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An assessment of the national effort towards feral cat control

A report for the Australian Government Department of the Environment and Energy

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The Interdisciplinary Conservation Science Research Group is a team of academic researchers based within RMIT University's School of Global, Urban and Social Studies. Our research focuses on understanding the interaction between society and our environment. We recognise that managing biodiversity demands a multidisciplinary approach that reconciles ecological, social and economic concerns.

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Executive Summary

Australia has one of the highest mammal extinction rates in the world. Thirty Australian mammal species have been lost since European settlement and many more remain threatened with extinction. One of the most significant threats to endangered Australian mammals and reptiles is predation by feral cats. In recognition of this, the Australian Threatened Species Commissioner has committed to reducing feral cat numbers across the continent, as a key action in the Australian Government's Threatened Species Strategy. Amongst other important objectives for threatened species management, the Strategy makes a commitment to cull 2 million feral cats across Australia by 2020, and 150,000 of those in the first year. However, evaluating this objective poses a major challenge; information on the number of feral cats killed is disparate and often not reported through official channels. In this report, we provide a bounded estimate of the national effort towards feral cat control, which may be used to assess progress towards the stated goals of the Threatened Species Strategy as well as provide a baseline for future assessments.

To produce an annual estimate of the number of feral cats killed across Australia, we draw on numerous datasets, including: existing repositories of data from organisations such as the RSPCA, local councils, conservation agencies and state government departments; data reported by individuals who engage in feral cat control derived from a strategic online survey; and estimates and extrapolations to individuals and organisations who are likely to engage in feral cat control but for whom we do not have data. When considering only the hard data reported through existing repositories and by respondents of our online strategic survey, we arrive at a reliable minimum estimate of the number of feral cats culled that ranges from 28,613 cats/year to 38,725 cats/year, with a most likely estimate of 33,855 cats/year. When we include extrapolations to individuals and organisations likely to be engaging in feral cat control but whose efforts are not recorded in existing datasets, we estimate that the current approximate annual feral cat cull rate is 211,560 cats, with plausible bounds between 135,522 and 287,598 cats.

The bounded estimate presented here is based on a number of assumptions, which are clearly articulated in the main document. We believe it represents a plausible, yet conservative, estimate of the number of feral cats killed in the last year. Notably, this estimate includes extrapolations to individual farmers and sporting shooters who engage in feral control using shooting as a preferred method, but excludes extrapolations to other individuals using other methods of feral cat control whose efforts are not captured elsewhere. These results suggest that if current rates continue, the feral cat control target articulated in the Threatened Species Strategy is likely to be met.

In addition to contributing to the estimate of the number of feral cats culled, we make the following relevant observations based on the findings of our strategic online survey:

- The vast majority of the feral cat control effort (>80%) is not captured through officially reported channels. More widely accessible repositories such as *FeralCatScan* may improve the collection of this information in the future.

- Shooting (or trapping and then shooting) is by far the most common method of feral cat control, accounting for 83% of the feral cats killed by respondents to our survey. Yet regulations governing feral cat control on public land are highly restrictive.

- While we did not specifically collect information regarding the change in effort over time since the implementation of the Strategy, qualitative data indicates that feral cat control effort by survey respondents has not changed substantially, suggesting that current annual cull rates may be indicative of those in the past. When asked what would encourage survey participants to increase their cat control effort, the most commonly stated reason was greater public acceptance of feral cat removal. Hence, message framing to improve public perceptions of feral cat control may be one mechanism to increase national cat control effort.

- Survey respondents generally understand the threat that feral cats pose to native wildlife and state this as the major reason for their engagement in feral cat control.

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Introduction

Australia has one of the highest mammal extinction rates in the world. Thirty Australian mammal species have been lost since European settlement and many more remain threatened with extinction (Woinarski et al. 2011. 2015.). One of the most significant threats to endangered Australian fauna is predation by feral cats (Woinarksi et al. 2011. 2015.). In recognition of this, the Australian Threatened Species Commissioner has committed to reducing feral cat numbers across the continent, as a key action in the Australian Government's Threatened Species Strategy (hereafter the Strategy: Australian Government 2015). Amongst other important objectives for threatened species management, the Strategy makes a commitment to cull 2 million feral cats across Australia by 2020, and 150,000 of those in the first year.

RMIT University's Interdisciplinary Conservation Science Research Group was engaged by the Australian Government Department of the Environment to explore the degree to which individuals and organisations are acting to control feral cats in Australia. Specifically, this project aimed to determine a national estimate of the number of cats culled across Australia over a 12-month period.

We tackled this problem from multiple angles. To produce a national estimate of the number of feral cats culled, we have compiled information collected from four different data sources: 1) hard data on feral cat control reported through existing data repositories; 2) an estimate of the number of feral cats killed by individuals and organisations that is unreported, based on data collected during a strategic online survey; 3) an estimate of the number of feral cats culled during targeted feral cat baiting programs; and 4) an estimate of the number of feral cats euthanased by local councils based on comprehensive data from NSW.

We also sought to to assess how well the threat of feral cats to native biodiversity is understood within the community, whether or not efforts to control feral cats had changed over time, and what people perceive as the major barriers to increasing feral cat control efforts in the future; these questions were addressed in targeted questions in our outline strategic survey. This report details our methodological approach, describes the data analyses, and discusses the results in the context of threatened species conservation. For the purposes of this study, we define feral cats as 'cats that live in the wild and can survive without human reliance or contact'.

Methodological approach

Our methodological approach was to produce a bounded estimate of the number of feral cats killed in the last year by adding together multiple sources of data with varying degrees of uncertainty. Some data, such as that contained in central repositories (*Dataset 1,* below), had virtually no associated uncertainty. Other data sources were associated with large uncertainty, driven by variation in the data itself as well as uncertainty in the assumptions that were made to arrive at an estimate. Our approach was to begin with the data we were most certain about, and then systematically add new data sources, each of which was underpinned by an explicitly stated set of assumptions. Uncertainty in individual datasets was propagated through the analysis and incorporated into the final, bounded estimate. Below, we describe the four sources of data we compiled to inform our estimate of the national feral cat control effort, followed by the statistical methodology used to arrive at individual estimates as well as a final, bounded estimate.

Data Sources

Dataset 1 – Existing data repositories

The first dataset comprised existing repositories of data sourced from organisations either involved in feral cat control or operating a centralized data collection database. We located and compiled the existing repositories of data on feral cat control from around Australia. We were assisted in this task by the Threatened Species Commissioner, who contacted 619 local councils, NRMs and CMAs in April 2016, requesting information on feral cat control. In response to this call-out, we received 96 letters with details about feral cat control. Where these responses contained figures on the number of feral cats killed, we recorded actual numbers. Where they contained the contact details of the person within the organisation responsible for managing feral cat control, we contacted this person. Of the 96 responses to the request for information from the Threatened Species Commissioner, 25 were able to provide specific numbers on feral cats culled (Table 1).

We contacted an additional 48 organisations thought to engage in feral cat control (including National and state land management and conservation organisations, and the community-information gathering source *FeralCatScan*: Appendix 1), seeking information on the number of feral cats killed or advice on other repositories of data. 13 of these organisations were able to provide specific numbers (Table 1). We confirmed that our search for existing data was exhaustive through discussions with more than 50 experts or individuals with a significant interest in feral cat control, including members of the *Feral Cat Taskforce*.

Table 1. Organisations that provided hard data on the number of feral cats killed in the last year. Double counts were identified (*highlighted*) by checking all records received through Feral Cat Scan, the on-line survey and the NSW local Governments. The full list of organisations contacted is provided in Appendix 1.

Organisation	**Feral Cat Deaths**
Animal Management in Rural and Remote Indigenous Communities	8
Australian Wildlife Conservancy	120
Biosecurity QLD	23
Bush Heritage	75
Central Deserts	*49*
Desert Wildlife Services	8
FecalCatScan	382
Kosciusko	37
Nature Conservation SA	130
Parks Victoria	55
Phillip Island Nature Parks	140
RSPCA	5,391
Sporting Shooters Association of Australia (Vic)	14
LGA / CMA / NRM	
Alexandria Council	*90*
Ararat	39
Bathurst	*143*
Brisbane City	850
City of Ballarat	8
City of Darebin	52
City of Darwin	110
City of Gold Coast	50
City of Holdfast Bay	25
City of Kwinana	85
City of Palmerston	100
City of Rockingham	5
City of Stirling	40
Gladstone Regional Council	92
Goulburn Broken	2
Latrobe Council	26
Loddon (Vic)	130
Logan	154
Mitchell Shire Council	40
Mount Barker	31
Port Headland	548
Port Phillip and Westernport CMA	120
Shire of Gunnedah	42

Shire of Irwin	2
Shoalhaven	15
Southern Downs QLD	200
Stirling (WA)	40
Streaky Bay	113
Toowoomba	120
Wellington (Vic)	380
Wheatbelt NRM	60
Total (excluding double counts)	**9,847**

Dataset 2 – Unreported data captured via a strategic online survey

While some data about feral cat control are reported through organised channels, we anticipated that a significant proportion of the feral cat control effort in Australia goes unreported, typically undertaken on private land by individuals. We designed an online survey to strategically capture unreported information on feral cat control across Australia. The survey was aimed at those who are likely to engage in feral cat control activities but may not record their efforts in a formal repository or database. Specifically, we targeted the survey towards those likely to engage in feral cat control as a part of their livelihood (ie. land-managers, farmers) or recreationally (hunters and sporting shooters).

It was important to ensure anonymity of survey respondents (to improve the chances of getting wide-scale survey participation, and to adhere to the requirements of RMIT's Human Research Ethics Committee). As such, we did not collect any information that would enable participants to be identified. Respondents were also under no obligation to answer any question they didn't want to; however, we did ask survey respondents to provide their postcode and describe themselves by selecting one or more occupation type (including Farmer, Sporting Shooter, Hunter, Land Manager etc). This enabled us to monitor the spatial extent of the survey's reach, and to confirm that we were capturing the target audience.

The strategic survey was designed to capture the following information from each participant:

- Whether they engaged in feral cat control and if so, how many feral cats they had killed in the last 12 months. Participants were invited to provide an exact number if they knew it. Otherwise, participants reported a range (eg. 1 – 5, 5 -10);
- The feral cat control methods they used;
- How long they had been engaging in feral cat control, and whether they had changed their efforts in the last 2 years;

- How much effort they invested in feral cat control, including the area covered and time spent; and
- Whether they reported their feral cat control efforts elsewhere. This enabled us to negate double-counting in our estimate of the number of feral cats killed and, at the same time, identify any new data repositories.

The survey also included a number of questions designed to improve our understanding of the perceived impacts of feral cats in the community, and potential options for reducing those impacts, including options that are alternatives to culling. In so doing, we noted that the survey was targeted to particular community groups and the results may not be representative of the broader community. Ethics approval for the survey was granted by RMIT University's Human Research Ethics Committee (Project Number CHEAN B 0000020204-06/16).

We developed the strategic survey and a distribution strategy in collaboration with the Threatened Species Commissioner's Office. The distribution strategy was designed to guide the distribution and promotion of the survey through representative organisations for farmers, recreational shooters and hunters, conservationists and land managers over a four-week period. However, after the survey went live on June 28, 2016, in went somewhat 'viral', with respondents continually responding at a rate of 50-100 per day. It was especially well received in rural and regional parts of Australia, and provided the grounds for positive discussion in the media surrounding issues of feral cat control in Australia (for example, Richard Faulkner was interviewed by ABC Great Southern Radio (21 July)). Given this unexpected response, we left the survey open until the rate of responses slowed towards a ceasing point, and we closed the survey after 9 weeks on August 26, 2016. At this point, we had 3,409 survey respondents, 2,047 of whom reported that they actively engage in feral cat control.

Figures 1 and 2 demonstrate the wide reach and representativeness of the survey participants, based on the self-description and postcode information (Figures 1 & 2). Hunters, sporting shooters and conservationists/ecologists are the descriptions most commonly selected by survey respondents. In addition, it is clear that the strategic survey is tapping into a previously unrecorded source of feral cat control data, as 1,686 survey respondents indicated that they do not record their feral control information elsewhere.

A copy of the strategic survey and a summary of results (from *Qualtrics*) are provided in Appendices 2 & 3.

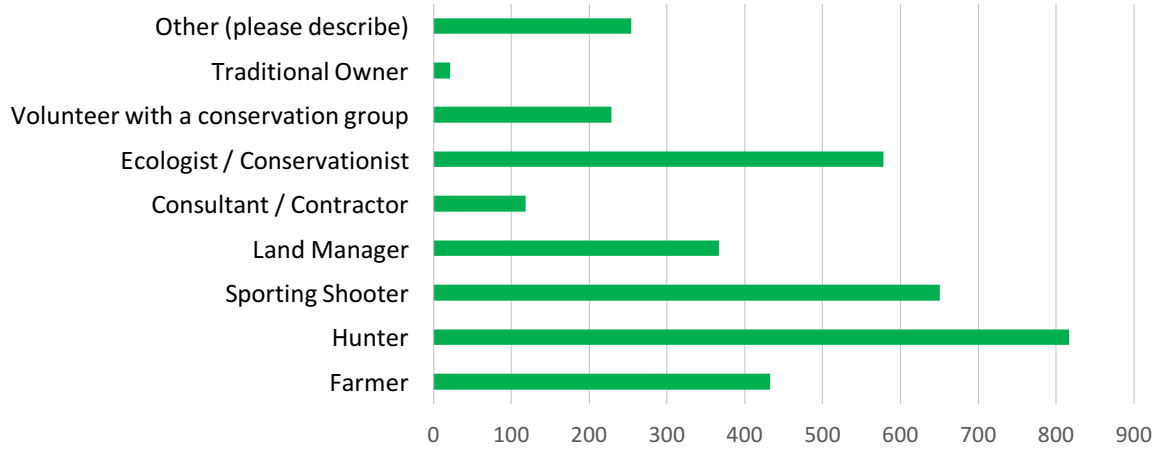

Figure 1. Self-description of all survey respondents. Note that survey respondents can select more than one option.

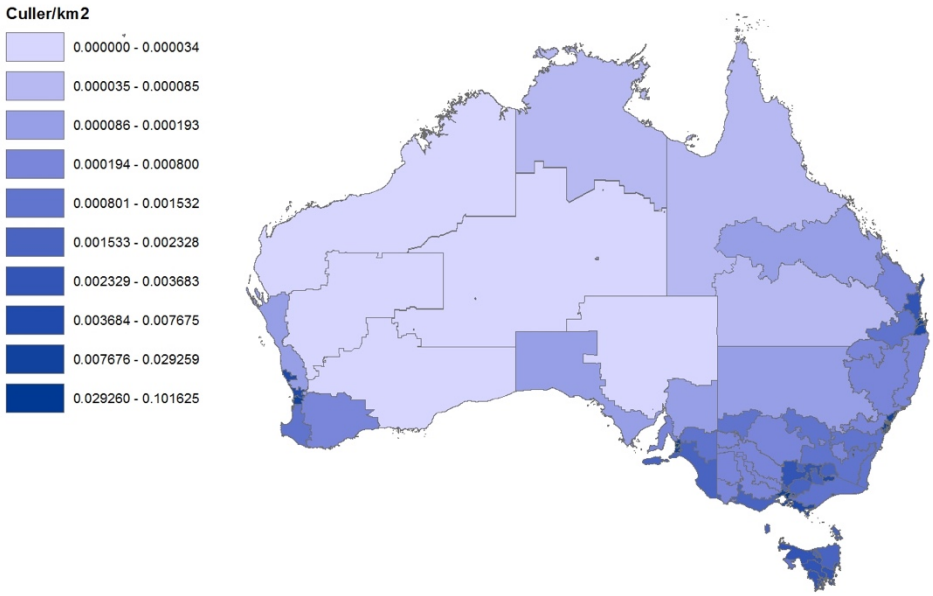

Figure 2. Density of survey respondents who engage in feral cat control, by 2-digit postcode.

