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Welfare of badgers (Meles meles) *subjected to culling: patterns of trap-related injury*

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Abstract

For over 25 years, European badgers (Meles meles) *have been subject to culling in Britain in attempts to limit the spread of tuberculosis (TB) to cattle. As part of a far-reaching evaluation of the effectiveness and acceptability of badger culling as a TB control measure, this paper assesses one aspect of the welfare of badger populations subjected to culling: the risk of badgers confined to cage traps prior to despatch becoming injured as a result of rubbing or biting on the cage. In a large-scale field trial, 88% of badgers received no detectable injuries as a result of being confined in the trap. Of those that were injured, 72% received only minor skin abrasions. A minority (1.8% of the total) acquired damage to the teeth or jaws that may have caused serious pain. Although trap rounds were commenced in the early morning, badgers were no more likely to sustain injuries when they remained in traps until later in the day. Coating of cage traps, intended to give the wire mesh a smoother surface, was associated with a reduction in the incidence of minor skin abrasions, although it may have slightly increased the frequency of less common but more serious abrasions. Modification of the door design reduced tooth damage. Traps will be further modified if appropriate. However, all aspects of the conduct of trapping operations must balance badger welfare with concerns for the health and safety of field staff.*

Keywords: *animal welfare, bovine tuberculosis, box trap, cage trap, capture myopathy, European badger*

Introduction

European badgers (*Meles meles*) have been subject to culling in Britain for nearly 30 years, in a series of attempts to reduce transmission of tuberculosis (TB; caused by *Mycobacterium bovis*) to cattle (Krebs *et al* 1997). Badgers' role in maintaining TB in cattle, and the effectiveness of badger culling as a TB control measure, are currently being assessed in an extensive field trial (The Randomised Badger Culling Trial: Bourne *et al* 1998, 2000a,b; Donnelly *et al* 2003; Woodroffe *et al* 2003). The trial, and its associated research, is formally evaluating not only the technical effectiveness of badger culling in reducing the incidence of cattle TB, but also its acceptability in the widest sense (Bourne *et al* 2000b, Woodroffe *et al* 2003). If badger culling is to be acceptable, both as a candidate TB control policy and as an experimental treatment, badger welfare must be taken into account in devising culling strategies.

The methods used to cull badgers will have a major impact on the welfare implications of culling. During the 1970s, badgers were destroyed by pumping cyanide gas into their dens (setts) (Krebs *et al* 1997). This practice was discontinued in 1982 on welfare grounds and, since then, badgers to be culled have been captured in cage traps and despatched by gunshot to the head (MAFF 1983). Independent audit of the despatch procedure indicated that death was instantaneous in "almost all, if not all, cases", and the despatch was considered "humane" (Kirkwood 2000; Ewbank 2003). However, the method used to capture badgers prior to despatch may also have welfare implications. As in previous culling operations — and in all ecological studies of badgers licensed by English Nature and the Home Office (eg Tuyttens *et al* 2000) — experimental culls carried out in the course of the trial have used cage traps to capture badgers. Alternative methods are available, however. Krebs *et al* (1997) proposed that stopped body snares be used as an adjunct to cage trapping in the field trial; this approach was not adopted, in part because no data were available on the welfare consequences of snaring for badgers, or for other species that might be caught by accident (Bourne *et al* 1998). More recently, one farming lobby group has called for gassing to be reinstated (TB Forum 2003). Any future evaluation of such methods as alternatives to cage trapping would need to take into account their welfare implications; hence it is important to document the welfare costs associated with cage trapping, as a baseline for comparison.

Wild mammals may become injured in cage traps by rubbing or biting on the cage itself (eg Belant 1992; Frank *et al* 2003). Serious trap-related injuries (eg tooth breakages) may have long-term debilitating effects, reducing animals' capacity to feed on natural prey (eg Rabinowitz 1986). Long-term effects are of minimal concern in this case, however, since all badgers are despatched within hours of capture. This paper therefore considers only the potential for suffering during the period in which the animals are caught inside the trap.

