FAUNA *of* AUSTRALIA

55. FELIDAE

E. JONES

Cat–*Felis catus* [CSIRO Wildlife & Ecology]

DEFINITION AND GENERAL DESCRIPTION

The felids are highly specialised predators that range in size from approximately 3 to more than 200 kg in body weight. Members of this family are characterised by relatively rounded skulls with short muzzles, long vibrissae, large eyes, retractable claws and distinctive coat markings. The family distribution is widespread over much of the globe and is represented by over 30 species. *Felis catus*, the domestic Cat, although an exotic species, is established so successfully throughout much of Australia, that it should be regarded as a significant element of the Australian fauna.

The term 'feral' is usually applied to those Cats of domestic origin that do not live in a close or dependent association with humans. Unlike other feral vertebrate species in Australia, the status of Cats is variable and different groups of feral Cats may have different lifestyles. At one extreme are self-perpetuating populations situated in remote or sparsely settled areas that have no contact with humans and survive by hunting available prey. At the other extreme are populations of urban stray Cats that scavenge much of their food and may come into day-to-day contact with humans. The existence of semi-domesticated rural Cats further complicates the picture. The latter group, although free-living, do share some form of commensal relationship with humans, which diminishes their feral status. Cats also are able to change their feral status with circumstances and so cannot always be categorised precisely.

Feral Cats are derived from common domestic Cats (not exotic or fancy breeds) so there is no anatomical or physiological difference between the two. Further, the ease with which domestic Cats can adapt to a feral existence indicates that domestication has not greatly changed or modified their original hunting and survival instincts.

Cats are predators that usually capture their prey by a sudden pounce or short swift run from concealment. Camouflage is greatly facilitated by their body markings and behaviour. They do not use cooperative hunting and rely primarily on sight, although hearing is also important. They may be active at any time of the day or night, but tend towards a crepuscular pattern of activity and, although they have the ability to climb well, spend most of their time on the ground.

HISTORY OF DISCOVERY

The history of domestication of Cats is incomplete and, therefore, still open to some conjecture, but true domestication occurred approximately 4000 years ago in Egypt (Baldwin 1975). Domestication also probably occurred concurrently in the Indus Valley (Ahmad, Blumenberg & Chaudhary 1980). The wild species of felid from which the domestic Cat was basically derived was the African Wild Cat *Felis sylvestris lybica,* but other species almost certainly were involved (Kratochvil & Kratochvil 1976; Armitage & Clutton-Brock 1981). The actual process of domestication also has been debated (Baldwin 1975; Todd 1978). Domestic Cats passed from Egypt to Greece and the Roman Empire and subsequently spread throughout the civilised world (Zeuner 1963).

Domestic Cats probably were introduced into Australia by early European settlers and feral populations may have become established soon afterwards. The major spread of feral Cats throughout Australia occurred during the nineteenth century, but the spread is not well documented. Feral Cats had penetrated into north-west South Australia and the adjacent area of Western Australia and were plentiful there by 1890 (Carruthers 1892). Cats were released in some areas in an effort to control the spread of European Rabbit (*Oryctolagus cuniculus*) (Rolls 1969). The rapid colonisation of much of Australia by Rabbits

during the latter part of the 19th Century probably facilitated the spread of feral Cats by providing them with both a source of food and shelter in the form of burrows. Today, feral Cats are found in most terrestrial habitats and their distribution is Australia-wide.

MORPHOLOGY AND PHYSIOLOGY

External Characteristics

Feral Cats in Australia fall within the size range reported by Scott (1972) for common domestic Cats. The mean body weight of adult males is approximately 4.5 kg (normal range 3.5–6.5 kg) and that of females is 3.2 kg (normal range 2.4–4.5 kg) (Table 55.1).

