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After the hunt

The future for foxes in Britain

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Acknowledgments

Much of the work reported here is our own, and over the years a wide variety of organisations have funded our fox research and the many graduate students who have worked with us. Thus we are grateful to the following organisations for their financial support:

- The Australian Meat and Livestock Research and Development Corporation
- The Burns Inquiry
- The Dulverton Trust
- The International Fund for Animal Welfare
- The Joint Nature Conservation Committee
- The League Against Cruel Sports
- The Leverhulme Trust
- The Mammal Society
- The Ministry of Agriculture, Fisheries and Food/Department for Environment, Food and Rural Affairs
- The Natural Environment Research Council
- The Nature Conservancy Council/Joint Nature Conservation Committee
- The Nuffield Foundation
- The Royal Society
- The Royal Society for the Prevention of Cruelty to Animals
- The Science and Engineering Research Council.

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Executive summary

Fox numbers

Three fox population estimates spanning a period of twenty years and using very different techniques all show that, at the start of the breeding season, there are about a quarter of a million adult foxes in Britain. The consistency of these estimates reinforces their reliability.

Are fox numbers changing?

Over the last 100 years, reductions in persecution levels led to a recovery of all carnivore populations, including fox numbers. During the first half of the 1900s, foxes colonised new habitats and recolonised areas from which they were exterminated by gamekeepers during the 1800s. However, over the last forty years all the available evidence suggests that fox numbers have not changed significantly in most of Britain. Over the last ten years fox numbers have declined in some urban areas, and possibly also in some rural areas, due to an outbreak of sarcoptic mange.

Will the ban on hunting have any effect on fox numbers?

There is no evidence to suggest that foxhunts played any role in the control of fox populations, nor is there any evidence that the introduction of the Hunting Act 2004 will have a significant impact on fox numbers.

What limits fox numbers in Britain?

All the recent work shows that fox numbers are not regulated by culling pressure, other than locally, or food availability. It is probable that social factors are the main factor regulating fox numbers in Britain.

Fox management and welfare

There is some indication that effort expended on shooting of foxes may increase immediately following the ban on hunting, at least in the short-term. However, the effect of increased effort on the numbers of foxes killed is unclear. Despite the lack of legal restrictions on shooting or an examination of competence, current standards of shooting of foxes are high. Shooting is likely to remain the most effective and practicable method for culling foxes, should this be necessary, for the foreseeable future. There is no evidence to suggest that this will cause any decline in fox welfare standards.

Foxes and conservation

Agricultural intensification is by far the major factor in the decline of most wildlife in Britain. Wildlife may suffer from fox predation if species are already reduced by habitat loss, pesticide use or other factors. Thus foxes do not pose a significant risk to conservation interests and there is no justification for widespread fox control on conservation grounds.

Foxes and agriculture

Fox predation has a direct economic cost to agriculture of approximately £12 million per annum. However, the bulk of fox diet is made up of rabbits, which cause in excess of £100 million damage to agriculture each year.
Fox predation therefore also brings significant indirect economic benefits to farmers, and foxes are probably economically neutral to agriculture.

Foxes and lambs

Lamb losses to fox predation are small in relation to other causes of lamb mortality. In most circumstances, there would be no benefit to farmers from carrying out additional fox control since, as fox populations are reduced, the benefits obtained by culling foxes are increasingly outweighed by the costs of doing so. The greatest benefits to lamb production are likely to be achieved through improved husbandry of lambs, especially during the first week of life.

Foxes and fowl

Predation of poultry by foxes is highest for free-range egg producers and negligible for table chicken producers. It is more likely to occur on farms where overall losses of birds are higher. This suggests that husbandry of the birds plays a key role in determining the level of fox predation. Losses of poultry to fox predation may be reduced most effectively by improved husbandry practices and simple preventive measures such as fencing and secure housing.

Foxes and other livestock

Fox predation of piglets is generally low. In economic terms, it is not worthwhile for most pig producers to spend additional money on fencing to prevent fox predation. However, in cases where specific problems exist locally, electric fencing is an effective preventative measure.

Foxes and pheasants

Fox predation of pheasants in release pens is generally low. However, the principal threat to pheasants from fox predation is likely to occur after they have left the pens. There are no data on the levels of fox predation on pheasants at these later stages of their development. Fox control by shooting can effectively increase autumn game populations. However, estates that rely on rearing game can release more birds to compensate for losses to predators.

Urban foxes

Foxes are widespread throughout urban areas in Britain, where densities are some of the highest recorded anywhere in the world. Despite this, they cause remarkably few problems and the vast majority of householders like to see foxes in their garden.

Diseases and attacks

Like most wild mammals, foxes carry a range of diseases. There is no current evidence that these pose a significant disease risk to humans and/or domestic animals, although more monitoring is needed to determine the prevalence of current disease levels and to assess their potential economic impact. Foxes present no significant threat of rabies. The risk of foxes attacking children is extremely low and negligible when compared to the risks posed by companion animals.

The future

Whilst a case can always be made for more information, it is clear that the fox is one of the best studied mammals in Britain, and that much of our knowledge on the ecology and behaviour of foxes is based on studies in Britain. Thus the conclusions presented in this report are based on data unrivalled in both quality and quantity. Further work needs to focus on dealing with specific management issues.

Overall conclusions

The economic assessments of the losses attributable to foxes have been consistent over the last half-century and there is no evidence that foxes cause widespread economic losses. However, the high degree of popularity of the fox suggests that its total economic value is likely to be substantial. The less tangible socio-economic and cultural benefits of foxes need to be considered alongside the more easily quantifiable economic impacts.

Introduction

In 1997 Philip Baker and Stephen Harris compiled two reports (with Robbie McDonald as a co-author of one report) that summarised the state of knowledge about the economic and ecological impact of foxes [9, 72]. These reports also considered the likely impact of a ban on hunting on fox numbers.

Since these reports were published, there has been extensive public discussion about the economic impact of foxes and the merits of different management techniques. These discussions culminated in a government inquiry chaired by Lord Burns into hunting with dogs in England and Wales, which reported in June 2000 [27]. The inquiry team received 461 written submissions, many of which were posted on the Inquiry's website *(www.huntinginquiry.gov.uk),* and 5945 letters submitted by individuals; commissioned a series of research contracts into hunting with dogs; held public hearings to discuss the draft research reports; and visited a variety of hunts. This inquiry was then followed by three days of Public Hearings in London in September 2002 chaired by Alun Michael, the Minister for Rural Affairs, in which the issues of cruelty and utility were explored in more detail. Although both these exercises considered all the hunted species of mammals, foxes were the focus.