Methods

All data were gathered in the course of the Randomised Badger Culling Trial. Badgers were trapped by staff of the Department for Environment, Food and Rural Affairs (DEFRA), operating under Crown Immunity. Justification for the trial, details of its design, and information on a broad array of other research implemented to underpin future TB policy are given in Bourne *et al* (1998, 1999) and Woodroffe *et al* (2003). Results from two of the treatments are given in Donnelly *et al* (2003). Procedures for recording trap-related injuries were introduced in May 2000; the data presented here were collected during May 2000–January 2001 and May 2002–August 2003. Culling was suspended in the intervening period during an epidemic of foot-and-mouth disease in Britain, and a closed season was imposed to avoid culling females with dependent cubs (see Woodroffe *et al* 2005, pp 19–25, this issue).

Badgers were captured in cage traps set at, or close to, badger dens. Cage traps were constructed of 50 × 50 mm wire mesh, with a door mechanism triggered when badgers tripped a string threaded through the back part of the cage. Where possible, traps were dug a few centimetres into the ground to improve their stability and to cover the mesh floor with soil. Traps were pre-baited with peanuts for up to two weeks before they were set. Traps were set in the late afternoon and checked early the next morning. Badgers were despatched in the trap, at the point of capture, by a shot to the head. The time of despatch was recorded in all cases and ranged from 0500h to 1535h. While standard operating procedures advised that all traps should be checked before noon, this deadline was missed on 4.0% of 5965 occasions. This occurred especially during on-site training of field staff in procedures for humane despatch (described in Kirkwood 2000), and consequently declined through the course of the study (7.9% of 2214 captures in 2000, 1.9% of 2676 captures in 2002, and 1.7% of 1075 captures in 2003).

In the course of the study, two changes were made to the trap design to try to reduce trap-related injury. Untreated wire mesh cages tend to rust quickly, creating an abrasive surface. Hence, in 2001, all traps were coated with a polymer to give a smoother surface, intended to reduce abrasion injuries. Subsequently, in November 2002, the door mechanism was modified to try to reduce tooth injuries. This modification involved adding a piece of angle iron to restrict badgers' access to the bottom of the door, a part of the trap that is often a target for biting.

All badgers culled in the course of the trial were subjected to necropsy by trained veterinarians, with a primary aim of determining their *M. bovis* infection status. Carcasses were stored in chilled cabinets and examined within 72 h of despatch where possible. In addition to collecting samples for TB diagnosis, veterinarians recorded whether each badger showed evidence of (i) fresh abrasions of skin on the snout; (ii) minor fresh abrasions on the lower limbs ('some hair loss, some redness but all lesions 2 cm or less'); (iii) cuts or more serious abrasions to the lower limbs ('lesions more than 2 cm with red or broken skin and hair loss'); (iv) recent damage to one or more claws; (v) recent damage to one or more teeth; (vi) damaged jaw and broken teeth. These are all trap-related injuries that have been recorded in ecological studies of badgers. Necropsy protocols were reviewed during 2001, and three new measures were recorded: (vii) minor fresh abrasions to the upper limb (definition as [ii] above); (viii) cuts or more serious abrasions to the upper limb (definition as [iii] above); (ix) cuts or abrasions on the head, other than the snout. Veterinarians also recorded each badger's age (adult or cub), sex, and whether the carcass was contaminated with mud (which might obscure trap-related injuries).

To provide a quantitative assessment of injury, we adopted a trauma scale given in ISO 10990-5 (1999). This scale scored claw loss as 2 points, each minor abrasion as 2 points, cuts and more serious abrasions as 5 points, and tooth breakage as 30 points. Jaw damage was not included in the ISO 10990-5 scale; we assigned this injury a score of 50 points. The severity of injury was then assessed as the sum of scores for all injuries received. While this scoring system was somewhat arbitrary, it provided an approximate ordinal index of trauma. Because the distribution of scores was highly skewed, these data were necessarily analysed using nonparametric techniques, as would be appropriate for ordinal data.

