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1 **Understanding Australia's national feral cat control effort**

2 Running title: Australia's feral cat control effort

3

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36 **Abstract**

37 *Context:* Feral cats (*Felis catus*) pose a significant threat to Australia’s native species and feral  
38 cat control is therefore an important component of threatened species management and  
39 policy. Australia’s Threatened Species Strategy articulates defined targets for feral cat  
40 control. Yet, currently, little is known about who is engaged in feral cat control in Australia,  
41 what motivates them, and at what rate they are removing feral cats from the environment.

42

43 *Aims:* We aim to document who is engaging in feral cat control in Australia, how many cats  
44 they remove and to estimate the number of feral cats killed in a single year. Furthermore, we  
45 seek to better understand attitudes towards feral cat control in Australia.

46

47 *Methods:* We used a mixed methods approach combining quantitative and qualitative  
48 techniques. Feral cat control data were obtained from existing data repositories and via  
49 surveys targeting relevant organisations and individuals. A bounded national estimate of the  
50 number of feral cats killed was produced by combining estimates obtained from data  
51 repositories and surveys with modelled predictions for key audience segments. Attitudes  
52 towards feral cat control were assessed by exploring qualitative responses to relevant survey  
53 questions.

54

55 *Key results:* We received information on feral cat control from three central repositories, 134  
56 organisations and 2,618 individuals, together removing more than 35,000 feral cats/year.  
57 When including projections to national populations of key groups, the estimated number of  
58 feral cats removed from the environment in the 2017-18 financial year was 306,105 (95% CI:  
59 287,808, 324,402).

60

61 *Conclusions:* Individuals and organisations make a significant – and largely unrecorded -  
62 contribution to feral cat control. Amongst individuals, there is a strong awareness of the  
63 impact of feral cats on Australia’s biodiversity. Opposition to feral cat control focused largely  
64 on ethical concerns and doubts about its efficacy.

65

66 *Implications:* There is significant interest in – and commitment to – feral cat control amongst  
67 some groups of Australian society, beyond the traditional conservation community. Yet more  
68 information is needed about control methods and their effectiveness to better understand  
69 how these efforts are linked to threatened species outcomes.

70

## 71 **Introduction**

72 The domestic cat, *Felis catus*, is one of the most damaging invasive species in the world  
73 (Lowe *et al.* 2000). Cats are hugely successful invaders and are now considered to have a  
74 near-global distribution, with Antarctica the only continent that is cat-free (Doherty *et al.*  
75 2017). They are also effective predators that can have a devastating impact on wildlife. In the  
76 contiguous US, free-ranging domestic cats are thought to be the biggest anthropogenic  
77 source of wildlife mortality, and ‘unowned’ (including feral, semi-feral and stray) cats are  
78 estimated to kill between 800 million and 3 billion birds and between 4.9 and 20.9 billion  
79 mammals annually (Loss *et al.* 2013). The impact of feral cats on native species has been  
80 particularly severe on islands, where they have been identified as a causal factor in the  
81 extinction of 33 birds, mammals and reptiles, and as a key driver of extinction threat to many  
82 more (Medina *et al.* 2011).

83 In Australia, 30 endemic mammal species have been lost since European settlement and  
84 many more remain threatened with extinction (Woinarski *et al.* 2015). Feral cats are  
85 implicated as a driver of extinction for most of the mammal species already lost, and are  
86 recognised as a significant threat to extant threatened species, many of which are also  
87 endemic (Doherty *et al.* 2017). The critical importance of feral cat management and control is  
88 recognised within Australia’s threatened species management policies (Legge *et al.* 2017;  
89 Doherty *et al.* 2019), including the Australian Government’s *Threatened Species Strategy*,  
90 which articulates a 5-year target of 2 million feral cats killed by 2020 (Australian Government  
91 2015). Significant management resources are now expended on efforts to remove feral cats  
92 from the landscape in order to improve outcomes for threatened species. While estimates of  
93 the range and population of feral cats in Australia are available (see Legge *et al.* 2017), little is  
94 known about who is engaging in feral cat control, what motivates them and how many cats

95 they remove from the environment. This information may be useful for evaluating the impact  
96 of current policy, as well as informing efforts to increase or improve feral cat control efforts  
97 in the future. However, understanding Australia’s feral cat control effort is hampered by the  
98 lack of a coordinated approach to feral cat management and reporting, and the unknown  
99 feral cat control effort undertaken by private citizens on private land (Garrard *et al.* 2017;  
100 Doherty *et al.* 2019). Efforts to better understand the scale of feral cat control are further  
101 complicated by the fact that feral cat control can be a divisive and emotional social issue  
102 (Russell *et al.* 2015; Marra and Santella 2016), which may reduce the scope for open and  
103 frank discussions about lethal control efforts.

104 In this study, we estimated the number of feral cats killed by lethal control methods across  
105 Australia in a single year (July 1 2017-June 30 2018; hereafter 2017-18), as part of work  
106 commissioned by the Australian Government’s Office of the Threatened Species  
107 Commissioner to underpin reporting against defined feral cat control targets under the  
108 *Threatened Species Strategy* (Australian Government 2015). To our knowledge, this is the first  
109 published estimate of this number, and we expect that this estimate may be useful as a  
110 baseline by which to assess changes in feral cat control efforts in the future. We also  
111 improved understanding of who is engaged in lethal feral cat control, why they are  
112 undertaking this activity, and how the threat posed by feral cats to Australia’s threatened  
113 species is perceived beyond the conservation and regulatory communities. Throughout, and  
114 consistent with the Australian Government’s definition, we defined a feral cat as a ‘cat that  
115 lives in the wild and can survive without human reliance or contact’ (Australian Government  
116 2015).

## 117 **Materials and Methods**

### 118 *Data collection*

119 Data on feral cat control numbers for 2017-28 were collected via three key sources (Figure  
120 1a). First, where possible, data were obtained from centralised repositories, including: 1) 237  
121 programs funded by the Australian Government; 2) *FeralCatScan*, a resource hosted by the  
122 Centre for Invasive Species Solutions and the Australian Government Department of the  
123 Environment ([www.feralscan.org.au](http://www.feralscan.org.au)); and 3) the Royal Society for the Prevention of Cruelty

124 to Animals (RSPCA). Second, data on feral cat control undertaken by organisations were  
125 collected via an online survey, targeted towards institutions likely to be engaged in feral cat  
126 control such as local councils, and conservation and Indigenous Protected Area organisations.  
127 The survey contained questions about the responding organisation, their feral cat control  
128 efforts (including the number of feral cats killed in the 2017-18 financial year, reported either  
129 as a specific number or a pre-defined range) and their motivations for engaging in feral cat  
130 control. Responses to individual questions were captured via fixed response options or, in  
131 some cases, open, short text responses. The survey was designed by the authors in  
132 collaboration with the Australian Government's Office of the Threatened Species  
133 Commissioner, who also assisted with the identification and recruitment of target  
134 organisations. A full copy of the survey distributed to organisations is available in the  
135 supplementary material.

136 Third, data on feral cat control by individuals were collected using a second survey, modified  
137 for individual respondents. The survey was targeted towards those individuals likely to be  
138 engaging in feral cat control, including farmers, hunters and shooters, and land managers;  
139 however, because of the non-probability sampling technique we employed, the survey was  
140 open to anyone who wished to participate. As was the case for organisations, the survey  
141 contained questions about the individual (participants remained anonymous and  
142 unidentifiable), their feral cat control efforts and their motivations for engaging in feral cat  
143 control. In addition, the individual survey contained a number of questions about the  
144 individual's attitudes towards feral cat control, captured via both closed-ended and open-  
145 ended questions, as well as 5-point Likert scale responses indicating level of agreement  
146 (Figure 1b). The survey was hosted online, and participants were largely recruited  
147 electronically via email and social media, with some assistance from key groups, including the  
148 Threatened Species Commissioner's Office and the Sporting Shooters' Association of  
149 Australia. We augmented online recruitment by mailing identical hard copies of the survey to  
150 a representative sample of 3,000 farmers (provided by Axiom Agrimarketing), as we thought  
151 it likely that some farmers may be unlikely to engage with an online survey. We received 326  
152 (11%) responses to the mail-out survey, which were manually entered into the online survey  
153 by AMK and GEG. A full copy of the survey distributed to individuals is available in the  
154 supplementary material.

