Managing deer and goats on public conservation land

A tool for selecting priority sites

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Department of Conservation
Te Papa Atawhai

New Zealand Government
Te Kāwanatanga o Aotearoa

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Summary

The New Zealand Department of Conservation's (DOC's) Wild Animals Management Programme is guided by the Te Ara ki Mua framework, a key objective of which is to undertake deer and goat control at priority sites.

To meet this objective, the Landscape Threats Advice team in DOC's Biodiversity, Heritage and Visitors Group were asked to lead the development of a system to identify priority sites for deer and goat management. A Design Team supported by a Reference Group of subject matter experts developed a tool that could prioritise sites based on their values, the threats of deer and goats to these values, the feasibility of management, and any complementary work at the sites.

A total of 482 sites were considered appropriate for management, each of which was ranked in order of priority and by management strategy (suppression, containment, exclusion or eradication). A shortlisting exercise was then undertaken that identified 42 sites to be sent to DOC Operations for detailed planning and a feasibility assessment.

There was general agreement that the outputs of the prioritisation tool reflected subject matter expert evaluations of the relative priority of sites for management. However, it was also noted that the separation between sites that were closely ranked was arbitrary at the site level, so the individual ranking of a site should not be used to prioritise it over its adjacent candidates – for example, the top 30 sites could not be reliably ranked in order of priority between themselves but were certainly higher priority than sites ranked from 50 to 80.

The Wild Animals Management Programme intends to maintain the prioritisation tool and update it with additional attributes of importance as they become available – for example, the threat of deer and goats to carbon sequestration. However, it is acknowledged that since the tool is largely informed by site-based information derived from prescription data for Ecosystem Management Units and Species Management Units, it does not translate well in places where macro-scale landscape control operations are needed to prevent the expansion of deer and/or goats. Therefore, a separate process will be undertaken to identify priority sites for the prevention of the expansion of goats.

1. Introduction

1.1 Why do we need to manage deer and goats?

Deer and goats are introduced browsing animals with no natural predators in Aotearoa New Zealand. Without enough hunting pressure, their populations grow rapidly and can damage native ecosystems. When numbers get too high, they:

- eat and trample native vegetation
- prevent forest regeneration
- alter soil qualities
- change the types and numbers of plants present in forests.

Recent reports show that these animals are becoming more widespread and abundant (Moloney et al. 2021), contributing to a decline in common tree species and changing the make-up of forests (Hawcroft et al. 2024). This threatens the habitats where many of the country's native species live, reduces ecosystem resilience to storm damage, and affects access to rongoā (medicinal) and taonga (treasured) species.

1.2 Te Ara ki Mua

Te Ara ki Mua (DOC 2022) was developed as an adaptive framework that supports the implementation of Te Mana o te Taiao – Aotearoa New Zealand Biodiversity Strategy (ANZBS; DOC 2020). The key action in Te Ara ki Mua is to reduce browsing pressure to support ecosystem resilience to disturbance, including climate change impacts. The framework includes the goals of the ANZBS and also uses the same pou (pillars) to describe the actions needed to improve management of wild animals in New Zealand: Tūāpapa (getting the system right), Whakahau (empowering action) and Tiaki me te Whakahaumanu (protecting and restoring) (Figure 1).

STRATEGIC DIRECTION	ANZBS		
	Te Ara ki Mua		
	TŪĀPAPA Getting the system right	**WHAKAHAU** Empowering action	**TIAKI ME TE WHAKAHAUMANU** Protecting and restoring
PRIORITY WORK PROGRAMMES OVER NEXT 4 YEARS	System review of wild animal management Monitor for understanding	Leadership by DOC and the Game Animal Council Strengthend kaitiakitanga Tell the story	Adaptive management Prevent range spread Scale up goat control

Figure 1. Alignment of the Department of Conservation's (DOC's) Wild Animals Management Programme with Te Mana o te Taiao – Aotearoa New Zealand Biodiversity Strategy (ANZBS).

There are currently eight areas of focus within Te Ara ki Mua, all of which align with the three pou of the ANZBS and support the wild animal related objectives and goals within the strategy. The following objectives relating to deer and goat control can be found under Tiaki me te Whakahaumanu (DOC 2022, p. 2):

- Existing goat control is enhanced and expanded to new sites, especially in areas with vulnerable endemic plant communities.

- Priority sites for adaptive management are identified and site-based plans are developed through engagement and partnership with whānau, hapū, iwi and stakeholders.
- Collaborative efforts prevent further range expansion by wild animal species.
- Deer-free areas are defended and maintained.

To meet these objectives, a decision support tool is required that can help prioritise effort and investment in deer and goat control to ensure that it is occurring in the right places.

1.3 Previous state of decision making for wild animal management within the Department of Conservation

In the absence of a national strategy for wild animal management over the last two decades, much of the Department of Conservation's (DOC's) decision making around where to undertake deer and goat control has been driven by regional or district priorities, which can be affected by local pressures and the need to fulfil statutory or political obligations. Many goat control sites on public conservation land (PCL) are legacy sites that were initiated under old strategies, and the very small number of deer control operations that are still running on PCL are mostly restricted to maintaining the deer-free status of regions or sites.

Many of the current deer and goat control operations on PCL are significantly underfunded. This is often the case for threat-based programmes, particularly those targeting weed and ungulate control, which have been significantly defunded over the last decade due to changing priorities and inflationary pressures. This has often resulted in a reduction in the intensity or scale of control operations, so that outcomes are achieved across smaller areas or, commonly, not at all.

Consequently, national strategic and coordinated decision making has been absent from all deer and goat control operations over the last decade or more. The introduction of the Te Ara ki Mua framework and the formation of DOC's Wild Animals Management Programme to implement the framework has sought to resolve this.

1.4 Development of a prioritisation tool

The development of a prioritisation tool and the outputs from such a tool will help inform decisions on where to manage deer and goats on PCL. However, it is important to understand that this will be a decision support tool, not a decision-making tool – it will inform decisions on where to invest but will not make the final decision. This is because social, political and macro-scale management considerations cannot be evaluated or quantified by a tool that is driven by data at a site-based level. Therefore, sitting above the tool, there needs to be a clear national strategy on the priority objectives for management, where these are and the funding available to deliver them. It is only when these are known that the outputs of the tool can be used in the right decision-making context.

It is also important that the tool is trusted by stakeholders – we can build the best tool in the world, but if managers and practitioners do not trust or respect the outputs, be it due to a lack of understanding or distrust of the process or people involved, then the tool will not deliver on its purpose. Therefore, equal investment should be put into the social process of stakeholder and practitioner engagement, so that they understand the purpose, context and utility of the tool, and respect the outputs.

The tool will be refined and adapted over time. We cannot expect the variables, weightings and outputs to remain constant over time, so a review and refinement process needs to be undertaken at regular intervals (e.g. every 2 years).

2. Scoping the tool

Several regional and national prioritisation tools have been developed by DOC to guide where biodiversity threats and assets should be managed, and threat prioritisation tools are continually being developed internationally. Therefore, we reviewed the most relevant or contemporary of DOC's threat management prioritisation tools, along with two of the most relevant tools that have been utilised in other countries to support threat management programmes.

We reviewed the purpose, process and parameters of each prioritisation tool to understand the general prioritisation approaches taken and look at similarities and differences between the attributes being considered and the weighting or classification approaches being used to generate prioritised outputs.

2.1 Threat management prioritisation approaches used by DOC

2.1.1 National deer and goat stocktake: matrix approach

A national stocktake of DOC's deer and feral goat control operations was undertaken in March 2022. Nine regional workshops were run that involved Biodiversity, Heritage and Visitor Group staff, Wild Animals team staff, biodiversity planning staff, Operations managers, senior rangers, and hunters. Data were gathered on:

1. existing operations; and
2. where DOC could undertake control activities if further resourcing became available for the 2022/23 financial year.

After the workshops, the team clarified and prioritised the information gathered using the criteria provided in Table 1. The control strategy used and integration with other work at the site were two key attributes that were incorporated into the tool development.

Table 1. National deer and goat stocktake prioritisation criteria.

Priority		Outcome objective[a] and site score	Strategy	Integration with other control work
High	1	1.1 or 1.2; < 840	Containment	Area has other pest control in place (e.g. 1080 for possum control), is predator free, is a national park or includes defended exclusion zones
	2	1.1 or 1.2; < 840	Eradication	Area has other pest control in place (e.g. 1080 for possum control), is predator free or is a national park
	3	1.1 or 1.2; < 840	Sustained control	Area has other pest control in place (e.g. 1080 for possum control), is predator free or is a national park
	4	1.1 or 1.2; > 840	Containment	Area is a national park
Medium	5	1.1, 1.2 or 1.6	Containment	Area has pest control contributions from others (e.g. regional councils)
	6	1.1, 1.2 or 1.6	Eradication	Area has pest control contributions from others (e.g. regional councils)
Low		1.1 or 1.2; areas > 840 should not be prioritised for suppression operations 1.6; areas should not be prioritised for sustained control operations		

a Objectives have been taken from the Department of Conservation's Outcome Monitoring Framework: doc.govt.nz/omf.

2.1.2 National Predator Control Programme (NPCP)

The NPCP[1] targets the control of possums, rodents and mustelids at various prioritised sites throughout New Zealand. The control operations can be driven by mast seeding events or increased numbers of predators.

Key prioritisation criteria include the:

- current state of forest health
- presence of nationally threatened species (e.g. mohua/yellowhead, pekapeka/bats)
- previous investment
- site status (special/non-special)
- budget
- cost of control per hectare.

An application has been developed as part of the programme to weight and rank sites depending on the priorities of the programme (Figure 2). Data are extracted from national datasets such as Ecosystem Management Unit (EMU) and Species Management Unit (SMU) datasets, which are underpinned by the outputs of a national Zonation (Moilanen et al. 2009) exercise. The methods used in this data extraction approach and the weighting approach taken are very appropriate for inclusion in the development of a site prioritisation tool for deer and goat control.