This widespread public consultation exercise led to the passing of the Hunting Act 2004, which came into force in February 2005. Other than specific exempt activities, hunting foxes with dogs was made illegal. This series of public consultations has ensured that there is now more information available about the ecology of foxes, and their economic impact, than probably any other wild mammal in Britain. So it is now timely to review what we know about the ecology of foxes, the impacts that they have, whether there is any evidence that fox populations need to be managed and, if so, by what means, and what welfare issues are associated with different management strategies. In particular, we also consider whether the ban on hunting foxes with dogs will have any impact on either foxes or dealing with any potential problems they may pose.

In this report we have provided a succinct summary of the new scientific findings made since the previous two reports were published, and conclude each section with a summary of the current state of knowledge.

Fox numbers

- The fox is one of our most widespread mammals, being found throughout mainland Britain, the Isle of Wight and Anglesey but absent from all the Scottish Islands except Skye and Harris in the Outer Hebrides [53]. Earlier claims that foxes were abundant on the Isle of Man [64] were erroneous, and there is no convincing evidence that they have become established on that island [86].

- Density estimates are based on the number of adult foxes at the start of the breeding season because the number of cubs produced can vary between years.

- In 1995 it was estimated that there were 240,000 adult foxes in Britain [53]. This was a preliminary estimate because the calculations were based on extrapolations of known fox densities from a limited number of sites. However, it was in close agreement with an earlier estimate of 252,000 adult foxes, which was based on subjective estimates of fox densities in different landscapes [65].

- In 1995-1997, the Game Conservancy Trust conducted night counts of foxes using spotlight counts along roads to quantify fox abundance in three regions: East Anglia, the Midlands and mid-Wales [56]. In these areas they estimated that fox densities varied between 0.16-1.17 foxes/km^2. If these density estimates were correct, the total population estimate of 240,000 adult foxes [53] would have been far too high. Based on the estimates produced by the Game Conservancy Trust, the total number of foxes in Britain would have been under 200,000. Such a low figure seems very unlikely. However, spotlight counts along roads are widely believed to under-estimate fox density [25, 67, 91, 96], particularly in areas where spotlights are also used to shoot foxes at night.

- Subsequent work using data collected by The Mammal Society confirmed that some of the density estimates produced by the Game Conservancy Trust were too low. In 1999-2000, The Mammal Society undertook a national fox survey of Britain based on counts of fox droppings in 444 1-km squares in different landscapes. Fox density ranged from 0.21-2.23 foxes/km^2 [118]. Using these data, it was estimated that the total rural fox population was 225,000 adult foxes [118].

- There is no recent estimate of the number of urban foxes. Fox numbers have declined substantially in many towns and cities due to the spread of sarcoptic mange [13, 127], although other areas have been colonised recently [127]. It is probable that, across Britain as a whole, reductions in fox numbers due to mange are offset by the expansions into new urban areas and that there has been little change in the total number of urban foxes. Thus the estimate of 33,000 foxes in urban areas based on data from the 1980s [53] is still reasonably reliable.

- Thus the total adult fox population in Britain at the start of the breeding season is 258,000, of which 225,000 live in rural areas, 33,000 in urban areas.

CONCLUSION

Three fox population estimates spanning a period of twenty years and using very different techniques all show that, at the start of the breeding season, there are about a quarter of a million adult foxes in Britain. The consistency of these estimates reinforces their reliability.

Are fox numbers changing?

- In many regions, the number of foxes killed annually on game estates by gamekeepers increased between the 1960s and the early 1990s [105], although it has now stabilised [20]. However, there are several reasons why the number of foxes killed by gamekeepers is not a reliable method of monitoring changes in fox numbers. The main problem is that over these decades there were dramatic changes in the methods used to kill foxes; these include the outlawing of poisons, self-locking snares and, in Scotland, gin traps (they were made illegal earlier in England and Wales). These techniques have been offset by an increase in the use of night shooting, particularly with rifles. So the data across different time periods are not comparable.

- Most of the foxes killed on game estates are dispersing juveniles and counting the number of dispersers killed is not a measure of the changes in the breeding fox population, the key measure of population change. This problem is exacerbated because much of Britain is not covered by gamekeepers [105], and the way game estates are managed is not typical of the majority of Britain. In fact, large parts of Britain have no fox control of any sort since around 40% of farmers do not control foxes [115, 125], and these areas provide surplus foxes that are the dispersers that form the bulk of animals killed by gamekeepers. The other practical problem with the data provided by gamekeepers is that the more time they spend out shooting foxes, the more they kill, since as soon as a gamekeeper removes one disperser, another moves in to take its place. Since the amount of effort expended by gamekeepers on fox culling is not recorded, there is no way to calibrate the data.

- A study by The Mammal Society, based on counts of fox droppings, could detect no increase in fox numbers between 1999/2000 and 2002 in eight of nine regions of mainland Britain when hunting ceased following the outbreak of foot-and-mouth disease in 2001 [16, 17]. The only region where fox numbers increased was eastern England. Fox numbers in this area were believed to be recovering following extensive past persecution by gamekeepers. At the same time, fox numbers declined in south-east England despite a temporary ban on hunting, probably due to the spread of sarcoptic mange, a parasitic infection that often kills foxes.

- Results from a collaborative mammal monitoring programme also suggest that fox numbers are probably stable [20], although this programme has not been running long enough to detect long-term trends in fox numbers with a reasonable level of confidence.

- There are no quantified data on the changes in the number of urban foxes in Britain. In Bristol, the only city for which there are quantified data, the number of foxes in 2005 was only a fifth of those present before the arrival of sarcoptic mange in 1994. It is probable that, across Britain, fox population declines in urban areas due to sarcoptic mange have, at least in part, been offset by expansion into new urban areas.

CONCLUSION

Over the last 100 years, reductions in persecution levels led to a recovery of all carnivore populations, including fox numbers. During the first half of the 1900s, foxes colonised new habitats and recolonised areas from which they were exterminated by gamekeepers during the 1800s. However, over the last forty years all the available evidence suggests that fox numbers have not changed significantly in most of Britain. Over the last ten years fox numbers have declined in some urban areas, and possibly also in some rural areas, due to an outbreak of sarcoptic mange.

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Will the ban on hunting have any effect on fox numbers?

- Around 425,000 fox cubs are born each year [53], and since fox populations are not increasing, this level of productivity must be offset by the same number of deaths each year. Published estimates of the number of foxes killed by different means are largely speculative, although it is probable that road deaths are the single greatest cause of mortality [9].

- Formerly, registered packs of hounds killed 21,000 to 25,000 foxes annually [27], which amounted to around 5% of the total fox mortality. Furthermore, roughly half of the foxes killed by these hunts were cubs killed before the main hunting season, and it is likely that many of these would have failed to find a vacant territory and died anyway.

