CHAPTER 12

DOMESTIC CAT (*Felis catus* L.)

Introduction

The domestic cat (*Felis catus* L.) co-exists with human communities in very substantial numbers (Table 12.1) as household pets or companion animals, as semi-domestic 'working' cats in farms, factories etc., and as free-living feral cats, famously around dockyards (Dards 1981), hospitals and other public institutions (Rees 1981, Howes 1985f). Table 12.1 reveals that these numbers are extremely high compared with estimated totals of all other British carnivora, domestic cats outnumbering their entire estimated populations by almost 6 to 1.

Table 12.1 **Population estimates of terrestrial and riparian carnivora in Britain compared with domestic and feral cat (data from Harris *et al*. 1995)**

Stoat	462,000
Weasel	450,000
Badger	250,000
Fox	240,000
American mink	110,000
Otter	7,350
Polecat	5,000
Pine marten	3,650
Wildcat	3,500
Feral ferret	2,500
Total	**1,534,000**
Domestic cat	8,000,000
Feral cat	813,000
Total	**8,813,000**

In an attempt to record and quantify the population size, structure and predatory activities of free-range cats in Yorkshire, questionnaire surveys were designed to investigate domestic cats on farms and in town centre, suburban and rural situations, as elaborated in Howes (2002c), which is provided as Appendix 12.

N.B. All references to Figures, Appendices and Tables hereafter apart from those prefaced by 12. refer to those in Howes (2002c).

A survey of farm cats in Yorkshire.

With the enthusiastic assistance of members of the Yorkshire and Humberside

Federations of Young Farmers' Clubs, a survey of farm cat populations throughout the Yorkshire regions was conducted from September to December 1979. Using a standard questionnaire, volunteers recorded the type and size of the farm, the number of cats kept there and, where known, their age, sex and whether they had been neutered. Methods of rodent control and reasons for keeping cats on farms were also recorded. Most of the farms surveyed were the homes of the volunteer surveyors or the homes of their friends or neighbours.

In order to detect local variations in the size and structure of cat populations in such a large and geographically varied region as Yorkshire, the resultant data were divided for separate analysis according to topographical and agricultural characteristics: Pennines, Vale of Mowbray, Southern Vale of York, Humberhead Levels, the North York Moors, Vale of Pickering, Wolds and Holderness .

Howes (2002c Appendix 1) shows the numbers of farms surveyed, frequencies of various farming practices, farm acreages, number of cats, reasons for the presence of cats, methods of rodent control and perceptions as to their effectiveness for this purpose. Howes (2002c Appendix 2) provides statistics on gender and rates of neutering, and for those cats for which age data were provided, Howes (2002c Appendix 3a) classifies intact and neutered males and females into age classes.

Of the 239 farms surveyed, 226 (95%) had cats, the numbers varying from 1 to 30 (!). The most frequent 'colony' sizes were from two to five cats (on 58% of farms), the county mean being 4.9. Table 12.2, which compares the mean 'colony' sizes across Yorkshire farming regions, shows marked variations and indicates an intriguing progressive increment of colony size from south and west (3 on Pennine farms) to north and east (7 on farms of the North York Moors). By comparing the numbers of cats with the declared farm acreages, a mean farm cat population density was shown to be one cat per 52.7 acres (21.3 ha). Again, Table 12.2 shows marked variations, the smaller mixed or stock rearing farms of the North York Moors and the Pennines recording one cat to 21.3 acres (8.6 ha) and 40.5 acres (16.4 ha) respectively, compared with the situation on the huge arable farms of the Humberhead Levels and the Wolds recording one cat per 76.2 acres (30.8 ha) and 78 acres (31.6 ha) respectively.

The ages of 558 cats (48% of total sample) for which gender and neutering information was available are shown in Howes (2002c Appendix 3a & Figure 3a). The oldest individuals were two neutered females, both reportedly 15 years old, although the most elderly farm cat in the survey, was claimed to be 17 years old, was omitted from

Table 12.2. FARM CAT POPULATION DENSITY					
Region	**Farms Sampled**	**Acreage**	**No. of Cats**	**Acres per Cat**	**Cats per Farm**
Vale of Pickering	5	1812	29	62.48	5.80
Holderness	14	3480	74	47.02	5.28
North York Moors	16	1965	92	21.35	7.07
Vale of Mowbray	21	3668	119	30.82	5.66
Humberhead Levels	26	8149	107	76.15	4.12
Vale of York	31	11043	151	73.13	4.87
Wolds	38	15223	195	78.06	5.13
Pennines	88	16283	402	40.50	3.03
TOTAL	**239**	**61,623**	**1,169**	**52.71**	**4.89**

this sample owing to lack of information on either gender or neutering status.