155 Online surveys were hosted on *Qualtrics* ([www.qualtrics.com](http://www.qualtrics.com)). The data were collected for a  
156 5-week period from July 23 to August 24 2018. Approval for the collection of data from  
157 organisations and individuals via targeted surveys was granted by RMIT University’s Human  
158 Research Ethics Committee via the Design and Social Context College Human Ethics Advisory  
159 Network (CHEAN); project number CHEAN A 21547-05/18. Participation in surveys was  
160 voluntary – any assistance in participant recruitment was in the form of distributing  
161 advertisements for the survey. For consistency, across all modes of data collection, we  
162 provided respondents with a specific definition of a feral cat: “a cat that lives in the wild and  
163 can survive without human reliance or contact”.

#### 164 *Estimating the national feral cat control effort*

165 We sought to produce a bounded estimate of the number of feral cats killed in a 12-month  
166 period (2017-18) by combining multiple sources of data which had varying degrees of  
167 uncertainty (Figure 1a). Some data had little associated uncertainty, but other data sources  
168 were associated with large amounts of uncertainty, driven by variation in the data itself as  
169 well as uncertainty due to the assumptions that were necessary to arrive at an estimate,  
170 including assumptions about the total population of people engaging in feral cat control and  
171 the average number of cats they killed. We began by aggregating the data that had the least  
172 associated uncertainty – data compiled from centralised repositories.

173 Next, we calculated the number of feral cats reported killed by organisations and individuals  
174 who responded to our online and mail-out surveys. We avoided potential double-counting at  
175 this stage by eliminating responses from organisations and individuals who indicated that  
176 their control efforts had been reported to one of the central repositories, as prompted by a  
177 specific question in our survey. While some respondents were able to provide an exact  
178 figure, many were only able to provide a range, resulting in some uncertainty in the  
179 estimates of the number of feral cats killed. When tallied, this information produced three  
180 estimates of the number of cats killed: a *conservative* estimate that assumed the lower value  
181 of the reported range; a *central* estimate that assumed the median value of the reported  
182 range; and a *generous* estimate that assumed the upper value of the reported range. Where  
183 an exact number was provided, this number was used when calculating the conservative,  
184 central and generous estimates.



185 By summing the figures recorded in central repositories and reported in our surveys, we  
186 produced a bounded *reliable minimum estimate* of the annual national feral cat control  
187 effort. While there is some uncertainty in this estimate, what is certain is that it is an under-  
188 estimate of the total number of feral cats killed in Australia over the period in question.  
189 Specifically, the number of organisations and individuals responding to the surveys  
190 represents only a subset of those undertaking feral cat control, and thus this estimate  
191 includes only a proportion of the total number of feral cats killed by organisations and  
192 individuals involved in unreported feral cat control, respectively. To address this problem, we  
193 used simple statistical models to describe the distribution of the number of feral cats killed  
194 by key audience segments who completed our survey, in order to extrapolate our data to  
195 national populations of these segments (Figure 1a). We applied this process, described  
196 below, to three audience segments for which we had some reliable information about  
197 national populations; specifically, local councils, farmers and shooters/hunters. These groups  
198 represented the most significant contributors to reported feral cat control, comprising the  
199 majority of active feral cat control respondents to our surveys, and of reported feral cat  
200 removals.

201 For each group, we followed the same process which proceeded in three steps, using a  
202 Bayesian approach. In the first step, we used a simple negative binomial model to estimate  
203 the mean number of cats killed by individual respondents in each group/cohort. Because we  
204 aimed to be conservative in our projections beyond hard data, we used the lower bound of  
205 the reported number of cats killed where respondents did not provide an exact number. The  
206 negative binomial distribution is a discrete probability distribution that is useful for modelling  
207 clumped count data (McCarthy 2007). For example, as is the case with our data, there may  
208 be a high proportion of counts in the lower values near zero. Under these conditions, the  
209 variance among counts is greater than assumed by the Poisson distribution, another discrete  
210 probability distribution commonly used to model counts (McCarthy 2007). The negative  
211 binomial distribution was assessed to be a good fit to the data on feral cats killed and  
212 outperformed the Poisson distribution when compared using the deviance information  
213 criterion (DIC) (Spiegelhalter *et al.* 2002), a parsimonious metric that balances the goodness  
214 of fit of a model with its simplicity. In the absence of reliable variables for the target  
215 populations (local councils, farmers and hunters/shooters), models were fitted without

216 covariates.

217

218 Next, we estimated the size of the target population to which we wished to project; in this  
219 case, the number of local councils, farmers and shooters/hunters that engage in feral cat  
220 control but did not respond to our surveys. Here, we made a number of assumptions and  
221 relied on external data sources as well statistics obtained from our surveys. Target  
222 populations were estimated to be 276 (local councils), 5,602 (farmers) and 36,930  
223 (hunters/shooters) (see Table S1). Last, we projected the fitted distributions of the number of  
224 feral cats killed by individual local councils, farmers or shooters/hunters to the target  
225 populations to obtain an estimate of the number of feral cats killed by each group that were  
226 not recorded by our surveys. Because we used a Bayesian approach, outputs for each  
227 population took the form of a full statistical distribution from which estimates can be drawn,  
228 rather than a predicted estimate with bounds. Models were fitted and estimates made in  
229 JAGS, an open source program for Bayesian statistical modelling using Markov Chain Monte  
230 Carlo (MCMC) simulation (Plummer 2003) via the *rjags* package (Plummer 2016) in R (R Core  
231 Team 2018). In the MCMC implementation, we generated four chains, and estimates were  
232 taken from 5,000 iterations after a burn-in of 500. Standard diagnostics were performed to  
233 assess model convergence and fit.

234

235 An estimate of the number of feral cats killed across Australia in the 2017-18 financial year  
236 was obtained by adding the projected estimates for unrecorded local councils, farmers and  
237 shooters/hunters to the minimum reliable estimate derived from figures recorded in central  
238 repositories and reported in our surveys. We calculated a bounded estimate that used the  
239 *central* estimate reported by respondents to our surveys, but were conservative in making  
240 inferences beyond hard data, using the lower bound estimates reported in our surveys to  
241 make projections to national populations of engaged local councils, shooters and farmers  
242 that did not respond to our surveys. We propagated uncertainty in the projected estimates  
243 by assuming that the predicted number of cats in each dataset are independent; in this case,  
244 the overall mean is equal to the sum of the individual means, and the overall variance is  
245 equal to the sum of the individual variances.

246 *Qualitative Analysis*

247 We analysed qualitative survey responses from individual respondents who indicated that  
248 they were opposed to feral cat control (we did not collect this information from  
249 organisations). The data were 'coded' according to key 'concepts' and 'categories' that  
250 emerged from the responses (Blaikie 2000). Hence, data analysis was informed by a thematic  
251 approach (Boyatzis 1998), which helped to identify and present the patterns found in the  
252 qualitative material (Braun and Clarke 2006). Responses were coded line by line using an  
253 open coding technique (Glaser 1998). Individual responses could contain statements aligned  
254 with multiple themes.

255

## 256 **Results**

### 257 *A reliable minimum estimate of feral cat control*

258 We received data on feral cat control from a central repository containing information on  
259 237 conservation programs funded by the Australian Government, and databases managed  
260 by FeralCatScan and the RSPCA. In 2017-18, these databases reported that 296  
261 (conservation programs), 64 (FeralCatScan) and 3,345 (RSPCA) feral cats (RSPCA 2018) had  
262 been killed or euthanased, respectively, with a total of 3,705 cats.

263

264 We received responses to our online survey from 316 organisations, including 69 which did  
265 not engage in feral cat control. Two hundred and one of these organisations (64%) were local  
266 or regional councils (Figure S1). We were able to extract feral cat control figures from 218  
267 organisations, including 140 local councils, 17 conservation organisations, 7 farmers'  
268 associations, 6 community groups, 6 Indigenous Protected Area or Ranger groups and 2  
269 sporting shooters' associations. The most commonly reported method of feral cat control by  
270 these organisations was trap and take elsewhere for euthanasia (65%). Comparatively fewer  
271 (11%) reported baiting for feral cat control (Figure S1). The total number of feral cats killed by  
272 these organisations in 2017-18 ranged from 10,697 (conservative) to 13,420 (generous), with  
273 a central estimate of 11,984. Of these, 8,996 (75%) were reported by local councils.

