Australia's National
Science Agency

Public perspectives towards using gene drive for invasive species management in Australia

Invasive animal species in Australia

Many pest animal species live and reproduce in high numbers across Australia. This includes animal species, such as cane toads, feral cats, foxes, rodents, wild pigs, wild rabbits. These species significantly damage Australia's agricultural industries, natural landscapes, and biodiversity. For example, feral cats kill an estimated 1.8 billion Australian animals every year.

Feral animals can also carry livestock diseases and cause significant damage to land and native vegetation. This results in agricultural production losses of more than $800 million per year. Sites of cultural significance to Indigenous peoples are also at risk to pest incursions.

Adding further complexity, current methods of pest control being used to manage local landscape, such as baiting, trapping and shooting, are labour-intensive and expensive. They also have animal welfare implications and are considered ineffective at scale.

Genetic technologies that are developed using synthetic biology have the potential to reduce or in some cases eliminate populations of invasive pests in parts of Australia. But there are multiple social, cultural and institutional considerations to understand before genetic technologies could feasibly be integrated with current pest management practices.

Synthetic biology

We're conducting a series of surveys to better understand what the public thinks about a field of biotechnology called *synthetic biology*.

Synthetic biology (synbio) is a rapidly emerging area of science. It has the potential to deliver sustainable, targeted and cutting-edge solutions to many global challenges. Synbio involves using advanced genetic technologies to design, build and test targeted changes in an organism's genetic information (DNA) through its ability to read and write DNA.

CSIRO, through its program of research called the Synthetic Biology Future Science Platform (FSP) is playing a key role in advancing Australia's progress in one of the fastest growing areas of modern science. The research will help us to understand and contribute to, where appropriate, global developments in areas including manufacturing, industrial biotechnology, environmental remediation, biosecurity, agriculture and healthcare research.

The findings of this study, which has been supported by the Synthetic Biology FSP, will be used to inform scientists, policy-makers and the wider community about societal views on the development and application of possible new synbio applications in Australia.

What is this report about?

The purpose of this research was to understand public attitudes towards the use of novel **gene drive technology** for the management of invasive species in Australia. In this study, we used feral cats in Australia as our example species and conducted a survey with two samples of Australian residents. The first sample included residents living in parts of South Australia where feral cats are a known pest species. This enabled those experiencing feral animal problems in their region to provide place-based feedback on a proposed genetic tool to help solve the problem. The second sample included participants from the broader Australian public, to ensure our results captured a diversity of perspectives.

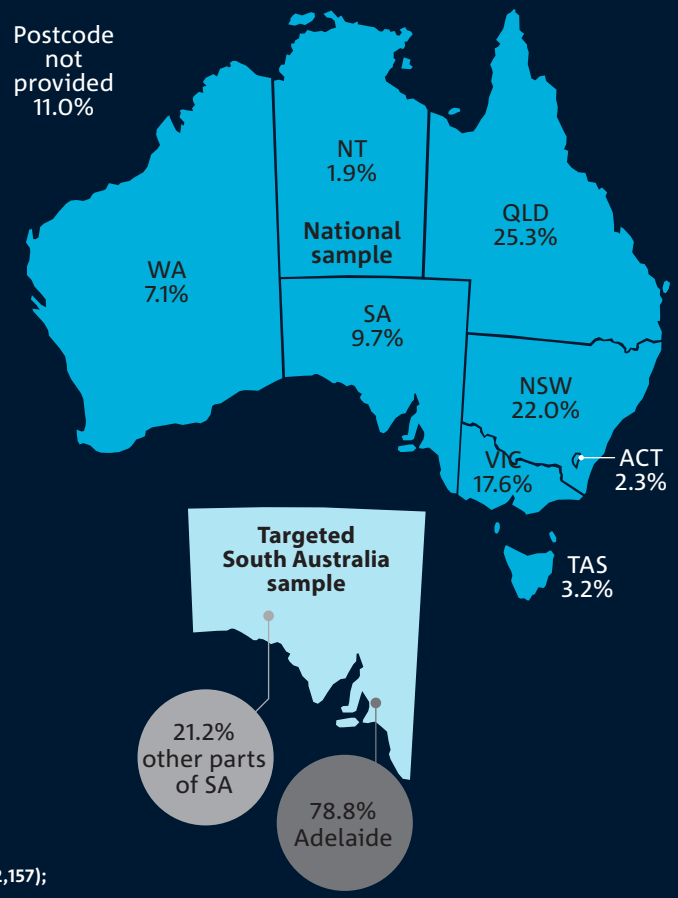


Figure 1. National sample via social media, broken down by State (N=2,157); and targeted representative sample in South Australia only (N=1,666).

Do Australians think pest species are a problem?

This research began by asking participants the extent to which they believed pest species in Australia posed a threat to Australia's biodiversity and agricultural industries. Most respondents believed feral animals such as cats, rabbits, foxes and pigs were a high to extreme threat to Australia's natural biodiversity, and a moderate-high threat to Australia's agricultural industries.

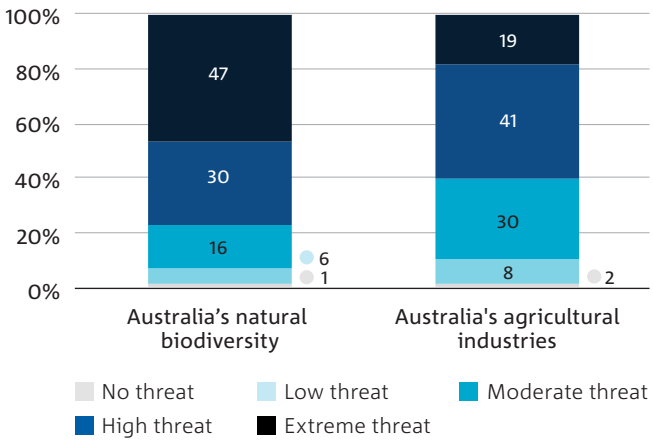


Figure 2. Public views on the level of threat that feral animals (e.g., cats, rabbits, foxes, pigs) pose to Australia's natural biodiversity and Australia's agriculture industries, as a percentage (%) of total responses.

Understanding gene drive: a novel synbio solution for pest management

A gene drive is the mechanism by which a specific genetic trait can be spread through a pest population's DNA, so that all future generations are more likely to inherit that particular trait. Therefore gene drive can also be called 'biased inheritance'. Importantly, each gene drive is species-specific and cannot spread to other non-target species.

An example of a biased trait could be to increase the likelihood of a species' offspring being a single sex (e.g., males). Over time, as only male offspring are born, the population can no longer effectively reproduce. The pest population is subsequently reduced over multiple generations. In this way, gene drives may offer more targeted, humane and effective pest control than traditional methods.

Gene drive technology could significantly reduce pest populations throughout Australia by limiting the species' opportunities to breed. The technology could thus help protect agricultural industries, natural ecosystems, and native species in the process, by reducing populations of pest animals.

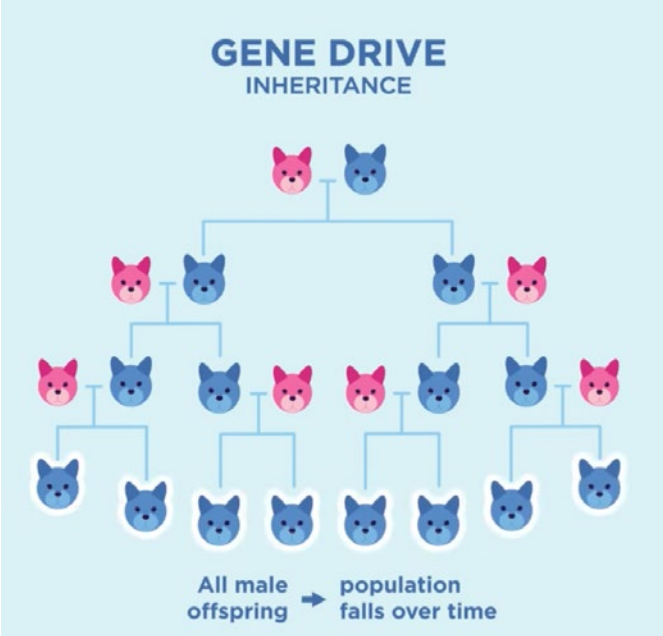


Figure 3. Gene drive inheritance, showing how the likelihood of a single sex offspring increases over time.

What do Australians know about synthetic biology and do they support its use?

Prior to presenting information about using gene drive for managing pest animals, we asked participants what they knew about synthetic biology in general terms, and whether they would support its use in certain applications.

Our combined survey sample of 3,823 Australians showed that:

- Public knowledge of synthetic biology (including genetic technologies) was generally low, with most people having 'a little knowledge' or 'some knowledge' of this area.
- In general, public support for using synthetic biology to solve environmental conservation and human health problems, and to improve agricultural productivity was high:
  - around 60–65% were supportive or very supportive
  - around 20% were neither opposed nor supportive
  - around 15% were opposed or very opposed.

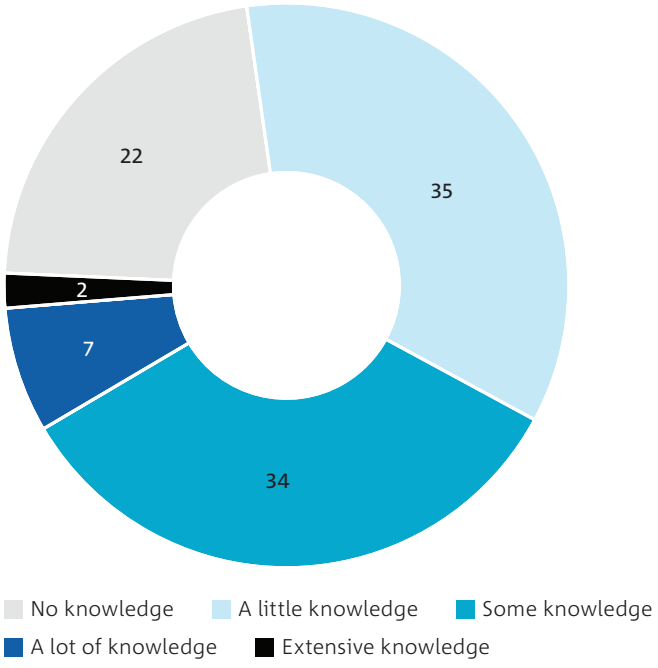


Figure 4. Self-reported public knowledge of synthetic biology, as a percentage (%) of total responses.

