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Best-practice management of feral cats and red foxes: workshop 2 report

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Cover photograph

Feral cat detected during small mammal surveys. Photo: NSW Environmental Trust Feral Cat Project.

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Acknowledgement of Country

We acknowledge the Traditional Custodians of the land where the workshop planning and analysis of data took place, the Anaiwan people. We acknowledge and respect their continuing culture and the contribution they make to the life of Armidale and the surrounding region.

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1. Executive summary

Feral cats are a primary driver of endemic species' decline and development of methods for management of cat populations is prioritised in the Australian Government's ***Threatened species action plan 2022–2032***. A range of tools and strategies exist for controlling cat populations to minimise their negative impacts, including aerial and ground baiting programs, cage trapping, leghold trapping and shooting. However, many management tools face barriers to their implementation from legislation, permit limitations and cost. Program efficacy can also be impacted by factors specific to the area being managed, such as resource availability which may limit how susceptible cats are to management options. The problems posed by multiple control options and highly variable outcomes from control programs can be substantial barriers to planning and undertaking effective feral cat management. To synthesise this information on the relative impact of feral cat management programs under different environmental conditions, we asked experts in management about the impacts of aerial and/or ground baiting programs when used alone or in combination with 3 other common cat control methods – cage trapping, leghold trapping and shooting.

We convened an 8-hour workshop over 2 consecutive days with 24 experts in feral cat management. Experts had experience in research, management and policy, and were drawn from around Australia and New Zealand from a range of universities, government and other conservation-focused organisations. Following the IDEA protocol (investigate, discuss, estimate, aggregate; Hemming et al. 2018), experts were asked to complete 2 rounds of an online survey with a discussion phase between the 2 rounds. The survey was used to quantify the impact of 25 different management scenarios using aerial or ground baiting programs when used alone or in combination with cage trapping, leghold trapping and shooting.

Workshop participants answered the management scenario questions for 6 different ecoregions and 5 different bait types. There was variability in the expected reduction in feral cat populations following the management scenarios as a result of the techniques being employed and the bait type used. Generally, an integrated management approach utilising all 5 management techniques was associated with the greatest reductions in feral cat populations regardless of ecoregion or bait type. However, in many of the experts' estimates, there were only small increases to the expected reduction when supplementary techniques, such as cage trapping or shooting, were used in addition to aerial and ground baiting.

Through this workshop experts have provided insights on the key general principles of feral cat management for guiding future control programs. Key outcomes from this workshop highlight the importance of integrating management techniques to manage feral cat populations and the limitations of specific management techniques in different environments. The information contributed here will be combined in a decision tool so that managers can have reasonable expectations about potential combinations of control options for their local scenario.

2. Introduction

Reducing the impacts of cats (*Felis catus*) is a global conservation priority (Nogales et al. 2013). In Australia, feral cat densities vary considerably between regions and can fluctuate dramatically between wet and dry periods (Legge et al. 2017). Factors such as multiple introductions (Abbott 2002), cats' high reproductive output (Hone et al. 2010) and ability to move large distances (Jansen et al. 2021; Roshier and Carter 2021) have led to them becoming ubiquitous across Australia. Consequently, research has established that feral cats are a primary driver of endemic species' decline (Dickman 1996; Doherty et al. 2017; Woinarski et al. 2015, 2018). To address this, the Australian Government has listed predation by feral cats and European red foxes (*Vulpes vulpes*) as Key Threatening Processes under the *Environment Protection and Biodiversity Conservation Act 1999.* Threat Abatement Plans have been developed that identify the research, management and other actions needed to ensure the long-term survival of native species and ecological communities affected by predation by feral cats and foxes. Key targets in the *Threatened species action plan 2022–2032* are the management of feral cats and foxes using best-practice methods across important habitats for susceptible priority species and in priority places where they are a threat to condition. Developing and defining best-practice management for feral cats and foxes are identified as actions to achieve the action plan's targets.

A range of tools and strategies exist for controlling cat populations to minimise their negative impacts. Australian cat control programs tend to use some combination of poison baiting, leghold trapping, cage trapping and shooting. However, the success of these programs has been highly variable in space and time (Algar et al. 2007; Denny and Dickman 2010; Moseby and Hill 2011; Fancourt et al. 2021). Newer methods are also emerging, most notably grooming traps (Read et al. 2014), but cost tends to limit their implementation at large scales. Thus, in the face of feral cats as a key threatening process, Australian land managers are faced with multiple management options but the prospect of uncertain outcomes.

Baiting has become a mainstay of many large-scale programs because of the prospect of substantial population reductions (Comer et al. 2020, 2018; Algar et al. 2007; Burrows et al. 2003), potentially making it ideal as the starting point for integrated control programs (Dorph and Ballard 2022). Unfortunately, poison baiting also has some clear limitations. Apart from cat-targeted baits not currently being available in all jurisdictions (Johnston and Algar 2020), feral cat management efforts relying on baits can be hampered by non-target bait removal (Fancourt et al. 2021), reduced bait uptake when prey availability is high (Christensen et al. 2013), problems associated with road access (Algar et al. 2007) and limited bait longevity under wet conditions (Gentle et al. 2007).