To permit multivariate analysis, we grouped injuries as 'minor abrasions' ([i], [ii] or [vii] above), 'cuts or serious abrasions' ([iii], [iv], [viii] or [ix] above), and 'injury to the teeth or jaw' ([v] and [vi] above), and classified badgers according to whether or not they showed each category of injury. To permit comparison of data gathered before and after 2001 (when necropsy protocols expanded), for some analyses we classified badgers caught in 2002–2003 as 'injured' according to the criteria used in 2000 (ie if a badger only showed evidence of injuries that would not have been recorded in 2000, it was classified as 'uninjured' for the purposes of some analyses).

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Table 1 Trap-related injuries recorded in 5964 badgers (including 4985 'clean' badgers not contaminated with mud) culled between May 2000 and August 2003. Data given for 2000–2003 (the entire study period) omit those injuries not recorded in 2000 (ie cuts and abrasions on the upper limb and head [other than snout]). 2002–2003-only data include all types of injury. Sub-totals are given in italics.

	Number (%) injured 2000–2003		Number (%) injured 2002–2003 only	
Type of injury	**Total**	**Clean only**	**Total**	**Clean only**
Total without injury	*5054 (88.8%)*	*4407 (88.4%)*	*3338 (89.0%)*	*2912 (88.6%)*
Abrasion of snout only	200 (3.5%)	181 (3.6%)	89 (2.4%)	83 (2.5%)
Abrasion of limbs only	213 (3.7%)	200 (4.0%)	139 (3.7%)	134 (4.1%)
Abrasion of snout and limbs	48 (0.8%)	46 (0.9%)	21 (0.6%)	21 (0.6%)
Total with skin abrasion only	*461 (8.1%)*	*427 (8.6%)*	*249 (6.6%)*	*238 (7.2%)*
Cuts on limb only	13 (0.2%)	13 (0.3%)	15 (0.4%)	14 (0.4%)
Damage to claws only	49 (0.9%)	40 (0.8%)	43 (1.1%)	34 (1.0%)
Cuts on head only	–	–	17 (0.5%)	16 (0.5%)
Cuts on limb with damage to claw	1 (0.02%)	0 (0%)	0 (0%)	0 (0%)
Total with cuts only	*63 (1.1%)*	*43 (0.9%)*	*75 (2.0%)*	*64 (1.9%)*
Cuts on limb with abrasion of snout	3 (0.05%)	3 (0.06%)	2 (0.05%)	2 (0.06%)
Cuts on limb with abrasion of limb	2 (0.04%)	2 (0.04%)	2 (0.05%)	2 (0.06%)
Damage to claw with abrasion of snout	3 (0.05%)	2 (0.04%)	2 (0.05%)	1 (0.03%)
Damage to claw with abrasion of limbs	4 (0.07%)	4 (0.08%)	1 (0.03%)	1 (0.03%)
Cuts on head and abrasion of snout	–	–	4 (0.1%)	3 (0.09%)
Cuts on head and abrasion of limb	–	–	1 (0.03%)	1 (0.03%)
Cuts on limb with abrasion of snout and limbs	1 (0.02%)	1 (0.02%)	0 (0%)	0 (0%)
Damage to claw with abrasion of snout and limbs	1 (0.02%)	1 (0.02%)	0 (0%)	0 (0%)
Cuts on head and abrasion of snout and limb	–	–	1 (0.03%)	1 (0.03%)
Total with cuts and abrasions	*14 (0.2%)*	*13 (0.3%)*	*13 (0.3%)*	*11 (0.3%)*
Damage to teeth only	68 (1.2%)	56 (1.1%)	50 (1.3%)	40 (1.2%
Damage to teeth and jaw only	13 (0.2%)	10 (0.2%)	9 (0.2%)	8 (0.2%)
Damage to teeth with abrasion of snout	4 (0.07%)	4 (0.08%)	1 (0.03%)	1 (0.03%)
Damage to teeth with abrasion of limb	6 (0.1%)	6 (0.1%)	6 (0.2%)	6 (0.2%)
Damage to jaw with abrasion of snout	2 (0.04%)	2 (0.04%)	1 (0.03%)	1 (0.03%)
Damage to teeth with cuts on limb	1 (0.02%)	1 (0.02%)	1 (0.03%)	1 (0.03%)
Damage to teeth and claws	8 (0.1%)	6 (0.1%)	7 (0.2%)	6 (0.2%)
Damage to teeth and claws and cuts on limb	0 (0%)	0 (0%)	1 (0.03%)	0 (0%)
Total with tooth breakage or jaw damage	*102 (1.8%)*	*85 (1.7%)*	*76 (2.0%)*	*63 (1.9%)*
Total injured	**640 (11.2%)**	**578 (11.6%)**	**413 (11.0%)**	**376 (11.4%)**

