Submission - Draft Biosecurity Plan and Program Management of Cats

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Executive summary

- **Science-based, not complaints-based, approach needed** The Brisbane City Council's invasive species program with a target of 1,000 cats culled per year is complaint-based rather than science-based, and is ineffective in reducing the numbers of urban stray cats or their associated problems in the medium to long-term.

- **Trapping sites are repopulated** Such low-level culling leads to rapid repopulation at the trapping sites because of immigration from surrounding areas, and increased survival of juveniles because of removal of dominant cats. Cat numbers may increase rather than decrease as a result of low-level culling (Lazenby et al 2014).

- **Lethal control needs much higher killing rates** Lethal control of the urban stray cat population requires that the rate of culling exceeds the breeding rate (Miller et al 2014). It is estimated that 30-50% of the population must be trapped and killed every 6 months to effectively reduce urban stray cat numbers (Miller et al 2014).

- **Council will need to kill 43,000 cats in the first year** For effective reduction of the stray cat population over 10 years using lethal methods, approximately 43,000 cats will need to be culled just in the first year in the BCC area, and similar levels in ensuing years. Clearly, this rate of culling is cost prohibitive and logistically challenging for the Council, and unlikely to be supported by the community.

- **Current program does not achieve BCC's aims** The current level of lethal control with a target of 1000 cats/year is clearly well below the number needed for effective population control, and therefore achieves none of BCC's aims – to reduce wildlife predation by cats, decrease the risk of disease spreading to humans, pet cats and wildlife, and decrease nuisance complaints.

- **Non-lethal, science-based biological control can achieve BCC's aims** Non-lethal biological control programs in which urban stray cats are trapped, desexed, and adopted or returned to the point of capture have been shown overseas and in pilot studies in Australia to effectively reduce cat numbers, cat-related complaints, and cat and kitten intake and euthanasia in shelters and pounds.

- **Non-lethal, biological control reduces wildlife predation, and disease risks** By decreasing the urban stray cat population using desexing as biological control, wildlife predation by cats is decreased. By decreasing the proportion of young and undesexed cats, environmental contamination by toxoplasmosis is reduced, limiting the risk of spread of disease to humans, wildlife and pet cats.

- **Permits are available for non-lethal biological control** Under section 212 of the *Biosecurity Act 2014,* BCC can obtain a restricted matter permit for the purposes of biological control.

- **Science-based biological control is supported by CEOs of RSPCA and AWLQ** The CEOs of RSPCA Queensland and the Animal Welfare League Queensland have given their support to a proposed trial of non-lethal biological control based on desexing unowned cats.

The facts

- **Urban stray cat densities** Densities of urban stray cats typically range from 50 to 100 cats/1000 residents, but may be as high as 230 cats/1000 residents (Tan et al 2017).

- **Brisbane's stray cat population** Brisbane is estimated to have around 71,000 stray cats. On average, 22% of households in Brisbane feed stray cats, most of which are not desexed. The Brisbane urban stray cat population is increasing each year as the human population increases.

- **Most incoming shelter cats are strays** Of approximately 1,500 cats impounded by BCC municipal animal facilities in 2015-16, 80% of adults and 90% of kittens were urban strays.

- **Replacing culling with adopting is not feasible** Simply replacing culling by adopting is not feasible. There are already not enough new homes available annually in the BCC area to cope with the number of stray cats. In addition, some adult urban stray cats are not well socialised to people, and are not candidates for adoption.

- **Non-lethal biological control reduces complaints** Published reports from North America and Europe clearly demonstrate that desexing and adopting or returning urban stray cats to their original location markedly reduces cat-related complaints and euthanasia rates in shelters and pounds (Levy et al 2014). An adult cat desexing target of about 54% of the population gives effective change at the community level.

- **How non-lethal biological control works** Under this non-lethal management paradigm, healthy and treatable desexed stray cats are adopted when possible. If not adoptable, they are returned to their original location to stabilise the colony.