Methods of cat control used to supplement baiting programs also vary in applicability and effectiveness, depending on timing (Molsher 2001) and local resources (Johnston et al. 2007). Many programs add trapping or shooting to try to remove additional cats following baiting, but program effort and success are variable. Like baiting, cage trapping success may be tied to prey availability with relatively fewer captures expected when food sources are plentiful (Christensen et al. 2013). Managers have also noted that a key barrier to the use of leghold trapping and shooting as integrated control techniques, is a lack of experienced operators (Dorph and Ballard 2022).

The problems posed by multiple control options and highly variable outcomes from control programs can be substantial barriers to planning and undertaking effective feral cat management. Synthesising published data to find a solution is likely to be insufficient as much of the relevant knowledge about feral cat control is held by individuals involved in management programs, rather than by academics. Expert elicitation provides a means of gathering this disparate data into a useful form (Hoffman and Lintern 2006). In the workshop documented here, we worked with 24 feral cat management experts from Australia and New Zealand to quantify estimated reductions in feral cat populations that should occur under a range of management scenarios. Specifically, we asked experts about the impacts of aerial and ground baiting programs in different ecoregions, when used alone or in combination with 3 other common cat control methods – cage trapping, leghold trapping and shooting.

3. Methods

We convened an 8-hour workshop over 2 consecutive days with 24 experts in feral cat management. Six facilitators led the structured elicitation of expert knowledge about feral cat management and its likely outcomes. Facilitators aided in the design and format of the workshop, led the discussion at each stage, and collated the results. They did not attempt to influence the discussion around management techniques or the knowledge gaps. The workshop was approved by the Human Research Ethics Committee at the University of New England (HREC Project Number: HE23-012).

3.1 Workshop participants

Workshop participants were drawn from around Australia and New Zealand from a range of universities, government and other conservation-focused organisations (Table 4-1). However, all participants were required to have research, management or policy experience relating to at least 2 of the 5 management techniques of interest (aerial baiting, ground baiting, leghold trapping, cage trapping and shooting). Participants had substantial experience in research, management implementation and policy and their experience ranged from < 5 years' experience to > 30 years' experience for the management techniques examined here. Participants were drawn from a number of ecoregions, and these ecoregions were used to split the participants into 3 key groups for a discussion phase during the workshop.

3.2 Terminology

Following the outcomes of a preceding workshop (Dorph and Ballard, 2022), we generated definitions for 5 key management techniques: aerial baiting, ground baiting, leghold trapping, cage trapping and shooting (Table 3-1). Although other techniques, such as grooming traps (Read et al. 2014), are emerging, the 5 techniques chosen were those identified in Workshop 1 as the primary techniques broadly applicable to feral cat control in Australia. Definitions for these 5 techniques included a guide standardising the effort of bait or trap density within a given area so experts considered the same control effort when responding to the survey questions. The management definitions and guidelines were developed considering information from 4 main sources: existing standard operating procedures, state and territory legislation, Australian Pesticides and Veterinary Medicines Authority permits, and methods reported in peer-reviewed and grey literature.

Experts were also provided with ecoregion mapping and definitions based on the descriptions provided by the Australian Department of Sustainability, Environment, Water, Population and Communities (2012) (retrieved from: **dcceew.gov.au**). The defined ecoregions were: (1) Deserts and xeric shrublands, (2) Mediterranean forests, woodlands and scrub, (3) Temperate broadleaf and mixed forests, (4) Temperate grasslands, savannas and shrublands, (5) Tropical and subtropical grasslands, savannas and shrublands, (6) Montane grasslands and shrublands, and (7) Tropical and subtropical moist broadleaf forests.

Table 3-1. Management technique definitions provided to experts for consideration during the online survey.

Action	Definition
Aerial baiting	Applied in late-autumn or early winter at a rate of 50 baits/km^2. Baits are dropped from a fixed wing or helicopter. Flight lines are spaced at 500m or 1 k-m intervals to meet density target for baiting region. Bait type varies based on state/territory approvals. All baiting activity must avoid waterways and residential areas.
Ground baiting	Applied along vehicle accessible trails and other linear features in the landscape. Depending on state/territory, can be 50 baits/km^2 or 25 baits/km^2. Bait type varies based on state/territory approvals. All baiting activity must avoid waterways and residential areas.
Cage trapping	Wire cage traps located within 50 m of tracks or linear features (e.g. creek lines, fire breaks, fence lines). Traps are distributed at a density of 100 traps within 10,000 ha separated by a minimum of 200 m. Traps remain open for 5–10 consecutive days. Traps are baited with a food lure (e.g. chicken or fish). For the purposes of this workshop, we consider cage trapping to be conducted within the 4 weeks after baiting.
Leghold trapping	Padded or soft-jaw leghold traps installed as either single or paired units in the ‘cubby’ or ‘walk-through’ formation placed along or adjacent to tracks or linear features. Traps are distributed at a density of 50 traps within 10,000 ha separated by a minimum of 200 m. Traps remain open for 5–10 consecutive days. Traps should be lured with a scent lure (most commonly cat urine/faeces mix). For the purposes of this workshop, we consider leghold trapping to be conducted within the 4 weeks after baiting.
Shooting	Nocturnal with aid of spotlight or thermal scope, can occur from back of vehicle or on foot. Involves a team made up of one hunter and one spotter. Hunting should occur for one week and result in 4 hours hunting per night. For the purposes of this workshop, we consider shooting to be conducted within the 4 weeks after baiting. This does not include opportunistic shooting – only the targeted hunting of cats.