Table 55.1 Measurements of a sample of adult feral Cats (males >3800 g; females >2500 g), from south-eastern Australia. Values are means ± SD, weight (g) and length (mm). N = 66 males and 63 females. (Jones unpublished data)

MEASUREMENT	MALES	FEMALES
Weight	4771 ± 573	3270 ± 451
Head and body length	530 ± 35	483 ± 30
Tail length	288 ± 19	267 ± 18
Hind foot	124 ± 5	112 ± 5
Ear	59 ± 3	56 ± 3

The teeth of Cats are adapted for killing prey and shearing tissue. Their canines are long and there are no teeth with large flat crowns suitable for chewing. The third upper premolar and lower molar are the major tissue shearing teeth, the carnassials. Cats do not chew their food. Pieces of tissue are sheared off with their carnassial teeth and swallowed. The dental formula is I 3/3 C 1/1 PM 3/2 M 1/1.

Feral Cats can be easily recognised in the wild by their rounded skull and long tail, but their most distinctive characteristics are their coat colours and markings. Domestic Cats are polymorphic for a variety of genes affecting coat colour, coat pattern and hair characteristics (Robinson 1977). Many of these genes are found also in feral populations. Pairs of alleles commonly found in domestic Cats are striped (t+) versus blotched (tb); agouti (a+) versus non-agouti (a); orange (O) versus non-orange (O+); dominant piebald spotting (S) versus non-spotted (S+); short hair (L+) versus long hair (L); and intense (d+) versus dilute (d). The orange alleles are sex-linked and located on the X chromosome. The heterozygote (O+O) is, therefore, a female in which both orange and non-orange are expressed simultaneously. This results in a phenotype of both orange and black or orange and agouti, called a tortoiseshell. Coat colours commonly found in feral Cats are tabby (agouti), black (non-agouti), orange and sometimes tortoiseshell. All may have variable amounts of white (piebald spotting) on the coat and in both tabby and orange (and some tortoiseshell) Cats either the striped or blotched coat pattern is visible. Gene frequencies of these alleles have been reported for a group of feral Cats from an agricultural habitat in Tasmania (Dartnall 1975) and for various habitats in south-eastern Australia (Jones & Horton 1984). Other records of coat colours found in feral Cats have been summarised by Strong & Low (1983).

Throughout much of the semi-arid and arid areas of inland Australia the most frequently occurring alleles of feral Cats are striped and agouti (giving the wild type coat colour of striped tabby), although blotched, orange and piebald spotting also occur. This is most likely a result of natural selection for the wild

type coat colour of striped tabby. Higher frequencies of piebald spotting, dilute and long hair are found in feral populations from the more heavily settled agricultural areas, a sure indication of gene flow from domestic Cats. In the eastern highlands of Victoria, however, higher frequencies of blotched and non-agouti and a lower frequency of piebald spotting occur. The net result of this is to confer a much darker coat on the Cats, possibly the result of natural selection in response to the forest environment.

To maintain a positive nitrogen balance, Cats require a protein-rich diet which cannot be compensated for by an increase in carbohydrate. This high protein requirement ensures that Cats are carnivorous and prevents them from exploiting carbohydrate foods, such as fruit, in the way that some canids do. Cats eat grass frequently, but the reason for this is not clear. Cats also can live without access to free water. They are capable of producing a concentrated urine and obtain both tissue fluid and metabolic water from their prey. This, coupled with their habit of spending much of the day inactive in a rabbit burrow or other shelter, enables them to maintain a positive water balance. The ability to survive without water is a major factor in their successful colonisation of most of the semi-arid and arid zones of inland Australia.

Cats are capable of killing prey approaching their own body weight in size, such as the Brushtail Possum (*Trichosurus vulpecula*) and adult rabbits, but such prey are only killed after a struggle. Larger prey, such as Rabbits, are killed by a bite to the neck or base of the skull, whereas smaller prey, such as the House Mouse (*Mus musculus*), are given a quick killing bite to the head or body and swallowed whole. Feral Cats are rapid feeders and may eat up to 10% of their body weight in food at a single sitting. In one study, the mean weight of Rabbit eaten per meal by feral Cats was 273 g with a maximum of 470 g (Jones & Coman 1981). For small Rabbits (<400 g), virtually the whole carcase may be eaten, except for some of the viscera such as the caecum. For larger rabbits, the head is sometimes severed, then skin, muscle tissue, bone and viscera consumed. Small birds may be eaten completely, but the wings may be sheared off larger birds at the pectoral girdle and discarded, then much of the body eaten.