- **Cat population declines** Over time, desexed stray cats die naturally, leading to a gradual decrease in population, with models estimating that minimal numbers remain after 7-13 years (Miller et al 2014).

- **Community supports non-lethal biological control** This non-lethal method of biological control is generally well supported by communities, and often funded by welfare agencies and community groups, substantially reducing costs to governments. Australian research shows that 82% of people would support a trial in their area (Rand 2015), and 79% of Brisbane residents support non-lethal control of urban stray cats in Brisbane (Rand 2017).

- **Non-lethal biological control is effective in Australia** In Australia, recent studies (Tan et al 2017; Swarbrick 2013, Swarbrick and Rand 2018) have demonstrated that desexing and adoption or return is an effective and humane method of reducing urban stray cat populations, cat-related complaints, and pound and shelter intake. For example, median colony size decreased from 11.5

to 6.5 cats in just 2 years in 44 colonies (Tan et al 2017), and by 80% in one large colony over 9 years (Swarbrick and Rand 2018).

Introduction

Thank you for the opportunity to comment on this important document. In our submission, we propose a cost-effective, evidence-based and socially acceptable way for the Brisbane City Council (BCC) to meet its general biosecurity obligations with respect to cats.

Most of our submission relates to the management of urban and peri-urban stray cats. At the end of our submission, we outline some suggestions for the effective management of feral cats.

Terminology

We use the term '**urban stray cat**' for unowned or semi-owned cats living in urban and peri-urban areas.

We use the term '**feral cat**' for cats living away from human settlements, and independent of humans for food or shelter.

Contents

Key statistics

Brisbane's current population (local government area): 1.184 million

Estimated Australian stray cat population: 60 cats per 1,000 people

Estimated urban stray cat population in Brisbane: 71,000, possibly higher due to 'hot spots'

Current invasive species program: Removes (mostly by killing) 800-1,000 cats per year, 70% of which are juveniles (less than six months old), leaving dominant and fertile adults to continue breeding

Current program cost: Approximately $230,000 per year is currently spent on trapping and killing. This equates to more than $230 per cat

Section 4 - General Biosecurity Obligation (GBO)

Under the *Biosecurity Act 2014*, BCC is required to take all reasonable and practical measures to prevent or manage biosecurity risks and not to exacerbate adverse effects (Section 4 draft plan).

Current invasive species program – summary

It is our contention that BCC's current invasive species program for cats:

- Does not protect wildlife
- Does not reduce stray cat numbers in the medium to long term
- Does not reduce the risk of disease spread to humans, wildlife or pet cats
- Does not resolve complaints in the medium to long term.

In summary, it does not meet the BCC's general biosecurity obligation, nor represent science-based control of urban stray cats.

It is also inhumane and jeopardises the safety of owned domestic cats.

BCC currently kills about 800 to 1,000 urban stray cats annually. Tasmanian research (Lazenby et al 2014) has demonstrated that low-level killing such as this leads to rapid repopulation of these sites because of immigration from surrounding areas. Low level culling also increases survival of juveniles.

If BCC expects that a lethal-based program will reduce urban stray cat numbers to meet its GBO, the rate of culling must exceed the breeding rate (Miller et al 2014). Miller estimates that 30-50% of the population must be trapped and killed every six months to control urban stray cats.

Typically, there are 60 cats per 1,000 people in an Australian city. In Brisbane, a city of 1.184 million people, the urban stray cat population is likely to be about 71,000, perhaps more because of 'hot spot' areas.

Using the current approach to population control, at least 43,000 cats will need to be killed just in the first year. Clearly, this rate of killing is cost prohibitive and logistically challenging for the Council, and unlikely to be supported by the community.

GBO is intended to safeguard the environment

The intention of the *Biosecurity Act 2014* is to safeguard the environment. The Act provides flexibility in managing invasive species, with responses matched to the level of harm or risk and customised to suit local conditions and the assets or industries that are priorities for protection.