Since these are essentially not pet cats in the sense of most domestic house cats, a detailed knowledge of cat age may be imprecise, particularly in the larger colonies. The accuracy of declared cat ages can only be regarded as approximate and the resultant mean and survivorship calculations should be regarded as only tentative. The most frequent claimed age was two years, making up 21% of the sample. Assuming cats of less than one year to be on average 6 months old, the mean age for the entire sample was 3.3 years. The numbers of intact and neutered males and females are given separately for each year age category in Howes (2002c Appendix 3a) and provide the basis of mean age calculations which showing that for intact females this was 3.3 years, compared with 3.0 for intact males. For neutered cats, mean ages were substantially greater, with 5.0 years for females and 4.7 for males. The under-representation of cats under one year old is no doubt due to the absence from the survey of dependent unweaned kittens, though other anomalous depressions in the survivorship curve Howes (2002c Figure 3a) (at years 1, 7 and 11) could be due to intermittently low recruitment into the population during epizootics of cat flu or feline enteritis (J. Jack *pers. comm*.).

Statistics on the 971 cats for which gender and neutering data were available have been assembled into Howes (2002c Appendix 2), from which % frequencies have been calculated for the regional sub-sets and for the county sample as a whole. Males made up 36.6% of this sample, a lower rate than for pet cats in rural, suburban and

urban areas (see Howes 2002c Figure 7) fitting in with the popular concept that intact adult 'tom' cats have 'harems' of females.

105 animals (10.8%) had been neutered, again a markedly lower rate than for pet cats, even those in rural areas (see Howes 2002c Figure 6). Neutering rates differed between the sexes, accounting for 15.2% of males and only 8.3% of females. Although undertaken partly as a means of controlling colony size, the necessary veterinary expenses incurred, particularly in neutering female cats, may be regarded as unjustifiable in the context of the overall farm budget. The wide regional variations in neutering rates possibly provides evidence for this interpretation, with the small mixed farms of North York Moors recording a neutering rate of 3.8%, whereas the huge farms from the arable (probably wealthier) regions recording 13% (Humberhead Levels), 14.8% (Holderness) and 18.7% (Wolds).

The role of the farm cat

In an attempt to evaluate the practical role of cats on farms, enquiries were made as to whether cats were kept for rodent control, as pets, or for any other reasons (see Appendix 1). Cats were partially regarded as pets on 39% of farms, but were kept exclusively for rodent control on 86% of them. Of the perceived effectiveness of cats in farm rodent control, they were regarded as playing an effective anti-rodent role on 90% of farms: indeed on 21% of these, farm cats were claimed to be the only form of rodent control necessary. Attitudes and experience varied somewhat, with 10% of farmers regarding cats as of little or no use in rodent control and, according to annotations on returned forms, on 7.6% of farms they were positively not welcome, farmers claiming that their presence was due to an inability to get rid of them. Interestingly, footnotes on several returned forms maintained that the presence of cats on farms generally suppressed the build-up of rodent pests or kept populations below levels where it became necessary to employ commercial rodent control contractors. It was also felt that they prevented or delayed re-colonisation after major infestations had been dealt with, as borne out by experiments monitored by Elton (1953).

Discussion and general observations

Farm cat populations were found to be largely self-perpetuating, although colonies eradicated by cat flu (one colony of 10 cats died out during the course of the survey) and in one case by road casualties, were re-established by introductions of young cats

from neighbouring farms. 7.6% of farms harboured colonies which were claimed to be unwanted and untended. The tenacity of the colonies was evidenced by some farmers, not sympathetically disposed towards cats, claiming that populations had become established through strays taking up residence (5% of colonies were of purely feral origin), or that colonies had persisted despite attempts to discourage them. Colony size was claimed to be partially under the control of the farmer in that unwanted kittens, if located early enough, were frequently destroyed or given away to either neighbouring farms or as domestic pets. Although neutering was employed as a means of population management, this practice was relatively marginal, affecting only 10.8% of the sample.

At mean population densities, such as one cat per 78 acres (31.6 ha) on the Wolds or even one cat per 21 acres (8.5 ha) in north-east Yorkshire, it may seem unlikely that farm cats would have any significant effect on small vertebrate populations in the wider countryside: indeed Elton (1953) showed that cats had little effect on field rat populations. However, these densities seem high compared with some wild predators, Harris *et al.* (1995) estimating a post-breeding density for stoats in unimproved grassland and arable land as being 2 per 1 km^2 or a maximum of one fox social group (1 adult male and a breeding female) per 1 km^2. As cats, particularly females and immature males, generally remain in the vicinity of the farm buildings (Macdonald 1981), it is more likely that here they could exercise a more focused and effective control over synanthropic species such as house mouse and common rat. However, Elton (1953) demonstrated that even here they had little effect on well established rat infestations, although they were found to be very efficient at preventing rats (perhaps not familiar with the terrain) from re-colonising after premises had been cleared of rodents.