Dataset 3 – Targeted feral cat baiting programs

Toxic baiting of vertebrate pest species is a widely used technique for managing species' populations. Targeted feral cat baiting with the toxin *Eradicat* (the only cat-specific bait currently available) has been employed at 17 sites around Australia in the last year. We estimated the number of feral cats killed by these baiting programs in the last year using information on the number of feral cats estimated to be present in the baited areas (using Legge et al.'s (2016) feral cat density map) and estimated baiting efficacy rates compiled from the existing literature.

Dataset 4 – NSW local government pound data

Local governments in NSW keep detailed records about euthanasias occurring in their council-operated pounds. This includes information on the species (ie. cat, dog) and the reasons for euthanasia (ie. feral, owner-requested). We acquired the 2014-15 database from the NSW Government Office of Local Government. This is effectively a subset of *Dataset 1* (*Existing Repositories*), but we are treating it as a separate dataset because it is systematically compiled across multiple organisations and also because some specific assumptions are required in order to estimate of the number of feral cats killed each year.

Estimating feral cat control numbers

This section describes the process of estimating feral cat control numbers from datasets with varying levels of uncertainty. We begin with the data for which there is least uncertainty; reliable estimates of feral cat deaths from existing repositories and other hard data. We then move on to predictions of feral cats killed from cat baiting programs, which rely on estimates of feral cat density and *Eradicat* efficacy obtained from the literature. Finally, we describe the process of extrapolating known information about the number of feral cats killed by survey respondents and NSW local councils to the national scale. This extrapolated data is the least reliable; however, we have drawn on reliable information where possible and otherwise been extremely conservative in our assumptions. We therefore feel confident that this process has produced a plausible, yet conservative, estimate of the number of feral cats killed across Australia in the last year.

Feral cat control data for which there is little or no uncertainty

The most reliable estimate of the number of feral cats killed comes from data that includes hard estimates of feral cat deaths. This includes existing data repositories (*Dataset 1*), estimates reported by respondents to the strategic online survey (*Dataset 3*) and estimates recorded by NSW local governments (*Dataset 4*).

Dataset 1 – Existing repositories

We were able to obtain data on the number of feral cats killed in the last year from 44 organisations, which equated to 9,847 feral cats (Table 1). Of these, the RSPCA and *FeralCatScan* made up a significant proportion.

Dataset 3 – Strategic online survey

Survey respondents were asked to report an estimate of the number of feral cats they had killed in the last year. Some respondents provided a range (ie. 1-5 cats), and others reported an exact number. We extracted this information for the 2,047 respondents who reported

engaging in feral cat control. When tallied, this information produced 3 estimates of the number of cats killed: the conservative estimate assumed the lower value of the reported range; the most likely estimate assumed the median value of the reported range; and the generous estimate assumed the upper value of the reported range. Where a respondent provided an exact number, this number is used when calculating the conservative, most likely and generous estimates. When tallying these results, we removed observations that had been reported through other channels that were already accounted for in *Dataset 1*.

Based on these assumptions, the number of feral cats killed in the last year, as reported by respondents to our strategic online survey, ranged from 12,797 to 22,909, with a most likely estimate of 18,039.

Dataset 4 – NSW local council euthanasias

We extracted feral cat euthanasia data from 147 local governments in NSW. We assumed that feral cat euthanasias included only those for which the reported reason was 'feral' or equivalent in description. We believe this is a conservative, but realistic, interpretation of the data. The total number of feral cats euthanased by NSW local governments was 5,969 cats/year.

(Note that this estimate is for 2014-15, as the numbers for 2015-16 were not available at the time of sampling. We must therefore make the assumption that the 2014-15 figures are representative of those in 2015-16).

Reliable minimum estimate from hard data

Based on this data, we provide a **reliable minimum estimate** of the number of feral cats culled that ranges from 28,613 cats/year to 38,725 cats/year, with a most likely estimate of 33,855 cats/year (Table 2).

Table 2. Estimated number of feral cat deaths provided by hard data. 'Conservative', 'Most Likely' and 'Generous' estimates correspond to estimates that include the lower, median and upper values of the number of cats killed, as reported in the online survey.

	Estimate		
Source	**Conservative**	**Most Likely**	**Generous**
Existing repositories (not incl. NSW LGAs)	9,847	9,847	9,847
NSW Councils	5,969	5,969	5,969
Strategic Survey	12,797	18,039	22,909
Total	28,613	33,855	38,725

Included assumptions:

1. *NSW council data*: only included data where the reason given for euthanasia was 'feral' or equivalent in description.

2. *NSW council data*: Euthanasias reported for 2014-15 are representative of those in 2015-16.
3. *Strategic survey data*: where the reported number was "More than 200", we have assumed a number of 200 for the Conservative, Most Likely and Generous estimates.

Data exclusions:

1. *Strategic survey data*: We excluded data on feral cat control provided by respondents who stated that they report their feral cat control efforts to a repository or organisation that is included in *Dataset 1* (Table 1).

Estimating knock-down from feral cat baiting programs

Targeted feral cat baiting with the toxin *Eradicat* has been employed at 17 sites around Australia in the last year. We estimated the number of feral cats killed by these baiting programs in four steps. First, we identified sites in which *Eradicat* baiting had occurred in the last 12 months, and created a spatial layer of these sites. Second, we estimated the population of feral cats in each baited area using the national feral cat density spatial layer developed by Legge *et al.* (2016). This involved conducting a zonal statistics analysis in ArcGIS (v10.2, ESRI, Redlands, CA, USA) to estimate the average feral cat density (including mean and 95% confidence intervals) for each 1x1km grid within each baited site. This estimate was then multiplied by the area (in km^2) of each baited site to determine the feral cat population in each site. Third, we identified plausible estimates of the efficacy of *Eradicat* baiting from the published and grey literature on the topic (Table 3). Efficacy rates were confirmed by expert knowledge (Keith Morris, DPAW). Fourth, we applied these efficacy rates to the estimated feral cat populations in each baiting area to estimate the number of feral cats killed.

Table 3. Estimated efficacy of cat baiting programs, based on a review of the literature. Efficacy is reported as the % of cats in a baited area thought to be killed.

	Estimated Efficacy (% cats killed)			
	Low	**Mid**	**High**	**Reference**
	50	73	96	Algar & Burrows, 2004
	25	50.5	76	Algar *et al.* 2007
	0	37.5	75	Cristensen *et al*. 2013
	82	86	90	Johnston *et al*. 2010
	14	32	50	Moseby *et al*. 2011
	23	48.5	74	Short *et al*. 1997
Average	**32**	**55**	**77**	

When using the most likely efficacy rate (0.55), we estimated that the number of feral cats killed in targeted baiting programs in the last year was 2,346, with a lower bound of 2,089 and an upper bound of 2,603 (Table 4).

Table 4. Estimated number of feral cats killed in targeted baiting programs for three estimates of *Eradicat* efficacy. Uncertainty in estimates is attributable to error in the number of feral cats estimated to occur in each baiting area.

	# Feral Cats Killed		
Baiting Efficacy	**Lower 95% CI**	**Mean**	**Upper 95% CI**
Lower estimate (0.32)	1,216	1,365	1,514
Most likely estimate (0.55)	2,089	2,346	2,603
Upper estimate (0.77)	2,925	3,285	3,644

Included assumptions:

1. Cat populations in baited areas were calculated assuming 2015-16 was an 'average' year (Legge et al. 2016).

Note: We investigated, but did not include, estimates of feral cat control from other vertebrate pest baiting programs (including wild dog, feral pig and fox baiting programs). Available data for these programs is hugely variable and often lacking in detail. In addition, the effect of off-target baiting on feral cat populations it not well documented, and any attempt to estimate of off-target knockdown of feral cats is therefore unreliable.

Extrapolating feral cat control data to the National scale

While we can produce a reliable minimum estimate of the number of feral cats killed from the hard data reported in Table 2, we know that the data reported by NSW local councils and respondents to our strategic survey represents only a proportion of the total number of feral cats killed last year by local councils and other individuals and organisations involved in unreported feral cat control.

We used advanced statistical modelling methods to extrapolate the feral cat control data from NSW local councils and the strategic survey to a national scale. Here, we make a distinction between *predicting*, in which modelled relationships between known data points and predictor variables are used to make estimations to new data points, and *extrapolating*, in which estimates for new data points are inferred from trends in known data points. In the absence of meaningful predictor variables, we rely on extrapolations to expand feral cat control estimates to the national scale.

Dataset 4 – NSW council euthanasias

We assumed that the number of cats euthanased by NSW local councils could be modelled using the Poisson distribution, a discrete probability distribution useful for modelling count data (McCarthy, 2007). The Poisson distribution has a single parameter, λ, which is equal to both the mean and the variance. We investigated whether variability in the number of cats

euthanased by NSW local councils could be explained by a range of candidate predictor variables (Table 5), according to:

$$\log(\lambda_i) = \alpha + \beta x_i,$$

where λ_i is the number of cats euthanased by council i, α is the number of cats euthanased at the mean value of the predictor variable, x_i is the value of the predictor variable for council i and β is the effect of the predictor variable on the number of cats euthanased. We randomly selected 70% of the data to build the model and left the remaining 30% of the data as validation observations. We then assessed the capacity of the model's estimates to predict to new data (within the NSW dataset) by calculating the coefficient of determination (R^2) between the predicted and observed number of cats euthanased. We iterated this process 10 times for each candidate predictor variable, with our results suggesting that none of the candidate predictors were useful in explaining the variation in the observed number of cats euthanased by NSW local councils (Table 5).

Table 5. Candidate explanatory variables tested and their predictive power as measured by R^2

Variable Tested	Description	R^2
hdens	Average human population density in the LGA	0.01
catdens	Average feral cat population density in LGA (from Legge et al. In press)	0.02
propAg	Proportion of the LGA covered by agricultural land use	0.01
propUrb	Proportion of the LGA covered by urban land use	0.01
propPA	Proportion of the LGA covered by protected areas	0.02
propRes	Proportion of the LGA covered by residential land use	0.01
rates	Council rates per capita (2014-15)	0.02

Given that we could find no meaningful predictor variables to explain the variation in the number of cats euthanased by NSW local councils, we took a different approach. Instead of using variables to predict the number of cats euthanased in councils outside of the existing dataset, we aimed to describe the variation in the NSW data by fitting an extra term to our model that accommodates for overdispersion in the data. Overdispersion refers to the situation in which the observed variance is greater than that expressed by the distribution (Kery & Royle, 2016). As with the previous model, we randomly selected 70% of the data to build the model and left the remaining 30% of the data as validation observations. After 10 iterations, we observed that the overdispersed Poisson model was a good fit to the data (R^2 = 0.87), and that it was therefore accurately predicting the actual number of euthanasia across all NSW (Observed = 5,969 cats; Predicted = 6,573 cats, SD = 903).

We then fitted the overdispersed Poisson model using all NSW council data and extrapolated the model's distribution to all other councils in Australia (n = 407). Based on this extrapolation, we estimated the number of feral cats euthanased by Australian local councils (excluding NSW councils) to range from 13,218 to 20,052, with a most likely estimate of

16,344. These figures are the averages of 10 separate model iterations, in which we recorded the mean number of cats, as well as the upper and lower bounds of the 95% confidence interval.

Included assumptions:

1. We based our model fitting and extrapolations only on data where the reason given for euthanasia was 'feral' or equivalent in description.
2. The number of euthanasias recorded by NSW local councils in 2014-15 is representative of those in 2015-16.
3. Importantly, this estimate assumes that councils from other Australian states are euthanasing feral cats at the same rate as those in NSW. There several reasons to believe that this may not be the case, however, NSW councils are hugely variable in area, population, land use and resourcing, which may minimize the likelihood that they represent an anomaly on the national scale.

Dataset 3 – Strategic online survey

We used the same extrapolation methodology described above for the NSW council data to extrapolate the results of the strategic survey to the national scale. The challenge for upscaling the results of the strategic online survey was that, although we had an unexpectedly high response rate from a representative range of respondents, we had little reliable information about our target population (ie. the number of Australians actively engaging in feral cat control but not reporting it through any official channels). We therefore focused our efforts on extrapolating our results to subsets of the population for which we had some reliable information about the target population; namely, shooters/hunters or farmers who use shooting as a preferred method of feral cat control.

We have chosen to focus on this subset of the total population of Australians engaging in unrecorded feral cat control for two main reasons: (1) we can get reliable estimates of the number of shooters and farmers who engage in feral cat control; and (2) shooting was by far the most common feral cat control method reported by survey respondents. Of the people who reported engaging in feral cat control, 73% reported shooting as a preferred method of cat control, and shooting accounted for 83% of the total number of cats killed.

We identified three potential target populations from the strategic survey: people who are a shooter/hunter but not a farmer; people who are a farmer but not a shooter/hunter; and people who identify as a farmer and a shooter/hunter. We fitted overdispersed Poisson distributions (as described above for the NSW council data) to each of these groups independently. We therefore required specific estimates of the target population for each group.

We assumed that membership of the Sporting Shooters Association of Australia (SSAA) was a reasonable estimate of the number of shooters/hunters in Australia and the number of registered farms was a reasonable estimate of the number of farmers in Australia. We were

provided with reliable estimates of these numbers by the SSAA and ABARES, such that we estimated the number of shooters/hunters in Australia to be 180,000 (SSAA, pers comm) and the number of farmers in Australia to be 120,211 (ABARES, pers comm). From the strategic survey, we estimated that 18% of shooters/hunters also self-report to be farmers, and 43% of farmers also self-report to be shooters/hunters. Based on these figures, we estimated the Australia-wide populations of these 3 groups to be:

- Shooter/hunter but not farmer: 137,985
- Farmer but not shooter/hunter: 78,196
- Shooter/hunter and farmer: 42,015

The final step for determining the size of the target populations, and therefore the populations to which we would extrapolate our results, was to adjust the above figures to account for the proportion of farmers, shooters/hunters that actively engage in feral cat control, and the proportion which we assume are already reporting their efforts through official channels. The former we based on a conservative estimate obtained from the SSAA (9.6%), and the latter, we extracted from the strategic online survey. After making these adjustments, final estimates of the target populations (ie. shooters/hunters and farmers who actively engage in feral cat control) were:

- Shooter/hunter but not farmer: 15,284
- Farmer but not shooter/hunter: 8,735
- Shooter/hunter and farmer: 4,710

We tested for an effect of State and Territory on the number of cats shot by each group, but did not find one, indicating that the modelled distributions could be extrapolated without consideration of State. After extrapolating to each group, we estimated the number of feral cats shot by shooters/hunters and/or farmers in Australia that are not recorded through any other channel considered here to be within the range of 83,036 and 234,962 cats/year, with a most likely estimate of 159,015 cats/year (Table 6).

