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The utility of killing foxes in Scotland

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Commissioned and published by the League Against Cruel Sports Scotland.

LEAGUE AGAINST CRUEL SPORTS

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Executive summary

Several factors may have contributed to this decline but there is no evidence that it is related to levels of "pest control".

In fact "pest control", especially when a dominant animal is killed, can lead to a local increase in numbers as more foxes move in to compete for the vacant space.

Fox numbers and population trends in Scotland

Detailed studies in Scotland have shown that changes in fox numbers from the 1960s to 1980s were related to changes in food availability, driven by changes in land use, not levels of "pest control". In the mid-1990s it was estimated that there were 23,000 adult foxes in Scotland, and these produced around 41,000 cubs each year. Fox densities in Scotland are significantly lower than in England and Wales. Population monitoring data collected by the British Trust for Ornithology show that the fox population in the United Kingdom as a whole declined by 29% between 1995 and 2014. Data collected by the Game & Wildlife Conservation Trust suggest a similar decline in fox numbers in the uplands of Scotland. Several factors may have contributed to this decline but there is no evidence that it is related to levels of "pest control".

Fox social behaviour

While foxes occupy territories, these are not exclusive and large numbers of non-resident foxes explore occupied territories throughout the year, especially in winter. Summer is the only season when the number of residents exceeds the number of non-residents exploring a territory. This large pool of non-residents, especially during autumn and winter when young foxes born the previous spring are dispersing, enables fox populations to resist high levels of "pest control", especially in winter.

Effects of "pest control" on fox numbers

Work in Scotland in the 1970s and 1980s suggested that improvements in the management of hill sheep, leading to fewer carcasses over winter, might reduce the fox population more than the levels of control. Fox losses, whether by "pest control" or natural mortality, are rapidly replaced, especially in winter which is the main dispersal period. In fact "pest control", especially when a dominant animal is killed, can lead to a local increase in numbers as more foxes move in to compete for the vacant space. There is no convincing evidence that "pest control" is having a significant effect on fox numbers in Scotland or elsewhere in Britain, the ban on hunting with dogs has not led to an increase in fox numbers, and using packs of hounds to drive foxes out of cover to waiting guns can have a significant disruptive effect on the behaviour of foxes and leads to higher, not lower, fox numbers in the spring.

There is no logic in trying to reduce predator numbers to reduce livestock losses. Widespread "pest control" in winter may lead to higher, not lower, livestock losses.

Fox numbers have declined, not increased, since the bans on hunting came into effect. So if lamb losses have increased, this must be due to factors other than changes in fox numbers or changes in methods of fox "pest control".

Effects of "pest control" on fox predation levels

We are only just starting to understand the effects of "pest control" on fox predation levels. Early work in Scotland showed that widespread fox control in winter was ineffective in reducing lamb losses, and that targeted control at fox breeding dens in spring was more effective. More recent studies on carnivore populations generally have shown that livestock losses appear to be unrelated to predator density, and that there is no logic in trying to reduce predator numbers to reduce livestock losses. Widespread "pest control" in winter may lead to higher, not lower, livestock losses.

Is the fox a pest?

Early studies in Scotland showed that the losses of hill lambs to foxes were low compared to other causes of mortality, and subsequent work in Scotland and elsewhere has reinforced that conclusion. Losses of other free-range livestock are also minimal. Farms with higher livestock losses to foxes often have higher levels of mortality generally, suggesting that fox predation may be associated with poor husbandry. Despite all the evidence to the contrary, some farmers continue to argue that losses of lambs to foxes is increasing following the ban on hunting in Scotland in 2002 and in England and Wales in 2004. There is no evidence to support this perception, and fox numbers have declined, not increased, since the bans on hunting came into effect. So if lamb losses have increased, this must be due to factors other than changes in fox numbers or changes in methods of fox "pest control".

The welfare issues of using two dogs to flush foxes

Packs of dogs are difficult if not impossible to control in dense cover, and this has a number of welfare consequences. Foxes find it harder to evade the hounds and they are often caught and killed by the hounds or driven to ground. Two-thirds of the foxes killed by gunpacks in Wales in 1998/1999 had to be dug out with terriers. Packs of hounds also catch and kill wounded foxes. Using two hounds to flush foxes is likely to ensure higher levels of welfare, since the hounds are easier to control, and flushing a fox more slowly reduces the risk that it will be wounded rather than killed by the waiting guns. ■

Background

1. I was asked by Mr Robbie Marsland, Director, League Against Cruel Sports, Scotland to consider two issues: (i) the utility of killing foxes between November and March and (ii) the number of dogs used in "flushing to guns".

2. In addressing these issues, I have focussed on information from Scotland. Much of this comes from the second half of 20th century, thanks to the pioneering analyses of Drs Ray Hewson and Hugh Kolb who worked for the Department of Agriculture and Fisheries for Scotland, as it then was. They used the number of foxes killed in different parts of Scotland to monitor fox population trends and used these data to compare the effects of widespread fox "pest control" versus landscape changes, and the consequential effects on food availability, on fox numbers in Scotland. Ray Hewson also undertook some of the early studies into the impact of fox predation on lamb losses. While these data are a little dated, Hewson and Kolb's conclusions have been reinforced by later studies. So their results have stood the test of time and are relevant to the current situation in Scotland. I also quote studies in Britain as a whole, and from elsewhere in the world, where they help put the situation in Scotland into context, show the generality of the conclusions, and/or update the state of knowledge. ■

Fox numbers and population trends in Scotland

Hewson (1990) attributed fox population changes in Scotland to changes in patterns of land use rather than any effects of "pest control".

3. From 1948, the number of foxes killed in Scotland was high until the advent of myxomatosis in the mid-1950s, when the numbers of foxes killed declined, but only for three years, and the reproductive performance (measured as the number of cubs killed per adult) was only poor in 1956, immediately following myxomatosis. However, there was no decline in the number of foxes in Argyll, where field voles and deer and sheep carrion were the main food source for foxes. There was an increase in the number of foxes killed in Scotland from around 1960, which was thought to reflect an increase in vole numbers. The absence of rabbits meant that the vegetation was less heavily cropped, providing more cover and food for field voles (Hewson & Kolb 1973).

4. In the 1970s the pattern was less clear. More foxes were killed in north-east Scotland than in the 1960s; this was because foxes had recolonised the agricultural areas of the north-east after an absence of some fifty years (Hewson & Kolb 1973). While more foxes were killed across Scotland from 1971 to 1978, annual variation in the numbers of foxes killed was higher than in the 1960s, and these fluctuations were associated with large changes in the numbers of field voles, especially in the west of Scotland. The peak in fox numbers killed in 1974 appeared to be due to an increase in overwinter survival of adults in the west of Scotland due to a peak in vole numbers (Kolb & Hewson 1980). There was also a decline in the ratio of cubs to adults killed, suggesting that fewer cubs were being born, possibly because the fox population had reached its "carrying capacity" (Hewson 1984).

5. Live prey suitable for foxes is uncommon on the moors and hills of west Scotland, and here foxes subsist largely on carrion, especially in winter (Kolb & Hewson 1979; Hewson 1981, 1983). However field voles are also an important source of food (Hewson *et al*. 1975) and variations in fox numbers are associated with peak years in field vole numbers (Hewson 1983); one fox population in west Scotland varied by a factor of about four between years depending on field vole numbers. Land use changes, especially afforestation in the uplands, may bring about local increases in foxes associated with the big increase in field voles that follows ploughing and planting (Hewson 1981). In summarising his studies, Hewson (1990) attributed fox population changes in Scotland to changes in patterns of land use rather than any effects of "pest control".

6. Following the studies of Ray Hewson and Hugh Kolb, there were three fox population estimates from the whole of Britain. The first two were based on estimates of fox densities in different types of habitat. Macdonald *et al*. (1981) estimated that there were 252,000 adult foxes in Britain, and Harris *et al*. (1995) provided the first fox population estimate for Scotland. They estimated that, of the 240,000 adult foxes in Britain, 23,000 were in Scotland, compared with 195,000 in England and 22,000 in Wales. These figures are for the end of winter, after the main period of "pest control", which is when the lowest point in the annual cycle of fox numbers occurs. So the average density at the end of winter was 0.3 foxes km-2 in Scotland, compared with 1.3 foxes km-2 in England and 1.1 foxes km-2 in Wales. The relatively low densities in Scotland are due to the large areas of uplands, where foxes are much less common.