Trapping and killing cats as the principal biosecurity management method for urban stray cats is not based on science and will not enable Brisbane to meet its GBO.

Alternative cost-effective, evidence-based program to meet GBO

Non-lethal management programs, in which urban stray cats are trapped, desexed, and either adopted (if sociable) or returned to the point of capture, have been shown overseas and in pilot Australian studies to effectively reduce stray cat numbers and cat-related complaints, as well as intake and euthanasia in shelters and pounds, for minimal cost. These programs, known as trap, desex, adopt or return (TDAR), or trap-neuter-return (TNR), are an effective, evidence-based method of biological control (Miller et al 2014; Levy et al 2014; Swarbrick 2013, Tan et al 2017, Shepar and Wolf 2017, Swarbrick and Rand 2018).

Over time, desexed stray cats die naturally, leading to a gradual decrease in population size. Models estimate that minimal numbers remain after 7 to 13 years (Miller et al 2014).

Because this effective, low-cost and humane method of biological control achieves reductions in urban stray cat numbers, wildlife predation, spread of disease, and impact on pet cats are reduced.

TDAR is a scientifically validated and accepted method of biological control for other Australian free-living species, where numbers need to be controlled and where killing is not acceptable to people. For example, it is currently being used with kangaroos and koalas in Canberra (ABC Radio 2015, ABC News 2013).

Under the *Biosecurity Act 2014*, BCC can obtain a restricted matter permit for the purposes of biological control. This can be obtained from the Department of Agriculture and Fisheries, and will enable BCC to legally conduct the TDAR program. The application process entails submitting an application form and a permit plan.

High level of community support for TDAR

Killing large numbers of cats each year is unlikely to be supported by the community.

A 2017 survey (Rand, unpublished data) found that a majority (75%) of Brisbane residents favoured TDAR. Four per cent of people said stray cats should be left alone where they are, and therefore would likely support non-lethal rather than lethal methods of control. Only 22% preferred Brisbane's current trap and kill program. Reasons given for not supporting TDAR were concerns about the effect on wildlife and spread of disease to humans, both of which would in fact be reduced with TDAR compared to the current, complaint-based culling program.

Another internet survey conducted in 2015 (Rand, unpublished data) found that 82% of Australians would support a TDAR trial in their area, despite 70% of respondents believing cats had a negative effect on wildlife in their area.

Because of strong community support for TDAR, a collaborative approach using volunteer community stakeholders may be possible for such a program in Brisbane, to assist in conducting the trapping instead of using paid staff and contractors. This would significantly reduce costs. Furthermore, in line with the aims of the draft plan, using volunteers and existing community organisations will lead to greater community ownership of such a program.

Section 6 – Costs and the risk assessment approach

Under Section 6 of the plan (page 6), costs associated with treatment, eradication or failure to adequately manage a species are a component of the risk assessment. Here we present some preliminary modelling on costs and outcomes of various approaches to urban stray cat management.

Costs of current program (trap and kill)

- The current BCC trap and kill program removes approximately 1,000 cats per year at an annual cost of $230,000 (based on $230/cat). To meet best practice guidelines of holding cats for 3 days, costs would be increased to $350/cat (or an annual cost of $350,000).
- This program results in a marginal 1.3% decrease in total cat numbers over a 10-year period, failing to meet the council's GBO.

Costs of current method in order to meet GBO (trap and kill)

- To effectively reduce stray cat numbers, 30-50% of urban stray cats would need to be killed every 6 months for 10 years (Miller et al 2014).
- In Brisbane, using the lowpoint cull-rate of 30%, this means killing at least 21,000 cats every 6 months (43,000 in the first year) with continued high culling rates for 10 years.
- The estimated cost of a trap and kill program of this scale is **$15 million** in the first year alone. This estimate is based on $350/cat including trapping, holding and killing.
- Costs would decrease each year because of a reduction in the cat population, but total costs of this program over 10 years would approach $30 million.
- Note that the current BCC program fails to use best practice for temperament testing before killing, which mandates that cats are held for 72 hours for valid assessment (Slater et al 2010). To follow best practice, additional costs would thus be incurred for construction of cat holding facilities in the BCC area to hold approximately 1,600 to 2,800 cats. The community is likely to strongly support a minimum 3-day holding period, given the number of wandering and lost pet cats that would also be caught in such an extensive trapping program. Conservatively, this would add a further $1 million to the costs of an effective culling program in the first year.

