

Using theory and scientific experience to assess the impact of house-based domestic cats *Felis catus* (Lo) on prey populations and prey community structure

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ABSTRACT

This paper attempts to apply theory from more than 100 years of scientific experience and experimentation in predator-prey ecology and introduced species ecology to predict the likely effects of predation by domestic cats (*Felis catus*) on prey populations and community structure. Those aspects of the predatory behaviour of domestic cats which are of most importance in predicting their impact on prey populations: 1) the degree of prey selectivity or 'dietary preference'; 2) the exhibition of switching behaviour; 3) changes in predatory activity in response to changes in prey density; and 4) the extent to which high and constant densities of the predator are ameliorated by reduced prey consumption rates as a result of dietary supplement.

In suburban environments, the influence of predation by domestic cats on prey abundance and community structure probably increases, relative to the influence of habitat change, with increasing suburb age, particularly in the absence of physical disturbances such as fire. However, it may never be as important as habitat availability and indeed may never be significant at all. Removal of the predator may allow some animal species to increase in abundance but others may decline. The details of these changes are very difficult to predict. Similarly, following predator removal, total species diversity is as likely to decline due to increased inter-specific competition, as it is to increase due to the invasion of species previously excluded by predation.

In remnant habitat, the impact of predation by domestic cats is probably less likely to be important in determining the relative abundance of the more common species than in suburban environments, but more likely to contribute to local extinctions of rare species. As in suburban environments, predation on introduced species in remnant habitat may reduce predation on native species. However, the ability of domestic cats to control introduced species which prey on, or compete with, native species will be difficult to demonstrate. In light of this uncertainty, any attempt to prevent domestic cats hunting in remnant habitat patches should be integrated with a program to eliminate or control populations of other introduced species, such as black rats and rabbits, which are preyed upon by domestic cats and are known to prey on or compete with native species.

INTRODUCTION

'The answer is 42; the problem is, you don't understand the question'. This rather unsatisfactory response to Mankind's inquiry as to 'the meaning of life, the universe, and everything' from the mega-computer 'Deep Thought' in Douglas Adams' classic satirical novel 'The Hitchhiker's Guide to the Galaxy' is surprisingly (or perhaps not) applicable to many of today's environmental controversies. The search for answers in the debate surrounding whether predation by house-based domestic cats (hereafter referred to as domestic cats) can affect populations of native Australian wildlife (and if so, in what way?) is no exception. For the characters in Adams' novel, the problem lies in not properly understanding the question being posed, thereby rendering the answer meaningless. The problem with regard to domestic cat research is slightly different. In this case, the question being posed is often the wrong one or, occasionally, the question is correct, but a different question has been answered.

Work on predation by domestic cats in Australia was largely pioneered by Paton (1991) in Adelaide, initially to address the question 'are cats taking certain species of birds?' and subsequently 'what is the crude rate at which domestic cats take prey?'.

A survey conducted in Tasmania around the same time by Trueman (1990) aimed to 'assess the impact being made by domestic and semi-domestic house cats on the wildlife of southern Tasmania', In spite of this worthy objective, the study produced only an estimate of the number and species of prey killed by domestic cats in Hobart (extrapolated to southern Tasmania) and made no attempt to assess the impact (if any) of this predation on prey populations in the region.

More recently, the Petcare Information and Advisory Service commissioned Rearth Research Pty Ltd to conduct independent research on predation by metropolitan domestic cats, the results of which were written up in a report released in April 1994. The broad aim of this work was to clarify the type and number of introduced and native species caught by domestic cats in response to the well publicised findings from Adelaide (Paton 1991). The question posed in the Rearth report introduction is: 'Previous research has shown that domestic cats are catching native wildlife. But - how many?' (Rearth 1994).

All of the studies mentioned so far have on occasion been described in the popular press as examples of research into the impact of domestic cats on Australian wildlife. However, the question of prey impact is either not considered, or incorrectly referred to, in the aims of all these studies and therefore, quite justifiably, little or no attempt has been made to address this question. Suspected ecological impact as a result of predation nonetheless remains the premise central to the domestic and feral cat debates. Rearth Research's recent contribution has added to information on the type and amount of vertebrate animals caught by domestic cats in Australian cities (albeit without any indication of how precise their figures are) but has unfortunately failed to bring us much closer to answering the fundamental question about 'cats, predation and everything'. While we need to know how much wildlife is caught by domestic cats, the important question is 'what impact does this predation have on prey populations and community structure?'.