Reproduction

Female Cats are seasonally polyoestrus and capable of producing up to three litters per year under optimum conditions. During the reproductive cycle, the female experiences proestrus for 1–2 days, oestrus for 3–6 days, then metoestrus for 7 days. Ovulation occurs only after mating and if the latter does not occur, the female returns to proestrus (Scott 1970). Because the onset of oestrus is influenced by photoperiod, a winter anoestrus usually limits yearly litters to two. The gestation period lasts approximately 65 days and at birth kittens weigh approximately 100 g. Studies on reproduction in colony Cats have shown that litters may be dropped in any month, but peaks of births occur in spring and late summer (Robinson & Cox 1970).

Reproduction in feral Cats is similar to that of domestic Cats, except that in feral populations it is more likely to be influenced by environmental factors. Reproduction in feral Cats in south-eastern Australia has been studied by Jones & Coman (1982a), who found a bimodal distribution in births with a major peak occurring in spring, followed by a secondary peak during summer and early autumn (Fig. 55.1). This illustrates that females usually produce two litters per year, with most experiencing oestrus in winter. There was clearly an effective (but not total) anoestrus during autumn and early winter, followed by oestrus, conception and then a post-partum anoestrus. A second oestrus then occurred which was less precisely timed than the first, leading to the second litter. The

timing of this second oestrus was clearly more variable than the first and may have depended upon factors such as size and survival of the first litter. Females in their first breeding season may produce only one litter, particularly if sexual maturity is reached later in the breeding season. The mean prenatal litter size for this group of Cats was 4.4 (range two to seven). Sexual maturity in females was attained at an age of approximately 10–12 months with a weight of approximately 2400 g. In the autumn, lactating females were sometimes found in the company of the offspring from their first litter, indicating a second litter. A small number of females also may experience a post-partum oestrus, as some were found to be both pregnant (early stage) and lactating.

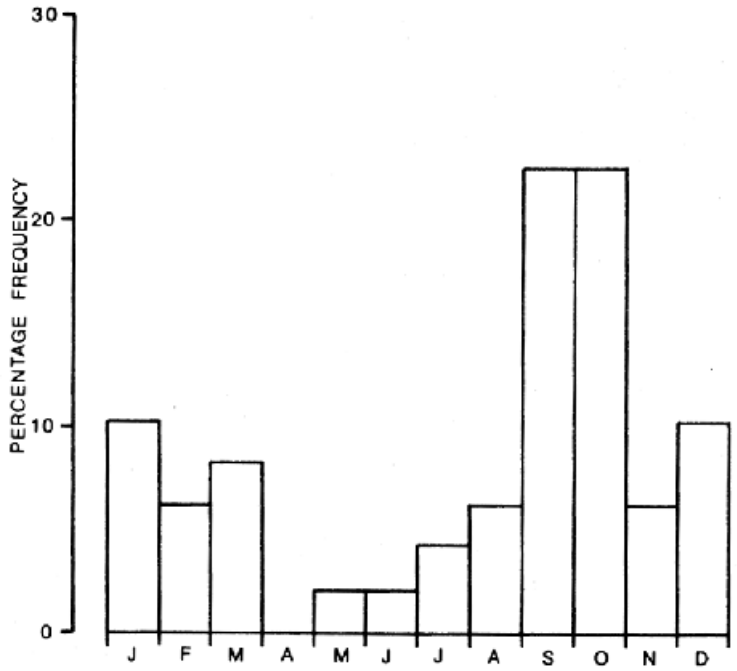

Figure 55.1 Monthly distribution of litters of feral Cats from south-eastern Australia, over a three-year period. (After Jones & Coman 1982a)

The age at attainment of sexual maturity for males was more variable than for females. At the earliest, late stage spermatids or spermatozoa appeared in the testes when the Cats weighed 2600 g, but there was a rapid increase in testes weight between mean body weights of 3200 g and 3800 g. This indicated that spermatids or spermatozoa first appeared in the testes of Cats that were approximately 8 months old and that full sexual maturity was attained at an age of 12–14 months. Further, although the adult male Cats were fertile throughout the year they exhibited a low level testicular cycle in phase with the female cycle, with epididymides weights at a minimum during the autumn female anoestrus. A latent physiological reproductive cycle is also reported for male colony Cats (Aronson & Cooper 1966).