In Scotland the 23,000 adult foxes produce around 41,000 cubs each spring. So if fox numbers are to remain constant, around 41,000 foxes die each year in Scotland, and Kolb & Hewson (1980) showed that any impact of "pest control" replaces rather than is additive to natural mortality.

7. Webbon *et al.* (2004) undertook the first stratified survey of fox densities in Britain, at the end of winter in 1999 and 2000. They calculated that there were 225,000 foxes in rural areas of Britain (95% confidence intervals 179,000 to 271,000). Including urban areas, this gave a total population of 258,000 adult foxes. Rural fox densities in different landscapes ranged from 0.21 to 2.23 foxes km-2, with the lowest densities in upland areas of Scotland. While all three studies used different approaches, they produced remarkably consistent results. At the end of winter there are around a quarter of a million adult foxes in Britain; each spring on average around 425,000 cubs are born (Harris *et al.* 1995). In Scotland the 23,000 adult foxes produce around 41,000 cubs each spring. So if fox numbers are to remain constant, around 41,000 foxes die each year in Scotland, and Kolb & Hewson (1980) showed that any impact of "pest control" replaces rather than is additive to natural mortality.

8. These three population estimates span a period of 20 years, suggesting that the fox population changed little over this period. Since then, a number of schemes have been introduced to monitor changes in the numbers of several species of mammals, including foxes. The most scientifically robust of these is run by the British Trust for Ornithology, which monitors population changes of several species of mammals seen during their annual breeding bird survey. This shows that, across the United Kingdom, the red fox population declined by 29% between 1995 and 2014 (Figure 1). Looking at the details, the fox population declined from 1995 until 2004, fluctuated between 2004 and 2013, although the general trend remained relatively stable, and then declined further in 2014 (Harris *et al.* 2015).

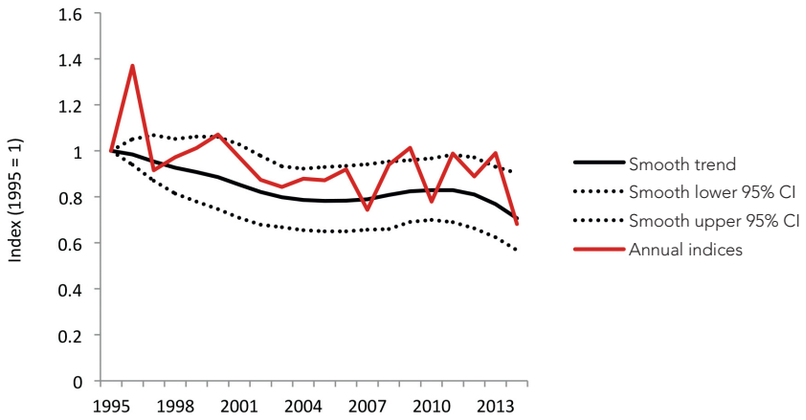

Figure 1. Fox population trends in the United Kingdom recorded by the British Trust for Ornithology's breeding bird survey. The graph shows the relative change from 1995; the red line shows the raw data, the black line the smoothed trend, and the dotted lines the 95% confidence intervals. From Harris *et al.* (2015).

Thus a diversity of factors, all unrelated to levels of "pest control", have an impact on fox numbers, reinforcing the conclusions of Ray Hewson and Hugh Kolb in Scotland.

9. This general pattern is supported by two other studies. The first compared fox faecal counts, a measure of fox abundance (Kolb & Hewson 1980; Sadlier *et al*. 2004; Webbon *et al*. 2004), in the winters of 1999 and 2000 with the winter of 2002. This found a 4.7% decline in fox numbers across Britain (Baker *et al*. 2002). The second was organised by the People's Trust for Endangered Species. This found that there was no change in the number of foxes killed on the roads between 2005 and 2011, a period when there was little change in traffic flow (Anon. 2013). So independent reports of a fox population decline in the early part of the millennium (Baker *et al*. 2002), and a period of stability from 2005 (Anon. 2013), support the trends produced by the British Trust for Ornithology.

10. Why there has been a gradual decline in fox numbers over the last twenty years is unclear, although during this period sarcoptic mange has been spreading across Britain and this disease can have a dramatic impact on fox numbers (Soulsbury *et al*. 2007). Also, increases in badger numbers have led to a decline in fox numbers, at least in some areas, possibly due to competition for resources (Trewby *et al*. 2008). While these may be contributory factors, a long-term study in Bristol, where there is no deliberate killing of foxes, has shown that fox numbers will change over time without any obvious associated changes in habitat quality, food availability, or patterns of mortality (Baker *et al*. 2001). Thus a diversity of factors, all unrelated to levels of "pest control", have an impact on fox numbers, reinforcing the conclusions of Ray Hewson and Hugh Kolb in Scotland.

11. However, a different population trend was recorded by the Game & Wildlife Conservation Trust's national gamebag census. This is based on the number of foxes killed by gamekeepers on shooting estates, and shows a continuous increase in the number of foxes killed in the United Kingdom, particularly between 1961 and the early 1990s (Figure 2). Overall the index of fox numbers killed tripled between 1961 and 2009 (Table 1). When this was broken down by the different environmental zones in Britain, between 1995 and 2009 there was no change in the number of foxes killed in the lowlands of Scotland and the intermediate uplands and islands of Scotland, whereas in the true uplands of Scotland there was a 27% decline in the number of foxes killed (Table 2).

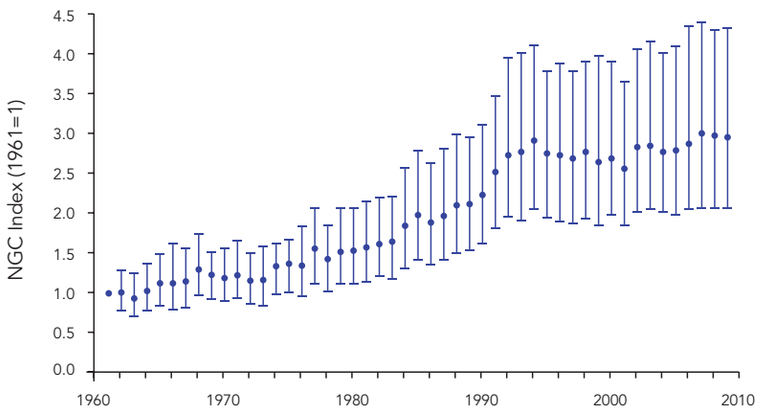

Figure 2. Fox population trends in the United Kingdom shown by the Game & Wildlife Conservation Trust's national gamebag census. The graph shows the relative change from 1960, and the vertical lines show the 95% confidence intervals. From Aebischer *et al*. (2011).

Table 1. Changes in fox numbers in the United Kingdom, as indicated by the Game & Wildlife Conservation Trust's national gamebag census. The figures show the percentage change with the 95% confidence intervals; * indicates that the change was significant at $P < 0.05$. From Aebischer *et al.* (2011).

Country	No. of sites	Start year	End year	Change (%) 1961-2009	Change (%) 1984-2009	Change (%) 1995-2009
United Kingdom	1185	1961	2009	**203*** 130 to 290	**62*** 46 to 81	**11*** 1 to 21

Table 2. Changes in fox numbers in different parts of Britain, as indicated by the Game & Wildlife Conservation Trust's national gamebag census. The figures show the percentage change, and the vertical lines indicate the 95% confidence intervals; * indicates that the change was significant at $P < 0.05$. From Aebischer *et al.* (2011).