How then can we resolve this most difficult and perplexing question? Unfortunately the short answer is 'not at all easily'. Predation by domestic cats is just one of a suite of factors (including habitat disturbance, climatic variation and other predators) which may limit prey populations, and its effect is difficult to isolate from those of other disturbing influences. A definitive resolution can only be obtained by conducting experiments, focused on different communities in different environments, where one set of populations of cats is manipulated and another serves as an experimental control, replicated in space and in time.

This type of experimental field procedure is neither new nor untried. It reflects the basic means by which scientists are able to proceed in experimental ecology, or any other experimental science for that matter. When Evan Jones (1992) states that it is difficult to disentangle the ecological impact of feral cats (*Fe/is catus*) from impacts caused by habitat destruction or predation by other introduced and native predators, he is not, as is proposed by Ronald Strahan (1992), applying the 'principles of British justice to environmental accusations', but rather applying the principles of reductionist science to the rejection or otherwise of a pre-determined hypothesis. However, the social, logistic and financial constraints that apply when attempting to conduct experimental research on domestic cats in suburban or suburb fringe environments, makes it highly unlikely that quantitative data of this kind will be available in the near future at least.

So what can be done in lieu of the experimental research described above? Monitoring prey densities at the same time as collecting data on the predatory habits and behaviour of domestic cats, or at least attempting to analyse predation data with respect to all available information on local prey abundance and shifts in prey abundance, is a step in the right direction. But there are other approaches. The aim of this paper is to increase awareness of ecological issues of significance in understanding the effects of predation by domestic cats, and to apply theory from more than 100 years of scientific experience and experimentation in predator-prey ecology and introduced species ecology to predict the likely effects of predation by domestic cats on prey populations and community structure.

It is, of course, quite possible that the question deemed to be of greatest importance by society is not 'what effect does predation by domestic cats have on prey populations and community structure?' but rather 'do domestic cats kill native wildlife?' or 'can domestic cats kill species 'X'?' or some other question. As might easily be imagined, this is a sizeable debate in itself. The debate is beyond the scope of this paper and therefore will not be dealt with further.

PREDATION THEORY AND THE ECOLOGICAL EFFECTS OF INTRODUCED SPECIES

Understanding predator-prey relationships between different species in different environments is still the focus of a vast amount of research. It is today possible to cite many examples where predation has a profoundly detrimental effect on prey populations and conversely, where predators have no apparent effect on the dynamics or abundance of their prey (Begon et al. 1990). There are also examples where a predator retains a fairly constant density in spite of fluctuations in the abundance of its prey; where a predator population tracks the abundance of its prey; where predator and prey populations are linked together by coupled oscillations in abundance; and where predator and prey populations fluctuate in abundance apparently independently of one another (Begon et al. 1990).

In an international review of the ecological effects of introduced birds and mammals, Ebenhard (1988) defined three different types of predator-prey relationships which are analogous (though more generalised) to the examples just described. In the first type, there is no real influence on the prey population. This situation may arise if the predator for some reason cannot maintain a population large enough to make its total predation pressure noticeable; that is, the predator population is regulated by factors other than prey numbers. The second type leads to prey extinction. This situation will arise if nothing keeps the predator population down and the prey has no refuge. The third predator-prey relationship type involves some kind of dynamic equilibrium permitting a coexistence of both species. The predator regulates the population of prey, but does not exterminate it, the only effect being a shift in abundance of the prey. In this scenario the density of the predator is regulated by the density of its prey at a level, or levels, whereby at any point in time it cannot irreversibly affect the prey population (Ebenhard 1988).

The manner in which predation intensity changes in response to changes in prey density is of obvious importance in determining the type of predator-prey relationship. Predation intensity varies in accordance with the numerical response (change in the density of a population of predators in response to changes in prey density) and functional response (change in predation rate per predator in response to changes in prey density) of the predator. Functional responses are commonly linear (type I), asymptotic¹ (type II) or sigmoidal (type III) (Holling 1959). A sigmoidal function occurs where an increase in prey density causes little change in predation rate at low prey densities, but a more-than-linear change in predation rate at intermediate prey densities. A predator may exhibit a type III functional response to one particular type of prey if it switches its attacks amongst various prey types depending on which are most abundant. In such a case the predator's abundance may be independent of the density of any particular prey type (Begon et al. 1990; Krebs 1994). This can lead to the prey being regulated at a low and stable level of abundance (Begon et al. 1990; Krebs 1994). A type III functional response may also occur as a result of heterogeneity in the environment leading to partial refuges in time for the prey species (Begon et al. 1990).