Comparisons of results of the study from south-eastern Australia and those of colony Cats (Robinson & Cox 1970) and feral Cats on subantarctic islands (Derenne 1976; Derenne & Mougin 1976; Jones 1977; van Aarde 1978) show no major differences in reproductive parameters such as breeding season, litter size or age at sexual maturity.

NATURAL HISTORY

Life History

Litters are dropped in sheltered lairs, usually rabbit burrows, hollow logs or dense thickets. Kittens may commence to eat solid food at approximately 4 weeks and may be weaned at approximately 8 weeks. The family unit of female and offspring is important for the development of the young. This unit may persist for approximately 7 months and is the only long-term social group of feral Cats. When this family structure breaks down, the adolescents may disperse until favourable habitat is found.

As adults, feral Cats are solitary, except for short-term pair bonding during the reproductive seasons, and occupy stable home ranges which vary in size from 1–10 km^2. Home range sizes depend partly upon food supplies and type of habitat, but differences between individuals may also play a part. While food supplies are adequate, the home ranges persist, but in times of severe food stress the stable home range structure may break down as the Cats are forced to move longer distances in search of food.

Although there can be an overlap of home ranges between individuals, strong territorial behaviour is suggested by urine spraying, pole-clawing, cheek-rubbing and sometimes direct conflict. Home ranges of two adjacent adult male feral Cats in a semi-arid region of north-western Victoria were stable over time (approximately 12 and 20 months, respectively) and both Cats utilised favoured areas (usually Rabbit burrows) as daytime rest areas (Fig. 55.2). This territorial behaviour may be used in times of food stress to exclude individuals of inferior status from scarce food resources by either threat or aggression. Once confined to marginal or non-productive areas, such lower ranked animals would have little chance of survival. Efficient exploitation of available food and other resources, such as habitat, results from this land tenure system.

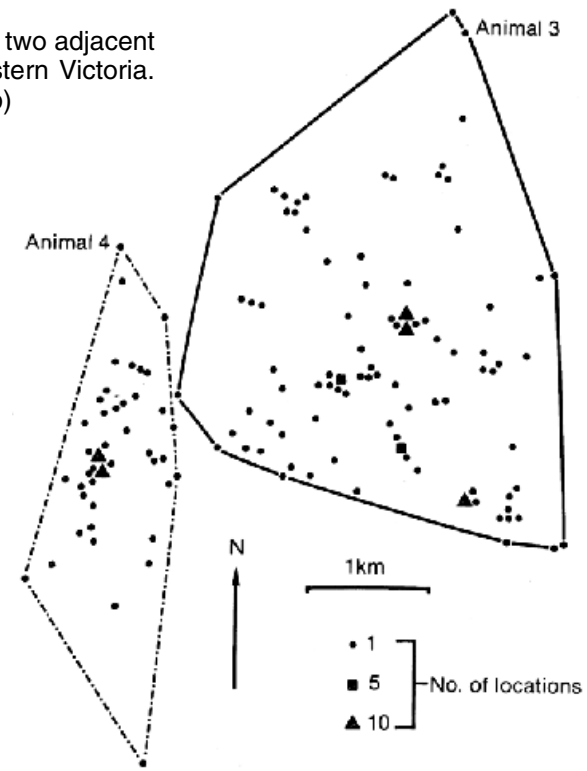

Figure 55.2 Home ranges of two adjacent male feral Cats in north-western Victoria. (After Jones & Coman 1982b)

Population Density

The population densities of feral Cats vary in response to various environmental factors such as habitat type and food availability. Imposed on these fluctuations are seasonal increases in populations due to reproduction. There are also changing annual differences in the size structure of the populations, as kittens become adolescents and as adolescents become adults. Seasonal changes in abundance and structure of a population of feral cats in north-western Victoria were investigated over a 4-year period by Jones & Coman (1982b) (Fig. 55.3). Relative abundance showed seasonal fluctuations with summer maxima and winter or spring minima, with the structure of the population changing seasonally. These fluctuations corresponded to both the reproductive season and food abundance, with the availability of the staple diet (Rabbit) lowest during winter and early spring. The major fluctuations occurred mainly in sub-adults. The population density varied from a minimum of 0.34 Cats / km^2 to a maximum of 3.5 Cats / km^2; probably relatively high for mainland Australia.