Costs of alternative method to meet GBO (trap, desex, adopt or return - TDAR)

- To be effective in reducing the urban stray cat population, a TDAR program should aim to desex at least 50% of the population, and in areas of high stray cat density leading to cat-related complaints, should aim to achieve 90-100% desexing rates.
- The estimated cost to achieve 50% desexing rates across the BCC area in the first year, that is 35,000 cats desexed, would be **$6.6 million** in Year 1 of the program (based on $175-200/cat for desexing, vaccination and microchipping). Due to the large number of cats being desexed, veterinary clinics may further reduce the desexing cost.
- The main cost to Council would change from staff salaries for trapping and killing, to the cost of desexing, vaccinating and microchipping cats. Trapping would mostly be undertaken by community groups at no cost to the BCC.
- **Desexing approximately 50% of the undesexed population every year would result in a desexing rate of 90% of the population after 5 years.** Costs would decrease each year because of an actual reduction in the cat population. Over a 10-year period the total costs of such a high-volume TDAR program would approach $15 million.
- An alternative low-volume TDAR program targeting 3,000 cats for desexing each year would cost approximately $655,000 per year, and would achieve an overall desexed rate of 50% of the population after 10 years.

Section 12 – Biosecurity programs and strategies for pest animal management

The draft plan (page 15) states that the strategies are aligned with the *Queensland Weed and Pest Management Strategy 2016-2020*, which recognises the following:

- Monitoring and assessment, and specifically the collection and validation of information, enables effective decision making
- Strategic planning framework and management strategies that have acceptable levels of stakeholder ownership and are informed by risk management are more likely to achieve desired results

Current program

The current trap and kill program is not evidence-based. It has little stakeholder ownership and is not informed by risk management principles.

Proposed TDAR program

TDAR as a form of biological control is informed by scientific evidence and constitutes effective risk management. Implementing TDAR will enable effective decision-making by facilitating the collection and validation of information, which can be shared with other Queensland councils ('good neighbour principle').

TDAR programs have high levels of stakeholder ownership and community collaboration (Levy et al 2014, Shepar and Wolf 2017, Tan et al 2017).

TDAR will enable the council to meet its statutory obligations while aligning with the objectives of community groups which, increasingly, are to reduce the killing of healthy and treatable cats.

The Australian Pet Welfare Foundation is available to assist in preparing the management plan.

Table 7 – Biosecurity program for pest animals in the Brisbane LGA

Table 7 (page 18) proposes a multi-faceted approach for the biosecurity program. This includes:

- Management response
- Education
- Collaborative opportunities
- Research, science and technology.

Most of the strategies in Table 7 can be achieved through the implementation of TDAR.

Management response

Management response strategies include:

- Eradication/reducing the density and containing the distribution
- Carrying out best practice humane control actions
- Containing the distribution through collaboration with partners and the community to achieve a holistic management approach.

✓ TDAR is the only method that will effectively reduce the density of urban stray cats, to the point of minimum non-problematic numbers remaining, and contain their distribution without causing an adverse economic impact to Council and its residents.

✓TDAR is world's best practice in humane cat management. It is cost-effective. It engages with the community.

✓Through marked reductions in urban stray cat numbers, TDAR will reduce wildlife predation, enabling Brisbane to efficiently meet its general biosecurity obligations.

