Environmental Trust
Cost-effective cross-tenure feral deer management project formative evaluation
September 2022

NSW GOVERNMENT

Natural Resources Commission

Enquiries

Acknowledgement of Country

The Natural Resources Commission acknowledges and pays respect to traditional owners and Aboriginal peoples. The Commission recognises and acknowledges that traditional owners have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters. We value and respect their knowledge in natural resource management and the contributions of many generations, including Elders, to this understanding and connection.

In relation to the areas subject to this evaluation, the Commission pays its respects to the Ngarigo Traditional Owners past, present and future.

List of acronyms

CISS	Centre for Invasive Species Solutions
NSW	New South Wales
NPWS	National Parks and Wildlife Service
COVID-19	Coronavirus Disease 2019
FAWU	Feral Animal and Weeds Unit
LLS	Local Land Services
SELLS	South East Local Land Services
DPI	Department of Primary Industries
VPRU	Vertebrate Pest Research Unit

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1   Executive Summary

The Cost-effective Cross-tenure Feral Deer Management Project (the project) aims to:

Develop new cost-effective, humane and coordinated control techniques for feral deer in NSW to ensure population levels can be managed sustainably by land managers into the future.

The project has $9.2 million in funding from the NSW Environmental Trust and a further $7.4 million in cash and in-kind contributions. The project is being delivered over an eight-year period, from July 2019 to June 2027. The project is managed by the NSW National Parks and Wildlife Service (NPWS), together with community and research partners.

This document reports on the results of the early formative evaluation, completed May-July 2022. The specific focus of the early formative evaluation is on the appropriateness of the project establishment and design, including the assessment of project risks.

The success of the project is very important. The threats posed by feral deer are increasing across the state and country. Land managers public and private are demanding cost-effective co-ordinated deer management solutions. Governments require reliable evidence to support the development of policy. Considerable public resources are invested in the project and demonstrating returns on that investment that extend beyond 'on park' deer management are expected.

The project design is very ambitious. There are many interacting project elements, control, research, stakeholder management across public and private tenures. The projects commencement coincided with a difficult time for operations. The Black Summer bushfires and their aftermath were quickly followed by the COVID-19 pandemic and the constraints of public health orders.

Although these factors impeded project establishment the project is now making up for lost time. The project is operating effectively on a day-to-day basis, resulting in the successful delivery of activities such as the collaring of deer, aerial shooting and vegetation monitoring site set up and maintenance.

That said, a lot of is work required to meet the projects expected outcomes. In particular the trialling of deer control techniques on private land and the identification of the barriers to their broader adoption is a priority. Achieving these outcomes may require adapting the current project and greater engagement with organisations and individuals focused on the control of deer on private land.

The key findings and recommendations from this evaluation are designed to assist the NSW National Parks and Wildlife Service, the Project Steering Committee and the NSW Environmental Trust improve this and future projects of this type.

2 Key findings and recommendations

Despite facing a range of challenges particularly during the early stages, the project is making good progress working towards most of its intended outcomes. This includes the collection of data on deer movement and vegetation impacts, establishing a comprehensive network of camera-traps and large-scale vegetation monitoring plots. The project team have begun work on different control options, though there remains substantial work to be done during the remainder of the project. In particular, there is a need to focus planning and operations on deer control techniques and the barriers to adoption by private and public land managers across the state.

Table 2 below outlines our key findings and recommendations for the project, with more detail provided in **Sections 5 and 6**.

Table 2. Key findings and recommendations (with relative priority provided in brackets)

Key finding	*Recommendation (priority)*
Formative Evaluation	
▪ The formative evaluation has identified risks to project outcomes that should be addressed as soon as practical. Project risks relate primarily to the cross tenure and experimental design elements of the project.	1. That the NPWS and the NSW Environmental Trust consider the formative evaluation report and revise the Project Business Plan (High)
	2. That any revision of the project business plan is informed by a reassessment of project risks (High)
Program documentation	
▪ The project has documentation supporting its management, particularly regarding operational management.	3. That the Project Steering Committee ensures that key program documents are consistent with project objectives and expected outcomes and appropriately approved. (High)
▪ The absence of an overarching research and monitoring framework in the early stages of the project created difficulties with most now resolved.	
▪ There are multiple project documents often with differing versions of the project vision, key questions and expected outcomes. While this is evidence of a project adapting it has contributed to different interpretations of the project's objectives.	
Stakeholder engagement	
▪ There are differing interpretations of the project objectives, within project documents, the views of key stakeholders and in the balance of project activities.	4. That NPWS amend the project communication and engagement plan to make the shared understanding of project objectives and expected outcomes i.e. cross tenure, cost effective feral deer management a priority. (High)
	5. That the Project Steering Committee ensure that key stakeholders have a shared understanding of the project objectives and expected outcomes. (High)

- Stakeholder engagement has been challenging for the project so far. This relates to both the history of engagement with landholders in the region as well as a relative lack of focus on this aspect of the project.

- There are risks that the project loses local landholder support and that the project does not adequately plan for the development of tools and information that landholders and agencies elsewhere can effectively use.

6. That the NPWS work in partnership with the South-East Local Land Services to amend the project communication and engagement plan so that the future adoption of tools/techniques by landholders and other agencies is prioritised. (High)

Governance and management

- The governance structure is overall appropriate but can be enhanced. Landholder representation could be increased from the existing single landholder on the Project Steering Committee.

- There is an opportunity to clarify the roles and responsibilities for Project Steering Committee members, including NPWS Southern Ranges Branch.
- The two other main governance groups – the Community Reference Group and the Scientific and Technical Advisory Group – have yet to be formed.

- A core objective of the project was facilitating behavioural change, as such forming the Community Reference Group is a priority.

- The external technical advisory function of the Technical Advisory Group has been informally fulfilled by a Project Steering Committee member. Such a streamlined arrangement is suitable but should be documented.

7. That the NPWS appoint another landholder representative to the Project Steering Committee. (High)

8. That the landholder representatives on the Project Steering Committee convene a Community Reference Group of landholders within the study area. (Medium)

9. That the Project Steering Committee revise the Governance Framework to Identify and clarify the complimentary roles and responsibilities of NPWS Programs and Operations. (Medium)

10. That the NPWS amend the governance framework to replace the requirement for a Scientific and Technical Advisory Group with an independent external reviewer. (Medium)

- While the project is funded to run independently of the NPWS operations branch, project effectiveness is contingent on collaboration. There is also a need for the project team to effectively coordinate with NPWS Southern Ranges Branch while receiving an underlying level of organisational and administrative support. Collaboration between these two groups has been challenging particularly during the establishment of the Project.

11. That the Southern Ranges Branch nominate an officer to operate as a liaison between the branch and the project team. (Medium)

12. That the Manager, Feral Animal and Weeds Unit (FAWU) ensure the project is appropriately represented at all relevant Southern Ranges Branch meetings. (Medium)

13. That the Manager FAWU request that the project team provide longer lead times for review/consultation of key plans/documents by Southern Ranges Branch. (Low)

- A key challenge faced by the project has been and remains the engagement and retention of appropriately qualified and experienced staff.

14. That the Manager FAWU and Senior Project Officer ensure that the risks of staff turnover are managed appropriately. (Medium)

Project design

- The project should be able to collect good evidence for most activities such as information on the cost-effectiveness of different control techniques (in terms of cost per deer) and insights on how different methods might be best used. However experimental design issues are likely to reduce the rigour of some of the research findings.

- Impacts on deer populations should be reasonably clear for the 'knock-down'. Understanding and attributing population impacts from later control works will likely be less clear because of the lack of a control and, therefore, an inability to account for external factors, density-dependent mechanisms, etc.

- Vegetation monitoring is detailed and should provide a wealth of data. However, there is a risk that experimental design will not show clear impacts and/or be difficult to attribute changes to changes in deer abundance.

- Assessing the agricultural impacts of deer may be problematic too, particularly considering the high levels of pasture growth associated with above average rainfall. The likely contribution of this research to project outcomes should be considered and adaptation may be required.

- These issues of attribution are common for most monitoring initiatives in complex systems. The question becomes whether the cost of different monitoring initiatives is commensurate with their likely value/results.

15. That the Manager FAWU explains to the NSW Environmental Trust the limitations of the experimental design and the likely implications on the rigour of the research findings. (High)

16. That the cost effectiveness of the vegetation monitoring research be reassessed considering the value of the insights it is likely to provide. (Medium)

- There is good alignment between the project activities and most of the intended outcomes identified in the Business Plan. There are, however, potential gaps in terms of:

- What the future methods for control are expected to be, how new/innovative they are and how their effectiveness alone and in combination will be assessed. The risk is that, if planning is not already in progress, waiting until the results of the 'knock-down' are analysed and reported on may leave sufficient resources but insufficient time for the development of a comprehensive set of follow up control trials.

- Although there are outcomes associated with broader agency and landholder adoption, this extension phase is not currently well detailed. Given this is core to the project being useful outside of the project area – and importantly is not straightforward – this is a gap worthy of further attention. There are also unspent funds for this activity.

17. That NPWS immediately commence planning for the delivery of Phase 2 of the project. (High)

18. The NPWS consider partnering with South-East Local Land Services and Landholder representatives on the Project Steering Committee to develop and resource a sub-project within the overall project that focusses on the project outcomes that relate to landholder adoption of new feral deer control techniques. (High)

Cost effectiveness considerations

- In relation to assessing the cost effectiveness of practices, it is unclear whether the project is currently collecting sufficiently detailed project records to identify:

  - staff time and resources required for different components

  - the in-kind contributions of landholders and other partners

  - the baseline landholder expenditure/effort on deer control.

