A summary of current research on the interactions between cats (domestic, free living strays and feral) and native wildlife on the eastern sea board.

1 Background

At the Council meeting of 10 April 2014, the following was resolved:

RESOLVED *that Council bring forth a report on the negative impacts of cats on native fauna, and recommendations for management.*

This report to include, but not be limited to:

- *a summary of current research on the interactions between cats (domestic, free-living strays and feral) and native wildlife on the eastern seaboard;*
- *what measures have been successfully employed by other Australian Councils to reduce the impacts of cats on native wildlife;*
- *recommendations as to possible measures Tweed Shire Council can adopt to reduce the impacts of cats on native wildlife; and*
- *suggestions on where these measures will fit into the organisational structure, and the resourcing implications of adopting such measures.*

This summary was prepared to satisfy Point 1 of the above resolution.

2 Introduction

For management purposes, cats are described using three categories — owned, stray and feral — although individual cats may move between these categories within their lifetime (Sharp and Saunders 2008). The following definitions describe each category.

- Owned cats - are cared for and live with humans. This relates both to cats that are confined on an owner's property or those that are allowed to roam outside of an owner's property.
- Stray cats - are un-owned but at least partly rely on humans for feeding and/or other husbandry. They cannot survive away from humans and live in urban/peri-urban areas.
- Feral cats - survive without any human contact or assistance.

Under some circumstances a stray cat, or more usually its descendants, may become truly feral. Stray cats may become owned cats again if they find suitable homes but it is extremely rare for a truly feral cat to ever become a pet (Lorang 2013).

In reality, these categories of cats are a continuum and individuals may move freely from one category to the other. Recruitment to the stray and feral groups from the domestic population constantly occurs when cats wander from their home to join existing feral or stray populations or when irresponsible owners dump unwanted cats and kittens (Lorang 2013).

It is important to remember that all of the above are the domestic cat species *Felis catus* and that stray and feral cats are simply an introduction of that domestic species to the urban, suburban and natural environment.

Australia's unique wildlife evolved in an environment that did not include cats. The relatively recent introduction of cats to Australia has added a predator with new hunting techniques that has changed the natural balance (Dickman 1996).

3 Issues specific to Tweed Shire.

3.1. Data on owned, stray and feral cats in Tweed LGA.

Cats are known to be present throughout Tweed Shire as owned, stray and feral animals.

Whilst it is known that stray cats are present in Tweed Shire, no population estimates have been made and there is no formal control program. Community members have the option of borrowing a cage trap from Council should they choose to control stray cats that visit their property.

Tweed Shire currently has 6610 registered cats; however this figure is not a true representation of the number of owned cats in the Shire. The accuracy of this figure is compromised by two main factors. These are: failure of some cat owners to microchip their cat, despite a legislative obligation to do so; and failure of some cat owners to alert Council when their registered cat has died or moved out of the Shire.

Since February 2011, there have been 345 complaints made to Council about cats. Of these, 127 complaints were about roaming cats.

Table 1, below, provides some statistics regarding Tweed Shire Council cat registrations and the euthanasia rates at TSC Pound.

3.2. Impacts on Threatened fauna in the Tweed

The Threat Abatement Plan for Predation by Feral Cats (2008) lists 81 endangered and vulnerable species that are known or perceived to be under threat from cats. Of these, **21 species occur within the Tweed Shire** (see Appendix 1).

A preliminary assessment of State and federally listed Threatened fauna has identified **a further 58 species that occur in the Tweed that have the potential to be impacted by cats** (see also Appendix 1).

Alongside the impacts on Threatened fauna, it is important to also consider the impact of cats on more commonly encountered native fauna of the Tweed, including mammals, birds, frogs and reptiles as well as insect fauna.

Table 1: Tweed Shire Council cat registrations and the euthanasia rates at TSC Pound

	2010	2011	2012	2013	2014
No. of cats lifetime registered in Tweed Shire	221	220	524	342	331
No. of cats registered as desexed	**Figures are limited for this request.**				
	2007- 2013			**Jan 2014 - April 2015**	
	2011 desexed cats			388 desexed cats	
No. of cats impounded at TSC Impounding Facility	**These figures are only available in Financial year.**				
	2009-2010	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**
	174	208	223	192	253
No. of cats euthanased at TSC Impounding Facility	75	94	82	63	71
Reason for euthanasia:					
At Owners request	No data	8	2	1	3
Not Suitable for rehoming	No data	86	80	32	39
Sick	No data	No data	No data	10	7
Feral	No data	No data	No data	20	22

3.3. Current programs in Tweed Shire

The following research and management programs are being implemented in Tweed Shire to manage the impacts of cats on native wildlife.

The Pest Management Program Area (PMPA) and the Compliance Unit have been working cooperatively to implement the following two programs.

- A cage trapping program for cats. Through funding provided by NSW Environmental Trust, ten cage traps for cats have been purchased. These are available for loan by community members who are having trouble with a roaming/feral cat. This supplements the six existing traps that are available for loan through the Council Pound. Each person is required to sign an 'Animal Welfare Protocol' prior to borrowing a trap. All cats trapped through this program are impounded at Councils Pound facility.

  Since June 2012, a total of 52 cats have been trapped in the traps purchased through NSW ET funding. These 52 cats were a combination of roaming domestic and feral cats. Where possible, the roaming domestic were reunited with their owner or re-homed. The temperament of feral cats makes them unsuitable for re-homing and these cats were euthanised. No data is currently available on the number of cats trapped through the Council Pound trap loan program. A new recording system has recently been put in place to ensure that this data is captured.

  It needs to be recognised that cage trapping for cats is a very resource intensive exercise, and that cats are notoriously difficult to trap. Once they have been trapped in a cage trap they are unlikely to be trapped a second time.

- Tweed Shire Council is dedicated to working with the community to promote positive and responsible pet ownership, and to minimise the impacts of domestic pets on native wildlife. To this end, PMPA and Compliance staff cooperatively submitted a successful grant application to the Office of Local Government Responsible Pet Ownership Grants Program.

  The amount grained through this grants program was $13,590.00, to be implemented between March and June 2015. Additional funding will be sought for a further two years following successful implementation of the first stage.

  This project is delivering a number of innovative educational initiatives to increase the knowledge and capacity of pet owners to responsibly manage their pets in the target area of Pottsville Beach.

  The project is delivering the following in the Pottsville Beach locality:

  - Subsidised 'de-sexing vouchers' for 40 low income residents that could be used at participating local vet clinics.
  - Free micro-chipping services and subsidised pet registration to eligible residents.
  - A presentation to Pottsville Beach Public School students about responsible pet ownership and the 'Pottsville Fauna Friendly Pet' program (see below).
  - Attendance by staff at Pottsville Beach markets days to promote; the project.

- Promotion and delivery of a series of two workshops/seminars delivered by RSPCA Queensland promoting responsible pet ownership, with topics including “Reducing Your Pets Impact on Wildlife”.
- Development and implementation of a voluntary 'Pottsville Fauna Friendly Pet’ program whereby residents can commit to owning a 'Fauna Friendly Pet’. This program encourages and guides community members to fulfil set criteria such as avoiding taking dogs into areas of bushland; and keeping their cat inside. Once owners have committed to the criteria, they will be sent a letter of accreditation and a method of identifying their property and pet, such as a plaque for their gate and/or a collar.

  Additional funding ($12,000.00) has been secured through the NSW Environmental Trust to roll out this program in Fingal during 2015-2016.

The Pest Management Program Area is implementing the following programs.

- Through funding provided by the Koala Beach Environmental Levy, monitoring of cats at Pottsville Beach and Koala Beach between March and June of 2014 was initiated to:
  - Ascertain whether cats are moving into Koala Beach from urban areas of Pottsville Beach where cat restrictions do not apply;
  - Identify possible movement routes and source areas of cats; and
  - Identify approximate density of cats, if present.

  Whilst monitoring did not record any cats in the Koala Beach Estate, it did demonstrate that cats are roaming within the Pottsville Beach CBD and Seabreeze Estate and some cats appear to be moving from these areas into adjacent bushland, including the Pottsville Environment Park. The Pottsville Environment Park is an area of high conservation value that supports a high number of susceptible threatened fauna, and is immediately adjacent to the Koala Beach bushland estate.
  - Recommendations made in the monitoring report included:
  - Regular camera monitoring that targets cats should be undertaken at suitable positions on the periphery of the Pottsville Environment Park.
  - Cat cage trapping should commence in conjunction with the above camera monitoring. Cage traps could be set in similar positions to camera traps. Roaming domestic cats trapped through this program will be reunited with their owner or re-homed. Feral cats will be euthanised.
  - To support cat management, a broader education/regulatory campaign should also be considered within the Seabreeze Estate and Pottsville Beach areas. This could potentially be expanded to include the whole of Tweed Shire.
- Through funding provided jointly by Council, the NSW Environmental Trust, and the Koala Beach Environmental Levy, a program of monitoring for wild dogs and foxes has been implemented on the Tweed Coast. Through this, many incidental images of cats have been recorded. Fifteen fixed-location cameras have been in place over a period of approximately 18 months (see Figure 1). Cats (both collared and un-collared) have been recorded on seven of these cameras. Cats

have been recorded on Council managed lands, Cudgen Nature Reserve and private property. It is worth noting that none of the landholders on the land on which the cats were recorded have a domestic cat as a pet. Figures 2 - 5 are images that have been captured through this program. The camera data collected through this program has guided the identification of cat trapping sites.

