⁵⁰	Hog deer	<ul style="list-style-type: none"> • Wilsons Promontory National Park, managed by Parks Victoria • Rural and peri-urban areas, with high public land visitation • Historical existence of Hog Deer in the area • Increased deer sightings around populated areas • Increase in deer population, likely due to regeneration of vegetation after bushfires in 2005 and 2009 • Increased deer population having negative impacts on native flora and fauna 	<ul style="list-style-type: none"> • Parks Victoria • Game Management Authority • Australian Deer Association • Sporting Shooters' Association Australia (Victorian branch) 	<ul style="list-style-type: none"> • Ground shooting in 3 targeted sites over 3 days in August 2015 • Volunteer recreational hunters • Restricted public access • Pre-established shooting zones and time periods (morning, evening and night) • Conventional stalking, sit and wait hunting and spotlighting from a vehicle 	<ul style="list-style-type: none"> • 42 deer culled • 60% (25) hinds and 40% (17) stags • Night time hunting more effective than morning and evening <p>Deer per km index:</p> <ul style="list-style-type: none"> • 71% decrease at Tidal River • 36 % decrease at Darby River Airstrip respectively • No change at Cotters South <p>CPUE:</p> <ul style="list-style-type: none"> • 1 deer per 3.07 hours of hunting 	<ul style="list-style-type: none"> • Spotlight transect counts before and after the program, animal per kilometre index. • Capture Per Unit Effort rate (CPUE) • Scientific analysis of culled deer • Data not conclusive about the effectiveness of the control
Kangaroo Island Deer Eradication Program 2006-2013 ⁵¹	Fallow deer	<ul style="list-style-type: none"> • Deer only recently became a pest on the island when 300 deer escaped from a deer farm adjoining a conservation area in 1999 • Potential for deer to spread disease which causes death among livestock • Limited impacts on native flora 	<ul style="list-style-type: none"> • Kangaroo Island Natural Resources Management Board • Local recreational hunters 	<ul style="list-style-type: none"> • Ground shooting, mostly conducted by KINRM staff (full time control officers) • Some assistance from local recreational hunters • Shooting undertaken at all times of year, but 	<ul style="list-style-type: none"> • 225 deer shot since 2006 (as at 2013) • population has been declining at an average rate of about 40% per annum • In 2013 it was estimated that there were only 10 individual deer remaining 	<ul style="list-style-type: none"> • Identification of deer tracks at dams in the autumn dry season • Remote cameras in high activity areas • Analysis of destroyed deer • CPUE • Community sightings

⁵⁰ 'Wilsons Promontory National Park Hog Deer Control Program Final Report', Game Management Authority, Victorian Government, 2015, pp. 4-10.

⁵¹ 'Case Study: Feral deer eradication on Kangaroo Island', Pest Smart, 2013, np.

