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Assessing the safety of collars used to attach predation deterrent devices and ID tags to pet cats

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Running title: Safety of cat collars
Abstract

Collar-worn deterrents reduce predation by cats while collar-mounted ID enhances return of lost animals. A perception that collars are hazardous limits adoption. We defined cases as ‘collar incidents’ (cat snagged its collar or caught a paw), ‘collar injuries’ (veterinary treatment needed for a collar incident), and ‘collar deaths’ (cat died), before integrating data from veterinarians, owners from the general public and owners from a welfare society. Despite biases associated with components independently, together they indicated that collar injuries or deaths are rare.

One hundred and seven veterinarians interviewed recalled one collar injury/2.3 years. At one practice over three years only 0.33% of 4460 cat cases were collar injuries, while 180 cat cases at four clinics during August and November 2011 included none. The 63 owners from the general public reported only one collar injury and no deaths in a lifetime of ownership, although 27% experienced collar incidents. In contrast, 22% reported cats needing treatment following road accidents, 53% reported cats needing treatment for fighting injuries and 62% had owned cats killed on the road. Most (62%) of the 55 respondents from the cat welfare society had experienced a collar incident, but only two cats needed treatment. One died. In contrast, 31% and 58% reported cats needing treatment for road accidents and fighting respectively, and 41% had owned cats killed on the road. Fighting and road accidents are greater hazards to roaming cats than collars, which offer the compensatory benefits of mounting predation deterrents and ID tags.

Keywords: animal welfare, cat collar, *Felis catus*, pet cats, urban wildlife, wildlife protection
Introduction

Interventions to conserve wildlife sometimes require adjustments to the husbandry of domestic animals (Vanak & Gompper 2009; Silva-Rodriquez & Sieving 2011; Wierzbowska et al 2011). These involve special sensitivities, because the changes are often relevant to people’s livelihoods in the case of farm animals (Hemson et al 2009; Jones et al 2011; Marchini & MacDonald 2012), their bonds of affection to domestic pets, or to their animals’ welfare (Calver et al 2011).

Pet cats Felis catus (Mammalia: Felidae) are a case in point. They are valued companion animals around the world, where they are maintained at high population densities that sometimes exceed 100/km² (Liberg et al 2000; Sims et al 2008). According to Baker et al’s (2010) definition, they live in close association with a household but wander largely at will, as distinct from housebound cats that are confined indoors, semi-feral cats that are partially provisioned, and feral cats whose self-sustaining populations have no direct reliance on humans. Many pet cats are occasional or frequent hunters at some time in their lives (Churcher & Lawton 1987; Barratt 1998; Gillies & Clout 2003; Lepczyk et al 2004; van Heezik et al 2010; Tschanz et al 2011). Rough estimates of their impact based on extrapolations from mortalities in local studies suggest that they kill up to 29.2 million birds and 57.4 million mammals annually in the UK (Woods et al 2003) and 100 million birds (Erickson et al 2005) and ‘more than a billion small mammals’ (American Bird Conservancy 2011) annually in the USA. There is debate over the reliability of these estimates, and whether this mortality is additive to other effects or if cats simply take prey that would have died of other causes (Patronek 1998; Kays & DeWan 2004; Beckerman et al 2007; Baker et al 2008). Nevertheless, enough owners are concerned
about the wildlife welfare issue caused by predatory cats to make the sale of collar-worn predation deterrents economically viable, while some local governments insist that cats in their jurisdiction wear a predation deterrent (Lilith et al 2010).

Predation deterrents available include bells, electronic warning devices, a neoprene ‘pounce protector’ that either visually warns prey or impedes the paws when pouncing, and brightly coloured warning material ringing a collar. Experiments show that bells reduce prey captures by 34 – 61% (Ruxton et al 2002; Woods et al 2003; Nelson et al 2005; Gordon et al 2010) electronic warning devices that chime by 38 – 51% (Nelson et al 2005) and pounce protectors by 44 – 67% (Calver et al 2007). Calver and Thomas (2011) found that another form of electronic device that sounded an alarm and flashed a light was effective, but Gillies and Cutler (2001) did not. Brightly coloured warning collars have not, to our knowledge, been tested.