We compared the probability that badgers showed signs of injury with their age, sex, time of despatch, season of capture (summer: May–August; autumn: September–October; winter: November–January) and trap type (before modification of trap design; after trap coating but before door modification; after both trap coating and door modification). The timing of trap modifications meant that not all combinations of trap design and season were available for analysis. In particular, summer was the only season in which data were available for all three trap designs, and 2000 was the only year in which data were available for all seasons with a consistent trap design. This was because in 2002 the door was modified prior to the winter season, and in 2003 data were only available for summer at the time of analysis. Hence, analyses were repeated considering summer only, and 2000 only, to further investigate the effects of trap design and season, respectively. These data were analysed by logistic regression, using a backward elimination procedure in Egret statistical software (Cytel 2003). This procedure initially includes all possible predictor variables, then sequentially drops from the model those variables that make the smallest contribution to model fit, until the model contains only those predictors that are significantly associated with the outcome variable. The test statistics and odds ratios that we report for logistic regressions are all adjusted for other significant predictors. We caution, however, that as sample sizes were very large, our analyses were sensitive to small differences in the incidence of injury, some of which might have little biological meaning.

Results

Injuries sustained

Of 5964 badgers examined, 5280 (88.5%) had no detectable injuries by the criteria operating at the time. The most common injuries were minor abrasions of the limbs (recorded in 4.6% of badgers; Table 1) and snout (recorded

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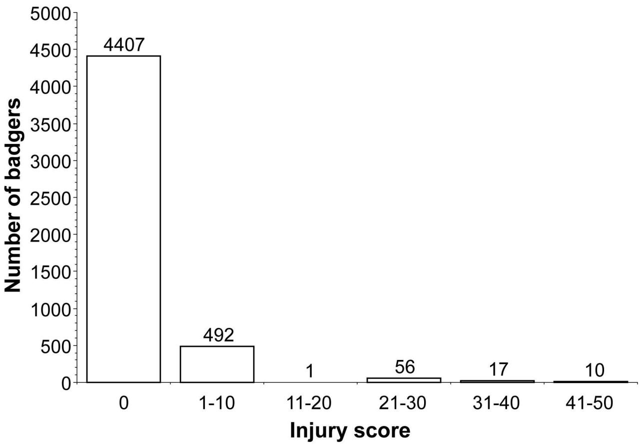
Figure 1



Frequency distribution of injury scores recorded from 4985 clean badgers culled in the course of the trial, based on a trauma scale modified from ISO 10990-5 (1999). Most badgers experienced no injuries.

in 4.4% of badgers). More serious injuries to the teeth or jaw occurred in 102 badgers (1.8% of total).