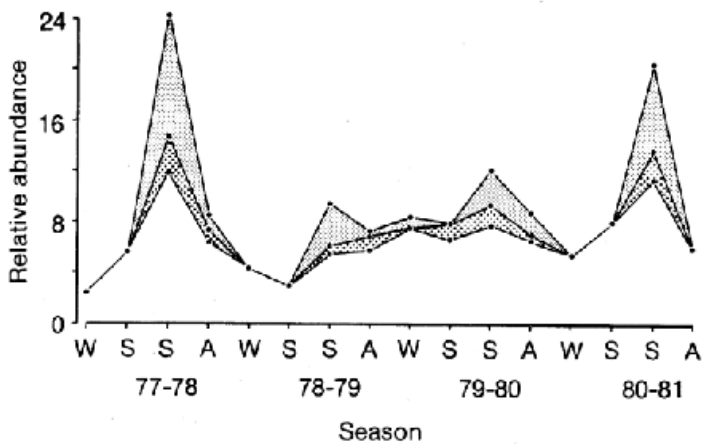

Figure 55.3 Seasonal changes in the relative abundance of adult, adolescent (coarse stipple) and juvenile (light stipple) feral Cats over 4 years, in north-western Victoria. (After Jones & Coman 1982b)

Diet

Dietary studies on feral Cats in Australia have been carried out by both analysis of scats and examination of stomach and alimentary tract contents. Food items have been reported by frequency of occurrence, by volumes of foods in stomachs and by estimated weights of fresh (undigested) foods eaten. These studies have shown that the diets of feral Cats are composed mainly of the food groups discussed below (Coman & Brunner 1972; Bayly 1976, 1978; Brooker 1977; Jones 1977; Jones & Coman 1981; Strong & Low 1983; Triggs, Brunner & Cullen 1984).

Introduced Mammals: This food group is dominated by only two species: Rabbits and House Mice. Rabbit is the major food (on a weight or volume basis), contributing up to 89% by weight to the summer diet of Cats in north-western Victoria. A size factor is also present in the Rabbits eaten. At Macquarie Island, individuals weighing 600 g comprise 81% of all Rabbits eaten. On mainland Australia, however, this situation is complicated by myxomatosis, which renders infected adult Rabbits more susceptible to predation. House Mice, the other species frequently eaten in this group, contributed up to 27% by volume to the diet in one study, but this value was influenced by a mouse plague during the study.

Native Mammals: A large variety of native mammals including phalangerids, burramyids, petaurids, smaller dasyurids, peramelids, murids and bats is eaten. Prey ranges in size from brushtail possums to small dasyurids, such as the Paucident Planigale (Planigale gilesi). In the eastern highlands of Victoria, native mammals had an overall frequency of occurrence in Cat alimentary tracts of 83% and contributed 40% by weight to the diet. This was due to the abundance and variety of native mammals present in a basically unaltered habitat. In contrast, in western New South Wales where small native mammals were few, this group contributed only 4% by weight to the diet.

Birds: Although on the mainland birds occur in the diet, they are not a major food item overall. Values range from a maximum of 18% by weight to a minimum of 1% by volume. On Macquarie Island, however, burrow-nesting petrels had a frequency of 45% in scats and a frequency of 49% in stomachs and alimentary tracts, their abundance and behaviour making them particularly susceptible to predation, a situation which usually does not exist in mainland Australia.

Reptiles: This group is only an important dietary item in arid regions, but has been recorded in all mainland dietary studies. Skinks are the most frequently eaten reptile, but dragon lizards and geckos also are commonly taken.

Arthropods: Many arthropods are eaten by Cats and, although their frequencies are sometimes high, their weight contributions to the diets are low. Groups eaten include centipedes, cockroaches, crickets, grasshoppers, beetles and wolf and huntsman spiders.