Environmental zone	Sites	Start year	End year	Change (%) 1961-2009	Change (%) 1984-2009	Change (%) 1995-2009
Easterly lowlands (England/Wales)	523	1961	2009	**370*** 232 to 630	**112*** 79 to 150	**26*** 11 to 42
Westerly lowlands (England/Wales)	214	1961	2009	**111*** 19 to 242	**86*** 50 to 134	**36*** 12 to 74
Uplands (England/Wales)	120	1961	2009	**91*** 40 to 437	**64*** 23 to 107	**16** -4 to 39
Lowlands (Scotland)	92	1961	2009	**240*** 22 to 514	**38*** 1 to 86	**0** -21 to 25
Intermediate uplands/ islands (Scotland)	51	1961	2009	**49** -14 to 211	**30** -15 to 143	**1** -23 to 24
True uplands (Scotland)	170	1961	2009	**102*** 17 to 227	**-10** -49 to 45	**-27*** -42 to -9

Most shooting estates have few or no resident foxes, and so there is a constant influx of foxes into the vacant habitat patch, and as fast as one fox is removed another is likely to replace it.

Summary: Detailed studies in Scotland have shown that changes in fox numbers from the 1960s to 1980s were related to changes in food availability, driven by changes in land use, not levels of "pest control". In the mid-1990s it was estimated that there were 23,000 adult foxes in Scotland, and these produced around 41,000 cubs each year. Fox densities in Scotland are significantly lower than in England and Wales. Population monitoring data collected by the British Trust for Ornithology show that the fox population in the United Kingdom as a whole declined by 29% between 1995 and 2014. Data collected by the Game & Wildlife Conservation Trust suggest a similar decline in fox numbers in the uplands of Scotland. Several factors may have contributed to this decline but there is no evidence that it is related to levels of "pest control". ■

12. While the Game & Wildlife Conservation Trust argues that the changes in the national gamebag census may reflect a reduction in fox density following the disappearance of rabbits due to myxomatosis in the 1950s, and that part of the increase in the number of foxes killed may reflect the subsequent rabbit recovery (*http://www.gwct.org.uk/research/long-term-monitoring/national-gamebag-census/mammal-bags-comprehensive-overviews/fox/*), there is no evidence that fox numbers declined long-term with the advent of myxomatosis. In Scotland the impact of myxomatosis was short-term (Hewson & Kolb 1973), and fox numbers actually increased in some parts of Britain following myxomatosis. Foxes were present in the agricultural areas of north-east Scotland in the early 1900s, but they disappeared for reasons that are not immediately clear. They started to recolonise these areas in the early 1960s, just after myxomatosis had wiped out the local rabbit populations in 1956 (Hewson & Kolb 1973; Hewson 1984). In Wales, foxes were caught incidentally in areas where there was a thriving industry catching wild rabbits with gin traps, and foxes were all but eliminated in parts of west Wales where there was intensive rabbit trapping. With the end of rabbit-trapping in 1955, fox numbers recovered, and they were said to be common in the early 1960s (Lloyd 1980a). Gin trapping was made illegal in Scotland in 1971.

13. While rabbits are the most frequent prey item of foxes in lowland Britain, they are a lesser component of their diet in upland areas (Baker & Harris 2003). However, foxes exploit a wide variety of food sources in all types of landscape and there was no evidence of increasing dietary specialisation as rabbit numbers recovered from myxomatosis (Baker & Harris 2003). In fact, the reverse is more likely: when rabbit numbers are low, foxes may play a role in limiting numbers, but not when rabbit numbers are higher (Trout & Tittensor 1989).

14. However, care must be taken when interpreting gamebag data because there is no measure of culling effort across the years. It is probable that the changes in the numbers of foxes killed each year reflect changes in the methods used to kill foxes, particularly the rapid increase in the use of night shooting (Bucknell 2001, 2010; Frain 2006; Hook 2013; Powell 2013), rather than actual changes in fox numbers. Most shooting estates have few or no resident foxes, and so there is a constant influx of foxes into the vacant habitat patch, and as fast as one fox is removed another is likely to replace it (see paragraph 19). So it is common for winter culls in particular to kill far more foxes than are resident in an area (paragraph 26). This increase in using night shooting would explain the dramatic rise in the number of foxes killed in lowland areas of England and Wales. It would also explain the opposite trend in Scotland, particularly in upland areas (Table 2), since night shooting is less suitable for upland terrains (Burns *et al*. 2000). This decline in fox numbers in upland areas of Scotland is consistent with the overall fox population trend recorded by the British Trust for Ornithology (Figure 1).

Fox social behaviour

Fox social groups were largest in the autumn and winter. Without any "pest control", the number of adult foxes in the seven social groups in Bristol declined by 20% in spring and 30% in summer.

15. Fox social behaviour is fundamental to understanding the impacts of hunting and other forms of "pest control" on fox populations. Foxes are territorial year-round and, depending on levels of mortality, form pairs or social groups, which exceptionally can include up to ten or more adults. While individual social groups may have a preponderance of one sex or the other, there are equal numbers of adult males and females across the population as a whole. Usually one litter of cubs is born on each territory in the spring, and some or all of these cubs disperse in the autumn and through the winter.

16. Ms Jo Dorning and I have been using camera traps to understand how fox group sizes change across the year in Bristol. Although we are working in an urban area, Bristol is the ideal habitat to study the factors influencing fox population dynamics because there has never been any organised "pest control". There is no basic difference in the behaviour of urban and rural foxes, and foxes regularly move between urban and rural areas. We used camera traps at several known feeding areas within the territories of seven fox social groups and photographed all the foxes in the area for forty consecutive days in spring (March to May), summer (June to August), autumn (September to November) and winter (December to February). We collected circa 750,000 photographs, of which 152,732 included foxes (the others were of a variety of other wild and domestic animals, humans, and blanks).

17. Although the study was carried out in the same habitat in north-west Bristol, group sizes were very variable (see Table 3). Across the seven fox social groups, in the four seasons we recorded 180 resident foxes (87 males, 93 females; some foxes were present in all four seasons), a sex ratio of 1 male to 1.07 females. Fox social groups were largest in the autumn and winter. Without any "pest control", the number of adult foxes in the seven social groups in Bristol declined by 20% in spring and 30% in summer. While each fox social group occupied its own territory, they were not exclusive, and we recorded large numbers of "non-residents" throughout the year. As Table 3 shows, summer was the only season when the resident foxes outnumbered the number of non-residents seen on each territory; in winter there were twice as many non-residents as residents. The seasonal changes in group size and number of non-residents are compared in Figures 3 and 4.

Table 3. Variations in the size of seven fox social groups in Bristol. We defined a group as the number of adults and subadults >5 months old seen on the territory on at least 50% of the days in each season. Animals were defined as non-residents if they were seen on fewer than half the days each season. The figures in brackets show the number of males:females.

Social group	Group size (M:F)				Number of non-residents			
	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
1	13 (8:5)	7 (2:5)	11 (7:4)	13 (8:5)	2	1	4	8
2	5 (2:3)	5 (2:3)	4 (1:3)	5 (2:3)	6	1	4	15
3	5 (3:2)	5 (3:2)	5 (3:2)	4 (2:2)	7	3	12	16
4	4 (2:2)	4 (2:2)	6 (3:3)	5 (2:3)	5	0	10	12
5	5 (3:2)	4 (2:2)	8 (5:3)	8 (4:4)	15	9	16	17
6	5 (3:2)	8 (4:4)	14 (5:9)	12 (5:7)	11	6	18	18
7	4 (1:3)	3 (1:2)	4 (1:3)	4 (1:3)	1	3	7	13
Mean	6 (3:3)	5 (2:3)	7 (3:4)	7 (3:4)	7	3	10	14
Total	41 (22:19)	36 (16:20)	52 (25:27)	51 (24:27)	47	23	71	99

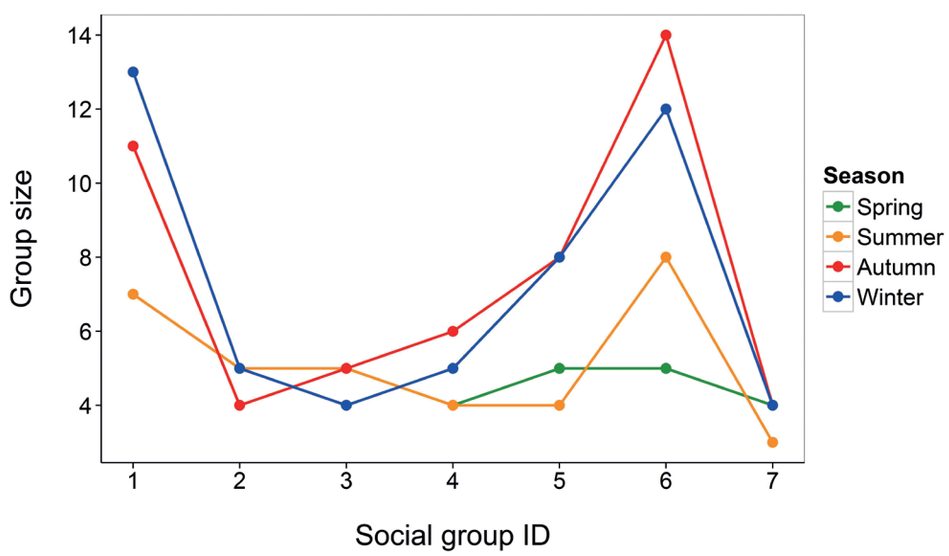

Figure 3. Seasonal changes in the number of foxes more than 5 months old recorded in seven fox social groups in Bristol.