274

275 Individual surveys were completed by 4,812 unique respondents, who were well spread  
276 across age categories and represented all states and territories (Figure 2a,b). Respondents  
277 identified themselves according to a range of categories (Figure 2c), including

278 conservationists, farmers, sporting shooters and traditional owners. Of these, 2,627  
279 respondents reported engaging in feral cat control, represented mostly by hunters and  
280 sporting shooters (41%) and farmers (21%). Most (91%) indicated that their feral cat control  
281 efforts were not recorded with any other organisation or database, indicating that our survey  
282 accessed previously unrecorded feral cat control information. Shooting was by far the most  
283 common method of feral cat control, with trapping and shooting on site and trapping and  
284 removal to another facility for euthanasia also relatively common (Figure 2d). Very few  
285 respondents reported using baiting (6%) or undisclosed humane methods (6%) to control  
286 feral cats. While respondents reported covering a large range of total areas, most (59%)  
287 spend less than 3 hours a month on feral cat control (Figure 2e,g). The majority of  
288 respondents had been engaged in feral cat control for more than five years, and reported no  
289 change in their efforts over time and little to no annual variation in the number of feral cats  
290 they killed (Figure 2f,h,i)

291

292 In total, the number of feral cats reported to have been killed by individual respondents to  
293 our survey in 2017-18 ranged from 13,946 to 25,942, with a central estimate of 19,659 feral  
294 cats. By summing the estimates obtained from centralised databases and organisations and  
295 individuals who responded to our survey, we provide a reliable lower bound of the number of  
296 feral cats killed across Australia in 2017-18 that ranges from 28,348 (conservative) to 43,067  
297 (generous), with a central estimate of 35,348 feral cats.

298

### 299 *Model-based projections for a national estimate of feral cat control*

300 The mean lower bound number of feral cats killed by the 158 local councils who engage in  
301 feral cat control and responded to our survey is 57 [95% CI: 43,73] cats per council per year  
302 (Figure S2a). Projecting this distribution to the 276 local councils who we estimate to be  
303 engaged in feral cat control but did not complete our survey (Table S1), we estimate that an  
304 additional 15,819 [11,721, 19,873] feral cats were killed in 2017-18 by Australian local  
305 councils who did not respond to our survey.

306

307 The mean lower bound number of feral cats killed by engaged farmers who responded to our  
308 survey was 6 [5,7] cats/farm/year (Figure S2b; assuming each farmer represents a single  
309 farm). Projecting this figure to the target population of 5,602 provides an estimate of the

310 number of feral cats killed by farmers in 2017-18 but not reported in our survey of 34,051  
311 [30,245, 38,040]. Similarly, the mean lower bound number of feral cats killed by active  
312 hunters and shooters who responded to our survey is 6 [6,8] cats/year (Figure S2c).  
313 Projecting this figure to the target population ( $n = 36,930$ ), provides an estimate of the lower  
314 bound of the number of feral cats killed by sporting shooters and hunters in Australia in  
315 2017-18 but not reported in our survey of 230,812 [213,857, 248,651] cats.

316

317 Overall, we conservatively estimate that in the 12-month period from July 1 2017 to June 30  
318 2018, the lower bound on the number of feral cats killed across Australia was 306,105 (95%  
319 CI: 287,808; 324,402) (Table 1), with a significant proportion of that estimate attributed to  
320 shooters and hunters.

321

### 322 *Beliefs about feral cats and attitudes towards feral cat control*

323 Individuals who are engaging in feral cat control do so for a number of reasons (Figure 3a).  
324 The most commonly stated reasons were *I am concerned about native wildlife and this is one*  
325 *way I can help* and *They are a pest*, selected by 87% and 68% of those engaged in feral cat  
326 control, respectively. More than a quarter (27%) of respondents indicated that feral cat  
327 control was *Just something I have always done*. As a result of feral cat control, people believe  
328 that there are more native wildlife, but statements relating to whether or not feral cat  
329 control results in a decrease in the number of feral cats were mixed (Figure 3b).

330

331 All respondents to the individual survey were asked the degree to which they agreed with a  
332 number of statements about feral cats, regardless of whether they engaged in feral cat  
333 control or their views on it. It was accepted amongst the majority of survey respondents that  
334 feral cats pose a threat to native species and that, in light of this, they do not enjoy an  
335 intrinsic right to exist in Australia. 88% of respondents agreed with the statement *Feral cats*  
336 *are bad for wildlife and cause a decline in native species*. Furthermore, most respondents  
337 disagreed with the statements *Feral cats have right to exist wherever they are and whatever*  
338 *impact they have* (87%) and *As a predator, feral cats play an important role in food chains*  
339 (70%). Around half of respondents agreed with the statements *Feral cats are a threat to*  
340 *livestock* (47%), *Feral cats can be dangerous and spread disease to humans* (54%) and *Feral*  
341 *cats harass and injure domestic cats* (54%), indicating that there is some belief that feral cats

342 pose additional threats beyond those to native animals.

343

344 When asked what would encourage them to increase their feral cat control efforts or begin  
345 feral cat control, respondents selected a wide range of statements. When considering overall  
346 agreement (ie. combining 'strongly agree' and 'somewhat agree' responses), statements with  
347 the most agreement were "*If laws to enforce feral cat control were introduced*" (75% agreed),  
348 "*If there was more information on the various methods to control feral cats*" (69%), "*If there*  
349 *was more information about how feral cat control efforts help protect wildlife* (69%), "*If there*  
350 *was more information on the positives of feral cat control*" (66%) and "*If it were easier to rent*  
351 *or borrow traps*" (65%). Respondents also agreed that reimbursement, making it easier to get  
352 a permit and training on humane control methods would encourage them to increase or  
353 begin feral cat control efforts. Confusingly, 75% of respondents also agreed with the  
354 statement "*Nothing would encourage me to begin or increase efforts to control feral cats*".

355

356 The 2,093 individuals who responded to our survey but were not engaged in feral cat control  
357 were asked about their views on it. Of these, the vast majority (75%) indicated that they were  
358 not opposed to feral cat control, 4% had no strong views, and 21% were opposed. Of those  
359 who were opposed to feral cat control, 402 (91%) provided a description of their reasons.

360 The most common themes that emerged in opposition to feral cat control (noting that some  
361 responses contained multiple themes) were: a preference for non-lethal control options like  
362 trap-neuter-return (147 comments); concerns that lethal removal methods are ineffective at  
363 reducing feral cat numbers (132 comments); animal welfare concerns relating to inhumane  
364 control methods (130 comments); and that it fails to address other real threats to native  
365 biodiversity, including habitat loss and climate change (99 comments). A full list of emerging  
366 themes and example text passages is provided in Table 2.

367

## 368 Discussion

369 Using multiple data sources including known data repositories and information about the  
370 feral cat control activity of targeted organisations and individuals, we derived a plausible,  
371 bounded estimate of the number of feral cats killed in Australia in a single year. Importantly,  
372 our study highlighted the significant, but previously unknown, contribution of individuals and

373 organisations towards feral cat control.

#### 374 *Implications for threatened species*

375 We have conservatively estimated that approximately 306,000 feral cats were killed across  
376 Australia in 2017-18. This estimate may be used as a plausible minimum baseline for future  
377 assessments or to assess progress towards policy objectives. For example, this represents  
378 approximately 15% of the overall 5-year target articulated in Australia's *Threatened Species*  
379 *Strategy*. However, to draw conclusions about the implications of feral cat control on  
380 threatened species conservation and management, better understanding of the impacts of  
381 reducing feral cat populations and the associated response of threatened species populations  
382 is required. For example, the majority of the feral cat control effort reported in our survey is  
383 being undertaken by individuals who live in the populous coastal areas of the eastern  
384 seaboard states of Victoria, New South Wales and Queensland. For legal reasons, it was not  
385 possible for us to collect information about where individuals were doing their feral cat  
386 control and so further investigation is required to determine the extent to which feral cat  
387 control is occurring in key areas such as the arid zone of Australia where feral cat densities  
388 are high (Legge *et al.* 2017) and native mammals particularly threatened by feral cats exist  
389 (McKenzie *et al.* 2007).

