Resilient Landscapes

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Current and emerging feral cat management practices in Australia

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NSW GOVERNMENT

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Cover photograph

Feral cat in a cage trap. Photo: Guy Ballard.

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Acknowledgement of Country

We acknowledge the Ngunnawal People – the Traditional Custodians of the land where this workshop took place. We acknowledge and respect their continuing culture and the contribution they make to the life of Canberra and the surrounding region.

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1. Executive summary

Australia sorely needs effective feral cat management programs to alleviate unsustainable impacts on endemic fauna and other negative impacts on livestock and people. Unfortunately, land managers lack clear guidance on how they should approach the design and implementation of best-practice feral cat management in their local contexts.

As a key first step in bridging the gap between 'supply and demand' for feral cat control knowledge, this workshop brought together Australian experts to establish reasonable expectations about the effectiveness of various control tools for managing feral cats in a range of different ecoregions.

Experts provided assessments of effectiveness for 10 contemporary feral cat management strategies for each of 4 ecoregions. This information will be used to develop an integrated management decision tool in subsequent stages of the project.

Additionally, participating experts were asked to identify and prioritise key research gaps in Australia's feral cat management. From the 18 topics they identified, experts agreed that (1) effective monitoring, (2) understanding cat impacts on prey species, (3) measuring the longevity of management benefits, (4) quantifying feral cat exchange between urban and natural areas and (5) finding ways to prioritise sites for eradication were the most pressing of Australia's feral cat management research needs.

2. Background

Feral cats have significant negative environmental and socio-economic impacts. In particular, cats pose a significant threat to the native birds, herpetofauna and critical-weight-range mammals on which they prey. Consequently, targets 8 and 9 of the Australian Government's ***Threatened species action plan 2022–2032*** (TSAP) identify research into the best-practice management for feral cats as a priority. Accordingly, it is urgent we provide land managers, especially those focused-on priority species and priority places, with clear guidance on how to successfully plan, implement and review their feral cat management programs. Such guidance relies upon understanding the management techniques currently in use nationwide and the factors affecting their success in different regions.

Factors such as ecoregion (defined based on climate and vegetation) or land use are known to affect feral cat populations and the management techniques which can be implemented for their control. For instance, higher cat densities are expected in areas of higher vegetation productivity (Bengsen et al., 2016) and cat behavioural patterns are likely to be impacted by land-use type (Doherty et al., 2014). These factors also influence the success of feral cat management programs. For example, poison bait longevity is affected by weather conditions in the weeks following a deployment (Algar et al., 2007; Fancourt et al., 2021). Jurisdiction-specific legislation relating to different land-use types will also determine where and how different techniques can be implemented. As such, it is important to consider both ecoregion and land-use type when assessing the impact of different feral cat management techniques.

Currently, empirical data regarding the impact of different feral cat management techniques is extremely limited. In particular, while research and knowledge around many feral cat management techniques has been published, the peer-reviewed literature can disproportionately reflect the views of a subset of the academic research community relative to other researchers and land managers. Many researchers and practitioners hold useful, but often undocumented and unexamined, knowledge and experience around feral cat management. Thus, the experience of many experts in feral cat management may be unrepresented within the peer-reviewed literature. Expert elicitation provides a means to gather this knowledge through facilitated discussion in a structured workshop setting. Such processes enable the collation and summarisation of knowledge from experts in feral cat management for different ecosystems.

For this project, 19 expert opinions were elicited to identify the current and emerging feral cat management techniques being used around Australia and the factors influencing their success. Specifically, we also examined the environmental, social and economic impact of each identified management technique by ecoregion and land-use type. Subsequently, the expert elicitation was used to identify knowledge gaps and, ultimately, the priorities for future research regarding feral cat management in Australia.

3. Methods

Using 5 facilitators, we captured the current and emerging feral cat management techniques used across Australia through a one-day workshop with 19 experts in feral cat management. Experts were encouraged to: identify the techniques used for feral cat management; identify the effectiveness, impact and cost of each method; identify key knowledge gaps in relation to feral cat management; and prioritise these knowledge gaps. The facilitators aided in the design and format of the workshop, facilitated the discussion at each stage and collated the results. Facilitators did not attempt to influence the discussion around management techniques or the knowledge gaps.

3.1 Selection of workshop participants

Workshop participants were members of the National Feral Cat Taskforce or their nominated representatives. The Feral Cat Taskforce is a national advisory group who provides information and support to the Threatened Species Commissioner and the Department of Climate Change, Energy, the Environment and Water on implementing feral cat actions and targets in the TSSAP. Members of the Feral Cat Taskforce have experience in academic research, management implementation and policy. Of the participants recruited, 4 had experience as a researcher, 7 had experience as practitioners, 3 had both and 5 had experience in policy (Table 3-1). They came from 16 different institutions and experience ranged from <10 years (10 participants) to >30 years (one participant) (Table 3-1).

3.2 Identifying current and emerging management techniques

The first stage of the workshop required experts to work in groups of 4 or 5 to discuss and describe the management techniques they had used in different regions around Australia. Experts were asked to consider their responses based on the ecoregion in which they had the most experience. Ecoregions were defined using the existing descriptions provided by the **Department of Sustainability, Environment, Water, Populations and Communities (2012)**.

In their groups, experts were asked to compile a list of feral cat management techniques. Workshop facilitators used this list to keep the conversation on track and encourage the workshop participants to progress through discussion of each management action in a timely manner. During this exercise, workshop participants were given 1.5 hours to answer a series of questions about each management action, including (1) where it had been used, (2) the spatial scale of use, (3) the season of use, (4) the annual frequency of use (5) whether the outcome was monitored and (6) any pros and cons associated with its use. Following these smaller group discussions, all experts participated in a facilitated discussion around the management techniques to separate those which are commonly used and those which may be used in the future. Once a list of current management actions was agreed upon, each group read out their definitions of the techniques. Discussions around these definitions were encouraged to clarify the participants' understanding of the management techniques. These

discussions led to a final list of 10 management techniques to be considered for the remainder of the workshop.

Table 3-1. Demographics of workshop attendees and the regions in which they have the most feral cat management experience (excluding facilitators). The number of workshop participants within each demographic is shown in brackets.