Relationships between neighbouring social groups are dynamic and larger males in particular encroach on the territories of their neighbours.

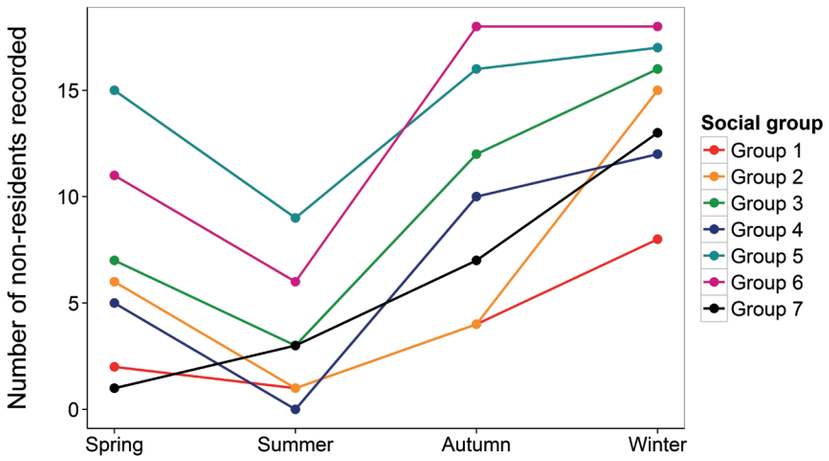

Figure 4. Seasonal changes in the number of different non-resident foxes over 5 months old recorded in the territories of seven fox social groups in Bristol.

18. Of the non-resident foxes, 96 (40%) were known or probable neighbours (i.e. animals from adjacent social groups); 6 (3%) were previous group members that were revisiting their natal group; and 138 (58%) were "strangers" (Table 4). "Strangers" included animals from adjacent territories that we did not recognise and animals from further away. Incursions by neighbours were lowest in the spring and summer. They may have been exploring a neighbouring territory to exploit a particular food source or simply "checking up on the neighbours"; relationships between neighbouring social groups are dynamic and larger males in particular encroach on the territories of their neighbours (Iossa *et al*. 2008). The influx of neighbours in the autumn coincides with the onset of the dispersal season: while foxes can disperse long distances, most move less than two territories from where they were born (Harris & Trewhella 1988; Trewhella *et al*. 1988; Soulsbury *et al*. 2011), and so at least some of these animals may be looking for opportunities to join a nearby social group. In winter, there is also a high influx of neighbours looking for additional mating opportunities (Baker *et al*. 2004; Iossa *et al*. 2008; Soulsbury *et al*. 2011).

Table 4. Origins of non-resident foxes recorded on the territories of seven fox social groups in Bristol. The percentages are for each column to show the seasonal changes in the proportions of neighbours, strangers and all non-residents.

	Known and probable neighbours	Previous group members	Strangers	Totals
Spring	16 - 17%	2	29 - 21%	47 - 20%
Summer	16 - 17%	1	6 - 4%	23 - 10%
Autumn	36 - 38%	1	34 - 25%	71 - 30%
Winter	28 - 29%	2	69 - 50%	99 - 41%
	96	6	138	240

The large number of non-resident foxes visiting a territory, especially in winter when most "pest control" takes place, explains why any impact of "pest control" on fox numbers is at best temporary.

19. The large number of non-resident foxes visiting a territory, especially in winter when most "pest control" takes place, explains why any impact of "pest control" on fox numbers is at best temporary. In Bristol, when the fox population crashed following an outbreak of sarcoptic mange in spring 1994, vacant territories were rapidly reoccupied, on average in about four days (Baker *et al*. 2000). Foxes mark their territories with urine, leaving up to ten scent marks per kilometre of travel (Arnold *et al*. 2011). The absence of fresh scent marks, and possibly lack of vocalisations, leads to the rapid incursion by new foxes to contest the vacant territory (Giuggioli *et al*. 2011; Potts *et al*. 2012, 2013). I explain the importance of resident foxes in excluding non-residents in paragraph 27.

Summary: While foxes occupy territories, these are not exclusive and large numbers of non-resident foxes explore occupied territories throughout the year, especially in winter. Summer is the only season when the number of residents exceeds the number of non-residents exploring a territory. This large pool of non-residents, especially during autumn and winter when young foxes born the previous spring are dispersing, enables fox populations to resist high levels of "pest control", especially in winter. ■

Effects of "pest control" on fox numbers

Changes in fox numbers in Scotland were driven by landscape changes and the associated changes in food availability for foxes, not by "pest control".

Improvements in the management of hill sheep, leading to fewer carcasses over winter, might reduce the fox population more than the levels of control.

20. Some of the most detailed early work on the effects of fox "pest control" operations on fox population dynamics was undertaken in Scotland by Drs Ray Hewson and Hugh Kolb as part of their work into fox population changes from the late 1940s. Throughout their studies, Hewson and Kolb were consistent in their view that changes in fox numbers in Scotland were driven by landscape changes and the associated changes in food availability for foxes, not by "pest control". For instance, at the end of the 1960s the reduced number of cubs being killed each year relative to the number of adults suggested that foxes may have reached the upper limit of their population density in some areas, and that the trends in the numbers killed were not being influenced by changes in methods of "pest control" (Hewson & Kolb 1973).

21. In later studies they concluded that mortality due to "pest control" in Scotland was moderate and that long term increases in numbers, as in the north-east, had occurred despite control measures (Kolb & Hewson 1980). They also found that very few animals caught were in poor condition, suggesting that direct starvation was relatively rare, and that this was because human control was replacing natural mortality (Kolb & Hewson 1980). They also highlighted that "pest control" efforts each winter were not affecting the size of the breeding population the following spring; even though more foxes were killed each winter from 1973 to 1977, the number of breeding dens each spring remained the same (Hewson 1981). It should be remembered that subsequent studies have shown that, in the absence of control, spring fox densities would actually decline by a fifth or more (paragraphs 17 and 28), so the data from Scotland suggest that killing foxes in winter is preventing this spring decline. I explain why this occurs in paragraph 27. Hewson (1984) concluded that changes in the numbers of foxes killed in the 1970s were caused by big changes in the numbers of field voles, and it was unlikely that the fox population in Scotland as a whole was being limited by "pest control" (Kolb & Hewson 1980). In hill sheep areas, sheep carrion in winter was probably the main factor determining the number of foxes, and Hewson (1990) suggested that improvements in the management of hill sheep, leading to fewer carcasses over winter, might reduce the fox population more than the levels of control.

22. In summary, following their extensive studies, Drs Ray Hewson and Hugh Kolb came to several important conclusions: (i) widespread "pest control" in Scotland had no impact on fox numbers and was simply replacing natural mortality; (ii) killing foxes in winter had no effect on the breeding population the following spring; and (iii) fox numbers in Scotland were limited by the availability of food, particularly field voles and carrion in upland areas.

They concluded that the level of "pest control" required for effective population control is impractical at the landscape scale.

There should have been a detectable population increase if hunting played any role in fox population control.