At the community level, predation may influence community structure irrespective of the exact nature of the predator's functional or numerical response. An intermediate intensity is most likely to be associated with high prey diversity, since too low an intensity may not prevent competitive exclusion of inferior prey species, while too high an intensity may itself drive preferred prey to extinction (Connell 1975; Huston 1979). Unfortunately, exactly what is intermediate predation intensity is very difficult to define *a priori*.

Community structure is often said to be largely determined by whether predators are generalists or are specialised in their predatory habits. Pimm (1991) asserts that the introduction of trophically generalised species should have profound effects on community composition because of the range of prey taken, while specialised species should produce fewer changes. Begon et al. (1990) and Krebs (1994) contend that generalist predators may be expected to increase community diversity, while specialist predators are also likely to enhance community diversity if their prey are competitively dominant. I suggest that the effect of generalists versus specialists on community structure is determined more by the degree of preference of one prey type over another relative to their availability, than simply by the total number of prey types taken.

Finally, the role of predators in shaping community structure is probably least significant in communities where physical conditions are most severe, variable or unpredictable (Connell 1975). However, under these conditions, predation may increase environmental stochasticity, and subsequently be crucial in determining the survival or extinction of a species already driven to very low abundance by other disturbances.

It is clear then that to predict the potential effects of predation by domestic cats on prey populations and community structure, we must incorporate all we know about the nature of the prey and associated environment, as well as about the nature of the predator. We would also do well to consider the outcomes of studies involving cats as predators where the question of prey impact has been examined.

POPULATION IMPACT STUDIES INVOLVING CATS AS PREDATORS

There is in fact a surprising number of studies examining the predatory habits of feral or domestic cats where some measure of prey population impact has been attempted (see Fitzgerald 1988). Only the most intriguing and informative studies with respect to prey impact and domestic cats are examined here.

Impact on rodents

Working in rural England during World War II, Elton (1953) found that cats supplied with supplementary food in the form of milk could only keep buildings free of Norway rats (*Rattus norvegicus*) once existing infestations were eliminated by other means (gassing, poison baits and trapping). The effect of cats was usually restricted to areas within about 50 metres of the buildings where the cat dwelt. In Maryland USA, Davis (1957) showed that while cats were not be able to eradicate Norway rats from farm buildings, they did have some effect on seasonal population changes. Cats were installed at rat infested farm buildings and provided with supplementary food. With the cats present, the rat population declined earlier in autumn than it had in previous years, and increased later in spring, after the cats switched to preying on young pigeons (Davis 1957).

In an intriguing study conducted in the United States midwest, Christian (1975) found that voles (*Microtus pennsylvanicus*) of different sex and age from a marked population were preyed upon by domestic cats in the same proportion as they appeared in a trapped sample, indicating either that predation by cats was non-selective or that its bias was the same as the trapping bias (Pearson 1985).

Studies by Oliver Pearson (1966,1971) and Erlinge et al. (1983,1984) show vole (*Microtus* spp.) populations are regulated differently by predator assemblages (including feral cats) depending on their relative abundance and preference as prey items. Where voles were the most abundant and most preferred prey, alternative prey such as gophers (*Thomomys bottae*), brush rabbits (*Sylvilagus bachmani*) and wood rats (*Neotomafuscipes*) allowed the predators to continue to hunt their preferred prey even as the vole population reached extremely low densities, subsequently dictating the timing and amplitude of vole population cycles (Pearson 1966, 1971). Where voles were secondary in abundance and dietary preference, an abundant primary prey source (European rabbits *Oryctolagus cuniculus*) allowed predator numbers to be buoyed to such an extent that annual predation on voles was of the same magnitude as annual production, and consequently vole populations remained fairly stable between years and did not fluctuate cyclically (Erlinge et al. 1983, 1984). In a study of domestic and feral cat predation on rabbits and rodents in rural Sweden, however, Liberg (1984) did not believe that cats *by themselves* were limiting any of their prey.