- Through funding provided by the NSW Local Land Services, Council has been provided with a remote camera that can take colour night time images. This will be a huge benefit to Council in providing images that allows the identification of individual animals, as this can sometimes be difficult with black and white night time images.

Further research and monitoring on cat ecology and the impact of cats on native wildlife within the Tweed region is an essential requirement for the preservation of biodiversity within the Tweed Shire and the management of threatening processes on all wildlife.

Figure 1: Map showing location of cameras, Tweed Coast

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Figure 2: Cat at Pottsville wetlands with captured native mammal

Figure 3: Cat on private property adjacent to Cudgen Nature Reserve.

Figure 4: Cat at Pottsville Wetlands with native mammal.

Figure 5: Cat recorded at Cudgen Nature Reserve

4 The impacts of cats on the eastern Seaboard

Cat ownership is deeply entrenched within Western society, and cats are highly valued in the Australian community as companion animals. It is now well-known that cats can provide considerable benefits to the health and well-being of their owners. Cats are also valued by some sections of the community for their role in controlling rats and mice.

While domestic cats have a societal benefit and intrinsic value to their owners, community concerns arise: when owned cats are allowed to roam beyond the owner's property; and stray and feral cats are identified within a local area. These concerns revolve around two main issues: impacts of cats on wildlife; and the social impacts of cats, including potential for nuisance behaviour and the transmission of disease (Eyles and Mulvaney 2014).

These issues are expanded on below.

4.1 Impacts of cats on wildlife

The domestic cat (referring in this context to owned, stray and feral cats as per Section 2.0) has become a feral predator and conservation threat in many regions of the world (DeVore 2010), and has been identified as one of the World's Worst Invasive Alien Species (Lowe 2000). Due to their abundance and behaviour as generalist predators, feral, stray and owned domestic cats have a high tendency to prey on many fauna species, including small mammals, herpetofauna (reptiles and amphibians), and passerine birds (Loyd *et al*., 2013).

Domestic cats are known to be Australia's most formidable introduced mid-sized predator and by virtue of their abundance in the majority of Australia's ecosystems, is a major predator of native fauna. They have been implicated in the national decline of several native fauna species across Australia (Denny and Dickman 2010), including small mammals, birds (especially ground dwelling birds), insects, reptiles, fish and amphibians (DEWHA 2008). In New South Wales, predation by **feral cats has been linked to the extinction of 13 species of mammals and 4 species of birds**. When combined with other threatening processes, such as habitat loss, much of Australia's native wildlife is struggling to survive.

Once caught by a cat, few prey animals survive. Even if the prey animal appears to have escaped, infection from the cat's teeth or claws or the stress of capture usually results in death (Coleman *et al*. 1997). In most parts of Australia cats are not confined or supervised (whereas dogs usually are) and are free to hunt as they desire.

4.1.1 Feral cats

Feral cats are wild living domestic cats that survive with no input from humans. They are carnivorous hunters that predate on animals up to 2kg, but more often take prey under 200g (Denny and Dickman 2010). The impacts of feral cats on wildlife are firmly established. Predation by feral cats has been implicated in the extinction and decline of many species of mammals and birds on islands around Australia and in other parts of the world, and in the early extinction of up to seven species of small mammals on the Australian mainland (DEWHA 2008).

In recognition of the immense ecological threat placed on native wildlife by feral cats, 'Predation by Feral Cats' has been federally listed as a Key Threatening Process

under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999. The Threat Abatement Plan for Predation by Feral Cats (2008) (Cat TAP), developed as a result of this listing, provides a blueprint for actions required to eradicate feral cat populations on Australian islands and control feral cat populations on the mainland (Appendix 1).

Whilst it is recognised that eradication of feral cats (or any other established vertebrate pest species) is not possible on the Australian mainland, properly coordinated and resourced control programs can achieve meaningful benefits for Threatened fauna populations.

The Cat TAP lists 36 mammal, 35 bird, seven reptile and three amphibian native species that are threatened and are known or perceived to be under threat from domestic cats in Australia. The Cat TAP also identifies four unlisted bird species, two unlisted reptile species and two listed critical habitats that may be adversely affected by feral cats (Denny and Dickman 2010).

The Cat TAP was reviewed in 2014. Through this review it was found that "The threat abatement plan for predation by feral cats has the goal of minimising the impact of feral cats on biodiversity in Australia and its territories by: protecting affected native species; and preventing further species and ecological communities from becoming threatened. This goal has not been achieved during the life of the plan." However, the review concluded that "the key threatening process is still valid and that a threat abatement plan is still a feasible, effective and efficient means to abate the threat." The review stated that this validity was dependant on the Cat TAP being updated to include recent advances in cat management technologies.

In 2000, 'Predation by Feral Cats' was listed as a Key Threatened Process under the NSW *Threatened Species Conservation Act* 1999 (TSC ACT). No Threat Abatement Plan has yet been developed by the NSW government, despite a legislative requirement under the TSC Act to do so.

The Cat TAP establishes a national framework to guide and coordinate a national response to the impacts of feral cats on biodiversity, identifying research and management actions required to ensure the long-term survival of species and communities affected by predation by feral cats. Consequently the Cat TAP is of limited relevance in providing practical actions to guide management of the impacts of cats in the Tweed.

The extent of the feral cat problem in the Tweed Shire is unknown.

4.1.2 Stray and unconfined owned cats

The control of stray and domestic cat populations is most commonly covered by legislation at the state and local government levels. In NSW, the legislation owned cats is the *Companion Animals Act* 1998.

Research by Jongman (1996) has suggested that although domestic cats make affectionate pets, most owned cats are not bred to be 'house cats' and many hunt as effectively as feral cats. Owned cats can exist at extremely high densities in the urban environment, up to 100 times denser than in the wild (Liberg *et al.* 2000). Owned cats typically receive prophylactic vaccinations and anti-parasite treatments and an abundant, dependable food supply. Whilst ensuring a cats health and food needs are met are essential components of being a responsible cat owner, it does

mean that cat populations are not limited by prey availability and disease (Liberg *et al.* 2000).

Although the body of work on the impacts of owned cats on native wildlife is not as comprehensive as that for feral cats, the limited studies that have been completed clearly demonstrate a significant negative impact. Key findings from this research are summarised below:

- Cats are opportunistic hunters with prey type largely dictated by availability.
- If owned cats have easy access to natural prey, they seemed to prefer that to 'cat' food.
- Prey choice of owned cats was similar to that of feral cats, although intake of native fauna by feral cats was significantly greater than owned cats.
- Individual owned cats vary considerably in the degree to which they predate native fauna.
- A large proportion of owned cats hunt, with a cats desire to hunt not suppressed by adequate supplemental food.
- Many cat owners are unaware of their cats hunting behaviour - many cats do not bring home trophies. Therefore predation rate of owned cats (particularly small prey types) may be much higher than that reported by cat owners.
- Cats may target a single species of fauna or group of fauna, coinciding with increased presence or activity of that species (breeding, foraging times, migration, etc). This has the potential to impact fauna at a local scale with the potential for localised extinctions.
- The proximity of owned cats to native bushland areas is relevant to the amount and type of native fauna impacted.

More detail on each of these studies is provided below.

Liberg (1984) found that the prey choice of owned cats was similar to that of feral cats, but the absolute intake of native fauna by the later was four times that of an average house-based cat. Short *et al.* (2002) found that rodents, birds and reptiles occurred more frequently in the diet of feral cats and food scraps occurred more frequently in the diet of semi-feral cats, although their dietary diversity was similar (Brickner-Braun 2007).

A number of studies have shown that individual owned cats vary considerably in the degree to which they predate wild animals, with many probably taking few or no prey (Churcher and Lawton, 1987; Barratt, 1997, 1998). Whilst not all owned cats are hunters, most cats hunt instinctively and the motivation for a cat to hunt is often independent of hunger (Liberg 1984, Warner 1985, Fitzgerald and Turner 2000). The amount of time spent hunting varies widely between individual cats (van Heezik *et al.,* 2010) and some cats appear to be more active or successful hunters than others. Many cat owners are unaware of the hunting behaviour of their pet, as many cats that are hunters do not bring home trophies (Woods *et al.* 2003). A number of studies have also shown that hunting activity may occur both day and night (Barratt 1997; Lilith *et al*. 2006; Morgan *et al*. 2009; Van Heezik *et al*. 2010).

Unlike some predators, a cat's desire to hunt is not suppressed by adequate supplemental food. Even when fed regularly by people, a cat's motivation to hunt

remains strong, so it continues hunting unless confined (Coleman *et al.* 1997). During a study in Canberra, Barratt (1997) demonstrated that owned cats retained their "exceptional predatory ability". This study also showed that owned cats appear primarily opportunistic in their predatory behaviour. Liberg (1984) found that when owned cats had easy access to natural prey, they seemed to prefer that to household food.

Morgan *et al*. (2009) provide evidence about predation in an urban wetland reserve including a significant record of invertebrates as prey species. Young cats were responsible for 95% of invertebrate prey and this was the second most common prey type by number. Invertebrates accounted for 216 prey items of which 72% were native porina moths with one cat retrieving 92% of those moths. Water was no barrier to predation, with cats observed swimming across defensive swales to islands where native birds nested, and jumping across ditches and drains to enter the internal parts of the wetland.