Table 6. Estimated number of feral cats shot annually by Australian shooters/hunters and farmers and not reported through official channels.

	National estimate of feral cats shot in 2015-16		
Target Population	**Lower 95% CI**	**Mean**	**Upper 95% CI**
Shooters/hunters	49,607	95,529	163,194
Farmers	26,944	44,882	73,948
Shooters/hunters & farmers	8,110	18,604	37,165
Total*	83,068	159,015	234,962

* Assuming the predicted number of cats in each dataset are independent and normally distributed, the overall mean is equal to the sum of the individual means, and the overall variance is equal to the sum of the individual variances.

Included assumptions:

1. We assumed that the number of cats shot by hunters/shooters/farmers who responded to our survey was representative of the number of cats shot by hunters/shooters/farmers who engage in feral cat control but did not respond to our survey. We are confident that this is reasonable given that our survey data included respondents in this category who did not report killing any cats in the last year, and because we relied on the lower bound of the estimates provided (See point 2, below).
2. Our overdispersed Poisson models were fitted to the lower estimate of the number of cats killed (ie. used the lower bound of reported ranges for shooters/hunters, farmers and farmers/shooters/hunters). Our extrapolations are therefore based on the most *conservative* assumptions about the number of feral cats shot per individual within each group.
3. We assumed that the membership of the SSAA was a reliable estimate of the number of shooters/hunters in Australia.
4. We assumed that the number of registered farms was a reliable estimate of the number of farmers in Australia.
5. We assumed that the proportion of farmers who are also shooters/hunters and vice versa extracted from our survey results was representative of these groups in the broader community.
6. We assumed that the proportion of shooters/hunters/farmers in our survey who reported their feral cat control efforts through recorded channels was representative of the target population. We were *conservative* in our interpretation of this statistic.
7. In the absence of reliable estimates assumed that the proportion of farmers and hunter/shooter/farmers engaging in feral cat control was the same as the proportion of shooter/hunters engaging in feral cat control. We were *conservative* in our application of this statistic, using a value 20% lower than the one provided by the SSAA. Reliable estimates of the proportion of farmers involved in feral cat control may become available in the future, based on the outcomes of ABARES current survey.
8. Our estimates are based on the most *conservative* assumptions about (1) the number of feral cats killed by individuals and (2) the size of the target population over which the extrapolation was made.

Note: Farmers and shooters/hunters that report shooting as a preferred method of feral cat control account for 57% of our survey respondents, and 57% of the reported feral cat deaths. Of the remaining 43% of total recorded cat deaths in our survey:

- 60% were killed by individuals who list shooting as a preferred method of control but are not farmers or hunters/shooters. The vast majority of these cats are attributable to people who record themselves as being either a 'conservationist' or 'land manager'; and
- 40% were attributable to a different method of feral cat control, mostly trapping, but some baiting and other methods.

As such, any national estimate based only on extrapolations to farmers and shooters or hunters whose preferred feral cat control method is shooting is likely to be an underestimate. However, we believe it is a defensible approach given that:

- this group of people represents the majority of respondents and feral cats reported in our survey;
- we do not have reliable estimates of the total number of conservationist, land managers, contractors and volunteers who engage in feral cat control; and
- we are accounting for other methods of feral cat control (trapping and baiting) in other parts of this analysis.

A national estimate of the feral cat control effort

Our final task was to add the estimates provided by the hard data, predictions from targeted feral cat baiting, and extrapolations to local councils and individuals who engage in unreported feral cat control to produce a single, bounded estimate of the number of feral cats killed across Australia in the last year. We added together the following estimates to determine our final estimate:

1. The most likely estimate from the hard data;
2. The most likely bounded estimate from the cat specific baiting programs; and
3. The bounded estimates from the extrapolated data, which are based on conservative assumptions about what is considered to be a feral cat (*NSW council data*); and numbers of feral cats killed by each shooter/hunter/farmer, proportion of shooters/hunters/farmers engaging in feral cat control and the proportion of shooters/hunters/farmers who are not reporting their feral cat control efforts through recorded channels.

To produce a single bounded estimate from the addition of multiple bounded estimates, we have assumed that the individual estimates are independent and normally distributed. In this case, the overall mean is the sum of the individual means, and the overall variance is the sum of the individual variances.

Based on this approach, our estimate of the number of feral cats culled across Australia in the past year ranges from 135,522 to 287,598, with a most likely estimate of 211,560 (Table 7). This reported range represents the interval within with we are 95% confident that the true value lies.

Table 7. National estimate of the number of feral cats killed in the last year. Upper and lower estimates represent the upper and lower bounds of the 95% confidence interval, which accounts for uncertainty in estimates from cat baiting and extrapolation of NSW council and survey data.

	National estimate of feral cats killed in 2015-16		
Data Source	**Lower 95% CI**	**Mean**	**Upper 95% CI**
Hard data – most likely estimate	-	33,855	-
Cat baiting data – most likely estimate	2,089	2,346	2,603
Extrapolated council data	13,218	16,344	20,052
Extrapolated survey data	83,068	159,015	234,962
Total*	135,522	211,560	287,598

* Assuming the predicted number of cats in each dataset are independent and normally distributed, the overall mean is equal to the sum of the individual means, and the overall variance is equal to the sum of the individual variances.

Qualitative findings

In this section, we present some of the qualitative results emerging from the National Feral Cat Control strategy survey. These results came from survey questions designed to improve our understanding of the perceived impacts of feral cats in the community, as well as the extent to which efforts to control feral cats have changed over time.

Perceived impact of feral cats

People undertaking our survey were very aware of the threat that feral cats pose to native wildlife in Australia and this concern was a major driver for those engaging in feral cat control. When asked about the understanding of what impacts feral cats have on the environment, the vast majority of survey respondents (80.6%) strongly agreed with the following statement: 'Feral cats are bad for wild life and cause decline in native species' (Figure 3). This result includes all participants of the survey, not just those who engage in feral cat control. Of those respondents who do engage in feral cat control, 86.7% stated that concern for native wildlife as a reason for doing so (Figure 4). Furthermore, very few (0.028%) survey respondents believed that feral cats had an intrinsic right to exist (Figure 3).

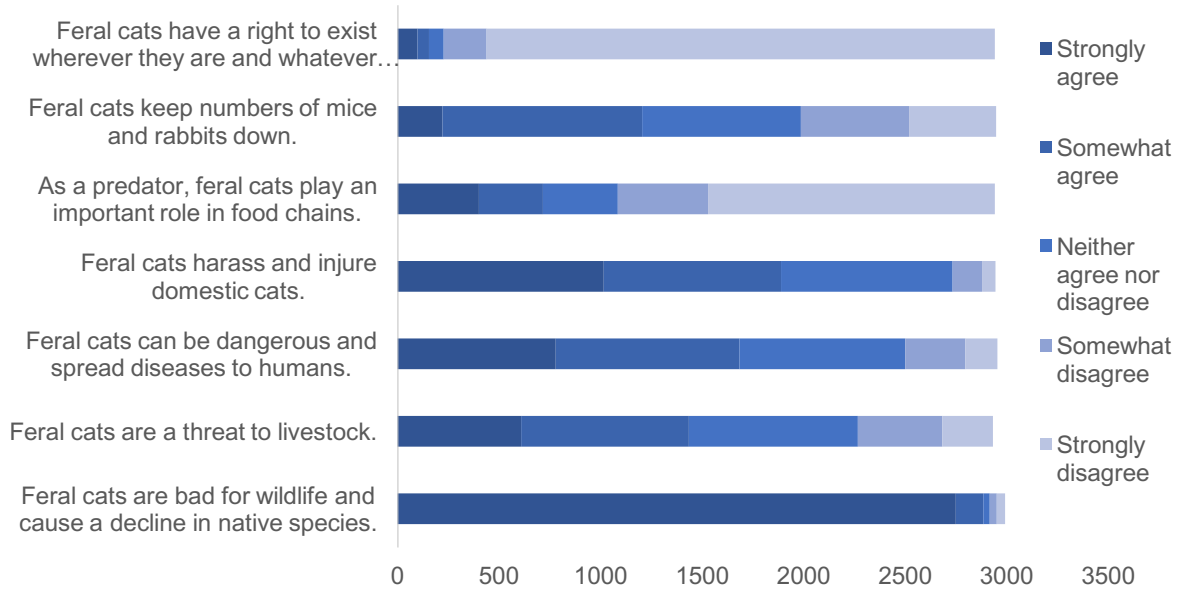

Figure 3. Perceived impact of feral cats on the environment, as reported by survey respondents.

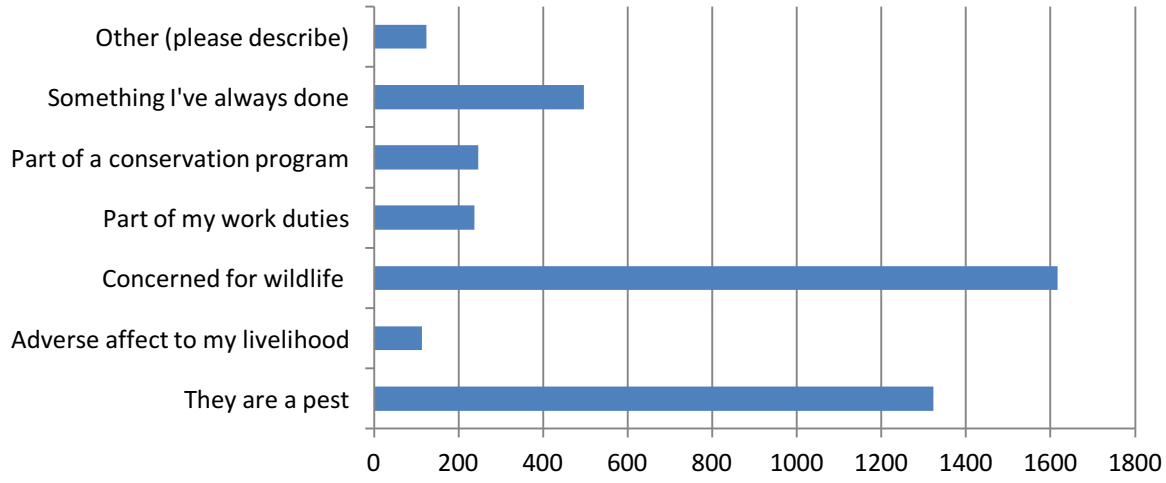

Figure 4. Reasons for engaging in feral cat control, as reported by survey respondents.

Change in feral cat control effort

The survey responses indicate that there has not been a substantial increase in effort to control feral cats over time, with the vast majority of survey respondents reporting that their efforts had stayed about the same and similar numbers reporting either an increase or decrease in feral cat control efforts (Figure 5). When asked what would encourage them to increase their efforts, the most commonly selected response was 'If there was an increase in

the public acceptance of feral cat removal', closely followed by 'If laws to enforce feral cat control were introduced' (Figure 6). Other strong encouragements were: 'If there was more information about how my efforts help protect wildlife', 'If there was more information on the positives of feral cat control', and 'If there was information available on the various methods to control feral cats'. Less than 50% of survey respondents indicated that a bounty or reinforcement fee would provide an incentive for them to increase their feral cat control efforts.

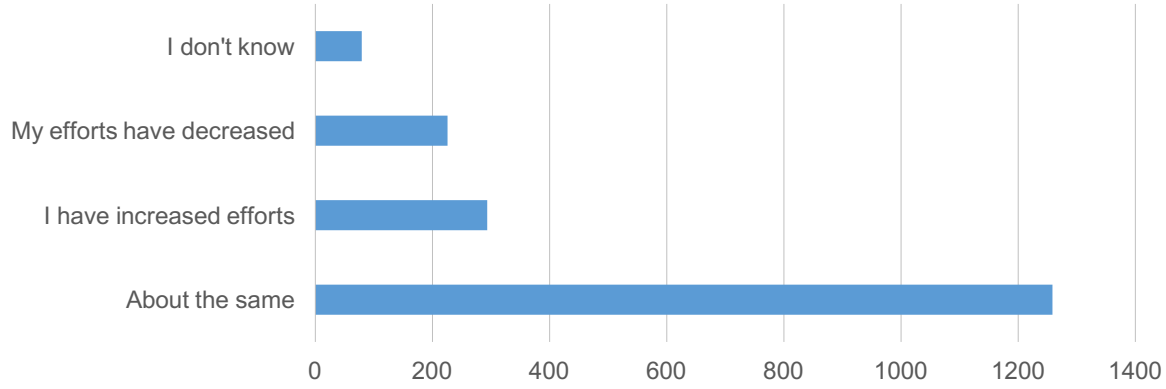

Figure 5. Changes to feral cat control efforts, as reported by survey respondents in response to the question "How have your feral cat control efforts changed over time?".

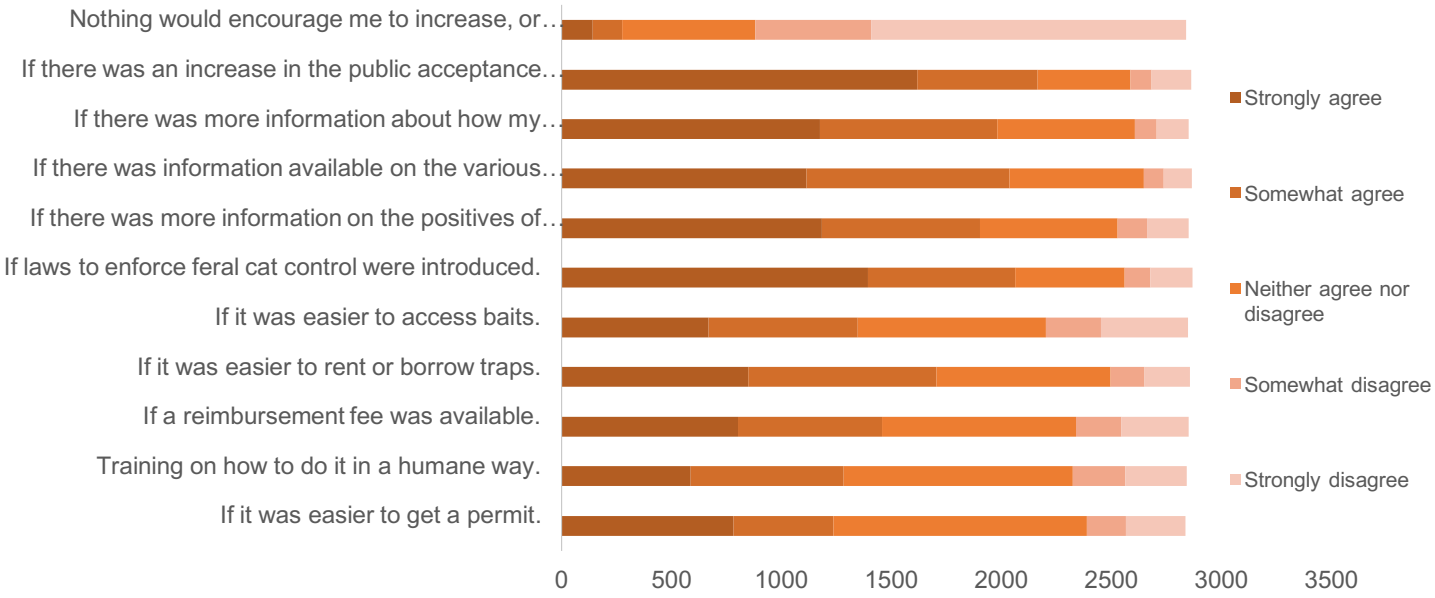

Figure 6. Incentives that would encourage an increase in feral cat control efforts, as reported by survey respondents.