Impact on rabbits

The impact of carnivores (red foxes *Vulpes vulpes* and feral cats) on rabbit populations on a 300km² nature reserve in semi arid Australia was tested using predator-removal experiments (Newsome et al. 1989). It was found that foxes and cats did control rabbit populations, but only after rabbit numbers had collapsed during drought, that is the predatory control was environmentally modulated (Newsome et al. 1989). The conclusion that carnivores can regulate rabbit populations once rabbit numbers have been reduced by some external agency, was the same as that found in a similar study conducted in New Zealand (Gibb et al. 1978, in Fitzgerald 1988) and by Elton (1953) in relation to farmyard cats and Norway rats.

Impact on birds

Mead (1982) examined the fate of banded birds in Britain and discovered that for six species more than 25 percent of the recoveries were of birds caught by cats. All six species were ground or low vegetation feeders regularly occurring in gardens. As indicated by Fitzgerald (1988), the relative abundance of some bird species may have been greater in the absence of cats, but no-one appears to have been able to demonstrate this experimentally. Mead (1982) emphasised that birds in rural and suburban parts of Britain have co-existed with cats for hundreds of generations and may now be under less pressure from cats than they were in the past from assorted 'natural' predators.

As part of a quite comprehensive study of predation by domestic cats in an English village, Churcher and Lawton (1987) examined prey items brought home by approximately 70 domestic cats over 12 months and attempted to measure the impact of domestic cat predation on house sparrows (*Passer domesticus*). They found that at least 30 percent of sparrow deaths were probably due to domestic cats, comprising about one-third of all the sparrows in the village at the start of the breeding season. The authors concluded that this estimate of predation was probably conservative as it was highly unlikely that all prey items were recorded and that domestic cats were a significant, perhaps even the most important, source of mortality for house sparrows in the village (Churcher and Lawton 1987). A similar study by Paton (1991) in Australia estimated domestic cats in suburban areas of Adelaide caught between 10 and 20 birds per hectare per year. This was suggested to represent approximately 50 percent of the standing crop of birds in suburban Adelaide given typical bird densities of between 10 and 30 birds per hectare. Paton further considered that honeyeater populations may be declining in remnant habitat adjacent to or surrounded by suburban areas as a result of birds being attracted to suburban gardens by the presence of a wide range of nectar producing plants, and then cropped unsustainably by domestic cats (Paton 1991). Again, as yet, this theory is untested.

Special cases - impact on island species

Birds have been affected most by the introduction of cats to islands but the impact is rarely well documented. In many cases the bird populations were not well described before cats were established and the possible role of other factors in changes in the bird populations are treated inadequately (Fitzgerald 1988). Some island species have become extinct after cats became established on the islands and island populations of other, more widespread, species have been eliminated (Fitzgerald 1988). An often quoted example of extinction is the Stephens Island wren (*Traversia lyalli*) from Stephens Island off the New Zealand coast, that was discovered, and exterminated, by the lighthouse keeper's cat in 1894 (Fitzgerald 1988).

Fitzgerald and Karl (1979), however, argue that feral cats in the forests of New Zealand may suppress populations of other, more damaging predators such as rats, and thus allow denser populations of birds than would exist without them. On Lord Howe Island off the Australian east coast, black rats (*Rattus rattus*) exterminated five endemic passerine bird species following their introduction in 1919 (Greenway 1967, Hindwood 1940, Recher et al. 1974, in Ebenhard 1988). Working on the diet and habitat utilisation of introduced rodents, feral cats and mongooses (*Herpestes auropunctatus*) in Hawaii, Amarasekare (1994) concluded that black rats were not a significant predator of endemic birds because of differences in microhabitat preference between endemic birds and rats, and the overall scarcity of rats. Predation by feral cats and mongooses probably limited black rats (Amarasekare 1994). The feral cat population, on the other hand, was itself limited by physical factors associated with high elevations and consequently was unable to respond to high observed densities of mice (*Mus musculus*). Under these conditions, instead of allowing the cat population to reach levels detrimental to endemic birds, the mice, as an abundant and predictable food source, were thought to reduce the effect of predation by cats on endemic birds (Amarasekare 1994).