Organisations represented	State or territory	Type of experience	Years of experience	Gender
University of New England (1)	NSW (3)	Researcher (4)	1–10 (10)	Male (11)
New South Wales Department of Planning and Environment (1)	NT (2)	Practitioner (7)	11–20 (5)	Female (7)
NRM Regions Australia (1)	Qld (1)	Both (3)	21–30 (2)	
Northern Territory Department of Environment, Parks and Water Security (1)	SA (2)	Policy (5)	30+ (1)	
Charles Darwin University (1)	Tas (1)			
Australian Department of Defence (1)	Vic (2)			
Department of Regional New South Wales (1)	WA (5)			
Australian Government Department of Climate Change, Energy, the Environment and Water (3)	ACT (3)			
Australian Government Department of Agriculture, Fisheries and Forestry (1)				
Centre for Invasive Species Solutions (2)				
Queensland Department of Agriculture and Fisheries (1)				
South Australian Kangaroo Island Landscapes Board (1)				
Victorian Department of Environment, Land, Water and Planning (1)				
Tasmanian Department of Natural Resources and Environment (1)				
Australian National University (1)				
Western Australian Department of Biodiversity, Conservation and Attractions (2)				

3.3 Estimating impacts of management techniques

Following the identification and definition of current feral cat management techniques, individual experts were asked to quantify the impact of each technique in 6 different land-use types (Table 3-2). These land-use types were based on existing primary and secondary class definitions from *The Australian land use and management classification version 8* (ABARES, 2016). Using Qualtrics (an online survey platform), experts then generated estimates for each of the land-use types related to (1) the reduction in the feral cat population that would occur one month from the implementation of a management program, (2) the reduction in the population that would occur 12 months from the implementation of a program and (3) the expected cost of implementing the management technique. Additionally,

the survey (Appendix 1) asked experts to consider (4) the proportion of the budget in their region attributed to each management technique over a 12-month period, (5) to what degree the management technique negatively impacts non-target native species over a 12-month period and (6) the social acceptability of the technique. Summaries of the experts' responses were generated and plotted using the 'ggplot2' package (Wickham, 2009) in R version 4.1.0 (R Core Team, 2021), then presented to the group for discussion.

Table 3-2. Land-use type definitions provided to experts during the workshop based on definitions from *The Australian land-use and management classification version 8* (ABARES, 2016).

Land-use type	ABARES land-use type	ABARES definition
Natural	Conservation and natural environments (PRIMARY CLASS)	Land used primarily for conservation purposes, based on maintaining the essentially natural ecosystems present (e.g. national parks, conservation areas, forest reserves). Land that has a relatively low level of human intervention. The land may be formally reserved by government for conservation purposes or conserved through other legal or administrative arrangements. Areas may have multiple uses, but nature conservation is the prime use. Does not include water reserves or wetlands in this category.
Production	Production from relatively natural environments (PRIMARY CLASS)	Land used mainly for primary production with limited change to the native vegetation (e.g. grazing in native vegetation, native forestry). The land may not be used more intensively because of its limited capability. The structure of the native vegetation generally remains intact despite deliberate use, although the floristics of the vegetation may have changed markedly. Where the native vegetation structure is, for example, open woodland or grassland, the land may be grazed.
Agricultural	Production from dryland agriculture and plantations (PRIMARY CLASS)	Includes land that is used principally for primary production, based on dryland farming systems. Native vegetation has largely been replaced by introduced species through clearing, the sowing of new species, the application of fertilisers or the dominance of volunteer species. The range of activities in this category includes plantation forests, pasture production for stock, cropping and fodder production and a wide range of horticultural production.
Rural residential	Rural residential (SECONDARY CLASS)	Rural allotments with houses built (or being built) and agricultural activity at the sub-commercial and/or hobby scale (excluding backyard/domestic garden areas or livestock as pets). Rural residential generally refers to areas with blocks larger than 0.2 ha that are located in a rural setting (away from the main urban setting), with agriculture unlikely to be the main form of income. If agricultural activities are larger than 2 ha, they should be included separately under the production from dryland agriculture class.
Urban residential	Urban residential (SECONDARY CLASS)	Land with houses, flats, hotels and so on within urban areas. This class may be used for land which is zoned for urban residential development where houses or apartments have not yet been constructed but infrastructure, such as roads and streetlights, is in place and it is clear that the intended land-use is urban residential.
Wetlands	Wetlands, Lakes, Reservoirs, and Rivers (PRIMARY CLASS)	Wetlands are areas of permanent or periodic/intermittent inundation, whether natural or artificial, with water that is static or flowing, fresh, brackish or salt, excluding estuary and coastal water. Lakes are a natural or human-made body of mainly static water surrounded by land. Reservoirs are a body of water collected and stored behind a constructed barrier for some specific use. Rivers are a natural channel along which water may flow from time to time.

3.4 Identifying research priorities

The final workshop task for participants was to write down three key knowledge gaps relating to feral cat management. These were compiled into a list and the experts participated in a facilitated group discussion to ensure all the identified knowledge gaps were included and represented correctly. This refined list of knowledge gaps was provided to the experts in another online Qualtrics survey so they could rearrange the list in order of research priority. The median ranking of each knowledge gap was calculated and the this was used to list the knowledge gaps in order of research priority.

4. Results

Experts identified that some of the ecoregion types were not suitable when considering feral cat management. Firstly, 'Montane grasslands and shrublands' were identified as a region where feral cat management is not currently undertaken. Secondly, 'Tropical and subtropical grassland, savannas and shrublands' and 'Temperate grasslands, savannas and shrublands' were considered equivalent in how management techniques are implemented. Additionally, the experts noted that island systems probably do not suit the ecoregion definitions provided and should be considered separately when discussing feral cat management techniques. Several caveats were also identified during this discussion including the influences that topography, human population density and landscape complexity can have on management techniques and outcomes.

4.1 Management technique definitions

Experts identified 10 techniques that are currently used effectively in feral cat management (Table 4-1) and 5 techniques, which are either not used frequently or may be used in the future. The latter techniques were gene drive technology, Felixer grooming traps, immunocontraception, trap-neuter-release programs and biocontrol (see Appendix 2).

Table 4-1. Definitions of management techniques identified as currently in use around Australia.

Technique	Description	Pros and cons of technique
Aerial baiting	A lethal technique in which a helicopter or fixed-wing aircraft is used to deploy poison baits. Several different bait types exist. Used in difficult to access areas, although decisions around use are based on economics as well as size and topography of the landscape. Not affected by ecoregion. Legislation for use differs between states **Scale**: variable (>100,000 ha) **Season**: typically winter **Return interval**: annual or biannual **Does monitoring occur**: hard to monitor **Tenure**: public, private.	**Pros** • fast technique with large scale of operation • does not require road access • can achieve reasonable cat knock down (50–90% decrease). **Cons** • humaneness and risk to non-target species • often ineffective – affected by weather conditions or prey availability • seasonal use only • permits and legislation • difficult to use for conservation in some regions for ecological or cultural reasons • target species can develop bait avoidance or resistance • may lead to prey switching in cats.
Ground baiting	A lethal technique in which poison baits are deployed along tracks, roadsides, park perimeters or fire edges. Several different bait types exist. Use overlaps with aerial baiting but is more targeted and limited in scale.	**Pros** • fast technique with large scale of operation • can achieve reasonable cat knock down (50–90% decrease) • not as expensive as aerial baiting • fewer baits per unit area than aerial baiting.