One drawback to the wider use of collar-mounted predation deterrents is a perception that cats wearing collars risk significant injury from snagging on objects or catching paws or teeth in the collar (Lord et al 2010). This view may also reduce the use of collar-worn ID tags that facilitate the return of lost animals (Lord et al 2010). Anecdotal reports of injuries abound online (eg Bruce 2009; Catton 2010; The Sure Flap Blog 2011) and clinical studies suggest that such injuries are difficult to treat successfully (Lascelles et al 1998; Lascelles and White 2001; Brinkley 2007). However, when Lord et al (2010) followed 478 owned, collared cats over six months, only 18 (3.3%) of them snagged a body part in their collar or caught the collar against an object. No cat required veterinary treatment or died as a result. Similarly, in reporting on surgical techniques for treating collar wounds, Brinkley (2007, p.111) called collar injuries ‘…an infrequent but regular
presentation in companion animal practice. For example, at three PDSA hospitals in the north-east of England, 26 confirmed cases were seen out of a total feline caseload of 15,000 in the four years between October 2001 and October 2005. This suggests that problems may be exaggerated and that more detailed study of their incidence is warranted. A logical first step is to determine the risk associated with collars, after which the risks of collars plus predation deterrents can be investigated. It would also be valuable for reassuring owners uncertain whether or not to fit their cats with collar-mounted ID tags.

This study assessed the incidence of mishaps involving cat collars and perceptions of the safety of different collar designs in an Australian suburban context, using an integrated data analysis approach based on the experiences of veterinarians, a cross-section of owners from the wider community and owners who were members of a cat welfare society. We also collected data from the same sources on the incidence of fighting injuries and road accident trauma to place the collar data in the context of other hazards to free-roaming cats in suburbia. Although each component has its own potential biases, by integrating them in one comprehensive study we could reach an overall judgement on the hazards associated with wearing collars so that cat owners could make informed decisions on fitting collar-mounted predation deterrents or ID tags.

Materials and methods

We defined all cases in which a cat snagged its collar on an object or caught a body part in its collar as a ‘collar incident’. If the cat was neither injured nor killed, we called the collar incident ‘minor’. If a cat required veterinary treatment because of a collar incident,
we described this as a ‘collar injury’ and if a cat died from a collar incident we called this a ‘collar death’.

It is plausible that veterinarians and different groups of owners may have varying experiences of these categories. For example, veterinarians would not see cats killed outright in a collar incident, although owners often would (see Kolata et al. 1974 for a discussion of this as a general principle in trauma cases). Owners might also vary in their experience of collar incidents depending on the level of care they give their cats, with those owners who inspect the fit of the collars frequently experiencing fewer problems. Accordingly, we collected data from veterinarians and sampled cat owners from the general community as well as those from a cat welfare society.

*Interviews with veterinarians and veterinary practice records*

We interviewed 107 veterinarians in general practice, predominantly specialising in small animals, at the Pan-Pacific Veterinary Conference in Brisbane, Australia, in May 2010. They came mainly from Australia and New Zealand. Veterinarians were approached during social breaks in the conference program and asked how many years they had practised, how many collar injuries or deaths they recalled over that time and if there were any comments about collar injuries or deaths they wished to make. These interviews were short, so we did not ask further questions about fighting injuries or road accidents.

As a check against possible recall bias in these interviews or the non-representativeness of the sample, we also examined practice records. We were granted access to records of
cats treated at a large practice that treated first opinion, specialist referral and 24-hour emergency cases in Perth, Western Australia, between 2007 and 2009. It was not always possible to determine the exact cause for which the animal was presented because the cases were mostly classified by the nature of the injury, but we did note where a collar was implicated. Identifying fighting trauma and road accident injuries was not as clear, so we did not attempt it. In addition, veterinarians from four practices across the metropolitan area in Perth, Western Australia, agreed to note the cause of consultation for all cats presented during the first weeks of August and November 2011 (southern hemisphere late winter and spring) when many cats are active outdoors. These records covered collar injuries, fighting trauma and road accident trauma. Given that the informants were veterinary professionals, we did not provide direction on discriminating different types of injury. In none of the cases from the large practice nor the four practices across the metropolitan area did we ask whether or not cats were neutered, given that the neutering rates for pet cats in Australia exceed 90% (Calver et al 2011 and references cited therein).