Ebenhard (1988) states that the argument posed by Fitzgerald and Karl (1979) [and later by Amarasekare (1994)], that it is perhaps better to have cats and rats than only rats, is based on the assumption that cats control rats. He illustrates this point using an analogous interaction between feral cats and introduced rabbits. On Dassen Island off South Africa, Apps (1984) found that feral cats primarily ate rabbits and seabird carcasses, and did not seriously threaten seabird populations. In addition, the cats controlled the number of rabbits such that seabird nesting habitat was not threatened by overgrazing. The sole removal of either species could therefore be detrimental to the seabird colonies. Conversely, Taylor (1979) suggests the introduction of rabbits onto Macquarie Island allowed feral cats to increase to the extent that a population of red fronted parakeets (*Cyanoramphus novaezelandiae erythrotis*), with which the cats had previously long coexisted, was exterminated. Ebenhard (1988) concluded that what happened on each island can be explained in terms of whether rabbits control cats or cats control rabbits. More specifically though, the problem may relate to dietary selection by the predator: not just to whether rabbits or birds are the primary or secondary prey items, but whether rabbits or birds are preferred prey items relative to their availability. The ability of a prey population to cope with a change in predation intensity, as a result of its status shifting from say, a neutral prey type to a preferred prey type, will also be important.

It remains now to use this theoretical and quantitative information to summarise the general nature of predation by domestic cats and attempt to predict its effect on prey populations and community structure, with particular reference to suburban environments and remnant habitats.

THE NATURE OF PREDATION BY DOMESTIC CATS

Domestic cats as predators may be described as sedentary generalists, occurring at relatively high densities in the suburban environment. Being domestic pets, their density is fairly constant through time and will not track fluctuations in prey density. It is likely though, that domestic cat density decreases as prey diversity and abundance increases, from inner to outer town or city suburbs. Finally, as a consequence of a regular dietary supplement, predation by domestic cats is not solely driven by hunger and therefore predation rates are substantially lower than if supplementary food was not available.

We may surmise then that we have a constant (but not necessarily abnormally high) predation pressure, effectively uncoupled from any fluctuations in prey abundance, that is, the predators show no numerical response. Spatial and temporal variation in prey caught by domestic cats (Churcher and Lawton 1987), the wide range of prey taken overall (Paton 1991) and seemingly non-selective predation (Christian 1975) indicates (but does not prove) domestic cats exhibit switching behaviour, and consequently predation intensity on any one prey species will decrease as its population declines (type III functional response). As the density of domestic cats is stable irrespective of prey density, by exhibiting switching behaviour, domestic cat predation may stabilise prey populations (Begon et al. 1990; Krebs 1994).

The fact that predation by domestic cats is essentially 'for fun', may also result in a reduction in predation intensity as total or preferred prey abundance declines. The reasoning behind this is that as prey abundance decreases, the hunting instincts of domestic cats are not as often stimulated by the presence of prey targets and therefore the cats may hunt less. On the other hand, because the predator population exhibits no numerical response, if predatory activity and interest remain constant as prey density decreases, and domestic cats show a strong preference for particular prey species and do not exhibit switching behaviour, the number of prey killed per unit time per individual predator may remain relatively high even at low prey densities (type II functional response), potentially driving the prey species to local extinction.

Those aspects of the predatory behaviour of domestic cats of most importance in predicting their impact on prey populations are therefore:

1. the degree of prey selectivity or 'dietary preference';
2. the exhibition of switching behaviour;
3. changes in predatory activity in response to changes in prey density; and
4. the extent to which high and constant densities of the predator are ameliorated by reduced prey consumption rates as a result of dietary supplement.

PREDICTING THE IMPACT OF DOMESTIC CATS ON PREY POPULATIONS AND COMMUNITY STRUCTURE

Suburban environments

Animal species breeding successfully in suburban environments (that is, whose population rate of increase is not consistently negative) have either persisted through the disturbances associated with the establishment of the suburb, including the introduction of cats, or have invaded or re-invaded that environment as the quality and diversity of habitat has increased with suburb age, in the presence of cat predators. These populations are therefore not naive to predation by domestic cats. In addition they have access to artificially sustained food supplies, which while they may vary in abundance for different species and in different suburbs, are usually buffered to some degree from climatic fluctuations. Increased heterogeneity of habitat associated with increasing suburban age is also likely to provide more partial refuges in time for prey species, reducing their susceptibility to predation at low densities. For these reasons alone, the effect of predation by domestic cats in suburban environments is more likely to be measured in terms of changes in community structure than in terms of population extinctions.