- Based on a questionnaire survey of farmers, gamekeepers and hunts, the only area where hunting with dogs comprised a significant proportion (c. 50%) of the total number of foxes killed annually was upland Wales [55]. However, the fox population density estimates used in that study were significantly below those published before [61] and subsequently [118], and so these estimates of the impact of hunting with dogs are flawed. Furthermore, since farmers over-estimate fox densities by 5 to 18 times [121] and the number of foxes killed on their land by hunts by 7 to 12 times [55], claims that hunting with dogs had a significant impact on fox numbers [55] are highly questionable.

- During the outbreak of foot-and-mouth disease in 2001, foxhunting was suspended outright for a total of 10 months and severely restricted for a further two months. A study based on counts of fox droppings in the two years preceding and the year following the outbreak of foot-and-mouth disease found no evidence of a change in fox numbers in eight of nine lowland regions [16, 17]. The only region where fox numbers increased was eastern England. Fox numbers in this area are believed to be recovering, having been largely wiped out by gamekeepers in the 19th century [105].

- Thus following the ban on hunting during the foot-and-mouth outbreak in 2001, there was no detectable increase in fox numbers in most of lowland Britain. These data suggest that:

  (i) either hunting had no effect on fox numbers; or

  (ii) other forms of fox control increased and compensated for the suspension of hunting; or

  (iii) that hunting had no effect on fox numbers and whilst other forms of fox control increased, they also had no effect on fox numbers.

  Whichever scenario is correct, it is clear that the permanent ban on foxhunting is unlikely to result in any increase in fox numbers.

- This conclusion is reinforced by a study in 44 commercial conifer forests in Wales during the winter of 2003/4 [8]. Faecal counts were used to quantify the impact of gunpacks (packs of dogs used to drive foxes to waiting guns) on fox numbers. Gunpacks had no significant impact on fox numbers, and in fact the trend was for fox numbers to be higher in the spring the more foxes that were killed. Thus this study concluded that restrictions on the use of dogs to control foxes are unlikely to lead to fox population increases in commercial conifer forests.

CONCLUSION

There is no evidence to suggest that foxhunts played any role in the control of fox populations, nor is there any evidence that the introduction of the Hunting Act 2004 will have a significant impact on fox numbers.

What limits fox numbers in Britain?

- Each fox group occupies a territory that is defended against other groups. The size and shape of each territory is determined by the spatial and temporal availability of food. Territory size varies considerably, from 0.1 km^2 in urban areas to 40 km^2 in upland areas.

- Even though most fox mortality is caused by humans, either through collisions with motor vehicles or by culling [55, 84, 85], there is no evidence that killing foxes has any effect on fox population size other than locally. The only two studies that have quantified the impact of winter culling (most foxes are killed in the winter) on the spring breeding population, one in Scotland and the other in Welsh coniferous forests, both found that, where more foxes were killed in the winter, spring numbers tended to be higher [8, 54]. So both these studies suggest that fox culling can be counter-productive, and that removing resident populations leads to higher numbers of immigrants.

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- The relationship between fox numbers and food availability is complex. In Welsh woodlands, fox numbers were highest in younger plantings where food availability was believed to be highest, and fox numbers declined in mature blocks where there were fewer rabbits and field voles [8]. Conversely, in Bristol, whilst there was no clear long-term change in numbers over a period of thirty years preceding the arrival of sarcoptic mange [18], the size of social groups rose dramatically in response to excess feeding by local residents [14].

- However, there is little evidence that food availability limits fox numbers nationally. Three different fox population estimates over the last twenty years have suggested that there has been no change in fox numbers at the onset of the breeding season, despite dramatic increases in both the numbers of rabbits [53], the main food source, and released pheasants [105]. Similarly, in Bristol a recent study found that fox territories contain a super-abundance of food that greatly exceeds the requirements of a fox social group and that territory sizes could be substantially smaller.

- Disease can have a dramatic impact on wild mammal populations. In this respect, the most significant disease for British foxes is sarcoptic mange. The recent outbreak has probably resulted in high mortality of foxes in both urban [13] and possibly rural areas over the last decade, and has led to population declines locally. This is best documented in Bristol, where the mange epidemic reduced fox numbers by over 95% [18]. However, a lack of data means that the impact of mange on fox numbers in Britain as a whole is hard to quantify.

CONCLUSION

All the recent work shows that fox numbers are not regulated by culling pressure, other than locally, or food availability. It is probable that social factors are the main factor regulating fox numbers in most parts of Britain.

Fox management and welfare

- Foxhunters claim that hunting with hounds is the most humane method of killing foxes. They claim that the fox is either killed by a quick bite to the neck or escapes unhurt. They argue that other methods of killing foxes cause more suffering and that welfare standards would, therefore, be lowered if the foxes that were killed by hunting were killed by other methods that inflict more suffering.

- Future fox welfare standards are, therefore, dependent upon the relative degree of suffering inflicted by hunting compared to these other methods, and any potential increase in the use of other, less humane, means of killing foxes following the ban on hunting with dogs.

- Hunting with hounds did inflict suffering. A study of foxes killed by hounds above ground and submitted for post-mortem examination indicated that the animals died from profound trauma inflicted by multiple dog bites rather than a quick bite to the neck [35].

- Despite claims that hunted foxes were either killed or escape, with no wounding, there are many accounts from the hunting literature of instances where foxes that escaped the hounds and went to ground subsequently perished [1, 33, 81]. This was believed to be the result of the trauma of being chased.

- There are widespread claims that hunts only killed sick or weak foxes. There are no data to support such assertions. Furthermore, it was highly unlikely that practices such as cub hunting, where woods were surrounded and the foxes prevented from escaping, blocking earths to prevent hunted foxes going to ground, and digging out any animals that did manage to escape, could have been in any way selective.

- As the majority of foxes currently killed are taken by shooting [55, 71, 84, 85], which is generally viewed as the most effective form of fox control [125], this is the method most likely to increase in prevalence in the future. Compared to a survey undertaken in the early 1970s [2], the importance of shooting as the main means of fox control has increased over the last thirty years.

- A recent study by the Middle Way Group compared the ability of people with different levels of shooting expertise to hit a life-size target of a fox with either a shotgun or rifle. The authors concluded "under common field conditions, for every fox shot dead with a shotgun, at least the same number of foxes are wounded and many of these are never found" i.e. a 50% wounding rate [39, 40]. However, many of the people participating in this trial were people who had seldom or never fired a gun. There is no evidence to suggest that there is a widespread lack of skill in people who regularly shoot foxes. The majority of foxes shot each year are killed by gamekeepers [105] or by sportsmen with rifles [26]; both groups are skilled shots.