Sixteen percent (n = 979) of 5964 badgers were recorded as being muddy at post mortem. Injuries were found less often on muddy badgers (χ^2 = 23.1; *df* = 1; *P* < 0.0001; muddy badgers 6.3% [n = 979], clean badgers 11.6% [n = 4985]). This occurred because minor abrasions were recorded less often on muddy badgers (χ^2 = 32.2; *df* = 1; *P* < 0.0001; muddy badgers 3.6% [n = 979], clean badgers 9.1% [n = 4985]). There was no significant difference between muddy and clean badgers in the incidence of cuts and more serious abrasions (χ^2 = 0.03, *df* = 1, *P* = 0.86; muddy badgers 1.3% [n = 979], clean badgers 1.5% [n = 4985]) or tooth or jaw damage (χ^2 = 0, *df* = 1, *P* = 1; muddy badgers 1.7% [n = 979], clean badgers 1.7% [n = 4985]). Badgers were most likely to be muddy when captured in winter (χ^2 = 879, *df* = 2, *P* < 0.0001; summer, 6.7% [n = 3493], autumn, 28.6% [n = 1019], winter, 31.1% [n = 1452]). One explanation for these findings is that minor skin abrasions may have been more difficult to detect on badgers that were muddy. To avoid under-estimating the true numbers of injured animals, analyses of minor skin abrasions include only the 4985 clean badgers subjected to post mortem examination. The frequency distribution of injury scores is shown in Figure 1.

Variation in the probability of experiencing minor abrasions

The multiple logistic regression analysis (which excluded muddy badgers) showed significant effects of trap type (Wald statistic = 53.1; *df* = 2; *P* < 0.001), badger age (Wald statistic = 23.9; *df* = 1; *P* < 0.001), and season of capture (Wald statistic = 22.1; *df* = 2; *P* < 0.001). Neither badgers' sex nor their time of despatch (whether expressed as minutes from midnight, or before/after noon) was significantly associated with the probability of receiving minor abrasions.

As expected, badgers were significantly less likely to experience minor abrasions after traps were modified in an attempt to reduce injury (Table 2; before any trap modification, 12.8% [n = 1691]; after coating of traps to give a smoother surface but before door modification, 8.1% [n = 1682]; after coating of traps and door modification, 6.0% [n = 1606]). Cubs were less likely than adults to experience minor abrasions (Table 2; cubs, 5.3% [n = 1088]; adults 10.1% [n = 3881]). Minor abrasions occurred less frequently in winter (Table 2; 6.5%, n = 997) than in summer (9.2%, n = 3247) or autumn (11.7%, n = 725). The effects of age and trap type were similar when only data from the summer season were considered. Likewise, the effects of age and season were similar when only data from 2000 were considered.

Variation in the probability of experiencing cuts or more serious abrasions

The logistic regression analysis showed significant effects of trap type (Wald statistic = 11.09; *df* = 2; *P* = 0.004) and season of capture (Wald statistic = 6.39; *df* = 2; *P* = 0.041). Badgers' age, sex and time of despatch were not significantly associated with the probability of receiving cuts or serious abrasions.

Surprisingly, modification of traps to provide a smoother surface appeared to be associated with an increase in the proportion of badgers experiencing cuts or more serious abrasions (Table 2; before trap modification, 0.7% [n = 2213]; after coating of traps to give a smoother surface but before door modification, 1.9% [n = 1872]; after door modification, 1.8% [n = 1879]). Like minor abrasions, cuts and more serious abrasions occurred most often on badgers captured in autumn (Table 2; 2.3%, n = 1019), with lower injury rates in summer (1.1%, n = 3493) and winter (1.6%, n = 1452). However, there was no significant effect of trap type when only data from the summer season were considered (Wald statistic = 0.89; *df* = 2; *P* = 0.65), and the odds ratios were somewhat different (before trap modification, 1 [reference]; after trap coating but before door modification, 1.25; after door modification, 0.86; cf Table 2). Likewise, there was no significant effect of season when only data from 2000 were considered (Wald statistic = 0.87; *df* = 2; *P* = 0.64), and the odds ratios were different (summer, 1 [reference]; autumn, 0.70; winter, 0.14; cf Table 2).

Variation in the probability of experiencing damage to the teeth or jaw

The logistic regression analyses showed significant effects of trap type (Wald statistic = 24.6; *df* = 2; *P* < 0.001) and badger age (Wald statistic = 5.3; *df* = 1; *P* = 0.021). Sex, season and time of despatch were not significantly associated with the probability of acquiring tooth damage.