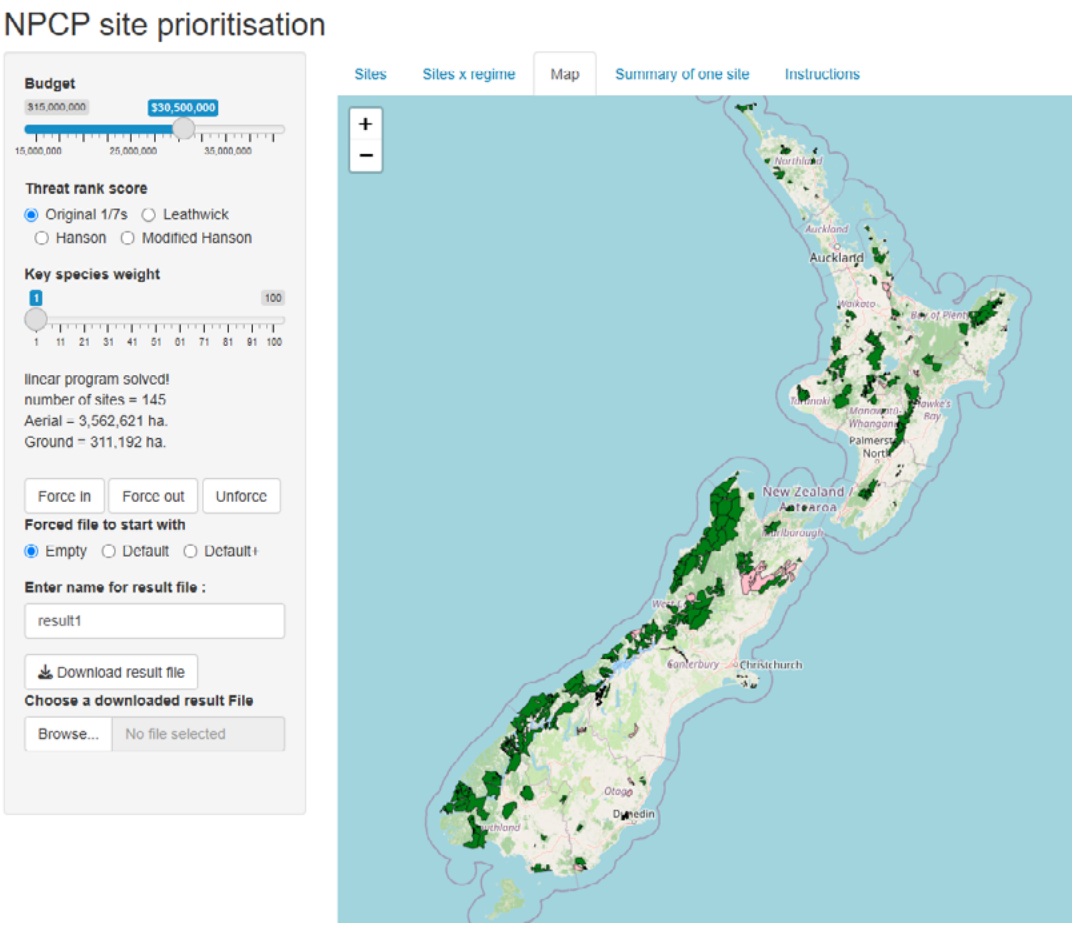


Figure 2. Interactive prioritisation platform built for the National Predator Control Programme using the open-source R package Shiny.

1 doc.govt.nz/predator-control-programme

2.1.3 National Feral Goat Control Plan 1995–2004

The priorities for DOC's National Feral Goat Control Plan (DOC 1998) were to consider management at sites that would achieve:

- limitation of introduction or dispersal
- eradication
- sustained control.

This plan included a prioritisation system that was developed to rank operational areas for goat control based on the following criteria:

1. Score botanical values of the area
2. Score wildlife values of the area
3. Weight the highest score according to the threat from goats
4. Sort equally weighted scores

The same process was also recommended for deer in DOC's National Deer Control Plan (Parkes 1996).

Although the plan is now outdated, more contemporary prioritisation tools utilise some similar criteria, although it is important to note that species and botanical priorities are now accounted for in the EMU and SMU rankings, so their inclusion is somewhat redundant.

2.1.4 Local ecologically damaging pressure-led programme

This programme took a pressure-led approach at a district scale to evaluate pressures that are already present in New Zealand. The focus was limited to pressures that are ecologically damaging in their current location or would be ecologically damaging in other locations should they spread there. Ecologically damaging pressures included animal, weed, human-related and abiotic pressures, could be recently emerged or locally uncommon, and could be currently managed or unmanaged.

Each pressure received an ecological score based on the following criteria:

- Consequence of no control
- Rate of spread / population increase
- Urgency (consequence × rate of spread / population increase)
- Feasibility of control

The ecological score was then coupled with resourcing and cost estimates to generate a final score for each pressure. The end user could then systematically determine a relative cost/benefit of managing one pressure over another.

2.2 Prioritisation approaches used in Australia

2.2.1 Spatial conservation action planning (SCAP) tool

The SCAP tool (Thompson et al. 2020) was developed for the state of Victoria in Australia to enable integrated landscape management that meets conservation objectives. Three key attributes enabled prioritisation across heterogeneous landscapes: species distributions, implementation costs and benefits, and threats. The model considered species distributions for 4,400 native terrestrial species, and spatially explicit models were developed for 19 threats. Management action benefits were mapped, and location-specific actions were ranked according to their contribution to minimising the risk of species loss in the next 50 years. This has provided decision-makers with a transparent, objective decision support tool that helps them prioritise where in the landscape they should implement cost-effective management for conservation benefits.

2.2.2 Priority Threat Management (PTM) approach

The purpose of the PTM approach (Carwardine et al. 2019) is to prioritise threat management to maximise the benefit to cost ratio of in situ biodiversity protection. The process uses both expert elicitation and empirical data on major threats to biodiversity, feasible threat management actions and likely biodiversity responses under different management scenarios. A significant benefit is that it can be used in data-deficient situations by incorporating expert and stakeholder knowledge. It is envisaged that it will be most useful in providing guidance for species and ecosystem conservation projects across broad regions.

2.3 Recommended approach

Building a prioritisation framework generally requires consideration of two factors, each of which is related to multiple criteria of concern:

1. **Prioritising the ecosystems that are under threat from the pressure:** This requires consideration of questions that will help determine which ecosystems are of greatest concern, such as the following:
    - Which systems are vulnerable to the threat?
    - What is the likely impact of the threat?
    - What is the scarcity of the system?
    - How can we ensure environmental representativeness, both spatially and biophysically?
2. **Prioritising where to undertake the work:** This requires consideration of questions around the operational feasibility, such as the following:
    - Which control strategy should be used and what is the likelihood of success?
    - Are there any synergies with other control operations?
    - What is the land status?
    - Are there any sociopolitical influences?
    - What is the cost-effectiveness?

Two broad prioritisation approaches are used when considering these factors: the deterministic matrix approach and modelled matrix approach.

The deterministic matrix approach involves defining the attributes of importance and then determining the scores or rankings for each category. Generally, the scores are averaged across weighted criteria or simple calculations are used to provide a final score for a site that can be compared with scores for other sites. This approach is considered relatively simple and can rely on both quantitative empirical data and qualitative data from subject matter experts (SMEs).

The modelled matrix approach is more complex. It will often involve mechanistic modelling and can account for uncertainty in parameters, which can then be modelled across criteria. It can also involve machine learning techniques and multiple costing scenarios for management at a site.

Most prioritisation exercises in New Zealand have used a deterministic matrix approach. However, this relies on quantitative data being available and expert input being accurate when considering criteria such as the feasibility of achieving a goal at a site, for which SMEs would provide a pre-determined score. By contrast, with a modelled matrix approach, the feasibility would be calculated by multiplying the probability of uptake of the approach with the likely success of the approach (i.e. it could factor in and model uncertainty and perform sensitivity analyses).

Another aspect of the approaches that are commonly used in New Zealand is that they tend to be focused on successfully managing the threat assuming that a given level of management will achieve the outcome. While this is suitable for eradication programmes, we know very little about

the relationship between management targets (result targets) and ecosystem responses (outcome targets) for suppression programmes, so it is important to acknowledge that determining success *a priori* will carry a large degree of uncertainty.

After talking to DOC technical staff who have been involved in other prioritisation exercises (particularly those involved in the NPCP) and considering the other tools reviewed here, it was concluded that we should apply a simpler deterministic matrix-based approach for this prioritisation exercise because:

- it would be quicker to develop and time was limited to around 6 months
- there was a high degree of familiarity with the process among DOC staff
- the outputs are realistic and trusted by SMEs who know the sites
- it could be quickly adjusted to incorporate new knowledge or attributes
- it would not rely on the development of models, which can take time and require bespoke skills to maintain
- the data could be easily extracted or incorporated into future DOC systems (e.g. Biodiversity Outcome Plans, which use a similar data format and set of attributes).

It was also acknowledged though that this approach had the disadvantage that some categories would be reliant on subjective SME opinion, which could subconsciously bias the weighting of the matrix to suit the desired/expected outcomes.

3. Programme structure, implementation and engagement

3.1 Design Team formation

The purpose of the Design Team was to design a prioritisation tool, oversee data capture from Operations staff into the tool, and produce a final dataset that could be used to prioritise, rank and shortlist sites. A Reference Group was engaged throughout this process for review and endorsement (see section 3.2) and a Governance Group was engaged at key milestones (see section 3.3).

A Design Team was formed that had the necessary combination of skills to develop a tool to the specifications provided within the tight timeframe. The following key skills and experience were identified as being desirable:

- Project management and leadership
- Facilitation of a wide range of contributors
- Prioritisation tool development
- Data analysis and presentation
- Familiarity with and accessibility to DOC's biodiversity information systems and data sources
- Geospatial data management and presentation
- Understanding of DOC's wild animal control programmes, species and ecosystems across a wide geographical area
- Good connections and rapport with Operations staff
- Patience and flexibility

Considering these skills, a core Design Team was assembled comprising the following DOC staff members:[2]

- George Ledgard, Technical Advisor, Landscape Threats Advice (Project Lead)
- Amy Hawcroft, Science Advisor / Spatial Ecologist, Monitoring Design and Advice
- Richard Earl, Technical Advisor, Monitoring and Insights (GIS Lead)
- Thomas Emmitt, Technical Advisor, Landscape Threats Advice
- Graeme Elliot, Principal Science Advisor, Landscape Threats Science

3.2 Reference Group formation

The purpose of the Reference Group was to undertake user testing and provide feedback, ratify a final methodology, and help produce a final shortlist of prioritised sites to be used by Operations when producing operational plans.