Eyles and Mulvaney (2014) discuss one of the few comprehensive studies of predation by domestic cats (Barratt 1997). This study, which was undertaken in Canberra, collected information from homeowners on the type and frequency of prey returned to the home by cats. This study found that over 67 species of prey were caught by domestic cats, with small introduced mammals caught most often, followed by birds (27%, of which 14% were native), native reptiles 7%, native frogs 1%, and native mammals 1%.

This study also identified that seasonal spikes in hunting and variation in cat diet is significant for small native bird species, juvenile birds and reptiles. Mice and rat take was highest in winter and in suburban environments, whereas predation on juvenile birds and reptiles increased from late spring to summer when these species were more abundant and active. Estimates based on this study indicate that owned cats in the Canberra urban environment hunt about 480,000 animals each year, including 20-27% of the standing crop of native birds (Elyse and Mulvaney 2014).

Eyles and Mulvaney (2014) also outline how Barratt's Canberra study teases out the spatial effect of habitat and urban edge and how this interacts with degree of predation pressure on reptiles and birds. In relation to the types and frequency of prey returned to home by cats, reptiles, while a minor proportion of prey overall, were the most predated species within 50 m of grassland habitat and accounted for 23% of prey within 50 m of woodland or open forest. Native birds as prey increased closer to woodland source habitats. Restriction of the movement of cats is likely to diminish predation, particularly in residential areas close to these habitat types. Domestic cats are generally more active for longer periods in spring and summer which corresponds with the breeding cycle of many prey species (Barratt 1997; Robertson 1998).

Figure 6: Owned, free-roaming cat wearing a KittyCam videocamera. From Loyd *et al.* (2013).

Barratt (1997) found that birds were caught in the early morning and reptiles in the afternoon. Significantly, reptiles and frogs were the third and fourth most important prey types in all months. Barratt also concluded that the level of predation on birds and reptiles confirmed that cats were actively hunting during the day, and cats favoured ground-foraging and dwelling species.

However, Robertson (1998) puts forward that the predation rate of owned cats (particularly as it relates to small prey types) may be much higher than that reported by cat owners as smaller animals are more likely to be consumed at place of capture and not brought home.

A recent study undertaken by Loyd *et al.* (2013), confirms this. Loyd *et al* (2013) employed the use of KittyCam video cameras on break-away collars on free-roaming owned cats to assess the accuracy of previous studies that relied on data captured through prey returns (refer Figure 6).

This study then analysed the hunting activities of owned, free-roaming cats in both rural and urban areas and found that cats bring less than a quarter of their captures back to their residence. This suggests that previous studies of cat predation which depended on information collected from prey returns may have vastly underestimated the total take of hunting cats. This study also supports previous studies (Liberg 1984; Molsher 1999) that have shown cats are opportunistic predators and that prey selection is correlated with prey availability. Loyd *et al.*

(2013) put forward that similar technologies should be applied in other geographic areas to corroborate their findings.

Whilst the studies above provide information on the types and numbers of fauna being predated by owned cats, studies of the impacts of owned cats at a prey population level are scarce. Assessing the impact of cats on populations of native species, as opposed to predation on prey individuals is difficult. In addition to predation by cats, there are a range of other variables that can lead to reductions in the abundance, distribution and densities of species. These variables include climatic events (drought, fire, flood, etc), habitat modification, disease, and food resource distribution and density (Denny and Dickman 2010). It would be difficult to determine the relative contribution that each of these variables, including predation by cats, have on populations of native fauna.

4.1.3 Transmission of disease to wildlife

Domestic cats serve as a reservoir for numerous wildlife and human diseases. These diseases may be transferred to wildlife species that come in contact with feral, stray and owned cats, potentially threatening vulnerable populations. A study by Moodie (1995) recorded 30 pathogens and parasites cats have transferred to native wildlife of which cats are the definitive host. Transmission of disease and parasites to native wildlife from domestic and feral cats has reduced species abundance, distribution and overall ecological fitness of some populations of native fauna (Henderson 2010 in Denny and Dickman 2010).

The protozoan parasite *Toxoplasma gondii* of which cats are the only host, has produced recorded cases of birth defects, terminated births, blindness and paralysis in bird and mammal species such as the Bennets Wallaby, Quokkas, Possums and Wombats (Moodie 1995). In a Tasmanian study, 10 out of 150 Eastern Barred Bandicoots (*Perameles gunnii*) were found to be infected by this protozoan parasite (Denny and Dickman 2010). The pseudophyilidum tape worm, of which the cat is a host, has been recorded in numerous mammal, snake and frog species.

4.1.4 Impacts of cat predation in urban areas

Due to the decline of natural areas and the rapid expansion of developed areas, urban habitats are critical to the future protection of biodiversity (Loyd *et al.* 2013).

With the recent growth in interest in urban ecology, it has become clear that many populations of birds and mammals are on the edge of sustainability in human-modified habitats, as urban animals respond to the challenges of living in highly altered and fragmented habitats (Thomas *et al.* 2014). Urban wildlife is not restricted to parks and natural areas; many species of birds, bats, lizards and amphibians can still be found in gardens in suburban areas.

Owned cats that live in highly urbanised areas have a significant effect on native wildlife, as cat numbers in these areas are generally high whilst numbers of many native species are low (Barratt, 1998; Baker *et al*., 2008; Van Heezik *et al*. 2010). The urban landscape tends to be saturated with cats and although not all are active hunters, their densities are so great and their home ranges so flexible that their presence is felt virtually everywhere (Van Heezik *et al*., 2010).

Urban herpetofauna are under a wide range of pressures due to urbanisation (Van Heezik and Ludwig 2012), including vehicle strike and predation by domestic animals. Loyd *et al*. (2013) recommends that predation of suburban reptiles receive

further research attention to determine if there is any population-level impact due to this mortality factor. As previously mentioned, many owned cats regularly roam during the day (Barratt 1997), and the necessary habit of basking in warm sunlight leaves herpetofauna very visible to cats, increasing risk of mortality.

4.1.5 Ranging behaviour of cats and interactions with wildlife

During studies to determine the ranging characteristics of owned cats, Thomas *et al*. (2014) found that cats ranged further during the night. This is consistent with the findings of studies on feral cat ranging movements.

In reviewing cat tracking studies, Elyse and Mulvaney (2013) found incursions of domestic cats, ranging from 80 to 1000 metres, into bushland reserves. Elyse and Mulvaney (2013) report that these studies provide useful data about the home ranges and movements of cats, which can guide the spatial extent of containment that would be required to prevent forays into nature reserves.

In a study on domestic cat predation in Canberra, Barratt (1997) found that six of ten house cats went beyond the suburban edge and the remaining four moved between 390m and 900m into bushland habitat. The more dominant cats roamed up to 1 km into the reserve (Barratt 1997).

A NSW study of domestic cats in Booderee National Park settlements showed that cats used roadside tracks and vegetation as routes to hunting grounds and kept close to fence lines for cover (Meek 2003). Buffer zones of up to 500 metres around nature reserves have been recommended to exclude roaming cats in urban – bush interface settings (Lilith *et al.* 2006).

Metsers *et al.* (2010) acknowledges that cat exclusion buffers to protect vulnerable species may need to differ between regions. This study recommends buffers be more than one kilometre wide at the urban edge to allow for variation in cat movement behaviour, landscape conditions, and proximity to urban development. The tendency for cats to roam increased distances if they don't encroach on another cat's territory also complicates the consideration and effectiveness of buffers (Elyse and Mulvaney 2013).

Within the Tweed Shire, remote camera monitoring in bushland in the Round Mountain and Pottsville Wetland areas have recorded individual cats travelling between permanent camera sites at night, a distance of 1.5km and 750m respectively. Remote camera monitoring has also recorded the predatory behaviour of cats, with cats recorded on camera carrying prey items including small arboreal mammals like gliders and possums (Refer Figures 3 and 5).

Whilst there have been limited studies into the ranging behaviour of owned cats, studies consistently show that cats roam significant distances and proximity of the cats place of residence to a bushland reserve affects the degree of impact a cat has on locally occurring fauna.

4.1.6 Proximity of residential areas and domestic cat source populations to bushland reserves

The issue of cat predation has been raised as a potential problem in the development of new residential areas that are constructed near natural areas important for biodiversity conservation (Thomas *et al.* 2014).

Whilst not all cats hunt, it has been clearly shown that, collectively, owned cat populations kill large numbers of prey, and with the continued expansion of urban areas into rural and bushland habitats, the importance of cat predation as an ecological factor is increasing (Baker 2005). Barratt (1997) found that in relatively undisturbed environments adjoining new residential development, predation by domestic cats may have a substantial impact on locally abundant, patchily distributed populations of native fauna, particularly mammals.

Baird *et al.* (2005) discuss how owned cats are likely to have the greatest impact on native fauna where new housing developments adjoin areas set aside for the conservation of biodiversity due to the relatively high number of domestic cats likely to wander into these conservation areas.

Encroachment and habitat alteration of natural areas has led to increased contact between owned cats and wildlife (Willson *et al.* 2015). Under this context, free ranging owned cats are a major threat to native fauna (Loss *et al.,* 2013), as suburban residential areas may retain sufficient aspects of nearby wilderness to maintain high densities and diversities of native species that have high probabilities of encountering predatory domestic cats.

As pointed out by Tidemann (1994), the effect of owned cats moving beyond suburban edges into remnant habitat is akin to the effects wrought by a predator newly introduced to an island environment. While the cat is mobile, many of the native fauna species in remnant habitats are relatively immobile and exist in patchily distributed and isolated fragments. Populations have been isolated and reduced largely because of habitat clearance, but owned cat predation can be the final straw that leads to local extinctions (Preisser *et al*. 2005).