This strongly supports the need for more information and public awareness about the impact of feral cats and what can be done about the problem. It also indicates a need for stronger policy and legislation to guide feral cat control.

We also received in excess of 1,650 extra comments from survey participants, covering topics from domestic cat management to hunting on crown land. There is a great opportunity to extract the common themes and perceptions from this information in a formal qualitative data analysis. This type of analysis may be useful for informing effective messaging for feral cat control, as well as policy and legislation improvements.

Concluding Remarks

This research project assesses progress towards achieving the target articulated in the Threatened Species Strategy of 2 million feral cats culled by 2020 (Australian Government 2015). For the first time, we have a plausible estimate of feral cat control in Australia by which to assess current and future effort. Using a combination of data sources including known data repositories, a strategic survey and estimates of baiting and council euthanasia programs, we estimate that the current approximate annual cull rate is 211,560 cats, with plausible bounds between 135,522 and 287,598. Our survey results indicate that the contribution of private individuals to feral cat control is extremely significant, and that the vast majority (in excess of 80%) of feral control may currently be unreported through official channels. Shooting (or trapping then shooting) is the main method of feral cat control.

While we did not specifically collect information regarding the change in effort over time since the implementation of the Threatened Species Strategy (Australian Government 2015), qualitative data collected through our strategic survey indicates that culling by private individuals has not changed substantially over the years or in recent times. The methodology employed here could potentially be undertaken in future years to assess change in effort over time.

How reliable are these results?

Given the diverse and fragmented nature of the data that this report relied upon, many assumptions were required to arrive at the estimate of national feral cat control effort, and there were many sources of uncertainty. Importantly, we were conservative in our extrapolations from hard data to mitigate the potential for over-estimation. For example, we relied on the lower bound of estimated ranges provided in the strategic survey. By consistently making conservative assumptions, we are confident that the estimates reported here represent a reliable minimum estimate.

How could we improve data reliability?

Key uncertainties in this study stem from the lack of systematic data collection and reporting, the lack of data from councils, the lack of data for non-shooters, assumptions regarding the number of cats killed by individuals who didn't respond to the survey and the definition of 'feral cats'. Following are suggestions for improving the reliability of future estimates of cat control effort:

- A more systematic reporting structure (potentially through *FeralCatScan*) would enable more precise analysis of the scale and spatial location of feral cat control in Australia.

- NSW is the only state that has systematic collection and recording of data on feral cat euthanasias in local council pounds. This system could be replicated across Australia to improve data reliability. Trapping and baiting success data from all councils would also beneficial.

- Our extrapolation from the strategic survey data was only conducted for farmers, hunters or shooters who list shooting as a preferred method (approximately 57% of the reported cat control effort captured by the survey). The actions of conservationists, land managers, contractors and volunteers were not included in the extrapolation exercise because we didn't have reliable estimates for the total population size of these groups or the proportion of individuals who engage in feral cat control. *FeralCatScan* data may improve the collection of this information in the future.

- Our extrapolations from the survey data relied on a series of assumptions about the number of shooters, hunters and farmers engaging in feral cat control and the proportion who are currently reporting their efforts through official channels. Through the course of this research, we became aware of a number of organisations who are particularly active in the space, and independently collect data which is potentially very useful. For example, the Sporting Shooters Association of Australia conducted a survey of its membership in 2010 in which it specifically asked about engagement in feral cat control. In addition, ABARES are currently conducting a survey of farmers in which feral animal control is one area of interest (unfortunately, time constraints meant that we could not use their findings in our analyses). Collaboration with these groups represents a promising opportunity to improve and further refine estimates of feral cat control in the future.

- Tighter definition and interpretation of 'feral cats' could also improve data reliability. For example, approximately 30% of cats euthanased by the RSPCA are considered 'feral', but it is not known how this interpretation compares with the definition used by local councils and other organisations.

Complimenting NESP TSR Projects – Other land management techniques

This project has successfully worked in collaboration with the Threatened Species Recovery Hub (TSR Hub), under the National Environmental Science Program (NESP). Whilst helping to facilitate further understanding of feral cat management in Australia, it will compliment research being undertaken within the TSR Hub to explore the effectiveness of alternative management approaches. The results of this project also support the need for the current and proposed projects being facilitated by the TSR Hub. These include, but are not restricted to, projects investigating: the impacts of cat baiting and the response of threatened species; the indirect effect on feral cats in response to managing other pest species; how fire and grazing effect the impact of feral cats; the role dingoes play on the impact of feral cats; the use of guardian dogs; control and eradication programs in fenced areas and on islands, and creating models to predict where and when feral cats have the greatest impact to inform better strategic and targeted management.

Acknowledgements

We would like to acknowledge the cooperation of and information provided by a number of research groups and organisations, including Agforce Queensland, Animal Management in Rural and Remote Indigenous Communities (AMRRIC), Australian Wildlife Conservancy, Bush Heritage, Central Desert Native Title Services, Centre of Excellence for Environmental Decisions, Desert Wildlife Services, Department of Environment Land Water and Planning (Vic), Department of Parks and Wildlife (WA), Ecological Horizons Pty Ltd, members of the Feral Cat Task Force, Invasive Animals CRC, Landcare Australia, Local Government NSW, Nature Foundation South Australia, National Environmental Science Program - Threatened Species Recovery Hub, NSW Farmers, NT Farmers, Parks Victoria, Phillip Island Nature Parks, Primary Producers & Livestock SA, Queensland Farmers, Royal Society for the Prevention of Cruelty to Animals (RSPCA), Sporting Shooters Association of Australia (National and State branches), Tasmanian Farmers and Growers Association, Trust For Nature, Victorian Farmers Federation and WA Farmers. In addition, we would like to acknowledge the advice and contribution of members of RMIT's Interdisciplinary Conservation Science Research Group. Georgia Garrard and Sarah Bekessy are supported by the National Environmental Science Programme Threatened Species Recovery Hub.

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Appendix 1. List of organisations contacted

Organisation	Contact	Data Provided	Brief Notes	# Feral Cats Culled
Bush Heritage	Jim Radford	yes	Signed off on notes recored from meeting about BH approach to feral cat control. Estimates 50 - 100 culled. Focus on other techniques.	75
Nature Conservation SA	Alex Nankivell	yes	Provided highly detailed data of efforts on two properties	130
PINP	Beau Fanle	yes	Provided graph of feral cats removed per year since 1997	140
AWC	Faye Lewis	yes	database provided with details of feral cats removed from each sanctuary	120
Trust For Nature	Joanna Fulton	nil	Acknowledged that feral cat control was being carried out. Passed on link to survey through networks.	
Landcare Australia	Rob Novotny	nil	Acknowledged that feral cat control was being carried out. Promoted survey through newsletter and social media.	
Blue Mountains World Heritage Institute	Rosalie Chapple	nil	projects in the past. No current programs occuring. Blue Mountains Council considers it 'too hard' basket.	
Central Deserts	*Kate Crossing*	*yes*	*Provided numbers which were also added to ferascan*	*49*
Desert Wildlife Services	Rachel Paltridge	reports provided	Worked with Central Desterts. Also provided data from baiting projects.	8

Ecological Horizons	Katherine Moseby / John Reid	Baiting data	projects going on and soon beginning eg. 'Secret Rocks'. Katherine has a strong opinion that its not necessarily the number of cats we remove that is the answer. She believes that certain indivdual cats have the highest impact. Eg. Large males on quolls. '8 out of 200 cats are killers (of quolls)'. Baiting gets gets the naieve cats that are of lesser threat. Holistic land management techniques (fire, stocking), and targeted approach to high impact individual cat types would be the best approach/es.	
FecalCatScan	Peter West	Provided details from database.	154 shot, 170 cats cage trapped, 15 in soft-jaw traps, 43 Other (inc. Traditional Hunting, hand caught, car)	382
RSPCA	Bidda Jones	Details in Annual Report	31% feral of 17389 euthanased. It's believed that these euthanased cats do not cross over with councils.	5391
SSAA (National)	Matt Godson	nil	No official stats or repostitory. Developing feral cat strategy, and pest control app through Farmer Assist program - to be linked to Feral Scan	
SSAA (Vic)	David Croft	yes	between 2013 and 2016, there were 54 cats taken by 5 shooters. 1672 members in Conservation and Wildlife Management (CWM) program. A lot more occurs on private land. MOU with Parks Vic.	14
SSAA (NSW)		nil		

SSAA (QLD)	Matt Godson	nil	500+ members in CWM program. Have data but no resources to extract required data on feral cats. :(	
SSAA (NT)	Craig Cousins	nil	12 members in Alice Springs registered with the CWM program	
SSAA (Tas)	Mike Cook	nil	working to devolop pest management program	
SSAA (WA)	Mark Foster	nil	130 members in CWM program. Cats often taken in 'Red Card' (*fox hunting*) program.	
SSAA (SA)		nil	300 members in CWM program	
Arid Recovery	Katherine Moseby	nil	No current cat control activities accounted for	
VRA (Victorian Rangers Association)	Discussed with committy	nil	Passed survey link through networks	
CARA (Council of Australian Rangers Association)	Pete Cleary	nil	Passed survey link through networks	
CLC	Sam Rando	nil	No data. Took survey to Rangers.	
KLC		nil		
APY	John Reid	nil	John to pass on APY Annual Report (being drafted). Researching alternative techniques.	
AMMRIC	Bonny Cumming	yes	8 euthanased (many more desexed). Ackwnowledged reports of feral cat issues among many communities.	8
Kosciusko	Provided by TSC office	yes		37
Biosecurity QLD	John Augusteyn	yes	Taunton NP (low numbers 2016 due to baiting trial occuring, results soon)	23
DELWP (Vic)	Kate McArthur / Simon Denby	nil	Working on policy and declaring feral cats as 'pest' in Victoria.	

Park Vic	David Stephenson	yes	Report, tables and maps provided for work on French Island. Probably the most accountable source aquired.	55
DEWNR (WA)	Katherine Moseby	nil	No current data. A few projects ramping up!	
DAF (Qld)	Tony Pople	nil	Nothing going on. Has an interest. Passed on survey through networks.	
EHP (Qld)		nil	No repository. Cats recognised as threat to wildlife. Actions required identified. Large cull numbers recorded in 2014 after two year initiative in collaboration with defence department.	
OEH (NSW) / Parks and Wildlife	Rob Hunt, Guy Ballard, Richard Kingswood, Linda Broome	nil	Projects occuring. Nothing reported. Feral cats often culled opportunistically/ as a by-product of other activities. In many cases feral cats put in the 'too hard' basket.	
DPAW (WA)	Keith Morris		Western Shields baiting data provided	
DLRM (NT)	Greame Gillespie	nil	Project ramping up in West Mac ranges. Feral cat work on the radar. Nothing happening or currently recorded.	
DPIPWE (Tas)	no response from attempts to contact. Details from website	nil -	No official repository. Have 'Cat Management Act 2009' - whereby "cats found in a prohibited, rural or remote area may be trapped, seized or humanely destroyed"	
DEFENCE	Frederick Ford	nil	No official numbers released. Occasionally feral cats removed from defense land.	
ABARES	Nyree Stenekes	nil	Survey out currently that may indicate levels at which farmers invest in feral cat control	

National Farmers Federation	No response - corporate overseeing body	nil		
NSW Farmers	Arian Moshefi	nil	Agreed to distribute survey through networks, e-news and social media.	
Victorian Farmers Federation	Melanie Brown	nil	Agreed to distribute survey through networks, e-news and social media.	
Primary Producers SA	Deane Crabb	nil	Agreed to distribute survey through networks, e-news and social media.	
WA Farmers	Melanie Dunn	nil	Agreed to distribute survey through networks, e-news and social media.	
NT Farmers	Samantha Fleming	nil	Agreed to distribute survey through networks, e-news and social media.	
Queensland Farmers Federation	Mark Neville	nil	Agreed to distribute survey through networks, e-news and social media.	
AgForce Queensland	Michael Allpass	nil	Agreed to distribute survey through networks, e-news and social media.	
Tasmanian Farmers and Graziers Association	Nick Steel	nil	Agreed to distribute survey through networks, e-news and social media.	
Reported by Australian LGAs and NRMs via reponse to TSC letter.	**24 recoded efforts from 96 respones. Accumulative annual results are divided, and 31% of euthansed records assumed feral. * Implications of defining feral cat.**			
Southern Downs QLD				200
Brisbane City			1700 in last 2 financial yrs	850
Logan				154
Toowoomba			384 euthanased, 31% assumed feral	120

Wellington (Vic)				380
City of Ballarat				8
City of Darebin			Last calendar year the Council impounded 872 cats and achieved a euthanasia rate of 19%	52
Loddon (Vic)				130
City of Gold Coast			2015-2016 Untreatable-Feral (Council Trapped In Feral Colony) Cats (over 6 months of age) euthanized:44 Kittens (under 6 months of age) euthanized: 6 Untreatable-- Stray-Severely Aggressive/Withdrawn- Fear Based Cats (over 6 months of age) euthanized: 42 Kittens (under 6 months of age) euthanized: 8	50
Stirling (WA)				40
Arrarat			627 removed from environment in lst 5 years. Divided by 5 and 31% taken.	39
Streaky Bay				113
Mount Barker			100 euthanased, 31% assumed feral	31
City of Darwin			Since 2013, 947 feral cats have been removed from the municipality through voluntary trapping by residents	110
Shire of Irwin			provide cat traps for hire to local residents and offers an appropriate disposal program. Also looking for new initiatives to tackle the issue.	2
Latrobe Council			A total of 82 cats were captured and euthanized in the 2015 calendar year	26
City of Palmerston			Around 300 per year that are being euthanised. Their program has been running for the past 6 years.	100

Goulburn Broken			In two specific places: Providing cat traps for land holders and monitors the numbers	2
City of Holdfast Bay			Providing traps and education	25
City of Rockingham			5 feral cats trapped. (Foot hold traps, cage traps, den/warren destruction and RHDV release)	5
Mitchell Shire Council			Euthanised cats: 88 in 2013, 116 in 2014, 117 in 2015 and 24 in 2016	40
Shoalhaven			*included in NSW pound data*	15
City of Stirling			In excess of 40 cats have been captured since July 2015	40
Shire of Gunnedah			In 2015 Council assisted in trapping approximately 130 feral cats. (delivers them to local vets where they are processed and, if deemed necessary, euthanized.)	42
City of Kwinana			Since the 1 November 2013 the team have trapped 411 cats. Of these cats 254 were euthanised as they were feral/diseased	85
Gladstone Regional Council			92 Captured from July 2015 to June 2016	92
Port Headland				548
Alexandria Council			*included in NSW pound data*	*90*
Bathurst			*included in NSW pound data*	*143*
Wheatbelt NRM				60
Port Phillip and Westernport CMA				120
Total				**9847**
Further discussions with Experts				
Euan Ritchie			notes documented	
Tim Doherty			notes documented	

Richard McLellan			notes documented	
Kelly Miller (Deakin Uni)			notes documented	
Hugh McGregor			notes documented	
Sarah Legge			notes documented	
Response from Task Force members at meeting			notes documented	

Appendix 2. National Feral Cat Control Survey

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

You are invited to participate in a research project being conducted by RMIT University. Please read this page carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please contact one of the investigators.