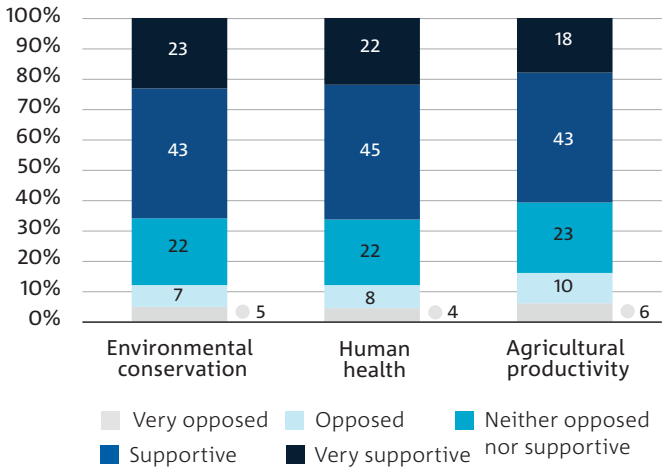


Figure 5. Support for using synthetic biology to solve problems in the areas of environmental conservation, human health and agricultural productivity, as a percentage (%) of total responses.

CASE STUDY

Gene drive for feral cat control

Gene drives video

In the next stage of the survey, participants watched an animation explaining gene drive for invasive animal control in Australia. Feral cats were used as an example gene drive target.

Case study facts: Feral cats (*Felis catus*)

- The species is considered one of the most threatening invasive alien species worldwide.
- Feral cats occupy over 90% of the Australian continent and are recognised by the Department of Agriculture, Water and the Environment and the Invasive Species Council as an extreme threat for Australia.
- In Australia, cats kill approximately 3.2 million mammals, 1.2 million birds, 1.9 million reptiles and 250,000 frogs *per day*, and a majority are native species. Source: Threatened Species Recovery Hub, 2020 <https://www.nespthreatenedspecies.edu.au/media/eeufmpqx/112-the-impact-of-cats-in-australia-findings-factsheetweb.pdf>.
- Feral cats can breed from approximately one year of age.
- They have a short gestation period (65 days) resulting in up to three litters of 2–7 kittens each year.
- Domestic and feral cats are the same species, differing only in terms of their level of domesticity.
- Feral cats have contributed to the extinction of at least 21 mammals, two reptiles and 40 bird species; they continue to threaten at least 360 mammal, reptile and bird species worldwide.
- Current strategies available for feral cat management are failing to negate the catastrophic impact this pest causes on native wildlife. Genetic technologies to aid in the management of feral cats have not yet been proven.

To explore the effects of different types of information on participant responses to the technology, we experimented with four different endings (*information conditions*) to the animation – regulation, biodiversity, economic and control conditions.

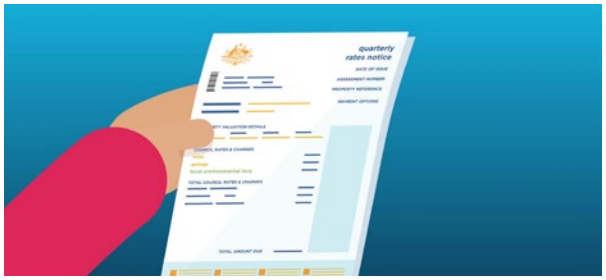
Participants were randomly assigned to view one of the four possible animations. The breakdown of participants across the four conditions was:

- Control condition 25.01%
- Regulation 25.32%
- Biodiversity 24.20%
- Economic information 25.48%

Different animation endings

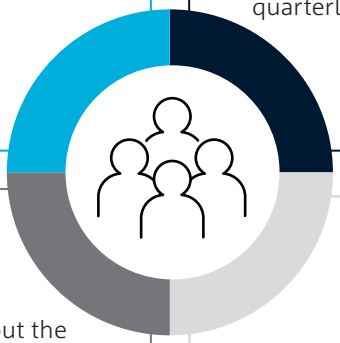
Regulation

Explained to participants the likely regulatory path for this technology (e.g. assessment by the Office of the Gene Technology Regulator) from development to release (e.g. from tightly controlled settings to possible wider releases).



Economic

Provided general information about a long-term funding option for the release of gene drive animals for pest management. For example, households may have a regular environmental levy added to their quarterly council rates notice, or pay increased fees at parks and campgrounds to help fund technology implementation and monitoring in those areas.

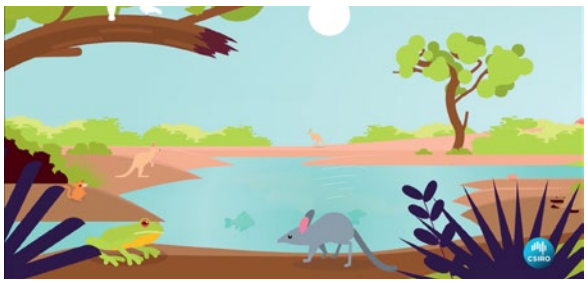


Biodiversity

Presented participants with a trajectory of likely biodiversity outcomes with and without the use of gene drive technology. This ending explained that gene drive animals could provide a new way to control feral animals at a larger scale and, without new approaches, biodiversity levels may continue to decline, putting some native species at risk.

Control

Did not convey any additional regulation, biodiversity or economic information to participants. The ending simply stated that gene drive animals could significantly reduce pest populations throughout Australia, protecting agricultural industries, native species, and natural ecosystems. This final conclusion was presented in all conditions.



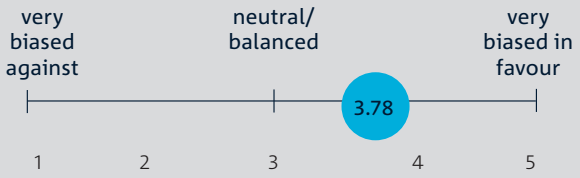
Understanding of gene drive information

Most participants understood the information presented in the animation and answered four true-false questions designed to demonstrate their understanding of the content (average comprehension score of 3.75 out of 4).

In terms of self-rated understanding of the information, most participants (over 90%) felt that they understood what gene drive technology was about, and why it might be needed. Almost 80% felt they understood the potential risks moderately to very well.

Perceived bias of gene drive information

On average, participants believed the technology animation was slightly biased in favour of gene drive technology for pest control.



Stated support for development of gene drive technology

Participants were asked to indicate their level of support for the development of gene drive technology for pest control in Australia, as described by the animation. 66% of respondents were supportive or strongly supportive. Around 10% indicated little or no support for its development.

Most participants agreed that gene drive technology would be better than current methods of feral cat control, and that current cat control methods (e.g. baiting and trapping) were more harmful to animals than a gene drive solution.

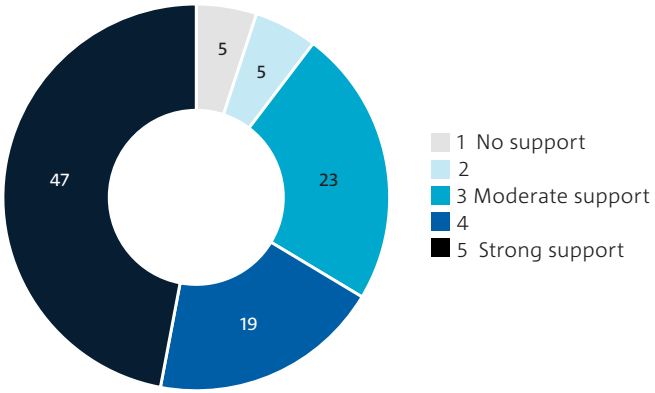


Figure 6. Level of support for the development of gene drive technology for pest control in Australia, as a percentage (%) of total responses.

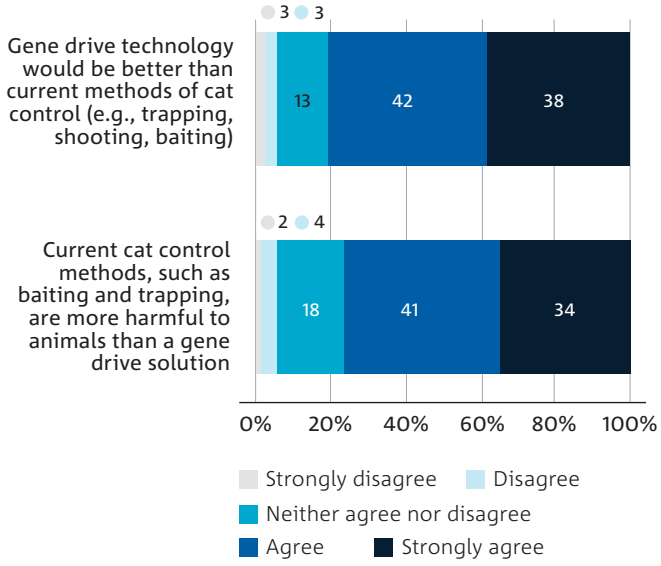


Figure 7. Perceptions of relative advantage of gene drive technology over current cat control methods, as a percentage (%) of total responses.

Attitudes toward gene drive technology

To further understand participants' views towards using gene drive technology for feral cat control, we asked people to rate their attitudes towards the technology using common adjectives and associations.