User testing was iterative, and the Design Team adjusted the criteria and weightings as this testing progressed. Final collaborative workshops were then held with the Design Team and Reference Group to check the quality of the data and produce a final shortlist of sites.

The Reference Group comprised the following DOC staff members:

- Dean Clarke, Technical Advisor, Monitoring Design and Advice
- Keith Broome, Senior Technical Advisor, Landscape Threats Advice
- Keith Briden, Senior Technical Advisor, Landscape Threats Advice
- David Carlton, Senior Wild Animals Advisor, Wild Animals
- Pete Thomas, Wild Animals Lead, Wild Animals
- Andy Glazier, Wild Animals Lead, Wild Animals
- Kellie Mayo, Technical Advisor, Landscape Threats Advice

3.3 Governance Group formation

The purpose of the Governance Group was to provide assurance, quality control and risk management throughout the process. Meetings were generally held every 2 months to update the Governance Group and allow them to provide feedback on the process and outputs and ratify the next steps at milestones through the development process. They also considered the outputs of the prioritisation exercise against the total budget and objectives of the Te Ara ki Mua framework and provided feedback on any other political or social attributes that needed to be considered.

The Governance Group had the ability to request a re-weighting of the criteria to ensure that wider programme priorities would be met. However, transparent justification was needed to alter weightings against the initial recommendations of the Reference Group, and no re-weightings were requested during the process.

The Governance Group comprised the following DOC staff members:

- Ben Reddiex, Director National Programmes
- Mike Perry, Wild Animals Manager
- Hilary Aikman, Director Terrestrial Biodiversity
- Shannon Patterson, Landscape Threats Advice Manager

2 Note that all job roles included in this report are as at March 2002 when the prioritisation tool was being developed.

3.4 Engagement and implementation timeline

The entire process, from development of the tool through to recommendation of the final 42 sites, took approximately 10 months. As with all new processes, it was difficult to determine how long it would take, and Cyclone Gabrielle delayed engagements with North Island Operations teams for 2 months. This delay, along with other minor delays, put the process 3 to 4 months behind the original intended schedule.

Figure 3 provides an overview of the process components and timeline.

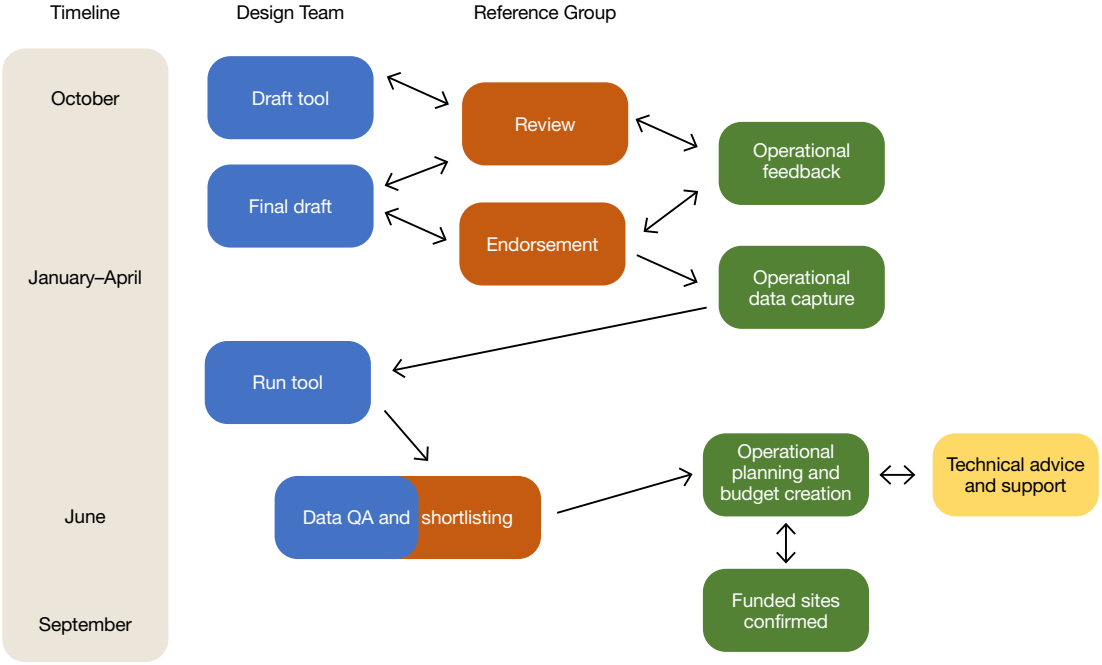


Figure 3. Responsibilities of the teams involved in developing the prioritisation tool.

4. Data requirements

4.1 Attributes and capture criteria

Data attributes and criteria for data capture were developed based on the review of recommended approaches (see section 2).

Each attribute was broadly associated with five information requirements:

- Ecosystem and species values
- The threats of deer and goats to these values
- The appropriate management approach to mitigate the threats and protect these values
- The feasibility of implementing that management approach
- Synergies with complementary work at the site

Within each of these areas, there were key attributes that contributed to a site score and additional attributes that were designed to inform and develop thinking prior to populating the key attributes. For example, the fields that required a ranger to estimate deer and goat abundance at a site were designed to get the ranger thinking about densities and impacts to provide a quality answer for the next data field – the current ecosystem impact with respect to browsers. Only the ecosystem impact question fed into the site score, but this needed to have some critical thinking behind it.

It was essential that the data capture criteria enabled efficient and accurate data collection, but this was not without its challenges. Data capture guidelines were created so that multiple staff could engage with rangers while maintaining consistency. These guidelines were piloted within two district offices to ensure that they made sense and generated consistent data. Prior to each data capture session with the districts, data capture staff were briefed on the guidelines to ensure that they understood the context and purpose of the questions – this was particularly important when there had been long periods between data capture sessions.

A summary of the key attributes is provided in Table 2, while a full list of the attributes and criteria for how the data were to be collected is presented in Appendix 1.

4.2 Sources of attribute data

Where reliable and accurate data could be obtained from pre-existing quantitative sources, attribute data were pre-populated prior to engaging district Operations staff. Where no data were available from internal or externally published datasets, rangers were required to fill out these attributes, with support from SMEs. The data capture guidelines and supervision by SMEs were put in place to minimise bias and subjectivity when trying to complete these more qualitative fields.

The key data sources used are summarised in Table 2, while more detail around the quantitative data sources used to pre-populate various attributes prior to approaching Operations staff for their data is provided in section 4.3. The majority of the pre-populated data were taken from the Integration dataset,[3] which was collated for an EMU and SMU ranking exercise completed in 2018. Consequently, the data were based around the boundaries of EMUs and SMUs, which do not cover all areas of PCL or even all current operational sites.

3 The Integration dataset was developed under DOC's Natural Heritage Management System (NHMS) to capture species and ecosystem values and pressures at a site (referred to as SMUs and EMUs), utilising the Zonation approach (see section 2.1.2).

Table 2. Key attributes captured for each site within the prioritisation tool.

	Attribute	Context	Data source
Conservation values	Site name	Name of EMU, SMU or WAMU	Prescription data + expert elicitation
	Suitability for management	Yes/no – based on rangers' knowledge of whether effective management is possible at the site	Expert elicitation
	Ecosystem vulnerability score	Effect of ungulate browsers on ecosystem and species values	Prescription data
	Current ecosystem impact from browsers	Current impacts of browsers on the ecosystem and species	Expert elicitation
Legislative and sociopolitical considerations	Land status	PCL land status	NaPALIS data extraction
	Political/legislative obligation	Political and legal obligations to manage ungulates	Expert elicitation
	Iwi responsibilities	Known iwi interest in the site, including any settlement obligations	Expert elicitation
	Local hunter interest	Known hunter interest in the site, including the frequency of use and species present	Expert elicitation
Management	Goal of ungulate control	Primary goal of ungulate control (ecosystem restoration, species protection, biosecurity – RPMS/incursion, sociopolitical)	Expert elicitation
	Control strategy required to meet goal	Eradication/containment/suppression/prevention-exclusion	Expert elicitation
	Control integration	Beneficial synergies with other control programmes	Expert elicitation + NPCP data extraction
	Non-financial achievability	Based on the certainty/likelihood of success for the control strategy, excluding finances	Expert elicitation
	Prior investment – gains made	How much prior investment has benefited the control strategy	Expert elicitation
	Financial cost of meeting control strategy	Estimated programme costs over 10 and 50 years to meet the control target	Expert elicitation

Abbreviations: EMU, Ecosystem Management Unit; NaPALIS, National Property and Land Information System; NPCP, National Predator Control Programme; PCL, public conservation land; RPMS, Regional Pest Management Strategy; SMU, Species Management Unit; WAMU, Wild Animal Management Unit.

The sites being ranked were first related to spatial data, including EMUs and SMUs, using GIS. Management units with only a small area of overlap (< 25%) were not counted, as it was assumed that the operation was not designed to protect the values within these.

Scores were calculated in R version 4.4.2 (R Core Team 2024) and transcribed to a Microsoft Excel spreadsheet.

4.3 Calculation of attribute scores and the final site score

A separate process was used to calculate an individual score for each attribute. The final site score was then calculated using the following equation:

Site score = 0.75*(standardised ecosystem impact score + standardised species impact score) + 0.25*(management history score + feasibility score)

Thus, 75% of the final site score was derived from the calculated ecosystem impact and species scores, while 25% was derived from the management history and feasibility scores.

The ecosystem and species data used in this process are stored in the Integration dataset.

4.3.1 Ecosystem impact score

The ecosystem impact score indicates the pressure that deer or goats put on the ecosystems represented in the related EMU. This is standardised to a score of 0 to 1 by dividing each site by the score of the highest scoring site. If no EMU overlaps the site, the score will be 0.