A number of studies have shown that the extent of the impacts of unconfined owned cats on native wildlife varies depending on their proximity to natural areas, and that cats that live close to remnants of bush are likely to kill a wide range of native wildlife (Loss *et al*. 2012; Baker 2005; Lilith *et al.* 2006).

Loss *et al.* (2012) showed that whilst owned cats had less of an impact on wildlife than un-owned cats, owned cats still cause substantial wildlife mortality, and that populations of threatened fauna in close proximity to areas with cats face an especially high level of risk. This study recommended that simple solutions to reduce mortality caused by owned cats should be pursued, such as limiting or preventing outdoor access.

Through their study in New Zealand, Morgan *et al*. (2009) also identified the heightened predation risk in restored habitats where a single cat could have a dramatic impact on founder populations of native fauna. While populations of common fauna may not be affected rarer, vulnerable species, require additional protection. This study demonstrated that domestic cats will exploit local natural areas, usually if a cat's place of residence is adjacent or very close by.

The study undertaken by Morgan *et al.* (2009) reached similar conclusions to Loss *et al*. (2012). Both studies concluded that, although cats may not be driving population decreases of the common species, rarer 'at risk' native species may require additional protection from the occasional super-predator cat in the local area. Accordingly, the adoption of a precautionary approach by wildlife managers regarding domestic cats is recommended.

In relation to Tweed Shires urban reserves, current efforts to restore habitat and connectivity between urban/peri-urban bushland reserves and subsequent increased native animal diversity could be undermined by cats roaming into these areas from neighbouring properties and suburbs.

Many of Tweed Shires residences are adjacent to, or embedded within, areas of natural bushland that hold a high conservation value. Whilst having habitat close to bushland brings human benefits from everyday interaction with wildlife, it also means native wildlife are highly vulnerable to predation from roaming owned cats. Small populations of threatened fauna in these areas are particularly at risk of localised extinctions due to predation cats.

4.1.7 Indirect impacts of cat predation

Predation has a direct effect on prey survival, but may also have indirect effects (Brickner-Braun 2007). Even if an animal is not killed, indirect negative effects on breeding ability and behaviour (due to cat stalking and chasing) are possible.

Domestic cats may also compete with native predators for prey animals. Due to their generalist diet, cats compete with native fauna that feed on both vertebrate and invertebrate species. Unlike many other predators, domestic cats do not strictly protect or defend their territories and therefore live in much higher densities in colonies that can grow to include dozens of animals (Coleman *et al*., 1997).

An additional indirect impact is that the behaviour of native animals may change in response to the risk of predation. For example, an animal that perceives a high risk of predation will not stray far from cover, thus limiting foraging and available food resources (Denny and Dickman 2010). Reduced nutrition may increase the rate of mortality and/or the number of young that can be successfully raised.

In a review of 166 predation research studies across a wide range of taxa, Preisser *et al*. (2005) estimated the non-lethal effects of predation to be greater than the lethal effects, and that the effects of predator intimidation became more pronounced at higher food chain levels.

Beckerman *et al.* (2007) and Bonnington *et al.* (2013) also suggest that there are sub-lethal effects on urban birds as a result of cat presence in the system, including: reduced reproductive performance, increased nest defence, and reduced parental provisioning (decreasing nestling growth rates).

4.2 Social impacts of cats

4.2.1 Nuisance cats

Under the NSW *Companion Animals Act* 1998, cat owners are not subject to the same regulations imposed on domestic dog owners, and cats are free to roam across most tenures. As a result, free roaming or unconfined domestic cats represent a significant source of neighbour aggravation and public nuisance complaints to Local Government authorities relating to noise (from mating and fighting), territory marking, defecating in neighbours gardens, and attacking other pets (caged birds etc.).

Additionally, as awareness about biodiversity develops among urban residents, a growing number of people who have created wildlife friendly environments in their

backyards are also becoming frustrated that their efforts are undermined by the activities of neighbours' cats (Van Heezik 2010).

4.2.2 Transmission of disease and parasites

As detailed in Section 4.1.3, domestic cats serve as a reservoir for numerous wildlife and human diseases. Whilst these diseases may be transferred to native fauna, domestic owned cats may acquire numerous diseases from wildlife and transmit them to their human owners, such as Toxoplasmosis (Brickner-Braun 2007). If rabies were to be accidentally introduced into Australia, there is a high risk that feral cats would act as carriers of the disease (Dept. Sust., Envir., Water, Pop. and Comm. 2011).

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Appendix 1: Threat Abatement Plan for Predation by Feral Cat (2008)

THREAT ABATEMENT PLAN for predation by feral cats 2008

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and the Arts

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Content

1 Introduction

This threat abatement plan (TAP) establishes a national framework to guide and coordinate Australia's response to the impacts of feral cats on biodiversity. It identifies the research, management and other actions needed to ensure the long-term survival of native species and ecological communities affected by predation by feral cats. It replaces the threat abatement plan for predation by feral cats published in 1999 (EA 1999a).

1.1 Threat abatement plans

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Australian Government develops TAPs and facilitates their implementation. To progress the main strategic development actions, the Department of the Environment, Water, Heritage and the Arts (DEWHA) assesses the potential for partnerships and co-investments with other government agencies, industry and other stakeholders. An important part of implementation of the TAP is ensuring that knowledge of improved abatement methods is disseminated to potential users.

Mitigating the threat of invasive species is not simply a matter of providing better technical solutions such as improved baits for pest animal control. It also involves understanding and addressing social and economic factors; for example, through supporting the efforts of private landholders and leaseholders to manage invasive species on their lands for biodiversity conservation and primary production. In addition, research and development programs for controlling vertebrate pest species need to integrate interests relating to both primary production and environmental conservation.

Regional natural resource management plans and site-based plans provide the best scale and context for developing operational plans to control invasive species. They allow primary production and environmental considerations to be jointly addressed, and control to be integrated across the local priority vertebrate pests within the scope of other natural resource management priorities.

The national coordination of pest animal control activities occurs under the Australian Pest Animal Strategy, released in 2007 by the Natural Resource Management and Primary Industries Ministerial councils. The Vertebrate Pests Committee, comprising representatives from all Australian, state and territory governments, has responsibility for implementation of the strategy. This TAP provides guidance for the management of feral cats within that broader context.

1.2 Threat abatement plan for feral cats

1.2.1 The threat

The first recorded instance of cats being brought to Australia was by English settlers in the 18th century, although cats may have arrived much earlier with other human visitors (Baldwin 1980). Cats were deliberately released into the wild during the 19th century to control rabbits and mice (Rolls 1969). Today there are about 18 million feral cats in Australia (McLeod 2004), distributed through all habitats (except some of the wettest rainforests) in mainland Australia and Tasmania and on many offshore islands.

Feral cats are a serious vertebrate pest in Australia, and have severe effects on native fauna. Predation by feral cats is listed as a key threatening process under the EPBC Act. Feral cats are a threat to a large number of native species (see Appendix A), although impacts from feral cat predation are not restricted to these species.

This TAP has been put into place as a feasible, effective and efficient way to abate the threat of predation by feral cats.

1.2.2 The impacts

Various characteristics help to explain the invasiveness and impact of cats. They can colonise a wide range of habitats. As carnivores, they eat a wide range of prey and can survive with limited access to drinking water. The survival rate of kittens is not high, but cats can breed in any season, allowing rapid increases in numbers.

Cats have direct impacts on native fauna through predation. They can kill vertebrates weighing as much as 3 kg (Dickman 1996), but preferentially kill mammals weighing less than 220 g and birds less than 200 g. They also kill and eat reptiles, amphibians and invertebrates (Dickman 1996). Cats can also have indirect effects on native fauna by carrying and transmitting infectious diseases (DEH 2004). They are thought to have contributed to the extinction of many small to medium-sized mammals and ground-nesting birds in the arid zone, and to have seriously affected populations of bilby, mala and numbat (DEH 2004).

1.2.3 Managing the threat

As cats are so widely established in Australia, the focus of management is generally on abatement of the impacts of established populations, rather than prevention and preparedness. Control of cats is difficult as they are found in very low densities over large home ranges, making them difficult to locate. Control methods include trapping, shooting and exclosures.

Interactions between pest species mean that control of cats can have effects on other invasive animals, such as rabbits and rats. For example, eradication of cats from some islands (e.g. Macquarie Island) has led to an increase in the rabbit population, resulting in extreme environmental damage, including increased destruction of nesting sites and landslips. An understanding of these interactions is important when designing and recommending pest animal control programs. In many situations, concurrent multi-species programs will be required. Integrating control techniques will maximise the success of control programs.

Although total mainland eradication may be the ideal goal of a cat TAP, it is not feasible with current resources and techniques. Cat populations must instead be suppressed and managed to mitigate impacts in targeted areas where they pose the greatest threat to biodiversity. Eradication may be achievable in isolated areas, such as small reserves and offshore islands. Progress in control programs must be monitored to ensure that objectives are met and to allow management options to be adapted to changing circumstances. Best-practice management of cats must involve reduction of the threat not only to targeted threatened species, but also to native species that may be affected by cat predation.

1.2.4 The review of the 1999 TAP

In accordance with the requirements of the EPBC Act, the original TAP for predation by feral cats (EA 1999a) was reviewed in 2004–05 by the Bureau of Rural Sciences (BRS) (Hart 2005) as part of a broader review encompassing the original TAPs for foxes (EA1999b), goats (EA1999c) and rabbits (EA1999d).