Field observations on arable (root crop) farm land on the Hatfield Levels in the southern Vale of York showed that cats seasonally congregate for hunting around field-side root crop stores (clamps) established hundreds of metres from the nearest buildings. Foxes are also attracted to these field-side stores, their diets, studied from scat analysis (Howes *in press*) consisting largely of young common rats. It is reasonable to assume that the same quarry also attracts the cats. Cats are also known to move to newly mown hay meadows and fence lines overlooking recently dredged ditch networks to prey on rodents made vulnerable by disturbance and removal of cover. Under such circumstances, farm cats in the USA have been shown to successfully compete for prey against wild predators. Pearson (1964) showed that cats alone had reduced a rodent

population by 88% and George (1974) gives an example of cats competing effectively for small mammals against birds of prey.

Clearly farm cats only represent one component of the total rural cat population, others being feral or pets kept on adjacent domestic premises. Since Elton's (1953) studies, urban development in rural communities has proceeded apace and the effect of cat predation on small mammals and competition with other mammalian predators must be considerably greater than in the 1950s.

Two characteristics of domestic (pet) house cat populations are that males (for whatever reason) tend to outnumber females (see Howes 2002c Figure 7), and that the population is subject to a relatively higher rate of neutering (see Howes 2002c Figures 6 and 8). Using data from Howes (2002c Appendix 2) as an index of 'petness', Wolds farm cats exhibit the highest level of 'petness' in the Yorkshire region. Here, males, which make up 47.6% of the population (mean for Yorks. = 36.6%) are more frequent than in any other farming region, also with 25.3% of the Wolds farm cat population being neutered (mean for Yorks. = 10.8%), this is also the highest level in the region. The role of cats on Wold farms may be indicative of changes in the status of farm cats generally. Perhaps John Gray's (1733) poetic vision of farm cats being purely *guardians of a nation's cheese* could be changing, cats adding the therapeutic role of 'companion animal' to their repertoire of perceived benefits.

Ownership levels and population structure of domestic house cats in Yorkshire

Questionnaire surveys, undertaken by Howes (2002c) with the assistance of the YNU affiliated societies, Doncaster Museum and Doncaster schools, were used to gather information on the population densities, sex ratios, neutering rates and age structure of pet cat populations in urban, suburban and rural areas of Yorkshire. Although preliminary data from these studies were referred to in Tabor (1983) and Gilbert (1989), the final results were presented in their entirety in Howes (2002c). The survey was conducted from September to December 1980. Surveyors recorded the numbers and, where known, the ages, sexes and neutering status of cats from ten domestic properties adjacent to (but not including) their own home. In addition, housing types were recorded, as were a range of habitat types and land-uses. The general nature of the sampling area was allocated to three categories described as urban/town centre, suburban and rural. 371 survey questionnaires were completed, the resultant data on housing types, adjacent habitats and land-uses and cat ownership levels summarised in

Howes (2002c Appendix 4). Statistics on gender and rates of neutering are summarised in Howes (2002c Appendix 5) and for those cats for which age data were provided, Howes (2002c Appendix 3b) categorises intact and neutered males and females into age classes.

How the housing types and the habitat and land-use availability varied across the three district categories is illustrated in Howes (2002c Figures 4 a-c and Figures 5 a-c respectively). Of the housing type analysis (monitoring the relative frequencies of flats, terraces, semi-detached and detached properties), the most significant feature, which increased along with cat population density, were the detached properties with a surrounding garden 'territory' which increased from 9% of properties in town centre and urban areas, to 37% in suburban districts to 49% in rural areas.

For the habitat and land-use availability analysis, the relative frequencies of larger gardens of above 150 yd^2 and access to adjacent arable and pasture land seemed to be most significant, large gardens being represented in 5%, 16% and 19% of urban, sub-urban and rural districts respectively, and agricultural land being represented in 0%, 17% and 47% of urban, sub-urban and rural districts respectively. Curiously, the availability of parks, sports fields and allotments seemed to be negatively related to the presence of cats; thus it could be said that from a cat's point of view, these municipal provisions are no compensation for the absence of rural open space and protected large gardens.

Of the 3,710 properties surveyed, 1,401 cats were recorded, giving a mean population level of 37.76 cats per 100 households. The levels of ownership varied substantially according to housing region, the fewest, at 25.09 cats per 100 properties, being recorded in town centre and urban areas, rising to 33.76 in sub-urban districts, with the highest ownership level of 53.12 in rural areas. These statistics are of considerable significance when considering aspects of predatory pressure and may in some cases have a bearing on the sustainability of populations of certain prey species and of other native wild predators (see Howes 2002c Table 4).