The Integration dataset includes a matrix that relates each pressure type (deer or goats) to each ecosystem type. The values in the matrix are impact scores (Table 3), which were derived based on SME advice and indicate how much each pressure would transform the ecosystem type if present and left unmanaged. If an ecosystem type could be affected by both goats and deer, then the ecosystem impact score is the higher of the two.

Sites may contain multiple ecosystem types, each of which has its own impact score for deer or goats depending on the ecosystem's resilience. The site impact score is the area-weighted mean of its individual ecosystem scores.

Table 3. Conversion of ecosystem pressures to numeric impact scores.

Impact score	Meaning	Standardised impact score
0	Pressure does not exist for that ecosystem type	0
1	Minor – No change in ecosystem structure or function, and very minor loss in composition or low-level impacts on some species	0.25
2	Intermediate – Minor structural or functional change, and moderate compositional change and/or decline or loss of some species	0.5
3	Moderate – Change in structure and/or function and/or composition, and/or significant loss of one or more key species	0.75
4	Transformational – Major change in structure, function and composition of the ecosystem over a substantial area relative to the extent of the ecosystem (extreme cases can result in ecosystem extinction)	1

4.3.2 Species impact score

The species impact score is the sum of the individual scores for all threatened species impacted at that site. This is standardised to a score of 0 to 1 by dividing each site by the score of the highest scoring species. If there are no threatened species affected by deer or goats in the related EMUs or SMUs at the site, the score will be 0.

Individual species scores

An individual species score was calculated for each species using the following equation:

$$\text{Individual species score} = \text{standardised management score} \times \text{standardised threat score} \times \text{standardised population score}$$

We recorded the New Zealand Threat Classification System (NZTCS) status (Rolfe et al. 2022) for each species present at the site and the pressures that affect its persistence according to the Integration dataset. Only species for which 'deer', 'goats', 'tahr' or 'chamois' have been identified as pressures were included.

MANAGEMENT SCORE

The Integration dataset has a recommended management standard for each pressure identified as affecting a species' persistence. The management score is the highest management standard for either deer or goats, converted to a number (Table 4).

Table 4. Conversion of recommended management standards to numeric scores.

Target standard	Standardised score
Zero density	1
Very low levels	0.7
Low levels	0.3
Moderate levels	0.1
No management	0

THREAT SCORE

The conservation status of a species was retrieved from the NZTCS database[4] and converted to a number between 0.1 and 1 (Table 5).

Table 5. Conversion of New Zealand Threat Classification System (NZTCS) statuses to numeric scores.

NZTCS status	Standardised score
Threatened – Nationally Critical	1
Threatened – Nationally Endangered	0.9
Threatened – Nationally Vulnerable	0.8
Threatened – Nationally Increasing	0.75
At Risk – Declining	0.7
At Risk – Recovering	0.6
At Risk – Relict	0.3
At Risk – Naturally Uncommon	0.2
Not Threatened	0.1

POPULATION SCORE

In the Integration dataset, each species' population (EMU or SMU) has been assigned a category by SMEs. This was converted to a number as shown in Table 6.

Table 6. Conversion of species' population categories to numeric scores.

Score	Meaning	Standardised score
A	Population is essential for national persistence of the species	1
B	One of several populations that are interchangeable for persistence of the species	0.7
C	Potentially viable if managed but not essential for persistence of the species	0.3
R	Requested by local staff in prescription review but not reviewed by subject matter experts	0.1
X	Not a viable population	0

4 nztcs.org.nz

4.3.3 Predicted potential vegetation (PPV) score

The Potential Vegetation of New Zealand layer (Landcare Research 2012) was used to determine ecosystem vulnerability to deer and goat browsing pressure at 53 sites that did not overlap EMUs or SMUs and so did not have ecosystem or species scores.

The layer provides different information from the ecosystem scores and tends to place more weight on warm forests and less weight on cool forests and alpine-dominated sites.

Each of the 53 sites received a PPV score between 0 and 1 that equated to the percentage of the whole site covered by species that are classified as 'preferred' by ungulates according to Forsyth et al. (2002).

Four sites did not have ecosystem/species scores or PPV scores assigned to them and so were not included in the ranking exercise (Table 7).

Table 7. Sites that could not be prescribed an ecosystem, species or predicted potential vegetation (PPV) score.

Site ID	Project name
400236	Kaikōura Peninsula
402354	Ngarupupu Point and Te Marama reserves
406233	Pukerua Bay
406349	Mimi Gorge Scientific Reserve

4.3.4 Management history score

The management history score was calculated as:

Management history score = prior investment in deer and goat control (50%) + other complementary management of browsers (50%)

Prior investment in deer and goat control

The Reference Group advised that historical management may not relate to current ecological integrity but is worth including in a site score because past decisions about where to invest in management were thoroughly evaluated. Historical management related to any deer or goat investment delivered at the site in the past 10 years and was scored by local rangers according to the criteria shown in Table 8.

Table 8. Management history scoring criteria.

Score	Meaning
0	Zero coordinated control and investment
0.25	Unplanned ad hoc control
0.5	Sporadic or under investment, and/or cannot demonstrate gains
0.75	Coordinated sustained control and some measured gains but more investment required to meet outcomes
1	Significant, effective and sustained programme with outcomes met

Other complementary management of browsers

The only other management undertaken by DOC that affects browser pressure is the application of aerial 1080. Therefore, this score was calculated as the percentage of the polygon under sustained control using 1080. The combined effects of possums and wild animals interact to affect forest ecological integrity. Ensuring that the threatened species that require predator control have longer-term habitat protection is also beneficial.

4.3.5 Feasibility score

The feasibility score reflected the non-financial technical likelihood of the preferred control strategy achieving the stated desirable ecological outcomes (likelihood of success) (Table 9). A feasibility score was calculated individually for deer and goats if they were present at the site and the scores were then averaged if both species were present.

Table 9. Operational feasibility scoring criteria.

Score	Meaning
1	100% confident can operationally and technically achieve the outcomes
0.5	Legitimate doubts on the operational and technical achievability of the outcomes OR only some of the outcomes will be met (e.g. the ecosystem but not the species can be protected)
0	Not achievable

4.3.6 Other data

The GIS analysis that related the ranked sites to spatial features included:

- Tier 1 sampling sites
- naturally uncommon ecosystems
- the DOC management region and district.

These were not included in the score but can provide interesting context.

Notes on the index of animal abundance at sites

At each of the national Tier 1 sampling sites, ungulate abundance was measured by counting the number of pellets in 30 subplots of 1 m radius on each of four 150 m long transects radiating from the corners of a central 20 × 20 m vegetation plot. The total number of pellets counted along a 150 m long transect gave a faecal pellet index (FPI) of relative ungulate abundance.

The Tier 1 FPI and rangers' subjective estimations of deer and goat densities were not included in site scores because FPI data were unavailable for many sites and rangers' estimates of deer and goat abundance were too subjective, and there is ambiguity in how these would be applied. Advice from the Reference Group was unclear around if it is preferable to prioritise sites with:

- high numbers of animals because there is a relationship between high numbers and a decline in ecological integrity; or
- low numbers of animals because there is evidence that places that have lost ecological integrity due to unconstrained animal populations take many decades to recover.

Therefore, we excluded animal abundance as a parameter when generating our site scores.

4.3.7 Financial data

Once all management data had been captured for a site, rangers were asked to produce ballpark figures for the control costs needed to meet their goals and objectives for the site over the first 10 years and the first 50 years of the programme.

The two time periods were used to distinguish the programme's upfront knockdown or implementation cost (first 10 years) from the long-term maintenance cost (the first 50 years). For example, building an exclusion fence may have a large upfront cost in the first 10 years but may be comparatively cheaper than other methods, such as suppression to zero density, when annualised out over 50 years.

Given the context of the request, we asked the rangers to focus on the operational delivery costs and not to factor in costs surrounding project management, capital expenditure, overheads, etc.

There were four main purposes of this exercise:

- To generate an approximate estimate of the cost per hectare to achieve the goal (which usually relied on one main control technique).
- To understand the variability in rangers' estimations of control costs.
- To articulate to managers and staff the likely costs of large-scale ungulate control.
- To compare estimated annual costs against actual budgeted costs for those projects that were currently receiving funding.

Alongside these estimated costs over 10 and 50 years, we also populated currently funded sites with their budget for the 2022/23 financial year.

The exercise revealed a huge variability and capability in estimating costs among rangers. It also revealed that the costs for different management goal and method combinations were often significantly higher than the annual funding for currently managed sites. The exercise also provided financial means and ranges of costs for using different methods in different habitat types to meet different management goals.

This exercise created a starting point from which more precision and focus could be brought into understanding the costs to achieve effective management, which is a critical knowledge gap for wild animal management in New Zealand.

4.4 Peer review of design elements for data capture

Several of the methods and processes involved in calculating scores for ecosystems and species have previously been used to help prioritise sites within the NPCP, alleviating the need for intensive peer review. However, the Reference Group was utilised to peer review the methodology employed to derive site scores for ecosystem, species and management attributes.

This peer review process highlighted the need to obtain other data to evaluate sites that were not covered by prescriptions and therefore had no detailed information on values and threats from ungulates. The Design Team utilised the PPV dataset, which resolved this data gap (see section 4.3.3).

The Governance Group was briefed on the data elements and design at the end of this process, and no further suggestions were made.

5. Data capture from Operations staff

The data capture phase involved collecting information on attributes that required site-based operational knowledge which had not previously been captured in any existing DOC datasets. It was also used to peer review the relevant pre-populated data extracted from the various datasets outlined in section 4.

The data were captured in a series of face-to-face workshops with district and regional DOC Operations staff. Follow-up meetings were often required to complete this process due to staff absences or a lack of time to complete data capture during the face-to-face workshops.

In each workshop, members of the Design Team and Reference Group were paired up with operational rangers to complete the data capture process. Design Team / Reference Group members supporting the data capture process were provided with the written guidelines and briefed prior to the workshops to ensure that the process was consistent among the support staff and not open to interpretation. George Ledgard, the Design Team Lead, attended all data capture workshops to ensure consistency in the data capture and interpretation process.