PARTICIPANT INFORMATION

Project Title: National Feral Cat Control Survey

You are invited to participate in a survey about feral cat control in Australia. The information provided in this survey will help generate a better understanding of feral cat management in Australia, including how to make improvements. This survey is being conducted by Mr Richard Faulkner, Dr Georgia Garrard and Associate Professor Sarah Bekessy at RMIT University, and has been approved by the RMIT Human Research Ethics Committee. Contact details for research investigators and ethics committee are provided below. This research project is funded by the Australian Government.

What is the project about?

The aim of this project is to determine the extent to which feral cat control is occurring across Australia, and to estimate the number of feral cats that are removed from the environment each year. This project also seeks to understand how efforts to control feral cats are changing over time.

Why have you been approached?

You have been invited to take part in this research because you are an Australian resident, and you are someone likely to be engaged in, or exposed to, feral cat management activities. You must be aged 18 years or older to participate in the survey.

If I agree to participate, what will I be required to do?

This is a voluntary online survey and should take around 5 minutes. We will not ask for any identifying information - you will remain completely anonymous (you do not need to give us your name and email address!). We will ask for some basic, non-identifying demographic information (e.g., age range, and state/territory of residence). The survey itself is made up of a number of short questions about feral cats and what, if any, measures you take to manage feral cats. We will ask you to answer the questions to the best of your knowledge. There are no right or wrong answers.

What are the possible risks and benefits associated with participation?

We do not perceive any risks to you as a result of your participation in this survey. As mentioned above, we will not be collecting any information that would allow you to be identified. We are using Qualtrics, a well-known and highly regarded program for online surveys. This program allows us to block the collection of your computer's IP address, thereby providing additional security of your

anonymity. However, participants should be aware that the World Wide Web is an insecure public network that gives rise to a small potential risk that transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects. There are no direct benefits to you as a result of your participation in this survey. However, the results of this survey may contribute to improved feral cat management practices in Australia, which may benefit some participants.

What will happen to the information I provide?

Responses to the survey questions will be collated and stored in a spread sheet as group data, before being analysed. Results will be presented in a research report and may also be published in academic journals and presented at academic conferences. Only summary information will be provided in any resulting communications – you will not be identified or identifiable. Once we have completed our data collection and analysis, data will be stored securely on the RMIT server for five (5) years before being destroyed. Because of the nature of data collection, we are not obtaining written informed consent from you. Your consent to participate in this research is implied by the completion and submission of the survey. Following your participation, you may contact Richard (richard.faulkner@rmit.edu.au) or Georgia (georgia.garrard@rmit.edu.au) to obtain a summary of the results (expected to be available in late 2016).

What are my rights as a participant?

Participation in this survey is voluntary. As a participant, you have the right to: withdraw from participation at any time; have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and provided that so doing does not increase the risk for the participant; have any questions answered at any time.

Whom should I contact if I have any questions?

If you have any questions about your participation, please contact Richard Faulkner on (03) 9925 9095 or richard.faulkner@rmit.edu.au.

Investigators:

Associate Professor Sarah Bekessy, School of Global, Urban and Social Studies RMIT University (03) 9925 1858 sarah.bekessy@rmit.edu.au

Dr Georgia Garrard, School of Global, Urban and Social Studies RMIT University (03) 9925 9986 georgia.garrard@rmit.edu.au

Mr Richard Faulkner, School of Global, Urban and Social Studies RMIT University (03) 9925 9095 richard.faulkner@rmit.edu.au

If you have any concerns about your participation in this project, which you do not wish to discuss with the researchers, then you can contact the Ethics Officer, Research Integrity, Governance and Systems, RMIT University, GPO Box 2476 VIC 3001. Tel: (03) 9925 2251 or email: human.ethics@rmit.edu.au

Eligibility and Agreement to Participate.

- ❍ I am 18 years of age and agree to participate in this survey (1)

Q1 What is your age group?

- ❍ 18-35 years (1)
- ❍ 36-45 years (2)
- ❍ 46-55 years (3)
- ❍ 55+ years (4)

Q2 How would you best describe yourself? (select all that apply)

- ❑ Farmer (1)
- ❑ Hunter (2)
- ❑ Sporting Shooter (3)
- ❑ Land Manager (4)
- ❑ Consultant / Contractor (5)
- ❑ Ecologist / Conservationist (6)
- ❑ Volunteer with a conservation group (7)
- ❑ Traditional Owner (8)
- ❑ Other (please describe) (9) _____

Q3 What is your residential postcode?

For the purposes of this survey, feral cats are defined as “cats that live in the wild and can survive without human reliance or contact”.

Q4 Do you remove feral cats from the environment? (by 'remove' we mean kill on site or catch and take to another location for euthanasia by you or somebody else).

- ❍ Yes, I actively go out to remove feral cats. (1)
- ❍ Yes, if I see one I’ll try to remove it. (2)
- ❍ Yes, I sometimes remove feral cats as a by-product of other activities (4)
- ❍ No (3)

If No Is Selected, Then Skip To To what extent do you agree with the ...

Q5 Do you record your efforts and provide them to an organisation or regional database? (eg. upload to www.feralscan.org.au, or with local council / NRM / CMA etc.)

- ❍ Yes, my efforts are recorded with (please specify) (1) _____
- ❍ No, my efforts are not recorded (9)

Q6 How do you remove feral cats from the environment? (select all that apply)

- ❑ Shoot (1)
- ❑ Trap and then shoot on site (2)
- ❑ Trap then take to a facility for euthanasia (3)
- ❑ Bait (4)
- ❑ Other humane method (please describe) (5) _____

Q7 How many years have you been removing feral cats for?

- ❍ 1 year or less (1)
- ❍ For the last two years (2)
- ❍ For the last 2 - 5 years (3)
- ❍ For the last 5 - 10 years (4)
- ❍ For the last 10 - 20 years (5)
- ❍ For more than 20 years (6)

Q8 How many cats have you removed in the last 12 months?

- ❍ 1 - 5 (1)
- ❍ 5 - 10 (2)
- ❍ 10 - 20 (3)
- ❍ 20 - 30 (4)
- ❍ 30 - 40 (5)
- ❍ 40 - 50 (6)
- ❍ 50 - 75 (7)
- ❍ 75 - 100 (8)
- ❍ 100 - 200 (9)
- ❍ > 200 (10)
- ❍ I know exactly how many (please provide number) (11) _____

Q9 What area would you cover in your feral cat removal?

- ❍ Less than 10 Ha (1)
- ❍ 10 - 50 Ha (2)
- ❍ 50 - 100 Ha (3)
- ❍ 100 - 1000 Ha (4)
- ❍ 1000 - 10 000 Ha (5)
- ❍ 10 000 - 50 000 Ha (6)
- ❍ 50 000 - 100 000 Ha (7)
- ❍ > 100 000 Ha (8)

Q10 How much time (per month) would you spend removing feral cats?

- ❍ 0 - 3 Hrs (1)
- ❍ 3 - 5 Hrs (2)
- ❍ 5 - 10 Hrs (3)
- ❍ 10 - 20 Hrs (4)
- ❍ 20 - 40 Hrs (5)
- ❍ 40 - 60 Hrs (6)
- ❍ 60 - 80 Hrs (7)
- ❍ > 80 Hrs (8)

Q11 Why do you remove feral cats? (select all that apply)

- ❑ They are a pest (1)
- ❑ They adversely affect my livelihood (2)
- ❑ I am concerned about wildlife and this is how I can help (3)
- ❑ It is a part of my work duties (4)
- ❑ It is a part of a conservation program that removes cats (5)
- ❑ It's just something I've always done (6)
- ❑ Other (please describe) (7) _____

Q12 What changes have you observed as a result of removing feral cat? (select all that apply)

- ❑ There are less feral cats (1)
- ❑ There is an increase in native wildlife (2)
- ❑ I see less dead wildlife (birds, lizards etc.) (3)
- ❑ There are more mice and/or rabbits (4)
- ❑ Fox numbers have increased (5)
- ❑ I haven't observed any changes (6)
- ❑ Other (please describe) (7) _____

Q13 Since you began removing cats, have your efforts always been about the same, or have you increased or decreased your efforts over time?

- ❍ About the same (1)
- ❍ I have increased efforts (2)
- ❍ My efforts have decreased (3)
- ❍ I don't know (4)

Q14 To what extent do you agree with the following statements.

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Feral cats are bad for wildlife and cause a decline in native species. (1)	❍	❍	❍	❍	❍
Feral cats are a threat to livestock. (2)	❍	❍	❍	❍	❍
Feral cats can be dangerous and spread diseases to humans. (3)	❍	❍	❍	❍	❍
Feral cats harass and injure domestic cats. (4)	❍	❍	❍	❍	❍
As a predator, feral cats play an important role in food chains. (5)	❍	❍	❍	❍	❍
Feral cats keep numbers of mice and rabbits down. (6)	❍	❍	❍	❍	❍
Feral cats have a right to exist wherever they are and whatever impact they have. (7)	❍	❍	❍	❍	❍

Q15 To what extent would the following make you more likely to increase, or begin, your effort to control feral cats.

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
If it was easier to get a permit. (1)	❍	❍	❍	❍	❍
Training on how to do it in a humane way. (2)	❍	❍	❍	❍	❍
If a reimbursement fee was available. (3)	❍	❍	❍	❍	❍
If it was easier to rent or borrow traps. (4)	❍	❍	❍	❍	❍
If it was easier to access baits. (5)	❍	❍	❍	❍	❍
If laws to enforce feral cat control were introduced. (6)	❍	❍	❍	❍	❍
If there was more information on the positives of feral cat control. (7)	❍	❍	❍	❍	❍
If there was information available on the various methods to control feral cats. (8)	❍	❍	❍	❍	❍
If there was more information about how my efforts help protect wildlife. (9)	❍	❍	❍	❍	❍
If there was an increase in the public acceptance of feral cat removal. (10)	❍	❍	❍	❍	❍

Nothing would encourage me to increase, or begin, my effort to control feral cats. (11)	❍	❍	❍	❍	❍

Q16 Do you know Australia has a Threatened Species Commissioner, and Threatened Species Strategy, with a focus on reducing the number of feral cats in Australia?

- ❍ Yes (1)
- ❍ No (2)

Q17 Do you follow the Commissioner on social media? (select all that apply)

- ❑ Yes - I follow him on twitter (www.twitter.com.au/tscommissioner) (1)
- ❑ Yes - I follow him on facebook (www.facebook.com.au/tscommisisoner) (2)
- ❑ Yes - I watch his YouTube videos (3)
- ❑ No - I dont follow him on social media. (4)

Q18 Is this the first time you have participated in this survey?

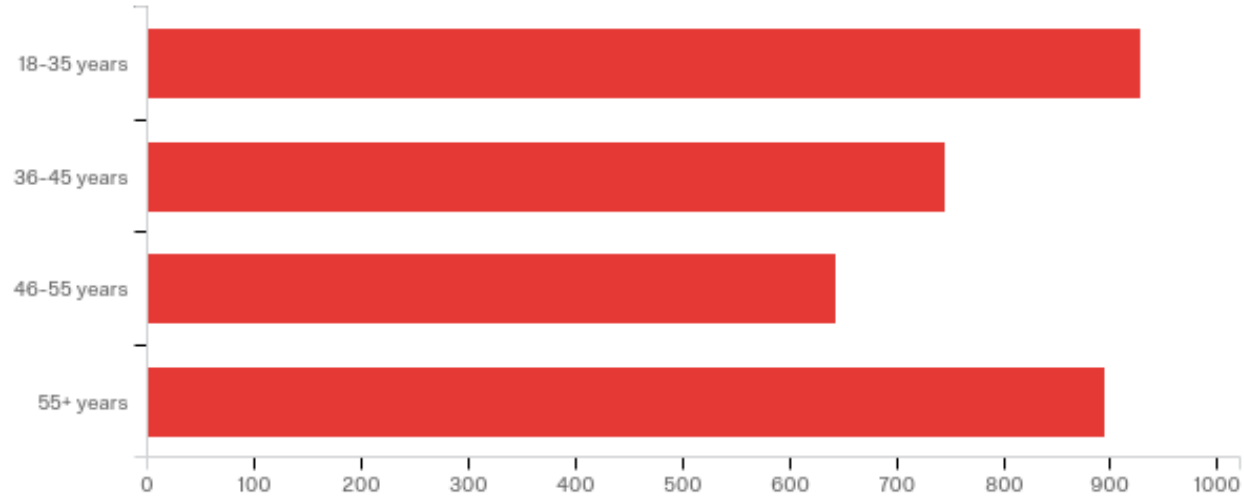
- ❍ Yes (1)
- ❍ No (2)

Q19 Do you have any other comments or suggestions that you believe would be helpful in further managing feral cats?