3.3 Quantifying the impact of management scenarios

A structured expert elicitation following the IDEA protocol (Hemming et al. 2018) was used to quantify the impact of 25 different management scenarios using aerial or ground baiting programs when used alone or in combination with 3 other methods – cage trapping, leghold trapping and shooting.

Following the IDEA protocol, experts were asked to complete 2 rounds of an online survey with a discussion phase between the 2 rounds. The survey was hosted on the online platform Qualtrics. During the survey, experts were asked to answer questions considering the expected change in feral cat populations for a 10,000-ha area in which they have experience. Due to differences between management approaches around the country, the participants were asked to provide information on the state or territory, ecoregion and bait type they were considering while answering questions.

Experts were provided with the online survey on the first day of the workshop to generate Round 1 estimates. Participants were asked to estimate the impact of the different management scenarios under lower-than-average rainfall (dry conditions) and higher-than-average rainfall (wet conditions) following each management scenario over 12 months. Experts were asked to indicate the number of cats removed in each management scenario by providing their best estimates of cats removed, the fewest cats removed, and the most cats removed, and how confident they were that their estimates captured the true number of cats removed. To standardise the experts' approach to estimating the number of cats present in their study region, the participants were provided with access to feral cat density maps for wet and dry years in Australia (reproduced with permission from Legge et al. 2017). Experts were allowed to adjust the estimated density values based on the literature and their prior knowledge.

On the second day, experts were shown the anonymised results of the Round 1 estimates and a facilitated discussion was conducted to address potential reasons for variation in survey responses. This led to several points of concern amongst the experts about how the questions were phrased and the 12-month time period which they were asked to consider. To address these concerns, the facilitators and experts agreed to revise this time period. Instead of considering a 12-month time period post-baiting, experts instead estimated a reduction in feral cat numbers by the end of a management program in their 10,000-ha area. Experts were then split into 3 groups based on the ecoregion for which they answered the survey questions. These groups were: (1) Deserts and xeric shrublands, (2) Grasslands, savannas and shrublands, and (3) Forests, woodlands and scrub. In these groups, experts were asked to discuss what factors may have led to differences in the estimates provided by the participants in the group. Following these discussions, the experts were provided with access to their previous survey response and allowed to revise their estimates drawing on any insights from the group discussions.

3.4 Data analysis

Results from Round 2 of the online survey were analysed to identify key trends influencing feral cat management programs. To account for under-confidence and over-confidence in the experts' estimates, we standardised the upper and lower estimates using linear extrapolation following the recommendations of the IDEA protocol (Hemming et al. 2018). The standardised estimates were then aggregated and summarised using R (v4.2.2; R Core Team, 2021). First, estimates of the numbers of cats removed from the population were converted into proportions so the experts' results were comparable across populations. Second, the experts' best, upper and lower estimates of the number of cats removed from the study areas were averaged by ecoregion and bait type to provide the mean expected response and associated uncertainty for each management scenario. Summaries of the results were then plotted using the 'ggplot2' package in R (Wickham 2009).

4. Results

Workshop participants answered the management scenario questions for all ecoregions except Montane grasslands and shrublands (Table 4-1). Estimates were provided for 5 different bait types and 6 Australian states and territories, with one response from New Zealand (Table 4-1).

Table 4-1. Demographics of workshop attendees (excluding facilitators) and their nominated ecoregion, state or territory and bait with which they have the most experience. The number of workshop participants within each group is shown in brackets. Relevant organisation state or territory information provided in square brackets. Organisations representing multiple states or territories are indicated by AUS.

Organisation represented	Gender	Selected ecoregion	Selected state or territory	Selected bait type
Australian Wildlife Conservancy [AUS] (1) Bush Heritage Australia [AUS] (2) Centre for Invasive Species Solutions [AUS] (1) CSIRO [AUS] (2) Department of Agriculture and Fisheries [Qld] (1) Department of Biodiversity, Conservation and Attractions [WA] (3) Department of Climate Change, Energy, the Environment and Water [AUS] / Office of the Threatened Species Commissioner [ACT] (3) Department of Energy, Environment and Climate Action [Vic] (1) Indigenous Desert Alliance [WA] (1) Murdoch University [WA] (1) NRM Regions Australia [AUS] (1) University of New England [NSW] / Dept. of Primary Industries [NSW] (1) University of New England [NSW] / NSW National Parks and Wildlife Service [NSW] (2) Department of Conservation [New Zealand] (1) Department of Primary Industries [Qld] (1) Qld Parks and Wildlife Service [Qld] (1) Self-employed (1) The University of Sydney [NSW] (1) Department of Primary Industries and Regional Development [WA] (1)	Male (12) Female (15)	Deserts and Xeric Shrublands (7) Mediterranean Forests, Woodlands and Scrub (5) Temperate Broadleaf and Mixed Forests (4) Tropical and Subtropical Grasslands, Savannas and Shrublands (4) Temperate Grasslands, Savannas and Shrublands (2) Tropical and Subtropical Moist Broadleaf Forests (1) Montane Grasslands and Shrublands (0)	WA (9) NSW (5) Qld (3) SA (2) Vic (2) NT (1) New Zealand (1)	Eradicat (9) 1080 dog baits (5) Curiosity (PAPP) (4) 1080 fox baits (2) Qld Curiosity bait (1080) (2) Other (2)[1]