The BRS review found that it was difficult to accurately determine the extent to which the cat TAP had reduced the impacts of cats on biodiversity. This reflects the current paucity of nationally consistent data on the ranges and densities of cats and their impacts, and the difficulties of linking outcomes in cat population changes to the outputs of the TAP. The invasive species indicator data to be produced under the National Monitoring and Evaluation Framework (NRMMC 2003) should improve the availability of continental overview data over the next year or so.

The BRS surveyed a broad range of stakeholders and assessed a range of projects commissioned by the Department of the Environment and Heritage (now the Department of the Environment, Water, Heritage and the Arts) that were developed under the auspices of the existing TAPs. This has helped to identify actions that will need to be initiated or continued into the future. The review concluded, however, that the cat-related projects that were assessed had positively contributed to reducing the impacts of cats. Furthermore, projects have addressed specific cat control needs in high-priority locations, and have supported the development of a cat toxin. Of the 29 actions in the 1999 TAP for cats, many were targeted by at least one project, and almost a third of the cat actions had been fully completed through one or more projects.

The BRS review proposed a number of changes to the actions found in the original TAP, but recommended that the objectives remain substantially unchanged. The review suggested that the implementation of the revised cat

TAP should give priority to improved national engagement, integrated pest animal control, flexibility in implementation, setting priorities for research, follow-through with research and development, and establishment of a new advisory panel for vertebrate TAPs. The review also recommended that the revised plan include measures to enhance existing processes through, for example, regional processes; control and monitoring techniques that support on-ground management; and monitoring of key projects according to national protocols.

This document replaces the 1999 TAP. It incorporates the knowledge gained in the intervening years and has been modified in line with recommendations from the review. The TAP aims to guide the responsible use of public resources and the best outcome for native species and ecological communities threatened by predation by feral cats. The plan seeks to achieve these outcomes by recognising the opportunities and limitations that exist, and ensuring that field experience and research are used to further improve management of feral cats. The activities and priorities under the TAP will need to adapt to changes as they occur.

1.2.5 Involvement of stakeholders

The successful implementation of this TAP will depend on a high level of cooperation between landholders, community groups, local government, state and territory conservation and pest management agencies, and the Australian Government and its agencies. Success will depend on all participants assessing cat impact and allocating adequate resources to achieve effective on-ground control of feral cats at critical sites, improve the effectiveness of control programs, and measure and assess outcomes. Various programs in natural resource management, at national, state and regional levels, can make significant contributions to implementing the plan.

2 Objectives and actions

The goal of this TAP is to minimise the impact of feral cats on biodiversity in Australia and its territories by:

- protecting affected native species and ecological communities, and
- preventing further species and ecological communities from becoming threatened.

To achieve this goal, the plan has five main objectives, developed through the review of the previous TAP (Hart 2005) and consultation with experts. These objectives are to:

1. prevent feral cats occupying new areas in Australia and eradicate feral cats from high- conservation-value 'islands'
2. promote the maintenance and recovery of native species and ecological communities that are affected by feral cat predation
3. improve knowledge and understanding of feral cat impacts and interactions with other species and other ecological processes
4. improve effectiveness, target specificity, humaneness and integration of control options for feral cats, and
5. increase awareness of all stakeholders of the objectives and actions of the TAP, and of the need to control and manage feral cats.

Each objective is accompanied by a set of actions, which, when implemented, will help to achieve the goal of the plan. Performance indicators have been established for each objective. Progress will be assessed by determining the extent to which the performance indicators have been met.

The sections below provide background on each objective, followed by a table listing the actions required to meet the objective. Twenty-one actions have been developed to meet the five objectives.

Priorities for each action are given in the tables below, categorised as 'very high', 'high' or 'medium'. Each action has also been assigned a timeframe within which the outcome could be achieved once the action has commenced. Timeframes are categorised as short term (i.e. within three years), medium term (i.e. within three to five years) or long term (i.e. five years or beyond).

☐ Objective 1

Prevent feral cats occupying new areas in Australia and eradicate feral cats from high- conservation-value 'islands'

Key actions for Objective 1 include identifying 'islands' of high conservation value, ranking the risk to such areas posed by feral cats, and developing and implementing management plans to protect such areas from feral cats. The actions are designed to prevent feral cats from extending their range in Australia, and to remove them from high-conservation-value 'islands' where this is feasible. The actions focus on offshore islands and on mainland 'islands' that are isolated or currently do not have cats. These actions are of medium to very high priority and many could be achieved within the next three to five years. Offshore islands are particularly significant as areas that can be maintained as cat free. DEWHA is establishing a national database of introduced animals across Australian offshore islands that will complement this work.

Action 1.1 focuses on collating data on conservation values of 'islands', the likelihood of significant impacts from cats, and the risk that predation by feral cats will become a threat in these areas.

Action 1.2 recognises the importance of targeting landholders and managers within and adjacent to cat-free areas of high conservation value with information that raises awareness of the threat posed by cats, to encourage community support for maintaining the cat-free status of these areas.

Action 1.3 develops contingency plans for preventing, monitoring and, if an incursion occurs, containing and eradicating feral cats in areas with high conservation values. Assessment of invasion risk by cats should use population genetic approaches for identifying past invasion routes. Action 1.4 implements these plans. Action 1.5 involves eradicating established populations of feral cats from those 'islands' considered of high conservation value, depending on feasibility and cost-effectiveness of eradication. These actions cannot be completed until Action 3.1 is complete. All planning and implementation work needs to recognise that cats are but one of many pests facing land managers and therefore should be undertaken within the context of integrated management activities.

It is important to determine whether eradication of feral cats leads to recovery of native species and ecological communities. Therefore, Action 1.6 involves monitoring numbers of native prey species in areas from which feral cats have been eradicated. Such monitoring should be carried out in line with national monitoring protocols, as soon as these are available (see Action 3.1).

Performance indicators

- No further establishments of feral cats in cat-free areas, particularly on offshore islands.
- Local communities recognise the importance for high conservation areas to be kept cat free.
- Successful eradication of isolated populations of feral cats where this is attempted.
- Increased populations of affected native species in areas from which cats, and other invasive species, have been eradicated.

Action	Priority and timeframe
1.1 Collate data on islands and on isolated mainland 'islands', assess their conservation value, the likelihood of significant biodiversity impacts from cats, and if there are no cats present, rank the level of risk of cats being introduced and having impacts in these areas.	High priority, short term
1.2 Work with communities, landholders and managers in and adjacent to cat-free areas of high conservation value to minimise the chance of an incursion.	High priority, medium term
1.3 Develop management plans to prevent, monitor and, if incursions occur, contain and eradicate any incursion by feral cats for 'islands' with high conservation values.	Medium priority, medium term
1.4 Implement management plans for high-conservation-value 'islands', including prevention and monitoring actions, and containment or eradication actions if incursions occur.	Very high priority, medium term
1.5 Eradicate established populations of feral cats from areas with high conservation values where this is considered feasible and cost-effective and is a high conservation priority.	Very high priority, long term
1.6 Monitor (using national monitoring protocols) native prey species in areas from which feral cats have been eradicated.	Medium priority, long term

☐ Objective 2

Promote the maintenance and recovery of native species and ecological communities that are affected by feral cat predation

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Key actions for Objective 2 include identifying priority areas for feral cat control, implementing and supporting regional control programs, and applying incentives for promoting and maintaining control programs adjacent to the priority areas. Actions 2.1–2.3 focus programs in feral cat control on the maintenance and recovery of native species and ecological communities affected by feral cat predation. These actions are of high or very high priority and all will require a medium-term commitment.

Control of feral cats in Australia at a continental scale is not feasible using the methods currently available. Therefore, it is necessary to identify priority areas for control based on scientific evidence of the significance of the population of native species or of the ecological community affected and the degree of impact posed by feral cats, relative to other impacts. In addition, the cost-effectiveness of a control program must be considered. These activities are covered by Action 2.1. Identification of priority areas could involve mapping the distribution of susceptible species, high-risk habitats and feral cats, to produce a national overview of priority regions (e.g. using the approach outlined in Dickman [1996] and NSW NPWS [2001]).

Once priority areas have been identified, the next step is to implement regional control, as described in Action 2.2. Organisations implementing control programs will be encouraged to focus on areas where feral cat control will help to reduce the threat to native species. The success of control programs should be monitored, applying national monitoring protocols as soon as these are available (see Action 3.1).

It is important to promote cat control in priority areas and in adjacent areas, to prevent reinvasion. Action 2.3 focuses on applying incentives for such actions on private and leasehold lands within and adjacent to priority areas.

Performance indicators

- Priority areas, where cat control is required to protect affected fauna, have been identified and are a focus for cat control programs.
- All feral cat control work involves pre and post-control monitoring of feral cat populations and key native species, according to national protocols, to measure the outcomes of control operations.
- Reliable native species population indicators are used to measure the outcome of reduced pest populations.