23. Most subsequent studies have supported these conclusions. It has long been known that dispersal in the autumn and winter is a major factor mitigating the impacts of any fox "pest control" operations, and this has been reinforced by several recent computer modelling studies. For instance, Harding *et al*. (2001) found that red fox populations in America could be reduced in the short term, but longer-term success required efforts to control juvenile and immigrant foxes. Rushton *et al*. (2006) concluded that *effective control of [fox] populations at landscape scales is not feasible or practical unless immigration from outside populations is low or can be controlled* and Lieury *et al*. (2015) concluded that immigration allows fox populations to resist high levels of "pest control".

24. Rushton *et al*. (2006) also compared the relative effectiveness of hunting with hounds, killing foxes at their den, winter shooting and fertility control (immunocontraception) in controlling fox populations. They concluded that the level of "pest control" required for effective population control is impractical at the landscape scale. Killing at dens during the breeding season had the greatest effect on fox numbers, whereas hunting with hounds had a low impact on population size because it takes place during winter, when there are large numbers of dispersing foxes. However, it must be remembered that this was a modelling study and the authors defined *killing foxes at their den* as targeting *adult female foxes, and where an adult female was culled, her pups also died*. While there are no welfare implications in a computer simulation, in reality there are significant welfare issues associated with killing breeding vixens at dens. While the Protection of Wild Mammals (Scotland) Act 2002 allows terriers to be used to flush foxes from underground for specific purposes, reasonable steps have to be taken *to ensure that the fox… is flushed as soon as reasonably possible after it is located and shot as soon as possible after it is flushed*. While it is possible to flush a vixen from the den, cubs (especially in the first few weeks of life) are very unlikely to be flushed and generally seek refuge in small recesses in the den. While some may be killed by the terrier (itself not permitted under the Protection of Wild Mammals (Scotland) Act 2002), the majority of cubs are likely to be left to die later of starvation and/or hypothermia, depending on the age of the cubs. So in reality killing a vixen at the den, and assuming that *her pups also died*, has very significant welfare implications.

25. The ineffectiveness of widespread winter "pest control" was also shown by two detailed field studies in Britain. Hunting with hounds was banned from 23 February to 17 December 2001 due to foot-and-mouth disease. There were also significant restrictions on access to the countryside, and so it is likely that other forms of fox control were also curtailed. With around 425,000 cubs born in the spring of 2001, just after the hunting ban came into effect, there should have been a detectable population increase if hunting played any role in fox population control. To see if this was the case, fox faecal counts were used to compare fox numbers in the same 1-km squares in late winter 1999 and 2000 (immediately before the outbreak of foot-and-mouth) and late winter 2002 (immediately after foot-and-mouth). In the absence of hunting, fox numbers across Britain as a whole did not increase but actually declined by 4.7% (Baker *et al*. 2002). Changes in fox numbers did not differ between areas that were and were not hunted by packs of hounds, and the magnitude of any fox population change was not affected by the level of hunting pressure in each area. So there was no evidence to suggest that hunting with hounds was playing any role in reducing fox numbers (Baker *et al*. 2002).

26. A subsequent study looked specifically at the effects of gunpacks on fox numbers in commercial forests in Wales. This found that even though roughly twice as many foxes were killed in the winter of 2003/2004 as had been present in autumn 2003, by spring the losses had been replaced by immigration. Furthermore, the more foxes that were killed in the winter, the higher the population in the spring i.e. killing foxes in winter was both ineffective and counter-productive (Baker & Harris 2006). This was almost certainly because more foxes moved in to contest the vacant territories than had been present originally. This reinforced an earlier study in Scotland; in three of the four habitats studied by Hewson (1986), the more foxes that were killed in winter (October to March), the higher the spring breeding population. While the increase was small, it showed that "pest control" in winter does not reduce the spring breeding population, and actually appears to prevent the natural decline in fox numbers in spring (see paragraph 21).

27. This may seem counter-intuitive but is due to the large number of non-resident foxes that visit territories and then move in to compete over the vacancy. This can be seen by clearly in social group 6 in the Bristol study (Table 3). The dominant male died in summer 2014, which led to an influx of non-residents. From a group size of 8 in summer, this rapidly increased to 13 in autumn and 12 in winter. It was also the social group with the highest number of different non-residents recorded on their territory in autumn and winter (18 in each season). The situation only stabilised the following spring, with a group size of 5, when a new male had established himself as dominant. These data show how the loss of a key member of a fox social group can have a dramatic impact on group dynamics and the number of animals resident on, and exploring, the territory.

28. Similar findings have been reported from elsewhere in the world. A study in Australia compared the effects of no fox control with poisoning once per year and three times per year over two years (poisoning is legal in Australia but not in Scotland or the rest of the UK). This showed that the different poisoning campaigns had no significant effect on fox abundance. While spring fox abundance had declined by an average of 27% in the sites poisoned once a year, and 35% at the sites poisoned three times a year, fox numbers still declined by 26% in the sites that were not poisoned (Greentree *et al*. 2000). This reflects the data from Bristol, where fox numbers declined in spring in the absence of any form of population control (Table 3). So group cohesion is important to regulating fox populations locally and "pest control" can lead to an increase, not a decrease, in fox numbers. This appears to be a general pattern with fox populations, having been recorded in Scotland, suburban Bristol, and commercial conifer forests in Wales.

29. The negative impacts of killing territorial carnivores are now also being seen in studies on other species. For instance, a recent study in Tasmania found that, contrary to expectations, the relative abundance of feral cats increased by 75% to 211% in areas where they had been culled. This was probably due to influxes of new individuals after the dominant resident cats were removed (Lazenby *et al*. 2014). Similar results have been seen in other social canids, the wild dog family which includes foxes. Several studies have highlighted the importance of reproductive (dominant) wolves in maintaining group cohesion (e.g. Borg *et al*. 2015). These results mirror those from the fox study in Bristol, which also highlighted the importance of dominant members of the social group in excluding immigrants and maintaining population stability.

30. The exception to this general perception was a study by the then Game Conservancy Trust. Heydon & Reynolds (2000a) concluded that the number of foxes culled in three regions of Britain (East Anglia, the east Midlands and mid-Wales) were close to the published estimates of productivity, and that "pest control", including shooting, snaring and various forms of hunting with dogs, was an important determinant of fox density, and that in parts of Britain "pest control" was at least partly additive to other forms of mortality (Heydon & Reynolds 2000b). However, there are a number of problems with this analysis, not least the fox densities they used in their calculations, which were estimated by long spotlight surveys along roads (Heydon *et al*. 2000). These have several methodological problems and under-estimate fox numbers; the density estimates in Heydon *et al*. (2000) are lower than those calculated by Lloyd (1980a) in mid-Wales and Webbon *et al*. (2004). Gwyn Lloyd worked at the then Pest Infestation Control Laboratory of the Ministry of Agriculture, Fisheries and Food, where he studied foxes in central Wales for many years, and was the leading fox expert of his day.

31. How this affected the Game Conservancy Trust's calculations is unclear. Also, it is unclear how the increases in the Game & Wildlife Conservation Trust's national gamebag census (paragraph 11) equate with their assertion that fox densities in parts of Britain were being substantially depressed by "pest control" (Heydon & Reynolds 2000b). In particular, while they described fox population density in East Anglia as being reduced by "pest control", their own data and that of others showed that fox numbers had actually been increasing in Norfolk for much of the 20th century (Lloyd 1980b; Tapper 1992).

The Committee of Inquiry into Hunting with Dogs in England and Wales concluded that a permanent ban on hunting was unlikely to result in a dramatic increase in fox numbers.

Fox "pest control" operations seem to produce very little effect on adult population structure, adult mortality rate or adult life expectancy.

32. The Game Conservancy Trust's study was undertaken before hunting with dogs was made illegal, in Scotland in 2002 and England and Wales in 2005. The Committee of Inquiry into Hunting with Dogs in England and Wales concluded that a permanent ban on hunting was unlikely to result in a dramatic increase in fox numbers (Burns *et al*. 2000) and this has proved to be the case (paragraph 25). While it is possible that other forms of "pest control" increased to compensate for the ban on hunting with dogs, there is no evidence that this has occurred and, prior to the ban in England and Wales, most people involved in fox "pest control" said that an end to hunting with dogs would make no difference to their levels of control (White *et al*. 2003). So the events following the bans on hunting with dogs in Scotland and then England and Wales do not support Heydon & Reynolds (2000b) conclusions that "pest control" in parts of Britain was at least partly additive to other forms of mortality.