Program name and status	Species	Operating environment	Program deliverers / partners	Methods	Outcomes	Monitoring
		and fauna, but concern that this will increase without eradication		more intensive in autumn		essential for monitoring as deer numbers reduced.
Alpine National Park 2015-2017 (currently operating) ⁵²	Sambar (and Fallow deer)	<ul style="list-style-type: none"> Alpine National Park, managed by Parks Victoria Evidence of increased deer populations Increased negative impacts on native flora and fauna, waterways, peatlands and other habitat degradation 	<ul style="list-style-type: none"> Parks Victoria Sporting Shooters Association of Australia Australian Deer Association 	<ul style="list-style-type: none"> Ground shooting, with control operations at scheduled intervals over 3 years Volunteer recreational hunters Focus on 3 areas, Bogong High Plains, Howitt and Wellington Plains 	<ul style="list-style-type: none"> 4 deer culled in first 24 hour control operation involving 12 hunters, and 4 parks staff 	<ul style="list-style-type: none"> “detailed scientific monitoring program to assess its effectiveness in reducing deer numbers and impacts on areas of high environmental value” Ongoing impact-based monitoring methods being implemented
Dandenong Ranges National Park 2014 (complete) ⁵³	Sambar and Fallow deer	<ul style="list-style-type: none"> Dandenong Ranges National Park 	<ul style="list-style-type: none"> Parks Victoria Sporting Shooters Association of Australia Australian Deer Association 	<ul style="list-style-type: none"> Ground shooting Spotlight shooting at night and stalking in daylight hours Contracted volunteer recreational shooters Four areas targeted Yellingbo Nature Conservation Reserve, Dandenong Ranges National Park, and the Warramate Hills Nature Conservation Reserve in Gruyere. 	<ul style="list-style-type: none"> 100 deer culled “positive signs of environmental recovery and revegetation in areas that have previously been damaged by deer activity” 	<ul style="list-style-type: none"> Ongoing impact-based monitoring methods being implemented
Hastings Wild Deer	Rusa, Fallow,	<ul style="list-style-type: none"> Wild deer present in the Port Macquarie area since 1908s – 	<ul style="list-style-type: none"> North Coast Local Land Services 	<ul style="list-style-type: none"> Ground shooting primarily 	Not available	<ul style="list-style-type: none"> “poor” records of culled deer up to 2015

⁵² ‘Deer control trial for a healthier Alpine National Park’, Parks Victoria, 2015 <<http://parkweb.vic.gov.au/about-us/news/deer-control-trial-for-a-healthier-alpine-national-park>>

⁵³ ‘Deer Control Program Question and Answers’, Parks Victoria, 2014, pp. 1-2; ‘Deer control trial for a healthier Alpine National Park’, Parks Victoria, 2015 <<http://parkweb.vic.gov.au/about-us/news/deer-control-trial-for-a-healthier-alpine-national-park>>

Program name and status	Species	Operating environment	Program deliverers / partners	Methods	Outcomes	Monitoring
Management Strategy 2015-2018 (currently under development)	Red, Chital, hybrids (Rusa and Sambar)	<ul style="list-style-type: none"> with recent increases Rural, peri-urban and urban areas Damage to rural and residential property, traffic hazards, impacts on local industry, spread of disease, negative impacts on flora, fauna and habitats (particularly in environmental offset areas) Population estimate in 2006 was “at least several hundred deer [...] with populations escalating” 	<ul style="list-style-type: none"> Deer Management Working Group 	<ul style="list-style-type: none"> Trialling some other methods 		<ul style="list-style-type: none"> Ongoing impact-based monitoring methods being trialled and implemented
Adelaide and Mt Lofty Ranges Fallow Deer Management	Fallow deer	<ul style="list-style-type: none"> Deer are a declared pest species Public land – conservation parks with high public visitation and neighbouring private landholders Rural and peri-urban areas Smaller and less established deer population than some other parts of Australia 	<ul style="list-style-type: none"> Natural Resources Adelaide and Mt Lofty Ranges 	<ul style="list-style-type: none"> Ground shooting Small teams, vehicle spotlighting Volunteer hunter accompanied by staff 	Data not publically available – there has only been one operating season of the program in its current form	<ul style="list-style-type: none"> Transects
Sutherland Shire Council Integrated Pest Animal Control Program⁵⁴ 2005-2016	Rusa deer	<ul style="list-style-type: none"> Sutherland Council LGA (Parks and Reserves) and private properties/Commercial properties through authorised agreements Conservation areas, peri-urban and urban areas Damage to Natural and residential property/assets, traffic hazards, impacts on local industry, spread of disease, 	<ul style="list-style-type: none"> Sutherland Shire Council NPWS GSLLS Sydney Water Water NSW Crown Lands ANSTO Commercial Property owners (by 	<ul style="list-style-type: none"> Public engagement (19,000 program notification letters/factsheets delivered, 12 newspaper program notification delivered, 1150 residential deer impact surveys completed) Desk-top recording of: 	<ul style="list-style-type: none"> 321 culling operations completed 728 deer culled 587 Invasive predators (fox/cat/dog) culled 2008 rabbits culled 12 hectares of high valve conservation areas (EEC etc.) protected by exclusion fencing. 17 hectares of high valve 	<ul style="list-style-type: none"> Spotlight transect counts at 25 sites repeated twice a year (485 surveys). Site presence counts at 32 sites repeated twice a year (632 surveys). 18 sites monitored with motion activated camera (deer presence/absence)

⁵⁴ Based on input from Sutherland Shire Pest Species Officer.