[1] Unspecified dried meat baits or generic rabbit bait

4.1 Deserts and xeric shrublands

Seven participants answered the survey for Deserts and xeric shrublands. Five participants answered the survey for Eradicat, one for Curiosity (PAPP) and one for 1080 fox baits. Eradicat was considered to have the highest population knockdown, followed by Curiosity (PAPP) (Figure 4-1).

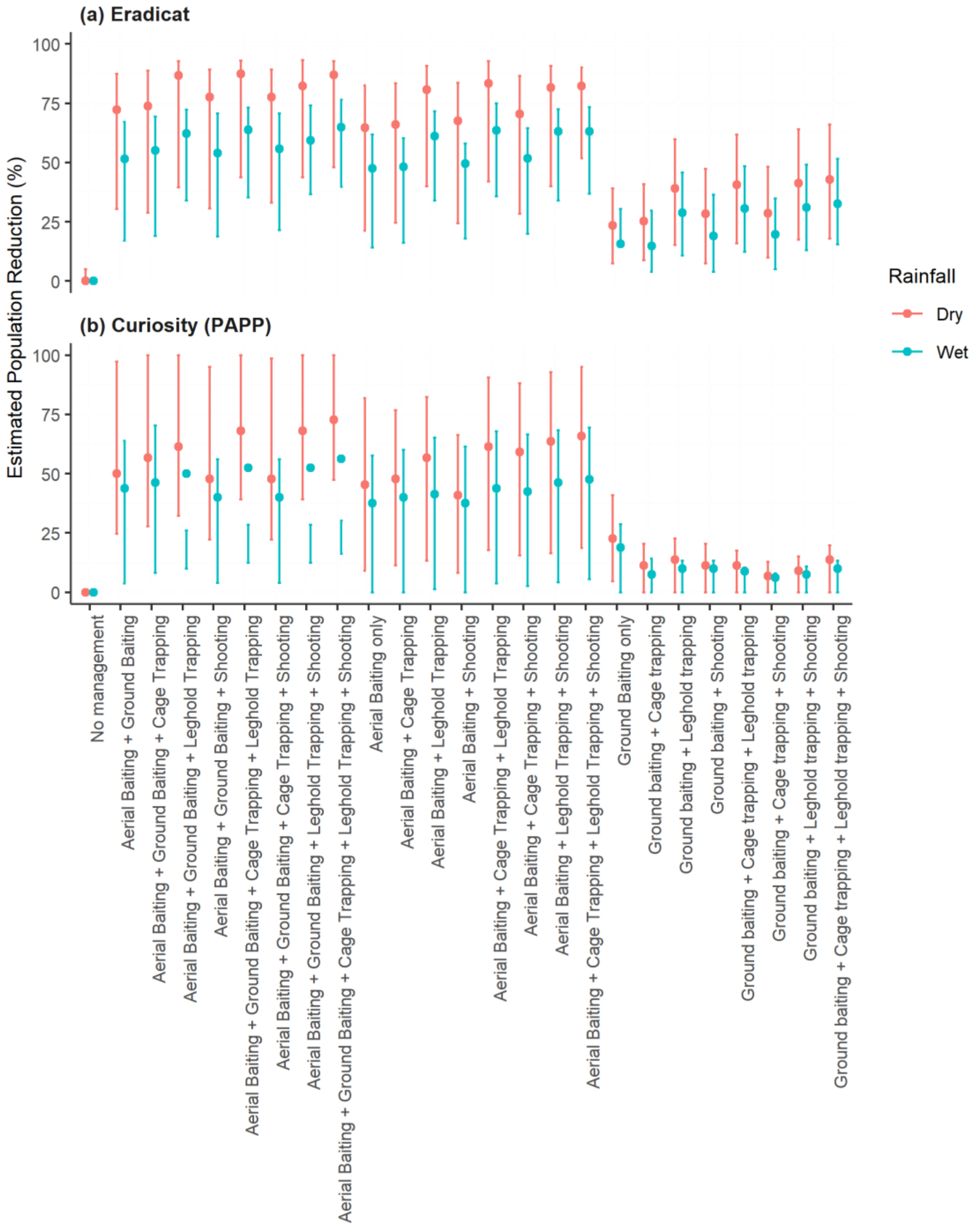

Figure 4-1. Expert assessment of the efficacy of 25 different management scenarios for reducing feral cat populations using Eradicat and Curiosity (PAPP) baits in Desert and xeric shrubland vegetation.