✓TDAR reduces the risk of disease spread to humans, wildlife and other pet cats. The average age of remaining cats is substantially older with TDAR than with culling programs. As a result, most remaining cats have been exposed to toxoplasmosis when younger, are mostly immune, and rarely shed oocysts (Dubey et al 1977, Dubey 1995). Therefore TDAR programs minimise environmental contamination with toxoplasmosis cysts compared to culling programs, where naïve kittens are continually being born, become infected with toxoplasmosis and shed oocysts. This results in environmental contamination, which has the potential to infect humans, wildlife and other cats, and cause disease.

✓TDAR involves working in collaboration with partners and the community using a holistic management approach. This contrasts with the current council-centric approach of trapping and killing.

Current program – humaneness and use of best practice

BCC's current invasive species program is not humane nor does it use best practice methodology:

× The current BCC program does not use valid best-practice methods to assess a cat's sociability and, therefore, its likely ownership. Behaviour is assessed soon after trapping, while the cat is still in the trap cage or a crush cage. Research clearly shows that three days are needed after trapping to validly evaluate a cat's sociability (Slater et al 2010). The RSPCA markedly reduced the proportion of cats classed as feral on admission by increasing assessment time from 24 to 72 hours, and providing less social cats with the time to demonstrate sociability.

× Microchip scanning under the current program is conducted while the cat is in a crush cage. With the cat's body contorted, a microchip may not register on the scanner. This is far from established

best practice. Microchips migrate and may be missed on initial scanning, and repeat scanning is recommended with the cat in a different position.

× The method of killing cats that are in cage traps or crush cages is also inhumane and is not best practice. It is done using intracardiac injection (or wherever the needle enters the chest cavity) by people who are not vets or vet nurses. In contrast, shelter workers must have at minimum a one year certificate in animal handling before being involved with euthanasia. Intracardiac injection is not a method recommended by the Australian Veterinary Association.

× Alternative methods of culling cats used in the BCC program, such as the use of foothold traps followed by shooting, mean that a cat may be left in extreme pain in the trap for periods approaching 16 hours (Sharp and Saunders 2012). Foothold traps are not supported by the RSPCA or the Animal Welfare League.

Recommendation: If BCC wishes to continue with trapping approximately 1,000 cats per year, we propose that its current pound provider, Animal Welfare League Queensland, manage the cats trapped by BCC. This will ensure a more accurate assessment of their ownership status, their level of sociability and their potential to be responsibly rehomed.

This may require building a new facility to house the cats and increased funding to care for them.

Education

Education strategies in the plan include:

- Promoting extension programs to raise awareness of responsibilities in relation to owned cats
- Providing guidance material on best practice management options
- Encouraging and promoting citizen science research opportunities and community delivery of programs
- Encouraging public support for management activities through awareness programs

Extension programs

High densities of urban stray cats – 'hot spots' - are closely correlated with socioeconomic factors. In Brisbane, lower socioeconomic suburbs such as Inala, Acacia Ridge, Archerfield, Coopers Plains, Darra and Wynnum generate more cat-related complaints and represent a higher intake in the invasive species program, and at shelters, than other areas.

Education about the importance of desexing cats in these areas is unlikely to lead to higher rates of desexing, as cost is the prohibitive factor preventing desexing and 'responsible pet ownership'.

Through the provision of free or low-cost desexing targeted to low socioeconomic areas, the numbers of owned cats that are desexed will increase, leading to a reduction in the number of urban stray cats. For example, free desexing programs in the USA, targeted to the most underserviced communities with the highest cat shelter admissions, increased desexing rates to the average for the USA (90%), and reduced cat shelter admissions and rates of euthanasia (White et al 2010).

In Melbourne, Banyule City Council provided free desexing of cats in targeted low socioeconomic areas for 1.5 years. In that time, cat-related complaints declined and kitten intake was reduced compared to other areas. Based on the results achieved, the council has tripled the budget and expanded the program in 2017-18 to provide free desexing of cats (owned and unowned) in the postcodes with the highest cat-related complaints to council.