Surveys of the general public

We followed the protocol of Adams and Clark (1989) and interviewed cat owners approached in a large public park in Perth, Western Australia, in December 2010. We asked interviewees about how many cats they had ever owned and whether any cat they owned had ever experienced a collar incident, a collar injury or a collar death; a road traffic injury or death; or a fighting injury needing veterinary attention. We also showed interviewees actual examples of four different types of cat collar (Figure 1) and asked them if each type of collar was safe or unsafe for a cat to wear, or if they were unsure.
Lastly, we asked them if they had fitted collars to their current cats and, if so, if the collar was similar to one of the types illustrated.

Fig. 1 here.

Surveys of members of the Cat Welfare Society of Western Australia

The Cat Welfare Society of Western Australia (CWS) (http://www.cathaven.com.au/) is a not for profit society based in Perth, Western Australia, with 1002 registered members. In August 2011 we contacted members via the society newsletter, inviting them to complete an online survey offered through SurveyMonkey (http://www.surveymonkey.com/). The survey asked similar questions to those used in the interviews with the general public, substituting the line drawings in Figure 1 for showing actual collars.

Statistical analyses

Results were analysed using chi-squared tests, t-tests and comparisons of proportions using the relevant routines in VassarStats (http://vassarstats.net). Tests for assumptions such as equality of variances for t-tests were carried out in VassarStats prior to analysis and no data transformations were required. The significance values for all tests were set at 5% unless multiple dependent tests were used, when the significance values were adjusted using the sequential Bonferroni technique (Holm 1979). Where applicable, this is indicated in the results.
Results

Interviews with veterinarians and practice records

Eighty-five (79.4%) of the 107 veterinarians with a total of 1588 years of practice interviewed at the Pan-Pacific Veterinary Conference in 2010 had seen at least one collar injury. They recalled seeing 686 collar injuries overall, or approximately one every 2.3 years of practice. Most cases involved an axillary injury when a forelimb was passed through the collar, although one veterinarian reported seeing dental injuries (presumably from chewing the collar) and another a hanging incident when a cat was tree-climbing. Two cases were attributed to the collar being fixed too loosely and one to the collar being fitted too tightly. In 66 cases the veterinarians recalled the type of collar involved. Twenty-eight were flea collars, 26 were elasticised stretch collars and 12 were collars with a fixed buckle (no stretch band and no break-away clip). Several veterinarians believed that the incidence of collar injuries was declining because of the reduced popularity of flea collars. Only one veterinarian (less than 1% of the group) reported a cat that died from collar injuries.

The most extensive veterinary practice data came from the large practice that treated first opinion, specialist referral and 24-hour emergency cases. Over the three years 2007 to 2009, 4460 individual cats were treated. Fifteen cats had collar injuries (0.34% of all cat cases, 95% confidence limits 0.21% - 0.56%). Five of these were believed to be strays because they had no ID (tag or microchip) and the person presenting them was not the owner (0.11% of all cat cases). Records of 162 cat cases at four veterinary clinics during August and November 2011 (southern hemisphere late winter/early spring when cats are
often active outside) included no collar injuries, nine fighting injuries (5.5%) and no motor vehicle accidents.

*Interviews with the general public*

Sixty-five (21.7%) of the 300 people approached between January and March, 2011 were cat owners, a little less than the 25 – 33% of the Australians believed to own a cat (Grayson et al 2002 and Lilith et al 2006 and references cited therein). Sixty-three agreed to be interviewed. They had owned a lifetime total of 253 cats, or approximately four per owner. Thirty-three owners (53%) had fitted collars to their current one or more cats. The most common type was a simple buckle fitting without any stretch safety insert or break-away clip (Table 1). The most common reason (43%) for not fitting a collar was that the cat was microchipped and therefore did not need a collar (Table 2). The owners did not believe that all collars were equally safe ($\chi^2_6 = 23.89$, $p = 0.0005$) (Table 3).