- Not one of the shotgun trials undertaken in the Middle Way Group study [39, 40] was in accordance with the guidelines recommended by the British Association for Shooting and Conservation. Recent trials by the British Association for Shooting and Conservation confirmed that over 90% of foxes are killed with the first shot [69]. It should also be remembered that only using one shot in both trials does not replicate field conditions, and using a second shot to kill an animal is not a welfare issue [11, 29]. There are many other problems with this study that render the results meaningless [11].

- A study using X-ray plates from 764 foxes admitted to wildlife hospitals and/or their veterinarians were examined for evidence of wounding by rifles and shotguns: 6 had shotgun pellets, 2 had rifle bullets and 12 had airgun pellets [22]. Accounting for the proportion of the surface area of each fox examined and using data on the age structure of a range of fox populations in Britain, these data indicate that in the region of 9% and 3% of the foxes shot at are wounded with shotguns and rifles respectively each year. There was no evidence to support the high wounding rates claimed by the Middle Way Group [39, 40].

- Wounding with shotguns appeared to be the result of using appropriate shot sizes but at too great a range to achieve penetration [22]. Wounding with rifles appeared to be the result of using rimfire weapons with lower muzzle energy. These problems could be addressed by greater training of shotgun users, and by restrictions on the use of rimfire weapons.

- In Britain there is no close season for foxes, and no legal restrictions on the types of guns or ammunition that can be used to shoot foxes. The United Kingdom and Ireland (and some regions of Spain) are the only European Union countries where there is no mandatory examination of competence prior to being allowed to shoot live animals [60]. It would clearly be sensible to consider whether examinations of competence in the use of shotguns should be introduced to ensure that high standards of welfare are maintained. However, at the moment there is no evidence of widespread shooting of foxes by unskilled shots, although this situation should be monitored.

- There is little evidence to suggest that current shooting practices pose a significant welfare risk to foxes. So although 35% of farmers, gamekeepers, foresters and nature reserve managers said they would increase their level of lethal fox control in the event of a ban on hunting [125], an increase in the number of foxes shot should have no significant adverse welfare implications.

- Fertility control is a possible future, non-lethal, option to reduce fox populations where this is necessary. Its use is currently being investigated in countries such as Australia, where foxes have been introduced. Compounds such as cabergoline can be effective in reducing fertility in individual foxes [68]. However, the welfare implications of imposed sterility on social behaviour and its effectiveness at the population level are uncertain [32, 93]. There are also significant problems associated with the dissemination of compounds into wild populations.

- The application of fertility control to free-living, wild vertebrate populations remains a long way off. Even if suitable species-specific compounds and dissemination methods are developed, fertility control is only likely to be effective in maintaining populations at low levels following lethal control.

CONCLUSION

There is some indication that effort expended on shooting of foxes may increase immediately following the ban on hunting, at least in the short-term. However, the effect of increased effort on the numbers of foxes killed is unclear. Despite the lack of legal restrictions on shooting or an examination of competence, current standards of shooting of foxes are high. Shooting is likely to remain the most effective and practicable method for culling foxes, should this be necessary, for the foreseeable future. There is no evidence to suggest that this will cause any decline in fox welfare standards.

Foxes and conservation

- In countries where they have been introduced, foxes can have very significant impacts on wildlife. For example, in Australia, where foxes were originally introduced for hunting with dogs, fox predation poses a known threat to 11 native species [73]. Recent studies have also shown that introduced predators can have wide-ranging and hitherto unknown effects [30]. However, in countries where they are part of the native fauna, such as in Britain, the threats posed by foxes to conservation interests are minimal and localised.

- Predation by foxes has been implicated as a possible factor associated with the decline of birds such as corncrake, grey partridge, black grouse and capercaillie. However, other factors associated with the decline of these species include habitat loss and degradation, increased use of pesticides and collisions with deer fences, and for none of these species is fox predation the primary cause of any population decline. The Royal Society for the Protection of Birds, for instance, says that the main cause of grey partridge population declines is increased pesticide use, and for corncrake early and frequent mowing of meadows [38].

- Grey partridge populations may also have been reduced by a parasitic infection transmitted by pheasants released for sport shooting [92, 108, 109, 110, 111].

- A long-term study in Scotland indicated that capercaillie breeding success was positively related to food availability and negatively related to the combined abundance of foxes, crows and raptors [7]. A predator manipulation experiment indicated that breeding success was greater when most crows and some foxes were killed [7, 104].

- A study of fox predation on lapwings found that predation of nests by foxes was incidental and that foxes spent relatively little time foraging in lapwing breeding colonies [97]. Furthermore, small changes in reserve size significantly reduce the impact of foxes on nesting birds [98], and that fox predation was most severe in poor quality habitats.

- A preliminary study of curlew breeding success in Northern Ireland suggested that predation, principally by foxes, may be responsible for the decline of curlew in this part of Ireland [42]. Consequently these authors recommended large-scale manipulations of predator numbers to determine whether this was actually the case, as well as further investigations into habitat factors that may also be important.

- A recent review [31] has shown that more sustainable grouse numbers would be achieved if gamekeepers concentrated less on predator control and more on finding a balance between grouse and their food supplies. This would achieve more sustainable grouse populations and, in turn, increase the profitability of grouse moors.

- The breeding success of hen harriers on moors managed for grouse shooting, including the reduction of fox numbers, was much lower than on moorland not managed for shooting i.e. with foxes present [43]. This was attributed to direct illegal persecution of hen harriers by gamekeepers on grouse moors. Nest success within a particular land management class was not significantly different inside or outside the geographical range of the red fox, suggesting that the control of foxes had little positive benefit for hen harriers.

CONCLUSION

Agricultural intensification is by far the major factor in the decline of most wildlife in Britain. Wildlife may suffer from fox predation if species are already reduced by habitat loss, pesticide use or other factors. Thus foxes do not pose a significant risk to conservation interests and there is no justification for widespread fox control on conservation grounds.

Foxes and agriculture

- Based upon questionnaire surveys of farmers, the rabbit is perceived as the major agricultural pest in Britain [7, 63]. Rabbits were estimated to cause £120 million worth of damage annually in the mid-1980s [74], costs associated with badgers (including the costs associated with bovine TB) up to £60 million [59, 79], and costs associated with common rats and house mice together around £30 million [120]. In comparison, the direct costs associated with fox predation are around £12 million [75]. However, fox predation also brings economic benefits via the consumption of rabbits.

- Over its lifetime, a fox may be worth £150-900 pounds in increased revenue due to the consumption of rabbits [66]. The lower estimate in this range translates to an indirect economic benefit to farmers of at least £7 million each year from the adult fox population in Britain. Thus a conservative estimate suggests that the economic benefits of foxes to agriculture largely offsets their costs and it is highly probable that there is a net gain to farmers from foxes.