Guidance material

The Australian Pet Welfare Foundation will be happy to work with Council in developing Brisbane-specific material that can be disseminated to the community to explain the benefits of TDAR. Scientific publications explaining how TDAR achieves humane and cost-effective reductions in stray cat numbers are already available from overseas studies (Levy et al 2014, Shepar and Wolf 2017), as well as some from Australia (Tan et al 2017, Swarbrick 2013, Swarbrick and Rand 2018).

Citizen science research opportunities and community delivery of programs

Typically, TDAR programs are delivered by volunteer community members at greatly reduced cost to councils. These experienced citizen scientists have the motivation, commitment and experience in cat management to collate data on program delivery and outcomes.

Encourage public support through awareness programs

As previously discussed, because it is both effective and humane TDAR has high levels of community support.

Collaborative opportunities

Collaborative opportunity strategies listed in the plan include:

- Managing cats in a coordinated and collaborative way for efficiency and cost effectiveness
- Developing community-based programs for reducing population density
- Providing support and maintenance for local control efforts
- Investigating options for incentives for management on private land

✓As previously stated, TDAR programs are highly collaborative, community-based and cost effective. They achieve long-term reductions in population density of stray cats, with eventual reduction to minimum, non-problematic numbers, using accepted principles of biological control.

Council can provide support for TDAR programs by assisting with the principal cost of the program, which is veterinary costs for desexing.

Incentives of free or low-cost desexing, especially when this is facilitated through volunteer transport of cats for surgery, will lead to high uptake levels and significant reductions in the numbers of undesexed owned cats and, therefore, the number of urban stray cats and feral cats.

Such incentives can be offered in both urban and rural areas.

Research, science and technology

The proposed strategies include:

- development, adoption and implementation of the latest technologies in controlling population numbers
- quantifying the social, economic and environmental impacts of species in Brisbane
- investigating and trialling technologies to reduce breeding rates
- partnering with other institutions to investigate new treatment methodologies and test standard treatment practices

✓TDAR programs meet all aspects of this component of the draft plan. TDAR is a modern and effective way of controlling numbers, it reduces breeding rates and it presents opportunities of partnership with organisations such as AWL, RSPCA, the Australian Veterinary Association and community organisations.

Social cost of current program

A hidden social cost of the ineffective management of stray cats is the toll on the people who kill the cats. Fifty per cent of workers directly involved with killing develop post-traumatic stress disorder (PTSD), which may lead to depression, substance abuse, high blood pressure, sleeplessness and even suicide (Reeve et al 2005, Baran et al 2009, Frommer et al 1999, Rohlf and Bennett 2005). In shelters, staff turnover is proportional to the kill rate (Rogelberg et al 2007).

The potential cost of sick leave and retraining council, and shelter, staff should be considered in the cost of the current lethal cat management program.

TDAR markedly reduces shelter intake and euthanasia (Levy et al 2014, Johnson and Cicerelli 2014, Kass et al 2013).

Technologies to reduce breeding rates

Research is currently being conducted to develop non-surgical sterilisation treatments for cats. Once developed, this method of biological control may markedly decrease the cost of TDAR, but current products result in insufficient duration of effect (Benka and Levy 2015, Levy et al 2011).

Proposed biosecurity prevention and control program for cats

The proposed program (page 21) suggests that cats have a major impact on native species, and other animals, including through:

- predation on wildlife
- threatening critically endangered species
- carrying disease such as toxoplasmosis
- causing injury and transmitting disease to domestic cats
- carrying parasites that can affect humans
- causing health problems when in high numbers in urban areas.

Wildlife predation

No study in urban Australia has established that cats have a negative impact on native wildlife populations.

Mammals

A 10 year Perth study (Lilith et al 2010) investigated species diversity across three different bushland areas where cats were either:

- prohibited;
- required to be inside at night and wear a bell; or
- unregulated

The study found that medium-sized mammals, such as Brush-tailed Possums and Southern Brown Bandicoots, were not impacted by the presence or absence of cats. The smaller Mardo (*Antechinus flavipes),* which is highly susceptible to cat predation, was in higher numbers in areas where cats were unregulated.