- This data is fundamental to understanding the cost effectiveness of different control techniques and extends beyond simple 'field time' to understanding the costs of preparing for and administering different control interventions. It is also important information for thinking about the costs (and value) of other components within the project.

- There is currently a limited understanding of the cost barriers to the adoption of new deer control methods by land managers identified in the business plan.

19. That the NPWS ensure that appropriately granular data is being collected to inform the assessment of the cost effectiveness of combinations of different control techniques. (High)

20. That the NPWS liaise with DPI to incorporate the findings of existing research into the cost barriers to landholder and agency adoption of deer management control techniques. (Medium)

- The project team has some collaboration with existing deer control programs, including engagement with the Centre for Invasive Species Solutions (CISS) regarding the development of the deer selective feeder. However, there is an opportunity to better leverage existing research and related programs. For example, research into thermal technology by the DPI VPRU and whole of paddock trapping programs across the state by the Local Land Services.

21. That the project team strengthen links with other deer control projects, programs and initiatives to avoid duplication and ensure that learnings about different control methods can build on each other. (High)

Environmental Trust processes for high-risk, long-term projects

- The feral deer management project has some issues relating to the clarity of its overarching objectives. While the current business plan template requires a vision statement, it does not ask for objectives to be defined (i.e. integrated statements about 'what the project is doing and what it will change/achieve through those actions'). Distilling the range of activities from the current case down into a set of objectives might provide a clearer focus for the project, with an example/suggestion provided in Appendix 2.

- The current template also uses an outcomes hierarchy. While this is useful for identifying key deliverables/outcomes/outputs, it:

- does not provide a sense of how these items relate to each other, what the priorities are and where monitoring/evaluation effort is best placed

22. That the NSW Environmental Trust consider reviewing the suitability of the current business plan template for high-risk long-term projects. (Med.)

23. That the NSW Environmental Trust consider revising the planning and reporting schedule for high-risk long-term projects to ensure a balance of strategic and operational focus. (Low)

▪ leads to some 'shoehorning' of quantitative indicators for some outcomes that might be better dealt with in a more comprehensive evaluation plan.	
▪ This underpins a broader need to shift grantees away from delivering on easily counted outputs to things they should be aiming to achieve (true measures of success) that might be best assessed through evaluation.	
▪ The feral deer management project is large and complicated. During its early stages, there were issues with having appropriately qualified and experienced staff involved to ensure effective project establishment. ▪ Project success requires the effective collaboration of NPWS Programs and Operations. There is evidence to suggest that the two divisions are not always working together well.	24. That the NSW Environmental Trust ensure that proposals for high-risk long-term projects include an appropriate establishment period including objectives. (Medium)
▪ The current project monitoring /experimental design has some limitations. While the project was reviewed by different committees of the Trust these limitations were not identified. .	25. For projects with a significant research/development component, the NSW Environmental Trust should consider requiring an external review of any experimental design before approval. (Medium) 26. That the NSW Environmental Trust ensure that projects proposing behavioural change are supported by the type and quality of evidence required. (Low)
▪ Although the Business Plan talks about developing new and innovative deer management techniques, there is some work being done under the feral deer management project that is neither new nor innovative. A clearer assessment of what other work is happening and what the specific gaps that the project would address might help to ensure that pre-existing/concurrent work is appropriately recognised and incorporated.	27. That the NSW Environmental Trust require that major project proposals with a significant research component are accompanied by a review of related research and programs to ensure projects avoid duplication and build upon existing work. (Low)

3   Introduction

3.1   Overview

The Cost-effective Cross-tenure Feral Deer Management Project (the project) aims to:

Develop new cost-effective, humane and coordinated control techniques for feral deer in NSW to ensure population levels can be managed sustainably by land managers into the future. [1]

The project has $9.2 million in funding from the NSW Environmental Trust and a further $7.4 million in cash and in-kind contributions. The project is managed by the NSW National Parks and Wildlife Service (NPWS), together with a range of community and research partners. The project is being delivered over an eight-year period, from July 2019 to June 2027.
The project has the potential to provide substantial benefit to the NSW environment and economy and represents a significant investment of public resources over an extended period. As such, the evaluation of the project is scheduled at several key points. This document reports on the results of the early formative evaluation, completed in mid-2022.[2]

3.2   Objectives and scope of the early formative evaluation

The overall objectives of evaluating the feral deer management project are to:

▪   ensure transparency and accountability for the expenditure of public funds

▪   identify lessons and opportunities to improve project delivery

▪   explore the overall design, delivery and impact of the project to help to inform future decisions by the NSW Environmental Trust on project investments and design.

The specific focus of the early formative evaluation is on the appropriateness of the project establishment and design, including assessment of project risks. Evaluation questions for each stage of the feral deer management project are outlined in **Table 1**.

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[1]   Feral deer management project business plan. 2019. Environmental Trust.
[2]   In line with the NSW Government Program Evaluation Guidelines 2016 and the Cost-effective cross-tenure feral deer management project – Evaluation plan, developed by the Natural Resources Commission for the NSW Environmental Trust

Table 1. Key evaluation questions for the formative evaluation of the Cross-Tenure Feral Deer Project

Key evaluation questions	Sub-questions
1 **How well has the project been established and what lessons and improvements are there?**	a. To what extent are key project management documents and processes in place and being used?
	b. What challenges have there been and what are the implications?
	c. Are the project governance structures appropriate and how well are they working?
	d. What other lessons are there from the initial stages of the project?
2 **To what extent is the project design appropriate, given its intended outcomes?**	a. Are the project activities aligned with the intended outcomes?
	b. What key assumptions underpin the project and is the project design being adapted in response to learnings?
	c. Is the research/monitoring framework/design likely to provide the answers to key project questions?
	d. Is there a clear and shared vision of success?
	e. Is the planned expenditure on different components in line with the objectives of the project?
	f. To what extent are relevant stakeholders being involved?

3.3   Approach

The evaluation included an inception meeting, document review, interviews with project staff and stakeholders and an external review of project design. Evidence gathered was analysed and findings synthesised and reported.

- An inception meeting between the NSW Natural Resources Commission (the Commission) the NPWS project team and NSW Environmental Trust was held on 15 March 2022 to confirm the scope of the project, the overarching approach and the expected timing of key components.

- Document review. A range of documents supplied by the NPWS project team were reviewed, including:

  - the Project Plan (year 3 version)

  - the Business Plan

  - the Communication and Engagement Framework and examples of specific engagement plans for control activities

  - examples of 6-monthly reporting to the Environmental Trust and annual implementation plans

  - the Deer Monitoring and Research Framework and associated survey method protocols

  - terms of reference for governance bodies and examples of meeting minutes for the Project Steering Committee

- External reviews of the project design. Tony Pople from the Queensland Department of Agriculture and Fisheries reviewed relevant project documentation including a review of the ecological monitoring plan commissioned by NPWS (Michelle Dawson, LLS)

- Interviews with key stakeholders, which included:

  - NPWS project team (5)

  - Project Steering Committee members and Project partners, including staff from Local Land Services (LLS), Department of Primary Industry (DPI) NPWS Regional operations and University of Sydney (7)

  - An external deer control researcher (1)

  - Landholders involved in the project (4)

  Most interviews were conducted face-to-face from 26-29 April, however, some interviews also took place via videoconference when practical.

- Analysis and reporting - Following analysis, the Commission developed this draft evaluation report for review by the NPWS and the Environmental Trust.

3.4   Limitations

Much of the insight on the project is based on the feedback from key stakeholders. This evidence is inherently subjective and, as such, may contain biases. We have aimed to collect evidence from a range of sources to ensure differing viewpoints can be contrasted and a more robust set of findings can be generated. While this provides some rigour, the underlying subjectivity of the process should still be kept in mind when reviewing the report findings.

3.5   Report structure

This report provides:

- a summary of key findings and recommendations (**Section 2**)

- a brief background to the feral deer management project (**Section 4**)

- detailed results in relation to project establishment (**Section 5**)