Although between 32% and 43% of owners were unsure about the safety of the different types of collar, those who were confident to make a judgement rated the break-away collar with the stretch insert as the safest, followed by the break-away collar.

Table 1 here
Table 2 here
Table 3 here

Collar incidents were reported by 27% of owners (Table 4) and involved 20 cats (Table 5). However, only two cats belonging to different owners suffered collar injuries and no owners reported a collar death. In comparison, 22% of owners reported cats needing
veterinary treatment for road accident trauma (14 cats), 53% reported cats needing veterinary treatment for fighting injuries (48 cats) and 62% had owned cats killed on the road (39 cats) (Tables 4 and 5). The proportion of owners with experience of collar incidents was similar to the proportion whose cats needed veterinary treatment for road accident injuries, but less than the proportion of owners whose cats had received veterinary treatment for fighting injuries and the proportion of owners who had lost a cat in a road accident (Table 6).

Survey of Cat Welfare Society of Western Australia members

Fifty-one of the 1002 CWS members completed the survey online and a further four by hard copy, giving an overall response rate of 5%. This small sample is highly likely to be biased, which we consider in the discussion. Not all respondents answered every question, so the percentages given in the description below are based on the number of respondents answering specific questions.

The respondents had owned a life-time average of 6.4 cats. Twenty-six (53%) of the 49 owners who answered the question about whether or not their cats wore a collar had fitted collars to their current cats. Twenty respondents (41%) had not fitted a collar to their current cats and 3 (6%) did not own a cat at present. The most common collar used incorporated a break-away clip (Table 1). No one reason predominated for why some
CWS members did not fit collars to their current cats (Table 2). CWS members were emphatic that the buckle only collar was unsafe and regarded the collars with a break-away buckle or a break-way buckle and a stretch insert as safest (Table 3).

Sixty-two percent of CWS members reported a collar incident (Table 4), involving 85 cats (Table 5). Two CWS members (4%) reported collar injuries (four cats involved) and one member (2%) reported a single collar death. By contrast, 31% of CWS members reported cats needing veterinary treatment for road accident trauma (18 cats), 58% reported cats needing veterinary treatment for fighting injuries (74 cats) and 41% had owned cats killed on the road (31 cats) (Tables 4 and 5). The proportion of CWS members with experience of collar incidents was significantly higher than the proportion whose cats needed veterinary treatment for road accident injuries, but no different to the proportion of members whose cats had received veterinary treatment for fighting injuries and the proportion of members who had lost a cat in a road accident (Table 6).

In addition to the information on the cats they had owned, three respondents with experience working in animal shelters volunteered information on experiences with lost cats admitted to animal shelters. One recalled seeing 5 or 6 collar injuries in 2.5 years of part-time work in a shelter, suggesting a higher frequency of injuries than those seen by veterinarians in general practice. All cases involved extensive forelimb injuries. Two other respondents had seen ‘numerous’ collar injuries in animal shelters, mainly involving forelimbs caught in collars. One observed that problems arose most commonly from collars that were too loose and less often from ones that were too tight. She noted that collars made from stretch elastic were hazardous when the elastic began to fail and sagged, increasing the chance of a cat catching its paw.
Comparison of responses from the general public and CWS members

CWS members had owned a significantly greater life-time average of cats (6.4) than respondents from the general public (4) ($t_{111} = 3.26$, $p = 0.0015$). The proportion of owners in each category who had fitted a collar to their cats was similar ($z = -0.072$, $p = 0.94$). Aggregating the data into categories of ‘Standard collar’ and ‘Safety collar’ and excluding the categories ‘other type of collar’ and ‘can’t recall’, CWS members were more likely to use a safety collar than members of the general public ($\chi^2_3 = 20.14$, $p = 0.0002$) (Table 1).