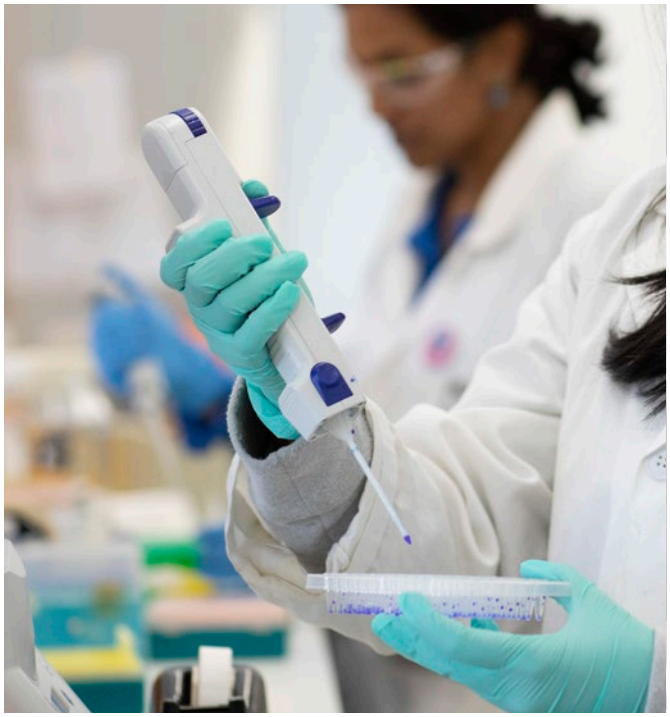
We included measures of risk-related attitudes, such as whether people rated the technology as risky or safe, harmful or beneficial, and other related attitudes.

The results showed that participants largely believed that gene drive for pest control was:

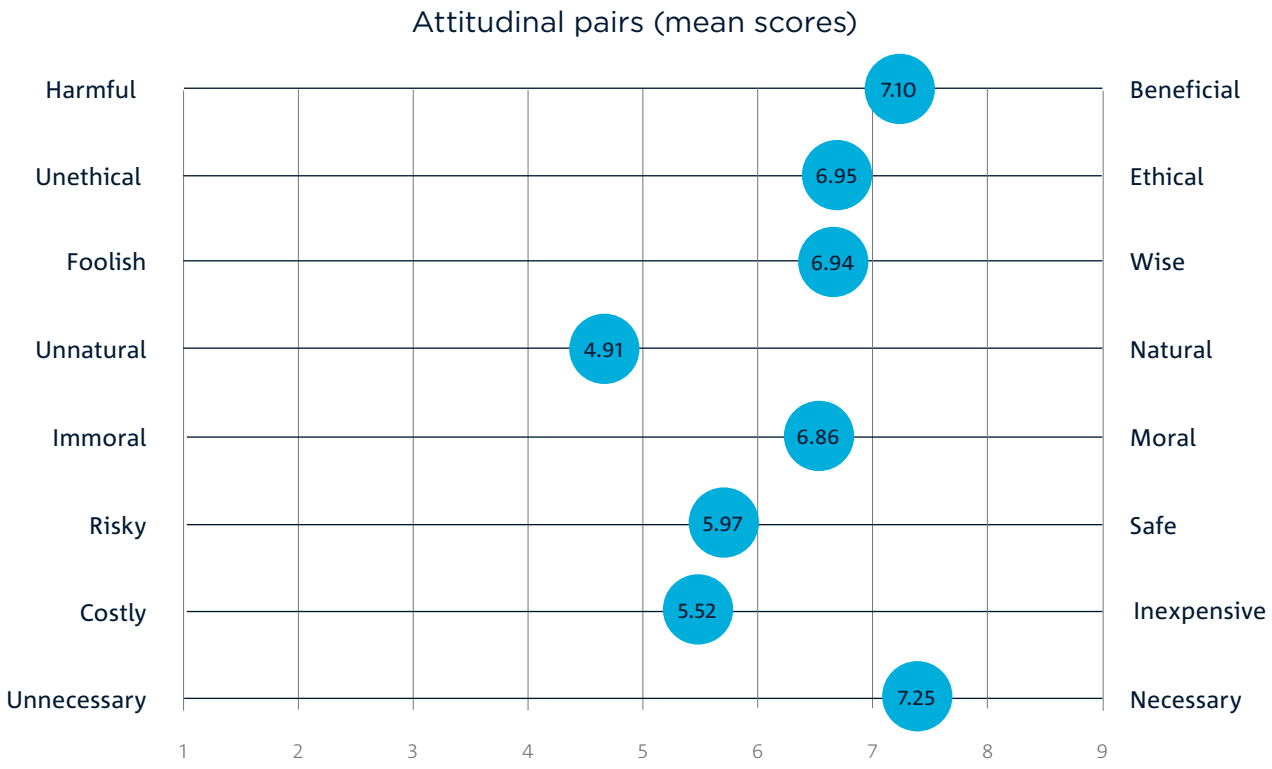
- more necessary/beneficial than unnecessary/harmful
- more ethical/moral than unethical/immoral
- more wise than foolish.

Participants were less certain about whether:

- the technology was natural or unnatural
- the technology would be costly or inexpensive
- the technology would be safe or risky.



Attitudes towards using gene drive technology for feral animal control



SCENARIO

Invasive feral cats in your local area

As part of the study, participants were presented with a "pest animal scenario". Based on information provided in the scenario (Box A), participants were asked to imagine that feral cats were a significant pest in their local area and needed urgent management. This scenario encouraged participants to consider gene drive technology as a pest management tool that could be implemented 'close to home', thereby raising the level of personal relevance of the technology.

By targeting participants from regions with known feral cat problems and a more realistic and relevant scenario, it was expected that responses would be more closely aligned to how people may likely respond to the technology 'in the real world'.

Box A. Pest animal scenario stimulus presented in the survey, asking participants to consider feral cats as significant pests in their local area.

Have your say!

We'd now like you to imagine that parks and bushland in your area are being considered as sites for the first on-land release of gene drive cats.

Feral cats in your local area have been responsible for the loss of a number of native bird and marsupial species. The population of feral cats in your area is rising as each feral cat can have up to 14 kittens per year.

It is becoming increasingly difficult to effectively control the growing numbers of cats and this is why gene drive technology is being considered as a potential management tool.

This gene drive technology will complement other tools already being used to manage the large feral cat population in your area (such as poison baiting, animal trapping, shooting of animals). The controlled release of gene drive cats and subsequent monitoring will be carried out by your local Natural Resource Management group and your Local Council.

Prior to the release of gene drive cats in your local area, your local council wants to hear from residents like you. Other residents in your local area have also been invited to have their say.

Please imagine this scenario as we describe it, even if your local area does not have a problem with feral cats.

In responding to the scenario, participants were asked to indicate their level of support for the use of gene drive to control feral cats in their local area more specifically, as well as use of conventional feral cat control methods (e.g., trapping, baiting and shooting) in their local area. Participants were also asked to choose between various control options combining gene drive cat control with conventional cat control for their local area.

Results showed that the largest proportion of respondents (45%) were strongly supportive of a release of gene drive cats to manage feral cat populations in their local area, based on the information described in the scenario. Just over 25% stated strong support for the use of conventional cat control methods (e.g., trapping, baiting and shooting) in their local area.

When given the choice between the release of gene drive cats and conventional methods of cat control in their local area, or a mix of both, 30% of people felt that an equal mix of gene drive cats and conventional methods was best. 40% of people preferred to predominantly use gene drive cats and another 13% of respondents felt using only gene drive cats was the best option.

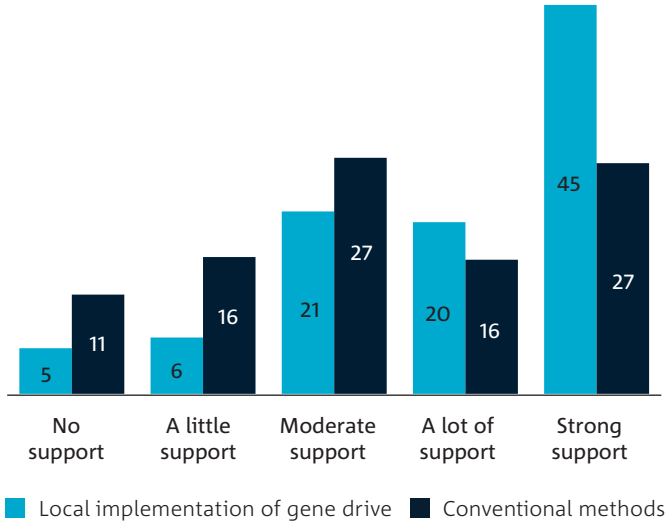


Figure 8. Levels of support for the local implementation of gene drive technology and conventional cat control methods, as a percentage (%) of total responses.