- Rabbit numbers grew steadily at a rate of approximately 2% per annum between the outbreak of myxomatosis in the 1950s and the early 1980s [114]. In the mid-1990s, the rabbit population was estimated at 37.5 million [53], approximately 50% of pre-myxomatosis numbers. Recent data from a number of sources suggest that rabbit populations may have declined slightly since that time, possibly due to an outbreak of viral haemorrhagic disease [20].

- Farmers tend significantly to underestimate the amount of damage caused by rabbit grazing [34]. Therefore, current agricultural losses may be far greater than previously estimated. The amount of revenue lost by farmers is related to crop type. At 1998 prices, one study estimated that annually a single rabbit would cost a farmer £6.50 consuming winter wheat, £1.40 consuming spring barley and £3.40 consuming grazing pasture [34].

- Rabbits comprise approximately 45-70% of the diet of foxes in lowland Britain [10, 119]. Predation by foxes can prevent rabbit population growth under certain conditions [19, 80, 83]. The slow recovery of rabbits following myxomatosis is likely to have been, in part, due to predation [112]. The current abundance of rabbits in Britain appears to be inversely related to the level of predator control, with rabbits most abundant where more predators are killed [113].

- Field voles are a major prey item of foxes, and foxes (with other avian and mammalian predators) probably have a significant impact on field vole numbers [15]. When present at high densities, field voles can be a serious cause of damage to young commercial trees [41]. Although there are no quantified data, it is probable that foxes are also making a significant reduction in economic losses in forestry [28].

CONCLUSION

Fox predation has a direct economic cost to agriculture of approximately £12 million per annum. However, the bulk of fox diet is made up of rabbits, which cause in excess of £100 million damage to agriculture each year. Fox predation therefore also brings significant indirect economic benefits to farmers, and foxes are probably economically neutral to agriculture.

Foxes and lambs

- Two questionnaire surveys asked farmers to report their perceived losses of lambs to foxes. One surveyed 273 sheep farmers in East Anglia, the east Midlands and mid-Wales [55], the other surveyed 490 sheep farmers from across Britain [77]. Flock size varied from 4 to 5,000 ewes.

- Lamb predation by foxes was perceived to be a relatively minor problem on the majority of sheep farms surveyed. In these surveys, 39-76% of respondents reported no losses of lambs to foxes. On average, experienced losses of lambs to foxes comprised approximately 1% of those lambs born, or 5-10% of those lambs that perished. However, losses between farms were highly variable, and some farmers perceived losses of up to 0.26 lambs per ewe and 150 lambs in total [75]. Perceived losses of lambs to foxes were higher on larger farms and in regions of high fox abundance [75].

- A study on actual, rather than perceived, losses of lambs to fox predation on two Scottish hill farms calculated losses at equivalent to 0.2-1.5% of total potential revenue from lamb production [124]. All confirmed cases of fox predation occurred during the period from birth up to 6 weeks of age. Confirmed cases of fox predation accounted for a maximum of 6% of all lamb losses.

- Most lamb mortality occurs in the first week of life [3, 23] and is due to poor husbandry rather than predation. A study of 108 UK sheep farms showed that larger flocks, poor ewe condition at breeding, and flocks with higher ewe-replacement rates were likely to have higher levels of postnatal mortality [23]. The authors of this study concluded that, to reduce mortality rates, farmers should concentrate on the importance of ewe condition at breeding, good hygiene at lambing, supervision of lambing and similar good husbandry practices.

- Financial analysis, based on relationships between lamb losses, fox density and the costs of fox control, suggests that it is only worthwhile for farmers to carry out additional control actions where regional fox densities are high [78].

- Where indoor housing of lambs is an option, it is an effective preventive measure against fox predation. However, housing of sheep after lambing is costly and, based on the threat of fox predation alone, it is not economically worthwhile for a sheep farmer to keep ewes and lambs indoors for more than a couple of days after lambing [78]. However, indoor housing has other advantages that can make it more worthwhile for farmers to make greater use of indoor lambing.

- The cost of culling individual foxes increases markedly as population density declines. Attempting to completely eliminate lamb losses to fox predation is unlikely to be economically efficient under most circumstances [78] since, as population density is reduced, the benefits of reducing fox numbers are increasingly outweighed by the costs of control.

- Based on perceived estimates of predation, foxes cost sheep producers across Britain approximately £9.4 million in 1999 [75]. To put this figure into perspective, in 1998 the Ministry of Agriculture, Fisheries and Food estimated that sheep producers in the UK lose up to 4 million lambs each year, at an annual cost to the industry of £120 million. Deaths due to misadventure and all predators combined accounted for just 5% of these losses; the other losses were due to a variety of management problems [3].

CONCLUSION

Lamb losses to fox predation are small in relation to other causes of lamb mortality. In most circumstances, there would be no benefit to farmers from carrying out additional fox control since, as fox populations are reduced, the benefits obtained by culling foxes are increasingly outweighed by the costs of doing so. The greatest benefits to lamb production are likely to be achieved through improved husbandry of lambs, especially during the first week of life.

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Foxes and fowl

- A survey of fox predation on chicken farms in three regions of England and Wales showed that, for flocks of less than 200 birds, the median values for the three regions ranged from 0 to 25% of their flocks lost to foxes, for flocks of over 1000 birds the figures were 0.1 to 1.3% [55].
- Based on the responses of 136 poultry producers in a questionnaire study, incorporating table chicken producers, free-range egg producers, turkey and geese producers, mean reported bird mortality due to fox predation was less than 2% [76].
- Chicken and turkey producers generally reported low losses to foxes (losses of 0.02% and 0.7% of flocks respectively, on average), with percentage losses being higher overall amongst goose and free-range egg producers (1.43% and 1.99% respectively, on average).
- There were marked differences between types of producers in the proportion of farms reporting at least some losses due to fox predation, ranging from 22.7% for table chicken producers to 77.6% for free-range egg producers.
- Nearly half the respondents of all producer types (47.3%) thought the numbers of birds lost to foxes had not changed over the past five years, whilst 22.5% thought these losses had increased and 13.2% that they had decreased.
- Egg producers may be more susceptible than table chicken producers to the effects of predation because a higher proportion of their smaller, lower density flocks will be outside at any one time because they make more extensive use of their outside area.
- Fox predation was more likely on farms with higher overall bird mortality, suggesting that factors relating to general husbandry practices may be connected to the likelihood of fox predation occurring.
- The proportion of total flock losses accounted for by fox predation was:

  0.7% for table chicken producers

  24.9% for free-range egg producers

  16.9% for turkey producers

  35.4% for goose producers [75].

- Across Britain, the total cost of fox predation per annum was:

  Negligible to table chicken producers [75].

  £653,000 to egg producers

  £221,000 to turkey producers

  £440,000 to goose producers [75].

