Letters

Shooting in the dark

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Measuring the welfare standards of practices used to cull wild mammals is difficult and controversial (eg Bateson & Bradshaw 2000; Urquhart & McKendrick 2003). The welfare issues arising from shooting concern (a) the rate at which animals are wounded, and (b) the level of suffering caused by these wounds. In a recent paper, Fox *et al* (2005) attempted to estimate wounding rates associated with shooting red foxes (*Vulpes vulpes*) in Britain, by using individual participants (n = 199), of differing skill levels, to shoot at a template of a fox mounted sideways-on on a moving sledge under 51 different regimes that varied in the type of weapon and ammunition used and the distance to the target. In conjunction with additional data on the likely penetration of the ammunition under the different regimes, each target was then scored by veterinarians as likely to have (a) killed the fox outright, (b) seriously or (c) lightly wounded the animal, or (d) missed the target completely. However, we believe that there is a range of errors associated with the conception and analysis of this study that invalidate the conclusions reached by the authors.

First, there is no *a priori* evidence to suggest that the majority of regimes included in the study reflect practices actually occurring in Britain, even if they are legally permissible. For example, over half of the foxes shot in Britain are killed by gamekeepers, who might reasonably be expected to be skilled shots, and many others are likely to also be killed by skilled marksmen (Bucknell 2001), whereas 37% and 25% of the regimes tested by Fox *et al* (2005) involved unskilled people (who had seldom or never fired a gun before) and semi-skilled people (who shot several times per year, but who did not consider themselves to be above-average shots) respectively.

Second, there is no evidence to suggest that foxes are regularly shot with inappropriately sized weapons and/or ammunition, and in a way that is not compatible with the code of practice put out by the British Association for Shooting and Conservation (*Lamping [Night Shooting]*: www.basc.org.uk). For example, the average total wounding 'tax' calculated for the regimes in Fox *et al*'s (2005) study was 2.1 individuals seriously or lightly wounded per animal killed. Given that approximately 80 000 foxes are shot per annum (Pye-Smith 1997), these figures imply approximately 168 000 foxes would be wounded each year. Most fox shooting is undertaken in the autumn and winter; the total fox population at the end of winter is 258 000 (Webbon *et al* 2004), with approximately double this number at the onset of autumn following reproduction and subsequent cub mortality. Consequently, Fox *et al*'s (2005) study indicates that one third to two thirds of the national population is wounded by shooting each year, which should be readily evident. Yet, the RSPCA, the major animal welfare organisation in Britain, rarely takes in foxes suffering from shot wounds (A Lindley personal communication 2004), suggesting a marked disparity with the figures calculated by Fox *et al* (2005). The average total wounding tax based upon those regimes that were in accordance with 'governmental guidelines' (Geddes 2001 cited by Fox *et al* 2005) was substantially lower (0.7, n = 14 regimes) than that arising from the other regimes (2.6, n = 37).

Third, the wounding tax figures presented by Fox *et al* (2005) relate to the probabilities per shot fired. In reality, given that foxes are relatively small animals (5–6 kg), when shot with either a rifle or shotgun an injured animal is generally bowled over (S Harris personal observation), especially when running, giving the practitioner the opportunity to fire again at a stationary or near-stationary target within a few seconds. Thus, most wounding that does occur is a transitory event with little or no welfare implications (Coupland 2003). Therefore the key issue is the number of wounded animals that escape. From the figures presented by Fox *et al* (2005) the probability that an individual would escape wounded from just one shot under regime R12 is 10%, compared to only 1% with two shots. Consequently, the wounding tax figures presented in the manuscript inflate the expected number of animals wounded.

Finally, in their analyses, Fox *et al* (2005) restrict the data to two randomly selected shots (one where the sledge was pulled left-to-right and one where it was pulled right-to-left) per participant per regime, but with different participants involved in different numbers of regimes. The effect of different factors on each of the outcomes was then analysed using a series of independent one-way ANOVAs (Tables 3–9) to examine the outcome of each shot fired. There are three critical assumptions underlying the use of this type of ANOVA: data points are independent; data are normally distributed; and variances are equal (Zar 1999). The data utilised by Fox *et al* (2005) violate all of these assumptions. First, the data are pseudo-replicated and non-independent since participants contributed to some regimes but not others. Furthermore, there is insufficient replication of participants across regimes to adopt a repeated-measures approach. Second, for each independent factor examined, four separate tests have been conducted on those shots resulting in (1) 'kills', (2) 'serious wounds', (3) 'light wounds', and (4) 'misses'. Thus, in examining the effect of each factor on kill shots, for example, each datum appears to have been coded as either 'shot resulted in a kill' versus 'shot resulted in a serious wound, light wound or miss'. Therefore the data set consists of dichotomous coded