Technique	Description	Pros and cons of technique
	Legislation for use differs between states. **Scale**: 10,000–20,000 ha **Season**: typically winter **Return interval**: annual **Does monitoring occur**: yes **Tenure**: public, private.	**Cons** • humaneness and risk to non-target species – on-track deployment means higher exposure to non-target species, in particular birds • often ineffective – affected by weather conditions or prey availability • seasonal use only • permits and legislation • difficult to use for conservation in some regions for ecological or cultural reasons • target species can develop bait avoidance or resistance • may lead to prey switching in cats • not as effective as aerial baiting with lower encounter rates • if baits are buried, cats will not take them.
Live trapping – leg-hold trapping	Specialist technique using soft/padded leg-hold traps, generally with a lure (e.g. olfactory, visual and/or auditory). Traps are checked daily. The placement and setting of traps are essential to the program success and to ensure non-target species captures are avoided. Requires a protocol for processing and euthanising the animal once it has been captured. Often used in areas where you cannot use baiting or used following a baiting program. Legislation for use differs between states **Scale**: 10,000–60,000 ha **Season**: year-round **Return interval**: variable **Does monitoring occur**: yes **Tenure**: public land.	**Pros** • non-targets can be released unharmed • more effective than cage traps. **Cons** • cost- and labour-intensive requiring experienced staff to implement • can only be used at smaller spatial scales • higher risk of injury to target and non-target animals when used incorrectly • can be seen as inhumane with issues around social license and acceptability • site access can limit use • cannot be used in urban interface.
Live trapping – cage trapping	Specialist technique using cage traps in conjunction with scent- or food-based lures. Traps are checked daily. The placement and setting of traps are essential to the program success and to ensure non-target species captures are avoided. Requires a protocol for processing and euthanising the animal once it has been captured. Typically used in areas where firearms or baiting programs are prohibited or are considered too risky (e.g. national park visitor areas). It can be used in areas where domestic	**Pros** • non-targets can be released unharmed • easy and affordable method • relatively urban friendly and good social licence • aids in eradication from areas. **Cons** • requires experienced staff • time and labour-intensive method • can only be used at smaller spatial scales • low success rates, with trap avoidance likely

Technique	Description	Pros and cons of technique
	cats may be captured. Often used following baiting programs. **Scale**: 100–20,000 ha **Season**: year-round **Return interval**: variable **Does monitoring occur**: no **Tenure**: public, private.	• non-target species frequently captured – food lures capture more non-targets • site access can limit use.
Shooting	A lethal technique in which a firearm is used to euthanise target animals. Can be either nocturnal or diurnal with the aid of either spotlights or thermal visualisation. Often used in conjunction with other management techniques for the final animals remaining in an area. **Scale**: localised around assets **Season**: year-round **Return interval**: variable **Does monitoring occur**: no **Tenure**: public, private.	**Pros** • exact numbers of animals killed is known • very good when used with other techniques – particularly for closed populations (e.g. islands, fences) • good for specific cats that avoid cages • many people licensed to shoot (e.g. farmers, natural resource managers) • less intrusive and can be more humane than other techniques **Cons** • requires permitting and legislation, with legislation limiting where shooting can occur. • requires vehicle or track access • cost and labour intensive – cannot be applied broad scale • humaneness can be an issue depending on the skill of the individual • needs to occur as part of a proper management program • limited to non-urban landscapes • low encounter rate.
Tracking by rangers	An extremely specialised skill in which Traditional Owners or rangers track cats in areas with sandy substrate. Currently limited to central and western Australia **Scale**: localised **Season**: year-round **Return interval**: variable **Does monitoring occur**: no **Tenure**: public, private.	**Pros** • substantial social and cultural benefits including getting people out on Country • exact numbers of animals killed is known. **Cons** • requires extremely skilled trackers • requires sandy substrate • difficult to maintain an ongoing effort • needs encouragement for rangers to keep going back to the same place • little is known of the humaneness of the technique with potential welfare issues (e.g. stress of being hunted to exhaustion).
Detector dogs	The use of dogs to detect where cats have been so baiting or trapping programs can be prioritised. Dogs can also be used to position (bail) cats so that they can be caught or shot.	**Pros** • very effective in smaller island habitats, including fenced areas

Technique	Description	Pros and cons of technique
	Should be considered a complementary technique rather than a main method of management. **Scale**: localised **Season**: year-round **Return interval**: variable **Does monitoring occur**: no **Tenure**: public, private.	• allows the recapture of certain cats which you may not be able to recapture using other methods. **Cons** • success tends to be location-specific • some regions detect scat/spoor really well, but have difficulty finding an actual cat • lots of skill required, with substantial training and handling costs • harder to use when baits are present • harder if snakes are active • can be a biosecurity risk.
Habitat modification	The use of fire or grazing to improve vegetation structure and minimise the impacts of feral cats. It is not specifically a cat management technique and requires use in conjunction with a direct-action management technique. **Scale**: N/A **Season**: N/A **Return interval**: N/A **Does monitoring occur**: N/A **Tenure**: public.	**Pros** • improves the general landscape resilience • can be relatively cost-effective addressing several pressures at once. **Cons** • not an effective technique to control cats specifically • fire is generally a reactive technique • evidence base is not substantial and can be conflicting.
Resource modification	Targeted control of prey species with the aim of reducing the prey population to reduce the predator population. In particular, for use on rabbit populations. **Scale**: N/A **Season**: N/A **Return interval**: N/A **Does monitoring occur**: N/A **Tenure**: public.	**Cons** • risk of prey switching damaging native populations.
Fencing	A supplementary technique in which a fenced area is created to maintain population levels of threatened species. Feral cats are removed from this fenced area using other management techniques **Scale**: N/A **Season**: N/A **Return interval**: N/A **Does monitoring occur**: N/A **Tenure**: public.	**Cons** • expensive.

4.2 Estimated impacts of management techniques

For the 10 currently used feral cat management techniques, experts identified the ecoregion for which they had the most experience in management and then answered a series of questions related to each technique's ecological, social and economic impact. It is worth noting the while the experts were asked to answer the questions for all techniques, there was considerable confusion about how to answer the questions for 'fencing'. This is partly because the questions were necessarily designed before the workshop and not with requirements specific to fencing in mind. Additionally, there was less detailed discussion around the definition of fencing as a management technique. This made it unclear whether, when assessing the impact of fencing on feral cat populations, the impact should be assessed while the fence is being constructed, or post-construction once feral cats have been removed from an area. For these reasons, the estimates provided for fencing are not commented on here but are reported in Appendix 2 for transparency.

Experts answered the workshop questions for 4 ecoregions: 'Deserts and xeric shrublands' (3 responses), 'Mediterranean forests, woodlands and shrubs' (3 responses), 'Temperate broadleaf and mixed forests' (7 responses) and 'Tropical and subtropical grassland savannas and shrublands' (2 responses). For these different land-use types, experts were asked to identify the expected reduction in the feral cat population at 2 temporal scales: 1) one month from the start of a management program for each technique (Figure 4-1; Appendix 2) and 2) 12 months from the start of the management program for each technique (Appendix 2). Many of the techniques were considered by experts as either not applicable in certain land-use types or experts could not provide an estimate of the expected response. Therefore, we only present here results for techniques in which more than 50% of the experts provided estimates of the reduction in the feral cat population (Figure 4-1). Graphs showing all estimates provided by experts can be found in Appendix 2.