Figure 7 in Howes (2002c), based on the amalgamation of data from the farm cat study with that from the domestic cat gender and neutering survey (see Howes 2002c Appendix 2 & 5), shows that sex ratios vary substantially according to rurality and housing regions. Male cats on farms and in rural properties represent 36% and 44% of their respective populations, whereas males in sub-urban and urban/town centre regions represent 54% and 51% respectively. Two factors which may be at work here are a)

disproportionate mortality rates for males and b) gender preference in domestic cat ownership. The causes of mortality which may affect males to the extent that sex ratios are tipped in favour of females could be due to intact males wandering in search of mates and thereby subjected to road traffic accidents or being killed or injured by dogs or via 'vermin' traps, or injury through fights with other intact males for access to mateable females. If wandering and fighting are characteristic behaviours of intact males and if these behaviours are suppressed or absent in males which are neutered (pre-maturity), then the proportion of males in a population could be a function of the rate of male neutering within that population. Interestingly, Howes (2002c Figure 8) shows that the % frequency of males in a population does indeed rise as male neutering rates increase.

According to anecdotal input to this study, evidence for gender preference being a major influence in domestic cat population composition seems to be contradictory. On the one hand there are owners who claim to prefer male cats on the basis that males do not become pregnant and are cheaper to have neutered; on the other hand there are those who, despite the higher cost of neutering, prefer females on the basis that they don't 'spray', 'caterwaul' less vociferously, and are less likely to wander and be killed. If cost of neutering was a significant factor affecting choice, then one would expect the less affluent urban and town centre areas to have a higher incidence of males and for the more affluent suburban sample to have a higher incidence of females. Figure 6 shows this is not the case.

Statistics on gender ratios and neutering rates are available from cat ecology and behavioural studies (e.g. Dards 1981, Macdonald 1981, Rees 1981, Tabor 1983, Churcher & Lawton 1987, Soulsby & Serpell 1988). However, since neutering levels are regarded as being central to the management of a range of cat-related animal welfare and public health issues (Hammond 1981, Jackson, 1981, Remfrey 1981) it is surprising how few surveys have been undertaken. The Yorkshire study appears to be unique in revealing patterns of variation across different land-use and housing type categories.

Howes (2002c Figure 6) shows that major differences occur in cat neutering levels according to land-use and housing areas with below 15% on farms and below 45% in rural areas, with over 70% in both suburban and urban areas. Although the farm and rural neutering levels are particularly low, even the Yorkshire suburban and urban figures are relatively low compared with the 82% of males and 90% of females recorded for the London suburb of Romford (Tabor 1983). Differences in neutering rates between

the sexes however, show relatively little variation in the pet cat samples. The situation with the farm cat ratio is discussed above.

The ages of 245 cats (17.5% of the total house cat sample for which gender and neutering information was available) are shown in Howes (2002c Appendix 3b, the basis of Figure 3b). The oldest individuals were a neutered male and female of 17 years and a neutered female of 19 years of age. Since these animals were generally not the pets of those completing the questionnaires (as requested), the declared cat ages can only be regarded as approximate. The most frequent claimed age was three years, making up 20% of the sample. Assuming cats of less than one year to be on average 6 months old, the mean age for the entire sample was 4.3 years. The numbers of intact and neutered males and females are given separately for each year age category in Howes (2002c Appendix 3b) and provide the basis of mean age calculations, showing that for intact females this was 3.9 years, compared with 2.9 for intact males. For neutered cats mean ages were substantially greater, with 4.7 years for females and 4.8 for males. As with the farm cat study, the under-representation of cats of less than one year of age is no doubt due to the absence from the survey of dependent unweaned kittens, though other apparent anomalies in the survivorship curve (at years 1, 2, 8 & 10) could, as was observed in the farm cat study, be due to intermittently low recruitment into the population during epizootics of cat flu or feline enteritis (J.Jack *pers. comm*.). In that this census was undertaken in 1980, a year later than the farm cat survey, it is interesting to note that anomalies in the survivorship pattern in Howes (2002c Figure 3a; shifted on a year in Figure 3b) indicate that the relatively unmanaged farm cat populations and the cosseted house cat populations are subject to the same epidemiological cycles and survivorship trends.

The domestic cat has little dietary need to hunt, but still harbours a potent behavioural drive to ambush, attack and kill (Turner & Meister 1986). Anecdotal accounts of cat prey items (be they birds, mammals, herptiles or fish) gathered by various natural history societies, has periodically thrown light on the taxonomic range, relative frequency and seasonality of prey taken by domestic cats. Mead's (1982) analysis of cat-killed ringed birds submitted to the British Trust for Ornithology (BTO) bird ringing scheme perhaps provided the earliest critical insight into the hunting strategies of cats and indicating which bird species are most likely to fall victim.