390 We also note that under some conditions, removal of feral cats can be an ineffective or  
391 counter-productive method for reducing predation of native species. For example, low-level  
392 *ad hoc* feral cat control can precipitate a devastating period in which new feral cats  
393 immigrate to a region at a higher number, ultimately resulting in an increase in feral cat  
394 activity (Lazenby *et al.* 2015). Furthermore, among feral cat populations, some individuals  
395 (typically large male cats greater than 3.5kg in weight) pose a greater threat to endangered  
396 mammal fauna than others (Moseby *et al.* 2015). Older, larger cats can be highly efficient  
397 hunters but also become human- and light-shy, therefore requiring a higher level of targeted  
398 effort to be removed using standard control practices. Therefore, targeted control measures  
399 aimed at removing these more cautious individual cats may produce better results for  
400 threatened species than broadscale population control (Moseby *et al.* 2015). Our results do  
401 not enable us to distinguish between *ad hoc* and targeted feral cat control.

402 We found no qualitative evidence to support a recent increase in feral cat control effort  
403 amongst our survey respondents. If the removal figures estimated by our study are indicative  
404 of those in the past, they would not be sufficient to influence a meaningful decrease in  
405 national feral cat populations given their high reproductive rates and reinvasion potential.  
406 Indeed, previous research has indicated that it is necessary to remove more than half (57%:  
407 95% CI 24-93%) of a population of feral cats annually to achieve a decrease in their density  
408 (Doherty *et al.* 2019). Assuming a conservative estimate of the national feral cat population  
409 size (1.4 million: Legge *et al.* 2017), as many as 800,000 feral cats would need to be removed  
410 annually over multiple years to achieve this outcome. Having said this, national eradication of  
411 feral cats has not yet been put forward as a feasible outcome in Australia; ongoing  
412 eradication efforts in smaller-scale, contained environments such as islands and fenced areas  
413 are a more realistic outcome (Department of the Environment and Energy 2017). Feral cat  
414 control is an active area of research, and more empirical evidence is required to assess the  
415 relative impact of a range of individual feral cat control strategies (e.g. alternative toxins  
416 (Johnston *et al.* 2011; Moseby *et al.* 2011; Buckmaster *et al.* 2014), Toxic Trojans (Read 2016)  
417 and cat grooming traps (Read *et al.* 2014)) compared to population control methods (e.g.  
418 trap-neuter-return (but see Longcore *et al.* (2009)), habitat (McGregor *et al.* 2014) and  
419 ecosystem management (Kennedy *et al.* 2012)) for improving the resilience of native species  
420 in the face of feral cats.

#### 421 *Uncertainty in estimates of feral cat control effort*

422 Making robust estimates of the number of feral cats killed across the continent presents  
423 numerous challenges (Doherty *et al.* 2019). Given the diverse and fragmented nature of  
424 available feral cat control data and information, many assumptions were required to arrive at  
425 a national feral cat control estimate, which introduced unmodelled uncertainty. Key sources  
426 of uncertainty include different interpretations/understandings of whether a cat is  
427 considered feral (although we tried to minimise this by providing a clear definition in our  
428 surveys) and unmodelled error in the estimates of the total number of local councils, farmers  
429 and shooters/hunters engaging in feral cat control, which are based on defensible proxies of  
430 the total populations and self-reported rates of engagement in feral cat control (local  
431 councils, shooters/hunters) (Table S1).



432 We used the membership of the Sporting Shooters Association of Australia as a proxy for the  
433 number of shooters/hunters in Australia, although a recent report commissioned by the  
434 Commonwealth Department of Health estimated that there could be as many as three times  
435 this figure (RMCG 2019). Shooters/hunters comprised the majority of survey respondents  
436 and projections to this cohort accounted for the majority (75%) of the national estimate of  
437 feral cats killed. Where possible, we used independent studies and investigations to estimate  
438 key parameters (for example, using ABARE's recent landholder survey to estimate the  
439 proportion of farmers who engage in feral cat control: Stenekes et al. 2017); however, even a  
440 small error in the numbers of sporting shooters engaging in feral cat control could lead to a  
441 meaningful difference in the overall estimate of feral cats killed in Australia.

442 To mitigate the potential for over-estimation (which we deemed to be more undesirable than  
443 under-estimation in the context of assessing progress towards targets), we were conservative  
444 in our inference beyond hard data, using the lower bound of estimated ranges from the  
445 targeted surveys when projecting estimates of the number of feral cats killed beyond our  
446 sample. By using the lower bound of reported numbers, we are confident that the projected  
447 figures presented represent conservative lower bound estimate. More intensive sampling of  
448 targeted cohorts of the population engaged in feral cat control may facilitate the calculation  
449 of a more central estimate, which would likely have greater bounds of uncertainty.

450 The challenges we faced revealed opportunities for improving the reliability of feral cat  
451 control evaluation. We found that systematic reporting and collection of feral cat control  
452 data is generally lacking. A coordinated approach that brings together active and relevant  
453 organisations to agree on a feral cat definition (or definitions), prioritise data collection  
454 where it is most needed, and capture data in a standardised data repository will improve the  
455 accuracy and efficiency of future efforts to understand feral cat control in Australia. Our  
456 findings suggest that a significant proportion of feral cats killed in Australia is currently not  
457 recorded in systematically compiled databases (such as those maintained by local councils or  
458 the RSPCA), and may still be overlooked even if coordination of organisational efforts to  
459 capture feral cat control efforts were improved. The development and maintenance of a  
460 reporting system that specifically targets private citizens would be necessary to better  
461 capture the scale and spatial location of feral cat control efforts in the future. This would  
462 likely involve collaboration between regulatory authorities, animal welfare and conservation

463 organisations and key industry and interest groups. Furthermore, improved oversight of the  
464 way in which feral cat control is occurring may help to alleviate some of the concerns raised  
465 by those who are currently opposed to feral cat control. For example, by monitoring how  
466 feral cats are being killed and better understanding the animal welfare implications of  
467 specific control actions.

468 Finally, we acknowledge the likely bias of our survey towards those individuals and  
469 organisations that primarily use shooting and trapping to control feral cats. Other methods,  
470 such as poison baiting, were less commonly reported in our surveys and are less easily linked  
471 to estimates of the number of cats killed. Furthermore, we did not include other activities  
472 that may contribute to feral cat control; most notably, off-target take-down from other  
473 vertebrate pest baiting programs (including wild dog, feral pig and fox programs) and  
474 traditional hunting efforts by Indigenous Australians. The effect of off-target baiting on feral  
475 cat control populations is not well documented; however, previous research has consistently  
476 demonstrated poor bait uptake by feral cats in Australia (Moseby and Hill 2011). While  
477 historically common in some regions, traditional hunting of feral cats appears to have  
478 diminished in recent years (Paltridge 2016). Encouraging the revival of traditional hunting  
479 techniques through incentives and support for Indigenous Ranger programs may be a  
480 potential opportunity to increase feral cat control in desert landscapes of high conservation  
481 value.

#### 482 *The role of individuals in feral cat control*

483 Our study highlighted the significant contribution of individual citizens (e.g. farmers and  
484 shooters/hunters) towards feral cat control. Regardless of uncertainty in our estimates,  
485 control of feral cats by citizens is revealed as an important part of the current feral cat  
486 management picture, complementing the efforts of organisations like local councils and  
487 conservation NGOs. Active individuals are aware of the negative impact of feral cats on native  
488 wildlife and appear to be motivated by an intrinsic care for nature more so than personal  
489 benefit. This intrinsic care for nature could be harnessed and fostered through information  
490 campaigns designed to promote feral cat management within key groups in targeted areas.  
491 This may deliver improved outcomes for threatened species, albeit with caveats around the  
492 effectiveness of feral cat management for reducing native species predation by feral cats,  
493 discussed above. However, care should be taken to avoid crowding-out these intrinsic

494 motivations through the promotion of extrinsic motivations; for example, by promoting the  
495 personal benefits of feral cat control or through policies that would provide financial  
496 incentives (see, for example, Frey and Jegen (2001) and Kusmanoff *et al.* (2020)). Future  
497 research that analyses the costs and benefits of feral cat control undertaken by different  
498 stakeholders – considering factors such as successful kills relative to overall effort, location  
499 and impact on threatened species – could provide useful guidance on the relative importance  
500 of individuals and organisations for achieving feral cat management targets.