33. It has long been recognised that at least 70% of the fox population needs to be killed each year to reduce numbers, but this will only have a small impact and will take a long time. Higher levels of mortality are required to have a significant impact on fox numbers. In mid-Wales, where foxes were shot, snared, dug out with terriers, and extensively hunted with both mounted packs of hounds and gunpacks, adult mortality was still only 57% per annum, although cub mortality was higher (Lloyd 1980a). With around a quarter of a million adult foxes producing 425,000 cubs each year in Britain, 64% mortality per annum is needed across the fox population as a whole to maintain a constant population size (Baker *et al*. 2002). Nearly 40 years ago Harris (1977) concluded that fox "pest control" operations seem to produce very little effect on adult population structure, adult mortality rate or adult life expectancy. This was mirrored by the studies in Scotland (Hewson 1981), and there is nothing to suggest that it is still not the case in Scotland.

Summary: Work in Scotland in the 1970s and 1980s suggested that improvements in the management of hill sheep, leading to fewer carcasses over winter, might reduce the fox population more than the levels of control. Fox losses, whether by "pest control" or natural mortality, are rapidly replaced, especially in winter which is the main dispersal period. In fact "pest control", especially when a dominant animal is killed, can lead to a local increase in numbers as more foxes move in to compete for the vacant space. There is no convincing evidence that "pest control" is having a significant effect on fox numbers in Scotland or elsewhere in Britain, the ban on hunting with dogs has not led to an increase in fox numbers, and using packs of hounds to drive foxes out of cover to waiting guns can have a significant disruptive effect on the behaviour of foxes and leads to higher, not lower, fox numbers in the spring. ■

Effects of "pest control" on fox predation levels

In-bye lambing probably reduced losses to foxes and that lambs returned to the hill at three to five days old are almost out of the preferred size for foxes.

34. Following his extensive studies on fox populations in Scotland, fox predation on sheep, and sheep behaviour and mortality in Scotland, Dr Ray Hewson concluded that non-selective fox "pest control" over the winter did not reduce complaints of lamb-killing by foxes. However, the destruction of foxes and cubs at breeding dens in the spring often stops local instances of lamb-killing (Hewson 1986). This was one of the earliest studies to highlight the ineffective nature of widespread fox "pest control" in the winter in reducing lamb losses the following spring.

35. Hewson (1990) tested his ideas by looking at lamb losses at Eriboll, in north-west Scotland, in the absence of any fox control between 1987 and 1990. He compared this with the nearby Balnakeil estate, where foxes were being killed by snaring, shooting, and destruction of adults and cubs at spring breeding dens. In the absence of control, he found no increase in fox predation on lambs, in the number of foxes, or the number of breeding dens at Eriboll. He noted that in-bye lambing probably reduced losses to foxes and that lambs returned to the hill at three to five days old are almost out of the preferred size for foxes.

36. When summarising the situation in Scotland, Dr Hans Kruuk, an internationally-renowned scientist based at the then Institute of Terrestrial Ecology at Banchory, Aberdeenshire, concluded that, while foxes get much of the blame for the "black loss" of lambs, this is unjustified. He also noted that, in 1987, farmers and the government paid fox clubs and others £75,000 (£200,000 at current values) to kill foxes for "pest control" without obvious benefits in reducing either losses to foxes or fox numbers (Kruuk 2002).

37. Lloyd (1980a) came to very similar conclusions from his work on hill sheep in central Wales. He concluded that *in sheep-rearing areas the killing of foxes (except to relieve particular circumstances) may not materially alter the extent of lamb losses, and unless a large proportion of the population is removed over a large area, control will certainly not have any significant effect on the overall population size.*

Similarly to Hewson (1990), he recommended that *damage by foxes could be considerably reduced by keeping lambing ewes under cover, since most losses occur when lambs are under twenty-four hours of age.*

Thus extensive studies by independent government scientists in the upland areas of Scotland and Wales produced virtually identical conclusions: widespread killing of foxes for "pest control", especially in winter, had no effect on spring lamb losses. Locally, targeted control at breeding dens in the spring was more effective at reducing lamb losses, and small improvements in husbandry would have a significant impact on lamb losses, including losses to foxes.

While efforts to manage the impacts of predators invariably concentrate on attempts to reduce predator numbers, livestock losses appear to be unrelated to predator density.

Summary: We are only just starting to understand the effects of "pest control" on fox predation levels. Early work in Scotland showed that widespread fox control in winter was ineffective in reducing lamb losses, and that targeted control at fox breeding dens in spring was more effective. More recent studies on carnivore populations generally have shown that livestock losses appear to be unrelated to predator density, and that there is no logic in trying to reduce predator numbers to reduce livestock losses. Widespread "pest control" in winter may lead to higher, not lower, livestock losses. ■

38. Despite the early work in Scotland, there are still relatively few studies looking at the effects of widespread fox "pest control" on livestock losses. Nearly 50 years ago Mann (1968) showed that there was no difference in lamb mortality in three fox-proof and three unprotected enclosures in southern Australia, even though foxes were seen regularly. Similarly, Greentree *et al*. (2000) found no effect of fox control operations on lamb production in Australia.

39. Looking at other species of canids, Conner *et al*. (1998) found no relation between the number of lambs killed and coyote numbers, which they suggested may be because most of the coyotes that were killed were not killing sheep. They suggested that one solution was better targeting of problem coyotes, as Ray Hewson and Gwyn Lloyd had suggested for foxes. As Kruuk (2002) had earlier concluded for government-subsidized fox control in Scotland, Berger (2006) found that government-subsidized coyote control in the United States had been ineffective in reducing predation on sheep.

40. There is also growing evidence that predator control can actually enhance livestock, and hence economic, losses. Some of the best data come from a 25-year study of livestock losses to wolves in Idaho, Montana and Wyoming. This showed that predation levels were higher the year following wolf control; the odds of livestock losses increased by 4% for sheep and 5-6% for cattle with increased wolf control until control levels reached unsustainable levels (Wielgus & Peebles 2014). These authors recommended that lethal control of individual problem wolves may be necessary in the short-term, but that non-lethal alternatives should be considered. Again, it may appear counter-intuitive to find that livestock losses are increased, not reduced, by predator control, and there are several ideas to account for this. It may be due to the disruption of the social groups (see paragraph 27), so that the animals that move in are less familiar with where to find wild prey, or are less able to hunt wild prey, or the increased number of animals that move in to contest the vacant space leads to higher livestock losses. Of course, these may all be contributory factors; more research is needed to understand the adverse effects of "pest control" on livestock losses.

41. There have been a number of studies looking at livestock losses to various carnivores across the world, and an analysis combining data from 28 of these found that, while efforts to manage the impacts of predators invariably concentrate on attempts to reduce predator numbers, livestock losses appear to be unrelated to predator density (Graham *et al*. 2005). So trying to reduce predator numbers does not make sense when trying to reduce losses of livestock.

Is the fox a pest?

Maximum losses due to fox predation in any one year were equivalent to 1.5% on the Midlothian farm and 0.6% on the West Perthshire farm, compared to overall lamb mortalities on the two farms of 10.2% and 9.3% respectively.

Keeping ewes with twins or triplets indoors for the first week or so after birth might significantly reduce lamb losses.