Estimates of the expected reduction in feral cat populations varied within and between techniques depending on ecoregion and land-use type (Figure 4-1, Appendix 2). In natural and production landscapes, experts indicated that after one month, baiting techniques would lead to a greater reduction in the cat population than other techniques, followed by trapping, then shooting. However, baiting techniques were not considered suitable for use in many of the other land-use types (Appendix 2). Trapping techniques, shooting, detector dogs and resource modification were considered suitable in the majority of land-use types for all ecoregions. These techniques were considered more effective in Mediterranean forests, woodlands and shrubs than in other ecoregions (Appendix 2).

For all management techniques, the scale of the reduction expected by experts changed little after 12 months (Appendix 2). However, the expected reduction from habitat modification did increase, perhaps suggesting it was functionally considered to be more of a strategic investment than a reactive control.

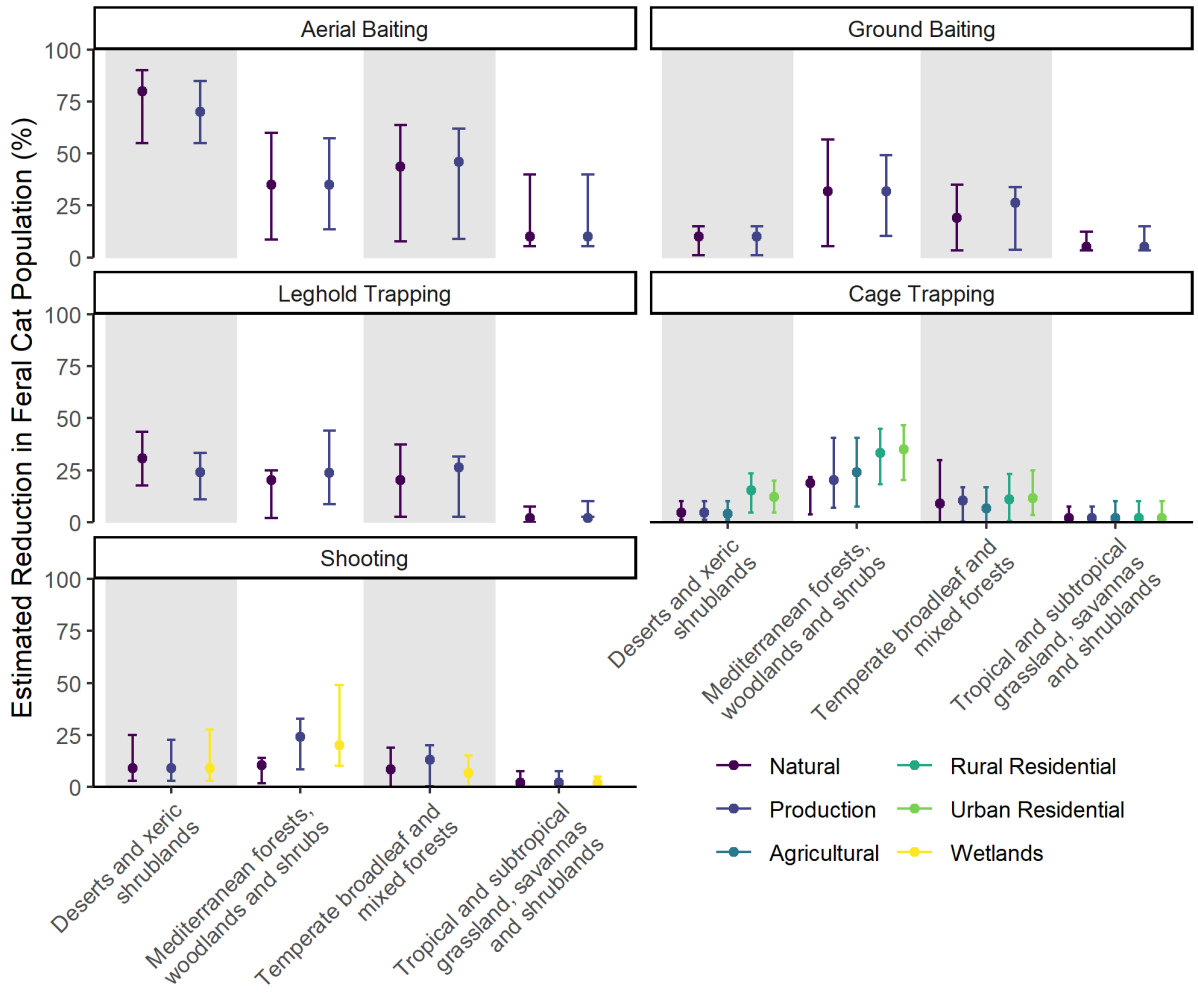

Figure 4-1. Average best, lower and upper estimates from experts on the percentage reduction in feral cats one month from the beginning of a management program for the different land-use types and ecoregions with estimates from more than 50% of experts (Table 8-1).

The potential negative impact of each management technique on non-target native species is presented in Figure 4-2a. Baiting, trapping and fencing received relatively more concern from the experts than other techniques, while detector dogs and tracking by rangers were considered least likely to have negative impacts on native non-targets.

Experts' opinions on the perceived social tolerance of each technique are depicted in Figure 4-2b. None of the techniques were described as 'unacceptable' but some experts considered there was 'low tolerance' for baiting, leg-hold trapping and shooting. Conversely, 'high tolerance' was ascribed by some experts to many of the techniques, including cage trapping, shooting, detector dogs, tracking by rangers, habitat modification, resource modification and fencing.