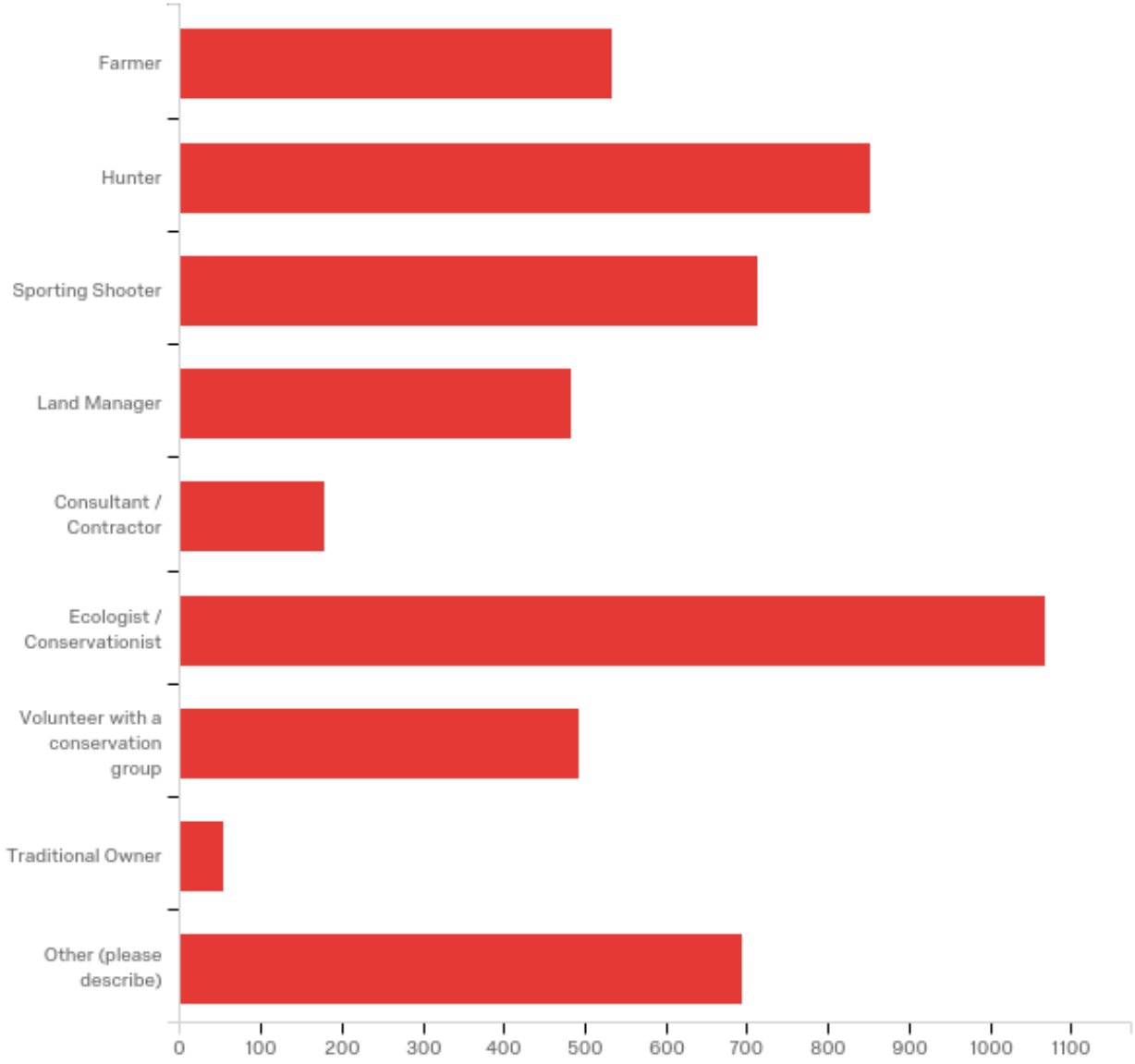
Appendix 3. Responses to strategic online survey

October 26th 2016, 11:46 pm MDT

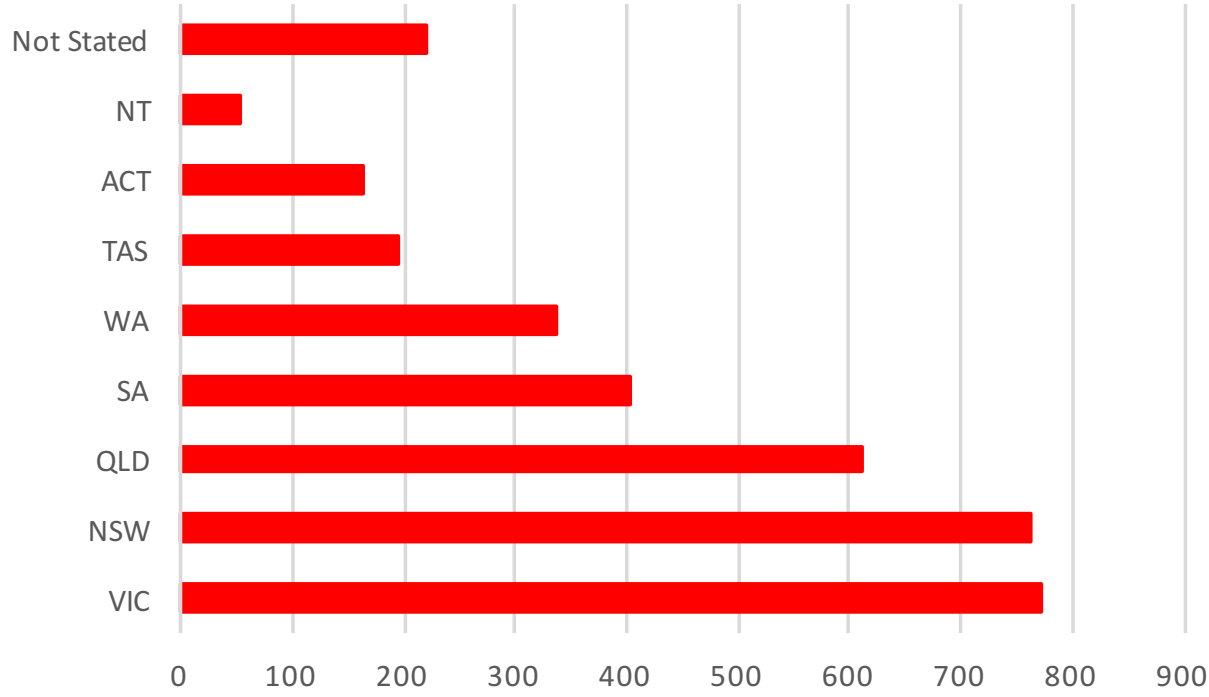
Q1 - What is your age group?



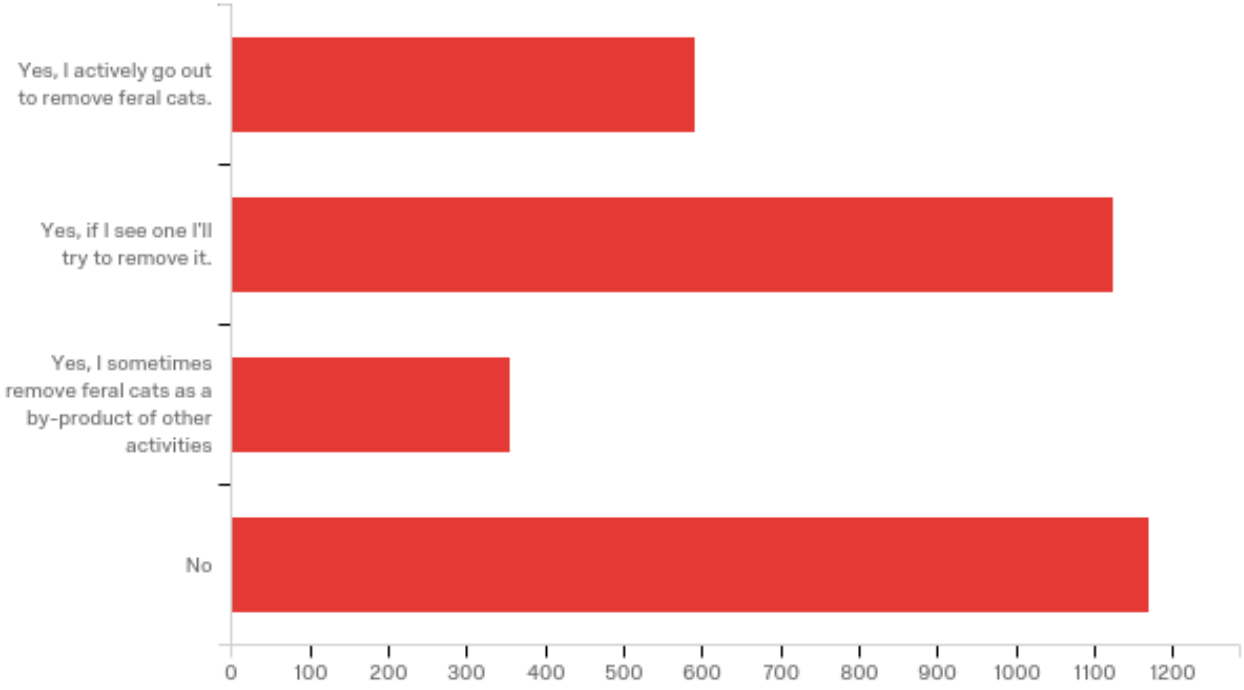
Q2 - How would you best describe yourself? (select all that apply)



Q3 – What is your residential postcode? (Agglomerated by State)



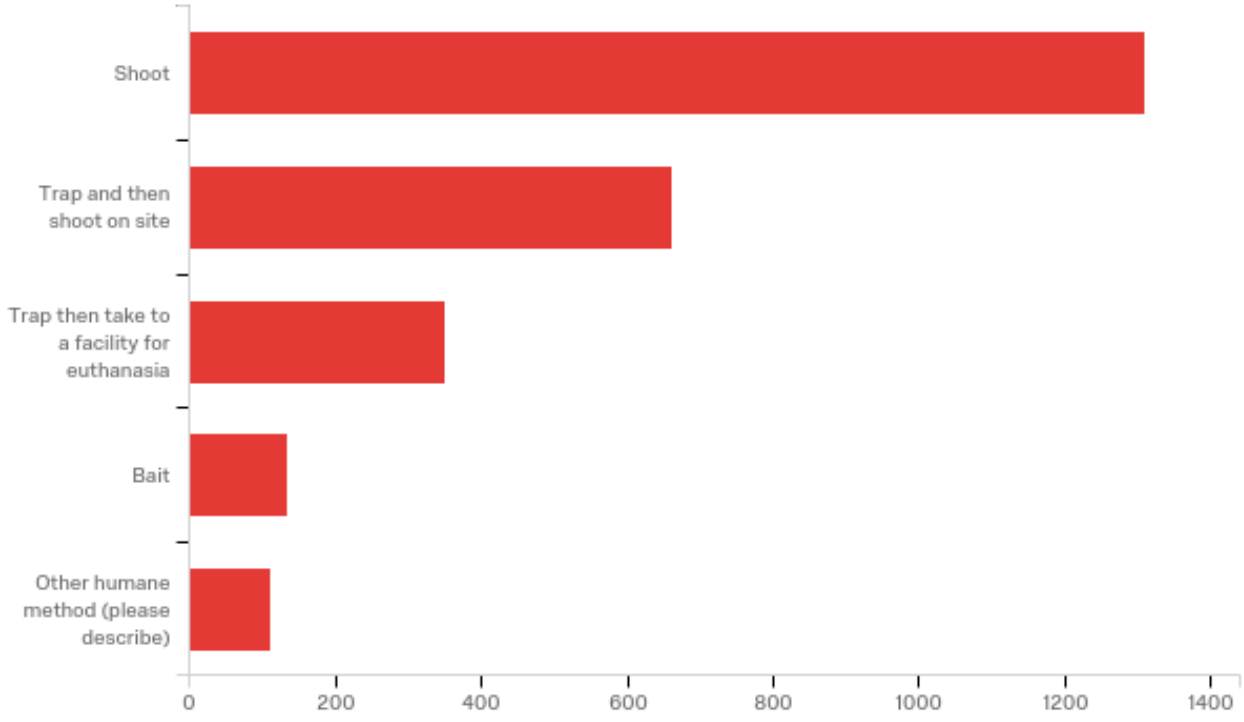
Q4 - Do you remove feral cats from the environment? (by 'remove' we mean kill on site or catch and take to another location for euthanasia by you or somebody else).



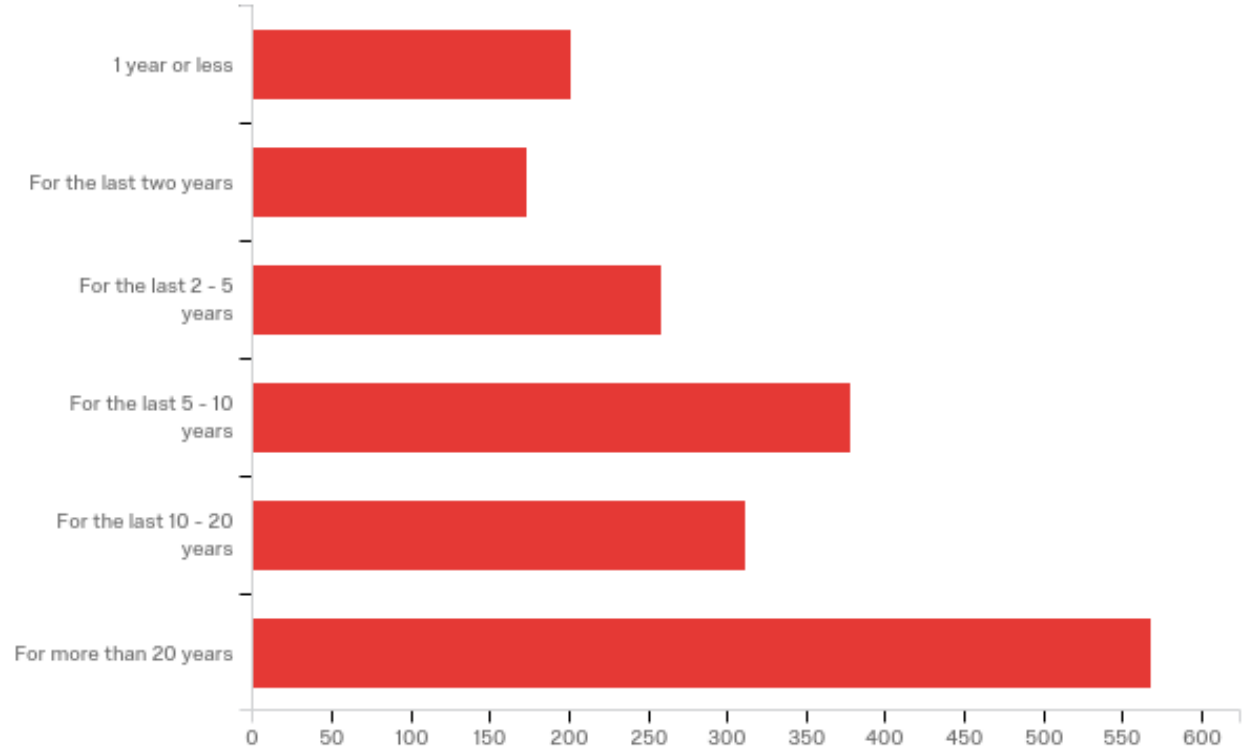
Q5 - Do you record your efforts and provide them to an organisation or regional database? (eg. upload to www.feralscan.org.au, or with local council / NRM / CMA etc.)