The influence of predation by domestic cats on prey abundance and community structure in suburban environments probably increases, relative to the influence of habitat change, with increasing suburb age, particularly in the absence of physical disturbances such as fire. However, it may never be as important as habitat availability, and indeed, may never be of significance at all. For bird communities at least, population abundance and species richness in suburban environments is predominantly determined by the type and quality of source habitats (for example, lightly or heavily disturbed forest, woodland and grassland remnants), the distance from source habitats and the total availability and diversity of suburban habitat, as determined by suburb type, age and location (Munyenembe 1985; Green 1984).

Prey species most likely to be excluded from suburban habitats or to have their populations controlled by domestic cats will be those which are preferred as prey items, that is, actively selected for relative to their availability (or accessibility) in the environment. These species may well be native. For example, active selection of small arboreal marsupials, such as sugar gliders or birds that feed or nest close to the ground, may severely limit the distribution of these species in suburban environments. However, if domestic cats can control populations of introduced species that prey on, or compete with native species (for example, black rats, starlings), then certain native species may ultimately benefit. The black rat is a particularly damaging predator because it is arboreal and can eat the young and eggs of many bird species (Ebenhard 1988).

To conclude, predation by domestic cats in suburban environments is likely to be analogous to, say, predation by lions in a southern African national park. Prey species are caught and killed on a daily basis, but are not driven to extinction as a result of this predation. As pointed out by Mead (1982) in relation to bird predation in suburban environments in Britain, and emphasised more generally by Pimm (1991), if you remove the predator, some animal species *may* increase in abundance and others *may* decline, but the details of these changes are very difficult to predict. Similarly, following predator removal, total species diversity is as likely to decline due to increased inter-specific competition, as it is to increase due to the invasion of species previously excluded by predation. Species extinction as a direct result of predation is only likely to occur if the prey do not or cannot breed in suburban environments but are continually drawn into the suburbs to feed, or as part of a migratory cycle, and are then heavily preyed upon. However, the attraction to the suburban environment would need to be very great, the proportion of the prey population culled be very high, and the response of the remaining prey population to reduced intraspecific competition be very poor, for such an extinction to occur.

Remnant habitat

The ecological effects of predation by domestic cats in remnant habitat is quite different to that in suburban environments. Within a suburb, both predator and prey have successfully invaded a highly modified environment and the resulting relationship may reflect, superficially at least, an evolved predator-prey relationship on a continental landmass. The effect of domestic cats moving beyond suburban edges into remnant habitat, in Australia is likely to be more analogous to the effects wrought by a predator newly introduced to an island environment. The communities in remnant habitats may include species that have not invaded the suburban environment either because of, or in spite of, the domestic cat population, and will be naive to predation of this kind. In addition, while species which successfully invade suburban environments are likely to be mobile and widespread, vertebrate species in remnant habitats may be relatively immobile and patchily distributed.

The effect of domestic food supplement allowing cats to continue to hunt in habitat islands as prey become increasingly scarce, may be more significant than the potentially ameliorating effect of a reduced prey consumption rate. Prey species in remnant habitat probably have to also contend with fluctuating food supplies in accordance with climatic fluctuations and disturbance events such as bushfires.

The intensity of predation by domestic cats in remnant habitat adjacent to, or surrounded by, suburban areas will probably be lower than in the suburbs themselves, as only a fraction of the total domestic cat population is likely to make significant excursions into these areas (Barratt, in press). However, total predation intensity may be higher depending on the presence and abundance of other predators such as foxes and raptors.

To conclude, the impact of predation by domestic cats in remnant habitat is probably less likely to be important in determining the relative abundance of the more common species than in suburban environments, but more likely to contribute to local extinctions of rare species. Hunting by domestic cats may therefore pose a serious threat to some wildlife populations in nature reserves or on relatively undisturbed private blocks (for example, weekend retreats, hobby farms etc.). The presence or absence of introduced species, such as black rats and rabbits, in remnant habitat will be important in predicting the impact of predation by domestic cats on native species. As in suburban environments, predation on introduced species may reduce predation on native species. However, the ability of domestic cats to control introduced species which prey on, or compete with, native species, will be difficult to demonstrate. In light of this uncertainty, any attempt to prevent domestic cats hunting in remnant habitat patches should be integrated with a program to eliminate or control populations of other introduced species, such as black rats and rabbits, which are preyed upon by domestic cats and are known to prey on or compete with native species.

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Footnote

¹ that is, increasing at a decreasing rate

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