Participants estimated the most effective management scenarios for Eradicat baits involved use of all 5 management techniques (~87% population reduction; uncertainty estimates: 47%–93%). However, experts generally considered ground baiting added little to program efficacy (Figure 4-1) with scenarios using all techniques except ground baiting estimated to reduce populations by ~82% (uncertainty estimates 44%–93%). Management scenarios evaluated for Curiosity (PAPP) showed similar trends to Eradicat, with much lower expected efficacy of ground baiting compared to aerial baiting (Figure 4-1). For management scenarios using 1080 fox baits, neither aerial nor ground baiting was considered to have a strong impact on populations (~5% population reduction, uncertainty estimates: 0%–25%), with most reduction coming from the supplementary management techniques used. The largest expected population reduction came from using aerial baiting in combination with cage trapping, leghold trapping and shooting (~40% population reduction; uncertainty estimates: 17%–68%). Generally, experts considered a higher knockdown would occur in drier years compared to wetter years for all bait types.

4.2 Forests, woodlands and scrublands

Of the participants who answered the survey questions for Forest, woodland and scrubland vegetation types: 4 considered Eradicat baits in Mediterranean forests, woodlands and scrub, 3 considered 1080 dog baits in Temperate broadleaf and mixed forests, and one considered Curiosity in Tropical and subtropical moist broadleaf forests. Feral cat reductions were expected to be higher for populations in Mediterranean forests, woodlands and scrub using Eradicat baits compared to in Temperate broadleaf and mixed forests using 1080 dog baits (Figure 4-2). Management scenarios using combinations of aerial and ground baiting were considered more effective than either technique alone, although experts did not consider there was likely to be much difference in population reduction when using aerial baiting alone compared to aerial and ground baiting in combination (Figure 4-2). Management scenarios were predicted to have a greater effect in drier years compared to wetter years. The difference between efficacy in wet and dry years was reduced when considering techniques not reliant on food as a lure (i.e. leghold trapping and shooting; Figure 4-2).

Low overall efficacy for baiting programs was expected for Tropical and subtropical moist broadleaf forests, primarily due to canopy cover. Ground baiting in these systems was also considered ineffective due to high non-target bait uptake. Consequently, the maximum expected reduction in these systems was ~12% (uncertainty estimates: 0%–25%). This was for any scenario using all of cage trapping, leghold trapping and shooting, in any combination with aerial or ground baiting. There was no difference in program efficacy predicted for wet and dry years.

4.3 Grasslands, savannas and shrublands

For systems including Grasslands, savannas and shrublands, experts provided estimates for a range of bait types. In Tropical and subtropical grasslands, savannas and shrublands, one expert provided estimates for the efficacy of 1080 Dog baits, one for Curiosity (1080), one for Curiosity (PAPP) and one for Eradicat. In Temperate grasslands, savannas and shrublands, one expert provided estimates for 1080 fox baits, and one for Curiosity (PAPP). Generally, experts expected cat targeted baits (i.e. Curiosity and Eradicat) to have a higher estimated impact on cat numbers than non-cat targeted baits such as 1080 fox baits and dog baits (Figure 4-3).