Program name and status	Species	Operating environment	Program deliverers / partners	Methods	Outcomes	Monitoring
		<p>negative impacts on flora, fauna and habitats (particularly in Endangered Ecological Communities)</p> <ul style="list-style-type: none"> Increasing human habituation of deer (feeding by residents, deer staying in presence of humans for long periods/not afraid of humans) Increase in deer population, likely due to regeneration of vegetation after bushfires in 2001 	financial contribution)	<p>complaints about deer impacts and motor vehicle accidents established</p> <ul style="list-style-type: none"> Ground shooting at 189 sites. Emergency stalking (injured animals and high risk areas), Hide shooting and spotlighting from a vehicle. Use of night vision and thermal imagery. Trials of other control methods/deterrents Exclusion fencing Vegetation Harbour Control Revegetation with less palatable native species 	<p>conservation areas (EEC etc.) revegetation with less palatable native species</p> <ul style="list-style-type: none"> 115 hectares of Vegetation Harbour Control implemented 15 vegetation impact (caused by deer) survey plots established Decrease in deer numbers observed over time. Decrease in complaints about Deer impacts Decrease in reported motor vehicle accidents caused by deer. Decrease in numbers of deer habituated to humans (feeding events and isolated permanent populations). Decrease in observed vegetation impacts caused by deer 	<p>Total 396 days of monitoring.</p> <ul style="list-style-type: none"> 8 research (deer browse by vegetation species) impact areas established 2008-11. 15 vegetation impact areas (species composition/presence) surveyed annually. 4 deer post mortem pathology analysis completed.

6.4 Comparison to and insights on the NIWDMP

The materials above provide a range of points for comparison with the NIWDMP that either support its approach and achievements to date, or provide insights into potential opportunities for the future:

- The NIWDMP has experienced many of the same challenges facing deer control efforts elsewhere.
- To effectively control or reduce deer populations, programs need to be removing high numbers of deer. Without a clear idea of the size of the population in the Northern Illawarra region, it is difficult to estimate what percentage of the population has been removed through the program. Nevertheless, the outcome-based monitoring (i.e. surveys of damage) and the ecological surveys suggest that the NIWDMP is, at minimum, impacting on deer population growth rates.
- The size and scale of the NIWDMP is much larger than many other programs around the country.
- While detailed information on CPUE, cost/deer removed or similar cost-effectiveness measures is not widely available, a cursory examination of the information in Table 4 indicates that the NIWDMP compares favourably to other programs in terms of the number of deer removed per unit of effort (6.2 deer per operational night; ~\$380/deer).⁵⁵
- The program uses the most widely accepted and appropriate control method given the context (ground-shooting using professional contractors). Key features supporting the use of contract shooters in the NIWDMP include the operating environment (which includes urban areas) and the intensity of the operation required (i.e. the high number of deer spread across a broad area).
- As with other programs around the country, the NIWDMP has explored and experimented with a range of control methods as part of its approach.
- Other programs have successfully collaborated with volunteer shooters, which has been a challenge for the NIWDMP. In many parts of the Northern Illawarra such collaboration is not feasible (because of the urban/peri-urban location of deer). However, there may be opportunity in the future for exploring collaboration between rural residents and accredited volunteers. Tightly controlled programs such as the NPWS' Supplementary Pest Control Trial⁵⁶ or the 'facilitative' approach of Parks Victoria⁵⁷. Key elements of these programs include:
 - accredited, trained and registered volunteers
 - coordination with other control activities
 - access to similar methods as professional shooters (e.g. spotlighting)

⁵⁵ Cost/deer calculated from expenditure breakdown in NIWDMP Annual Report 2015. Excludes additional cost of research activities. Program coordinator time assumed to be 75% operational, of 0.5 FTE fraction (~\$37k) per annum for five years. Likely to be an overestimate of ongoing costs, given high establishment costs.