CWS members’ judgements about the relative safety of collars differed significantly from that of the general public in a three-way contingency table analysis (three-way interaction, $G^2_{17} = 146.12$, $p < 0.0001$) (Table 3). Although both groups rated the break-away collar incorporating the stretch insert as the safest, CWS members were much more emphatic that the buckle only collar was unsafe. They were also more confident overall in rating particular collars as safe or unsafe. Significantly more CWS members reported a collar incident than owners in the general community (Table 4). The proportions of owners whose cats had experienced road traffic trauma or fighting injuries were similar to those reported by the general public (Table 4).

Discussion

Overall incidence of collar incidents, injuries and deaths relative to road accident trauma and fighting injuries
Collar incidents were common, but collar injuries or deaths were much rarer. Twenty-seven percent of owners from the general community and 62% of owners from the CWS experienced at least one, but only 3% and 6% respectively sought veterinary care for a collar injury and only one owner from the CWS reported a fatality. The higher frequency of incidents, injuries and death reported by CWS members may result from a biased sample (only 5% of those invited returned a survey), with owners who had a bad experience being more likely to complete the online survey. In contrast, 63 of the 65 owners (97%) from the general public sample agreed to be interviewed.

The low instance of collar injuries and collar deaths contrasts with the 62% of owners from the general community and 41% from the CWS who had owned cats killed on the road, or the 53% and 58% respectively who had owned cats needing veterinary treatment for fighting injuries. Even if the CWS sample was biased toward owners with poor experiences with collars, collars were still well beneath fighting and road accidents as causes of trauma. Given that only 53% of owners from both the general community and the CWS had fitted collars to their current cats, it is reasonable to expect a higher incidence of road accident trauma and fighting injuries relative to collar injuries and deaths, because the sample of cats wearing collars is more restricted. However, even doubling the incidence of collar injuries to 6% for the general public and 12% for CWS members as a correction still leaves these figures well beneath those for road accident and fighting trauma.

The veterinarians in general practice corroborated the evidence from owners. Although 79.4% had seen at least one collar injury, the number of injuries was low and there was
only one collar death (although we could not confirm the incidence of cats wearing collars in the population from which the cases came). Practice records were the only component of our data not subject to recall bias. There were only 0.33% collar injuries in one large practice over three years and no collar injuries at four clinics during August and November 2011, although these clinics did record a 5.5% incidence of fighting injuries. (Again, we could not confirm the incidence of cats wearing collars in the population from which the cases came, but we assume it was similar to the 53% recorded in each of our owner surveys). While the long-term data from the largest practice may be underestimates because the cause of injury was not always noted, even if increased 10-fold they still indicate a low incidence of collar injuries. Our approach in collecting these data from practice records is a common one in relation to attributing trauma to different causes in companion animals (e.g. Kolata et al 1974; Kolata 1980) and is, we believe, appropriate.

Three respondents’ observations on animals admitted to shelters suggests a higher incidence of collar injuries there, possibly because stray or lost cats lose weight and are more likely to snag an ill-fitting collar. In the case of 10 cats presented with axillary injuries (at least eight caused by collars) in Cambridge, UK, Lascelles et al (1998, p. 477) noted that: ‘All the cats presented with a history of absence from home for a period of several weeks, with the wound discovered on return.’ Similarly, Brinkley (2007, p.111) observed that ‘…the usual presentation is that of an active cat that has been missing from home for a period of time, often several weeks or months. The cat may return home with a front leg still trapped in the collar; alternatively, the collar is missing but the cat has a typical, unilateral, indolent, axillary wound.’ These descriptions are consistent with a loss of weight leading to an ill-fitting collar. The importance of fitting
collars correctly to reduce the risk of catching paws is well-known from wildlife
telemetry studies (eg Haramis et al 2011), especially when animals lose weight in the
period immediately after collaring (eg Cypher 1997). Owners who check the fit of their
pet’s collar frequently can avoid this problem.