- detailed results in relation to project design (**Section 6**).
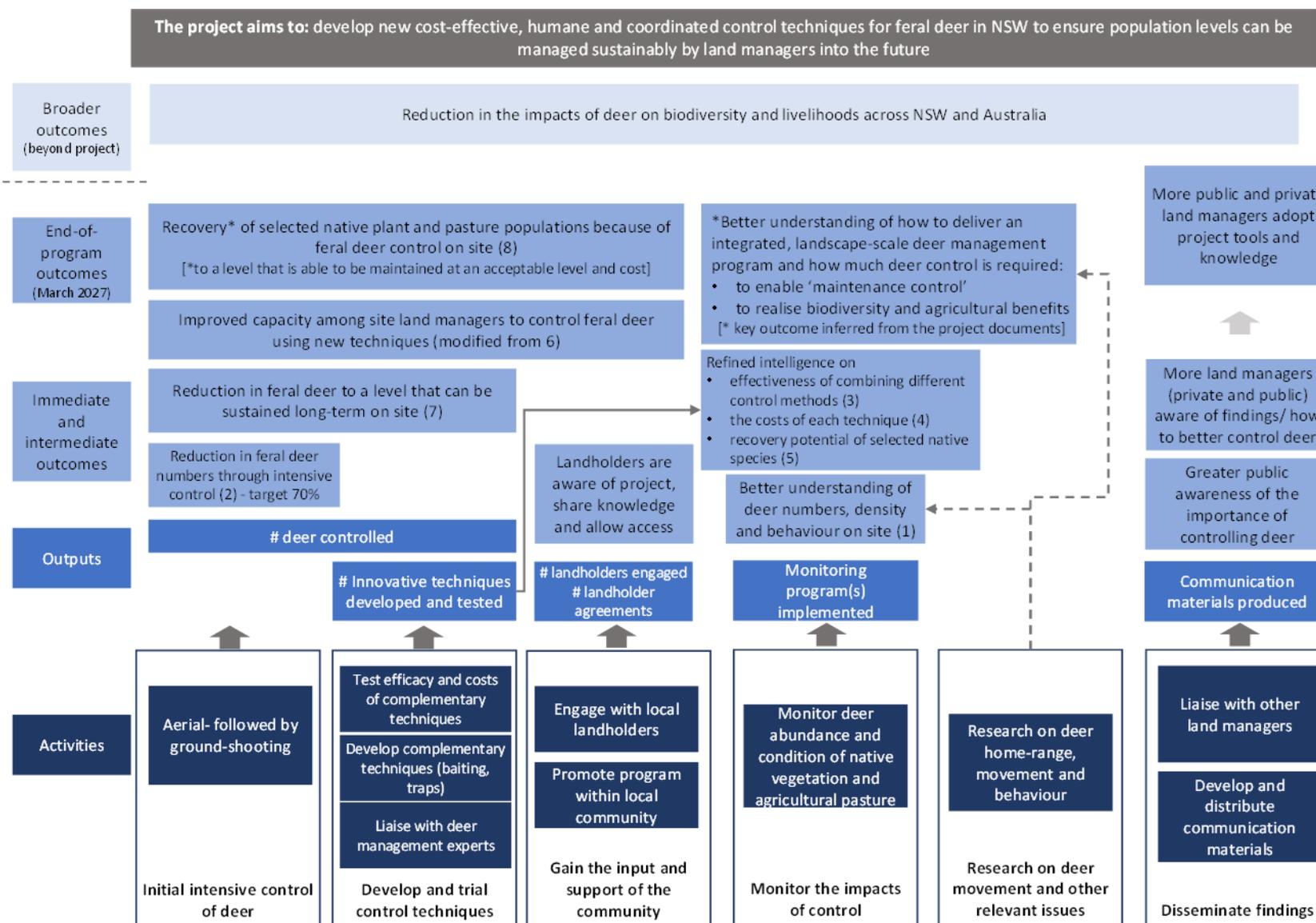
4   Background to the feral deer management project

As noted, the project aims to develop cost-effective, humane and coordinated control techniques and strategies for feral deer in NSW. Specifically, it aims to develop management strategies that can be applied across different tenures to keep feral deer populations at an acceptable level and within the resources available to public and private land managers.

The project focuses on testing a range of control techniques at a landscape scale to better understand how to cost effectively control deer. Particularly, whether a large-scale 'knock down' of the population (~70% reduction) can then be maintained by landholders using techniques available to private landholders. The investigative, exploratory nature of the project means that a substantial proportion of its work is researching deer populations, their impacts and control techniques.

This focus is complemented by project activities that seeks to extend the results of this applied research. This includes raising the profile of deer management and fostering adoption of the new methods and approaches among private and public land managers.

A detailed program logic was developed during the evaluation planning stage for this project and is outlined in **Figure 1**. Note that this logic was developed specifically to inform the project evaluation based on the Business Plan and Deer Monitoring and Research Framework. The logic may not reflect how different stakeholders understand the project (see **Section 5.7**).

The project aims to: develop new cost-effective, humane and coordinated control techniques for feral deer in NSW to ensure population levels can be managed sustainably by land managers into the future

Broader outcomes (beyond project)

Reduction in the impacts of deer on biodiversity and livelihoods across NSW and Australia

End-of-program outcomes (March 2027)

Recovery* of selected native plant and pasture populations because of feral deer control on site (8)
[*to a level that is able to be maintained at an acceptable level and cost]

*Better understanding of how to deliver an integrated, landscape-scale deer management program and how much deer control is required:
- to enable 'maintenance control'
- to realise biodiversity and agricultural benefits
[* key outcome inferred from the project documents]

More public and private land managers adopt project tools and knowledge

Improved capacity among site land managers to control feral deer using new techniques (modified from 6)

Immediate and intermediate outcomes

Reduction in feral deer to a level that can be sustained long-term on site (7)

Refined intelligence on
- effectiveness of combining different control methods (3)
- the costs of each technique (4)
- recovery potential of selected native species (5)

More land managers (private and public) aware of findings/ how to better control deer

Reduction in feral deer numbers through intensive control (2) - target 70%

Landholders are aware of project, share knowledge and allow access

Better understanding of deer numbers, density and behaviour on site (1)

Greater public awareness of the importance of controlling deer

Outputs

deer controlled

Innovative techniques developed and tested

landholders engaged
landholder agreements

Monitoring program(s) implemented

Communication materials produced

Activities

Aerial- followed by ground-shooting

Initial intensive control of deer

Test efficacy and costs of complementary techniques

Develop complementary techniques (baiting, traps)

Liaise with deer management experts

Develop and trial control techniques

Engage with local landholders

Promote program within local community

Gain the input and support of the community

Monitor deer abundance and condition of native vegetation and agricultural pasture

Monitor the impacts of control

Research on deer home-range, movement and behaviour

Research on deer movement and other relevant issues

Liaise with other land managers

Develop and distribute communication materials

Disseminate findings

5　　Results – Project establishment

5.1　　Overview

This section addresses the key evaluation question: How well has the project been established and what lessons and improvements are there?
In answering this question, we respond to the following sub questions:

a)　　To what extent are key project management documents and processes in place and being used?

b)　　What challenges have there been and what are the implications?

c)　　Are the project governance structures appropriate and how well are they working?

d)　　What other lessons are there from the initial stages of the project?

5.2　　Project management documentation and processes

The program has a range of documentation supporting management, particularly in terms of the operational aspects of the project – camera monitoring protocols, deer trapping standard operating procedures (SOPs) and regular reporting to the NSW Environmental Trust.

Despite project activities being well underway, until early 2021 there was no overarching research and monitoring framework to guide data collection and other program activities. Given the project's focus on monitoring and research this represented a considerable gap that has contributed to the different interpretations of the project objectives and expected outcomes. This gap has been partially addressed with the development of the Deer Monitoring and Research Framework which sets out a clear rationale, conceptual model and set of research questions. That said, the framework remains draft and does not align with the project's objectives and expected outcomes. Specifically, it does not include the "off park" business plan outcomes crucial to project success:

▪　 *Increased uptake from other pest management agencies to utilise the project's tools and knowledge for future feral deer control efforts, and*

▪　 *Increased willingness from other landholders in adopting the new deer management control techniques.*

This omission has resulted in a lack of research focussed on land manager adoption such as assessment of land managers capacity and the identification of barriers to the adoption of new deer control techniques.

While most documentation has a reasonable level of detail, the exception is the planning and framing of project communication and engagement. This is consistent with the point above regarding the project's primarily "on park" focus. Despite the importance of communication and engagement to the adoption outcomes sought by the project the framework contains little specific information about which stakeholders are to be involved in the project, the intent of engagement and how this is planned to occur.

The various plans, frameworks, project logics and other documents sometimes have different interpretation of the project's aims and objectives. There may be value in creating a schematic that identifies the roles and relationships of key project documents. There is also merit in reviewing current documents (including the research framework), to ensure clarity and consistency with project objectives and expected outcomes.

Table 3. Key project documents for the feral deer management project

Document	Overview	Comments
Project management and operations		
Business Plan - Cost-effective cross tenure feral deer management. (Apr 2019)	Environmental Trust template outlining project context, planned outcomes, key outputs, budget, risks, etc.	Provides the 'source of truth' for agreement between the Environmental Trust and NPWS. Content is based on ET template requirements and covers a good range of project-related considerations. Although the template includes outcomes, it does not include a succinct statement of the project objectives (the project vision is reasonable, but a slightly more specific set of objectives would assist.
Project Plan Year 3, 2021-2022. (May 2021)	The operational document for the project, including the "'road map' enabling the effective day-to-day management and control of the project".	Reasonable level of detail across key components expected of a project plan. One key issue, however, is that the plan does not clearly state the objectives of the project. Also, the 'scope' section focuses on the need for detailed ecological research, rather than pointing to the program being about the adoption of control methods by public and private landholders. This might be misleading to new team-members or others using the plan to guide project activities. There is also a general focus on 'outputs and a need for the logic diagram to effectively link between outputs /objectives and outcomes
Annual implementation plan: July 2021-June 2022. (March 2021)	Environmental Trust template for planning activities and budget for the upcoming year.	Provides reasonable level of detail given this is expected to provide the Environmental Trust with an indication of the plan for the year. Note that the focus on outputs (often monitoring plans, reports etc.) often makes it unclear what is actually happening. Including a Gannt chart or similar might help in clearly outlining what is happening when for the upcoming year.
Communication and engagement framework. (no date)	*"… provides a guide for the Cross Tenure Feral Deer Management Project to gain awareness and support from the public and government agencies who may benefit when the project reaches its objectives"*	Substantial amounts of generic 'engagement framework' material rather than project-specific planning. Lacks detail on who is being engaged and how. e.g. refers to "universities", "national committees". Would benefit from more detailed consideration of what is needed from/for each group and how these fits with the project objectives – e.g. what change is desired and how this will be achieved.
Control 2021 Engagement Plan	Appears to be operational-level plan for Aerial Control & Thermal Testing in 2021	Appears to be a high-level checklist of actions. Unclear whether it provides value to the team.
Feral deer project logic. (No date)	One-page logic model outlining key activities and a mix of expected outputs and outcomes.	Good level of detail for a simple program logic, capturing key features of the project in a single page. Would benefit from having a clearer 'line-of-sight' to the project vision/aim as articulated in the business case. It does not talk about broader extension of program and/or the lessons from the engagement with landholders as an outcome of the program.