42. In summarising his studies on foxes and lambs in Scotland, Hewson (1990) concluded that *some losses of lambs to foxes seem inevitable. They should be seen against the general pattern of losses of hill lambs. The average production of hill lambs surviving to June per 100 ewes in west Scotland over a five-year period varied between 66 and 71, but ranged from 45 on high exposed hill ground to 91 on sheltered holdings near the coast. Production varied greatly between adjacent holdings. It is against this background that predation by foxes of up to one to two per cent of the lambs, and often much less or none, must be considered. Lloyd (1980a) estimates the figure for Wales at 0.5%. Many shepherds in west and north-west Scotland, including some of the most experienced, do not complain of losses. Killing of lambs by foxes appears to be a random and unpredictable process. Hewson (1990) also pointed out that There are no foxes on the island of Mull but production of lambs over a three-year period was no better than on similar ground on the mainland, in other words predation by foxes was part of, rather than additive to, the normal scale of lamb losses.*

43. More recently, White *et al.* (2000) looked at the impacts of fox predation on two Scottish hill farms (one in Midlothian, the other in West Perthshire). They found that the maximum losses due to fox predation in any one year were equivalent to 1.5% on the Midlothian farm and 0.6% on the West Perthshire farm, compared to overall lamb mortalities on the two farms of 10.2% and 9.3% respectively, levels of mortality that are not uncommon among Scottish blackface lambs (Houston & Maddox 1974). White *et al.* (2000) suggested that the higher losses at the first farm were because all ewes lambed indoors at the second farm and were turned out into lambing paddocks 24 to 36 hours after lambing. Since ewes with multiple births suffered more losses because the lambs were smaller and the ewe was less able to protect more than one lamb, they suggested that keeping ewes with twins or triplets indoors for the first week or so after birth might significantly reduce lamb losses.

Ewes and lambs should only be kept indoors for a day after lambing to minimise the economic losses to fox predation.

During its lifetime each fox was worth £156 to £886 to a farmer through reduced losses due to rabbit grazing.

44. Moberly *et al*. (2003) analysed data on lamb losses supplied by sheep farmers from across Britain; they reported lamb losses of 0.0008 to 0.26 per ewe. While it was undoubtedly the case that fox predation was over-estimated by the farmers who completed the questionnaires, their losses were generally perceived to be low on the majority of farms, and fox predation made up a small proportion of the lamb losses they reported. This study also highlighted that indoor lambing was an important measure preventing fox predation but the effect of fox control on livestock predation was difficult to determine. To examine this further, Moberly *et al*. (2004a) used an economic analysis to identify the most cost-effective strategies to reduce lamb losses to foxes. This showed that ewes and lambs should only be kept indoors for a day after lambing to minimise the economic losses to fox predation. When looking at the economics of fox control, indoor housing was a more cost-effective way of reducing lamb losses than additional fox control. Reducing fox density had relatively little effect on expected lamb losses. Furthermore, this assumed that there was no immigration to replace the fox that was killed, when in reality this occurs rapidly (paragraph 19). Perhaps most importantly, they showed that it was not economical to prevent all fox predation and that simply estimating predation losses is of limited use for informing management decisions.

45. When looking at other agricultural losses reported by farmers, Moberly *et al*. (2002, 2004b) found that free-range chicken and turkey producers generally reported low losses to foxes (average losses of 0% and 0.04% of flocks respectively), with losses being higher overall amongst goose and egg producers (0.5%, on average); this difference was in part due to the time that the birds were on the farm. On average, 0.3% of piglets born outdoors were reported killed by foxes, with losses of up to 5%. All these data were provided by the producers themselves; only losses of stock raised outdoors were included in their calculations since losses of intensively-reared stock were miniscule. Higher losses to foxes were often associated with higher stock losses generally, suggesting that losses to foxes may have been higher on farms with lower standards of husbandry generally (e.g. Moberly *et al*. 2004b).

46. These calculations also ignore the economic benefits of foxes, which are considerable, especially in reducing losses to rabbits. Baker & Harris (2003) calculated that the agricultural losses and benefits to foxes were at worse equal and that foxes are economically neutral and probably an economic benefit to farmers. Macdonald *et al*. (2003) went further and calculated that during its lifetime each fox was worth £156 to £886 to a farmer through reduced losses due to rabbit grazing. While based on many assumptions, both these analyses indicate that foxes provide significant economic benefits to farmers overall, and these should be included in any assessment of the economic impact of foxes. Losses and benefits vary between farms and types of farming; losses are more likely to be incurred by free-range poultry and possibly pig producers, whereas benefits are more likely to accrue to farmers producing sheep, cattle, cereals and other crops.

Despite all the evidence to the contrary, some farmers continue to argue that losses of lambs to foxes is increasing following the ban on hunting in Scotland in 2002.

47. While all the evidence shows that losses of livestock to foxes are low, there remains a widespread perception among a small number of farmers that foxes cause significant economic losses. For instance, a survey of farmers in Wiltshire found that farmers' opinions regarding the need for fox control were often contradictory and not directly governed by their own interests; while two-thirds did not consider the fox to be a personal pest, most believed that foxes should be controlled everywhere because they were too numerous, although far fewer believed that foxes were responsible for actually taking domestic livestock. Where farmers had livestock losses, their main concern was chickens, which were generally not kept commercially (Baker & Macdonald 2000).

48. Despite all the research to the contrary, claims persist that foxes cause serious economic losses, and that widespread "pest control" is the only solution. For instance, during the ban on hunting during foot-and-mouth disease, Welsh farmers put out press reports claiming that Britain's fox population had soared, that attacks on lambs had increased sharply in the spring of 2001, and that this posed a serious economic threat to sheep farming (e.g. http://www.theguardian.com/uk/2002/jan/06/hunting.ruralaffairs). In fact the British fox population declined by 4.7% during the ban on hunting (Baker *et al.* 2002). Similarly, the press release from the Federation of Welsh Farmer's Packs accompanying the report by Naylor & Knott (undated) (http://www.fedwfp.co.uk/wordpress/wp-content/uploads/.../fwfp-research-release.pdf) said that a recent survey of Welsh farmers had shown that 76% of the farmers asked had lost more lambs to foxes since 2005, when the Hunting Act 2004 came into effect. It is hard to understand why lamb losses should be increasing when fox numbers are declining (paragraph 8) unless it is due to factors other than changes in fox numbers or changes in methods of fox "pest control".

Summary: Early studies in Scotland showed that the losses of hill lambs to foxes were low compared to other causes of mortality, and subsequent work in Scotland and elsewhere has reinforced that conclusion. Losses of other free-range livestock are also minimal. Farms with higher livestock losses to foxes often have higher levels of mortality generally, suggesting that fox predation may be associated with poor husbandry. Despite all the evidence to the contrary, some farmers continue to argue that losses of lambs to foxes is increasing following the ban on hunting in Scotland in 2002 and in England and Wales in 2004. There is no evidence to support this perception, and fox numbers have declined, not increased, since the bans on hunting came into effect. So if lamb losses have increased, this must be due to factors other than changes in fox numbers or changes in methods of fox "pest control". ■

The welfare issues of using two dogs to flush foxes

Typically gunpacks would have 40 or 50 guns positioned on all sides of the covert or section of the covert to be drawn.

49. Once the Protection of Wild Mammals (Scotland) Act 2002 came into effect, the foxhunts operating in Scotland changed their modus operandi and say they used packs of dogs to drive foxes out of cover to waiting guns (*http://www.countrysidelearningscotland.org.uk/wp.../Factfile-Fox-Hunting.doc*). So they say they are now operating in the same way as the gunpacks found in Wales and elsewhere prior to the implementation of the Hunting Act 2004 in England and Wales. Basically, a pack of dogs is used to drive foxes to waiting guns. Shotguns are used, not rifles, and these have a limited range: the British Association for Shooting and Conservation recommend that a 12 bore shotgun with a load of not less than 36 grams of large shot such as no. 1 or no. 3 can be used to shoot foxes at ranges up to 30 metres *(http://basc.org.uk/cop/lamping/*). This means that the guns would need to be spaced around 50 metres apart to ensure they can shoot any fox that was flushed and kill it humanely, and so the larger the area being hunted, the more guns are needed. Typically gunpacks would have 40 or 50 guns positioned on all sides of the covert or section of the covert to be drawn (Weeks undated). So when the Ministry of Agriculture, Fisheries and Food (as it then was) organised a fox shoot on around 800 hectares of heathland in Camberley in an attempt to contain a potential rabies outbreak in 1969, they needed 60 guns and drove the area in sections over a two day period (Hendrie & Westcott, 1970). The process of lining people up around the covert is the same as was used during cub-hunting when foxhunting was legal; a fox will try to escape from any point in the covert, and it is not possible to predict exactly where it will emerge. So all sides need to be lined with waiting guns (if the fox is to be shot) or, when cubhunting was legal, with a line of foot and mounted followers who would stop the foxes from trying to escape.