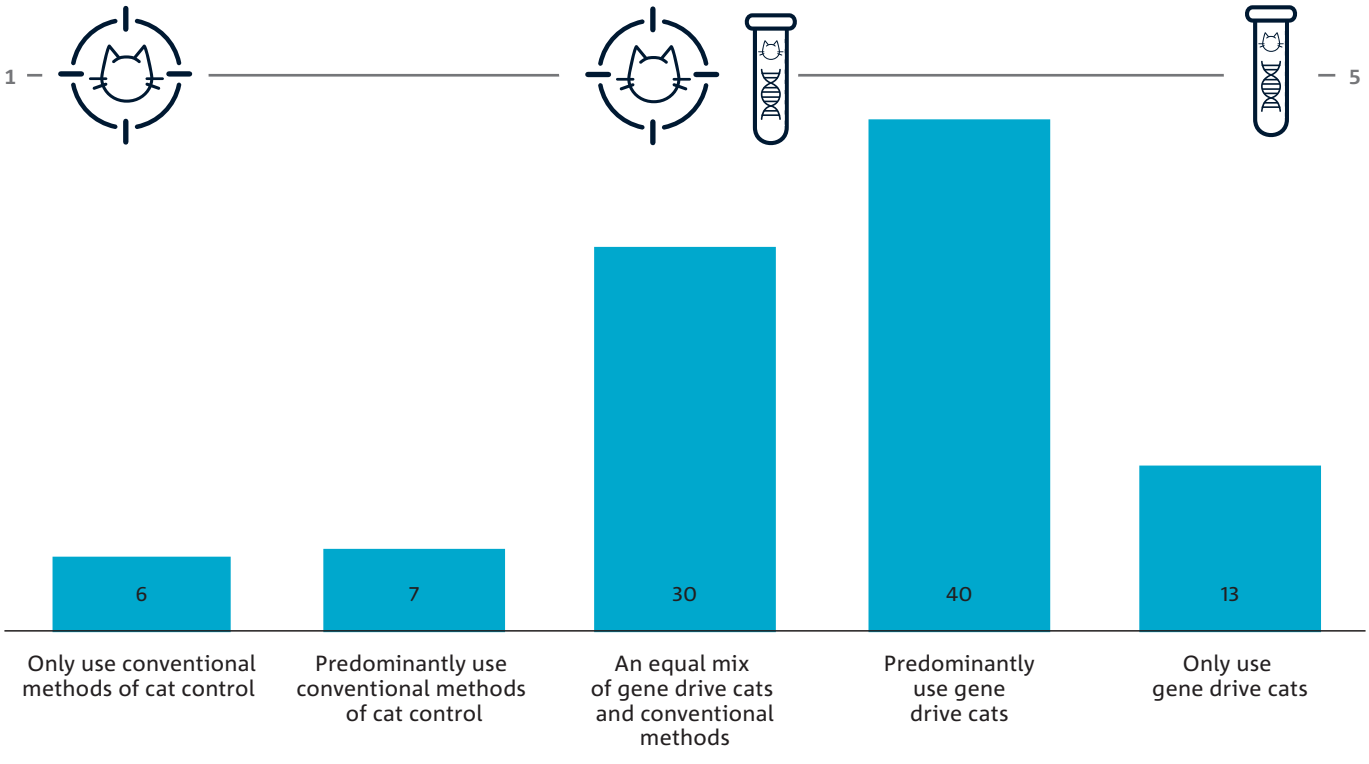
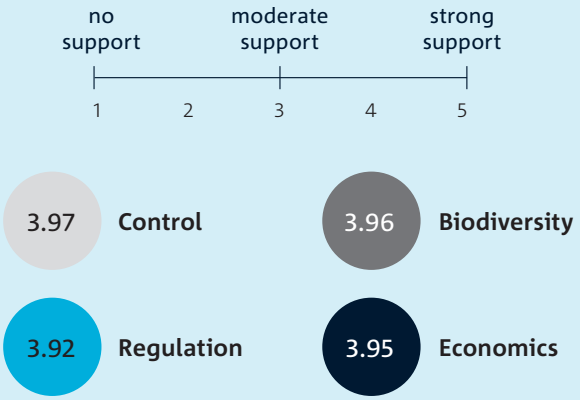


Figure 9. Public support for mixed method approaches to feral cat control, using a combination of conventional methods of cat control (e.g., shooting, baiting, trapping) and gene drive technology, as a percentage (%) of total responses.

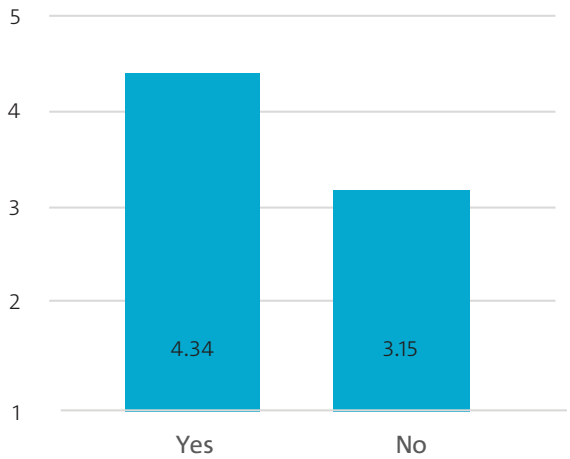
Local implementation support

Support for local implementation did not significantly differ across the different information conditions presented to participants. In all information conditions, participants reported similarly moderate levels of support for local implementation of gene drive cats.



Local problem

Participants who identified a feral cat problem in their local area (44% of people surveyed) were significantly more supportive of gene drive release than those who did not report a local feral cat problem (21% of people surveyed).



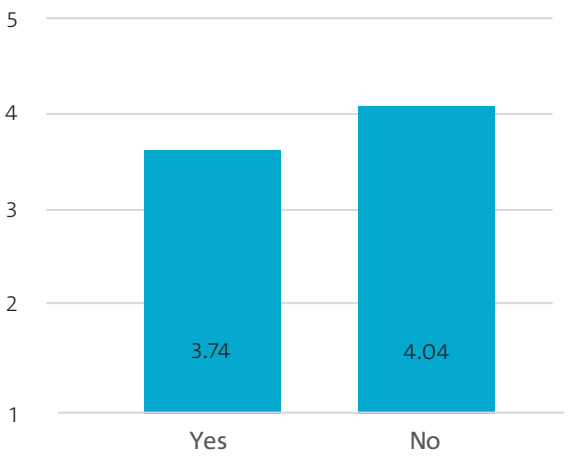
Are feral cats a problem in your local area?

Data range 1= no support 5= strong support

Figure 10. Support for release of gene drive cats in local area, by local feral cat problem

Cat ownership

Participants who owned a cat, or regularly took care of a cat (30% of people we surveyed) were significantly less supportive of gene drive release than those who did not own a cat or regularly take care of a cat (64% of people we surveyed).



Do you own a cat, or regularly take care of a cat?

Data range 1= no support 5= strong support

Figure 11. Support among respondents for local gene drive release, by cat ownership status, as a percentage (%) of total responses.

Reasons for different levels of support

To achieve greater insights into why people were (or were not) supportive of using gene drive technology for the management of pest species, participants were asked to briefly explain (via text input) their reasons for supporting, or not supporting, a gene drive cat release in their local area. Example responses based on the level of support are provided here for illustrative purposes, to demonstrate participants' reasoning for their response.

No Support

Just because you CAN do it, doesn't mean you SHOULD do it. This is just a lazy way to deal with the problem, which is human beings, not the animals. There wouldn't be 'feral' species without human interference in the first place... CE23

The history of failed scientific attempts to control pests in this country gives me no confidence at all hence I do not support a gene drive cat release. CE27

Too risky, too many unknowns of long term effects. CE39

I am opposed to all forms of artificial genetic engineering. The technology has immense potential for both corporate or government misuse as well as catastrophic and irreversible unforeseen results. CE48

Moderate support

There are worse pests...cane toads. CE549

I don't see feral animals in my area often. Hard to say if it would be useful. CE1137

I would support it if I knew from experts that it was going to be safe. I am not a scientist and therefore cannot make a wise decision but I have faith that we have good scientists that can make wise decisions on my behalf. CE1167

Strong support

I believe it is safer and more effective than baiting, trapping and shooting CE2625

Feral cats are so destructive to our ecosystems. They need to be removed for the sake of billions of native wildlife. CE2870

I am deeply concerned about biodiversity loss in Australia and any technology that gives our native fauna a chance is winner. CE2889

This seems a very humane way to control breeding in feral cats. CE2828

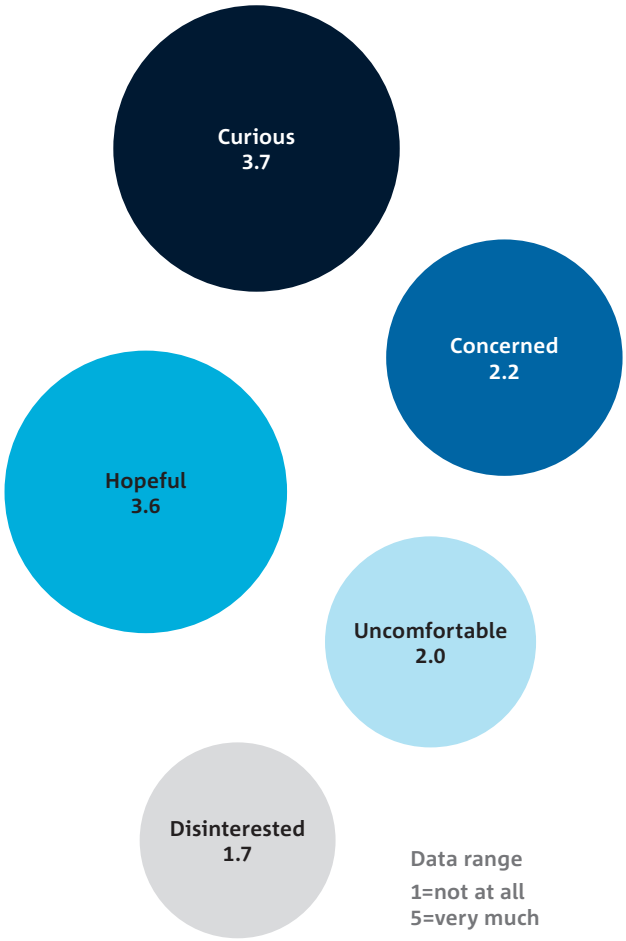
Understanding emotional reactions to the introduction of gene drive technology

Emotional reactions

To understand emotional reactions to the introduction of gene drive technology for feral cat control, the survey asked respondents to indicate the level at which they experienced various common emotions when thinking about a gene drive cat release in their local area.