		Note also that an agreed logic model would ideally be integrated into the project planning documents.
Vision and mission statement	1-page document with project vision and mission	Unclear how this fits with other documentation, including the project logic, project plan and business plan. Note that the vision does not match the vision in the business plan.
Project governance		
Governance framework. Version 3. (2021)	"… provides a framework for the project to establish an advisory committee and panels, to ensure the project meets the NSW public sector policies and codes, as well as meet obligations as grantee."	Outlines the role of key stakeholders/groups in the project at a high level, including the Project Steering Committee, Scientific and Technical Advisory Group and Community Reference Group. Appropriate level of detail as a high-level framework, with detail provided in terms-of-reference.
Terms of reference for project committees. Version 2. (2021)	"… outlines the terms of reference for advisory committees established to support the Cross Tenure Feral Deer Management Project."	Reasonable level of detail for project committees (including guidance on conflict of interest, purpose, remuneration, meeting timing). Lacks detail on committee membership and the member selection process.
Research and monitoring design		
Deer Monitoring and Research Framework. (May 2021)	A document that formalises the research and monitoring processes into a cohesive framework.	Very good overview of the project, its rationale, its underlying assumptions/ conceptual model and the questions it is seeking to address. However, the document remains draft and does not align with all project outcomes.
Ecological Monitoring Plan. Version 3. (Dec 2021)	"… a discussion and selection of survey methods and design that attempts to provide a justified and manageable monitoring program …", focusing on the response of vegetation communities to deer abundance changes because of project activities.	Good level of detail at both a broader design and implementation level. Has been clearly updated in response to feedback, addressing gaps in in the framing of monitoring questions. One key element it does not address is providing statistical analysis of the power of the monitoring design, though the most recent version refers to work by biometrician Dan Krix, and commentary that "all parties were satisfied with the replication, statistical power and capacity of the methodology to answer the research questions"[3]
Aerial Thermal Survey Design. (2020)	Sits under the project's Monitoring and Research Framework 2019-27. Outlines the approach to the aerial transects for surveying deer abundance in the project area.	Provides a good level of detail on the rationale of and approach to the survey.
Camera Monitoring Design. (2020)	Sits under the project's Monitoring and Research Framework 2019-27. Outlines the approach to the camera trap array and	Provides a good level of detail on the rationale of and approach to the camera monitoring.

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[3]   Environmental Trust deer project – Ecological monitoring plan. Version 3. December 2021. David Woods for NPWS. Appendix 2, p. 71

	time-lapse cameras for monitoring deer abundance and activity in the project area.	
Standard Operating Procedure for Clover Trapping of Feral Deer	Developed for officers, contractors, and volunteers of the Feral Deer Project, providing clear procedures and instructions specific to trapping for the feral deer project	Provides a good level of detail on the procedures for clover trapping.

5.3   Key challenges

Project commencement coincided with a difficult time for operations. The Black Summer bushfires and their aftermath were quickly followed by the COVID-19 pandemic and the constraints of public health orders. This impeded project establishment however the project is now making up for lost time. The project is operating effectively on a day-to-day basis, resulting in the successful delivery of activities such as the collaring of deer, aerial shooting and vegetation monitoring site set up and maintenance.

Most interviewees were positive about the recent project achievements, particularly when compared to delivery in the project's first two years. The challenges to project establishment and implementation have generally been well managed, with the project team adapting their approach to and delivery of the project. These challenges have included:

▪   Difficulties hiring and retaining

This was a key issue, particularly during the early stages of the project but remains a key risk. It arises from a confluence of factors, including the regional location of the project, the need for people to relocate there for a temporary position and the range of skills and expertise required by staff (ranging from high-level project management skills to fieldwork skills to research expertise). While the current project manager has a good level of skills and experience suited to the role, stakeholders indicated that the original project manager was not sufficiently experienced for the scale and complexity of the project.

▪   Pre-existing and challenging community relationships

This was an observation made both by NWPS staff as well as landholders. For example, one noted:

The barrier is that these landholders have been brought in and out [of projects and programs] so many times by the NSW government they are fatigued and sceptical. (Interviewee)

This has made the task of engaging and working with landholders although critical to project outcomes, challenging.

▪   Wet weather

Above average rainfall has hampered access to the study area delaying monitoring work. It has also led to high levels of food availability, making baiting more difficult and potentially masking feral deer impacts on vegetation both native and pasture.

▪   Collaboration between the NPWS Operations and the NPWS Programs.

The project is led by NPWS Programs Division and operates on land managed by NPWS Southern Ranges Branch. The project has sufficient resources to operate independently of NPWS Southern Operations Branch. However, because the teams are separate, there have

been issues in coordinating field activities between the project and other NPWS Southern Ranges Branch (e.g. issues with the project shooting while dog trappers are at work). Because the deer team is largely new, there have also been issues regarding the use of different organisational processes. There have also been examples of the project team not receiving the support required to identify and apply those processes or to leverage pre-existing local knowledge. A dedicated liaison officer between the project team and Southern Ranges Branch is recommended.

5.4   Project governance

The Feral Deer Project Governance Framework outlines the governance arrangements and is outlined in Table 4. The central relationship is between the NSW Environmental Trust as grantor with ultimate oversight over project scope and budget and the NSW NPWS as the agency responsible for managing and delivering the project.

The framework identifies three key groups/committees that provide additional oversight, guidance and that serve a consultative function:

- Project Steering Committee
- Scientific and technical advisory group
- Community reference group.

Although the governance structure is appropriate for the project. The Project Steering Committee has had some establishment issues and the advisory groups have not been established.

Key issues appear to have been:

- Landholder representation on the Project Steering Committee.

There is currently only one landholder sitting on the Project Steering Committee. Some interviewees criticised previous landholder members for not being representative of landholders in the area and not acting as effective conduits for information.

We did have a Project Steering Committee with some key individuals but we found they were a bit unreliable. We thought those people were communicating when they weren't … and that did put people's noses out of joint. (NPWS interviewee)

However, other interviewees indicated the loss of these landholder[s] from the committee was problematic:

"Their resignation was not a good thing. We're now struggling to get local landholder representation in committee … [and that] has reflected poorly on us locally as well" (NPWS interviewee)

Although broader representation and consultation is planned through a Community Reference Group, this group has not been established (as of May 2022).

- Misaligned expectations.

Compounding the issue above, there also appears to have been different interpretations of what the project was about and what role the landholder representatives on the committee would have in informing the project scope and implementation.

"Land manager stuff should happen across the whole logic, not a pillar at the side. We used to think we were doing it with the team, but then we thought the deer team thought they were

doing it for us, but actually they are doing it to us … The issue was the culture of engagement and honouring inputs of knowledge from other people". (Landholder interviewee)

▪   Role clarity at agency level.

Some interviewees indicated there could be greater clarity about the roles and expectations of NPWS Programs and NPWS Southern Ranges Branch. This partially links to previously noted challenges relating to the interaction and overlap between the project team and the NPWS Southern Ranges Branch team, including reporting lines and the role of senior staff in decision making.

"As an agency, we need to go have a chat about the governance of the project". (NPWS interviewee)

▪   Lack of technical/scientific oversight.

Although the project has had input from appropriate scientific experts at key points (e.g. in the design of the vegetation monitoring protocol), there was no technical/peer-review mechanism established from the start of the project. In 2021 an external researcher was brought in to review the project and develop the overarching monitoring and research framework. This has been hugely beneficial for the project but has come late in the design process, limiting its influence on key elements of design.

A University of Sydney lecturer is on the Project Steering Committee and supervising a PhD student engaged in the project. A Scientific and Technical Advisory Group is proposed but has not been established.

Table 4. Governance summary - adapted from the Feral Deer Project Governance Framework

Organisation or team	Role in project
NSW Environmental Trust	As grantor, the Environmental Trust approves the Project Business Plan and notes Final Reports
Environment Trust-Invasive Species Technical Review Committee	Endorses annual implementation plans, annual progress reports and final reports
Environment Trust Administration	Oversees the management of the grant. Approves 6-month and Annual Progress Reports, Annual Implementation Plans and variations to the project, including timeframe, budget, and scope. Processes progress payments.
NPWS – Project team	Overall lead of project delivery and reporting. The team includes, Pest and Weeds Unit Manager, Project Lead Manager, 2 Project Support Officers, Technical Officer, Senior Field Officer and Assistant Field Officer.
Project Steering Committee	Provides support, guidance and oversight of the project's progress and ensures the project management aligns with the stated governance principles, identifies emerging risks and ensures the project deliverables are aligned with the approved business plan and budget.
Scientific and Technical Advisory Group	Contributes to understanding and resolution of technical or scientific-related issues within project plans.
Community Reference Group	To ensure that the project adheres to the principles of engagement set by the agency: Purposeful, Inclusive, Timely, Transparent and Respectful. Contributes to project understanding, acts as a conduit for information and advice to and from the community to the project team and represents community interests.

6   Results - Project design

6.1   Overview

This section addresses the key evaluation question: To what extent is the project design appropriate, given its intended outcomes?