Low rates of collar injury or death are unlikely to be restricted to Perth or Australia in
general. In their descriptions of treatment of axillary injuries either definitely or likely to
have been caused by collars, Lascelles et al (1998) reported 10 cases referred to their
specialist practice in Cambridge, UK, between May 1992 and March 1997. Lascelles and
White (2001) treated a further 10 cases referred to the same practice between March
1996 and March 1998. We interpret these figures as indicative of a low incidence of
severe collar injuries, although they were referrals and therefore possibly only a subset
of all collar injuries treated by the referring veterinarians. Brinkley (2007) also reported
a low incidence of 0.17% collar injuries from 15000 feline cases in four clinics in north-
eastern England between October 2001 and October 2005. In the United States Lord et
al (2010) reported that 18 (3.3%) of 478 cats involved in a trial of the suitability of cat
collars over a six-month period experienced a minor collar incident, but there were no
collar injuries or collar deaths. Our respondents reported a higher incidence of collar
incidents and collar injuries, but they related to lifetime experiences, not just six months.
Together, we believe that the reports of Lascelles et al (1998), Lascelles and White
(2001), Lord et al (2010) and our data support a conclusion that minor collar incidents
are more common than collar injuries or collar deaths, which are rare.

Furthermore, international studies highlight motor vehicle accidents, not collar injuries,
as a major cause of death or trauma in cats (although we do not know the proportions of
cats in each of the following studies that wore collars). In the case of 4591 Swedish cats registered for life insurance, Egenvall et al (2009) reported no collar deaths specifically. They might have been included in the 3% of cats dying of unspecified trauma, but this is still considerably less than the 9% killed in traffic accidents. Similarly, in Cambrésie, France, Moreau et al (2003) reported that 66 of the 259 cat deaths they investigated were accidental, which they attributed to cats wandering. Twenty-seven (40.9%) of these were road fatalities, 26 (39.5%) were poisoning and 13 (19.6%) were ‘other’. With regard to injury rather than death, when considering all cats insured with one Swedish company between 1999 and 2006 trauma was the most common cause for presenting a cat for veterinary treatment (Egenvall et al 2010). Within the trauma category, ‘bite/cut/wound’ ranked as the most common, with ‘hit by car/train/vehicle’ third. Collars were not mentioned, although possibly they could have contributed to ‘bite/cut/wound’. In a Pennsylvania, USA, emergency veterinary hospital, Kolata et al (1974) found that the most common causes of trauma in 121 cat cases were motor vehicles (16.3%), animal interaction (14.7%), falls (13.9%), crushes (10%) and unknown causes (39.5%). In a later study including 156 cats from a Pennsylvania, USA, clinic and 35 cats from a Georgia, USA, clinic, the most common causes of trauma were motor vehicles (17.9% Pennsylvania and 28.6% Georgia), animal interaction (16.0% Pennsylvania and 22.8% Georgia) and unknown causes (36.5% Pennsylvania and 25.7% Georgia) (Kolata 1980). Collar injuries were not mentioned in either case. Although they might have been included in the large ‘unknown’ category, Kolata (1980) noted that most injuries were caused by ‘external mechanical force’ – in our opinion, not a good description of a collar injury. Childs and Ross (1986) and Rochlitz 2003a,b; 2004) also document motor vehicle accidents as a major cause of mortality and trauma for cats.
None of these studies gives the relative incidence of collar incidents, collar injuries, collar deaths, road traffic trauma and fighting injuries for a group of collar-wearing cats. However, Calver et al (2007) provide such data in a study of 62 collar-wearing cats followed over six weeks in a test of a collar-worn predation deterrent. The cats spent three weeks wearing a collar alone and three weeks wearing the collar and a device. In this short period one collar incident was reported (which led to the owner withdrawing the cat from the study) and 11 cats were injured in fights. Although data were not statistically significant, fewer cats fought or roamed when wearing the predator deterrent. When owners were followed up eight months later, one cat had suffered a collar injury, another had lost a front leg in a road accident, two were poisoned and one had broken both her canines in a fall. Ten cats were reported as fighting. One suffered muscular injuries, two received veterinary treatment for abscesses and one owner self-treated her cat’s abscesses. The minor collar incident and the collar injury give an overall rate of collar incidents of 3.2% over nine months, very close to the 3.3% over six months reported by Lord et al 2010. The incidence of fighting injuries was considerably higher (17.7%), the incidence of general trauma slightly higher (4.8%), and the incidence of road accident trauma was lower (1.6%).