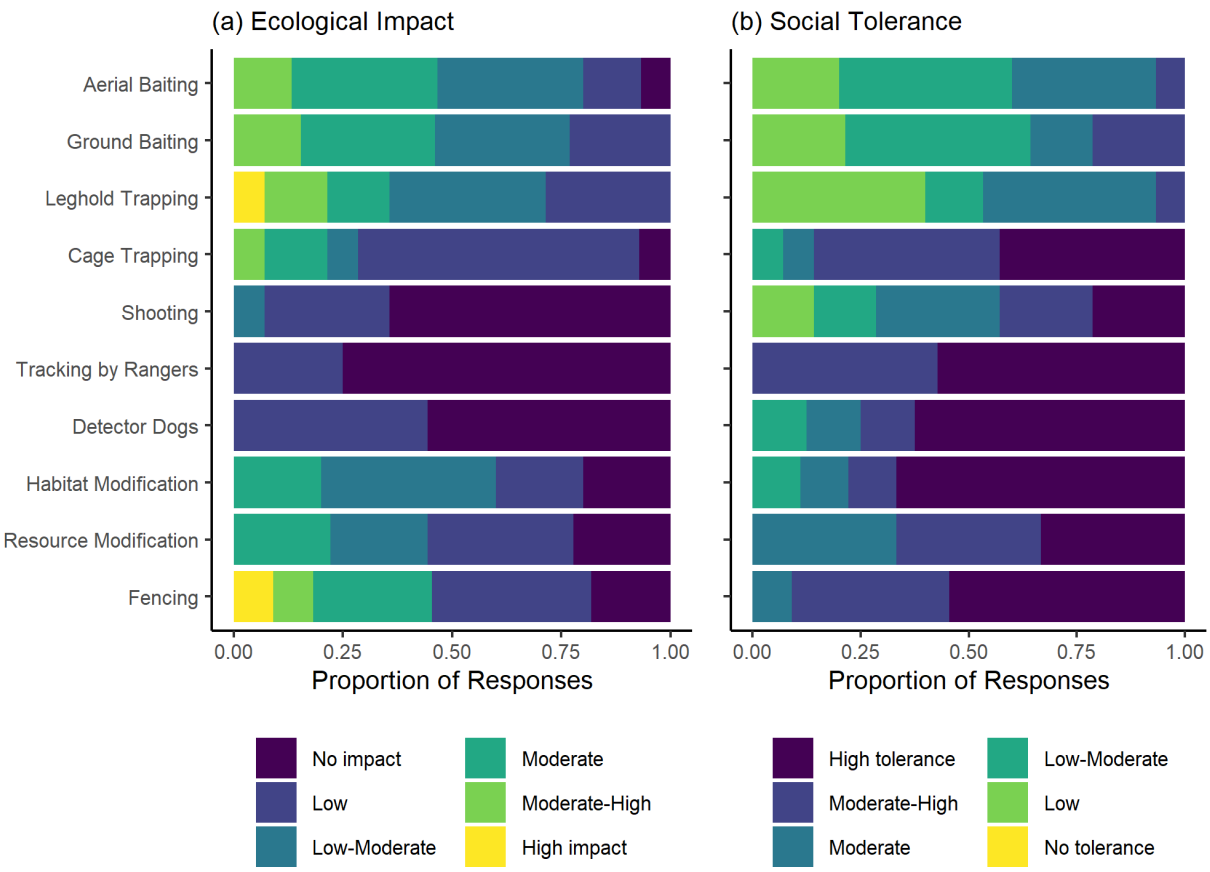

Figure 4-2. Expert opinions on (a) the negative ecological impact of management techniques on non-target native species and (b) the social tolerance of the different management techniques.

Regarding the economic cost of each management technique, experts identified fencing and aerial baiting as the most expensive techniques followed by detector dogs, leg-hold trapping, cage trapping, shooting and habitat modification (Figure 4-3, Appendix 3). There were differences in how the budget is allocated to different management techniques in the different ecoregions (Appendix 3). However, generally the experts agreed that the majority of the budget available for feral cat management went to aerial baiting (Appendix 3).

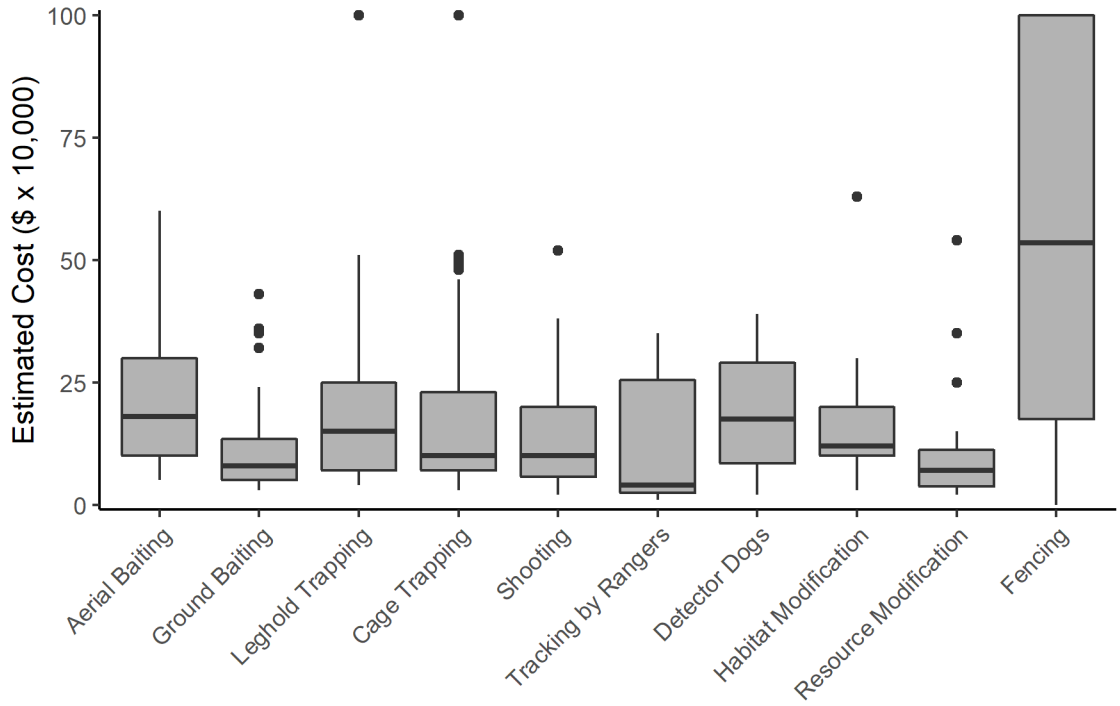

Figure 4-3. Estimated cost of each management technique.

4.3 Research priorities

Many of the knowledge gaps identified related to the requirement for successful monitoring of feral cat populations in order to implement successful management programs. The various knowledge gaps from experts around this point were summarised into a single general knowledge gap pertaining to how we can improve monitoring to inform management. Most experts ranked this knowledge gap as the single highest research priority (Table 4-2). Other key research areas identified by experts related to the implementation of management programs, the longevity of management, ethical considerations around management and more (Table 4-2).

Table 4-2. Expert identified knowledge gaps ranked in order of research priority from highest to lowest.

Priority	Knowledge gap
1	How do we best monitor to inform management (where cats occur, how they are using the landscape, cat density, juveniles and subadults, novel techniques e.g. eDNA)?
2	What are the impacts of cats/foxes/dogs on prey species with and without management?
3	What is the longevity of a management program including time to reinvasion?
4	How much movement is there between urban/peri-urban environments and natural environments and how can we best manage this?
5	Which areas do we prioritise for eradication?
6	How to manage across multiple tenures over time to increase the time to reinvasion?
7	In a cost-benefit framework, how can we optimise and prioritise resource expenditure in an adaptive manner?
8	How do we achieve and maintain social licence, how can we best communicate this and how does it change over time?
9	How far can we push ecological manipulation as a method for control (e.g. dingoes, grazing, rabbits, fire)?
10	What is the fine scale habitat use of cats/foxes/dogs?
11	How can Indigenous practices contribute to cat management?
12	How can we develop effective novel management practices (e.g. gene drive, new baits)?
13	What is the appetite for the management of domestic cats and how does this vary across jurisdictions?
14	How do we convert research into practice?
15	How can we ethically kill cats in traps?
16	How do we ‘kill the last cat’ in an area?
17	How do we develop national data on cat management – what’s working, where do we put future effort?
18	How do we support private land holders to manage cats to deliver outcomes?