⁵⁶ Supplementary pest control trial – interim evaluation. 2016. Natural Resources Commission.

⁵⁷ Government agency stakeholder interviews (GMA).

- clear, frequent and open communication between stakeholders around expectations, objectives and processes.

Because of the high level of coordination required to support this approach, the cost-effectiveness of using volunteers remains unclear. Further work by the NRC and emerging programs in the north coast of NSW may provide clearer insights here in the future.⁵⁸

- Monitoring of control programs is essential to understanding their efficacy and value. This is easier with smaller, more isolated populations and programs. The large, dispersed nature of deer in the Northern Illawarra creates additional challenges in this respect. The approach to monitoring in the NIWDMP to date has made use of a variety of methods, including monitoring the ultimate impacts of the program (i.e. the impacts experienced by residents). This approach is well-supported by other programs, most of which are trialling some form of asset-based/impact monitoring.⁵⁹
- Effective stakeholder engagement was cited as a key element of other programs and this appears to have been well dealt with in the NIWDMP case.
- There is good support for and acknowledgement of the importance of having a cross-tenure approach to deer control.⁶⁰ Work in South Australia indicates that having deer declared and managed as a pest species helps in integrating pest management programs within the core business of land managers (public and private).

⁵⁸ 'Hastings Wild Deer Management Strategy 2016-18', North Coast Local Land Services, 2016.

⁵⁹ Government agency stakeholder interviews (North Coast LLS; GMA; Parks Victoria; Natural Resources AMLR).

⁶⁰ Government agency stakeholder interviews (GMA; Parks Victoria; North Coast LLS; Natural Resources AMLR)

7 Key findings and recommendations

7.1 Key findings

Based on the results and discussion in Sections 2-6 above, the key findings of this evaluation of the NIWDMP are:

- **The program has successfully developed a risk-based operations plan and, in turn, implemented a safe and integrated control program** for deer in the Northern Illawarra. This includes:
 - Developing a comprehensive set of documentation and procedures relating to Health, Safety and Environment planning.
 - Active monitoring and adaptation of the program to ensure standards are maintained—e.g. in addressing potential performance issues relating to fatigue management.
 - Gaining the endorsement of relevant agencies (NSW Police, Firearm Safety and Training Council).
- **The above points have allowed the program to gain the support of a range of landholders** and, in turn, access to their land for control operations.
 - There has been a steady increase in the number of properties involved through time, with 347 individual landholdings participating as of the end of 2015.
 - An emerging problem is that properties that are not involved in the program are starting to become sources of or refuges for deer.
- **Program staff have liaised and coordinated with other control efforts in the region** (e.g. those run by NPWS). However, these other programs are smaller and less intense than the NIWDMP and, in some cases, agencies have been difficult to engage. This again creates the potential for these areas to become refuges for deer.
- **The NIWDMP appears to be reducing the socio-economic impacts of wild deer on landholders in the Northern Illawarra**, though a sustained, long-term reduction in impacts likely requires a longer-term program. Evidence around changes to the socio-economic impacts from deer come from a range of sources, most of which show stable or downward trends in impacts:
 - Complaints peaked in 2009, with a very slight (and statistically non-significant) downwards trend through to 2015.
 - The reported value of the damage done by deer in urban areas is highly variable, but appears to be decreasing, dropping from \$354/respondent in 2012 to \$255/respondent in 2014 (though the decrease is statistically non-significant).
 - Urban surveys show little meaningful change in the proportion of respondents reporting collisions, near-misses or property damage from deer.
 - Rural residents reporting at least one type of impact have declined from 79% in 2011 to 58% in 2014 and those reporting impacts from illegal hunting have decreased from 81% to 43% in 2014.
 - Most landholders (5) interviewed for this evaluation felt the impacts of deer had lessened, citing a reduction in property damage, grazing pressure, car accidents and illegal hunting.