In answering this question, we respond to the following sub questions:

a)   Are the project activities aligned with the intended outcomes?
b)   What key assumptions underpin the project and is the project design being adapted in response to learnings?
c)   Is the research/monitoring framework/design likely to provide the answers to key project questions?
d)   Is there a clear and shared vision of success?
e)   Is the planned expenditure on different components in line with the objectives of the project?
f)   To what extent are relevant stakeholders being involved?

6.2   Alignment of activities and outcomes

There is good alignment between the project activities and most of the intended outcomes identified in the Business Plan (Table 5). For example, many of the immediate and longer-term outcomes relate to enhanced understanding of deer numbers in the project area and reductions in deer from control activities. These clearly and logically relate to much of the work being done on the project. However, there are some outcomes that, at this stage, are not strongly supported by project activities. In particular:

- The project is centred on a large-scale knock-down of deer (70% reduction), followed by the assessment of the effectiveness other control works to maintain the reduced abundance. It is not clear, however, whether this will provide the outcome *"refined intelligence on the effectiveness of combining different control methods"*.

- While the project has a much clearer framework for its monitoring and research work now compared to the outset, there is still some ambiguity about what will be learned about the effectiveness of different control methods.

"I can see that the people doing the work would get enormous learning from it, but those lessons are not easily shared in that format" (external stakeholder).

Similarly, one of the ultimate outcomes relates to *"developing and implementing new innovative, cost-effective and humane control techniques".* The project centres on the achievement of this outcome. However, at present the amount of 'new innovative' techniques is limited. Multiple stakeholders spoke positively about the baiting stations being developed by NPWS in partnership with the Centre for Invasive Species Solutions. However, some indicated that this work was well underway before the project and wouldn't require a large amount of resourcing from the project team.

Beyond this, a range of stakeholders indicated and supporting publications suggest:

- aerial shooting for deer is a relatively common practice

- thermal techniques are commonly used by private and commercial operators and other land managers

- deer fencing and trapping work is currently being trialled by related projects.

That said, several interviewees highlighted landholder interest in trialling paddock scale traps.

"I suspect realistically, at end of project, we will have a good bait feeder for some very particular situations but not really for widespread use and know a bit more about how to improve efficiency of monitoring and aerial shooting but I'm not expecting any revolutionary changes in deer management from this project" (external stakeholder).

Interviews with the project team highlighted a general sense that research into innovative control techniques would be elevated in Phase 2 of the project. However, they identified risks that sufficient time and resources may not be available. There are also risks that sufficient willing landholders to engage in these trials may not be available.

"From my understanding, Phase 2 will be a lot of innovative control…baiting, fencing, experimental design. In terms of planning resources, I think we can get by, but implementing it and monitoring - Our on-ground field monitoring resources are slim and we need to think about future resource allocation". (Project team interviewee).

The two final outcomes that do not currently align with project activities are:

- Increased uptake from other pest management agencies, and
- Increased willingness from other landholders in adopting the new deer management control techniques.

Both outcomes relate to stakeholder engagement and research into behavioural change. As discussed, the communications and engagement plan is high level and lacks any detail regarding the achievement of these outcomes. Given that these outcomes are core and challenging, addressing this gap should be a priority. The private landholder adoption outcome may be best integrated into the recommended private landholder focussed project as discussed in section 6.7.

Table 5. Project outcomes as identified in the Business Plan and our assessment of whether there are planned project activities that clearly aligned with these outcomes.

Timeframe	Outcome	Aligned activities
Immediate outcomes (by September 2022)	Increased understanding of deer numbers, density and behaviour on site	Clear alignment: Extensive effort being put into aerial surveying, camera traps, movement tracking using GPS collars
	Reduction in feral deer numbers through intensive population control	Clear alignment: Intensive control planned via aerial shooting and other control techniques
	Enhanced capacity to deploy new cost-effective control technologies	Moderate alignment: The project is setup to identify cost-effective control methods. It has so far made progress on developing a new bait-feeder and this is the indicator of success in the business plan. However, it is unclear what other 'new' technologies might be developed and, importantly, how they will be deployed (i.e. extended to and adopted by landholders and land managers).
	Expanded resources to deliver control techniques	Clear alignment: Additional staff (supported with additional resources) are actively controlling deer in the project area

	Raised public understanding of the impacts of deer	Clear alignment: Communication (e.g. newsletters) with local landholders, involvement of community members in Community Advisory Group (planned), development of promotional videos (planned). The caveat is that the target for views of promotional videos is very low (100) and, therefore, the overall value/cost-effectiveness of this approach is questionable.
Intermediate outcomes (August 2024)	Refined intelligence on the effectiveness of combining different control methods to reduce deer populations	Moderate alignment: Primary work is focused on how much a large-scale knock-down costs and whether follow-up control efforts are then sustainable at a lower level. Unclear whether alternative methods for 'knock-downs' are being considered, what the future combinations might be and/or how they will be assessed 'in combination'. Unclear how transferrable the lessons will be to other contexts.
	Increased knowledge of the costs involved for each type of control technique	Clear alignment: Plans to collect cost data should lead to this outcome
	Greater evidence of recovery potential of selected native species	Clear alignment: Substantial effort is being put into monitoring native species and how they might recover in the absence of deer (acknowledging there are potential issues with the monitoring design as discussed in Section **Error! Reference source not found.**)
	Provide insight for other relevant organisations regarding the project tools and implementation efforts	Moderate alignment: Other organisations are involved in the project steering group but other engagement activities are unclear at this stage
	Raised public awareness of the need for a landscape scale management approach for deer	Clear alignment: Communication (e.g. newsletters) with local landholders, involvement of community members in Community Advisory Group (planned), development of promotional videos (planned). The caveat is that the target for views of promotional videos is very low (100) and, therefore, the overall value/cost-effectiveness of this approach is questionable.
Ultimate outcomes	Improved capacity to control feral deer through developing and implementing new innovative, cost-effective and humane control techniques	Moderate alignment: The entire project is setup to identify cost-effective and humane control techniques. It has so far made progress on developing a new bait-feeder but it is unclear what the other 'innovative' techniques might be.
	Reduction in feral deer numbers to a level that can be sustained long term on site	Clear alignment: The combination of aerial and ground shooting as well as other techniques is directly aligned with this outcome.
	Recovery of selected native plant and pasture populations because of feral deer control on site	Clear alignment: The reduction in deer (through a variety of techniques) is directly aligned with this outcome.
	Increased uptake from other pest management agencies to utilise the project's tools	Moderate alignment: There is some involvement from other agencies through the Project Steering Committee and select initiatives (e.g. analysis of

	aerial surveys). There is no clear strategy (including in the communications and engagement strategy) for how this longer-term outcome will be achieved.
Increased willingness from other landholders in adopting the new deer management control techniques	Moderate alignment: Landholders have been involved in the Project Steering Committee and are expected to participate in the Community Advisory Group, but there is no clear strategy for how other landholders will be encouraged to adopt the new techniques (currently limited to some awareness raising activities)

6.3   Key assumptions and evidence of adaptation

There are several key assumptions that underpin the project. The project has already shown good evidence of adapting to learnings about these assumptions as it has rolled out. Table 6 outlines the key assumptions from the Project Plan[4], along with several additional assumptions identified in the Business Plan.

Table 6. Key project assumptions and evidence to date from the project

Assumption	Evidence to date
Assumptions from Project Plan	
High numbers of deer in project study site	Aerial surveys indicate this is a valid assumption, with the February 2022 survey suggesting there are almost 4000 deer in the project area.[5]
Deer causing impact to environmental systems	Previous research shows this is a reasonable assumption and early evidence from vegetation monitoring shows impacts from browse damage likely attributable to deer.[6]
Feral deer can be removed at greater than 70 percent of calculated population	Assumption to be tested
Elimination of >70% of Feral deer herbivory and trampling, will increase biomass and vegetation condition	Assumption to be tested
Output products will be cost effective	Assumption to be tested
Demonstrated uptake of cost beneficial control tools	Unclear if this will be tested as part of the project
Deer control is within the invasion curve part that is feasible to control but not eradicate.	Unclear if this will be tested as part of the project
Additional (non-overlapping) assumptions from Business Plan	
Sharing knowledge and tools from this project will lead to more successful pest management for deer across NSW	Likely beyond the project scope to test

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[4]   Project Plan Year 3, 2021-2022. May 2021
[5]   Mt Kosciusko, Thermal Surveys February 2022. March 2022. O'Dwyer-Hall, E. Department of Primary Industries
[6]   Vegetation monitoring results November 2021. NPWS

There are many landholders beyond this project who want to reduce the impact of deer on their properties	Unclear if this will be tested as part of the project
The pest management sector will apply this project's newly found knowledge	Unclear if this will be tested as part of the project
Public understanding of the benefits of broad scale deer control will provide long term support for effective deer management	Likely beyond the project scope to test
An informed public will support the project's outcomes	While the project has been supported among community members in the project area, there have been tensions and issues (as detailed in Section 6.7)

6.4   Research/monitoring design and project objectives

This section explores whether the research/monitoring design is likely to provide the answers to key project questions. This is important as the project aims to encourage change in deer management practice for a range of land mangers public and private. Changing practice is difficult and the evidence supporting change will be carefully scrutinised. The research and monitoring design has emerged as a key issue as the project has been designed and implemented.

In the early stages of the project, a range of research activities were initiated with the objective of setting baselines prior to the scheduled large scale deer control activity labelled the "knock-down'. These activities included:

- camera-trap arrays

- aerial survey methods

- GPS-collaring of deer

- deer movement and behaviour using DNA analysis of scats

- an ecological (vegetation) monitoring plan, which included erecting exclusion fences and vegetation surveys.