50. In dense cover, the hounds are free-running and not under the control of the huntsman. How these packs of hounds operated is described in the Federation of Welsh Packs' 1999 submission to the Committee of Inquiry into Hunting with Dogs in England and Wales (*http://fedwfp.co.uk/*). In paragraph 9.04, they say *in a large wood or forestry plantation hounds may hunt the fox in cover, with the result that the waiting guns may not have an opportunity to shoot. Conversely the hounds may immediately hunt their fox towards a waiting gun, who dispatches it. In the event of the fox being wounded the close attendance of the hounds means that if injured it is quickly caught. During the period that hounds are hunting a particular fox, others may very well be disturbed and move offering the standing guns an opportunity to cull. It may transpire that foxes do not afford the guns the opportunity to shoot and consequently they are caught by the hounds, put to ground or lost. Whilst drawing (seeking a fox) the packs might 'mark' (indicate that the fox is located underground) when terriers will be used and the fox humanely accounted for.*

Because they are working in dense cover the hounds are not under the control of the huntsman; that the hounds often catch and kill foxes; foxes are often hunted to ground and that around two-thirds of the foxes are dug out and killed with terriers; and foxes are often shot and wounded rather than killed humanely.

51. Paragraph 9.05 says... *During such a days [sic] hunting, a fox may often avoid the guns and leave the area being hunted, with hounds in pursuit. Again once it has avoided the 'ring' of followers with guns, it is hunted by the hounds until it is caught, put to ground, shot or lost.*

52. Paragraph 9.06 says... *Large numbers of foxes can be accounted for on such days shooting, especially early in the season. It is a productive method of control especially when small woodlands or similar areas are hunted that play host to large number of foxes. Some of these foxes may never be directly hunted by the hounds, but move within the area hunted because of the presence of the hounds and present the guns with an opportunity to shoot. In actual fact hounds may only hunt one fox, but several may be shot.*

53. Paragraph 13.01 says that… *each and every member pack of the Federation is reliant upon terriers to account for a substantial part of their annual tally" and (paragraph 13.02) adds that the Federation of Welsh Packs consider "it imperative from a welfare point of view that if an injured or wounded fox goes to ground during a days [sic] hunting, then terriers must be used to humanely account for it, so as to avoid prolonged suffering. With such an emphasis upon fox control within Wales, the digging of foxes that are found underground, or are hunted to ground is the norm, with all member packs of the Federation and curtailment of the use of terriers would severely compromise the effectiveness of the fox culling. Paragraph 13.03 of the submission says In order to portray more effectively how extensive and essential the use of terriers are in fox control with member Packs of the FWP, a sample record with a geographical spread is shown below:*

Name of hunt	Percentage of total for the 1998/1999 season dug out
Afonwy	45%
Cambrian	43%
Cwrt y Cadno	80%
Plas Machynlleth	30%
David Davies	90%
South Pembrokeshire	85%
Average	**62%**

54. So it is clear from the submission of the Federation of Welsh Packs that, when using a pack of hounds to flush foxes from cover so that they can be shot by waiting guns: more than one fox is likely to be hunted by hounds when they are in cover; because they are working in dense cover the hounds are not under the control of the huntsman; that the hounds often catch and kill foxes; foxes are often hunted to ground and that around two-thirds of the foxes are dug out and killed with terriers; and foxes are often shot and wounded rather than killed humanely. It should also be remembered that there are significant welfare implications associated with terrier work.

This pattern of hunting is contrary to the aims of the Protection of Wild Mammals (Scotland) Act 2002, which was designed to protect wild mammals from being hunted with dogs.

This conclusion ignores the more major welfare issues, including whether more or fewer foxes were shot and wounded when using a pack of hounds compared to using two dogs.

55. This pattern of hunting is contrary to the aims of the Protection of Wild Mammals (Scotland) Act 2002, which was designed to protect wild mammals from being hunted with dogs. Section 2 (1) permits the use of a dog that is under control to flush a wild mammal from cover for various specified purposes, if the target wild mammal is found or emerges from cover, it is shot… once it is safe to do so. Section 3(b) of the Act requires a person to take reasonable steps to ensure that the fox… is flushed as soon as reasonably possible after it is located and shot as soon as possible after it is flushed. As the Federation of Welsh Packs' 1999 submission to the Committee of Inquiry into Hunting with Dogs in England and Wales makes clear, it is not possible to achieve these goals when using a pack of hounds to flush foxes from cover.

56. The Federation of Welsh Farmers' Packs (formally the Federation of Welsh Packs) commissioned a study in Scotland during the winter of 2012/2013 to compare the efficiency of using two hounds with a pack of hounds to flush foxes from cover (Naylor & Knott undated). A number of key issues were not addressed in this report, including: how many foxes were shot and killed cleanly; how many were wounded and then killed by the dogs; how many were wounded and escaped; how many were wounded and then caught and killed by the hounds (see paragraph 50); and how many foxes were hunted but escaped. Lloyd (1980a), for instance, described the movements of a radio-collared fox in mid-Wales that was hunted on at least four occasions by packs of hounds, both mounted packs and gunpacks. It survived all four hunts, although it made substantial movements each time after it was hunted. Nor does the report address the fundamental issues of whether using a pack of hounds is more effective in reducing the spring fox population size (paragraph 26) or in reducing levels of lamb losses (paragraph 34). There are also a number of methodological problems with the study, such as the assumption that vocalising by the hounds is a sign that a fox is being pursued: while this indicates that the hounds are on a fresh scent, it does not show that they are actively pursuing a fox.

57. Despite these methodological limitations, Naylor & Knott (undated) concluded that *a pair rather than a pack of hounds a) is less effective in flushing foxes to guns and b) imposes a longer duration of pursuit on foxes that might be associated with welfare compromise*. This conclusion ignores the more major welfare issues, including whether more or fewer foxes were shot and wounded when using a pack of hounds compared to using two dogs, and whether more foxes were caught and killed by a pack of hounds than when using two dogs. Furthermore, the authors provide no evidence to suggest that a longer chase has significant welfare implications: it could equally well be argued that moving foxes slowly out of cover with two dogs is less stressful than using a pack of dogs to chase a fox quickly out of cover.

However, whether or not a pack of hounds is more effective in flushing foxes from cover is not the issue, since gunpacks are not effective in reducing fox numbers, and the more foxes that are killed, the more foxes that are likely to be present in spring.

58. However, whether or not a pack of hounds is more effective in flushing foxes from cover is not the issue, since gunpacks are not effective in reducing fox numbers, and the more foxes that are killed, the more foxes that are likely to be present in spring at lambing time (paragraph 26). So there is no "pest control" gain from flushing more foxes from cover. Whether two hounds taking longer to flush a fox from cover has any *welfare compromise* is speculation, and not supported by the evidence.

59. The Federation of Welsh Packs' 1999 submission to the Committee of Inquiry into Hunting with Dogs in England and Wales suggests that there are likely to be significant welfare benefits of using two hounds to flush foxes from cover, and these were not addressed in the study by Naylor & Knott (undated). These include: a lower chance of the fox being caught and injured or killed by the hounds; being moved slowly out of cover with two hounds that are under control is likely to be less stressful than being pursued by a pack of hounds; moving foxes slowly through and out of cover will enable the waiting guns to get a better shot, thereby reducing the risks of wounding; and fewer foxes being flushed at any one time also reduces the risks of wounding. It should also be remembered that Lloyd (1980a) showed that gunpacks are ineffective in killing the foxes in a particular piece of cover, but repeated hunting can have a significant impact on their behaviour. This may be one of the factors enhancing levels of livestock losses following "pest control" operations (paragraph 40).

Summary: Packs of dogs are difficult if not impossible to control in dense cover, and this has a number of welfare consequences. Foxes find it harder to evade the hounds and they are often caught and killed by the hounds or driven to ground. Two-thirds of the foxes killed by gunpacks in Wales in 1998/1999 had to be dug out with terriers. Packs of hounds also catch and kill wounded foxes. Using two hounds to flush foxes is likely to ensure higher levels of welfare, since the hounds are easier to control, and flushing a fox more slowly reduces the risk that it will be wounded rather than killed by the waiting guns. ■

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