Why are emotions important?

Emotions are a reflection of how people interpret and respond to the world around them. The scientific literature suggests that people heavily rely on their emotions or feelings to judge risk when making decisions or behavioural choices. One of the main explanations why humans do this is because emotions are thought to serve as decision-making shortcuts that help people make faster decisions, which can be very helpful in some situations (such as when a person is time-poor or is working in unfamiliar or complex situations). Emotions and feelings can help us determine whether something is good or bad or harmful or beneficial. Therefore, in the early stages of technology development such as this, studying how people emotionally react and respond to information about novel synthetic biology can help researchers understand how we perceive and assess risk in the context of a novel technology.



Results showed that participants generally experienced moderate positive emotions (such as hopeful and curious) and less negative emotions (such as discomfort and concern) when thinking about a gene drive cat release in their local area. Very few people reported feeling disinterested when thinking about the technology.

Considering a new integrated solution for invasive pests

Perceived effectiveness

An important factor in understanding public support for the development of gene drive technology is a belief in whether the technology would be effective in controlling feral cats in one's local area. That is, would a single-sex bias in feral cat offspring (delivered via a gene drive) influence a decline in feral cat populations over time.

Approximately 75% of respondents agreed or strongly agreed that gene drive technology would be effective in controlling feral cats in their local area, over time, and that the natural environment in their local area would benefit from the use of gene drive technology to control feral cats.
We also asked participants how beneficial they viewed the technology overall.

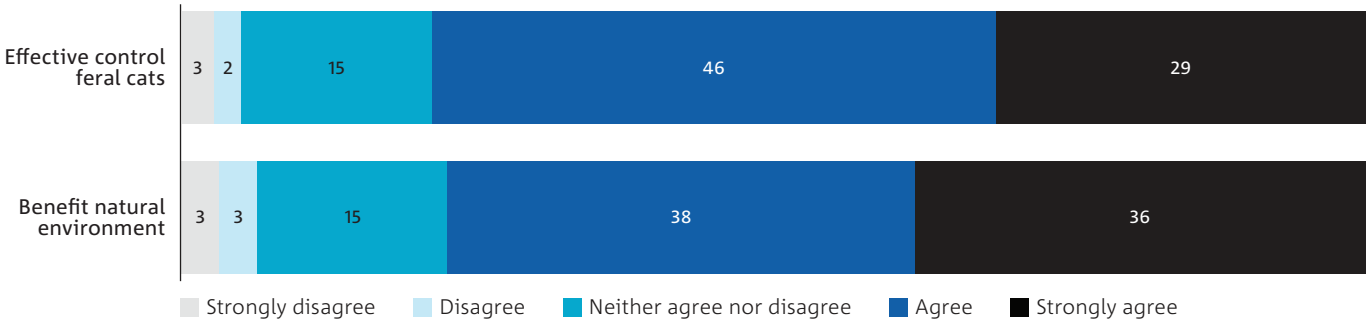


Figure 12. Belief that gene drive technology would be effective in controlling feral cats in local area, and that the natural environment in local area would benefit from the use of gene drive technology, as a percentage (%) of total responses.

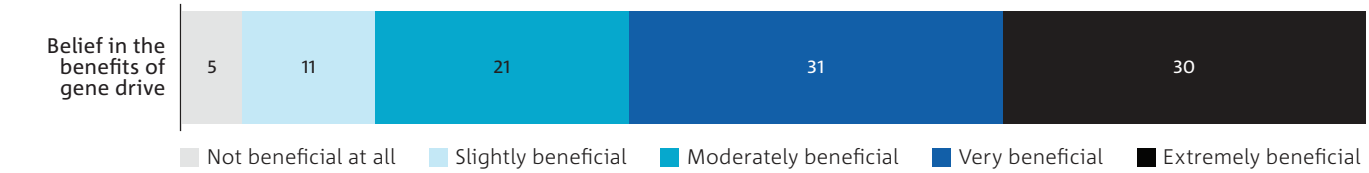


Figure 13: Belief in the extent of the benefits of gene drive technology in your area, as a percentage (%) of total responses.

Risk and uncertainty

As with all new technologies, there may be some risk and uncertainty about the possible long-term effects of using gene drive to control feral animals. Participants were asked whether they believed the risks associated with using gene drive technology to control feral cats in their local area could lead to widespread negative impacts. We also asked participants whether they were worried about the risks of gene drive technology negatively affecting human health.

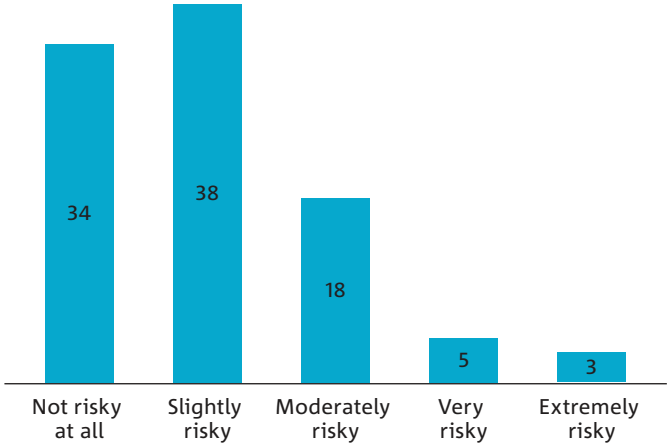


Figure 13. Belief that gene drive technology to control feral animals in local area would be risky, as a percentage (%) of total responses.

Risk of widespread negative impacts

51% did not agree or strongly disagreed that using gene drive technology to control feral cats can lead to widespread negative impacts in their local area

17% agreed or strongly agreed that there is a risk of widespread negative impacts in their local area

27% of people neither agreed nor disagreed

Willingness to accept uncertainty

Interestingly, most people were at least moderately willing to accept some uncertainty around the long term effects of using gene drive to control feral cats in their local area.

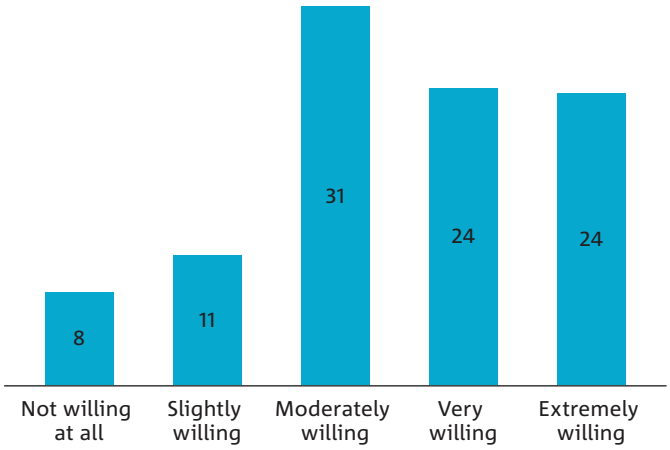


Figure 14. Participants' willingness to accept uncertainty, if the technology was used in local area, as a percentage (%) of total responses.

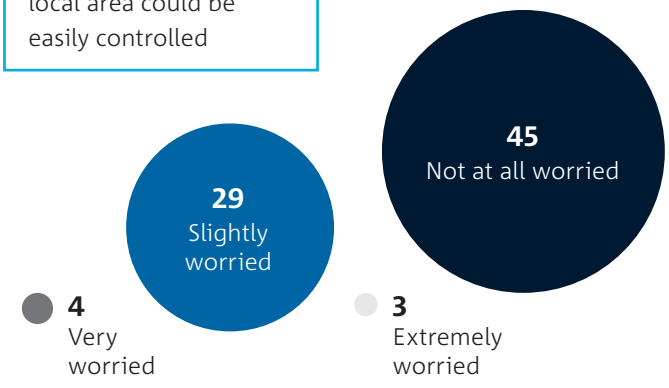
Risks could be easily controlled

45% agreed or strongly agreed that the risks associated with using gene drives technology to control feral cats in their local area could be easily controlled

17% did not agree or strongly disagreed that the risks associated with using gene drives technology to control feral cats in their local area could be easily controlled

33% of people neither agreed nor disagreed

To what extent are you worried about the risk of gene drive technology negatively affecting human health?



Willingness to pay

Participants were asked to consider how much they would personally be willing to pay for different cat control methods in their local area. This allowed additional information about which cat control option (or combination of options) people might prefer. The results showed that at least 50% of participants would be willing to pay $5 or more per quarter for any form of cat control method, with around two-thirds willing to pay $5 or more for a gene drive cat release only.