These activities commenced in the absence of an overarching and co-ordinating monitoring and research framework. In response a LLS expert was engaged in 2021 to develop the projects monitoring and research framework. The draft framework provided a clear conceptual model and articulated a set of monitoring and research questions to guide experimental design and data collection.

[We built] into the research framework the knockdown. They were trialling methods and doing different things all over the place, but so many other variables influence the system, so if you want to look at any effects [of control] you have to make it a strong one. (project team member)

Importantly the aims of the draft framework are based on the Office of Environment and Heritage Scientific Rigour Statement[7]. The statement requires, appropriate design, meticulous implementation and the objective analysis and reporting of results. The draft framework was developed at a similar time to a review of the ecological monitoring plan. This review highlighted several limitations to the current monitoring design including:

- Lack of clarity whether the monitoring will be sufficiently powerful (in the statistical sense) to detect changes at time scales relevant to the deer project

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[7]   https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Research/Our-science-and-research/scientific-rigour-position-statement.PDF?la=en&hash=0E2C793A95EB9EDB280062B6F2BFF9DADB620D07

- That the exclosure design may not be able to address a research question about the impacts of herbivores on native vegetation (during the life of the project) because the unfenced plots are expected to have reduced abundances of deer (as per the primary aim of the project) and may, in fact, be similar to the two fenced treatments

Some of these issues have been addressed with modified methods, though others were considered to be unfeasible within the scope of the project.

To inform this evaluation the Commission engaged Dr Tony Pople of Biosecurity Queensland to independently review the project's experimental design. He provided commentary against each of the main questions in the draft framework. **Table 7** summarises his feedback and his full report is provided in **Appendix 1**.

The key points to note are:

- The lack of nil-treatment areas in the experimental design will limit interpretation of the data and ultimate conclusions.

- The project should be able to provide evidence in relation to deer control. This includes information on the cost-effectiveness of different control techniques (in terms of cost per deer) and insights on how different approaches might be best deployed.

- The flow-on impacts of control activities on deer populations should be reasonably clear for the 'knock-down' because of the scale of the intervention.

- Understanding and attributing population impacts from later control works will likely be less clear because of the lack of a control and ability to account for external factors, density-dependent mechanisms, etc.

- Vegetation monitoring is detailed and should provide a wealth of data. However, there is a risk it will not show clear impacts and/or be difficult to attribute changes to changes in deer abundance.

Another point emphasised by the external reviewer was the range of related deer management research underway including:

- assessments of aerial and ground shooting

- reviews of deer fencing and trapping

- the development and testing of a deer selective feeder

- a report on the economic cost of feral deer in Australia.

He noted the importance of this project considering and drawing on the results in both the refinement of methods and during data analysis and interpretation.

Table 7. Summary of independent review of project design. Monitoring/ research questions are documented in the project evaluation plan and were originally drawn from the Business Plan and the Deer Monitoring and Research Framework

Monitoring / research question	Key points from review	Likelihood of addressing key areas of interest
Have different combinations of control methods resulted in different outcomes for deer populations?	- Data on the cost-effectiveness of individual control methods will be collected, so that the best combination can be estimated - Project is missing nil-treatment control to understand population	Likely to provide some information but may be gaps in what can be confidently concluded for key areas of interest – There should be good information on the different effort/cost per deer removed. There will be some insights on the flow through impacts on deer populations but

		outcomes in the absence of control methods.	attribution will be less clear as there are a range of other factors at play.
What is the optimal strategy for conducting a deer population knock down based on our knowledge of deer distribution, abundance, movement and sociality and deer control expert knowledge?	▪	Data from several activities can be combined to answer this	Likely to provide reasonable insight on key areas of interest – there should be good information on strategies for culling large numbers of deer (i.e. a 'knock-down').
Does the deer population decrease by 70% (± 10%) in the project area as a result of the population knock down intervention?	▪ ▪	With an accurate estimate of abundance from the thermal aerial survey the immediate percentage reduction from the cull can be calculated. Additional surveys will be needed to determine the impact of further culls on population size as the population fluctuates (up or down) over time.	Likely to provide reasonable insight on key areas of interest – there should be good information on changes to the deer population in the project area (though perhaps not to the level of accuracy suggested). The attribution to the project should be reasonable in the short term.
Has the initial reduction in deer numbers been maintained? (Series of questions on population trends)	▪ ▪	Regular monitoring by aerial and ground survey (camera grids) will answer this. Unfortunately, there is no nil-treatment area to indicate what would have happened without the control.	Likely to provide reasonable insight on key areas of interest – There should be good information on the population, but longer-term attribution will be less clear as there are a range of other factors at play.
How many deer are removed from the project area by each deer control method over the life of the project and how much time does it take? What species, age class and sex were removed?	▪ ▪ ▪ ▪	Numbers shot and, importantly, species should be known Deer removed by baiting will have to be estimated Determining age and sex will be tricky for all but ground shooting. The camera data will provide an estimate of population age structure and thus an indication of the selectivity (age, gender, species) of control methods	Likely to provide reasonable insight on key areas of interest
How much do different control techniques 'cost' to implement?	▪	There is a plan is to gather this data, which should be straightforward	Likely to provide reasonable insight on key areas of interest
Can we refine effectiveness of control techniques using intelligence gained from	▪	The response of collared individuals will be particularly instructive	Likely to provide reasonable insight on key areas of interest

monitoring deer abundance, distribution, movement and sociality? (Series of questions on deer ecology useful to management)	▪ Much of this work will be undertaken in a PhD project supervised by the University of Sydney, which is appropriate as it is a discrete project	
What is the impact of deer and other herbivores on vegetation communities (including agricultural pasture) within the project area? (Series of questions on deer impact on vegetation)	▪ vegetation change in the project area is being monitored sufficiently well to provide answers to many questions ▪ the interpretation of change will be difficult, particularly the impact of deer, because of a lack of a nil-treatment ▪ it may thus be difficult to attribute vegetation change to reduced deer abundance	Likely to provide some information but may be gaps in what can be confidently concluded for key areas of interest - The lack of a control and the short period of monitoring before the knockdown will make it difficult to clearly link changes to deer.
Does deer movement between open and vegetated areas potentially bias thermal aerial population estimates? If so, can correction factors be developed?	▪ Distance sampling should accommodate different detectability of animals in open or closed vegetation. ▪ With more sightings in open areas, a flatter detection function is modelled resulting in higher overall detection probability. ▪ If vegetation cover is recorded, then it can be included as a covariate in the modelling	Likely to provide reasonable insight on key areas of interest
Is there an improvement in detectability using thermal binoculars for ground and aerial surveys of deer? If so, by how much?	▪ McCarthy (2022) reports improved detection of deer in the study area using thermal binoculars when temperatures were slightly cooler (<12oC).	Likely to provide reasonable insight on key areas of interest
How much do different monitoring methods 'cost' to implement?	▪ The costs can be readily calculated from operational (e.g. helicopter charter) and labour costs. ▪ The frequency of monitoring will obviously greatly influence the cost and should be carefully considered ▪ Biannual aerial surveys need to be defended and a better use of funds may be to annually monitor a nil-treatment area as well as the project area	Likely to provide reasonable insight on key areas of interest – the outstanding question here is what the different methods cost relative to the information they provide/their accuracy

6.5   Is there a clear and shared vision of success?

There are a range of project documents that identify project aims, objectives and outcomes. However, project documentation and interviews with the project team and stakeholders suggest that the vision for the project is not clear and consistent. An example is a vision and mission statement developed by the project team which focusses on park outcomes rather than the cross-tenure objectives of the project business plan.

The project business plan states that the project aims to: *develop new cost-effective, humane and coordinated control techniques for feral deer in NSW to ensure population levels can be managed sustainably by land managers into the future.* In contrast, a more recently developed project vision and mission statement outlines the vision as: *Effective and coordinated pest control that protects biodiversity in NSW National Parks.*

Comments from interviewed stakeholders further highlighted confusion regarding the project's focus. While some stakeholders identified the primary focus to be deer control, others emphasised the research element of the project. One interviewee noted

"Is this research trial or pest control project? We need to define it and make sure we achieve that". (stakeholder)

There is no reason why the project cannot achieve a number of related outcomes. It is recommended that carefully crafted project communication is prepared that clarifies the outcomes the project seeks. Maintaining a shared understanding of project outcomes should also be a primary objective of the communication and engagement strategy. It is also recommended that key documents are reviewed and amended to ensure consistency and that the Project Steering Committee approve strategic project documents prior to adoption.

6.6   Alignment of expenditure and objectives

The project design section of the evaluation framework includes the question: Is the planned expenditure on different components in line with the objectives of the project? Project records show a substantial underspend on the project so far:

▪ $831,729 in year one

▪ $393,859 in year two.

This underspend has been largely due to the delays in project establishment including the engagement of a full complement of staff. Although these reasons are understandable it is indicative of the volume of work that remains outstanding. The project has many years remaining so there is time to achieve the project's expected outcomes. That said the risks to the project schedule from seasonal and other factors are significant and need to be managed effectively.

Project schedule constraints may pose risks to the achievement of project outcomes particularly those relate to activities on private land. It is recommended that the NPWS and the NSW Environmental Trust use the formative evaluation as an opportunity to revise the project plan and schedule.

The revision of the business plan should also include a reassessment of project risks. Currently project activities are generally arranged sequentially. The revision should consider how some project activities can operate in parallel. For example including a sub-project led by the South East LLS that focusses on the private landholder control methods as means of addressing both the project schedule and underspend issues.