Prior to the first formal workshops, three districts (Whakatāne, Murihiku and Rakiura) were included in a pilot study to test the guidelines, staff interpretation of the guidelines and the procedures for data capture. This was a very worthwhile process and improved the final draft of the data capture guidelines.

5.1 Data capture schedule

Data capture took approximately 3 months to complete. Data capture for all South Island districts took place in January and February 2023. Unfortunately, Cyclone Gabrielle deferred the North Island workshops from their intended dates in February to mid-May 2023.

On average, it took 10 to 15 minutes to capture and review data for a single site. However, the actual time taken to complete a single site was highly variable and depended on the complexity of management required at the site, the ranger's knowledge of the site and the level of detail included in the discussion. Often, when time was running short, conversations and the resulting data entry would become more succinct.

Based on the average of 15 minutes to complete face-to-face data capture for each site, it took approximately 90 hours to complete the entire data capture process. This excludes any follow-up clarifications or changes to other attributes that did not require district staff input.

5.2 Data capture guidelines

Although the data capture requirements were relatively simple, they were open to interpretation. As such, guidelines were developed to help rangers and support staff to interpret and enter the data in a consistent manner.

Guidelines were updated where necessary to avoid any misinterpretation or ambiguity.

For a copy of the data entry guidelines, see Ledgard (2024).

6. Results and shortlisting

6.1 Process overview

Our data collection phase identified approximately 624 sites that could be considered for prioritisation. Of these, 482 sites were considered appropriate for management and so selected for prioritisation. Most sites (>95%) were on PCL, but some incorporated private land within their treatment area.

There was general agreement that the outputs of this approach reflected SME evaluations of the relative priority of sites for management. However, at a site level, it was also noted that the separation between sites that were closely ranked was arbitrary at the site level, so the individual ranking of a site should not be used to place one site higher than its adjacent candidates – for example, the top 30 sites could not be reliably ranked in order of priority between themselves but were certainly higher priority than sites ranked from 50 to 80.

Due to the inherent variability in the accuracy of the data that informed the final rankings, each of the top 96 sites was individually peer reviewed and evaluated against its neighbouring candidates to ensure that there was a robust ground truthing of the top 100 sites. After this phase, a decision was made to shortlist no more than 50 sites.

When reviewing the shortlist, we excluded sites prioritised for deer control that were covered by the Wild Deer Free Northland programme, as this is a separately funded workstream through the Te Ara ki Mua framework. Where a Wild Animal Management Unit (WAMU) contained an individual site within it, the larger WAMU was generally selected, as there was general agreement that landscape-level management was preferred over individual site management. However, this became cost prohibitive for one very large WAMU (Kahurangi National Park, c. 500,000 ha) because funding it would come at the expense of delivering at a number of other high-priority sites. Aside from Kahurangi National Park, all other sites in the final 96 were available for final shortlisting, regardless of any existing funding arrangements.

6.2 The final shortlist

The agreed objectives of Te Ara ki Mua that are of relevance to the prioritisation of deer and goat management sites are to:

- prevent the range expansion of deer and goats (exclusion/containment)
- remove deer and goats where practicable (eradication)
- protect high-value species and habitats (suppression).

There was no programme-level guidance on the relative priority of these three objectives, so the Design Team and Reference Group agreed on the relative priority for the selection of sites from the top 96.

The Design Team and Reference Group acknowledged that preventing the range expansion of deer and goats was the highest priority, especially in areas that were deer and goat free or where these browsers presented a threat to large contiguous areas of high-value PCL, such as national parks. The second priority was the eradication or local extirpation of deer or goats, as this also reduces the national area occupied by these animals. As such, high-priority eradications that removed the risk of expansion into adjacent high-value goat- or deer-free PCL or preserved/restored the integrity of high-value ecosystems or species were included in the shortlist. Lastly, the highest value suppression sites were selected, as these are associated with a long-term, unwavering commitment

of control to protect their values. This hierarchy of priority was supported by the Governance Group prior to implementation.

The basic breakdown across these objectives is presented in Table 10.

Table 10. Breakdown of the shortlisted sites across Te Ara ki Mua objectives by species.

Objective	No. sites
Exclusion/containment: deer and goats	3
Exclusion/containment: deer only	5
Exclusion/containment: goats only	14
Eradication: deer only	0
Eradication: goats only	8
Suppression: deer and goats	7
Suppression: deer only	1
Suppression: goats only	4
Total	**42**

The other consideration when evaluating the final shortlist of 42 sites was ensuring that they provided a good geographical spread across New Zealand to ensure biogeographic representativeness. As can be seen from Figure 4, there are noticeable gaps along the east coast of the North Island, southern North Island, Marlborough and the southeastern South Island. Although there were sites in these areas that were in the top 96, these were not ranked high enough to make it into the top 42.

The spread of the operations by region and district is displayed in Table 11. A memo seeking authorisation to request operational plans from the identified districts was submitted to the Governance Group and approved (Ledgard 2023).

Why create a shortlist?

Quality ungulate management is likely to cost in the vicinity of $8 to $20 per hectare. Therefore, the less than $1.5 million operational budget that was allocated to sites selected from this process for the 2023/24 financial year could only afford the treatment of 75,000–150,000 ha of PCL.

Based on our knowledge of the approximate hectares required to be treated for each site, we knew that going much beyond a shortlist of 40 sites would significantly exceed the total area that could be funded. Therefore, to acknowledge the capacity pressures that Operations staff are under, a conscious decision was made not to go beyond this number and potentially waste the time of Operations staff by asking for operational plans for sites that could not be funded.

It is important to note, however, that around 15 of the 42 sites that were shortlisted already had some existing funding associated with them, while some did not require any more work other than surveillance and others would require feasibility studies before commencing operational delivery. It was not known how many of these 42 sites could be funded until individual site operational plans were received.

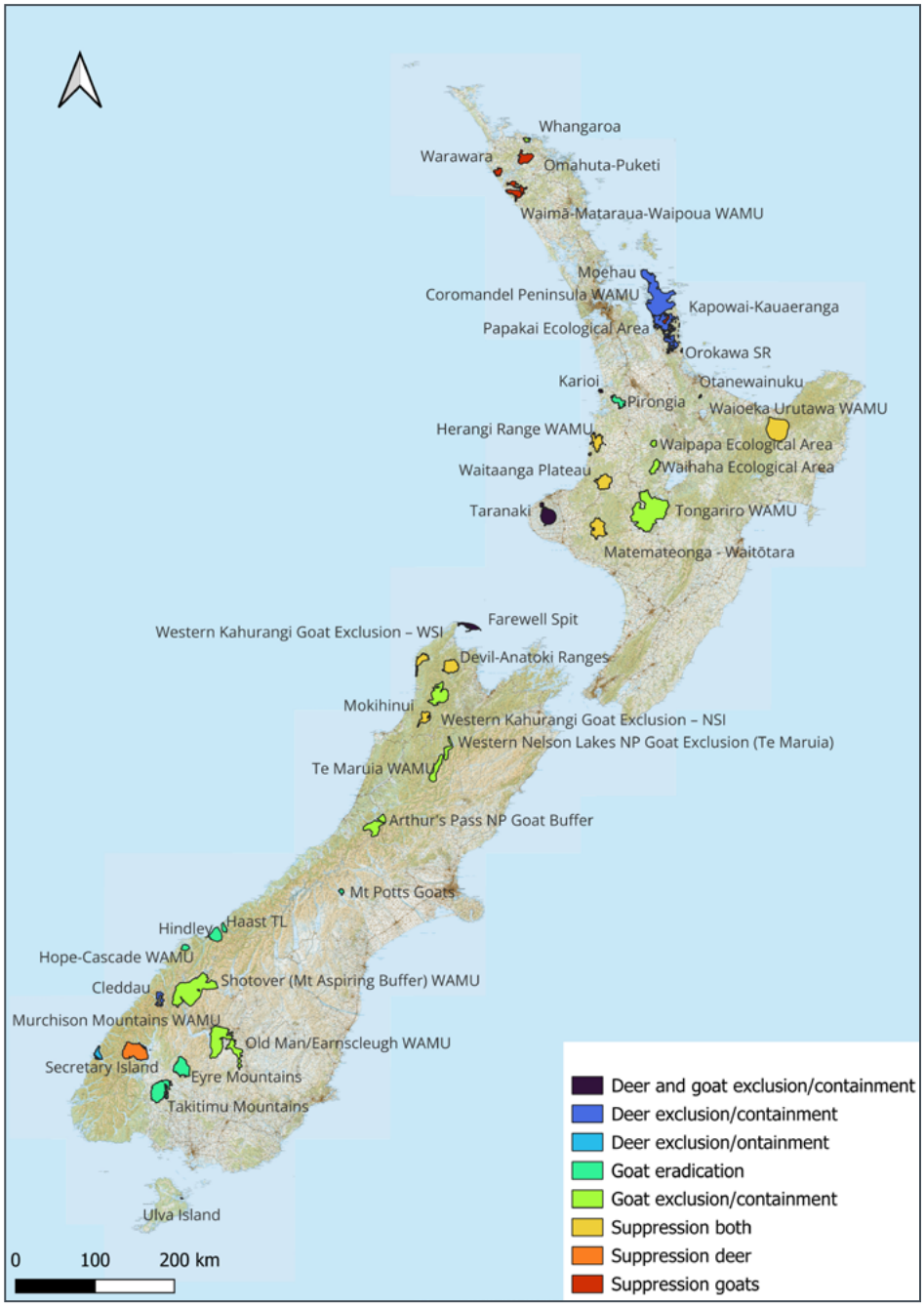


Figure 4. Locations of the 42 sites that were shortlisted for the development of operational plans (note that Ulva Island, which is part of Stewart Island / Rakiura, cannot be seen on the map). Site boundaries are indicative only and actual management may take place over a larger or smaller area.

Table 11. Sites requiring operational plans by Operations region and district.