While these data are representative of Cats from only a few localities in Australia, they clearly show feral Cats to be opportunistic predators that eat a wide variety of prey. At any particular time their diet consists of those prey species that are most available, although individual preferences may be shown when food is abundant. When given a choice, feral Cats are, first and foremost, predators of small terrestrial mammals. There are, however, differences in diet related to sex; males eat more larger prey such as rabbits and females feed less on rabbits and more on smaller prey such as birds, small mammals, reptiles and arthropods.

Behaviour

The behaviour of domestic Cats is discussed in detail by Fox (1975a) and Leyhausen (1979). Behavioural studies have not been made on feral Cats in Australia, but elsewhere feral urban Cats and free-ranging rural Cats have been studied (Dards 1978; Macdonald & Apps 1978; Liberg 1981).

These studies show that in contrast to the normally solitary existence of truly feral Cats, under conditions of increased urbanisation Cats are capable of more complex social interactions, enabling them to live at much higher population densities. This also highlights the adaptability of Cats in response to different environmental conditions.

Diseases and Parasites

Both internal and external parasites of feral Cats have been reviewed by Arundel (1977a, 1977b), but surveys have been limited in scope and confined mainly to the identification of arthropod and helminth parasites (for example, Coman, Jones & Westbury 1981a).

Any disease present in domestic Cats could be expected to occur in feral Cats. Both *Toxoplasma gondii* and feline panleucopaenia, amongst other protozoan and viral infections, are present in feral populations. Viral diseases such as

panleucopaenia may play a role in the mortality of kittens, but the prevalence of serum antibodies suggests that it and other diseases are not a major factor in the mortality of adults (Coman, Jones & Driesen 1981b).

Toxoplasma gondii, transmitted by Cats via their faeces, can lead to toxoplasmosis in a range of intermediate marsupial and eutherian hosts, including humans. The transmission by feral Cats of this disease to sheep in New South Wales, with consequent abortion in pregnant ewes, is of possible economic significance. A second area of concern is the role that feral Cats could play in the spread of rabies if the disease ever became established in Australia.

Ecological Impact

Feral Cats (Fig. 55.4) affect Australian native species by predation, by competing with native predators for needed resources and by acting as a reservoir for diseases or parasites likely to affect susceptible native species. Because Cats are such adaptable and opportunistic predators, their major ecological impact may be through direct predation.