CONCLUSION

Predation of poultry by foxes is highest for free-range egg producers and negligible for table chicken producers. It is more likely to occur on farms where overall losses of birds are higher. This suggests that husbandry of the birds plays a key role in determining the level of fox predation. Losses of poultry to fox predation may be reduced most effectively by improved husbandry practices and simple preventive measures such as fencing and secure housing.

Foxes and other livestock

- A study in Germany compared pre-weaning piglet mortality in indoor and outdoor pig production units over a five-year period. Piglet deaths were significantly higher in the outdoor units due to overlays, injuries, low viability, starvation, low birth weights, cold stress, wasting and scours [70]. Thus piglet losses in outdoor units are largely due to management practices and not predation.
- Based on the responses of 48 British outdoor pig producers to a questionnaire survey, reported fox predation of piglets was generally low, but over half of the producers surveyed (54%) reported at least one piglet killed by a fox [75].

- On average, 0.3% of piglets born were reported killed by foxes, with losses of up to 5%. Despite the potential problems with birds predating upon piglets, reported predation by animals other than foxes was generally insignificant.
- Farms with more sows were more likely to have experienced predation. Farm location was also an important factor determining the level of fox predation, with lower levels of loss in Eastern England and the Midlands. Higher losses were experienced on farms with villages nearby, which may be due to foxes being blamed for predation by dogs. Dogs are more likely to be present near villages, and kills by medium-sized dogs and foxes are indistinguishable from teeth marks [47].
- Electric fencing is an effective preventative measure against fox predation. Piglet losses to foxes decrease with increasing expenditure on fence maintenance, but at a declining rate. Therefore, a high level of expenditure on fencing to prevent fox predation is not justifiable in economic terms and the best strategy financially for producers is to tolerate some losses to foxes. In some cases, it is not worth spending any more on fencing than would be spent if losses to fox predation were not taken into account.
- Predation of piglets by foxes costs £966,000 nationally per year [75].

CONCLUSION

Fox predation of piglets is generally low. In economic terms, it is not worthwhile for most pig producers to spend additional money on fencing to prevent fox predation. However, in cases where specific problems exist locally, electric fencing is an effective preventative measure.

Foxes and pheasants

- Pheasant losses to foxes are generally low. From 59 respondents to a questionnaire survey, the mean loss of pheasants from release pens to fox predation was reported as 1.39%, and 36% of respondents reported no fox predation. However, some high loss levels were reported (up to 13.3% of birds released) [75].
- Just under half of respondents to this survey (45.8%) thought that the number of pheasants killed by foxes in release pens over the past five years had not changed, while equal proportions (22.0% in each case) thought that there had been an increase or a decrease in these numbers.
- There was no link between expenditure on fox control and pheasant losses [75].
- The only quantified assessment of the number of pheasant poults lost to foxes was undertaken as part a study into the impact of buzzards on released pheasants in southern England [57]. This showed that 4.3% of pheasants released were killed by buzzards, 3.2% by foxes.
- A study into the impact of buzzards on released pheasants showed that losses only occurred at a minority of sites where pen characteristics and release factors probably made it easy for individual buzzards to kill pheasants [57]. This suggests that better release protocols will minimise losses to predators. This is supported by a study which showed that losses to foxes were more likely to occur where more birds were released, and where other mortality, unrelated to predation, was high [75]. Both these studies suggest that poor management led to higher losses to foxes.

- The number of game birds reared and released by gamekeepers has increased dramatically since the mid-1970s [105], such that in 1997 more than 80% of gamekeepers relied on reared pheasants [71]. In 1960 approximately 50 pheasants were released per km^2 on British game estates compared with 250 in 1997. Only around 40% of these pheasants are shot each season. Since surplus pheasants are released each year, the true economic costs of losses to foxes are unclear. Certainly, gamekeepers who relied on released birds expended 60-75% less effort trapping stoats and weasels than gamekeepers who relied on wild birds, and so losses to predators are of less importance on reared pheasant shoots [71].

CONCLUSION

Fox predation of pheasants in release pens is generally low. However, the principal threat to pheasants from fox predation is likely to occur after they have left the pens. There are no data on the levels of fox predation on pheasants at these later stages of their development. Fox control by shooting can effectively increase autumn game populations. However, estates that rely on rearing game can release more birds to compensate for losses to predators.

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Urban foxes

- Foxes live in urban areas in America, Australia, Canada, Japan and several European countries [46]. Foxes first colonised urban areas in Britain in the 1930s; the rapid spread of low density semi-detached housing provided a new habitat that was highly suitable for foxes. These suburbs today still hold the highest fox densities. Foxes were recorded in the centre of large cities such as London by the 1960s [48, 49, 50].

- Foxes have only colonised a few cities, such as Cambridge and Norwich, in the last two decades [127]. This is because foxes were rare in the surrounding rural area and these cities were only colonised after fox numbers had built up in the surrounding countryside.

- Until recently, fox numbers were largely stable in urban areas, with no detectable long-term upward trend. However, the spread of sarcoptic mange has had a dramatic impact on fox numbers in many cities from Manchester southwards [127]. In Bristol, for instance, mange spread into the city from the surrounding countryside in spring 1994, and two years later over 95% of the fox population was dead [13, 18]. In 2005, fox numbers were still less than 20% of those present over a decade earlier before the arrival of mange.

- The majority of food for urban foxes is provided by local residents; one study found that 10% of local residents fed the foxes regularly [13]. In the 1980s meat, fat, bread, bird seed and similar items constituted about 60% of the diet of foxes in Bristol [52, 94]. The other 40% was made up of wild prey such as insects, earthworms, small birds and wild mammals. When fox densities declined after mange, the proportion of wild prey in the diet rose to 58% [5].

- In Bristol around 10% of all households fed the foxes regularly in the early 1990s [14]. Feeding urban foxes poses no problem so long as local residents do not try to make the foxes hand-tame, since this may encourage foxes to approach other people looking to be fed and even enter houses in search of food [46]. Over-feeding can also lead to local increases in the number of foxes and increased fouling of nearby gardens [14].

- People's attitudes about urban foxes have remained remarkably consistent. In 1979 the London Borough of Bromley received a complaint about the foxes in an overgrown allotment: they canvassed all 248 houses adjoining the allotments. Of the 76 people who replied, 5 (6.6%) wanted the foxes killed, 71 (93.4%) wanted them left alone [45].

- In 2002, nearly 4000 households across Britain completed a questionnaire about the wildlife in their garden [12]: they were asked to score their attitudes to all species of mammals on a scale of one to ten. Of the 3409 people who expressed a view on urban foxes:

  8.5% disliked urban foxes (score 1 to 3)

  25.8% had no strong views either way (score 4 to 7)

  65.7% liked urban foxes (score 8 to 10)

  47.5% of households scored foxes 10 out of 10, compared to just 4.9% who gave foxes a score of 1 out of 10.