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values. These data will not be normally distributed, and will violate the second and third key assumptions of this statistical approach. Such coding also gives rise to pseudo-replication across tests and renders interpretation difficult. For example, a difference in the mean value of 'shot resulted in a kill' versus 'shot resulted in a serious wound, light wound or miss' would not relate directly to differences in welfare standards since 'misses', which are of no welfare concern (Fox *et al* 2005, p 94), are included with those categories that could be of welfare concern.

Independent analysis of different factors is also only valid where other factors are assumed, or have been shown, to exert no effect. Therefore, it is inappropriate to test, for example, the effect of shotguns versus rifles (Table 4) without controlling for the effects of skill level, given that skill level had previously been shown (erroneously) to affect outcomes (Table 3). The only appropriate way to examine these data would have been to utilise a multivariate approach, such as ordinal logistic regression, incorporating the effect of all independent variables simultaneously. Yet, given that the data are not independent at the most basic level, a rigorous analysis can only be achieved by reducing the data set to those situations where each participant is included equally in all regimes. In a similar vein, the figures presented in the columns headed "Probabilities" and "Wounding 'tax'" in Table 2 appear to have been erroneously calculated from the total number of shots fired by all participants, regardless of whether each participant fired the same number of shots.Consequently, we believe that the results as presented in this manuscript are not a valid investigation of wounding rates arising from fox shooting practices in Britain: the premise of the regimes tested does not reflect the pattern of shooting actually occurring, there is no evidence of widespread wounding of foxes in this country, and the statistical analyses are fundamentally flawed.

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Response to Baker and Harris's letter 'Shooting in the dark'

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In commenting on our paper 'Wounding rates in shooting foxes' (Fox *et al* 2005) Baker and Harris make a number of unfounded assumptions. First of all, we have *not* claimed that the majority of the shooting regimes we tested "reflect practices actually occurring in Britain". Nobody knows how many foxes are shot in Britain, by whom or with what regimes. What we *do* claim is that all of the methods we tested were legal, that most are in common use, and that further, less welfare-friendly, regimes are also used. We know this because some of the 199 shooters involved in the study volunteered this information. For example, some claimed to have shot at foxes up to 120 yards with shotguns, hoping to wound or kill; others had used .410s beyond 25 m, and foxes have even been admitted to animal hospitals with wounds from air rifles (Harris 1978). We did not test these extreme regimes, nor do we claim — as Baker and Harris imply we do — that these extreme regimes are in regular use. Our regimes were chosen to explore not only those within government guidelines, but also those commonly used. The British Association for Shooting and Conservation is now using our protocols and targets to explore additional regimes and we commend them for their pro-active approach to improving animal welfare.

Baker and Harris claim that "over half of the foxes shot in Britain are killed by gamekeepers". We don't accept this claim. It may be true in parts of south and east England, but in other areas, such as Wales, there are few gamekeepers and most foxes are shot by other people. Again, nobody actually knows. Baker and Harris then claim that the gamekeepers "might reasonably be expected to be skilled shots". This may be so, and we have therefore explored the welfare benefits of skilled versus semi-skilled versus unskilled shooters in our study. It turns out that skilled shooters, although they kill a higher percentage, do not wound much less than unskilled shooters. But the real crux of the matter is the *motive* of the shooter, which we could not measure. Those that shoot for pest control as their first priority, inevitably have welfare only as a secondary priority. This is reflected generally in Britain's approach to pest control; the break-back mouse trap would not pass ISO fur-trapping standards (Harrop 2000). Yet we campaign against fur-trapping but not against mouse-trapping, and Defra licenses the use of some rodenticides despite admitting that they are 'markedly inhumane' (Pesticides Safety Directorate 1997; Fox 2002). Unlike deer-shooters, who wish to retrieve the carcass for the meat, people shooting pest foxes have no

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