501 Our survey reached a group of individuals who remain opposed to feral cat control for a  
502 range of reasons. Previous research has shown that opinions about lethal feral cat control  
503 can be extremely polarised and characterised by misinformation and a lack of trust, meaning  
504 that information campaigns are unlikely to resolve the disagreement (Peterson *et al.* 2012).  
505 More productive approaches are those that promote inclusivity and seek to address common  
506 values, and here our study may provide some guidance. For example, ensuring the methods  
507 used to control feral cats are both effective and humane is a concern shared by  
508 conservationists and opponents alike, so engaging those against feral cat control as  
509 stakeholders in the design of research and monitoring programs to investigate this issue may  
510 be beneficial. Furthermore, encouraging responsible cat ownership is important for both  
511 animal (pet) welfare and reducing impacts on wildlife (Elliott *et al.* 2019) and therefore  
512 resolving uncertainties in the discrimination of feral from pet cats is an important shared  
513 objective. This highlights the importance of continuing to emphasise message framing in a  
514 way that avoids demonizing all cats, including pet cats and their owners.

#### 515 *Limitations of our survey*

516 This is the first attempt to estimate the number of feral cats killed in one year in Australia,  
517 and provides a reliable, but conservative, baseline. We note that future attempts based on a  
518 similar methodology could benefit from the collection of additional information. Because  
519 feral cats were not declared an established pest on Crown land under Victoria's *Catchment  
520 and Land Protection Act 1994*, we could not collect information about where individuals were  
521 engaging in lethal feral cat control activities for risk of inadvertently collecting information  
522 that would amount to an admission of a felony. The feral cat was declared an established  
523 pest on Crown land in Victoria on 26 July 2018 (DELWP 2020), at least partially resolving this

524 issue. Future assessments of feral cat control that include spatially-explicit estimates of the  
525 number of cats killed could help improve understanding about the relationship between feral  
526 cat control and threatened species conservation. Where spatially-explicit data collection is  
527 not possible, even the collection of information on the type of environment in which feral cat  
528 control is taking place (e.g. remote, rural, urban) could provide useful information that would  
529 meaningfully improve understanding and estimates.

530 Our surveys were targeted towards those organisations and individuals who are engaging in  
531 feral cat control and therefore we do not claim that our findings are representative of the  
532 broader Australian community. In particular, we note that because our survey aimed to  
533 understand lethal feral cat control efforts, our estimate of the proportion of individuals who  
534 are supportive of this practice may be inflated. Nonetheless, 45% of individual respondents  
535 were not engaged in feral cat control activities, indicating that our survey reached an  
536 audience that is wider than those actively controlling feral cats. Because the primary aim of  
537 the research was to explore the national feral cat control effort, we chose not to collect  
538 demographic information, such as gender, in our survey as it was deemed unnecessarily  
539 invasive. Notwithstanding, uncontrolled demographic factors may influence attitudes  
540 towards feral cat control and some of the qualitative findings should therefore be interpreted  
541 with caution; as indicative issues and themes rather than absolute truths.

#### 542 **Conflicts of Interest**

543 The authors declare no conflicts of interest.

544

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559 availability of updated data and stochasticities in the modelling process. GEG, AMK and SAB  
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561 Threatened Species Recovery Hub.

562

563 REFERENCES

- 564 Australian Government (2015). *Threatened Species Strategy*. Australian Government  
565 Department of Environment & Energy. (Canberra, Australia.)  
566
- 567 Blaikie, N. (2000) '*Designing Social Research: the logic of anticipation*.' (Polity Press:  
568 Cambridge, UK.)  
569
- 570 Boyatzis, R. E. (1998) '*Transforming Qualitative Information: Thematic Analysis and Code*  
571 *Development*.' (Sage Productions: Thousand Oaks, CA.)  
572
- 573 Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research*  
574 *in Psychology* **3**, 77-101. doi: 10.1191/1478088706qp063oa.  
575
- 576 Buckmaster, T., Dickman, C. R., and Johnston, M. J. (2014). Assessing Risks to Non-Target  
577 Species during Poison Baiting Programs for Feral Cats. *PLOS ONE* **9**, e107788. doi:  
578 10.1371/journal.pone.0107788.  
579
- 580 DELWP (2020). *Feral Cat Declaration*. <online>  
581 <https://www.environment.vic.gov.au/invasive-plants-and-animals/feral-cats> Victorian  
582 Government Department of Environment, Land, Water and Planning. <Accessed 29 April>.  
583
- 584 Department of the Environment and Energy (2017). *Threatened Species Strategy: Progress*  
585 *report to the Minister for the Environment and Energy July 16–December 17*. Australian  
586 Government. (Canberra, Australia.)  
587
- 588 Doherty, T. S., Dickman, C. R., Johnson, C. N., Legge, S. M., Ritchie, E. G., and Woinarski, J. C.  
589 Z. (2017). Impacts and management of feral cats *Felis catus* in Australia. *Mammal Review*  
590 **47**, 83-97. doi: 10.1111/mam.12080.  
591
- 592 Doherty, T. S., Driscoll, D. A., Nimmo, D. G., Ritchie, E. G., and Spencer, R.-J. (2019).  
593 Conservation or politics? Australia's target to kill 2 million cats. *Conservation Letters* **12**,  
594 e12633. doi: 10.1111/conl.12633.  
595
- 596 Elliott, A., Howell, J. T., McLeod, M. E., and Bennett, C. P. (2019). Perceptions of Responsible  
597 Cat Ownership Behaviors among a Convenience Sample of Australians. *Animals* **9**. doi:  
598 10.3390/ani9090703.  
599
- 600 Frey, B. and Jegen, R. (2001). Motivation crowding theory. *Journal of Economic Surveys* **15**,  
601 589-611.  
602
- 603 Garrard, G. E., Faulkner, R. A., Mata, L., Torabi, N., Peterson, I. R., Gordon, A., and Bekessy,  
604 S. A. (2017). *An assessment of the national effort towards feral cat control*. RMIT University.  
605 (Melbourne, Australia.)  
606
- 607 Glaser, B. (1998) '*Doing Grounded Theory: Issues and discussions*.' (Sociology Press: Mill  
608 Valley, CA.)