- In the 1930s 116 foxes were shot in Richmond Park, and in the 1940s the Ministry of Agriculture Fisheries and Food started fox control in London, organising fox shoots (with 12 bore shotguns) in larger parks, on allotments, waste ground, etc. In the Kent suburbs alone, 181 foxes were shot in 1947, 103 in 1948 and 129 in 1949 [107]. This did not even slow the rate of spread into London and in 1970 MAFF stopped urban fox control; several London boroughs took over this role, but most stopped in the 1980s because it was costing a lot and there were no tangible benefits [45].

- Losses of pets to foxes are minimal: a survey of 5480 households in north-west Bristol showed that the maximum rate of losses in a year were 13 rabbits, 7 guinea pigs, 1 pigeon and possibly 8 cats, mainly kittens [44]. These were maximum losses because many were assumed to be the work of foxes e.g. when a cat disappeared it was assumed to have been taken by a fox. This area contained 20 fox family groups consisting of 68 adult foxes and 76 cubs [44]. Thus the maximum annual loss was 0.2 domestic animals per fox. Even these very low levels of predation could be significantly reduced by keeping rabbits and guinea pigs in more secure housing [46].

- Whilst risks to cats are extremely low, and foxes usually give way to cats, this very low level of risk can be further reduced by keeping cats in at night. This has the additional benefit of reducing cat predation on local wildlife [130] and reduces the risk that the cat will be involved in a road traffic accident [90].

- The same 5480 households suffered very few other problems; only 2.7% reported that their dustbins were frequently rifled, 16.4% occasionally and 80.9% never [44]. Again, these are maximum figures since rifling of dustbins was generally attributed to foxes even though this was frequently the work of domestic dogs, cats, badgers, and gulls. Bristol, like many other cities, now has wheelie bins and this low level of nuisance has largely disappeared.

- Despite assertions to the contrary, the change to wheelie bins had no observable effect on the behaviour of the foxes in Bristol, largely because dustbins were an insignificant food source. Nor are urban foxes starving: a recent study in Bristol found that each night on each territory there is at least 150 times as much food available as is needed by each fox [5].

- Any problems that do occur are largely nuisance value from fouling gardens, digging or damage to garden plants. Most of these problems are easily addressed using commercially available repellents [128].

- The only method suitable for the control of foxes in urban areas in Britain is cage trapping. The cost of trapping individual foxes rises at an increasing rate as fox density is reduced [125], and is an order of magnitude cheaper in spring and summer, than autumn and winter. The costs of control far outweigh the costs associated with fox predation and injury to companion animals. Other costs associated with foxes in urban areas include road traffic accidents and the potential transmission of disease to companion animals and/or humans, but there are no reliable estimates of these economic costs.

CONCLUSION

Foxes are widespread throughout urban areas in Britain, where densities are some of the highest recorded anywhere in the world. Despite this, they cause remarkably few problems and the vast majority of householders like to see the foxes in their garden.

Diseases and attacks

- In continental Europe and North America, foxes are a principal vector of rabies. However, rabies was wiped out in Britain in the early 1900s. Even when present, rabies was primarily a disease of domestic dogs and livestock and was never recorded in foxes, although it was present in wolves before they were exterminated in Britain.

- The risk that rabies will reach Britain is very low. The biggest risk is posed by infected dogs, although past experience has shown that even when present in dogs it is unlikely to transfer to foxes. Thus it seems unlikely that an infected dog will pose a significant threat to wild foxes. There are also good contingency plans in place to deal with a rabies event, should this ever occur [51, 101].

- Up to 70% of foxes carry antibodies to *Leptospira icterohaemorrhagiae,* the causative agent of Weil's disease; this is probably acquired by eating rats, and can be a significant cause of mortality in foxes. In Britain in the 1980s around 100,000 foxes were skinned each year to meet the demand for fur trims. Yet despite the large number of foxes killed and handled each year, there are no cases of Weil's disease in humans that are attributable to infection from foxes.

- *Toxoplasma gondii* causes toxoplasmosis and is found in a wide range of mammals. It is common in domestic cats [58] and dogs [117], but the domestic cat is the main definitive host [99]. A recent survey found antibodies to *Toxoplasma gondii* in twenty percent of UK foxes [131], and it is also common in foxes on the continent [117]. A closely related organism, *Neospora caninum,* is one of the major causes of bovine abortion, and domestic dogs are believed to be the main source of infection [99]. Whilst found in British foxes [131], a study on a dairy farm in Cornwall with a high level of neosporosis-induced abortion failed to link this to the local fox population [100], and experimental studies suggest that foxes may not spread this disease [95].

- *Mycobacterium avium* subsp. *paratuberculosis,* which causes paratuberculosis or Johne's disease, has recently been reported in a range of wildlife species in Scotland, including foxes, and further work is needed to clarify the role of wildlife in the epidemiology of this disease [21]. Whilst *Mycobacterium bovis,* the causative organism of bovine tuberculosis, has been cultured from the tissues of 1.15% of 954 foxes, foxes are not believed to play a role in the epidemiology of the disease [59].

- There is some evidence that infections of *Angiostrongylus vasorum* and *Crenosoma vulpis* (both roundworms) are on the increase in domestic dogs [89], and both parasites can be carried by foxes. However, at the current time, there is no evidence of a link between infections in foxes and infections in dogs.

- *Echinococcus granulosus* is found in British foxes [88]. It is transmitted from domestic dogs to livestock, and causes cystic echinococcosis in humans, which occurs at low incidence in mid- and south Wales and the English borders [82]. This, and recent surveys, suggest that this parasite is neither widespread nor common in the British fox population [88, 102]. The parasite may also be declining in the British fox population [102].

- Alveolar echinococcosis, caused by *Echinococcus multilocularis,* is locally present in Europe, where it can pose a significant risk to humans. However, despite rises in fox numbers in and around European cities, there is no evidence of an associated rise in the incidence of human disease [36]. Where present on the continent, killing foxes may exacerbate the problem by spreading the disease to new areas [116]. *Echinococcus multilocularis* is absent from Britain [102].

- About 50% of the foxes in Britain carry the intestinal roundworm *Toxocara canis* [87, 102], but there is no evidence that foxes pose a significant source of infection for domestic dogs or humans. Toxocariasis, whilst probably under-recorded in humans, is rare. Infection from soil contaminated by domestic dogs in public parks and playgrounds is thought to be the main source of infection [37] but infected dogs can also contaminate people directly [129].

- *Trichinella spiralis,* which causes trichinosis in humans, has only been recorded once in British foxes, nearly fifty years ago. More recent surveys of foxes have failed to find this parasite [88, 102].