Birds

A Perth study found that cat density has no effect on passerine bird populations. Decreasing bird populations were associated with increasing urbanisation and housing density, and increasing distance from bushland. The study concluded that habitat destruction and degradation, rather than cats, were the main factors impacting on birds (Grayson et al 2007).

A Sydney study of nest predation in 24 forest patches in the Sydney metropolitan area found that no nests were attacked by cats (Matthews et al 1999). Black Rats, Ringtail Possums, Antechinus species and other birds were the main predators. Nest predation was reduced when cats were present.

Most of the bird species that cats kill have an average life span of 2-4 years in the wild. This means that 25-50% are dying of other causes every year and would not survive to the next breeding season (Australian Government Department of the Environment and Energy, 2017).

Research also shows that birds caught by cats in urban areas are on average less healthy than birds killed by flying into windows and cars (Baker et al 2008, Møller and Errotzøe 2000). The researchers concluded that most cat-related bird deaths are not additive to the number dying each year.

Introduced species

A further study (Franklin et al 2018) found that the main prey items of cats are mice, followed by rats, small lizards, then common species of birds. A Brisbane City Council analysis of the stomach contents of 25 cats found only one species – the Black Rat (Brisbane City Council 2015).

Therefore, while cats may certainly kill individual native animals, they have not been found to have an overall impact on biodiversity in urban areas. It is also interesting to note that desexed cats have reduced energy requirements compared with undesexed animals (Mitsuhashi et al 2011), and this may also indirectly reduce wildlife predation under a TDAR program.

Toxoplasmosis

Toxoplasmosis is known to cause disease in humans, wildlife and cats. TDAR reduces environmental contamination with toxoplasmosis oocysts and therefore reduces the risk to humans, wildlife and pet cats.

In trap and kill programs such as the BCC's current program, new susceptible kittens are constantly being born, and represent a higher proportion of the stray cat population. It is these kittens who are most likely to be affected by the Toxoplasma parasite and to shed cysts (Dubey et al 1977, Dubey 1995).

In contrast, under a TDAR program, the number of kittens and younger cats in an area is rapidly reduced. There is a larger proportion of older cats that are immune to toxoplasmosis, that do not shed cysts and therefore do not cause environmental contamination. With only mature, desexed and immune cats remaining, the presence of Toxoplasma in the environment will be significantly less under a TDAR program than in trap and kill programs.

In addition, adult cats that are not yet immune, shed fewer cysts when infected by Toxoplasma than younger cats that are less than one year old (VanWormer et al 2017, Dubey et al 1977).

If there is concern about toxoplasmosis in the environment, TDAR will lead to a greater reduction for any given number of cats than the existing trap and kill program.

Injuring and transmitting disease to owned cats

The current trap and kill program results in the constant presence of undesexed cats. It is these undesexed cats, particularly males, that are more likely to fight and potentially spread Feline Immunodeficiency Virus (FIV) to pet cats through bite injuries.

TDAR reduces the likelihood of injury to owned cats and the spread of disease such as FIV. Under a TDAR program, there is less fighting as cats are desexed (Gunther et al 2011), so there is a reduced incidence of injury.

Parasites and human health problems from high numbers

Under a trap and kill program, no parasite treatment is provided. Under a TDAR program, parasite treatment is routinely provided when cats are desexed. After return to location, it can be provided when needed.

Council's current trap and kill program is based on complaints when urban stray cat numbers increase, and result in increased nuisance behaviours. TDAR proactively prevents the buildup of high numbers of stray cats. Numbers are stabilised and gradually reduce. Fighting, urine marking and roaming are greatly reduced. TDAR therefore reduces the likelihood of any health problems to people. Furthermore, complaints to council related to the noise of fighting, defecation and urination are markedly reduced.