- Data from Sydney Trains show a downward trend in the number of collisions with deer since the 2010-11 financial year.
- **In terms of the broader changes to deer populations** various pieces of evidence indicate that the deer program is, at minimum, suppressing population growth, with a more positive interpretation of the data indicating a longer-term downward trend in deer abundance.
 - Surveys of urban residents show a clear change in perceptions of deer abundance in 2014 compared to 2012. Many more respondents considered deer numbers were decreasing in 2014 (32%) as compared to responses in 2012, when just 9% considered deer to be decreasing.
 - Counts of deer on shoot operations (i.e. recorded for each site through time) show a downwards trend over the course of the program. Over 1695 deer have been removed as part of the program.
 - Ecological surveys in 2012 and 2015 suggest that deer densities increased between 2012 and 2015, but that the “current deer management program is suppressing the rate of growth of the deer population”.
 - Rapid assessments of deer density show decreases or stable densities at more than half of the sites surveyed.
- In terms of **awareness raising among community members** and other stakeholders:
 - landholders involved in the program appear to be highly satisfied with the quality of the communication from program staff and contractors
 - however, both landholders and other key stakeholders suggested that the broader awareness-raising done by the program could be increased, particularly given the need for the program to be working across the landscape
 - the ultimate goal of this objective was not clearly articulated in the NIWDMP plan and careful consideration of the level of awareness raising into the future is warranted.
- **While the program originally aimed to facilitate training to landholders, enabling them to better control wild deer themselves, this component of the program was discontinued.**
 - Landholders in the region face a range of challenges in implementing their own deer control operations, such as restrictions on firearms or logistical constraints.
 - Evidence from other programs suggests using volunteer hunters may be feasible on some properties (i.e. where deer numbers are high and accessible) to support contractor-based operations, provided there is sufficient oversight and accreditation.
 - As it stands, the discontinuation of the program would leave a significant gap in control works in the area.
- **Program staff and contractors appear to have put considerable effort into trialling, testing and refining methods of deer control**, though there are opportunities for more clearly documenting the approach to and findings from these research activities.
- **The program has faced a range of challenges**, including:
 - a lack of legislative backing for pest control, meaning landholders were not obligated to participate
 - securing funding for the program was an ongoing and time consuming process

- the size and complexity of the problem – the sheer number of deer in the region meant that the program, from the outset, faced a significant task
- the difficulty of getting clear estimates of deer density or changes to impact through time has meant the program is only beginning to accumulate enough data to provide insight on changes to deer populations..
- **The key lessons** from the program relate primarily to:
 - the importance of gaining the trust of and buy-in from landholders and other stakeholders; and that this takes significant time and effort
 - the value of a dedicated program coordinator to do this communication, to oversee and uphold safety standards and to drive other elements of the program.

7.2 Recommendations

Based on the key findings, results and discussion above, we recommend:

1. **The Northern Illawarra Deer Management Program, or a similar program of control, should continue to be supported and delivered.** The program is well managed and appears to be reducing or, at minimum, stabilising, the socio-economic impacts of deer in the region. In the absence of the program deer abundance and their associated impacts would increase. Given the high consequences of the risks to motorists, the expense of collisions with trains and the widespread impacts on residents, the costs of the program are relatively small. Ideally, the program would be expanded into areas that deer are beginning to use as refuges, such as train corridors and (currently) non-participating private land.
2. **The program should be funded for an interim one-year period while a new program is refined.** This bridging period will help ensure that the momentum of the current program is not lost when funding for the NIWDMP ceases in June 2016. The new program design should consider a range of factors, including, but not limited to, the recommendations outlined below.
3. **Future iterations of the program should seek to reduce the environmental damage caused by deer, particularly where there any key environmental assets at risk.** This may be in areas where there are vulnerable species or where other investment (e.g. regeneration works) is being made. This may include a concurrent program of research on the environmental impacts of deer on species/habitats of conservation significance.
4. **Future deer control in the area should adopt a regional perspective.** This may include development of a regional deer control strategy that includes Sutherland Shire Council, public land managers and councils to the south of Wollongong. The proposed amalgamation of councils in the Wollongong to Shellharbour region may encourage such a perspective, as well as more strongly supporting the goal of halting the southward expansion of deer populations.
5. **Monitoring of the program should be continued, including collecting data directly related to the outcomes/objectives of the revised program.** For example, data on the impacts of deer on residents. Collection methods should be refined where possible to make sure they

are sensitive enough to detect meaningful changes in outcomes/impacts (e.g. survey questions relating to the value of impacts). Statistical tests of power/sample size and comparisons with sites/areas outside of the control area may also be useful. Long-term monitoring of deer abundance, as established in the NIWDMP, should be considered, though rapid assessment methods may be more cost-effective (and ultimately as useful in management decisions) as pellet-counts. Spotlight-based surveys by contractors may be another option, as is more formal data collection by residents through a citizen-science type program. This may also yield benefits relating to community engagement (see below).

6. **In developing a new program, the role and value of community engagement should be carefully considered.** In the first instance, there is a need to more clearly articulate the goal of engagement activities—is there a need to get broad-scale community awareness? Is it sufficient to engage closely with key land managers? Broad scale community awareness-raising, for example, would require a different approach to awareness-raising and building support among targeted landholders (which might, for example, include more information sessions, workshops or similar activities). Clearly identifying the rationale for and goal of community engagement will be important in understanding the level of resourcing to be allocated to these activities.
7. **Any future version of the NIWDMP should consider maintaining an element of research.** This research should be well planned, strategic and clearly documented to ensure the lessons are useful and applicable more broadly. Collaboration with universities may be a cost-effective approach for designing and implementing quality research projects. Beyond control methods, research should also be supported/facilitated around the varied impacts of wild deer on the environment, on production (i.e. competitive grazing) and on the community.
8. **Relevant program stakeholders should continue to advocate for deer to be declared a pest species.**
9. **In any future program, staff should continue to liaise with public land managers, seeking opportunities to conduct operations on their land where strategic opportunities exist.**
10. **Consider how the learnings from the NIWDMP can be shared more broadly.** Key innovations from the program, such as real-time reporting and the specific lessons for operating in urban environments could be valuably applied in a range of contexts, including for species other than deer.

Appendix 1 Methodology in detail

A1.1 Key evaluation questions, criteria and data sources

Table 5. Key evaluation questions, criteria and data sources considered in the evaluation of the NIWDMP.

Key evaluation question(s)	Sub-question(s)	Indicator/ criteria considered	Indicative data source/ evidence
1. What is the background to and rationale for the NIWDMP?	a. what are the impacts of wild deer in the region?	<ul style="list-style-type: none"> • economic, social and environmental impacts • geographic distribution of impacts (including urban/rural) • change in abundance through time • changes in impacts over time 	<ul style="list-style-type: none"> • stakeholder surveys • population surveys (e.g. Eco Logical reports) • published literature (region-specific and more broadly) • impact data on rail network • impact data from NRMA etc. re: accidents
	b. what is the policy context for wild deer management?	<ul style="list-style-type: none"> • relevant legislation and changes to legislation • relevant policies • related social issues (e.g. deer as a game species and associated controls) 	<ul style="list-style-type: none"> • legislation and policies (e.g. <i>Local Land Service Act 2013; Game and Feral Animal Control Act 2002</i>) • interviews with key stakeholders • program documents
	c. how has the NIWDMP worked to manage wild deer in the region?	<ul style="list-style-type: none"> • origins and rationale • funding sources • stakeholders, collaborators and partners • activities • changes through time 	<ul style="list-style-type: none"> • program documents • interviews with key stakeholders
2. How effective has the program been at achieving its objectives?	a. what extent has the program developed a risk-based operations plan that establishes and maintains a safe, integrated and cooperative control program?	<ul style="list-style-type: none"> • comprehensiveness of plan • comprehensiveness of safety considerations, including legislative requirements, training/qualifications, site planning/risk assessment, reporting • appropriate stakeholder management/planning • perceptions of key stakeholders on adequacy of 	<ul style="list-style-type: none"> • program documents • interviews with key stakeholders • community feedback f