Investigations into the predatory activities of domestic cats in Britain received an unexpected boost during early stages of compiling *An Atlas of Yorkshire Mammals*

(Howes 1983) when in 1978-79, after mammal trapping and bird pellet analysis had been exhausted as sources of data, a questionnaire survey entitled *What the Cat Brought In* was designed as a ploy to garner records of small mammals from unrecorded areas. This exercise, which began to reveal fascinating insights into the predatory behaviour and impact of domestic cats, was continued in order to provide further information on this little studied aspect of cat ecology. Initially launched through the YNU and Doncaster Museum, it involved cat-owning members of YNU affiliated societies, and ultimately the general public, in monitoring for a year the prey items caught by their cats. Preliminary reviews of results were published in Howes (1979a, 1981a), which served to stimulate further interest.

Following the success of the Yorkshire prototype, a series of promotional and feed-back articles in the Mammal Society's *Youth News* (Howes 1979b, 1980b, 1981b) and the RSPB's Young Ornithologists' Club's *Bird Life* (Howes 1980c, 1981c), assisted by extensive press coverage, succeeded in developing the *What the Cat Brought In* project into a major national survey, which succeeded in monitoring the annual predatory activities of c.1000 domestic cats throughout Britain. Although summarised in Howes (1990, 1992), it was not until 2002 that the Yorkshire data were published (Howes 2002c).

There is currently a vigorous worldwide interest in the food ecology and predatory impact of domestic cats, the now extensive literature (though not including the Yorkshire component) being reviewed in Fitzgerald (1986), Turner and Meister (1986), Bradshaw (1992), Pearre and Maass (1998), and Woods *et al*. (2003).

The *What the Cat Brought In* questionnaire survey was designed to monitor the prey items caught by individual domestic cats living in rural, sub-urban and town centre areas for a year. To increase the likelihood of prey items being correctly identified, the survey was targeted primarily at the cat-owning members of local natural history and ornithological societies. In addition to recording the name, age, sex and neutering status of each cat, the questionnaire forms recorded the address of the surveyed cats, the prevailing housing types and nearby habitat and land-use types. The date of receipt and return of the form were noted, followed by the date and identification of each successive prey item. As an index of palatability, those items which were eaten or partially eaten were indicated.

The predatory activities of 180 cats (84 from rural, 70 from sub-urban and 26 from urban and town centre areas of Yorkshire) were each monitored for a year.

Monthly and annual totals of prey types are categorised separately for taxa of birds (35) mammals (16), fish (3), herptiles (2), and invertebrates (7) in Howes (2002c Appendix 6). The numbers of prey types recorded varied substantially according to hunting areas, Howes (2002c Figure 9) showing that biodiversity of prey taxa generally increased from the lowest level in urban/town centre areas to the highest in rural areas. Of the vertebrate prey items recorded in the overall sample, mammals made up 69.1%, birds 30.5% and other vertebrates (herptiles and fish) constituted 0.4; however, Howes (2002c Table 1) reveals substantial regional variations.

Some 5,205 vertebrate prey items were recorded, giving a mean annual prey capture rate of 28.91 per cat. However, a wide variation in rates of predation was evident across the housing regions, Howes (2002c Table 4) showing a mean annual rate per cat rising from 7.88 in town centre and urban areas to 37.51 in rural districts. Howes (2002c Table 1) shows the relative compositions of birds, mammals and other vertebrates across the three hunting areas, revealing the general principle that birds constitute the highest proportion (72.2%) of vertebrate prey in urban areas, declining to the lowest level (22.3%) in rural areas, whereas mammals constitute the highest proportion (77.6%) of vertebrate prey in rural areas, declining to the lowest level (27.8%) in urban areas. Interestingly this demonstrates a similar predatory trend as observed in the analysis of tawny owls prey in Greater London where high levels of bird predation were linked with the inner London Boroughs and the higher levels of mammal predation were encountered in the outer more rural districts (Bevan 1965).

By linking the mean prey capture figures per cat in Howes (2002c Table 1) with cat population density levels in Howes (2002c Appendix 4 & Figure 4a-c), it is possible from Howes (2002c Table 2) to separately estimate the predation levels of prey types per 100 households in town centre, suburban and rural housing/landuse areas. Again, this emphasises an increase in predation levels the more rural the hunting habitat becomes. Interestingly, although relatively token, the rate of predation on herptiles and fish in the suburban sample is probably a reflection of the frequency of ornamental garden ponds.