Northern NI	Hauraki-Waikato-Taranaki	Eastern NI	Central NI	Northern SI	Eastern SI	Western SI	Southern SI
Bay of Islands	**Hauraki**	**Tauranga**	**Tongariro**	**Golden Bay**	**Geraldine**	**Buller**	**Central Otago**
Omahuta-Puketi	Kapowai-Kauaeranga	Orokawa SR	Erua WAMU	Devil-Anatoki Ranges	Mount Potts – goats	Heaphy	Mount Aspiring Buffer WAMU
Whangaroa	**King Country**	Otanewainuku	Taurewa	Farewell Spit		Mokihinui	Old Man / Earnscleugh WAMU
Kaitaia	Herangi Range WAMU	**Whakatāne**	Tongariro WAMU	**Motueka – Biodiversity**		**Greymouth**	**Murihiku**
Warawara	Waihāhā Ecological Area	Waioeka Urutawa WAMU	**Whanganui**	Karamea headwaters		Te Maruia WAMU	Eyre Mountains
Kauri Coast	Waipapa Ecological Area		Matemateonga-Waitōtara	**Nelson Lakes**		**Hokitika**	Takitimu Mountains WAMU
Waimā-Matarau-Waipoua WAMU	**New Plymouth**			Te Maruia / Western Nelson Lakes NP goat exclusion		Arthur's Pass NP Goat Buffer WAMU	**Stewart Island / Rakiura**
	Taranaki					**South Westland**	Ulva Island
	Waitaanga Plateau					Haast WAMU	**Te Anau**
	Waikato					Hindley	Cleddau
	Karioi					Hope-Cascade WAMU	Murchison Mountains WAMU
	Pirongia						Secretary Island
	Whitianga						
	Coromandel Peninsula WAMU						
	Moehau						
	Papakai Ecological Area						

Abbreviations: NI, North Island; NP, National Park; SI, South Island; SR, Scenic Reserve; WAMU, Wild Animal Management Unit.

7. Development of operational plans

Once the shortlisting exercise had been completed, DOC districts that included shortlisted sites were notified via Task Assignment (see Perry 2023). Staff were asked to complete an operational plan within 30 days that would achieve the goals and objectives for the site and meet the following criteria:

- The operation was planned using the Animal Pest Operational Planning framework template *or* the Eradication Feasibility template for sites requiring an Eradication Feasibility assessment.
- Work was planned at the level of effort required to meet the outcome or result objective specified.
- Sites could have existing core funding, but any further funding that may be required to meet the objectives and deliver outcomes should be outlined.
- Sites could be part of regional strategies or supported by interagency funding for feral goat operations.

In hindsight, 30 days was too short a period for otherwise busy rangers. After 90 days, only a small percentage of operational plans had been completed, at which stage it was decided that any plans not close to completion would be shelved until the following financial year.

8. Decision on final sites

Operational plans were received for 21 of the original 42 shortlisted sites, as well as one additional site that had not been prioritised (Kaweka Forest Park goat incursion). All of these sites received funding. Two plans combined two individual sites for efficiency purposes: Western Kahurangi Goat Exclusion (Karamea Headwaters and Heaphy sites) and Western Nelson Lakes National Park Goat Exclusion (Te Maruia and Te Maruia WAMU).

The final selection of sites was heavily limited by the small number of operational plans received back from districts. The final sites and the primary rank and objective for each are outlined in Table 12.

Table 12. Final 21 sites selected for funding for the 2023/24 financial year (July–June inclusive).

Region	District	Pressure	Site	Priority rank	Shortlist objective
Hauraki-Waikato-Taranaki	Whitianga	Deer	Coromandel Peninsula WAMU	5	Exclude deer from Coromandel Peninsula. Boundary to be defined. Consider feasibility study for goat eradication from Coromandel.
Western SI	Buller	Goats	Mokihinui	12	Suppress deer and goats to low levels to allow full ecosystem restoration (highly palatable species present in understorey), aiming for SRI of > 0. CPUE target = < 1 deer or goat per hunter day for ground hunting.
Northern SI	Golden Bay	Deer & goats	Devil-Anatoki Ranges	13	Suppress deer and goats to low levels to allow full ecosystem restoration (highly palatable species present in understorey), aiming for SRI of > 0. CPUE target = < 1 deer or goat per hunter day for ground hunting.
Southern SI	Central Otago	Goats	Oteake WAMU	19	Exclude goats from Oteake Conservation Park, Dunstan Downs and Lindis Conservation Area.
Hauraki-Waikato-Taranaki	Waikato	Deer & goats	Pirongia	21	Develop feasibility study for eradication of goats and future suppression of deer from Pirongia Mountain.
Hauraki-Waikato-Taranaki	Whitianga	Goats	Moehau	34	Exclude goats from Moehau. CPUE target = non-detection of goats in Moehau.
Hauraki-Waikato-Taranaki	Hauraki	Deer & goats	Hauraki-Kapowai-Kauaeranga	45	Suppress deer and goats to low levels to allow full ecosystem restoration (highly palatable species present in understorey), aiming for SRI of > 0. CPUE target = < 1 deer or goat per hunter day for ground hunting.
Eastern NI	Whakatāne	Deer & goats	Waioeka Urutawa WAMU	46	Suppress deer and goats to low levels to allow full ecosystem restoration (highly palatable species present in understorey), aiming for SRI of > 0. CPUE target = < 1 deer or goat per hunter day for ground hunting.
Northern NI	Bay of Islands	Goats	Omahuta-Puketi	47	Suppress goats to low levels to allow full ecosystem restoration (highly palatable species present in understorey), aiming for SRI of > 0. CPUE target = < 1 goat per hunter day for ground hunting.
Southern SI	Wakatipu	Goats	Shotover (Mt Aspiring Buffer) WAMU	100	Exclude goats from Mount Aspiring National Park. Target = zero density along northern buffer of Shotover unit. Deliver in collaboration with Central Otago district.
Eastern SI	Geraldine	Goats	Mt Potts Goats	117	Develop feasibility study for eradication of goats from Mount Potts.

Continued on next page

Table 12 continued

Region	District	Pressure	Site	Priority rank	Shortlist objective
Northern NI	Bay of Islands	Goats	Whangaroa	121	Exclude goats from Whangaroa EMU / Mangōnui Forest. CPUE target = non-detection of goats.
Northern SI	Golden Bay	Deer & goats	Farewell Spit	122	Exclude deer and goats from Farewell Spit. CPUE target = non-detection of deer or goats on Farewell Spit.
Hauraki-Waikato-Taranaki	King Country	Goats	Waihāhā Ecological Area	165	Exclude goats from Waihāhā EMU. CPUE target = non-detection of goats.
Central NI	Tongariro	Goats	Tongariro WAMU	229	Exclude goats from Tongariro National Park. CPUE target = zero density along buffer zone (< 1 goat per hunter day for ground hunting) and non-detection of goats in the park.
Eastern NI	Tauranga	Goats	Otanewainuku	340	Exclude goats from Otanewainuku – reframe as western Bay of Plenty goat containment. Check goat presence status.
Eastern NI	Tauranga	Goats	Orokawa SR	402	Undertake a brief feasibility study for eradication of goats from Orokawa SR and surrounding forest parcel.
Lower NI	Hawke's Bay	Goats	Kaweka Forest Park	414	Goat incursion – reactive eradication.
Northern SI	Nelson Lakes	Goats	Western Nelson Lakes NP Goat Exclusion (Te Maruia and Te Maruia WAMU)	24 & 140	Exclude goats from Nelson Lakes National Park – population in Braeburn Range. CPUE target = zero density along buffer on western edge of park (< 1 goat per hunter day for ground hunting) and non-detection of goats in the park.
Western SI & Northern SI	Buller	Goats	Western Kahurangi Goat Exclusion (Karamea Headwaters and Heaphy)	27 & 7	Understand and defend goat-free areas in western Kahurangi. Work in collaboration with Northern SI.

Abbreviations: CPUE, catch per unit effort; EMU, Ecosystem Management Unit; NI, North Island; NP, National Park; SI, South Island; SR, Scenic Reserve; SRI, Seedling Ratio Index; WAMU, Wild Animal Management Unit.

9. Reviewing containment programmes

The ecological and threat data used in the prioritisation exercise were drawn from sites of around 30,000 ha or less that were included in the Integration dataset, allowing management actions to be planned at the management unit level (SMU/EMU). Where similar control was required to prevent expansion of a given browser species, multiple management units were merged to formulate a WAMU, enabling the threat to be managed at a landscape level rather than at a specific site. Unfortunately, however, EMUs and SMUs were often disconnected across the geographic distribution of the threat, so WAMUs did not cover the total extent of the threat, making it difficult to meet the key Te Ara ki Mua objective of preventing the range expansion of deer or goats.

When the question of where to manage is reframed from 'How do we protect a site or cluster of sites from a pressure?' to 'How do we prevent the expansion of the pressure?', a completely different lens is applied to where management should occur. Towards the end of the prioritisation exercise, it was abundantly clear that the approach used, and the outputs generated, did not lend themselves to adequately addressing the Te Ara ki Mua priority objective of preventing range expansion of deer and goats over large landscapes. This was particularly apparent for goats which, in certain parts of the country (e.g. central Otago, western Hawke's Bay/Tairawhiti), occupied areas with invasion/expansion fronts that were hundreds of kilometres long. After considering this, it was concluded that a separate exercise was needed to identify these macro-populations of goats and develop containment strategies for them that operated at the cross-regional/macro-landscape level where they were considered a significant threat to large areas of PCL. Additionally, the propensity for these populations to have cross-tenure impacts warrants the need to consider inter-regional and collaborative management approaches between agencies and stakeholders. While deer were also considered in this separate approach, deer containment programmes were more adequately captured in the prioritisation exercise due to being smaller in their geographic extent or covered under separate statutory commitments such as Wild Deer Free Northland.

Spatially, cross-regional/macro-landscape-level threat containment programmes can be integrated into the prioritisation dataset to allow synergies with site-based management programmes for the same threat to be identified and decisions around how best to coordinate and deliver complementary management to be made. This is one of the key goals of the biodiversity planning approach (BPA) – spatially prioritised and integrated work. The integration of outcome plans for the containment of goat populations at the population level with site-based outcome plans managing the same threat to protect assets will be a natural outcome of the BPA process.