Action	Priority and timeframe
2.1 Identify priority areas for feral cat control based on: • the significance of the ecological community or the regional population of the native species threatened by feral cats • the degree of threat posed by feral cats to species or ecological communities relative to other threats • the cost-effectiveness of maintaining feral cat populations below an identified 'threat threshold' in the region, and • the feasibility of effective remedial action.	Very high priority, medium term
2.2 Conduct and monitor regional feral cat control through new or existing programs, in priority areas identified in Action 2.1.	High priority, medium term
2.3 Apply existing and new incentives to promote and maintain on-ground feral cat control on private or leasehold lands within or adjacent to priority sites identified in Action 2.1.	High priority, medium term

☐ Objective 3

Improve knowledge and understanding of feral cat impacts and interactions with other species and other ecological processes

Key actions for Objective 3 include developing simple, cost-effective methods for monitoring impacts; improving knowledge of interactions between feral cats and native carnivores; improving knowledge of interactions between feral cats, foxes and wild dogs; identifying the potential impacts of cat-borne diseases; and identifying the unintended effects of feral cat control in isolation from other activities. Actions 3.1–3.5 focus on ensuring that feral cat programs do not lead to unintended effects and that control activities are targeted strategically, through better understanding of the impacts of feral cats and their interactions with other species. These actions are of medium to high priority and some could be achieved within the next three to five years, although others will require a long-term commitment. A range of available genetic marker analyses may be useful in improving our knowledge of cat ecology and how best to manage cats. Genetic markers can, for example, help improve understanding of invasion routes and population dynamics.

To determine the effectiveness of feral cat control programs, Action 3.1 is to develop simple, cost-effective methods for monitoring the impact of this invasive species on affected species and ecological processes relative to other sources of impact. Monitoring methods need to be reliable for different densities of both feral cats and the native species they prey on, and once developed should be adopted as national standards. Areas for investigation include the feasibility and practicality of individual identification of cats by genotyping scats or hairs, to help estimate cat abundance, particularly at low densities.

Interactions between feral cats and other species need to be considered when undertaking control programs. Action 3.2 is to investigate interactions between feral cats and native carnivores to improve understanding of the impact of feral cats on these species in terms of competition and predation. Similarly, Action 3.3 is to investigate interactions between feral cats, foxes and wild dogs (competition, predation or both) so that control activities for these three species can be more effectively integrated. For example, certain fences used to exclude feral cats can also exclude foxes and wild dogs.

Action 3.4 is to investigate the impact and potential impact on native species posed by cat-borne diseases such as toxoplasmosis.

Action 3.5 is to identify any unintended effects that feral cat control may have if it is not integrated with other management activities. This action depends on the results of Actions 3.2–3.4.

Performance indicators

- Reliable feral cat monitoring techniques have been developed.
- Feral cat control activities are targeted more strategically and better integrated with control of other invasive species.
- The unintended effects of feral cat control are avoided.

Action	Priority and timeframe
3.1 Develop simple, cost-effective methods for monitoring the impacts of feral cats, including reliable methods for monitoring feral cats and key native species at different densities.	High priority, short term
3.2 Investigate interactions between feral cats and native carnivores to identify the relative significance of competition and predation by feral cats.	Medium priority, long term
3.3 Determine the nature of interactions between feral cats, foxes and wild dogs to effectively integrate control activities for all three species.	High priority, medium term
3.4 Determine impacts of cat-borne diseases, such as toxoplasmosis, on native species.	Medium priority, long term
3.5 Identify any unintended effects that feral cat control may cause if conducted in isolation from other management activities.	High priority, medium term

☐ **Objective 4**

Improve the effectiveness, target specificity, humaneness and integration of control options for feral cats

Key actions for Objective 4 include developing a toxin–bait that would allow broadscale management, determining baiting strategies for different regions and holistic control programs, increasing strategic use of exclusion fencing, and increasing the adoption of standard control methods. Actions 4.1–4.5 focus on improving feral cat control through better use of existing techniques and the development of new techniques, including those for monitoring success of control in the field. Many of these actions require a medium-term commitment.

A major obstacle to control of feral cats is the lack of a toxin–bait that is attractive to cats. In response to this situation, Action 4.1 is to expedite existing work on such a product. Consideration should be given to a critical review of feral cat bait research. Effective feral cat control requires a high density of surface-laid baits; therefore, a toxin–bait needs to have a soft core (so it is palatable to cats) yet be unattractive or inaccessible to non-target species (e.g. birds, goannas, snakes) that are potentially at risk from current poisons such as para-aminopropiophenone (PAPP). This action is very high priority, and needs to be achieved as soon as possible, so that broadscale control of feral cats becomes feasible.

Once an appropriate bait has been developed, the next step (Action 4.2) will be to determine appropriate baiting strategies for various regions. This needs to include investigation of timing, frequency, bait density and placement, based on scientific evidence of prey availability, feral cat movements and areas that the animals use as refuges (e.g. during drought).

Where feral cats are eradicated from an area, rehabilitation may be needed to promote the recovery of native species and ecological communities. Interactions between species also need to be considered; for example, feral cats may be keeping another invasive species (e.g. rabbits) in check. Therefore, Action 4.3 is to take an integrated approach to control of feral cats, covering habitat rehabilitation and management of potential prey, competitors and predators. Such integrated control methods link with the identification of unintended effects, which are dealt with in Action 3.5 above.

Action 4.4 is to test and disseminate information on exclusion fencing, which has been successful in some areas. For example, in Queensland, eradication campaigns within exclusion areas have protected bilby colonies from feral cats and other predators. Fencing can be more cost-effective than baiting (which is ongoing) for particular habitats or topography.

To ensure feral cat control follows best practice, Action 4.5 is to promote the adoption and adaptation of the model codes of practice and standard operating procedures for the humane capture, handling and destruction of feral animals in Australia. This includes their recognition as a reference under the National Competency Standards for Vertebrate Pest Management (NTIS 2007).

Performance indicators

- Widespread use of improved cat baiting tools and methods.
- Increased use of exclusion fencing in situations where fencing is considered to be more cost-effective than ongoing baiting and to protect critically endangered species.
- Increased adoption and adaptation of the model codes of practice and standard operating procedures for humane management of feral cats, including their recognition as a reference under the National Competency Standards for Vertebrate Pest Management.

Action	Priority and timeframe
4.1 Develop an effective toxin–bait for cats.	Very high priority, medium term
4.2 Determine appropriate baiting strategies for various regions.	High priority, medium term
4.3 Ensure that habitat rehabilitation and management of potential prey, competitors and predators of feral cats are considered in feral cat control programs.	Medium priority, medium term
4.4 Test and disseminate information on exclusion fence designs regarding their cost-effectiveness for particular habitats or topography.	Medium priority, long term
4.5 Continue to promote the adoption and adaptation of model codes of practice and standard operating procedures for the humane management of feral cats.	Medium priority, medium term

☐ Objective 5

Increase awareness of all stakeholders of the objectives and actions of the TAP, and of the need to control and manage feral cats

Key actions for Objective 5 include preparation and distribution of extension material, and linking of all broadscale control programs to specific communication campaigns. Actions 5.1–5.2 focus on ensuring that the actions taken under the TAP, the impact of feral cats, and the need for control actions are better communicated to stakeholders. These actions are high priority and could be achieved within the next three years.

Action 5.1 involves preparation and distribution of extension materials. Extension materials will help to promote support for the 19 actions listed in Objectives 1–4 of the TAP, and promote understanding of, and use of, effective feral cat control techniques.

Since cats are kept as pets, there are public sensitivities to broadscale programs for feral cat control. Action 5.2 is therefore to develop a specific communication campaign to accompany such broadscale control programs when they occur.

Performance indicators

- Widespread use of current best-practice techniques in feral cat control.
- Increased awareness of the impacts of feral cats.
- Increased awareness of the TAP actions and objectives.
- Community support for the use of lethal control methods.

Action	Priority and timeframe
5.1 Promote: • broad understanding of the threat to biodiversity posed by feral cats and support for their control • support for the specific actions to be undertaken under this plan • the use of humane and cost-effective feral cat control methods • best-practice effective cat control in all tenures, and • understanding of predation by feral cats as a key threatening process.	High priority, short term
5.2 Develop specific communication campaigns to accompany the release of new broadscale cat control techniques, in order to address public sensitivities about cat control.	Very high priority, short term

3 Duration, cost, implementation and evaluation of the plan

3.1 Duration and cost of the plan

This plan reflects the fact that the threat abatement process is likely to be ongoing, as there is no likelihood of nationally eradicating all feral cats in the foreseeable future.

Investment in many of the TAP actions will be determined by the level of resources that stakeholders commit to management of the problem. The total cost of implementation cannot be quantified at the time of writing. In most cases, the ongoing costs of cat control will be high. Current options for control in mainland areas are trapping, shooting and construction of exclosures. All are expensive, time consuming and not suitable for broadscale implementation. Recent studies estimated the annual expenditure on feral cat control as $1.0 million (Bomford and Hart 2002) and $1.1 million (Reddiex et al. 2006). This relatively low current control cost is due to the lack of a suitable broadscale control technique. Once such a technique becomes available, national control costs are likely to increase dramatically.

This TAP provides a framework for undertaking targeted priority actions. Budgetary and other constraints may affect the achievement of the objectives of this plan, and as knowledge changes, proposed actions may be modified over the life of the plan. Australian Government funds may be available to implement key national environmental priorities, such as relevant actions listed in this plan and actions identified in regional natural resource management plans.

3.2 Implementing the plan

DEWHA will work with other Australian Government agencies, state and territory governments and national and regional industry and community groups, to facilitate the implementation of the plan. There are many different stakeholder interests and perspectives to take into account in managing cats. For example, Indigenous communities' views need to be fully considered. It will be important to consult and involve the range of stakeholders in implementing the actions in this plan.

The Australian Government will implement the plan as it applies to Commonwealth land.