Monthly totals of reported prey for all housing regions, provided in Howes (2002c Appendix 6), have been used to generate Howes (2002c Figure 10) which shows relative % composition of mammal and bird prey for the entire sample throughout the year. This shows that mammals outnumber birds in each month, exceeding 60% of vertebrate prey in the ten months from July to April, and exceeding 80% in October and

November. Predation on birds reaches a peak in the months of May and June when rates exceed 40% of vertebrate prey, followed by an isolated peak of above 35% in January. By separating the seasonal vertebrate prey data according to housing regions, Howes (2002c Figure 11 a-c) shows the increasing significance of birds as prey items in the suburban and urban samples, emphasising their exploitation during breeding season, exceeding 40% of vertebrate prey from May to August in the suburban sample and exceeding 80% from May to September in the urban sample. The suburban and urban samples also emphasise the winter predation of birds that peaks in December and January. It is likely that this phenomenon is a consequence of birds being artificially attracted during periods of hard weather into urban cat territories to feed on well stocked bird tables.

Considerable variation in the composition of the mammalian prey faunas in the urban, suburban and rural hunting zones is illustrated in Howes (2002c Figures 9 & 12), both of which show that taxonomic diversity increases from urban to rural hunting zones. Howes (2002c Figure 12) shows that murids (mice and rats), which accounted for 97% of mammals in the urban sample and only 58% in the rural sample, were the most frequently taken mammal prey group across the regions. Although the incidence of voles, shrews and other mammals increased with rurality, it was interesting to note token evidence of both shrew and vole occurrence in urban areas. Howes (2002c Figure 13, based on records in Appendix 6) shows specifically identified mammal species placed in order of frequency with the wood mouse accounting for 56% of the sample.

The following review deals with mammals in family order. Only eight bats were represented in the survey, although their presence from June to October and the fact that recorders described them in terms of ‘half inch’ and later ‘three quarter inch’ bats suggested that these were likely to be newly fledged young pipistrelle bats (s.l.). In addition, anecdotal information and *WTCBI* recording sheets submitted by correspondents elsewhere in Britain (Howes 1981a, 1981b) showed a pronounced peak of captures in May which coincided with the formation of summer nursery colonies. Since colonies are largely associated with domestic property, bats at this time are vulnerable to cats attracted to windowsills, dormer roofs etc. by the activities and ultrasound emissions of the aggregating bats. None of the bats were reported to have been eaten.

The usually subterranean mole is generally safe from cat predation, and indeed the 25 moles recorded in this survey represent only 0.7% of mammal prey items. The

occurrence of moles above ground tends to vary according to prevailing soil moisture conditions, typically in times of flood or drought. Interestingly, the peak of 15 captures in June and July of 1979 coincided with one such drought period. None of the moles were reported to have been eaten.

All three species of shrew were reported and although occurrences were monitored throughout the year, there was a pronounced peak in July and August (see Howes 2002c Appendix 6). With 409 reported captures, shrews represented the third most frequent mammal prey group, though significantly none were reported as having been eaten. That this may be associated to unpalatability, Macdonald (1977) demonstrated in his feeding experiments where foxes would only resort to eating shrews when particularly hungry.

All three species of vole were reported with the 630 captures, most of which were eaten, representing the second most frequent mammal prey group. Of those specifically identified, 78% were field voles, 21% were bank voles, and only 1% (2 specimens) were water voles. Although significant numbers are taken through the year, numbers rose markedly in July, remained high through the late summer and early autumn and peaked in October (see Howes 2002c Appendix 6). The sudden rise in vole predation in July may have been a response to field voles made vulnerable after the removal of grass crops. The autumnal peak in predation is probably due to the aggregations of new generations of voles with breeding continuing through the summer and early autumn.

Three species of mice were reported with the 2,160 captures, most of which were eaten, representing the most frequent mammal prey group. Of those specifically identified, 93% were wood mice, 6.5% were house mice, and only 0.1% (1 specimen) was harvest mouse. Seasonality of occurrence as prey was similar to that in the voles, with fewest captures in February rising to a late summer peak in September, a month earlier than for the voles (see Howes 2002c Appendix 6).

Although much discussed by correspondents, common rat was recorded on only 103 occasions and represented 7% of identified mammal prey items. Since specimens were frequently described as ‘young’ or ‘small’, this would indicate that adult rats tend to be avoided. Like the other rodent groups, there was a marked September and October peak, probably representing aggregations of new generations with breeding continuing through the summer and early autumn.

Rabbits, often described as ‘young’, were recorded on 159 occasions and represented 10% of identified mammal prey, all kills being reported in rural areas. Since they were taken throughout the year, some of those caught would certainly have been fully grown. A significant peak of kills recorded in August may have been in response to the appearance on the surface of newly independent young of the year or animals made vulnerable through the harvesting of cereal crops.