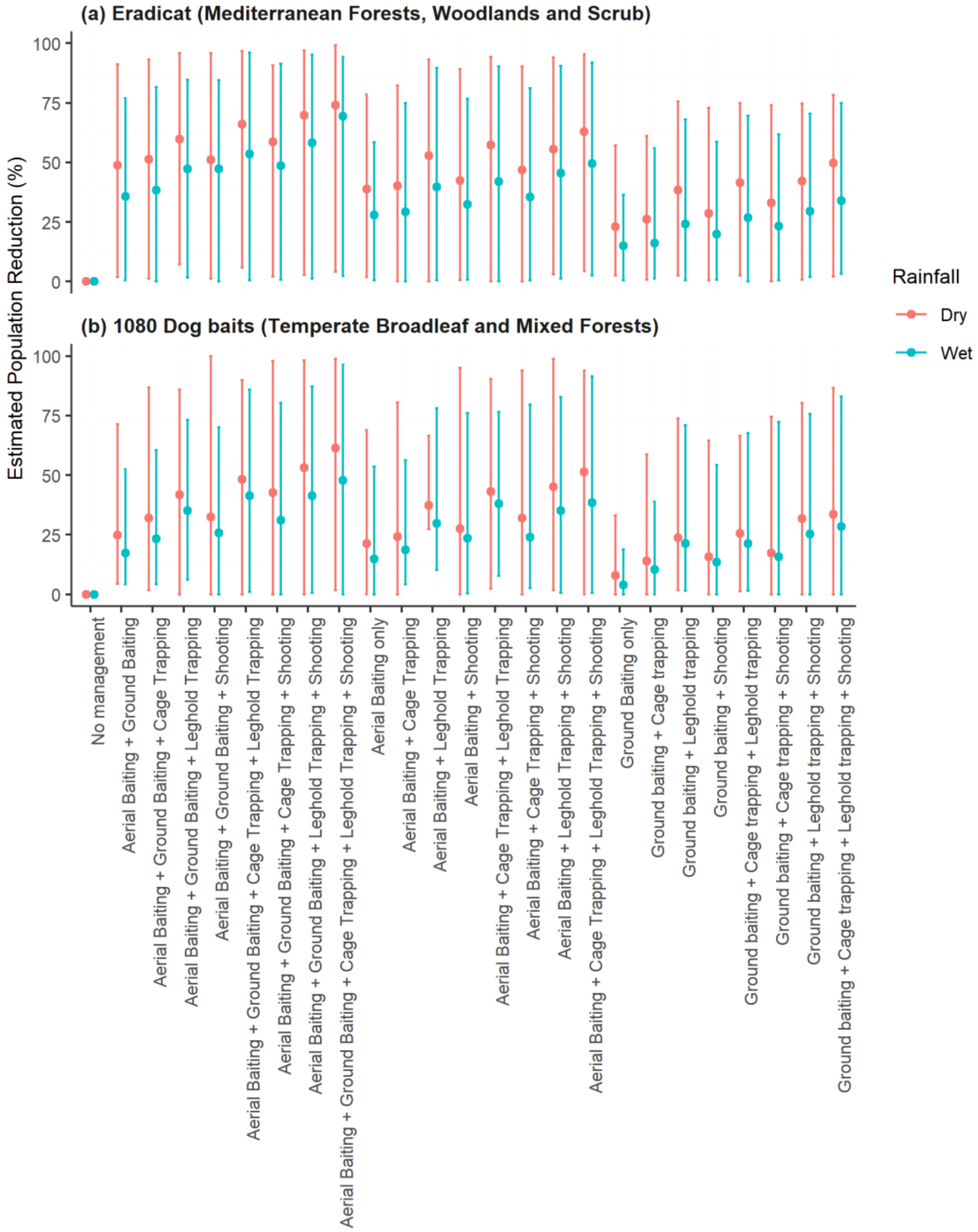

Figure 4-2. Expert assessment of the efficacy of 25 different management scenarios for reducing feral cat populations using Eradicat in Mediterranean forests, woodlands and scrub and 1080 dog baits in Temperate broadleaf and mixed forests.