10. The need for a holistic control strategy

In the prioritisation exercise outlined in this report, we drew on the priorities outlined in Te Ara ki Mua to help identify where DOC should invest in control. Determining the relative split of shortlisted sites across control themes (containment/exclusion, eradication and suppression) involved weighing up the priorities of Te Ara ki Mua with the anticipated cost of delivering the control strategy to achieve the desired outcomes at a site.

It was not possible to obtain clear direction on the relative priority of investment into these control themes against other priorities within DOC's Wild Animals Management Programme (e.g. adaptive management sites, regional collaborative plans, the National Wild Goat Hunting Competition). Therefore, it is recommended that a strategic document is produced outlining the control priorities for the Wild Animals Management Programme, derived from the Te Ara ki Mua framework and the relative amount of investment towards them. These would include (but potentially are not limited to):

- maintaining important deer- and goat-free areas (through containment and exclusion)
- ensuring that deer or goats do not threaten important ecosystems and species (suppression/containment and exclusion/eradication)
- maintaining or undertaking new control at priority sites, as directed by Regional Pest Management Strategy requirements
- undertaking control at three adaptive management sites
- developing regional collaborative plans (these could incorporate any of the above priorities at a regionally prioritised scale)
- funding existing control that does not fall under any of the above priorities.

Until the Wild Animals Management Programme has a clear united strategy on how it approaches and funds these control 'themes', it will remain unclear how the prioritisation tool will be used to guide where deer and goat control work will be undertaken. There are co-dependencies among some of the work areas described above and other parallel exercises that will support our understanding of the programme's priorities (e.g. the macro-scale goat containment exercise). Therefore, in its current state, the prioritisation approach developed here is best suited as a decision support tool within a programme that includes other competing priority work areas that must also be considered.

11. Keeping the data and outputs ‘alive’ for the future

The prioritisation exercise was a point-in-time exercise, and DOC is going through some fundamental changes as to how it prioritises and delivers its work.

The data that underpinned the prioritisation outputs will remain stable for the medium term. However, the prioritisation tool will need to be updated as more information on wild animal impacts and distributions, and the values that are impacted, is gathered. The refresh of the Biodiversity Data Inventory will improve our knowledge of deer and goat distributions and likely influence the scope and scale of containment, and potentially eradication operations.

The introduction of the BPA will influence future priorities and locations where DOC undertakes wild animal control. The BPA is currently incorporating site-based data from the prioritisation exercise into outcome plans (site-based management plans to address threats or protect assets). Developing an outcome plan for wild animal control is a prescribed approach for delivering wild animal management and outcomes at a prioritised site, and outcome plans for wild animals and their inclusion into the BPA prioritisation will be completed for the 2026/27 financial year. In the future, updating data, reviewing outcomes and prioritising where DOC undertakes wild animal control will be delivered through the BPA review and prioritisation process, much the same as it was when prescriptions for EMUs and SMUs were developed or reviewed through the Natural Heritage Management System (NHMS). A subset of prioritised sites (approximately 180) is currently being considered for the creation of wild animal outcome plans.

We recommend that the prioritisation tool is revisited in early 2027 to see if the data need to be refreshed and the tool (or the currency of its information) is still useful within the new framework of the BPA.

12. References

Carwardine J et al. 2019. Priority Threat Management for biodiversity conservation: a handbook. Journal of Applied Ecology. 56(2):481–490. doi.org/10.1111/1365-2664.13268

[DOC] Department of Conservation. 1998. Department of Conservation National Feral Goat Control Plan 1995–2004. A strategy for the sustained protection of native plant and animal communities. Wellington: Department of Conservation.

[DOC] Department of Conservation. 2020. Te Mana o Te Taiao – Aotearoa New Zealand Biodiversity Strategy 2020. Wellington: Department of Conservation. doc.govt.nz/globalassets/documents/conservation/biodiversity/anzbs-2020.pdf

[DOC] Department of Conservation. 2022. Te ara ki mua: a framework for adaptive management of wild goats, deer, wild pigs, tahr, and chamois. Wellington: Department of Conservation. doc.govt.nz/globalassets/documents/conservation/biodiversity/te-ara-ki-mua-framework.pdf

Forsyth D, Coomes D, Nugent G, Hall G. 2002. Diet and diet preferences of introduced ungulates (Order: Artiodactyla) in New Zealand. New Zealand Journal of Zoology. 29(4):323–343. doi.org/10.1080/03014223.2002.9518316

Hawcroft A, Bellingham PJ, Jo I, Richardson SJ, Wright EF. 2024. Are populations of trees threatened by non-native herbivorous mammals more secure in New Zealand's national parks. Biological Conservation. 295:110637. doi.org/10.1016/j.biocon.2024.110637

Landcare Research. 2012. Potential Vegetation of New Zealand [vector polygon layer]. LRIS Portal, 2012.

Ledgard G. 2023. Final shortlist of prioritisation sites to go to operations for the development of operational plans. Te Anau: Department of Conservation (unpublished memo; DOC-7417647).

Ledgard G. 2024. Deer and goat prioritisation – data capture guide. Te Anau: Department of Conservation (unpublished; DOC-7619764).

Moilanen A, Kujala H, Leathwick JR. 2009. The Zonation framework and software for conservation prioritization. In: Moilanen A, Wilson KA, Possingham HP, editors. Spatial conservation prioritization: quantitative methods and computational tools. Oxford: Oxford University Press; p. 196–210.

Moloney PD et al. 2021. Occupancy and relative abundances of introduced ungulates on New Zealand's public conservation land 2012–2018. New Zealand Journal of Ecology. 45(1):1–16. dx.doi.org/10.20417/nzjecol.45.21

Parkes J. 1996. The National Deer Control Plan: discussion paper 2, strategic options and system for ranking areas for deer control. Lincoln: Manaaki Whenua – Landcare Research. Landcare Research Contract Report No.: LC9596/65.

Perry M. 2023. Task assignment: operational planning information for prioritised ungulate management sites. Wellington: Department of Conservation (unpublished; DOC-7447322).

R Core Team. 2024. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing. R-project.org

Rolfe J et al. 2022. New Zealand Threat Classification System manual 2022. Part 1: Assessments. Wellington: Department of Conservation. doc.govt.nz/globalassets/documents/science-and-technical/new-zealand-threat-classification-system-manual-2022-part-1-assessments.pdf

Thomson J et al. 2020. Spatial conservation action planning in heterogeneous landscapes. Biological Conservation. 250:108735. doi.org/10.1016/j.biocon.2020.108735

13. Additional resources

Ledgard G. 2023. Final master data capture spreadsheet. Te Anau: Department of Conservation (unpublished Excel spreadsheet; DOC-7392701).

Ledgard G. 2023. Post operational briefing: deer and goat prioritisation tool development. Te Anau: Department of Conservation (unpublished; DOC-7528830).

Ledgard G. 2024. Deer and goat prioritisation tool development. Presentation to the NWACG. Te Anau: Department of Conservation (unpublished PowerPoint presentation; DOC-7621816).

Ledgard G. 2024. Simplified explanation of how site scores were developed. Te Anau: Department of Conservation (unpublished; DOC-7621931).

Appendix 1: Data collection fields

Field name	Variable	Explanation
Prescription ID	Number	Fill out where not completed from Prescription ID Master Tab.
Region	Free text	Fill out where not completed from Prescription ID Master Tab.
District	Free text	Fill out where not completed from Prescription ID Master Tab.
EMU or SMU name	Free text	**Exact** name of the prescription ID from Prescription ID Master Tab. If not an EMU/SMU, use DOC name for the site.
Should this site be considered for management?	Dropdown list	Rangers often know that some sites are not even worth considering (e.g. a high-value recreational hunting area of low ecological value; an area where large numbers of other browsers, such as wallabies or pigs, are not managed; private land). If the site is worth considering for management, select YES. Otherwise, select NO.
Overall comment on management appropriateness	Free text	Provide a good explanation if you selected NO above.
WAMU	Free text	If this site is part of a wider joint control programme, name that programme here (e.g. for a goat control programme across several separate reserves, each reserve will have its own prescription ID and budget but they will all be managed under the same control programme for the same outcomes and so will be treated as one management programme; these were sometimes captured in the AUSM layer). You can include areas that are not PMUs, but these should be exceptional and well justified, as they will not currently be ranked for species or ecosystem values and may bring the WAMU score down.
Commentary on WAMU	Free text	Any detail on management within the polygon, along with the purpose of the management, can be entered here. We do not need a lot of detail, as this does not feed into the score per se, it just adds context if somebody queries it.
What existing layer best represents your operation? AUSM PMU NaPALIS FLOC Planned/actual Needs new map	Free text – choose one or multiple options listed	Of all the layers available, indicate which best represents this site/control programme (note that near enough is good enough in this instance and multiple options can be selected). If no layer is available, you will need to draw one and supply it to your key contact as soon as possible via email.
Polygon ID/name	Free text	Use the OP ACTS mapping software to get polygon IDs, and type in the **exact** polygon ID to your corresponding layer choice(s) (it is important to get this correct), using commas to delimit different layers (e.g. for AUSM, NaPALIS – 300499, 2804984).
Key contact name	Free text	Name of the ranger who helped fill out this form who we can contact if we have any follow-up questions.
Threatened species value	Auto-populated number	**Do not edit.** Score derived from a separate exercise that considers the species threat from ungulate browsing; note that we are not including species that have a secondary threat from deer and goats (e.g. fish).
EMU impact score	Auto-populated number	**Do not edit.** Score derived from a separate exercise that considers the ecosystem threat from ungulate browsing (pressure scores). Only pressure scores of 3 and 4 are included; pressure scores of 1 and 2 are not streamed for management by the Department of Conservation and so are not considered here.
EMU area (ha)	Auto-populated number	**Do not edit.**
Area (ha) under deer management in AUSM	Auto-populated number	**Do not edit.** Hectares of deer control within prescription AUSM (from BPRS).
Area (ha) under goat management in AUSM	Auto-populated number	**Do not edit.** Hectares of goat control within prescription AUSM (from BPRS).
Percentage of area in AUSM	Auto-populated number	**Do not edit.** % of EMU or SMU within prescription AUSM.
Managed for deer/goats/both/none	Dropdown list	What do you currently manage at the site?
Number of T1 plots	Auto-populated number	**Do not edit.** Number of Tier 1 plots within the prescription management unit.