#	Answer	%	Count
1	Yes, my efforts are recorded with (please specify)	14.27%	292
9	No, my efforts are not recorded	85.73%	1754
	Total	100%	2046

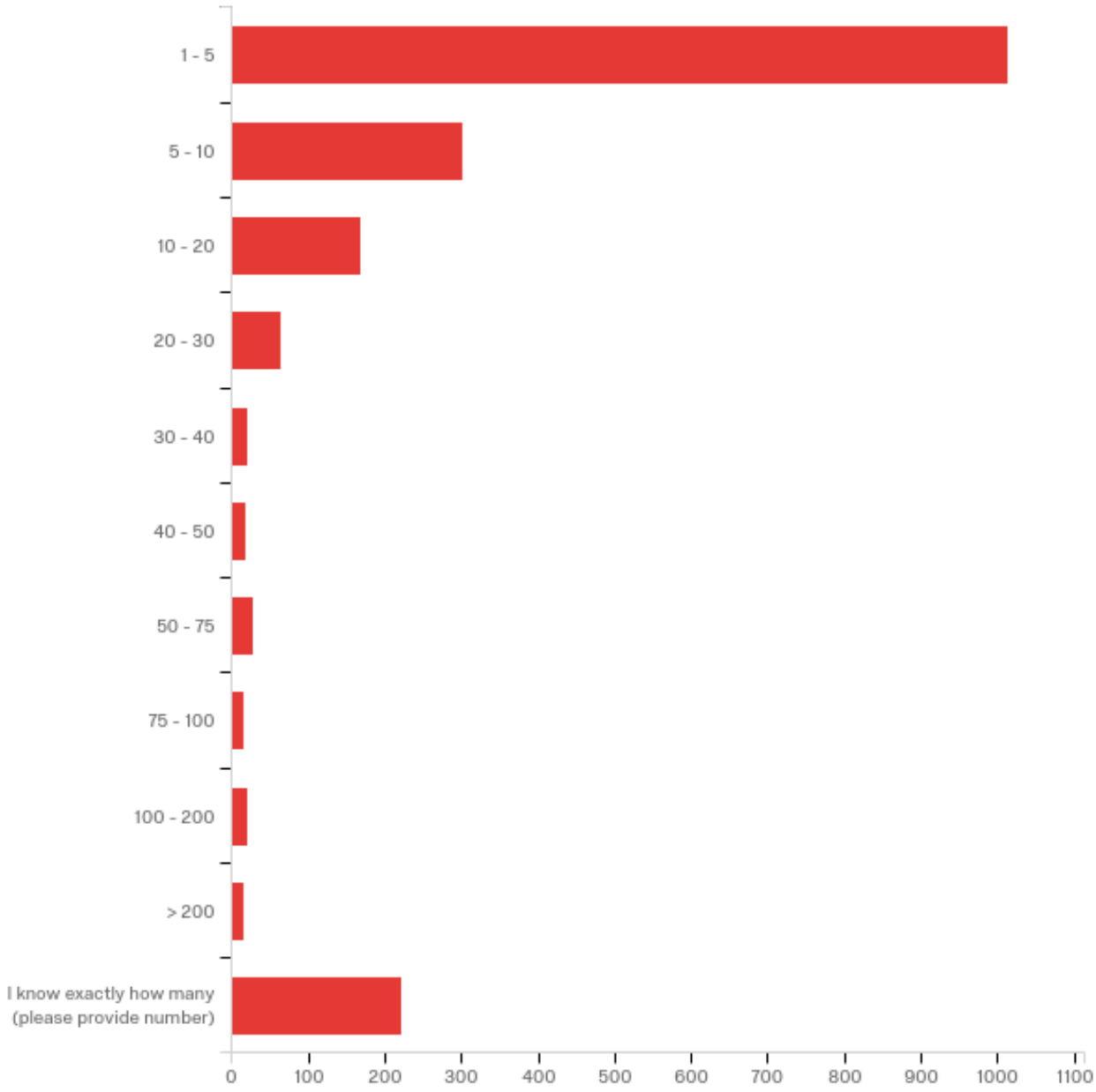
Q6 - How do you remove feral cats from the environment? (select all that apply)



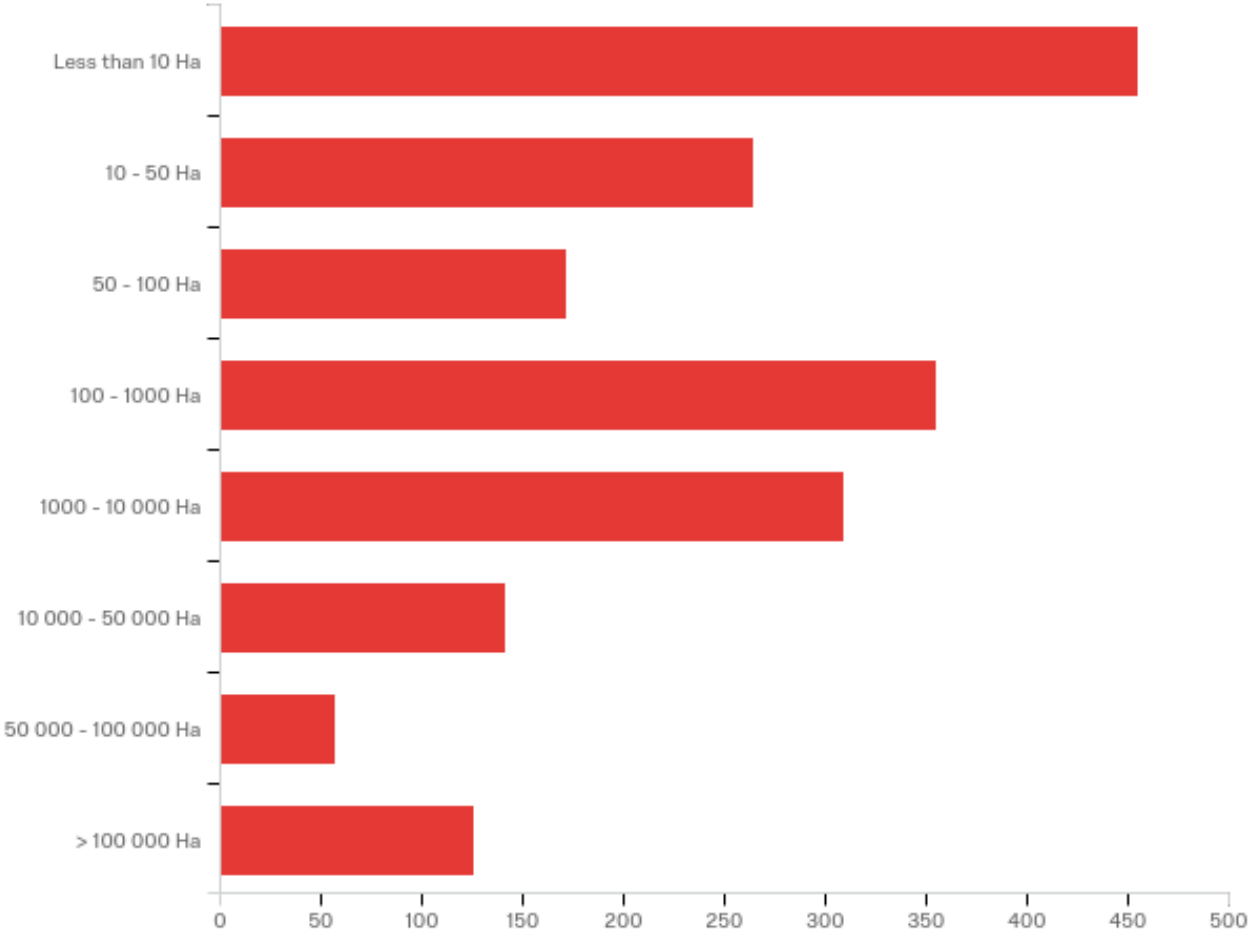
Q7 - How many years have you been removing feral cats for?



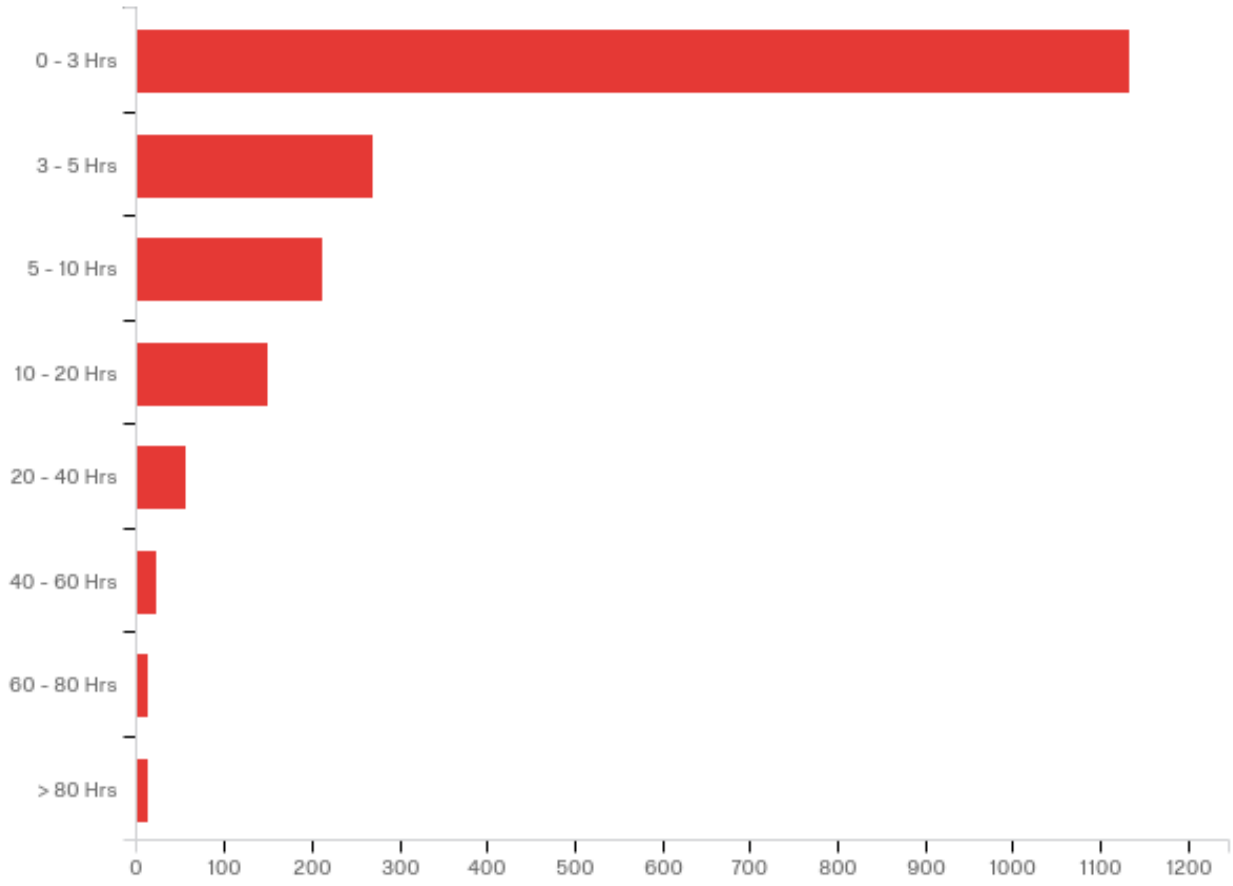
Q8 - How many cats have you removed in the last 12 months?



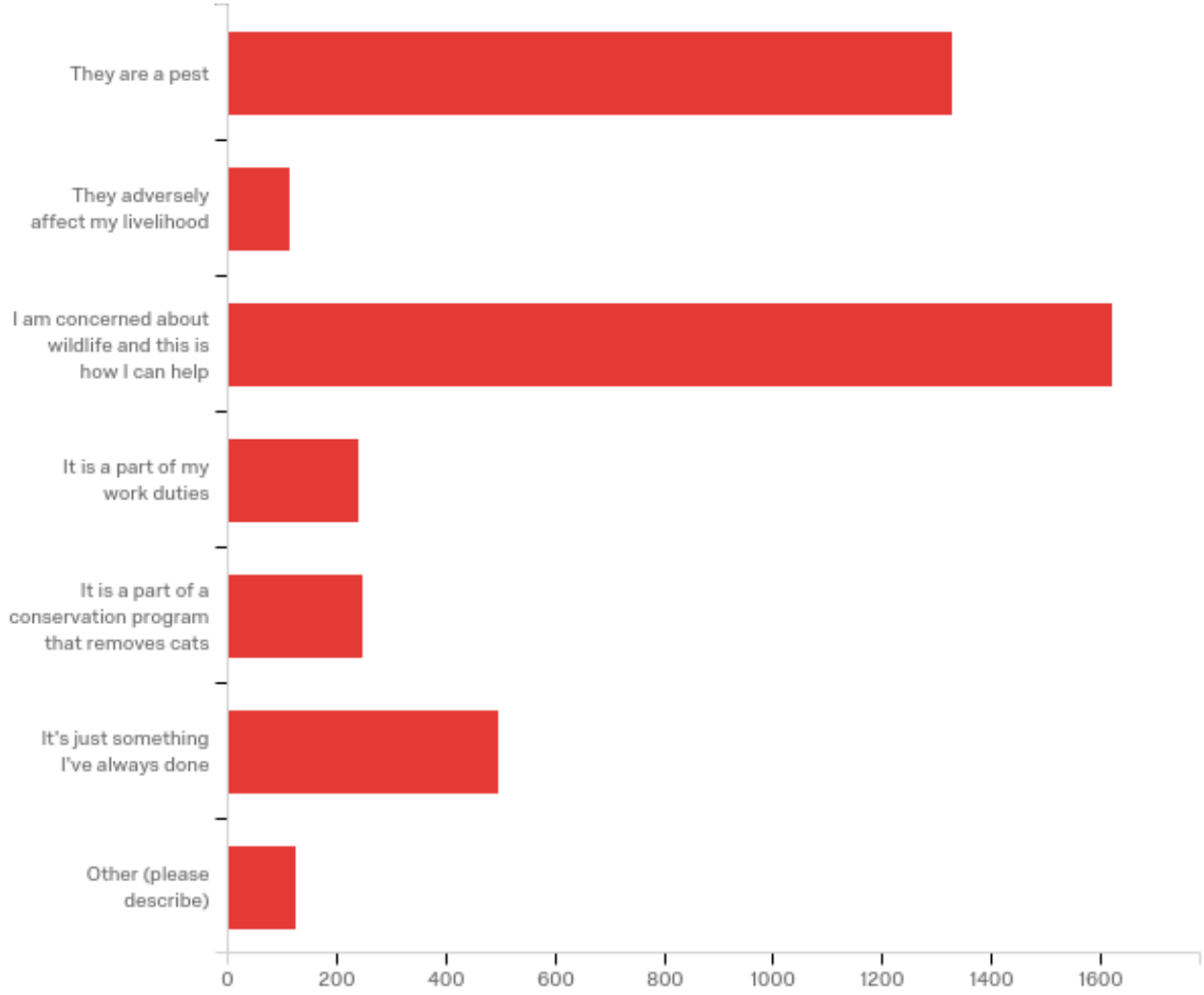
Q9 - What area would you cover in your feral cat removal?