5. Future project direction

We will be working with the workshop participants over the coming weeks to prepare the results of this workshop for publication in a peer-reviewed journal article.

During this workshop, experts made it clear that the project should shift focus from producing a management-action-specific decision tool (e.g. a tool to guide best-practice feral cat baiting) to a decision tool that will help land managers understand the likely impact (on the feral cat population) of combining various techniques into an integrated management strategy for their ecoregion and land-use type.

Accommodating these changes means that the structure of the planned future workshops should change. Only one subsequent expert workshop (held over 2 days) will be required to develop the information needed for an integrated-technique feral cat management decision tool. This change is also in keeping with feedback we received during our initial workshop that many experts would be unlikely to be able to participate in multiple future workshops.

Changing the planned workshops may also enable us to hold a separate workshop with Indigenous land managers and other experts with experience working with First Nations people on feral cat management to integrate relevant knowledge and experience into the final tool. Such a workshop on Indigenous knowledge would also meet some of the recommendations received in the later stages of the approval phase of this project.

These 2 workshops will be held in close succession in early 2023 with the integrated results from both workshops being released at the same time at the end of May 2023.

6. References

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7. Appendix 1: Qualtrics survey questions

1. Which ecoregion would you like to focus on for the purpose of this survey (choose one)?
   - ☐ Deserts and xeric shrublands
   - ☐ Mediterranean forests, woodlands and shrubs
   - ☐ Montane grasslands and shrublands
   - ☐ Temperate broadleaf and mixed forests
   - ☐ Temperate grasslands, savannas and shrublands
   - ☐ Tropical and subtropical grassland, savannas and shrublands
   - ☐ Tropical and subtropical moist broadleaf forests
2. In which Australian state or territory do you have the most experience (choose one)?
   - ☐ NSW
   - ☐ ACT
   - ☐ VIC
   - ☐ QLD
   - ☐ TAS
   - ☐ WA
   - ☐ SA
   - ☐ NT
   - ☐ Other (specify):

Answer the following questions assuming that a 10,000-ha patch of land is being managed under the land-use type ‘Conservation and natural environments’ within your ecoregion. Use the definition of ‘Conservation and natural environments’ from ABARES (2016) *The Australian land use and management classification Version 8*.

Conservation and natural environments: land used primarily for conservation purposes, based on maintaining the essentially natural ecosystems present (e.g. national parks, conservation areas, forest reserves). Land that has a relatively low level of human intervention. The land may be formally reserved by government for conservation purposes or conserved through other legal or administrative arrangements. Areas may have multiple uses but nature conservation is the prime use. Do not include water reserves or wetlands in this category.

3. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect one month from the start of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

   For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

4. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect 12 months from the beginning of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

   For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

   For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

   For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

5. What would you estimate is the cost of implementing this management technique for one month (provide estimate as multiples of $10,000s, e.g. 5 = $50,000)?

Answer the following questions assuming that a 10,000-ha patch of land is being managed under the land-use type ‘Production from relatively natural environments’ within your ecoregion. Use the definition of ‘Production from relatively natural environments’ from ABARES (2016) *The Australian land use and management classification version 8*.

Production from relatively natural environments: land used mainly for primary production with limited change to the native vegetation (e.g. grazing in native vegetation, native forestry). The land may not be used more intensively because of its limited capability. The structure of the native vegetation generally remains intact despite deliberate use, although the floristics of the vegetation may have changed markedly. Where the native vegetation structure is, for example, open woodland or grassland, the land may be grazed.

6. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect one month from the start of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

   For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

   For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

7. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect 12-months from the beginning of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

   For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

   For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

   For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

8. What would you estimate is the cost of implementing this management technique for one-month (provide estimate as multiples of $10,000s, e.g. 5 = $50,000)?

Answer the following questions assuming that a 10,000-ha patch of land is being managed under the land-use type ‘Production from dryland agriculture and plantations’ within your ecoregion. Use the definition of ‘Production from dryland agriculture and plantations’ from ABARES (2016) *The Australian land use and management classification version 8.*

Production from dryland agriculture and plantations: includes land that is used principally for primary production, based on dryland farming systems. Native vegetation has largely been replaced by introduced species through clearing, the sowing of new species, the application of fertilisers or the dominance of volunteer species. The range of activities in this category includes plantation forests, pasture production for stock, cropping and fodder production, and a wide range of horticultural production.

9. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect one month from the start of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

   For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

   For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

   For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

10. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect 12-months from the beginning of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

    For 'best', provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

    For 'highest', provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

    For 'lowest', provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

11. What would you estimate is the cost of implementing this management technique for one-month (provide estimate as multiples of $10,000s, e.g. 5 = $50,000)?

Answer the following questions assuming that a 10,000-ha patch of land is being managed under the land-use type 'Rural residential' within your ecoregion. Use the definition of 'Rural residential' from ABARES (2016) *The Australian land use and management classification version 8.*

Rural residential: rural allotments with houses built (or being built) and agricultural activity at the sub-commercial and/or hobby scale (excluding backyard/domestic garden areas or livestock as pets). Rural residential generally refers to areas with blocks larger than 0.2 ha that are located in a rural setting (away from the main urban setting), with agriculture unlikely to be the main form of income. If agricultural activities are larger than 2 ha, they should be included separately under the production from dryland agriculture class.

12. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect one month from the start of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

    For 'best', provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

    For 'highest', provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

    For 'lowest', provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

13. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect 12-months from the beginning of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval,

season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

14. What would you estimate is the cost of implementing this management technique for one-month (provide estimate as multiples of $10,000s, e.g. 5 = $50,000)?

Answer the following questions assuming that a 10,000-ha patch of land is being managed under the land-use type ‘Urban residential’ within your ecoregion. Use the definition of ‘Urban residential’ from ABARES (2016) *The Australian land use and management classification version 8.*

Urban residential: land with houses, flats, hotels and so on within urban areas. This class may be used for land which is zoned for urban residential development where houses or apartments have not yet been constructed but infrastructure, such as roads and streetlights, is in place and it is clear that the intended land use is urban residential.

15. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect one month from the start of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

    For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

    For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

    For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

16. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect 12-months from the beginning of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

    For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

17. What would you estimate is the cost of implementing this management technique for one-month (provide estimate as multiples of $10,000s, e.g. 5 = $50,000)?