Grey squirrels were caught on three occasions within the survey, but cat owners in suburban areas adjacent to community woodlands anecdotally reported frequent kills. In addition, one suburban and four rural weasels were reported in the survey.

Other mammals which though caught in Yorkshire were caught outside the survey period included brown hare and stoat. Notable historical cat kill records include the last red squirrel to be recorded in the Barnsley area, ambushed by two Siamese cats in March 1967 in the grounds of the Northern College, Stainborough (I. Mackerness *pers. comm.*), a black rat from the premises of R. Wade & Co. Hull on 10 February 1901 (Specimen in Hull Museum) and a dormouse killed on the banks of the Hodder in Bowland during the 1860s (Anon. 1884).

Birds featured significantly as prey items but despite extensive negative comments by correspondents on what was regarded as this unacceptable behaviour, the 1,586 kills represented only 30.5% of total reported vertebrate prey items. Considerable variation in the composition of the avian prey faunas in the urban, suburban and rural hunting zones is illustrated in Howes (2002c Figures 9 & 14), both of which show that taxonomic diversity increases with rurality. Figure 14 shows that house sparrows, which accounted for over 70% of birds in the urban sample and less than 30% in the rural sample, was the most frequently taken bird species across the regions. Curiously, like the house sparrow, the blackbird also exhibited an urban orientation, declining slightly in the suburban and rural samples. By contrast, the starling and song thrush exhibited a suburban orientation, declining in both urban and rural samples. Howes (2002c Figure 15, based on records in Appendix 6), shows the ten most frequently identified bird species placed in order of frequency with house sparrows accounting for 62% of the total sample, the next most frequently predated species being starling, blackbird and song thrush, representing 9, 7 and 5% respectively.

Of the 35 taxa of identifiable birds the ten most frequently taken species (Howes 2002c Appendix 6 & Figure 15) are generally similar to the cat-killed species of ringed birds identified by Mead (1982). All of the frequently taken prey species either

regularly feed or breed in domestic gardens and are therefore likely to live in close proximity to cats. However the most likely criterion of vulnerability is that house sparrow, starling, blackbird, song thrush, robin, dunnock and wren are essentially ground feeders, often feeding close to shrubs and vegetation which cats can use for purposes of ambush. Although blue tits are normally canopy feeders and are therefore out of reach of cats, they are regular visitors to bird-tables and garden feeding stations and frequently breed in nest boxes erected in sites vulnerable to house cats. Greenfinches are also generally arboreal feeders, though Mead (1982) points to their habit of feeding terrestrially on food debris dislodged from bird tables or nut feeders, making them particularly vulnerable to cat attack.

Seasonality of most prey species was closely associated with breeding period when adults were nest building and particularly when young were fledging. This is particularly noticeable in the blackbird with most casualties in May and June, song thrush with most casualties in May, June and July, robin with a peak in June and July and dunnock with a peak in July. The prolonged breeding period of the house sparrow is reflected in high levels of predation from May to August. With this slow-flying species nesting almost exclusively under the same roofs, so to speak, as their house cat predators and in feeding terrestrially in gardens, frequently on household scraps, it is understandable why this species constituted over 60% of all identified bird prey.

Of the migrant species, redwing (1 in January) was the only winter visitor, summer migrants being chiffchaff (1 in April), willow warbler (2 in July and 1 in August), house martin (2 in June and 4 in July), and swallow (1 in July and 1 in September). Although the two hirundine species frequently inhabit the same premises as house cats, their frequency as prey species is minute, presumably reflecting their aerial feeding behaviour and aerobatic skills. However, anecdotal information from correspondents and evidence in Mead (1982) suggests that by waiting on windowsills or roofs, individual cats contrive to catch birds as they leave or return to their nests.

Although the vast majority of prey species were small to medium sized passerines, larger species like black-headed gull (1), moorhen (3), collared dove (7), street pigeon (3), wood pigeon (16) and even pheasant (1) were also taken, though most of those reported were rescued and liberated by the cat owner.

Correspondents frequently referred to incidents where cats had regularly removed fish from garden ponds but actual evidence in the survey was sparse, producing only records of six specimens of three species (see Howes 2002c Appendix

6). Similarly, stories of cats catching large numbers of frogs during spawning season were not corroborated, the survey only producing records of 11 frogs and two newts. Small though this sample was, it identified an early spring time (March) seasonality in the suburban sample (see Figure 11b). Although not included in this survey, additional anecdotal records include a grass snake caught in Harthill in July 1975 (W. Ely *pers. comm.*) and a viviparous lizard caught at the Crown and Anchor, Kilnsea in July 1976 (J. Harrup *pers comm.*).