Key evaluation question(s)	Sub-question(s)	Indicator/ criteria considered	Indicative data source/ evidence
		planning	
	b. to what extent has the program reduced the socio-economic impacts of wild deer on landholders in the Northern Illawarra area?	<ul style="list-style-type: none"> landholder perceptions changes in deer abundance (from survey/ perception) key stakeholder perceptions number of deer removed changes to impacts through time (e.g. no. collisions etc.) 	<ul style="list-style-type: none"> resident surveys ecological survey reports other relevant studies (e.g. interviews with key stakeholders) program documentation operational data rail network data/insurance data
	c. to what extent has the program improved community and stakeholder awareness relating to the negative impacts and management of wild deer?	<ul style="list-style-type: none"> landholder/community perceptions through time number and type of awareness-raising activities perceptions of key stakeholders 	<ul style="list-style-type: none"> resident surveys document analysis program documents interviews with key stakeholders website statistics
	d. how has the program facilitated training to landholders enabling them to better undertake control of wild deer themselves and therefore helping to sustain the outcomes of this project post completion?	<ul style="list-style-type: none"> number and type of training activity feedback from attendees perceptions of key stakeholders examples or records of landholder control of deer 	<ul style="list-style-type: none"> program documentation interviews with key stakeholders
	e. how has the program kept abreast of and, where possible, fostered research on wild deer management, including exploring innovative and conceptual solutions?	<ul style="list-style-type: none"> use of research in program documentation examples of collaboration with or support for research other research-related project activities 	<ul style="list-style-type: none"> program documentation interviews with key stakeholders
3. Have there been any unexpected outcomes from the program (positive or negative)?		<ul style="list-style-type: none"> perceptions of key stakeholders landholder perceptions documented outcomes/impacts 	<ul style="list-style-type: none"> interviews with key stakeholders resident survey program documentation

Key evaluation question(s)	Sub-question(s)	Indicator/ criteria considered	Indicative data source/ evidence
4. What have been some of the challenges and lessons from the NIWDMP?		<ul style="list-style-type: none"> • perceptions of key stakeholders • documented challenges, issues and lessons 	<ul style="list-style-type: none"> • interviews with key stakeholders • program documentation
5. What can be learned from other deer or similar vertebrate pest control programs (i.e. involving ground-shooting in urban/rural areas) in Australia?		<ul style="list-style-type: none"> • lessons/insights from other programs • design principles from reviews/studies 	<ul style="list-style-type: none"> • literature/document review • interviews with managers/ coordinators of other programs
6. What recommendations are there for the program's future direction?		<ul style="list-style-type: none"> • findings from evaluation • input from stakeholders at summit workshop 	

A1.2 Engagement meeting

On 7 March 2016 we met with key South East LLS staff to:

- clarify the objectives of the project
- agree on the approach taken
- agree on reporting, timelines and project management processes
- identify relevant documents and datasets
- discuss key stakeholders for consultation
- discuss issues of confidentiality
- agree on the format of the draft and final reports, including clarifying the audience for those reports
- discuss milestone dates and invoices.

Following the engagement meeting we developed a draft evaluation plan. This builds on the material in this tender based on discussions with South East LLS staff. We also developed a draft program logic that outlines the key activities of the program, its outputs and its intended outcomes (Figure 10).