Relative safety of different types of collar

The cases where veterinarians in private practice reported the types of collar causing injuries are only anecdotal evidence, because we have no strong indication of the relative proportions of different types of collars in use, nor do we know when different styles of collar were first released to the market. Nevertheless, all the 66 cases recollected by veterinarians in general practice involved stretch collars, standard collars with neither
stretch inserts nor a break-away clip, or flea collars. Members of the general public and
the CWS rated break-away collars and break-away collars with stretch inserts as safer
than stretch collars or buckle only collars. However, many members of the general
public were unsure about the safety of different collar types and eight of 33 respondents
(24%) could not recall what type of collar their cats wore. We do not regard this as a
strong endorsement of any type of collar, but as indicating a need for reliable
information.

Lord et al. (2010) reported collar incidents in cats followed over six months while
wearing standard buckle collars (three of 176 cats), break-away collars (seven of 178
cats) and all-elastic stretch collars (eight of 169 cats) ($\chi^2 = 2.42, p = 0.30$, not
significant, our calculation). However, they did report that 36.1% of all the collars were
noticeably frayed after six months and that stretch collars (60.0% frayed) were
significantly more likely to deteriorate. Wildlife biologists also report welfare problems
arising from the perishing of elastic in radiotelemetry collars (Fuller et al., 2005), so the
long-term safety of stretch collars is questionable. We concur with Lord et al. (2010) and
Weiss et al. (2011) that owners should check the fit and condition of collars regularly.

**Animal welfare implications**

From a cat welfare perspective, collars are a cheap means of attaching an identification
tag to a cat so lost animals can be returned. Someone finding a lost cat only needs to call
the telephone number on the tag, rather than take the cat to a facility to read a microchip.
Unfortunately, studies of the success of owners finding lost cats or individuals or animal
shelters tracing owners report only low instances of cats with some identification (collar
tag or microchip) (eg 14%, Lord et al 2007a; 5%, Lord et al 2007b; 3% Slater et al 2012 and 5.6% of relinquished cats, Marston and Bennett 2009). In turn, this leads to low success rates of reuniting cats with their owners (eg 53% of cat owners who searched for their animals, Lord et al 2007a; 38% of people who found a lost cat, Lord et al 2007b; 2-5% of cats taken in by animal shelters, Humane Society of the United States, 2011).

These rates are consistently lower than reported for dogs, which are more likely to wear a collar with an ID tag (Lord et al 2007b). As a result, Lord et al (2010), Weiss et al (2011) and Slater et al (2012) endorse using collars with ID tags to improve cat welfare by facilitating the return of lost animals. In some cases, this is now reflected in legislation. For example, the Cat Bill 2011 (Western Australia) requires that ‘The owner of a registered cat must ensure that when the cat is in a public place the cat is wearing its registration tag’.

Collars are also convenient mounts for predation deterrents to reduce attacks by pet cats on wildlife (Ruxton et al 2002; Woods et al 2003; Nelson et al 2005; Calver et al 2007; Calver & Thomas 2011). The infrequent occurrence of collar injuries and collar deaths in this study and in the literature, suggest that owners of free-roaming cats can use collar-mounted deterrents to reduce predation with little risk to their cats providing they check the fit and condition of the collars frequently (Lord et al 2010; Weiss et al 2011). Studies of the efficacy of collar-mounted predation deterrents advise the use of safety collars (eg Nelson et al 2005), although only Calver et al (2007) report on any collar incidents or collar injuries that arose. The rate of 3.2% over nine months was similar to that of 3.3% reported by Lord et al (2010) over six months, suggesting that the predation deterrent did not change the likelihood of a collar incident. With these data to support them, wildlife
biologists and wildlife agencies can promote collar-mounted deterrents where cats are
allowed to roam freely.