609  
610 Johnston, M., Algar, D., O'Donoghue, M., and Morris, J. (2011). *Field efficacy of the Curiosity*  
611 *feral cat bait on three Australian islands*. In 'Island invasions: eradication and management. '  
612 (Eds C. R. Veitch, M. N. Clout, and D. R. Towns). (IUCN: Gland, Switzerland.)  
613  
614 Kennedy, M., Phillips, B. L., Legge, S., Murphy, S. A., and Faulkner, R. A. (2012). Do dingoes  
615 suppress the activity of feral cats in northern Australia? *Austral Ecology* **37**, 134-139. doi:  
616 10.1111/j.1442-9993.2011.02256.x.  
617  
618 Kusmanoff, A. M., Fidler, F., Gordon, A., Garrard, G. E., and Bekessy, S. A. (2020). Five  
619 lessons to guide more effective biodiversity conservation message framing. *Conservation*  
620 *Biology*. doi: 10.1111/cobi.13482.  
621  
622 Lazenby, B. T., Mooney, N. J., and Dickman, C. R. (2015). Effects of low-level culling of feral  
623 cats in open populations: a case study from the forests of southern Tasmania. *Wildlife*  
624 *Research* **41**, 407-420. doi: <https://doi.org/10.1071/WR14030>.  
625  
626 Legge, S., Murphy, B. P., McGregor, H., Woinarski, J. C. Z., Augusteyn, J., Ballard, G., Baseler,  
627 M., Buckmaster, T., Dickman, C. R., Doherty, T., Edwards, G., Eyre, T., Fancourt, B. A.,  
628 Ferguson, D., Forsyth, D. M., Geary, W. L., Gentle, M., Gillespie, G., Greenwood, L., Hohnen,  
629 R., Hume, S., Johnson, C. N., Maxwell, M., McDonald, P. J., Morris, K., Moseby, K., Newsome,  
630 T., Nimmo, D., Paltridge, R., Ramsey, D., Read, J., Rendall, A., Rich, M., Ritchie, E., Rowland,  
631 J., Short, J., Stokeld, D., Sutherland, D. R., Wayne, A. F., Woodford, L., and Zewe, F. (2017).  
632 Enumerating a continental-scale threat: How many feral cats are in Australia? *Biological*  
633 *Conservation* **206**, 293-303. doi: <http://dx.doi.org/10.1016/j.biocon.2016.11.032>.  
634  
635 Longcore, T., Rich, C., and Sullivan, L. M. (2009). Critical Assessment of Claims Regarding  
636 Management of Feral Cats by Trap–Neuter–Return  
637 Evaluación Crítica de las Demandas Relacionadas con el Manejo de Gatos Ferales en  
638 Programas de Captura–Esterilización–Liberación. *Conservation Biology* **23**, 887-894. doi:  
639 10.1111/j.1523-1739.2009.01174.x.  
640  
641 Loss, S. R., Will, T., and Marra, P. P. (2013). The impact of free-ranging domestic cats on  
642 wildlife of the United States. **4**, 1396. doi: 10.1038/ncomms2380  
643 [http://dharmasastra.live.cf.private.springer.com/articles/ncomms2380#supplementary-](http://dharmasastra.live.cf.private.springer.com/articles/ncomms2380#supplementary-information)  
644 [information](http://dharmasastra.live.cf.private.springer.com/articles/ncomms2380#supplementary-information).  
645  
646 Lowe, S., Browne, M., Boudjelas, S., and De Poorter, M. (2000). *100 of the World's Worst*  
647 *Invasive Alien Species: A selection from the Global Invasive Species Database*. Invasive  
648 Species Specialist Group (ISSG), International Union for the Conservation of Nature.  
649 Updated and reprinted 2004. (I. U. f. t. C. o. N. Invasive Species Specialist Group (ISSG).)  
650  
651 Marra, P. P. and Santella, C. (2016) '*Cat wars: the devastating consequences of a cuddly*  
652 *killer*.' (Princeton University Press: Princeton.)  
653  
654 McCarthy, M. A. (2007) '*Bayesian Methods for Ecology*.' (Cambridge University Press:  
655 Cambridge, UK.)

656  
657 McGregor, H. W., Legge, S., Jones, M. E., and Johnson, C. N. (2014). Landscape Management  
658 of Fire and Grazing Regimes Alters the Fine-Scale Habitat Utilisation by Feral Cats. *PLOS ONE*  
659 **9**, e109097. doi: 10.1371/journal.pone.0109097.  
660  
661 McKenzie, N. L., Burbidge, A. A., Baynes, A., Brereton, R. N., Dickman, C. R., Gordon, G.,  
662 Gibson, L. A., Menkhorst, P. W., Robinson, A. C., Williams, M. R., and Woinarski, J. C. Z.  
663 (2007). Analysis of factors implicated in the recent decline of Australia's mammal fauna.  
664 *Journal of Biogeography* **34**, 597-611. doi: 10.1111/j.1365-2699.2006.01639.x.  
665  
666 Medina, F. M., Bonnaud, E., Vidal, E., Tershy, B. R., Zavaleta, E. S., Josh Donlan, C., Keitt, B.  
667 S., Le Corre, M., Horwath, S. V., and Nogales, M. (2011). A global review of the impacts of  
668 invasive cats on island endangered vertebrates. *Global Change Biology* **17**, 3503-3510. doi:  
669 10.1111/j.1365-2486.2011.02464.x.  
670  
671 Moseby, K. E. and Hill, B. M. (2011). The use of poison baits to control feral cats and red  
672 foxes in arid South Australia I. Aerial baiting trials. *Wildlife Research* **38**, 338-349. doi:  
673 <https://doi.org/10.1071/WR10235>.  
674  
675 Moseby, K. E., Peacock, D. E., and Read, J. L. (2015). Catastrophic cat predation: A call for  
676 predator profiling in wildlife protection programs. *Biological Conservation* **191**, 331-340. doi:  
677 <https://doi.org/10.1016/j.biocon.2015.07.026>.  
678  
679 Moseby, K. E., Read, J. L., Galbraith, B., Munro, N., Newport, J., and Hill, B. M. (2011). The  
680 use of poison baits to control feral cats and red foxes in arid South Australia II. Bait type,  
681 placement, lures and non-target uptake. *Wildlife Research* **38**, 350-358. doi:  
682 <https://doi.org/10.1071/WR10236>.  
683  
684 Paltridge, R. (2016). *Kiwirrkurra IPA Cat Control Project Report*. Central Desert Native Title  
685 Services/Desert Wildlife Services.  
686  
687 Peterson, M. N., Hartis, B., Rodriguez, S., Green, M., and Lepczyk, C. A. (2012). Opinions  
688 from the Front Lines of Cat Colony Management Conflict. *PLOS ONE* **7**, e44616. doi:  
689 10.1371/journal.pone.0044616.  
690  
691 Plummer, M. (2003). *JAGS: A program for analysis of Bayesian graphical models using Gibbs*  
692 *sampling*. <http://mcmc-jags.sourceforge.net/>.  
693  
694 Plummer, M. (2016). *rjags: Bayesian Graphical Models using MCMC*. R package version 4-6.  
695 <https://CRAN.R-project.org/package=rjags>.  
696  
697 R Core Team (2018). *R: A Language and Environment for Statistical Computing*. (R  
698 Foundation for Statistical Computing: Vienna, Austria.)  
699  
700 Read, J., Gigliotti, F., Darby, S., and Lapidge, S. (2014). Dying to be clean: pen trials of novel  
701 cat and fox control devices. *International Journal of Pest Management* **60**, 166-172. doi:  
702 10.1080/09670874.2014.951100.



703  
704 RMCG (2019). *Economic and social impacts of recreational hunting and shooting* RM  
705 Consulting Group. (Bendigo, Australia.)  
706  
707 RSPCA (2018). *RSPCA report on animal outcomes from our shelters, care and adoption*  
708 *centres, 2017-18*. RSPCA, Australia.  
709  
710 Russell, J. C., Innes, J. G., Brown, P. H., and Byrom, A. E. (2015). Predator-Free New Zealand:  
711 Conservation Country. *BioScience* **65**, 520-525. doi: 10.1093/biosci/biv012.  
712  
713 Spiegelhalter, D., Best, N., Carlin, B., and Van Der Linde, A. (2002). Bayesian measures of  
714 model complexity and fit. *Journal of the Royal Statistical Society: Series B (Statistical*  
715 *Methodology)* **64**, 583-639.  
716  
717 Woinarski, J. C. Z., Burbidge, A. A., and Harrison, P. L. (2015). Ongoing unraveling of a  
718 continental fauna: Decline and extinction of Australian mammals since European  
719 settlement. *Proceedings of the National Academy of Sciences* **112**, 4531-4540. doi:  
720 10.1073/pnas.1417301112.  
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724 **Online Supplementary Information:**

725

726 *Surveys for organisations and individuals.*

727

728 *Table S1. Workings and justifications for target populations for projections to local councils,*  
729 *farmers and shooters/hunters who engage in feral cat control.*

730

731 *Figure S1. Summary statistics for responses to the organisation survey.*

732

733 *Figure S2. Fitted and projected distributions of the number of feral cats killed in the 2017-18*  
734 *financial year by local councils, farmers and shooters and/or hunters.*

735

## 736 Tables &amp; Figures

737

738 Table 1. Estimates of the number of feral cats killed across Australia from July 1 2017 to June

739 30 2018.