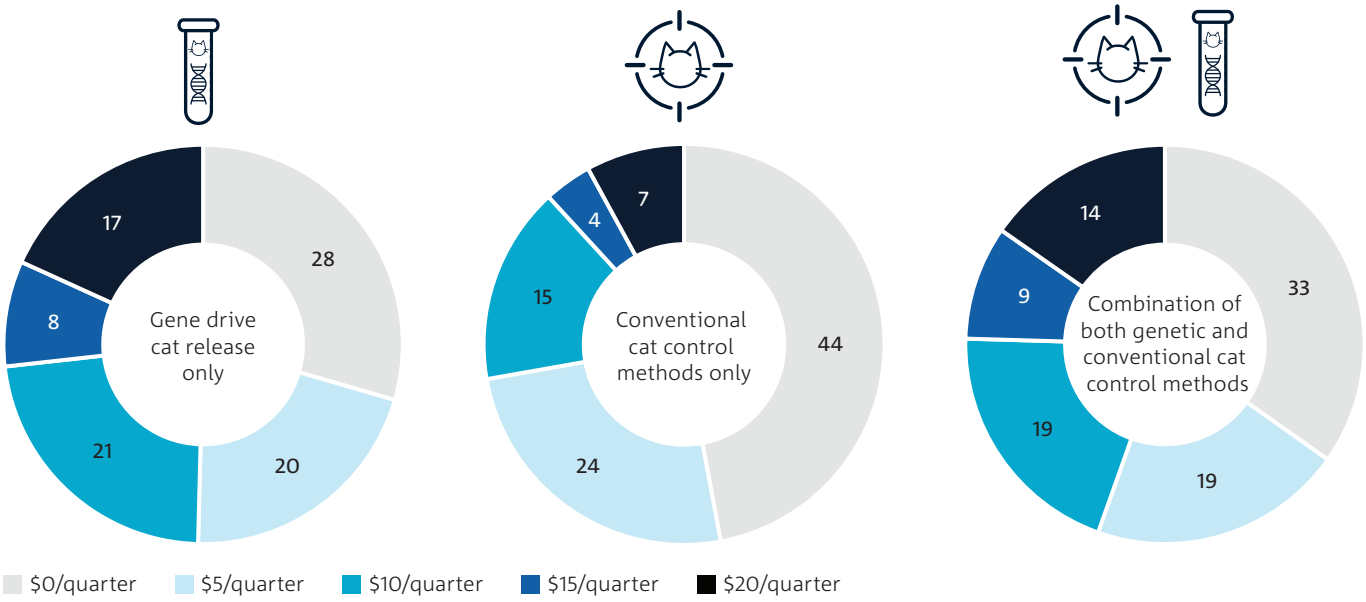


Figure 15. Participants' stated willingness to pay for gene drive and conventional cat control in local area, as a percentage (%) of total responses

Animal welfare considerations

Results showed that around 50% of respondents did not believe that releasing gene drive technology to control the feral cat population in their local area would harm/hurt feral or domestic cats. In comparison, around 15–25% thought it would be harmful. Approximately 70% did not believe that the technology is cruel to cats, while less than 10% thought the opposite. For each of these questions, there was roughly 20 to 30% who neither agreed nor disagreed.

The survey asked participants the extent to which they were concerned that domestic cats would become extinct over time if gene drive technology were used to control feral cats in Australia. More than 50% of the sample indicated that they were not at all concerned about this possibility, and another 21% were only slightly concerned. This result demonstrates that participants understood the intention of gene drive technology for targeting the management of wild and unneutered feral cats, rather than affecting domestic cats that are required to be neutered and contained.

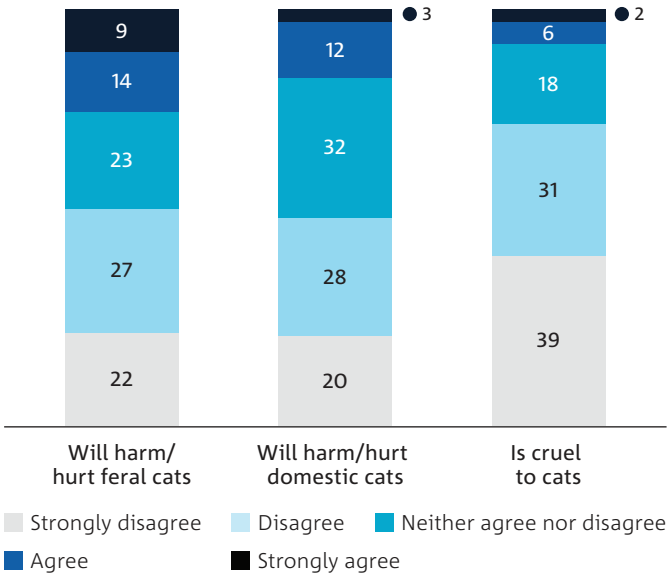


Figure 16. Animal welfare beliefs on releasing gene drive technology to control feral cats in local area, as a percentage (%) of total responses.

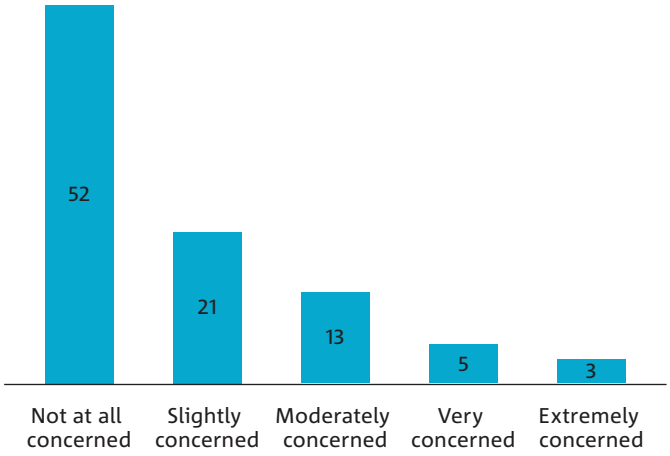


Figure 17. Participants' concern that domestic cats will become extinct over time with the use of gene drive technology to control feral cats in Australia, as a percentage (%) of total responses.

Local implementation considerations

When and where to implement

To understand stated support further, participants were asked to indicate at what point they personally thought it would be appropriate to release gene drive cats in their local area for conservation. 64% of the sample believed the right time to introduce gene drive technology to control feral cats was before any more native animals were lost in their local area (i.e. sooner rather than later). Again, 64% of respondents were also comfortable living within 5km of the release of gene drive cats and another 13% within 20kms of the release, assuming the release of gene drive technology was to go ahead in their local area.

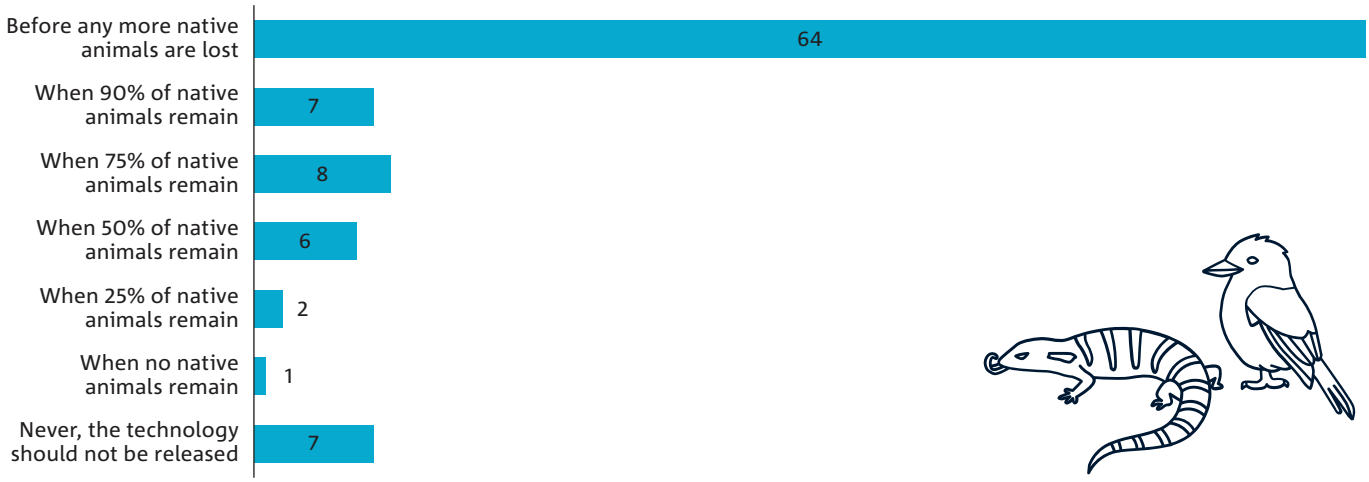


Figure 18. Participants' views on when it might be appropriate to release gene drive cats in local area to help native animals, as a percentage (%) of total responses.

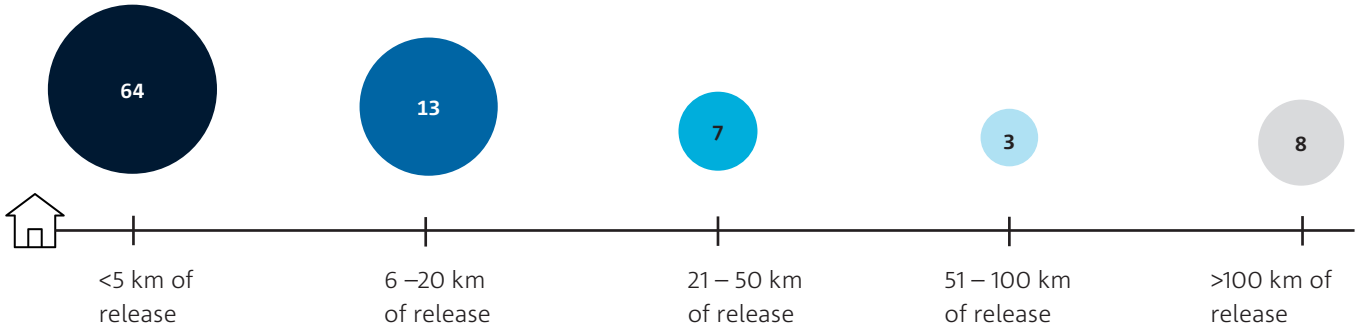


Figure 19. Closest distance respondents would feel comfortable living from the release of gene drive cats, as a percentage (%) of total responses.

Personal preparations

The survey also prompted participants to consider how they might prepare for a gene drive cat release if it were to take place in their local area, as described in the feral cat scenario they were provided (see Box A). The majority of participants (67%) agreed that they would neuter (de-sex) any cats they owned to prevent cross-breeding with the gene drive cats, and would try to keep any pet cats contained (63%), to reduce the chance of them mixing with the gene drive cats. One-third of participants indicated that they might also join a community group that helps decide how, when and where the release would occur.