DEWHA will support a TAP implementation team to assist and advise on the implementation of the plan. The team will draw on expertise in vertebrate pest management from state and territory agencies, and non-government organisations.

This TAP will operate under the overarching framework of the Australian Biosecurity System for Primary Production and the Environment (AusBIOSEC) and in the context of the Australian Pest Animal Strategy, both of which aim to reduce the impacts of invasive species on native species and ecosystems.

3.3 Evaluating implementation of the plan

It will be difficult to assess directly the effectiveness of the plan in abating the impacts of feral cats on Australia's biodiversity. However, the National Natural Resource Management Monitoring and Evaluation Framework (NRMMC 2003) established a program to provide national information about resource condition on a range of biophysical matters, including threats from vertebrate species such as cats. As part of this work, a range of indicators will provide information on the extent of the impact of priority vertebrate species on biodiversity, as well as national trends on their distribution and abundance.

The species in the table below may be adversely affected by predation by feral cats (that is, there is scientific proof, anecdotal evidence or the potential for impact). The threatened species included are listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The list is indicative and not

comprehensive.

Information for species listed under the EPBC Act is available from the Species Profile and Threats Database: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

Appendix A: Species affected by feral cats

☐ **Table A1: Threatened species and critical habitat that may be adversely affected by feral cats**

Type/category	Scientific name	Common name	Current status
Listed threatened species that may be adversely affected by feral cats			
Birds	*Cereopsis novaehollandiae grisea*	Cape Barren goose (southwestern), Recherche Cape Barren goose	Vulnerable
	Chalcophaps indica natalis	Emerald dove (Christmas Island)	Endangered
	Cinclosoma punctatum anachoreta	Spotted quail-thrush (Mt Lofty Ranges)	Critically endangered
	Cyanoramphus cookii (listed as *Cyanoramphus novaezelandiae cookii*)	Norfolk Island green parrot	Endangered
	Dasyornis brachypterus	Eastern bristlebird	Endangered
	Diomedea exulans	Wandering albatross	Vulnerable
	Fregetta grallaria grallaria	White-bellied storm-petrel (Tasman Sea), white-bellied storm-petrel (Australasian)	Vulnerable
	Gallirallus philippensis andrewsi	Buff-banded rail (Cocos [Keeling] Islands)	Endangered
	Halobaena caerulea	Blue petrel	Vulnerable
	Lathamus discolor	Swift parrot	Endangered
	Leipoa ocellata	Malleefowl	Vulnerable
	Leucocarbo atriceps purpurascens (listed as *Phalacrocorax purpurascens*)	Imperial shag (Macquarie Island)	Vulnerable

Type/category	Scientific name	Common name	Current status
Listed threatened species that may be adversely affected by feral cats			
	Lichenostomus melanops cassidix	Helmeted honeyeater	Endangered
Birds (continued)	*Macronectes giganteus*	Southern giant-petrel	Endangered
	Malurus coronatus coronatus	Purple-crowned fairy-wren (western)	Vulnerable
	Malurus leucopterus leucopterus	White-winged fairy-wren (Dirk Hartog Island), Dirk Hartog black-and-white fairy-wren	Vulnerable
	Melanodryas cucullata melvillensis	Hooded robin (Tiwi Islands)	Endangered
	Neophema chrysogaster	Orange-bellied parrot	Critically endangered
	Pachycephala pectoralis xanthoprocta	Golden whistler (Norfolk Island)	Vulnerable
	Pachyptila turtur subantarctica	Fairy prion (southern)	Vulnerable
	Pardalotus quadragintus	Forty-spotted pardalote	Endangered
	Pedionomus torquatus	Plains-wanderer	Vulnerable
	Petroica multicolor multicolor	Scarlet robin (Norfolk Island)	Vulnerable
	Pezoporus occidentalis	Night parrot	Endangered
	Pezoporus wallicus flaviventris	Western ground parrot	Endangered

Type/category	Scientific name	Common name	Current status
Listed threatened species that may be adversely affected by feral cats			
	Pterodroma heraldica	Herald petrel	Critically endangered
	Pterodroma leucoptera leucoptera	Gould's petrel	Endangered
	Pterodroma mollis	Soft-plumaged petrel	Vulnerable
	Pterodroma neglecta neglecta	Kermadec petrel (western)	Vulnerable
	Sterna vittata bethunei	Antarctic tern (New Zealand)	Endangered
	Sterna vittata vittata	Antarctic tern (Indian Ocean)	Vulnerable
	Stipiturus malachurus intermedius	Southern emu-wren (Fleurieu Peninsula), Mount Lofty southern emu-wren	Endangered
	Thalassarche chrysostoma	Grey-headed albatross	Vulnerable
	Thalassarche melanophris	Black-browed albatross	Vulnerable
Mammals	*Turnix melanogaster*	Black-breasted button-quail	Vulnerable
	Bettongia lesueur lesueur	Boodie, burrowing bettong (Shark Bay)	Vulnerable
	Bettongia lesueur unnamed subsp.	Boodie, burrowing bettong (Barrow and Boodie Islands)	Vulnerable
	Burramys parvus	Mountain pygmy-possum	Endangered
	Dasycercus byrnei	Kowari	Vulnerable

Type/category	Scientific name	Common name	Current status
Listed threatened species that may be adversely affected by feral cats			
	Dasycercus cristicauda	Mulgara	Vulnerable
	Dasycercus hillieri	Ampurta	Endangered
	Hipposideros semoni	Semon's leaf-nosed bat, greater wart-nosed horseshoe-bat	Endangered
	Isoodon auratus auratus	Golden bandicoot (mainland)	Vulnerable
	Isoodon obesulus obesulus	Southern brown bandicoot	Endangered
	Lagorchestes hirsutus bernieri	Rufous hare-wallaby (Bernier Island)	Vulnerable
	Lagorchestes hirsutus dorreae	Rufous hare-wallaby (Dorre Island)	Vulnerable
	Lagorchestes hirsutus unnamed subsp.	Mala, rufous hare-wallaby (central mainland form)	Endangered
	Lagostrophus fasciatus fasciatus	Banded hare-wallaby, marnine, munning	Vulnerable
	Leporillus conditor	Wopilkara, greater stick-nest rat	Vulnerable
	Macrotis lagotis	Greater bilby	Vulnerable
	Myrmecobius fasciatus	Numbat	Vulnerable
	Notoryctes caurinus	Karkarratul, northern marsupial mole	Endangered
	Notoryctes typhlops	Yitjarritjarri, southern marsupial mole	Endangered

Type/category	Scientific name	Common name	Current status
Listed threatened species that may be adversely affected by feral cats			
	Onychogalea fraenata	Bridled nail-tail wallaby	Endangered
	Parantechinus apicalis	Dibbler	Endangered
	Perameles bougainville bougainville	Western barred bandicoot (Shark Bay)	Endangered
	Perameles gunnii gunnii	Eastern barred bandicoot (Tasmania)	Vulnerable
	Perameles gunnii unnamed subsp.	Eastern barred bandicoot (mainland)	Endangered
	Petaurus gracilis	Mahogany glider	Endangered
	Petrogale lateralis MacDonnell Ranges race	Warru, black-footed rock-wallaby	Vulnerable
	Petrogale penicillata	Brush-tailed rock-wallaby	Vulnerable
	Petrogale persephone	Proserpine rock-wallaby	Endangered
Mammals (continued)	*Phascogale calura*	Red-tailed phascogale	Endangered
	Potorous gilbertii	Gilbert's potoroo	Critically endangered
	Potorous longipes	Long-footed potoroo	Endangered
	Pseudomys fieldi	Djoongari, Alice Springs mouse, Shark Bay mouse	Vulnerable
	Pseudomys fumeus	Konoom, smoky mouse	Endangered

Type/category	Scientific name	Common name	Current status
Listed threatened species that may be adversely affected by feral cats			
	Pseudomys oralis	Hastings River mouse	Endangered
	Sminthopsis aitkeni	Kangaroo Island dunnart	Endangered
	Sminthopsis douglasi	Julia Creek dunnart	Endangered
	Zyzomys pedunculatus	Central rock-rat	Endangered
Reptiles	*Delma impar*	Striped legless lizard	Vulnerable
	Egernia kintorei	Great desert skink, tjakura, warrarna, mulyamiji	Vulnerable
	Egernia obiri	Arnhem Land egernia	Endangered
	Eulamprus leuraensis	Blue Mountains water skink	Endangered
	Eulamprus tympanum marnieae	Corangamite water skink	Endangered
	Hoplocephalus bungaroides	Broad-headed snake	Vulnerable
	Lepidodactylus listeri	Lister's gecko, Christmas Island gecko	Vulnerable
Amphibians	*Heleioporus australiacus*	Giant burrowing frog	Vulnerable
	Litoria aurea	Green and golden bell frog	Vulnerable
	Philoria frosti	Baw Baw frog	Endangered

Type/category	Scientific name	Common name	Current status
Listed threatened species that may be adversely affected by feral cats			
Type/category	**Scientific name**	**Common name**	**Current status**
Unlisted species or taxa that could be adversely affected by feral cats			
Birds	*Amytornis textilis textilis*	Thick-billed grasswren (western)	
	Phaethon rubricauda westralis	Red-tailed tropicbird	
	Puffinus assimilis	Little shearwater	
	Zosterops tenuirostris	Norfolk Island white-eye, slender-billed white-eye	
Reptile	*Cryptoblepharus egeriae*	Blue-tailed skink	
	Emoia nativitatis	Forest skink	
Listed critical habitat			
Diomedea exulans (Wandering albatross) — Macquarie Island			
Thalassarche chrysostoma (Grey-headed albatross) — Macquarie Island			