740

<b>Data Source</b>	<b>Lower 95%CI</b>	<b>Estimate</b>	<b>Upper 95%CI</b>
Organisations			
Repositories	-	3,705	-
Reported in survey	-	11,984	
Projections to councils	11,872	15,894	20,106
<i>Organisation subtotal</i>	<i>27,561</i>	<i>31,583</i>	<i>35,795</i>
Individuals			
Reported in survey	-	19,659	-
Projections to farmers	30,245	34,051	38,040
Projections to shooters/hunters	213,857	230,812	248,651
<i>Individuals subtotal</i>	<i>256,694</i>	<i>274,522</i>	<i>292,351</i>
<b>TOTAL 2017-18</b>	<b>287,808</b>	<b>306,105</b>	<b>324,402</b>

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742

743

744 Table 2. Emergent themes from comments provided by 402 individuals who indicated they  
 745 were opposed to feral cat control. Also shown are the number of respondents who made a  
 746 comment that aligned with each theme, and representative comments for each theme. Note  
 747 that individual responses may contain multiple themes.

748

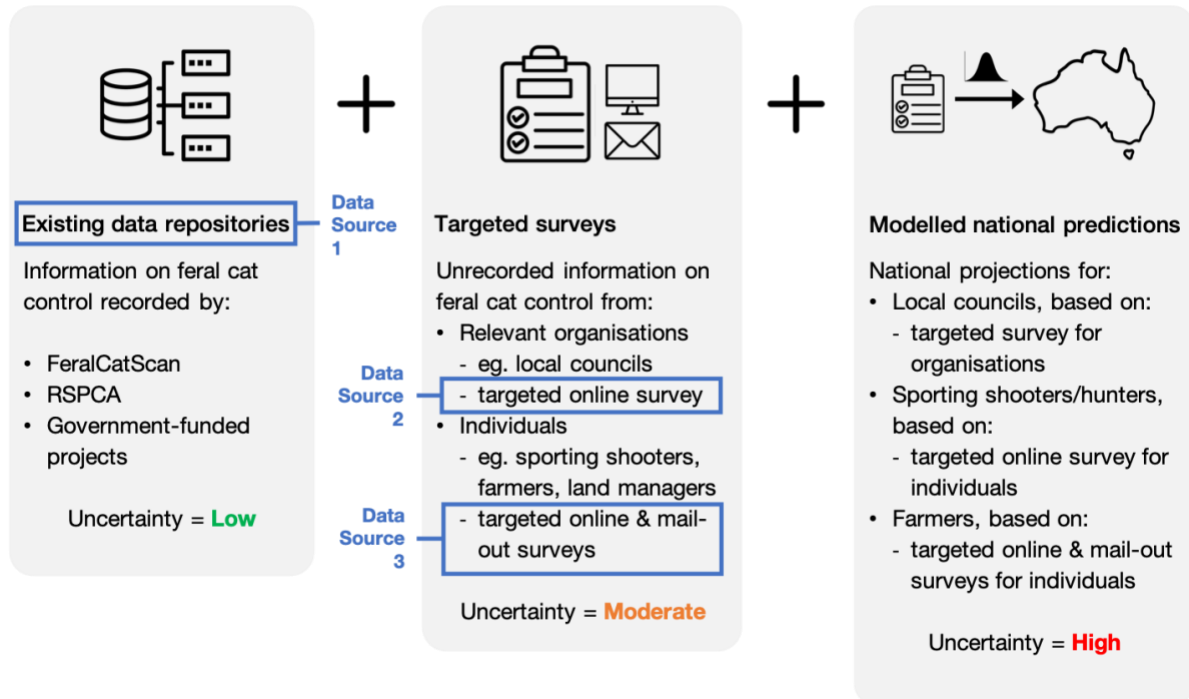
Theme	Count	Example(s)
Non-lethal feral cat control options are preferable	147	<i>"Trap Neuter Return is the only successful long term solution"</i> <i>"Education and strategies such as TNR would be more effective"</i>
Removing feral cats is ineffective	132	<i>"...research studies have...shown that low to medium level killing... increases rather than decreases the numbers of feral cats (one example is Lazenby et al 2014)."</i>
Animal welfare: methods are cruel & inhumane	130	<i>"I disagree with the inhumane methods used to kill these animals"</i>
Not addressing the real problem	99	<i>"Better to focus on human destruction of habitat - which does way more damage"</i>
Ethics: feral cats have intrinsic right to exist	98	<i>"All life has the same right to live"</i>
Vilifies and encourages cruelty towards all cats	49	<i>"Vilifies cats and encourages brutal behaviour against cats, including non-feral cats"</i>
No way to discriminate feral from owned or stray cats	43	<i>"There is no definitive way to know whether the cat is owned or actually feral"</i>
Uncertainty in outcomes, lack of monitoring/evidence	38	<i>"There is no real research on whether killing them will have an effect"</i> <i>"...the monitoring processes surrounding the removal of cats from environments are severely lacking"</i>
Increase in abundance of other pest species e.g. rats	25	<i>"If you remove cats, then you will have a rat and mice break out"</i>
Claims about impact of feral cats exaggerated	24	<i>"They Do Not do the amount of damage that man states they do."</i>
Feral cat control negatively impacts other animals	16	<i>"...poisoning and trapping negatively effects other native animals"</i>
Waste of money	8	<i>"Waste of money - funds can be used elsewhere..."</i>
Better to increase resilience of native animals to threats	5	<i>"We need to instead focus our efforts on reducing species' vulnerability to cat predation."</i>

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751

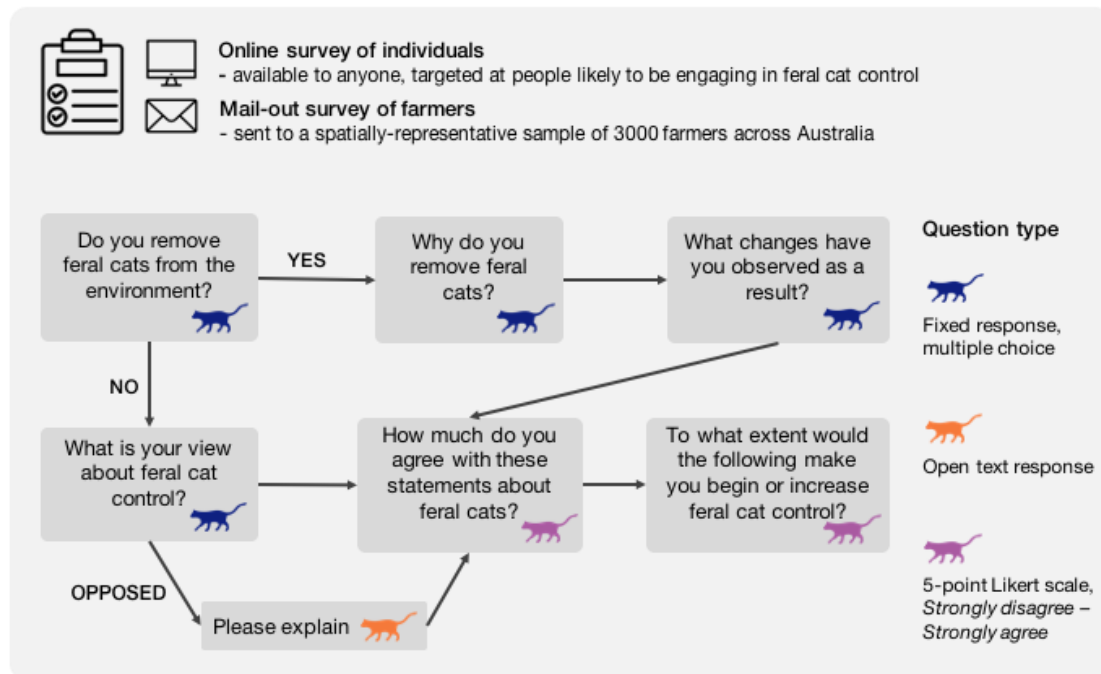
a. Building a national estimate of the number of feral cats 'controlled'