Invertebrates were substantially under-recorded for reasons of difficulty with identification and, more particularly, in monitoring this activity from which there would be few if any remains and which did not seem to engender the behaviour of 'presenting' the prey. However, of the 116 items recorded, Howes (2002c Appendix 6) shows a peak of activity from June to October. Anecdotally, recorders mentioned the indoor autumnal activity of their cats catching and eating the large *Tegenaria* spiders, the mature males of which nocturnally wander around the ground floors of domestic property in search of occupied female webs. Of the butterflies, large white, green-veined white, red admiral small tortoiseshell and peacock were listed, the latter two featuring in early spring when warm days in March and April brought specimens which had hibernated indoors, fluttering to sunlit windows where they were easily caught by sun-bathing cats. The same strategy also led to the demise of larger muscid flies and bumble bees in summer and in late summer the 'Drone flies' (*Eristalis* spp.). In addition there were anecdotes of cats catching large *Aeschna* dragonflies and bringing home the larvae of the elephant hawk moth.

The numbers of vertebrate prey items recorded for cats in each age group revealed that predatory activity rapidly builds to a peak of 43.5 vertebrate prey items per year at two years of age, numbers of prey items caught declining thereafter Howes 2002c Figure 16). Generally, cats up to four years old catch a mean of 31 vertebrate prey items per year, this falls to a mean of 20 for cats between five and nine years of age and only 15 for cats of ten years and above. That cats up to four years of age catch prey in excess of the sample mean of 28.91, may be related to the natural life expectancy of cats as a species, the survivorship graphs of both farm and house cats (Howes 2002c Figures 3a & 3b) showing substantial diminution in the proportion of the population of cats over four years of age.

Being generally well fed, the domestic cat is probably fitter to go hunting than its untended feral counterpart. In receiving a food source independent of the

productivity of their 'wild' environment, domestic cat populations, unlike those of wild predators, are not controlled by prey availability. They are therefore potentially in a position to a) severely deplete or eradicate wild prey populations and b) unfairly compete with native terrestrial carnivores.

The above predatory pressures generated by the enormous numbers of cats in Britain could well have a detrimental effect on vertebrate faunas around our towns, suburbs and rural villages, and where localised or rare prey species are involved, this could be of conservation significance. Soulsby and Serpell (1988) showed that the domestic cat population in Britain increased from 4 million in 1963 to 6.2 million in 1988, and the JNCC review of British mammal populations (Harris *et al*. 1995) estimated that this would rise to around 8 million by the year 2000. Harris *et al*. (1995) also considered that to this could be added an estimated 813.000 feral cats.

The *What the Cat Brought In* survey found that on average each cat brought in 29 prey items a year, which by simple extrapolation would suggest that Britain's 8 million domestic cats could be killing some 232 million vertebrates per year. Since the largest sample of cats (46.6%) in the survey were from the predatorily successful rural sample (see Howes 2002c Table 1), this blanket figure gives a misleadingly high impression. Having organised the Yorkshire cat prey and cat population surveys on the basis of distinct housing, habitat and land-use regions, this very crude global figure has been refined in Howes (2002c Table 4) to predict a potential annual predatory pressure by domestic cats per 100 households, giving figures in the order of 1,992, 890 and 197 in rural, suburban and town centre areas respectively.

In providing a statistical rather than a purely anecdotal review, this study usefully reveals that the predatory activities of cats vary substantially with: a) Age - predatory activity declining substantially after year 4 (see Howes 2002c Figure 16); b) Housing/land-use/habitat districts - annual predatory success (or perhaps opportunity) declining from 37.5 vertebrate prey item per cat in rural areas to 7.9 in town centre/urban areas (see Table 1); and c) Season - the majority of garden birds are taken in winter (December and January), presumably when attracted to bird tables, and during nesting season (notably in May and June) when fledglings are vulnerable (see Howes 2002c Figures 10 & 11a-c).

The restriction of nocturnal and crepuscular activities of the more numerous and more predatory younger cats would therefore achieve significant reductions in small mammal and bird predation and in turn would reduce competitive pressures on wild

carnivore populations, particularly if this prohibition were exercised on rural and suburban cats. If excessive predation on garden birds is perceived to be a problem, then the restriction of diurnal access to gardens during peak winter feeding and summer breeding periods would certainly reduce this effect. Whether the fitting of cats with a sonic (e.g. collar and bell) or optical (e.g. reflective collar) warning device could significantly reduce predatory success, would require experimental verification, though Woods' *et al.* (2003) analysis of the Mammal Society's 1997 cat prey survey showed that fewer mammals were brought in by cats that were wearing bells. Since birds rely initially on visual cues to identify potential predators, an examination of the species and numbers of birds caught by cats with different coat colours/pattern, may reveal which, if any, have a measurable effect on predatory effectiveness.