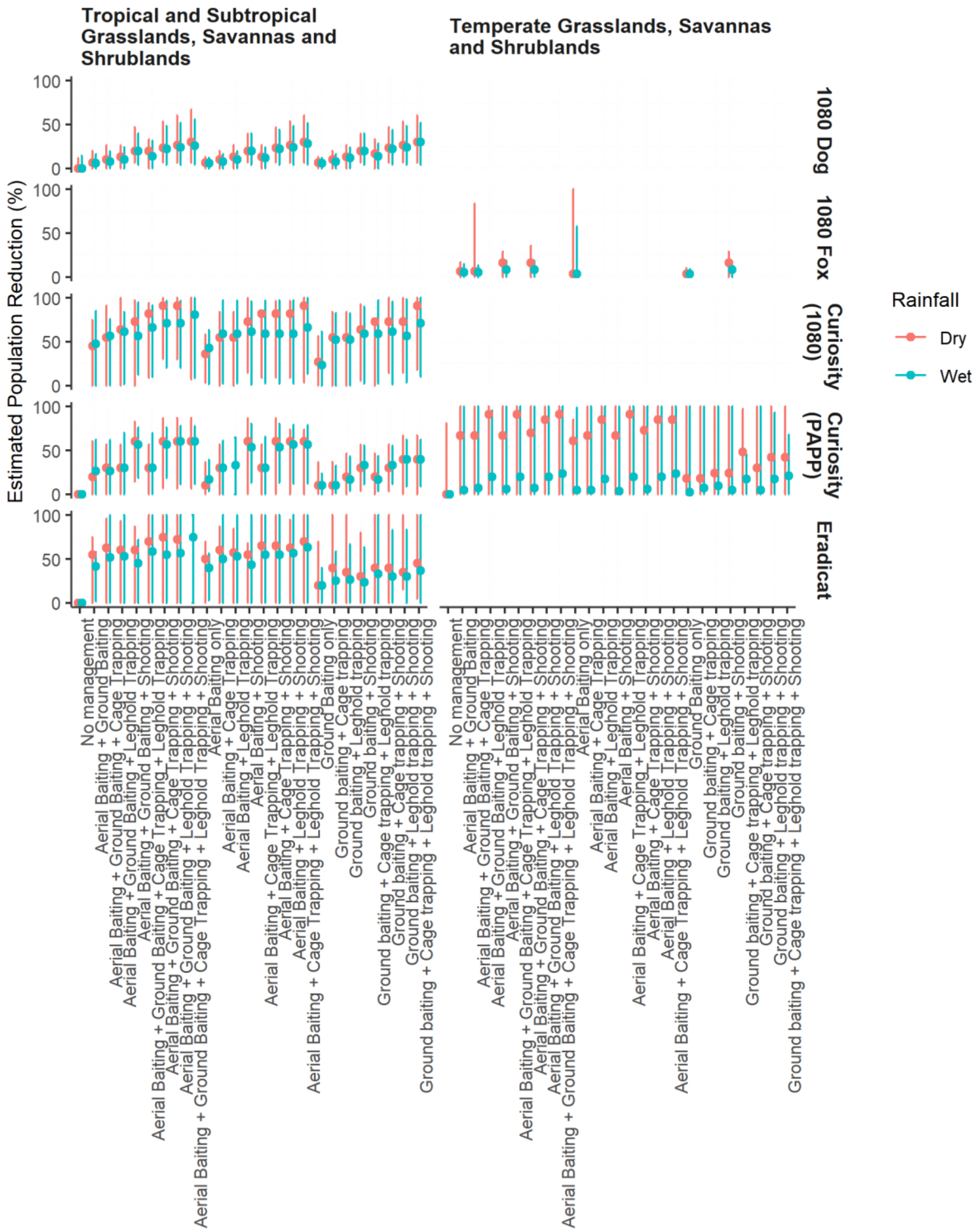

Figure 4-3. Expert assessment of the efficacy of 25 different management scenarios for reducing feral cat populations in Tropical and subtropical grasslands, savannas and shrublands and in Temperate grasslands, savannas and shrublands.

5. Discussion

Workshop participants provided estimates on the efficacy of feral cat management scenarios under a range of different vegetation types and for a number of bait types. There was variability in the expected reduction in feral cat populations following the management scenarios as a result of the techniques being employed and the bait type used. Generally, an integrated management approach utilising all 5 management techniques was associated with the greatest reductions in feral cat populations regardless of ecoregion or bait type. However, in many of the experts' estimates there were only small increases to the expected reduction when supplementary techniques, such as cage trapping or shooting, were used in addition to aerial and ground baiting.

5.1 Limitations to management scenarios

All management scenarios considered some combination of either aerial or ground baiting to reduce feral cat numbers. This is because baiting programs are able to effectively reduce feral cat populations for relatively little effort in comparison to alternative management techniques (Denny and Dickman 2010). However, restrictions to how and where baits can be deployed limited how effective experts considered the different management scenarios. For example, product labels require aerial baiting programs to avoid waterways and prevent potential contamination of water (e.g. Australian Pesticides and Veterinary Medicines Authority, 2013). In systems with very dense canopies where waterways cannot be sighted, such as Tropical and subtropical moist broadleaf forests, this prevents the application of aerial baits. Similarly, legislation and permits restrict the density that ground baits can be applied in many areas (e.g. Australian Pesticides and Veterinary Medicines Authority, 2013). When combined with site characteristics (e.g. limited road access) many experts considered scenarios using ground baiting only as much lower in efficacy relative to programs integrating aerial baiting. This is particularly evident in Deserts and xeric shrubland systems, where ground baiting programs have only a fraction of the impact of aerial baiting programs. State or territory restrictions may also limit where a baiting program can occur. For example, in Victoria, Curiosity (PAPP) baits are not allowed to be applied in any region where non-target species such as dingoes (*Canis familiaris*) or spotted-tailed quolls (*Dasyurus maculatus*) may occur, as there is risk of them taking baits (Robley et al. 2022). These restrictions to baiting programs means they may not be applicable as management techniques for all areas.

Most experts did not consider cage trapping to provide much benefit to management scenarios for 3 key reasons. Firstly, several experts highlighted cage trapping is limited by the requirement of a food lure to attract cats into cages – when prey availability is high, feral cats are unlikely to be drawn into a cage trap to consume the food lure. Secondly, experts suggested cats which are attracted to a food lure are also more likely to be susceptible to baiting. Consequently, a cage trapping program following the management technique definitions outlined herein would likely target cats already removed from an area by a baiting program. Finally, experts indicated that cage trapping programs were more likely to be successful in areas close to people or infrastructure where cats are desensitised to humans. This is not the reality in many areas where feral cats require management. Therefore, the majority of experts agreed that while cage trapping is more socially acceptable as a management technique, the time and effort required to implement cage trapping means it is often ineffective in practice.

Experts generally considered leghold trapping to provide the largest additional reduction in feral cat population relative to the other supplementary management techniques. This was because leghold trapping does not rely on hunger to attract feral cats, instead employing only careful trap placement or curiosity-inducing scents to trap cats. Consequently, experts generally expected less of a reduction in program efficacy between dry and wet years for programs implementing leghold trapping as a technique. However, ethical considerations and the potential for non-target species to be caught meant some experts were hesitant to use leghold trapping as a method in their study region.

Experts identified several limitations to the use of shooting as a management technique in the proposed scenarios, and only small potential gains when it was included. For many participants, the efficacy of shooting in their study region was limited by factors including low visibility due to vegetation, limited site accessibility, the skill of the shooter and the shooter's familiarity with the site. As a result, many experts indicated the most benefit to management programs from shooting came as a result of removing the last few cats that had survived other methods.