Information is available for overall staff costs, consultant costs, administration costs and capital expenditure. However, as the project aims to assess cost effectiveness, going forward there

should be an increased focus on maintaining records of expenditure of the different control methods. The cost of control methods is a primary barrier to land manager adoption and accurate information is important.

6.7   Stakeholder involvement

The project team has engaged with a range of relevant stakeholders in the design and delivery of the Feral Deer project. This engagement is primarily through the function of the Project Steering Committee which is chaired by the DPI Manager of invasive species strategy and includes the General Manager of the South East Local Land Services. As discussed, there is currently no Science and Technical Advisory Group or Community Reference Group established. Both are at the Expressions of Interest (EOI) stage.

Researchers

The project team consults with relevant experts, including research scientists within the DPI Vertebrate Pest Research Unit (VPRU) and academics and students from the University of Sydney who have research projects impeded in the project. The project team has also engaged with the NSW Local Land Services regarding deer research. Project team representatives also attended a multi-agency conference on alpine ungulate research and management. There has been limited engagement with researchers investigating landholder engagement and the project would benefit from such input. Some interviewees commented on the possibility of involving other agencies with specific knowledge of behavioural science as particularly relevant to the landholder engagement and adoption component of the project. The DPI VPRU have been working with the LLS in this regard and further involvement of the LLS in landholder engagement is recommended. Considering the current engagement with researchers a formalised Science and Technical Advisory Group may not be required. That said a technical reviewer external to the NSW Government may add value.

Related Projects

Interviewees and external reviewers highlighted that there are a range of related programs and research being undertaken in parallel (both in the state, or in Australia more broadly) that are relevant and complementary to this project. This includes the NSW Feral Cat project that has also been funded through the Environmental Trust, as well as the Illawarra Wild Deer Management Program and other work being funded by the CISS (see Section 5.4). Interviewees suggested that the project team would benefit in further engagement with these projects to leverage insights and reduce potential duplication of research efforts.

General Community

The project team noted that community engagement is not without risks as the project is contentious, particularly with the recreational hunting community. The local community receive mailouts to inform landholders of the project and gauge their interest to be involved. Quarterly newsletters provide updates on project progress, achievements and upcoming activities. Local landholders receive email notifications that aerial shoot activities are occurring in the area. The project team noted that they have been utilising the existing local (Southern Ranges Branch) Regional Advisory Committee (RAC) as a way to engage the broader community, though meeting is infrequent.

Landholders in the study area

The misalignment of landholder and project team expectations evident in project establishment remains. While there is currently one landholder representative on the Project Steering Committee, interviewees noted that this landholder does not often attend meetings. The proposed community reference group has not been established. That said some landholders interviewed are content with the engagement to date. Interviewees suggested that most landholders only want to be notified and kept up to date on progress. However, it is clear that

some landholders want to be heavily involved in project implementation particularly in terms of 'participatory research' and collaboration. Balancing these expectations is a challenge that needs to be addressed and greater involvement of the South East LLS may assist. There was a suggestion made that NPWS should consider paying a sitting fee to the landholder representative on the Project Steering Committee to incentivise attendance and engagement. While there was an acknowledgement that this may not be in line with NPWS's general processes and policies, the fact that this is an externally funded project may enable the project team to consider the option.

Some interviewees made suggestions that the deer movement data from the deer collars could be used to boost landholder engagement and interest. Platforms such as Movebank[8] can facilitate this process whilst addressing privacy concerns

"There's a lot of people both internal and external very interested in the project and it's a very exciting project. We talked about a bi-monthly map or newsletter or posting it on the website, but that feedback needs to occur more often. It can help overcome myths about 'deer only do this or live here' because it's reality on your screen". (external stakeholder).

6.8   Other findings to date

In addition to the findings on project design and implementation above, other findings that have emerged from the initial stages of the project are:

- The establishment of complex projects take time. Ensuring critical project elements are in place before commencement is critical to the management of project risks. Extending project schedules are likely to create less risks than starting prematurely. Recovering a project from initial missteps is difficult.

- The management of complex projects is difficult demanding a blend of skills. Identifying and prioritising selection of an appropriately qualified and experienced manager at the formative stages of a project of this scope and scale is critical.

- In terms of day-to-day project management, several interviewees suggested the project team could consult with Southern Ranges Branch staff earlier in planning key activities. This would help provide enough time for those operational staff members to provide appropriate input and provide support.

- The project identified the different strengths of the relevant NSW government agencies. The NPWS have substantial experience and expertise in the on-ground management of pest species. The DPI Vertebrate Pest Research Unit are adept in designing and implementing research projects. The LLS may be best placed to guide and/or support landholder engagement. Recognising these strengths in developing future projects of this type will help them to be more efficient and effective.

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8   https://www.movebank.org/cms/movebank-main

Attachment 1- Independent review of project design

Evaluation of NSW cross-tenure feral deer management program 2019-2027

Report to the Natural Resources Commission, NSW

Dr. Tony Pople

May 2022

Introduction
This report considers whether the project design adequately addresses a set of questions in the Evaluation Plan (Gilmour & Donahue 2021). The questions are itemised in Table 3 of the Evaluation Plan. It forms part of 'NRC formative evaluation #1' (Dawson 2021a), undertaken in the early stages of the 8-year project. This report initially provides detailed comment on the overall design and methods. It then provides briefer comment on each of the questions in Table 3 of the Plan.

Project design
The project area encompasses 285 km2 in the southern end of Kosciuszko National Park and adjoining private land. Deer culling (= the population knock-down and follow-up control) will occur in the area along with monitoring of deer abundance and vegetation. Control tools will also be assessed. Unfortunately, there are no nil-treatment areas (i.e. experimental controls) with which to compare the response to culling. Dawson (2021a) explains that was beyond the scope of the project. Presumably, that means that monitoring of nil-treatment areas could not be afforded.

Deer population dynamics
The lack of nil-treatment areas will limit interpretation of the data and ultimate conclusions. The problem is that it is unknown how population density would have changed without the knockdown. There is an assumption that it would have remained the same without culling. Density prior to culling is treated essentially as the control. If the population is increasing at 30% per year, then a cull of 30% of the population may result in no change in density after one year. Similarly, if the population is declining at 30% per year, say in a drought, then a 30% cull may see the population decline by 60% after one year (if culling is additive to natural mortality), or it may result in only a 30% decline (if culling is 'compensatory' as culled animals would have died anyway in the drought).

An aerial survey of the project area prior to the cull will provide an estimate of absolute abundance (see below) to allow the tallied cull to be calculated as a percentage of population size and how close this is to the target of 70%. However, the ability of land managers to hold the population at a lowered density will depend on the rate of increase of the culled population. The latter will be influenced by the potential rate of increase stimulated by the reduced density, but also by the potential rate of increase determined by prevailing seasonal conditions. The latter is best provided by nil-treatment areas.

Vegetation recovery
Whether a 70% reduction in population size is sufficient or indeed exceeds the reduction required for acceptable deer impact will depend on the vegetation monitoring. However, the lack of nil-treatment areas also affects interpretation of the vegetation monitoring. Following the knock-down, vegetation being grazed and browsed by a high-density deer population can no longer be measured. The assessment of feeding impacts of deer is based on a comparison between exclosures and other vegetation sampling with deer at reduced density and between

that sampling and the sampling prior to culling. However, the sampling prior to culling (i.e. the baseline) is limited. Feeding impacts of deer at high density in nil-treatment areas across a greater range of seasonal conditions may well be required to quantify the effects of reducing deer density.

Change in vegetation in the culled area can be ascribed to feeding by different suites of herbivores by comparing exclosures. There may be no difference in vegetation change between zero and reduced density of deer in the project area, as recognised by Dawson (2021b) and Woods (2021). Exacerbating this, the effect of rainfall on plant growth may override the effects of herbivore grazing and browsing. In contrast, there would be a greater contrast with vegetation change seen under high deer grazing pressure in nil-treatment areas.

Vegetation in the project area prior to culling is treated as the baseline and so is equivalent to a nil-treatment area. This assumes that it would have remained stable which is clearly false. Without culling, the vegetation will obviously change in biomass, composition and structure over time. As an extreme example, high rainfall may change the biomass and composition of the vegetation over a few years so that it is markedly different despite grazing by mammalian herbivores. A pre-culling baseline with a short time series allows the change to be quantified but cannot provide the explanation.

Nevertheless, vegetation change in the project area is being monitored sufficiently well to provide answers to many questions in Table 3 of the Evaluation Plan. It is the interpretation of change that will be difficult, particularly the impact of deer, because of a lack of a nil-treatment comparison.

Recommendation
There will be a reluctance to change the project design at this stage. There are some low-cost options to include at least one nil-treatment area. Aerial surveys are flown twice per year with no reason given for that frequency. A single survey could be flown annually allowing the savings to be used on surveying a nil treatment area. This would provide data on the dynamics of an unculled population. The program of vegetation sampling is labour intensive, time consuming and costly, making it less feasible to replicate in another area. There are cost-effective sampling methods (e.g. Bennett et al. 2021) that could be used in a nil-treatment area but would also need to be applied in the project area for comparison. These methods though, cannot separate the feeding impacts of macropods and deer on vegetation <1 m, which is a benefit of the partial exclosures. Finally, a conceptual model, more detailed than that presented in the Deer Monitoring and Research Framework (Dawson 2021, Figure 1), should be developed to support the project design, identify its limitations and help interpret results. This was recommended by Dawson (2021b).