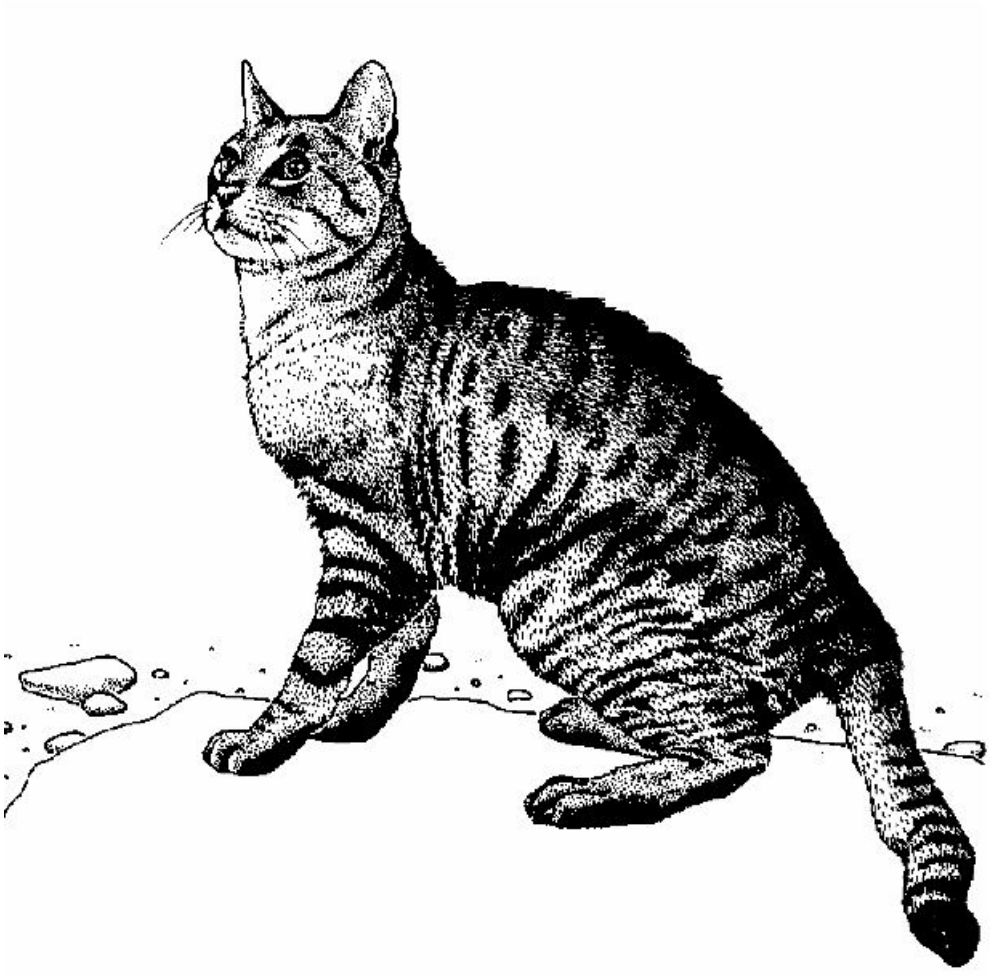

Figure 55.4. Under the Endangered species Protection Act of 1992, the Commonwealth promotes the recovery and conservation of native species and ecological communities. Threat abatement plans are a key mechanism in this process. The plan for feral cats places emphasis includes minimising predation on wildlife in areas of high conservation priority by reducing cat numbers. The plan for feral cats (Environment Australia 1999c) may be viewed at **http://www.biodiversity.environment.gov.au/plants/threaten/plans/threat_abatement_plans/land_degradation_by_feral_cats/index.htm.** (© Environment Australia). [K. McInnes]

[Although feral Cats are thought to have contributed to the decline or extinction of native birds and small mammals, much of the evidence is either indirect or anecdotal. The effects of feral Cats on native fauna are difficult to isolate from the other large scale ecological changes which have taken place in Australia since European settlement and from the effects of the Fox (*Vulpes vulpes*), another introduced predator. Dietary studies have established the native species eaten (and therefore at potential risk) by Cats, but no published studies have assessed the long-term effects of this predation. A prey species does not necessarily suffer any long-term deleterious effects from predation. In the eastern highlands of Victoria, the small native mammal eaten most frequently by Cats was the Bush Rat (*Rattus fuscipes*) (Jones & Coman 1981), but this species is still abundant in the area. Further, a mammal survey of the upper Richmond and Clarence Rivers in New South Wales also revealed that all expected species were present in good numbers, even though feral Cats were present (Calaby 1966). On the other hand, feral Cats have been blamed for the extinction of *Isoodon auratus* and *Lagorchestes conspicillatus* from Hermite Island in the Monte Bello Islands (Burbidge 1971).

Birds are not eaten in large numbers by feral Cats in mainland Australia and, again, it is difficult to obtain hard data on the impact of this predation. On islands, however, birds are often a major dietary item of Cats and the effects of this predation more noticeable. The extinction on Lord Howe Island of the White-breasted Storm Petrel (*Fregatta grallaria*), was caused by both Cats and Black Rats (*Rattus rattus*), but five species of land birds became extinct only after rats were introduced in 1919 (Recher & Clark 1974). Feral Cats on Macquarie Island also have contributed to the extinction of two species of land bird and two species of burrow-nesting petrel (Law & Burstall 1956). At present, the Antarctic Prion (*Pachyphila desolata*), and the White-headed Petrel (*Pterodroma lessonii*), form a major part of the Cats' diet (Jones 1977).

There is not yet enough evidence available to make any definite judgements on the overall impact of feral Cats on Australian wildlife. Clearly, there are instances where feral Cats have had a major impact on native species, acting either alone or in conjunction with other deleterious factors, but in other instances their presence appears to be benign.

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