Glossary

Critically endangered	Under the EPBC Act, a native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	Under the EPBC Act, a native species is eligible to be included in the endangered category at a particular time if, at that time, (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Feral	An introduced animal, formerly in domestication, with an established, self-supporting population in the wild.
Genotyping	The process of determining the genotype (i.e. the genetic makeup) of an individual with a biological assay.
Invasive species	A species occurring as a result of human activities beyond its accepted normal distribution and which threatens valued environmental, agricultural or personal resources by the damage it causes (Beeton et al. 2006).
Key threatening process	Under the EPBC Act, a process that threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.
Performance indicator	A criterion or measure that provides information on the extent to which a policy, program or initiative is achieving its outcomes.
Pest animal or species	Any non-human species of animal that causes trouble locally or over a wide area, to one or more persons, either by being a health hazard or a general nuisance, or by causing damage to agriculture, wild ecosystems or natural resources.
Threat abatement plan	Under the EPBC Act, a plan providing for the research, management and any other actions necessary to reduce the impact of a listed key threatening process on affected species and ecological communities.
Threatened species	A species under the EPBC Act listed as critically endangered, endangered, vulnerable or conservation dependent.
Vulnerable	Under the EPBC Act, a native species is eligible to be included in the vulnerable category at a particular time if, at that time, (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

Acronyms and abbreviations

BRS	Bureau of Rural Sciences
DEWHA	Australian Government Department of the Environment, Water, Heritage and the Arts
EPBC Act	the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
TAP	threat abatement plan

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Appendix 2: Threatened fauna from Tweed Shire known or perceived to be impacted by cats.

Species	Scientific Name	Conservation Status	Included in Cat TAP
Brush Tailed rock wallaby	*Petrogate penicillata*	Endangered (NSW) Vulnerable (Federal)	Yes
Long Nosed Poteroo	*Poterous tridacilius*	Endangered Population (NSW) Vulnerable (Federal)	Yes
Spotted Tailed Quoll	*Dasyurus maculatus*	Vulnerable (NSW) Endangered (Federal)	Yes
Yellow-Bellied Glider	*Petaurus australis*	Vulnerable (NSW)	No
Eastern Pygmy Possum	*Cercartetus nanus*	Vulnerable (NSW)	Yes
Brush-Tailed Phosagale	*Phascogale tapoatafa*	Vulnerable (NSW)	No
Red-Legged Pademelon	*Thylogale stigmatica*	Vulnerable (NSW)	Yes
Rufous Bettong	*Aepyprymnus rufescens*	Vulnerable (NSW)	No
Eastern Chestnut Mouse	*Pseudomys gracilicaudatus*	Vulnerable (NSW)	Yes
Common Planigale	*Planigale maculata*	Vulnerable (NSW)	Yes
Tusked Frog	*Adelotus brevis*	Predicted	No
Pouch Frog	*Assa darlingtoni*	Vulnerable (NSW)	No
Love-Ridges Frog	*Philoria loveridgei*	Endangered (NSW)	No
Giant Barred Frog	*Mixophyes iteratus*	Endangered (NSW and Federal)	No

Species	Scientific Name	Conservation Status	Included in Cat TAP
Eastern Sign-bearing Froglet	*Crinia parinsignifera*	Protected	No
Green Thighed Frog	*Litoria brevipalmata*	Vulnerable (NSW)	No
Common Eastern Froglet	*Crinia signifera*	Protected	No
Wallum Froglet	*Crinia tinnula*	Vulnerable (NSW)	No
Fleays Barred Frog	*Mixophyes fleayi*	Endangered (NSW and Federal)	No
Olongburra Frog	*Litoria olongburensis*	Vulnerable (NSW and Federal)	No
Beach Stone-Curlew	*Esacus magnirostris*	Critically Endangered (NSW)	No
Coxen's Fig-Parrots	*Cyclopsitta diopthalma*	Critically Endangered (NSW) Endangered (Federal)	No
Sanderling	*Calidris alba*	Vulnerable (NSW)	No
Magpie Goose	*Anseranas semipalmata*	Vulnerable (NSW)	No
Australasian Bittern	*Botaurus poiciloptilus*	Endangered (NSW, Federal)	No
Bush Stone Curlew	*Burhinus grallarius*	Endangered (NSW)	Yes
Beach Stone Curlew	*Esacus magnirostris*	Critically Endangered (NSW)	Yes
Pale-vented Bush-hen	*Amaurornis moluccana*	Vulnerable (NSW)	No
Superb-Fruit Dove	*Ptilinopus superbus*	Vulnerable (NSW)	No
Great Knot	*Calidris tenuirostris*	Vulnerable (NSW)	No
Barred Cuckoo-Shrike	*Coracina lineata*	Vulnerable (NSW)	No

Species	Scientific Name	Conservation Status	Included in Cat TAP
Greater sand-plover	*Charadrius leschenaultii*	Vulnerable (NSW)	No
Lesser Sand-Plover	*Charadrius mongolus*	Vulnerable (NSW)	No
Brown Tree Creeper- eastern species	*Climacteris picumnus victoriae*	Vulnerable (NSW)	No
Pied Oyster Catcher	*Haematopus longirostris*	Endangered (NSW)	Yes
Mangrove Honey Eater	*Lichenostomus fasciogularis*	Vulnerable (NSW)	No
Alberts Lyrebird	*Menura alberti*	Vulnerable (NSW)	No
Sooty Oyster Catcher	*Haematopus fuliginosus*	Vulnerable (NSW)	Yes
Comb crested Jacana	*Irediparra gallinacea*	Vulnerable (NSW)	No
Black Bittern	*Ixobrychus flavicollis*	Vulnerable (NSW)	No
Swift Parrot	*Lathamus discolor*	Endangered (NSW, Federal)	No
Collared Kingfisher	*Todiramphus chloris*	Vulnerable (NSW)	No
Olive Whistler	*Pachycephala olivacea*	Vulnerable (NSW)	Yes
Terek Sand-Piper	*Xenus cinereus*	Vulnerable (NSW)	No
Little Tern	*Sternula albifrons*	Endangered (NSW)	Yes
Red Goshawk	*Erythrotriorchis radiatus*	Critically Endangered (NSW) Vulnerable (Federal)	No
Broad Billed Sand Piper	*Limicola falcinellus*	Vulnerable (NSW)	No
Black- Tailed Godwit	*Limosa limosa*	Vulnerable (NSW)	No

Species	Scientific Name	Conservation Status	Included in Cat TAP
Grey-Ternlet	*Procelsterna cerulea*	Vulnerable (NSW)	No
White-Eared Monarch	*Carterornis leucotis*	Vulnerable (NSW)	No
Eastern- Bristle Bird	*Dasyornis brachypterus*	Endangered (NSW, Federal)	No
Comb Crested Jacana	*Irediparra gallinacea*	Vulnerable (NSW)	No
Scarlet-Robin	*Petroica boodang*	Vulnerable (NSW)	Yes
Marbled-Frog Mouth	*Podargus ocellatus*	Vulnerable (NSW)	No
Regent Honey Eater	*Anthochaera phrygia*	Critically Endangered (NSW) Endangered (Federal)	No
Little Lorikeet	*Glossopsitta pusilla*	Vulnerable (NSW)	No
Curlew Sand-Piper	*Calidris ferruginea*	Endangered (NSW)	No
Broad Billed Sandpiper	*Limicola falcinellus*	Vulnerable (NSW)	No
Black Tailed God-wit	*Limosa limosa*	Vulnerable (NSW)	No
Eastern Osprey	*Pandion cristatus*	Vulnerable (NSW)	No
Sooty Owl	*Tyto tenebricosa*	Vulnerable (NSW)	No
Barking Owl	*Ninox connivens*	Vulnerable (NSW)	No
Square-Tailed Kite	*Lophoictinia isura*	Vulnerable (NSW)	No
Collared-King Fisher	*Todiramphus chloris*	Vulnerable (NSW)	No
Wompoo Fruit Dove	*Ptilinopus magnificus*	Vulnerable (NSW)	No

Species	Scientific Name	Conservation Status	Included in Cat TAP
Southern Myotis Bat	*Myotis macropus*	Vulnerable (NSW)	No
Little Bent-Wing Bat	*Miniopterus australis*	Vulnerable (NSW)	No
Eastern Long Ear Bat	*Nyctophilus bifax*	Vulnerable (NSW)	No
Eastern Tube-Nosed Bat	*Nyctimene robinsoni*	Vulnerable (NSW)	Yes
Eastern Free Tail Bat	*Mormopterus norfolkensis*	Vulnerable (NSW)	No
Great Broad-Nosed Bat	*Scoteanax rueppellii*	Vulnerable (NSW)	No
Common Blossom Bat	*Syconycteris australis*	Vulnerable (NSW)	No
Three Toed Skink	*Coeranoscincus reticulatus*	Vulnerable (NSW, Federal)	No
Eastern-Grass Owl	*Tyto longimembris*	Vulnerable (NSW)	No
Little Eagle	*Hieraaetus morphnoides*	Vulnerable (NSW)	Yes
Varied Sittella	*Daphoenositta chrysoptera*	Vulnerable (NSW)	Yes
Spotted Harrier	*Circus assimilis*	Vulnerable (NSW)	Yes
Masked Owl	*Tyto novaehollandiae*	Vulnerable (NSW)	No