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Appendix 1 table continued

Field name	Variable	Explanation
MED FPI	Auto-populated number	**Do not edit.** The median FPI measured within the Tier 1 plots.
Current ungulate numbers: deer	Dropdown list	This is a subjective score and relies on the person filling out the data having a good understanding of ungulate (deer and goat) numbers and their impacts within the site. Select: • **None** if you are certain that no ungulates are present • **Few** if ungulate numbers are low, ungulate browse is inconspicuous and there are good numbers of highly palatable species within the browse tier that have little or no browse • **Moderate** if ungulate numbers are known to be present in moderate numbers, highly palatable species show significant amounts of browse, and moderately palatable species are present in the browse tier and only receiving moderate to light browse • **High** if there are high numbers of ungulates at this site, highly palatable species are almost non-existent within the browse tier and moderately palatable species are receiving heavy amounts of browse • **Very High** if no highly palatable species are present in the browse tier, there is severe browse on moderately palatable species and the understorey is devoid of regeneration except for unpalatable species • **Present – Unknown** if you are certain that ungulates are present but numbers are unknown (do not attempt to guess the number) • **Unknown** if you do not know the site well enough to make a call on if deer or goats are present.
Current ungulate numbers: goat	Dropdown list	
Current ecosystem integrity with respect to browsers	Dropdown list	This is a subjective score and relies on the person filling out the data having a good understanding of ungulate (deer and goat) and other browser impacts within the site. The score is based on ecosystem health (species impacts are ranked in a separate process). Select: • **No Impacts** if ungulate populations are low enough that there are no detectable impacts • **Minor Impacts** if ungulate browse is inconspicuous, there are good numbers of highly palatable species within the understorey that have little or no browse, and impacts on species are low enough that they do not impede reproduction and recruitment processes • **Moderate Impacts** if ungulate numbers are known to be present in moderate numbers, highly palatable species show significant amounts of browse, moderately palatable species are present in the understorey and only receiving moderate to light browse, and recruitment and reproduction processes are being compromised for some species, resulting in a decline due to browsing • **High Impacts** if there are high numbers of ungulates at the site, highly palatable species are almost non-existent within the browse tier, moderately palatable species are receiving heavy amounts of browse, and some species are in significant decline or only have remnant populations present, with browsing putting them at risk of local extinction at the site • **Extreme Impacts** if no highly palatable species are present in the browse tier, there is severe browse on moderately palatable species and the understorey is devoid of regeneration except for unpalatable species.
Site score out of 1	Auto-populated number	**Do not edit.**
Land status	Dropdown list	Use DOC GIS layers to find out what the **dominant** land status is. Choose from the following options: • Stewardship • National Park • Specially Protected Area • Conservation Park • Reserve • Marginal Strip • Wildlife Management Area • Waitangi Endowment Fund *If you wish to add a comment or another status of land administration, please right click the cell and add it as a comment.*
Political obligation, including RHAs, Treaty statute	Free text	If there is a strong political obligation to undertake ungulate control at this specific site (i.e. written specifically within a plan, community agreement or statutory document), please note this here. Insert details of any Treaty obligation at the site.

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Appendix 1 table continued

Field name	Variable	Explanation
Known iwi interest that impacts ungulate management	Dropdown list	Only complete this if there is a known direct iwi interest in ungulate management at the site. Additional context around your evaluation can be given in the previous field. The choice of L/M/H is subjective – this field is more about eliciting any information on iwi hunting values at this site and understanding likely interest.
Local hunter interest	Dropdown list	Indicate the interest of hunters at this site. Select: • **H** if there is very high hunter interest (regional/national) that will provoke a lot of attention if ungulate management occurs at the site (include notes that capture why and which species this applies to) • **M** if hunting occurs at the site but it is more a local (district) site of hunter interest (i.e. it is not known as a major site of interest to hunters) • **L** if the area is of minor value to most hunters.
Primary goal of ungulate control	Dropdown list	These two fields identify the primary goal for the wild animal control being undertaken at the site. In some cases, there may be two goals, which can be scored in the second field if necessary. The management purpose should fall under one of the categories provided. Select: • **Ecosystem Restoration** if ungulates are streamed for management to protect ecosystem values • **Species Protection** if ungulates are streamed for management to protect specific species values • **Biosecurity – RPMS/Incursion** if ungulates are being managed for biosecurity purposes (e.g. containment, exclusion/prevention) • **Sociopolitical** if ungulates are being managed as part of an agreement but management is not a priority in the district for ecosystem or species protection.
Control strategy needed to achieve goal – deer	Dropdown list	This field describes the necessary control strategy to achieve the primary purpose. Select: • **Eradication** if all animals will be eradicated from the site within a specific period • **Containment** if no dispersal will occur from a given containment area (i.e. buffer control) • **Suppression** if numbers are suppressed to a level that achieves the ungulate control strategy goal • **Exclusion/Prevention** if the area has no ungulates present and surveillance and control are taking place to prevent any incursions.
Control strategy needed to achieve goal – goats	Dropdown list	
Proposed control/management methods	Dropdown list	This is here to get the rangers thinking about the control strategies needed to achieve the goal as a precursor to thinking about cost. The response is not used in the final ranking and can be populated from stocktake data for the sites captured there. The methods chosen should be described using the activity-method nomenclature from the BPRS (e.g. Hunt Aerial / Hunt Ground / Barrier Fence).
Non-financial technical achievability of control strategy achieving outcomes (likelihood of success)	Dropdown list	This field is repeated for deer and goats individually. It captures the likelihood of success of the above control strategy meeting the outcomes, ignoring finances and sociopolitical constraints (i.e. Is the proposed control strategy actually feasible? Will managing deer and/or goats achieve your goals? Are you constrained to managing one species only? Are there other unmanaged species still compromising the achievement of your outcomes, such as wallabies or rabbits?). Select: • **1** if you are 100% confident you can operationally and technically achieve the outcome • **0.5** if there are some legitimate doubts around the operational and technical ability to achieve the outcomes OR only some of the outcomes will be met (e.g. you can protect the ecosystem but not the species) • **0** if the outcomes are not achievable.
NPCP predator control site	Auto-populated number	**Do not edit.** This field is to capture complementary DOC-led work that impacts browser numbers (ungulates and possums). Select: • **1** if there is cyclic 1080 control approximately every 3 years • **0.75** if there is cyclic 1080 control every >3–5 years • **0.25** if there is cyclic 1080 control every 6–8 years or sporadic 1080 control • **0** if there is cyclic 1080 control every >8 years or no 1080 control. (Note: There is no 0.5 category.)

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Appendix 1 table continued

Field name	Variable	Explanation
Is this part of a wider, coordinated multi-pest/ecosystem restoration programme where ungulate management complements wider goals (e.g. Te Manahuna Aoraki Project; Arawai Kākāriki wetland restoration programme; Project Janszoon)?	Dropdown list	This is to capture non-NPCP-led multi-pest/ecosystem restoration programmes that complement wild animal control. If this is the case for your site, select yes from dropdown list (Y/N).
Name and details of programme	Free text	Name of programme or leave blank.
Third party contribution	Free text	Is there a meaningful financial contribution to ungulate management at this site from a third party?
Details and $$	Free text	This field captures the total annual dollar figure contributed to **ungulate** management by a third party (e.g. regional council, iwi, hunter group), rounded to the nearest $10k. Please do not include funding towards other predator control.
Ungulate prior investment	Dropdown list	This field is to capture historical investment and the outcomes achieved at a site. Select: • **1** if there has been a significant, effective and sustained long-term programme as proven by quantitative data • **0.75** if investment is believed to be at or near 1 but there are no quantitative data to support the effectiveness • **0.5** if there has been sporadic investment or underinvestment, or the effectiveness cannot be demonstrated with data • **0.25** if there has been some token control but it has proven ineffective • **0** if there has been no control. Note that a programme that is long running but has had few outcomes to show for it should not score highly, while a new programme that has achieved significant reductions in ungulates and has had positive outcomes observed/measured should score highly.
Comment on ungulate prior investment	Free text	It is important to justify the above score by providing commentary in this field, so please be specific about the length of the programme, the gains it has achieved, etc.
Combined management score	Auto-populated number	**Do not edit.**
Values + management	Auto-populated number	**Do not edit.**
10-year cost of achieving control target	Free text number rounded to the nearest $10k	Initial knockdown and maintenance control over the first 10 years. Note: This includes the cost of buffer control and only needs to be a ballpark figure for the full 10 years. After this time, the operational goal should be being met and the project should be in 'maintenance' mode. Basic figures used to calculate costs: 1× ground hunter day = $500 1× helicopter hour for conventional control = $2k Deer fence = $40/m 1× helicopter hour TAAC = $3k
50-year cost of maintaining control target	Free text number rounded to the nearest $10k	Maintenance cost for programme. This is the 10-year cost PLUS the cost for the next 40 years based on the current annual cost in today's terms. For example, if the first 10-year cost = $1,000,000 and the costs beyond this = $10,000 per annum, then: 50-year cost = $1,000,000 + (40 × $10,000) = $1,400,000
Comments on cost	Free text	This is where you explain the ballpark costs and maintenance figures.
$/ha/year	Auto-populated number	**Do not edit.**

Abbreviations: AUSM, area under sustained management; BPRS, Biodiversity Planning and Reporting System; DOC, Department of Conservation; EMU, Ecosystem Management Unit; FLOC, functional location; FPI, faecal pellet index; NaPALIS, National Property and Land Information System; NPCP, National Predator Control Programme; PMU, Prescription Management Unit; RHA, Recreational Hunting Area; RPMS, Regional Pest Management Strategy; SMU, Species Management Unit; T1, Tier 1; TAAC, thermal-assisted aerial culling; WAMU, Wild Animal Management Unit.