752

753

b. Understanding beliefs about feral cats & attitudes towards feral cat control

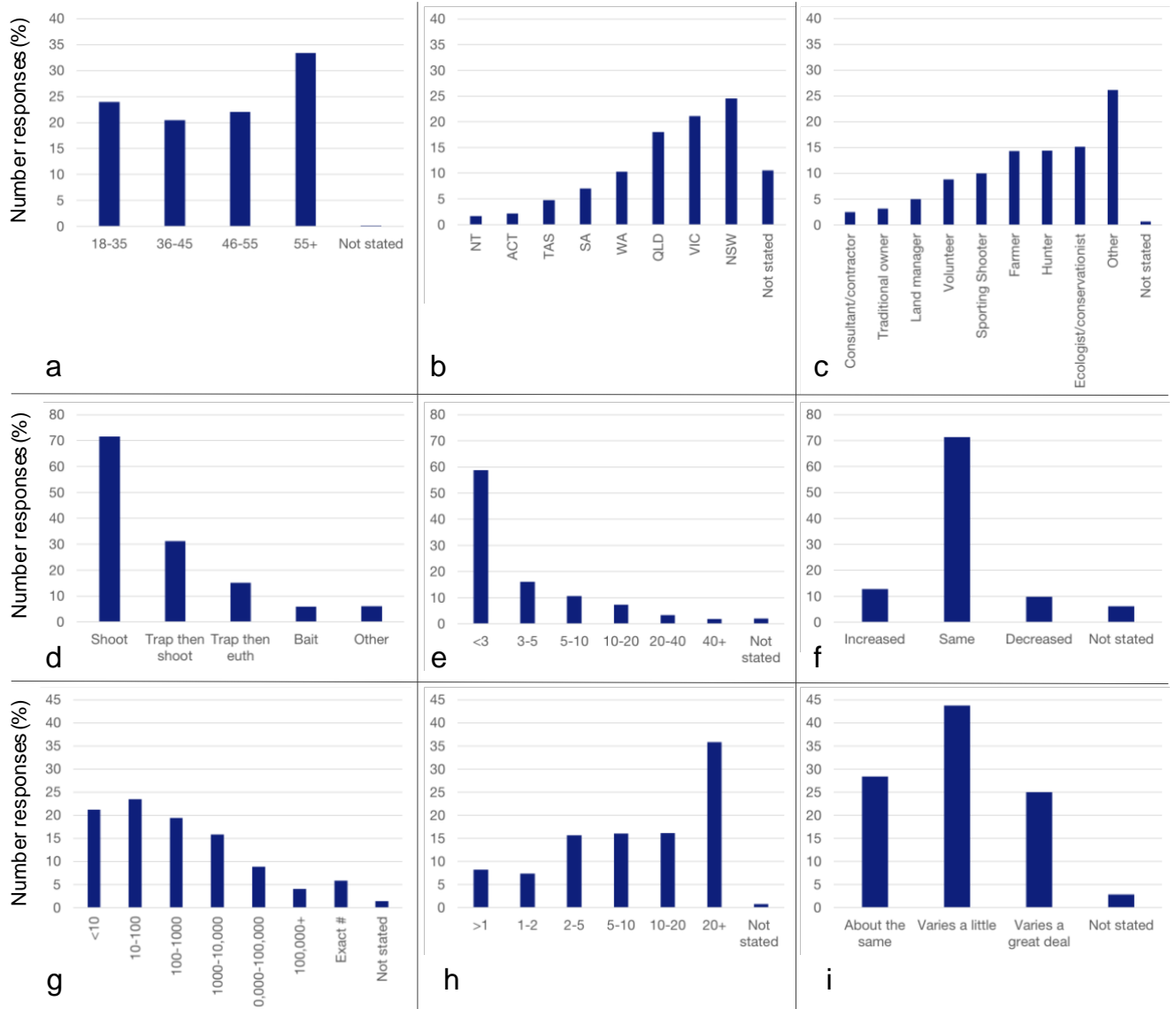


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755

756 Figure 1. Graphical depiction of the methods for a) estimating the number of feral cats

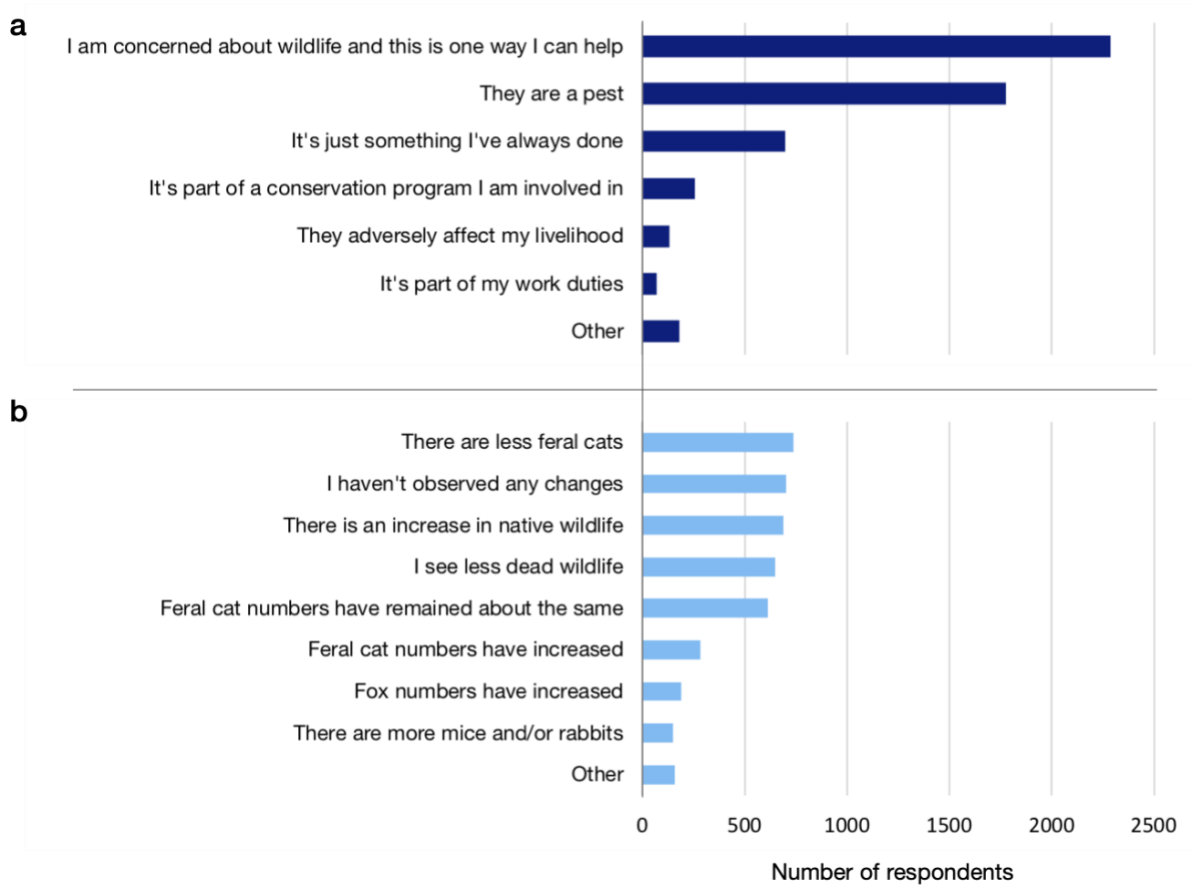
757 removed and b) collecting information on beliefs about feral cats and their control.



758  
759

760 Figure 2. Summary statistics for responses to the individual survey. (a-c) Demographic  
761 information of all respondents ( $n = 4,812$ ): a) age; b) state of residence; c) self-reported  
762 occupation/description. (d-i) Survey responses for respondents engaged in feral cat control ( $n$   
763 = 2,627): d) preferred method of feral cat control (individual respondents could select more  
764 than option); e) effort allocated to feral cat control (hrs/month); f) change in feral cat control  
765 effort over time; g) area covered by feral cat control efforts (ha); h) years engaged in feral cat  
766 control; and i) interannual variability in number of feral cats removed.

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Figure 3. Number of respondents who selected different responses when asked a) why they engaged in feral cat control and b) what changes they have observed as a result of their feral cat control efforts. These questions were asked only of those individuals who indicated that they engage in feral cat control ( $n = 2,627$ ).