Aerial surveys
Aerial surveys are a cost-effective method for monitoring deer abundance over time. Feral horses have been surveyed recently in the National Park using helicopters and distance sampling (Cairns 2020) and previously (Laake et al. 2008). The difference here is that thermal imagery rather than human observers is being used. The survey design has yielded reasonable precision (CV=29%, Dawson 2021a) although this may worsen as density declines through culling. Thermal imagery is increasingly being used in aerial surveys, including to survey fallow deer in Tasmania (Lethbridge et al. 2020), kangaroos in Victoria (Lethbridge et al. 2019) and feral pigs in Queensland (Matt Gentle, Biosecurity Qld, and Tarnya Cox, NSW DPI, unpublished data).

A limitation is the inability to routinely distinguish individual deer species (Dawson 2021a). The species mix will need to be determined by ground survey such as from the various camera traps used in the project area. It is well known that the raw counts from aerial surveys need correction as animals are missed. Detection probability (p) is <1. Distance sampling goes some way to correcting for incomplete counts by recording distances of sighted animals from the transect and then modelling detection probability from these data.

An important assumption in distance sampling is that animals are not missed on the transect line. Correction for this is possible using mark recapture distance sampling (MRDS, Burt et al. 2014). Using thermal surveys rather than human observers should increase detection probability. It is still likely that deer abundance will be underestimated in the project area using thermal aerial surveys given the vegetation and cryptic nature of deer, particularly sambar. I have not seen reports on the thermal survey in the project area so MRDS may in fact be being used.

It is being trialled with thermal surveys of feral pigs in southern Queensland (Matt Gentle and Tarnya Cox unpublished data). Deer density could therefore still be underestimated by aerial survey. If the underestimate is constant over time, then population trend will still be accurately determined. The two camera grids will usefully provide alternative estimates of trend and abundance as well as provide a proportional breakdown of the three species. Support for the application of camera grids in the project has recently been published (Bengsen et al. 2022a) and outlines their design and analysis. That study included two grids in Kosciuszko National Park providing 'plausible' and precise estimates of abundance of fallow and sambar deer.

Ability of the project to address specific monitoring or research questions
Below are comments on questions compiled in Table 3 of the Evaluation Plan (Gilmour & Donahue 2021). These were drawn from the Business Plan (Russell 2019) and the Deer Monitoring and Research Framework (Dawson 2021a).

Have different combinations of control methods resulted in different outcomes for deer populations?

It is unclear exactly what combinations of methods will be used to cull deer. Aerial culling will provide the knockdown then ground shooting and possibly baiting and trapping will be employed. Essentially, the reduction in deer numbers will be quantified, but the optimal combination of control methods may not have been used. Data on the cost-effectiveness of individual control methods will be collected, so that the best combination can be estimated. This could be done in a simple modelling exercise. An alternative and ideal approach would have been to undertake a management experiment with different control methods (or combinations) as treatments and nil-treatment areas as controls. These have been conducted in New Zealand (Forsyth et al. 2013) and in Victoria's Alpine National Park (Sebastien Comte, NSW DPI, unpublished data).

Research is being undertaken on the efficacy of deer control by other groups, particularly in a program of the Centre for Invasive Species Solutions (CISS). This includes assessments of aerial and ground shooting, reviews of deer fencing and trapping and development and testing of a deer selective feeder, which would be required to administer a bait to a deer population. A report has also been commissioned on the economic cost of feral deer in Australia. This current Environmental Trust project will be able to draw on the results of the CISS projects in refining its methods and during data analysis and interpretation.

What is the optimal strategy for conducting a deer population knock down based on our knowledge of deer distribution, abundance, movement and sociality and deer control expert knowledge?

Data from several activities can be combined to answer this. Again, modelling can help, but it will need to incorporate deer population dynamics and space use (i.e. spatio-temporal).

Does the deer population decrease by 70% (± 10%) in the project area as a result of the population knock down intervention?

With an accurate estimate of abundance from the thermal aerial survey (see above), the immediate percentage reduction from the cull can be calculated. Additional surveys will be

needed to determine the impact of further culls on population size as the population fluctuates (up or down) over time.

Has the initial reduction in deer numbers been maintained? (Series of questions on population trends)

Regular monitoring by aerial and ground survey (camera grids) will answer this. Unfortunately, there is no nil-treatment area to indicate what would have happened without the control.

How many deer are removed from the project area by each deer control method over the life of the project and how much time does it take?

What species, age class and sex were removed?
Numbers shot and, importantly, species should be known, although landholder and volunteer shooter data may be less reliable. Deer removed by baiting will have to be estimated approximately by those seen taking bait on camera. Determining age and sex will be tricky for all but ground shooting. The camera data will provide an estimate of population age structure and thus an indication of the selectivity (age, gender, species) of control methods. Data to be collected are identified in Table 3 of the Deer Monitoring and Research Framework.

How much do different control techniques 'cost' to implement?

The plan is to gather these data, which should be straightforward. Recent studies (e.g. Bengsen et al. 2022; Sebastien Comte unpublished data) have estimated the costs of controlling deer by aerial and ground culling. These will provide useful comparisons.

Can we refine effectiveness of control techniques using intelligence gained from monitoring deer abundance, distribution, movement and sociality? (Series of questions on deer ecology useful to management)

Culling becomes harder as a population is reduced as animals learn to avoid helicopters and ground hunters or there is selection for wary animals. Certain habitats may be difficult to access and so will harbour survivors. The response of collared individuals will be particularly instructive. Likely responses of the deer population have been outlined in the Deer Monitoring and Research Framework. Much of this work will be undertaken in a PhD project supervised by the University of Sydney, which is appropriate as it is a discrete project.

What is the impact of deer and other herbivores on vegetation communities (including agricultural pasture) within the project area? (Series of questions on deer impact on vegetation)

This has been discussed above. Change in vegetation over time is being monitored under grazing by different herbivore groups, including zero and reduced deer density. The benchmark or baseline is the state of the vegetation prior to a knockdown of deer. However, there is no nil-treatment area for comparison to account for vegetation changes due to seasonal factors (e.g. rainfall). It may thus be difficult to attribute vegetation change to reduced deer abundance. Change in vegetation over time is nevertheless being quantified in the project area, answering many of the subsidiary questions.
Reducing deer abundance may not result in detectable changes in vegetation, which was recorded by Ramsey et al. (2018) in New Zealand forests. This may be due to several factors. Deer may not be reduced to sufficiently low densities for long enough to alter vegetation. Rainfall and other abiotic factors may have a greater influence on vegetation biomass and composition. Finally, feeding by other herbivores may overshadow the effect of deer grazing and browsing. Both Dawson (2021b) and Woods (2021) recognise the need for long-term monitoring beyond the end date of the project to detect vegetation change and attribute this to a reduction in deer numbers.

There are a number of vegetation targets identified in the Business Plan such as percentage increase in abundance and condition of particular plant species. Regardless of whether these are true indicators of recovery or improvement in vegetation state, they are quantifiable and success in achieving targets can be determined. The monitoring program will provide progress towards these targets.

Does deer movement between open and vegetated areas potentially bias thermal aerial population estimates? If so, can correction factors be developed?

Distance sampling should accommodate different detectability of animals in open or closed vegetation. With more sightings in open areas, a flatter detection function is modelled resulting in higher overall detection probability. If vegetation cover is recorded, then it can be included as a covariate in the modelling. As explained above, detection on the line may not be certain (i.e. $p(0)<1$), particularly in closed vegetation, but this can be quantified using mark-resight methods (MRDS). This should work as long as all animals are 'available 'for detection. Some animals may be hidden from both the thermal imager and human observers and so unavailable for detection. This potential bias can be minimised by surveying at times when animals are unlikely to be in areas where they are undetectable. Alternatively, a comparison with ground surveys (e.g. camera grids) can quantify the bias (i.e. estimate a correction factor).

Is there an improvement in detectability using thermal binoculars for ground and aerial surveys of deer? If so, by how much?

McCarthy (2022) reports improved detection of deer in the study area using thermal binoculars when temperatures were slightly cooler (<12oC). This is consistent with thermal imagers operating best when there is a strong contrast between the sighting target's temperature and the surrounding environment. Another explanation is that thermal binoculars and sighting with the naked eye were equally bad at detecting deer at warmer temperatures when animals are perhaps behaving differently (e.g. resting). The actual detection probability of animals would be needed to resolve this.

It is unclear how the thermal binoculars are to be used in an aerial survey. The study results were not from an aerial survey and so cannot be simply extrapolated to one. It compared numbers seen from a hovering (i.e. stationary) helicopter at 500 feet with observers seated on the floor facing out. This is quite different to observing deer for density estimation on an aerial survey, where observers are in seats facing forwards and the helicopter is travelling at ~30-50 knots @ 200-220 feet. The thermal aerial surveys flown in the project area use a thermal imager mounted in the helicopter rather than hand-held thermal binoculars.

How much do different monitoring methods 'cost' to implement?

The costs can be readily calculated from operational (e.g. helicopter charter) and labour costs. The frequency of monitoring will obviously greatly influence the cost and should be carefully considered. Biannual aerial surveys need to be defended and a better use of funds may be to annually monitor a nil-treatment area as well as the project area (see above).

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Attachment 2 - Example of project objectives

As outlined in the recommendations in Section 3, the NSW Environmental Trust should consider requiring projects to develop project objectives. This goes beyond the vision statement to provide a clear set of priorities and integrated actions for guiding the project. As an example, we have developed a set of three primary objectives for the feral deer project based on the outcomes and research/monitoring questions in key project documents.

Figure 2. Example project objectives for the feral deer project.