Answer the following questions assuming that a 10,000-ha patch of land is being managed under the land-use type ‘Wetlands, lakes, reservoirs and rivers’ within your ecoregion. Use the definition of ‘Wetlands, lakes, reservoirs and rivers’ from ABARES (2016) *The Australian land use and management classification version 8.*

Wetlands, lakes, reservoirs and rivers: wetlands are areas of permanent or periodic/intermittent inundation, whether natural or artificial, with water that is static or flowing, fresh, brackish or salt, excluding estuary and coastal water. Lakes are a natural or human-made body of mainly static water surrounded by land. Reservoirs are a body of water collected and stored behind a constructed barrier for some specific use. Rivers are a natural channel along which water may flow from time to time

18. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect one month from the start of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

    For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

    For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

    For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

19. For each of the following management activities, provide realistic estimates for the reduction in the feral cat population you would expect 12-months from the beginning of a management program. Use the agreed-upon group definition of the management program for your ecoregion defined earlier in the workshop (frequency, return interval, season, etc). Here assume 100% is total removal of population following action and 0% is none removed.

    For ‘best’, provide your best guess if you had to put a single figure on your opinion of the reduction in the cat population that will occur.

    For ‘highest’, provide the highest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

For ‘lowest’, provide the lowest plausible value for the reduction in cats that occurs when you think of all the factors that make this cat population reduction likely to happen.

20. What would you estimate is the cost of implementing this management technique for one-month (provide estimate as multiples of $10,000s, e.g. 5 = $50,000)?

The following questions relate to other economic, social, and ecological impacts for each management technique.

21. Overall, what is a realistic estimate of the proportion of the budget over a 12-month period that is attributed to each management technique in your ecoregion (your total must equal 100)?
22. To what degree does each management action negatively impact non-target native species in the 12 months from the start of the management (place an ‘X’ in one box for each row)?
23. What is the social acceptability of the treatment? Where ‘low tolerance’ means people have strong negative feelings and resist the use of this management technique and ‘high tolerance’ means people have no concerns with this management tool being applied.
24. Do you have any additional comments you would like to add?

8. Appendix 2: Expected reduction in feral cat population supplementary results

Table 8-1. Summary of number of responses for each management technique in the different land-use types. 'N/A' indicates more than 50% of experts responded that the technique was not applicable for that land-use type. 'Low' indicates fewer than 50% of experts provided estimates of the techniques' effectiveness (i.e. either 'not applicable' or 'I do not know' responses were selected). 'High' indicates more than 50% of experts provided estimates of the techniques' effectiveness.

Technique	Land-use type					
	Natural	Production	Agricultural	Rural residential	Urban residential	Wetlands
Aerial baiting	High	High	Low	N/A	N/A	N/A
Ground baiting	High	High	Low	N/A	N/A	N/A
Leg-hold trapping	High	High	Low	N/A	N/A	Low
Cage trapping	High	High	High	High	High	Low
Shooting	High	High	Low	N/A	N/A	High
Tracking by rangers	Low	Low	Low	N/A	N/A	N/A
Detector dogs	Low	Low	Low	Low	N/A	Low
Habitat modification	Low	Low	Low	N/A	N/A	Low
Resource modification	Low	Low	Low	Low	N/A	Low
Fencing*	High	Low	Low	N/A	N/A	Low

* Results for fencing are not reported here as the questions were not framed well for this management technique leading to confusion on how to answer the question and variability in how this technique was considered.

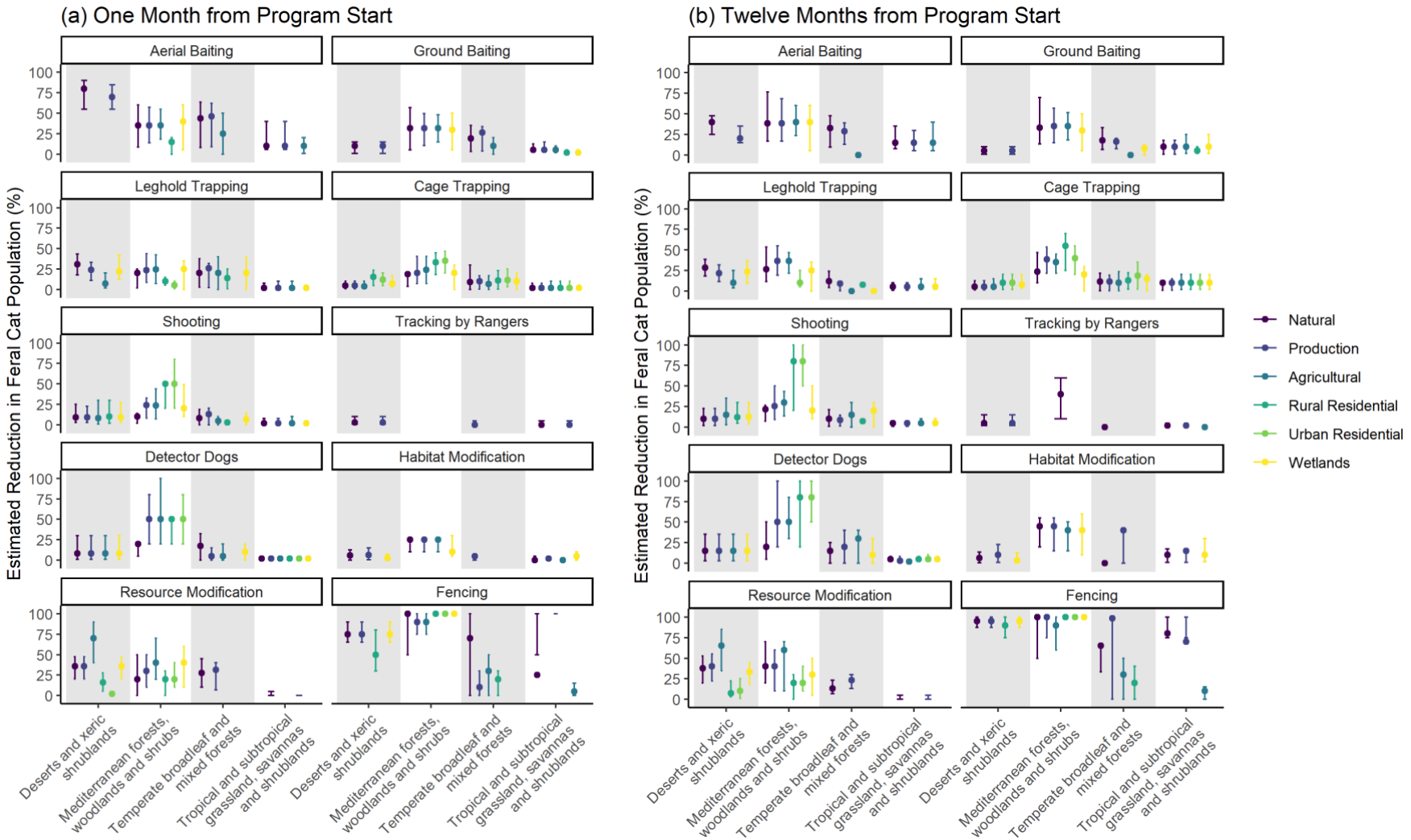

Figure 8-1. Average best, lower and upper estimates from experts on the percentage reduction in feral cats (a) one month from the beginning of a management program and (b) 12 months from the beginning of a management program in different land-use types and ecoregions.