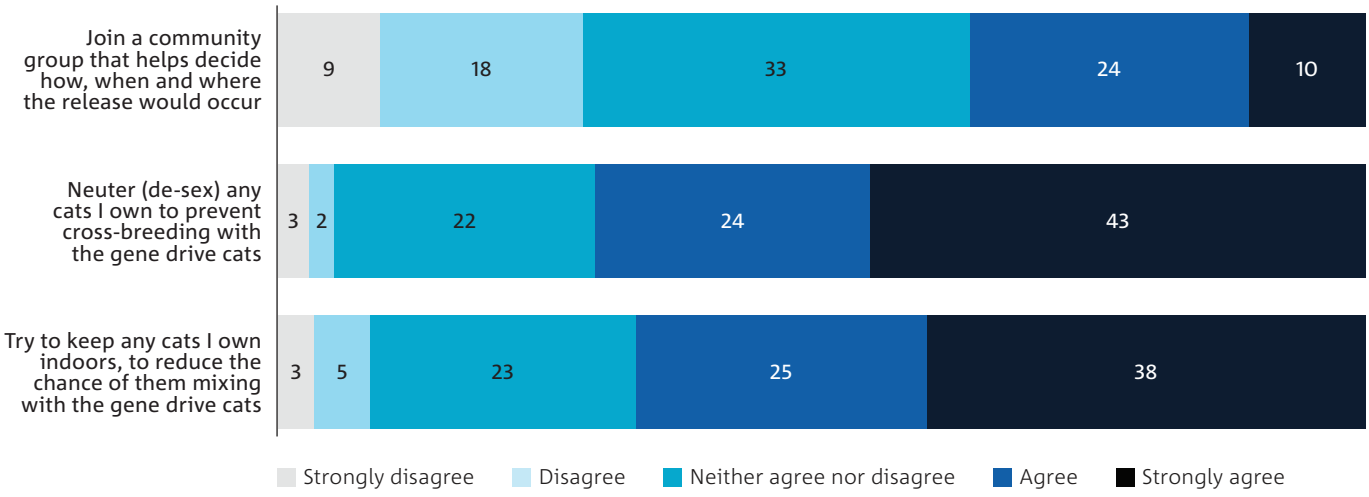
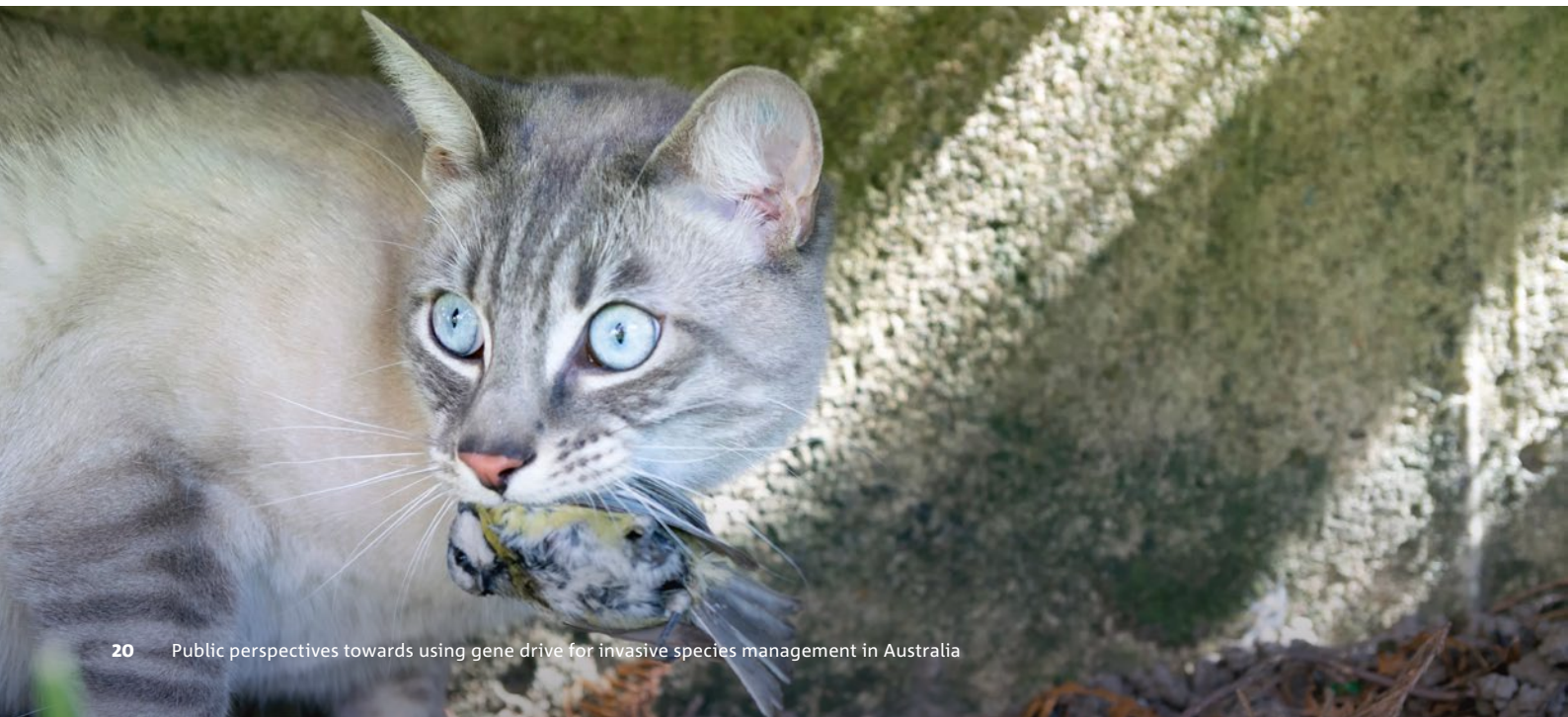


Figure 20. Respondents' preparation intentions assuming a gene drive cat release was to take place in local area, as a percentage (%) of total respondents.



Trust in technology development and management

Public trust in technology development was measured in four ways:

(a) trust in scientists to develop the technology safely

(b) trust that the technology would be used for public good (e.g. not solely to benefit corporations)

(c) trust in how the technology would be managed locally (i.e. trust in local authorities to responsibly monitor a gene drive release)

(d) trust that the technology would go through strict approval processes prior to release.

Most participants (~90%) expressed moderate to high trust in scientists developing the technology safely. However, slightly less (~70%) expressed the same level of trust that the technology would be used for public good. When it came to the management of the technology in the field, around 65% expressed moderate to high trust in local authorities to responsibly monitor the release, while close to 80% expressed the same level of trust that the technology would go through strict approval processes before release.

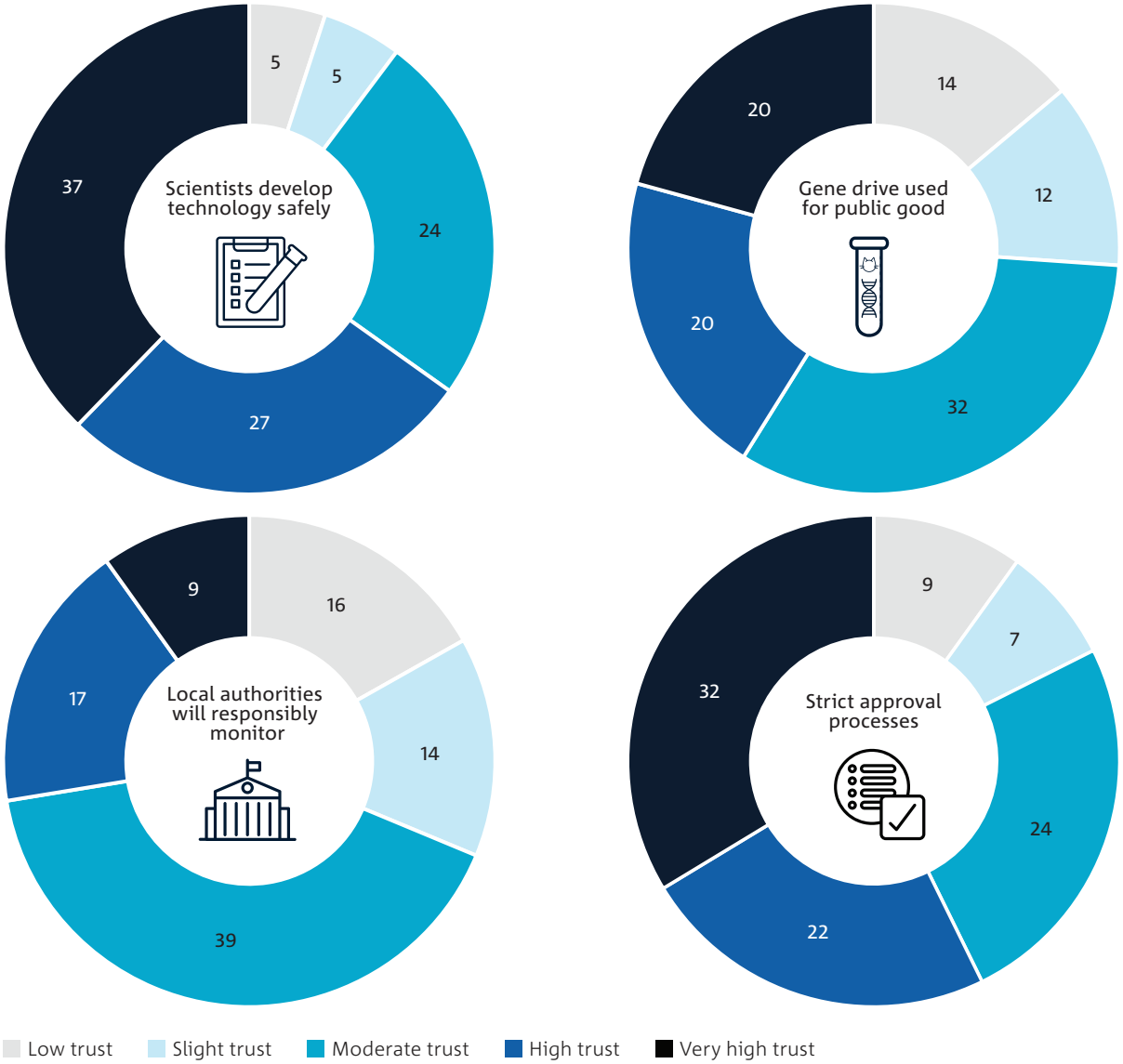


Figure 21. Participants' level of trust in different aspects of developing and managing a gene drive release to control feral cats, as a percentage (%) of total respondents.