Council objectives of cat program

The stated objectives of the council's cat program are to:

- Remove non-domestic cats from areas where they pose risks to native biodiversity
- Reduce non-domestic cat numbers in other situations, particularly where they have or could have environmental or social impacts
- Educate the community about the impact of non-domestic cats on the natural environment
- Educate the community about responsible pet ownership

Removal of cats from biodiverse areas

Due to the complexity of ecosystems, simply removing cats from an area with high biodiversity may not achieve the intended objectives of protecting wildlife. See 'Proposed program – feral cats' below. In addition, the current program of the BCC aimed at removing 1,000 cats per year results in no medium or long-term reduction in cat numbers.

Reduce cat numbers in other areas

This can be achieved through the implementation of a TDAR program. Continuing with a trap and kill program will not achieve reductions in numbers, due to cost and resource constraints.

Education about impacts of cats

Given the lack of Australian studies that indicate cats have a negative overall impact on wildlife populations in urban areas, any educational material should clearly explain the difference in impact of cats in urban versus remote undisturbed natural environments where endangered animals are found, and where there is evidence that feral cats have a contributing negative effect on populations. Habitat destruction is the number one cause of the decline in some native species. Urban areas are highly disturbed environments.

Education about responsible pet ownership

Failure to desex and be a responsible pet owner is largely related to socioeconomic factors. Low socioeconomic areas typically have higher numbers of urban stray cats. Greater compliance with Brisbane local laws, reduction in environmental concerns and achievement of the objectives of this plan can be achieved through the widespread provision of free and low cost desexing.

Proposed program – feral cats

Effective management of feral cats - those that do not live in urban and peri-urban areas and that may impact on Australian biodiversity - is a developing field and a significant challenge (Doherty et al 2017).

Feral cats are defined as those that get no food or shelter from humans, live at least 3-5 km from the closest human habitation, and survive primarily through predation.

It is essential that management programs for feral cats are well-supported by evidence, so that they meet their intended objectives, provide a return on investment, and are implemented within an adaptive management framework (Doherty et al 2017).

Many studies have found that simply removing cats does not protect wildlife. Often, other species - both introduced and native - continue to have an impact. Fire regimes, loss of habitat through clearing and development, and through climate change, also affect a species' ability to survive.

Management actions and measures of their success should focus on reducing the impacts of feral cats and on protecting vulnerable species, rather than having a focus on killing cats as the end goal.

They should be based on a decision-making process that considers the full range of control methods available and includes pre- and post-control assessment to measure each species' response. This will ensure programs are the most cost-effective and ecologically sound. Furthermore, programs must be as humane as possible.

Embracing scientific design principles in management trials is likely to produce the most reliable information regarding the efficacy of different approaches (Doherty et al 2017).

We suggest there are four priorities for future research and management of feral cats:

1. prevent feral cats from contributing to the extinction of the most vulnerable species
2. assess the efficacy of new management tools
3. trial options for control via ecosystem management
4. increase the potential for native animals to coexist with feral cats.

Conclusions

To meet its biosecurity obligations with respect to urban stray cats, BCC has two starkly distinct options:

- increase the trapping and killing of cats to 30-50% of the urban stray population every 6 months, or approximately 43,000 cats killed in the first year (based on an estimated total population of 71,000 cats). The estimated cost is approximately $15 million in the first year, plus substantial costs for constructing holding facilities to meet best-practice requirements.
- implement a trap, desex then adopt or return (TDAR) program of biological control. The estimated cost of this approach is approximately $6.6 million in the first year, with costs reducing over time.

The current trap and kill program is ineffective in reducing stray cat numbers, resulting in an increase in the stray cat population over time, and does not limit disease spread, health-related issues in people, complaints or costs. It will not enable BCC to meet its GBO.

TDAR has been demonstrated to be more effective in terms of reducing cat numbers over time, as well as managing the spread of disease, complaints and costs.

TDAR enables community collaboration, is likely to have community support and will position BCC as an Australian leader in the field of urban stray cat management.

For feral cats not living in urban or peri-urban areas, any management program must be based on science to ensure it is effective in reducing impacts on wildlife, rather than killing cats as the main goal. It must also use the most humane methods possible.

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