9. Appendix 3: Economic impact supplementary results

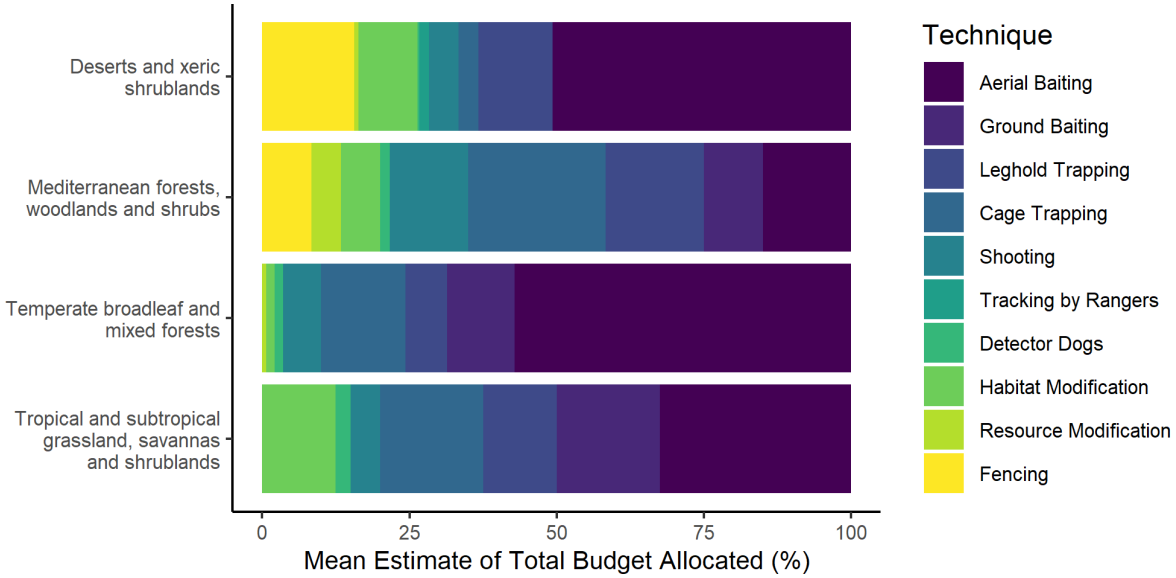

Figure 9-1. Mean expert estimate of the proportion of the budget allocated in each ecoregion to different management techniques.

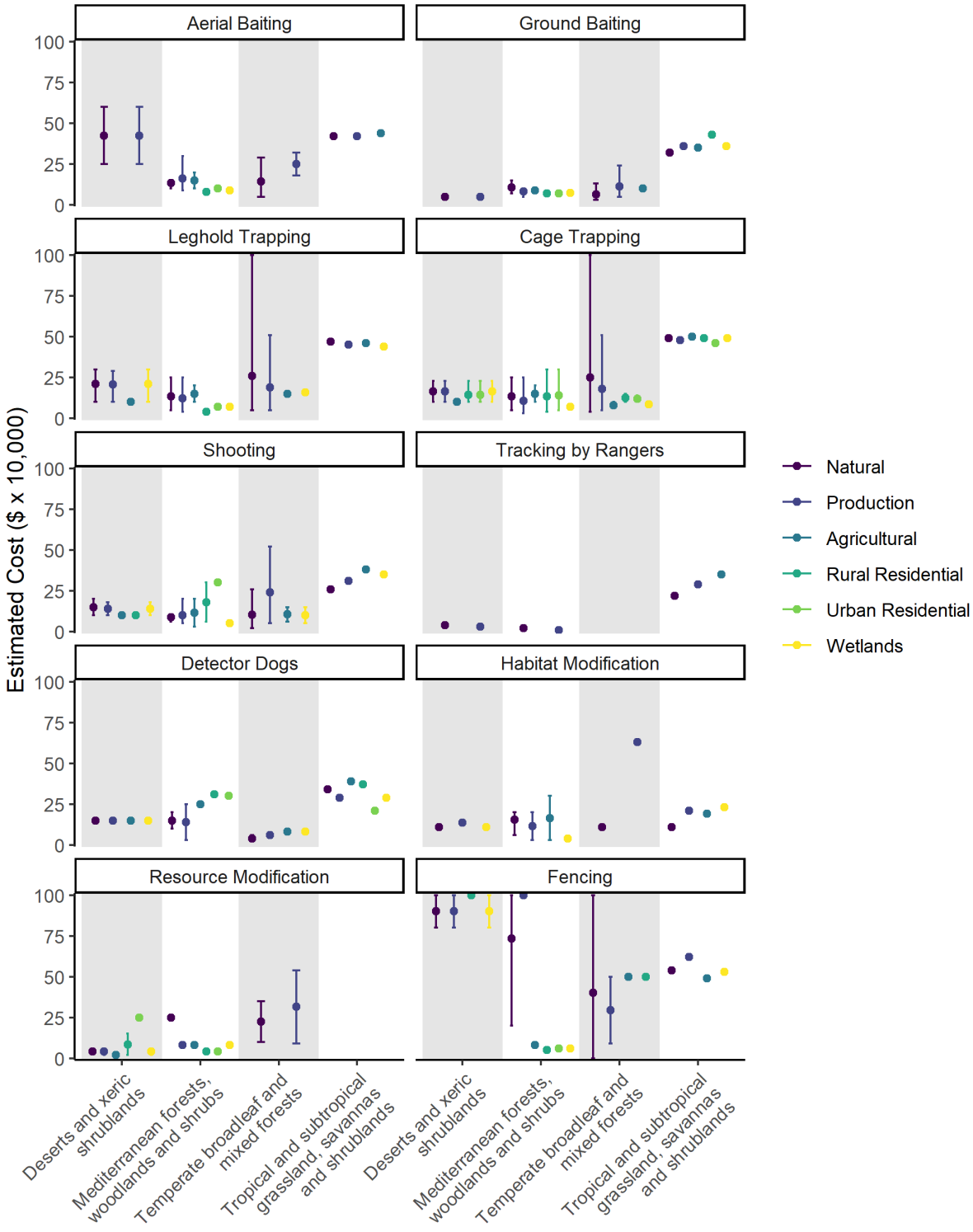

Figure 9-2. Mean, maximum and minimum estimated costs of each management technique in different ecoregions and land-use types.