There was a great deal of uncertainty around many of the experts' estimates for population reduction, emphasising how much there is still to learn about feral cat management. It is also clear that, in some systems, we know more about program efficacy than in others. For example, in Deserts and xeric shrublands there were a number of responses for the cat-targeted baits Eradicat and Curiosity. However, in the grassland and savanna ecoregions there was a wide variety of responses for the different bait types and large uncertainty associated with the estimates. In these systems, we have less focused knowledge on the impact of management programs deploying baits which have been developed to target feral cats. As further trials are conducted and more knowledge is gained, our understanding of the impact of programs in these areas should improve.

Given the limitations to the above methods, it is worth commenting on the potential benefit of additional methods for consideration in future. Baiting programs are limited in their application, while cage trapping, leghold trapping and shooting are both time intensive and cost intensive, so may only be applied to small areas. Broad-scale methods that alter the environment, such as fire or grazing management, may be alternative tools to reduce cat numbers by changing the available habitat at large scales (McGregor et al. 2014). At the other end of the spectrum, very focused tools such as grooming traps may provide a cost-effective means of targeting difficult to remove cats at the end of a management program (Moseby et al. 2020). Further research into the potential impact of these methods needs to be explored in more environments to estimate the potential additional benefit they may have to integrated management programs at a national level.

5.2 Recovery, demographics and density

Feral cat population recovery through immigration, emigration and reproduction was a recurring theme discussed by experts during the workshop. Experts noted the importance of the size and location of the management area for how rapidly population recovery following management may occur. In particular, management areas in close proximity to agricultural or unmanaged areas were noted to potentially have accelerated population recovery as cats immigrate from nearby unmanaged land. Notably, in relatively smaller areas of controlled habitat this reinvasion can occur relatively quickly (*sensu* Moseby and Hill, 2011). Consequently, the rate of feral cat reinvasion of an area following management should be considered carefully when deciding the timing and frequency of control programs.

Management techniques need not affect all age classes or sexes equally, potentially resulting in population biases that may need to be addressed to achieve management goals. For example, multiple experts stated during the workshop that, in some areas, male cats are more likely to be caught in cage traps than female. Similarly, participants described a long-term baiting program needing to be ‘reset’ when the cat population became dominated by large males uninterested in consuming baits (Lohr and Algar 2020). These scenarios highlight the need for integrated management approaches to target individuals in the population which are resistant to one or more management techniques.

A noticeable difference existed between many experts’ own estimates of control outcomes in wet and dry years, primarily for control techniques involving food lures. As well as reduced baiting effectiveness (Algar et al. 2007), experts suggested a drop in cage trapping effectiveness in wet years, when cats are less likely to be food-stressed, thereby requiring leghold trapping and shooting to remove feral cats that have not consumed baits.

5.3 The importance of monitoring

Reliable monitoring is vital for effective management, as emphasised by the strong focus on monitoring within the *Threatened species action plan 2022–2032*. With respect to feral cats, the need for improved monitoring was highlighted during this workshop by experts’ inability to comment with confidence on expected changes in feral cat populations over a 12-month period. Whilst some of this uncertainty was attributed to inherent variability within systems, it was also identified as due to a general lack of suitable long-term data from monitored populations.

This is also problematic because there is a need to understand what happens to populations subject to control year-on-year, not just within-year. As noted above, biases can occur within populations due to control selectivity (Lohr and Algar 2020). Population change can also accelerate (Read 2010) or decelerate (Claridge et al. 2010) under the influence of resource bonuses and deficits, respectively. Monitoring is required to identify these changes so that managers can take them into account when planning control efforts and evaluating the cumulative impacts of programs. On the latter point, it is possible that even when cats are not being consistently suppressed at a site, year after year, numbers may still reduce over a longer, multi-year term (e.g. see Department of Biodiversity Conservation and Attractions, 2022).

6. Conclusions and recommendations

Feral cat management remains a diverse and substantial challenge, due in part to the array of management approaches used across the country. Varying approaches in bait types used, bait deployment methods, and the effort invested in trapping and shooting programs means that it can be difficult to assess the relative success of different control programs. Fortunately, there is a wealth of existing knowledge about what works and what doesn't, across a broad range of Australian and New Zealand scenarios.

Through this workshop, participating experts made a substantial contribution to the collation of that knowledge so that land managers can understand key general principles (e.g. integrating multiple techniques is the best way to remove the most cats) and location-specific knowledge (e.g. limitations of techniques in some environments, like baiting in tropical forests). The information contributed here will be combined in a decision tool so that managers can have reasonable expectations about potential combinations of control options for their local scenario.

As well as estimates of control impact, the workshop also captured key information about the limits of what experts know. A lack of replicated studies, in space and time, prevented experts being more confident about changes expected as a result of control programs in many areas. The solution is to invest in carefully monitored management as experimentation, to get the most out of control programs. Monitoring for longer periods of time (e.g. multiple years) would also address another key limitation – the general lack of understanding about longer-term feral cat population dynamics.

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