Curiously, like cuts and serious abrasions, tooth damage occurred more frequently after modification of traps intended to provide a smoother surface (Table 2; before trap modification, 1.2% [n = 2213]; after coating of traps but before door modification, 2.9% [n = 1872]). However, the incidence of tooth damage dropped again (to 1.1%,

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Table 2 Significant predictors of trap-related injuries of badgers, and their associated odds ratios, estimated by multiple logistic regression. * Note that these patterns of cuts and more serious abrasions were not upheld by analyses considering only summer (to investigate independent effects of trap type) or only the 2000 trapping year (to investigate independent effects of season).

Injury type	Predictor variable	Class	Odds ratio
Minor abrasions	Age	cub	1 (reference)
		adult	2.06
	Trap type	before modification	1 (reference)
		after coating, before door modification	0.45
		after door modification	0.47
	Season	summer	1 (reference)
		autumn	1.64
		winter	0.61
Cuts or more serious abrasions	Trap type*	before modification	1 (reference)
		after coating, before door modification	2.50
		after door modification	2.58
	Season*	summer	1 (reference)
		autumn	1.91
		winter	1.56
Tooth or jaw damage	Age	cub	1 (reference)
		adult	2.0
	Trap type	before modification	1 (reference)
		after coating, before door modification	2.65
		after door modification	0.95

n = 1879) after traps were modified to limit biting of the doors. Like other types of injury, damage to the teeth or jaw occurred more often in adult badgers (Table 2; 1.9%, n = 4734) than in cubs (1.1%, n = 1230). These effects of age and trap type were similar when only data from the summer season were considered. The effect of age became non-significant when only data from 2000 were considered (Wald statistic = 13.1; $df = 1$; $P = 0.09$), although the odds ratios suggested a similar pattern (cubs, 1 [reference]; adults, 5.5).

Variation in the overall severity of injuries

Univariate nonparametric analyses of injury scores (including only clean badgers with some evidence of injury) provided no evidence to suggest that the severity of injuries was related to badgers' age (Mann-Whitney $U = 20163$, $P = 0.48$) or sex ($U = 42292$, $P = 0.62$), or to time of despatch (whether measured as minutes from midnight [$r_s = -0.015$, $P = 0.71$] or before/after the noon deadline [$U = 6783$, $P = 0.85$]), or to trap type ($H_{133,202,242} = 4.76$, $P = 0.092$) or to season ($H_{90,113,374} = 0.43$, $P = 0.81$).

Discussion

Most badgers (88% of clean badgers) received no detectable injuries as a result of being confined in the trap. Of those that were injured, most (74% of injured clean badgers) received only minor skin abrasions. A minority (1.8% of all badgers) experienced tooth breakage or jaw damage. The frequency and type of injuries recorded in this study were similar to those reported in a smaller sample of badgers examined by the independent auditor immediately following despatch (19% injured, n = 21; three with limb abrasions, one with snout and limb abrasions; Kirkwood 2000). The results presented here represent a baseline against which alternative trapping methods (eg body snares) might be compared in future.

This study investigated only one aspect of badgers' welfare during trapping operations: patterns of trap-related injury. This ignores other potential welfare costs of cage trapping, particularly stress (eg Broom & Johnson 1993). Detailed studies of animals' behavioural and physiological responses to restraint in cage traps (as measured, for example, in White *et al* 1991) could not readily be carried out in the course of the trial itself, but DEFRA has funded independent research on this issue. It is worth noting that restraint in cage traps might be expected to trigger a strong aversion to entering traps if it induces very serious suffering (ISO 10990-5 1999). No such strong aversive response appears to occur: in longitudinal studies of badgers, recapture rates are typically high (Tuyttens *et al* 1999).