- In Britain, sarcoptic mange (caused by the mite *Sarcoptes scabiei*) is widespread in urban and rural fox populations, having spread as far north as Manchester. This disease is often fatal to foxes, and can be transmitted to dogs, although it is much less serious in dogs and easily treated. Mange appeared in south-west Bristol in 1994 and spread north-easterly across the city. Mange appeared in the domestic dog population a month after it appeared in the local foxes [8].

- There is no evidence to suggest that foxes pose a significant risk of attack on people, and none of the occasional press reports that foxes have bitten babies appear to be typical fox bites. In comparison, bite wounds from domestic dogs and cats are common, although there are no good statistics from Britain. In the USA, 5 million Americans are bitten by dogs each year, 1000 people per day are treated in hospital emergency rooms, and 15 to 20 people die from dog bites each year. Most of these victims are children, almost always bitten in the face by the family dog or a friend's dog [4]. There are also more than 400,000 cat bites a year in the USA, the majority on the upper extremities or face. Cat-scratch disease, caused by *Bartonella henselae,* is also relatively common, with 22,000 cases a year in the USA and 2000 hospitalisations [58].

- The pattern of dog and cat ownership in Britain is similar to that in the USA; since Britain has a fifth of the population, the number of dog and cat bites is likely to be around a fifth of those reported in the USA i.e. around 1 million dog bites and 80,000 cat bites each year. In comparison, fox bites are negligible.

CONCLUSION

Like most wild mammals, foxes carry a range of diseases. These is no current evidence that these pose a significant disease risk to humans and/or domestic animals, although more monitoring is needed to determine the prevalence of current disease levels and to assess their potential economic impact. Foxes present no significant threat of rabies. The risk of foxes attacking children is extremely low and negligible when compared to the risks posed by companion animals.

The future

- It is clear that fox numbers are stable, that fox populations are largely self-regulating, that the ban on hunting is unlikely to have any impact on fox numbers, that widespread culling has no detectable impact on fox numbers and that the economic impact of foxes is low compared to many other species of wild animals in Britain. This is, therefore, an ideal opportunity to review what further information we need about the ecology and impact of foxes to identify when and why problems are likely to occur and, should problems arise, design better and more cost-effective methods of addressing these problems.

In particular, we need to:-

- Better understand how patterns of food availability and behavioural factors interact to determine fox numbers, and how further changes in rabbit numbers will affect fox numbers.
- Continue to monitor the levels of shot wounds in foxes (and other wildlife) and, should wounding levels rise, introduce mandatory tests on shooting skills. This would bring us into line with the rest of Europe [60]; it is remarkable that Britain still allows people to shoot at live targets without any test of their shooting ability.
- Introduce a close season for foxes: Britain is one of the few European countries that currently does not provide a close season [60], and this cannot be defended on welfare grounds. The case for providing a close season for foxes is as strong as for any other species.
- Better understand the situations in which foxes affect species of conservation concern and develop techniques, such as better habitat management, that will limit the impact of fox predation.
- Understand why, whilst most farmers suffer little or no economic losses to foxes, a small number suffer significant losses. Research to date suggests that this is related to poor management; we need to provide better advice to farmers on how to minimise the risks to their livestock.
- Improve our understanding of the economic costs and benefits of foxes, and in particular the costs of different management strategies.
- Quantify the relationship between fox numbers and economic impact.
- Understand the consequences of lethal control on economic losses, and in particular whether dispersing foxes that colonise vacant territories cause greater economic losses than resident foxes.
- Improve our understanding of the impact of sarcoptic mange on fox populations and how best to prevent it spreading to domestic dogs.
- Quantify the socio-economic and cultural benefits of foxes.

CONCLUSION

Whilst a case can always be made for more information, it is clear that the fox is one of the best studied mammals in Britain, and that much of our knowledge on the ecology and behaviour of foxes is based on studies in Britain. Thus the conclusions presented in this report are based on data unrivalled in both quality and quantity. Further work needs to focus on dealing with specific management issues.

Overall conclusions

- None of the conclusions reached in the two earlier reviews [9, 72] have changed over the last eight years, despite a lot more research and the exhaustive review process that preceded the Hunting Act 2004.

- Furthermore, it has long been recognised that foxes cause little economic damage and have significant economic benefits. Half a century ago, in a specially commissioned booklet, the British Field Sports Society [24] said:

  'The staple diet of a fox is not, as so many people apparently imagine, hens and ducks. Indeed, it is probably true to say that not 5 per cent of all the foxes in Christendom ever taste domestic poultry at all. The poultry killers are a handful of confirmed criminals who have combined a taste for hen with a comparative contempt for man. The majority of foxes live largely upon beetles, frogs, rabbits, and wild birds; carrion does not come amiss to them either, while they are the biggest destroyers of rats and mice in the world, far excelling the domestic cat in this useful art'.

  This was written when domestic stock such as hens and ducks were free-range and so would have been more vulnerable to fox predation than under today's more intensive management regimes. Yet even then losses to foxes were minimal.

- This assessment was still true in the mid-1970s: a nationwide postal survey of 3000 farmers (892 completed questionnaires) undertaken by NOP Market Research Ltd [2] showed that 70% of all farmers did not consider the number of foxes on and around their farms to be harmful, 64% of all farmers suffered no financial loss to foxes in the previous year (1973), 49% of all farms in Britain had no fox control of any sort, and on 22% of those that did, no foxes were actually killed [2].

- In the mid-1980s, when summarising the need for fox control, the British Field Sports Society [103] said:

  'Except in some sheep farming areas and where game are managed, the fox is generally harmless and is probably beneficial to forestry'.

- Although these are subjective assessments, based on the perceptions of the farming community, they are entirely consistent with the more detailed research published in recent years and there is no evidence that the economic impact of foxes has changed significantly over the last 50 years.

- In earlier sections, we have presented data on the direct and indirect financial impacts of fox predation. However, these represent just one component of the true economic value of foxes. The total economic value of wildlife also encompasses other values such as the socio-economic and cultural benefits of that species; for the fox these are likely to be considerable. A recent survey by the Mammal Society showed that the fox was one of the most popular British mammals, ahead of flagship conservation species such as the otter, red squirrel and water vole. People place a very high value on conservation programmes aimed at these species [123]. Since the public values foxes even more highly than those rarer species, the total economic value of foxes is likely to be substantial.

CONCLUSION

The economic assessments of the losses attributable to foxes have been consistent over the last half-century and there is no evidence that foxes cause widespread economic losses. However, the high degree of popularity of the fox suggests that its total economic value is likely to be substantial. The less tangible socio-economic and cultural benefits of foxes need to be considered alongside the more easily quantifiable economic impacts.

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