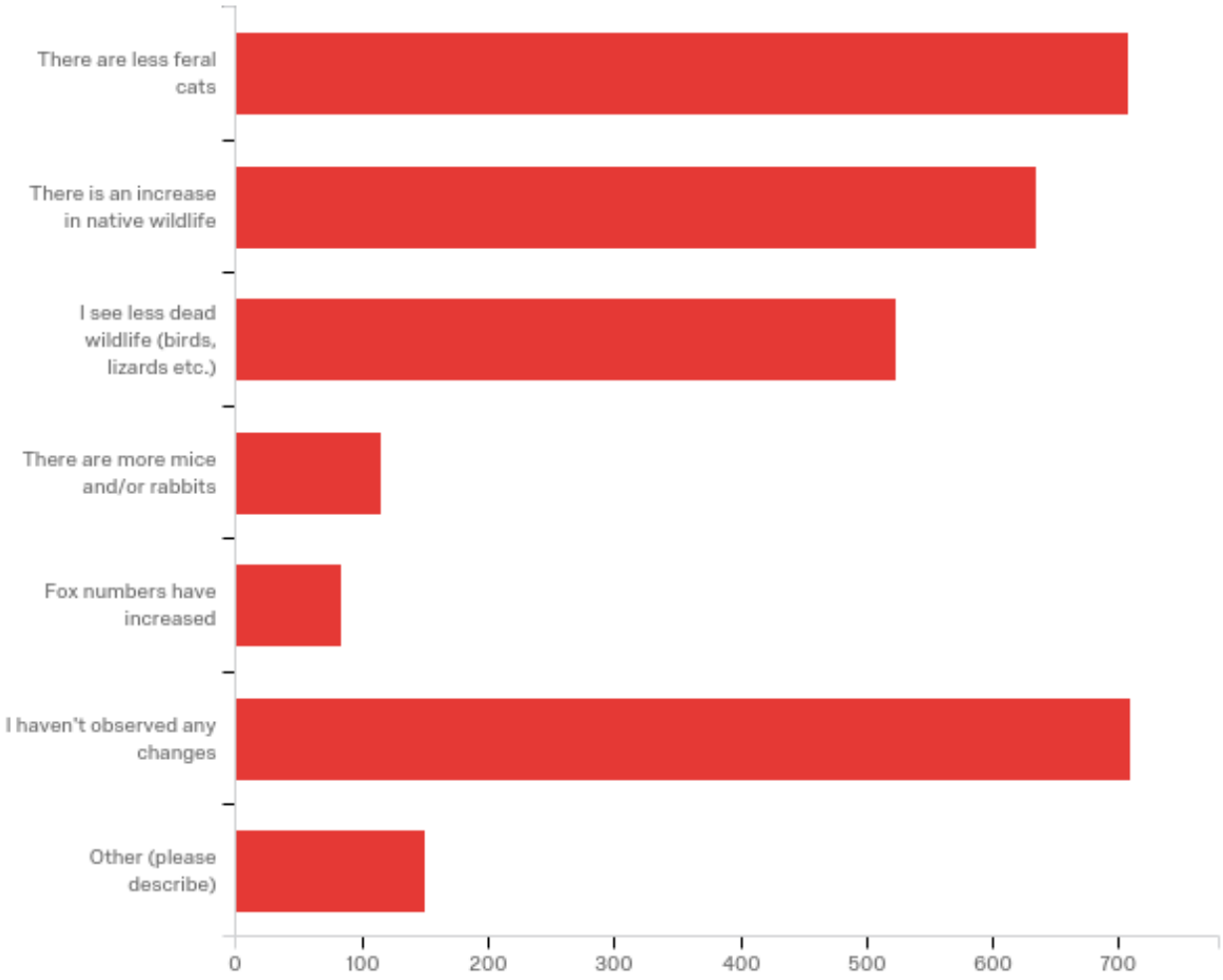
Q10 - How much time (per month) would you spend removing feral cats?



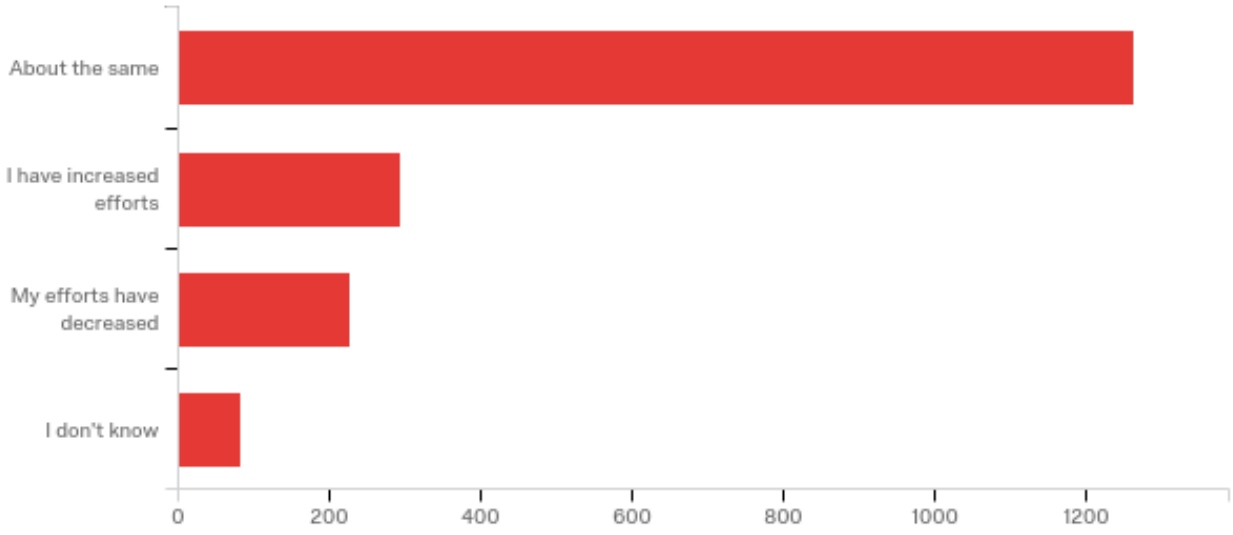
Q11 - Why do you remove feral cats? (select all that apply)



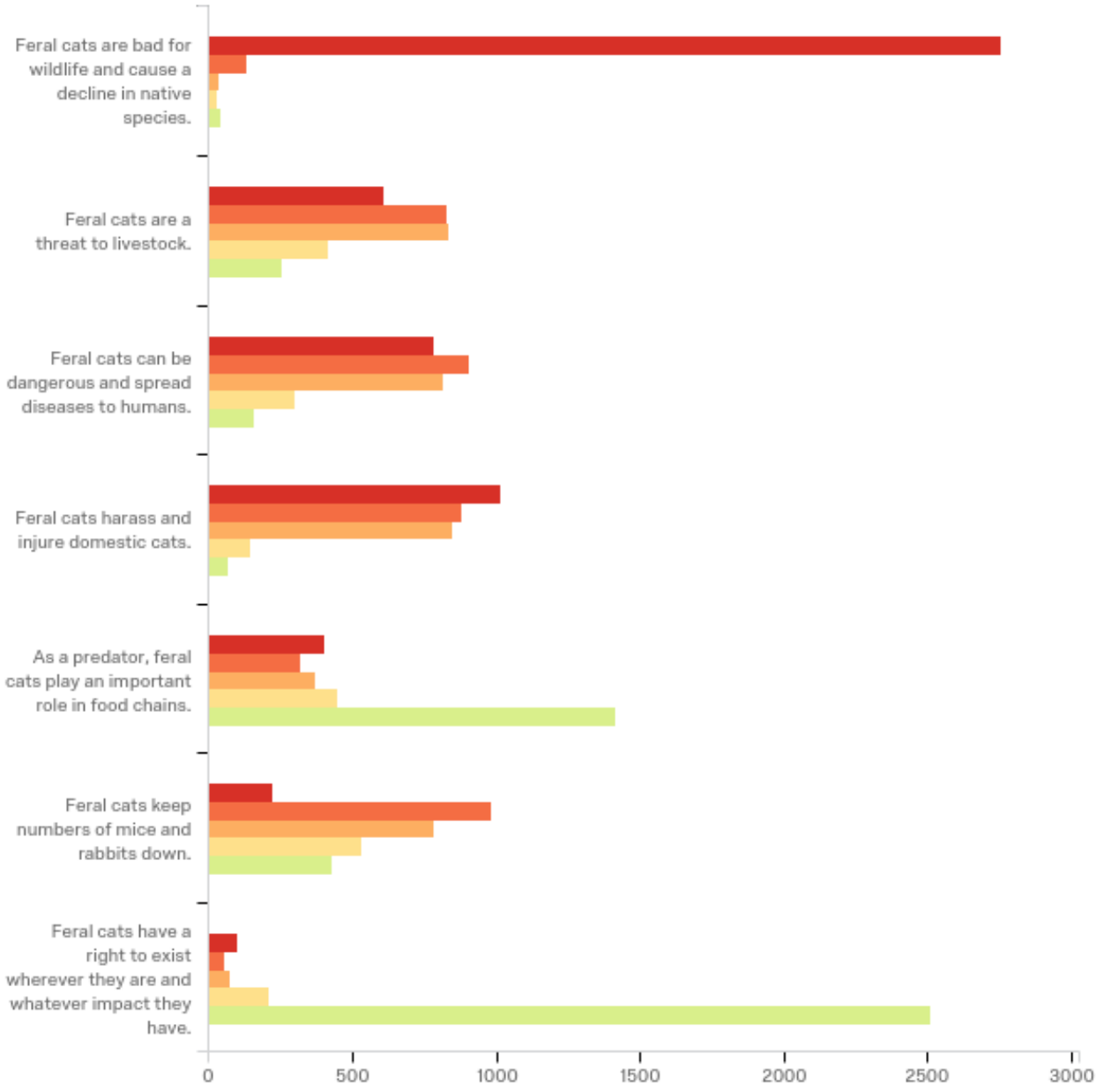
Q12 - What changes have you observed as a result of removing feral cat? (select all that apply)



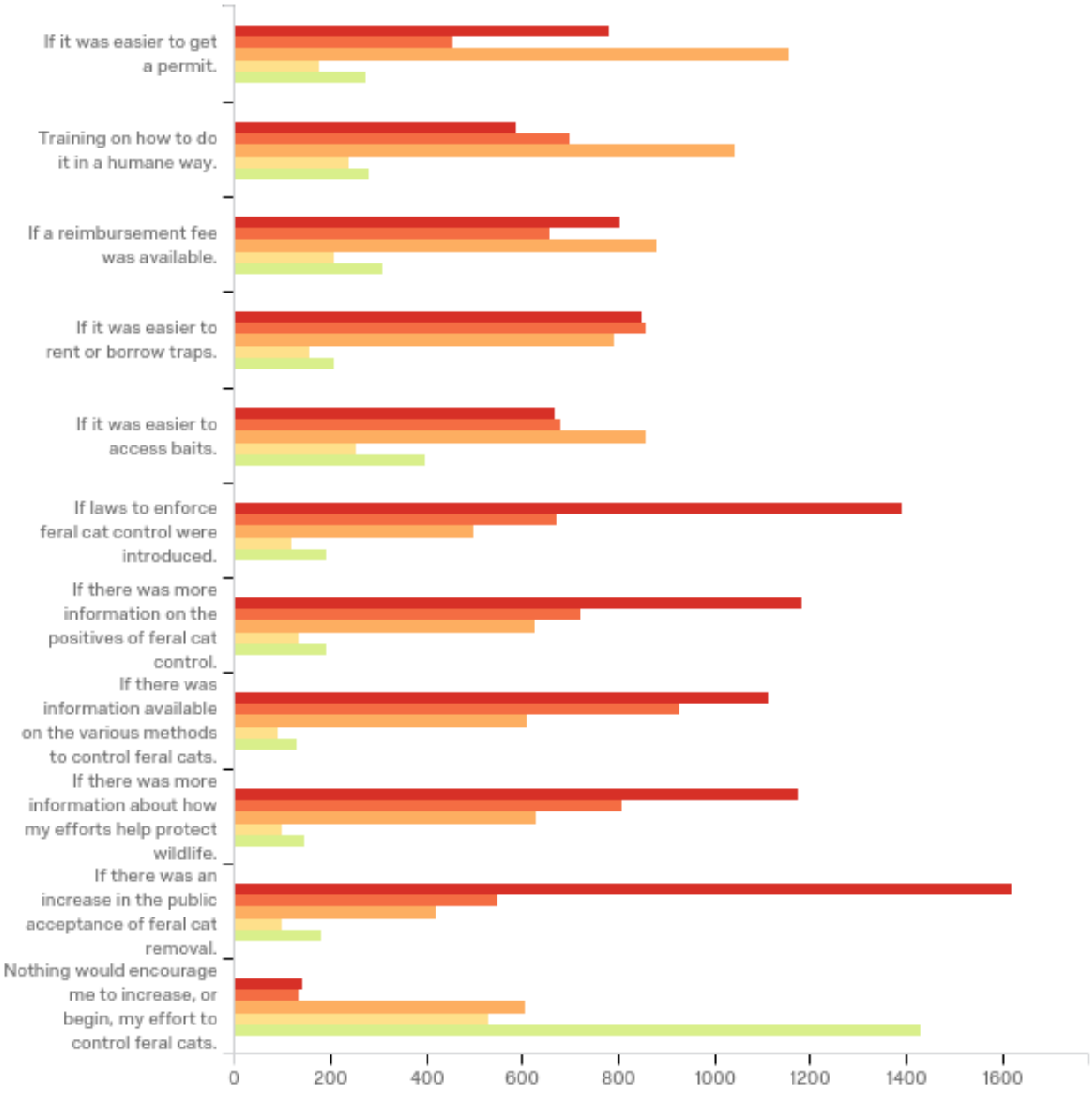
Q13 - Since you began removing cats, have your efforts always been about the same, or have you increased or decreased your efforts over time?



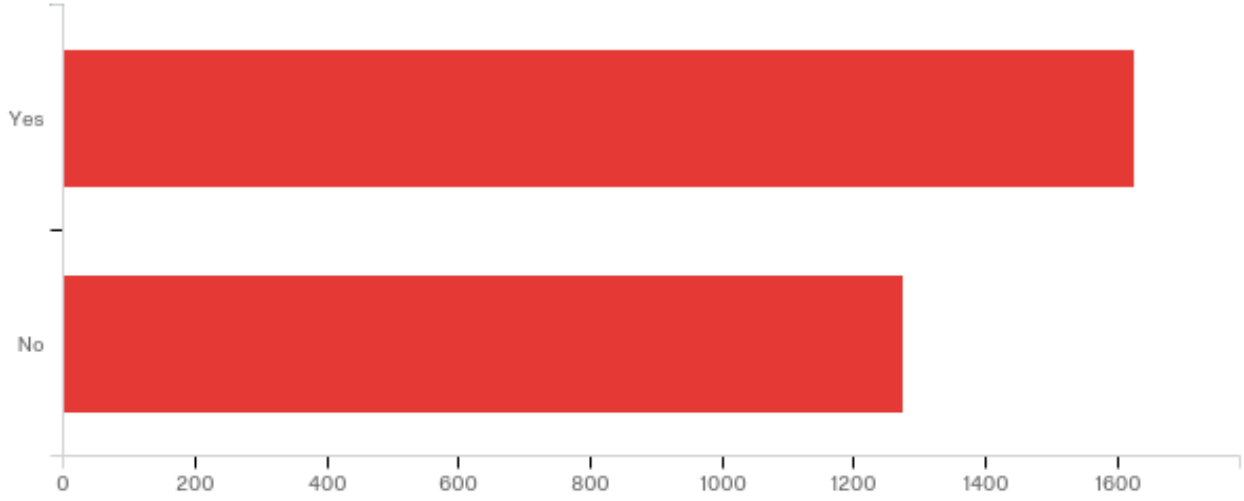
Q14 - To what extent do you agree with the following statements.



Q15 - To what extent would the following make you more likely to increase, or begin, your effort to control feral cats.



Q16 - Do you know Australia has a Threatened Species Commissioner, and Threatened Species Strategy, with a focus on reducing the number of feral cats in Australia?



Q17- Do you follow the Commissioner on social media? (select all that apply)