It is clear that at least some badgers attempt to escape from traps during the night: many reach through the bars of the cage and dig (so that a trench a few centimetres deep is found around the outside of the cage) or draw vegetation into the cage. However, badgers have usually ceased this activity by morning and the majority are inactive when field staff approach the traps. It is probably for this reason that badgers despatched later in the day are no more likely to show evidence of trap-related injury. Note that it is this digging behaviour that also introduces mud into cage traps.

Abrasions to the limbs and snout probably occur as a result of rubbing against the cage mesh during this period of activity. The traps used by DEFRA staff in 2000 were rusty, creating an abrasive surface likely to increase the probability of trapped badgers acquiring skin abrasions. In an

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attempt to reduce the frequency of such abrasions, all traps were treated during 2001 to coat the mesh with a smooth surface. While this successfully reduced the number of minor abrasions, it was also associated with an increase in the incidence of tooth damage, and might have been associated with an increase in cuts and more serious abrasions. This seems to be a consequence of the process of coating the wire mesh: the doors were wired open while the traps were dipped in molten polymer or powder coated with resin, and in some cases pieces of the wire became embedded in the coating and could not easily be removed. This problem is now being addressed.

Injuries to the teeth and jaws occur partly because the 50 × 50 mm mesh used to construct traps is large enough to allow badgers' muzzles to fit between the bars and to bite upon them. This might be prevented by using a smaller mesh size. However, the mesh needs to be sufficiently large to allow penetration and manoeuvrability of the barrel of the firearm used to despatch badgers. Failure to position the firearm correctly risks a misplaced shot (causing very serious suffering to the badger) as well as ricochet of the bullet from the bars of the cage. Hence, we currently consider the use of a smaller mesh to be unworkable. While all injuries to the teeth must cause suffering and are to be avoided where possible, it is worth mentioning that the rate of tooth breakage was low relative to that seen in some other carnivore species. Tooth breakages were recorded in 39% of 18 leopards (*Panthera pardus*) cage trapped in Kenya (Frank *et al* 2003).

A proportion of badgers were very muddy when despatched. In addition to concealing trap-related injury, this mud could itself raise welfare concerns since it presumably reduced the insulation provided by badgers' fur and could have led to hypothermia. Mud was a particular problem on two initial proactive culls carried out in late 2000, when 72% (of 162) and 74% (of 411) of badgers were found to be muddy at post mortem. While field staff make every effort to place traps in sheltered locations, some contamination with mud is inevitable if trapping takes place in poor weather and in agricultural habitats. Badgers have been released when severe weather limited field staff's ability to despatch them humanely (Ewbank 2003).

Minor abrasions were least common in winter. This might be because badgers are naturally less active at this time of year (Fowler & Racey 1988). While the overall incidence of abrasions might be reduced by increasing the proportion of trapping carried out in winter, this would have other welfare costs associated with poor weather (see above). Moreover, winter is the least efficient time of year to trap (Tuyttens *et al* 1999).

The period of time that badgers spend in the trap — and, hence, the opportunity for them to injure themselves — might be reduced by checking traps during the night. However, this might not lead to a net improvement in welfare: badgers' inactivity in the morning makes it easier for field staff to despatch them with a single well-placed shot. Being naturally nocturnal, badgers are much more active at night. This makes handling and chemical immobilisation more difficult at night (R Woodroffe, personal observation). Attempting humane despatch at night, with badgers that are active, might well increase the number of misplaced shots, leading to much more severe suffering of badgers. In addition, checking traps and using firearms at night would have health and safety implications for field staff, particularly where operations are disrupted by protestors.

To conclude, confining badgers to cage traps prior to despatch inevitably has implications for their welfare. However, the incidence of injuries is low and the great majority of these are minor. Because neither the incidence nor the severity of injuries was related to the time at which badgers were despatched, we conclude that current procedures for checking traps are adequate. Modification of traps has successfully reduced the incidence of skin abrasions. Further modifications of trap design may be needed to reduce the incidence of less common but more serious injuries (eg cuts, tooth damage). However, all aspects of the conduct of trapping operations must balance badger welfare with concerns for the health and safety of field staff.

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