A1.3 Consultation with key stakeholders

We:

- did face-to-face interviews with the NIWDMP coordinator and the Wollongong City Council project officer
- telephone interviews with other key stakeholders, such as landholders (8), committee members (3) and contractors (1).

We consulted with South East LLS staff during the engagement meeting to identify people of greatest relevance.

Interviews were designed to address gaps in other data sources (e.g. surveys) and address issues such as:

- perceptions of changes in impact
- perceptions of program safety
- key issues, challenges and potential improvements
- key success factors
- broader impacts of the program, including unintended outcomes (positive and negative)
- alternative approaches and options.

A1.4 Review of literature and other programs, including additional interviews

To complement program-specific evidence, we briefly reviewed the peer-reviewed and grey literature relating to other deer management programs and strategies in Australia.

The aim of the review was to identify lessons, insights and alternative practices from these other programs that would help inform and/or support future directions for the NIWDMP. Programs included:

- deer control trials in Wilsons Promontory, Alpine National Park and Dandenong Ranges (Victoria)
- the Kangaroo Island Deer Eradication Program (South Australia)
- the Hastings Wild Deer Management Strategy (NSW)
- the Adelaide and Mount Lofty Fallow Deer Management program (South Australia).

To complement program documentation, we interviewed four program managers/staff linked to the above programs to identify insights of relevance to the NIWDMP. Interviews were semi-structured and ranged from 20-60 minutes.

A1.5 Document review and analysis

Alongside the key stakeholder interviews and literature review noted above, a key element of the evaluation was reviewing and analysing program and other related documentation. This was sourced at the project engagement meeting included:

- program management plan
- a sample of site or shoot-specific risk assessments and operational plans
- a sample of minutes from of advisory committee meetings
- survey data from rural and urban resident surveys (2012 and 2014 urban survey, annual rural surveys from 2011-2014)
- deer abundance survey reports from 2012 and 2015 (Eco Logic Australia monitoring)
- contractor specifications
- reports/data from Sydney Trains, insurance agencies
- operational data, such as number/sex of animals removed
- program newsletters and media releases.

Our analysis involved using both qualitative and quantitative techniques to generate and summarise evidence against the key evaluation questions.

Qualitative analysis would be conducted on interview and descriptive documentation, including thematic analysis where appropriate. Quantitative data, such as survey results, were analysed primarily using descriptive statistics and, where appropriate inferential statistics to test for changes over time.

A1.6 Reporting

Drawing on the elements and analysis above, we produced a draft report for the South East LLS that addresses the key evaluation questions, including the program's performance against its objectives.

The draft was updated into a final report for the South East LLS based both on written feedback and input from a summit workshop. This workshop was held in the South East LLS Wollongong offices on 19 April 2016 and provided a forum for key program stakeholders (Table 6) to discuss the evaluation data and findings and contribute to the development of recommendations. The summit workshop aimed to:

- share the lessons about the effectiveness and impacts of the program and incorporate stakeholders' experience and knowledge into the evaluation process
- refine key findings in a collaborative way that is grounded in the experiences of the stakeholders
- help develop recommendations that are realistic and relevant.

Table 6. Summit workshop attendees.

Attendee	Organisation	Relationship to program
Stewart Harris	Sutherland Shire Council	Northern program coordinator
Michael Knez	South East LLS	Program coordinator
Michelle Dawson	South East LLS	Evaluation manager
Damian Gibbins	Wollongong City Council	Council project officer
Patrick Gilmour	First Person Consulting	Evaluator
Neil Rendell	South East LLS	Key regional stakeholder
Graham Wilson	Greater Sydney LLS	Key regional stakeholder
Frank Cook	Illawarra Coal	Key regional stakeholder
Eric Cope	Perentie Group	Contractor for deer control works
Mark McGaw	South East LLS	Key regional stakeholder