General values

Confidence in science

To gauge respondents' views regarding the role of science and its importance, we asked people whether they believed that science can provide solutions to environmental problems, and whether science is needed to progress society. Overall, most people agreed with these sentiments, reflecting a high level of confidence in science.

Around 90% of people agreed or strongly agreed that science can provide solutions to environmental problems and that science is needed to progress society

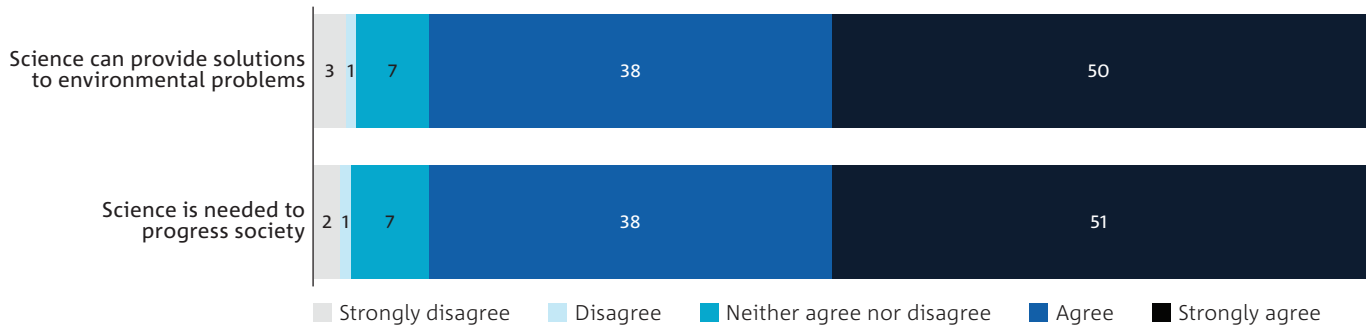


Figure 22. Extent to which respondents agreed with statements about science, as a percentage (%) of total respondents.

Wildlife value orientations

Participants had mixed views regarding animal values and rights. Just over half (51%) of all respondents generally agreed that animals should have rights similar to humans. However, around three-quarters (76%) agreed that when humans interfere with nature, it often produces disastrous consequences. Views tended to diverse on the question about whether humans have the right to modify the natural environment to suit their needs.

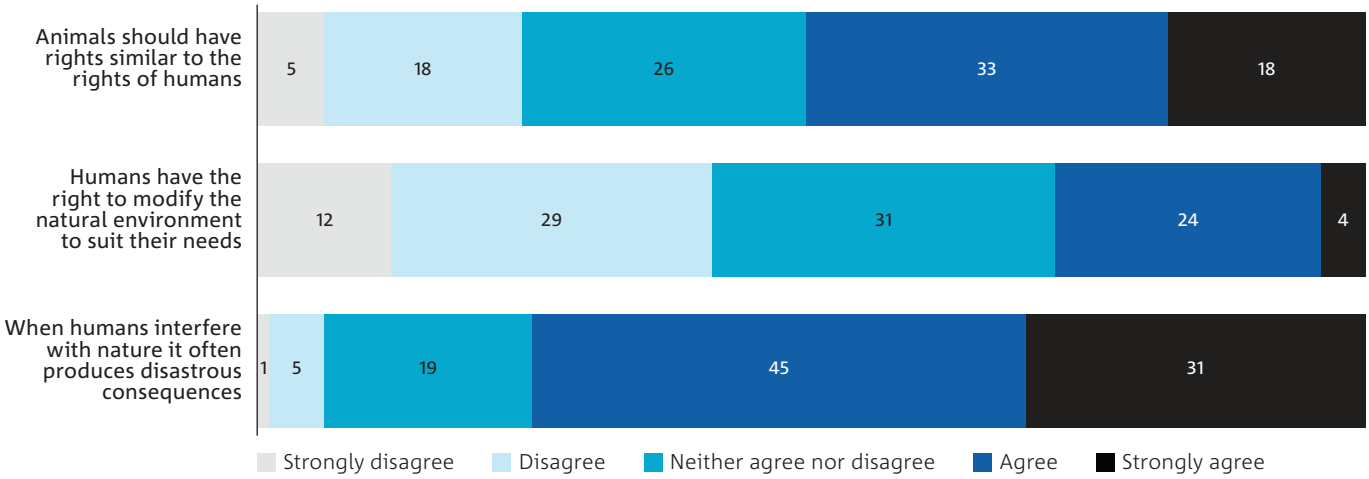


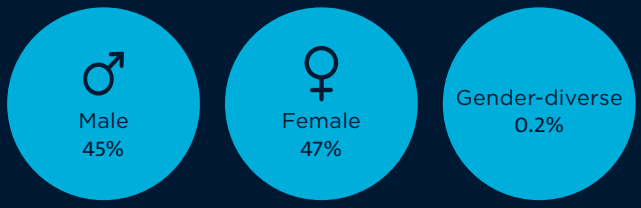
Figure 23. Participants' level of agreement with statements about nature, where 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree.

Description of the sample

Age

6% are missing.

Sex

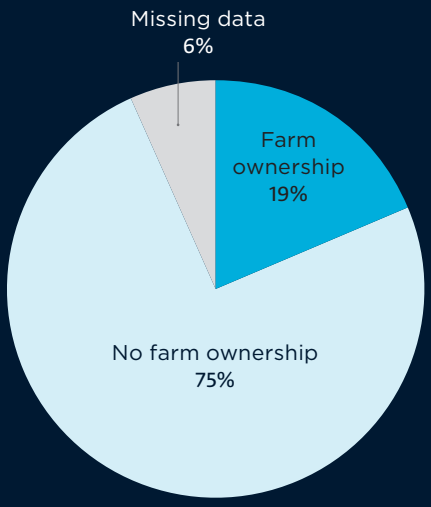


1.8% would prefer not to say. 6% are missing data.

Farm ownership

19%

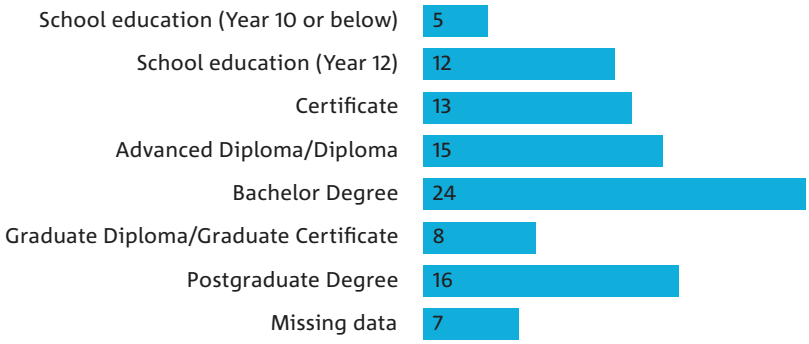
own or manage a farm, or own a large block of land (>2000 square metres)



Education

24%

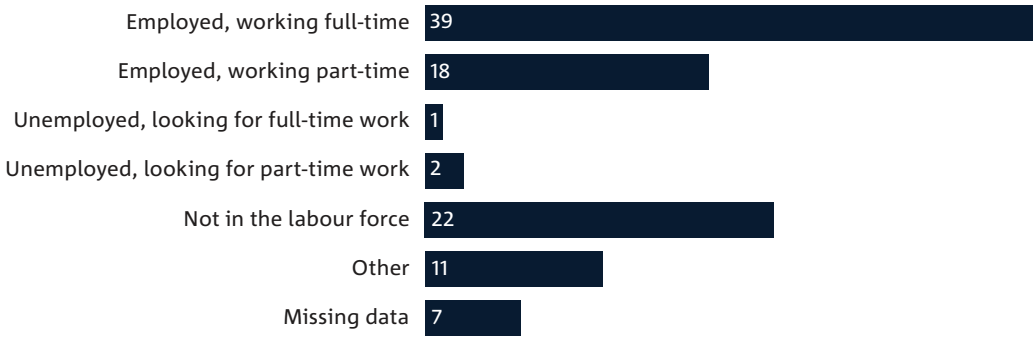
have a Bachelor degree



Employment

39%

describe their employment status as employed, working full-time

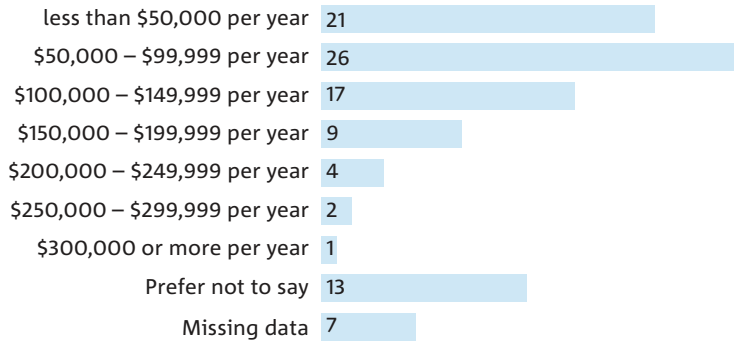


Income

26%

have a household income of $50,000 – $99,999 per year

Thinking of your annual household income (before tax and pre-COVID-19), what is the approximate total of all wages/salaries, government pensions, allowances and other income your household usually receives?



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