Confinement of cats indoors or in enclosed cat runs would eliminate predation, but it is
an unpopular measure with many owners (Grayson et al 2002; Lilith et al 2006; Calver et al 2011). Confinement is generally less than 10% of households owning cats across
Australia (REARK Research 1994 a,b; Perry 1999; Lilith et al 2006) and in the UK
(Sims et al 2008), although higher instances of up to 33% occur in parts of North
America (Dabritz et al 2006). Nevertheless, confinement avoids the significant problems
of fighting and road accident injuries and a case can be made on welfare grounds,
irrespective of any concern for wildlife. There may be health problems such as type 2
diabetes in under-exercised and over-fed housebound cats (Slingerland et al., 2009), but
Jongman (2007) argued that cats adapt well to confinement.

Our data on the incidence of injury and death related to road accidents and fighting,
together with published data such as that of Moreau et al (2003), Egenvall et al (2009),
Kolata et al (1974) and Kolata (1980), provide considerable support on cat welfare
grounds for wildlife biologists seeking to encourage confinement of cats or at least
restrictions on roaming. Placing the emphasis on cat welfare, not the contentious issue of
predation, may encourage acceptance. It may also reduce confrontation with well-
organised cat lobby groups contesting regulations or other interference in cat husbandry
that they consider excessive. For example, The Cat Fanciers’ Association, Inc. even has
a legislative group and offers support for achieving ‘acceptable and effective alternatives
to legislative restrictions’ (The Cat Fanciers’ Association, Inc 2012). With appropriate
data on the safety of collars and their benefits for cat welfare as well as wildlife
protection, as well as evidence of the dangers of unrestricted roaming, it may even be possible to enlist their support.

**Strengths and limitations of the study**

Our study used a range of different protocols (interviews, online surveys), the samples may not all be representative, and respondents may have suffered recall bias in documenting collar incidents, injuries and deaths. In spite of these difficulties, we believe that the principal findings that collar injuries and deaths are rare while road accidents and fighting are significant causes of death and injury are robust for four main reasons:

1. Each distinct approach supports the conclusion that collar injuries and deaths are rare and, where comparative data exist, that road accident trauma and fighting injuries are common.

2. Our data match the general rarity of reports of collar problems in published studies of mortalities and morbidity in cats, while both our respondents and the published studies agree that road accident trauma is a major cause of death and that fighting injuries are common.

3. The recollections of collar incidents, fighting injuries and road accident trauma are subject to identical potential for bias, so the relative incidence of these experiences should be accurate.

4. The records from veterinary practices are not subject to recall bias, yet they also support the conclusion that collar injuries are uncommon and certainly rarer than fighting trauma.
Concluding remarks

Predation on wildlife by pet cats is contentious and emotive (Calver et al 2011), so owners may resent arguments that cats should wear predation deterrents or their roaming be curtailed to protect wildlife. By contrast, highlighting that collars are low-risk and have welfare benefits may encourage their adoption, while greater awareness of the hazards to free-roaming cats may encourage restrictions on roaming. These measures will improve the welfare of pet cats by reducing the incidence of road trauma and fighting injuries and the welfare of wildlife by curtailing predation.

Lord et al (2010) attribute the low use of cat collars for identification to a widespread but mistaken belief amongst owners and veterinarians that cats do not tolerate collars or are injured by them. Their data and our results agree that collar injuries and collar deaths are rare, although minor collar incidents are more common. Checking collars frequently for fit and wear and adjusting or replacing them as necessary can reduce the chances of collar incidents. While risk from wearing a collar cannot be eliminated, it is far less than that arising from road accidents or fighting. A collar with an ID tag improves the chances of recovering a lost cat, while the collar is also a convenient attachment for one of the proven predation deterrent devices on the market. Owners may therefore simultaneously enhance their cats’ welfare and reduce predation pressure on wildlife – itself an animal welfare issue.

Nevertheless, it is also important to accept that reducing predation by pet cats is not a panacea for conserving urban wildlife. Issues of traffic, high housing densities, lack of reserves and even other pets such as dogs are also important (Patronek 1998; Chaseling
2001; Grayson et al 2007; Lunney et al 2007) and should be considered in future research. In comparison, cats are a ‘soft’ target. While owners have a range of predation deterrents to choose from and the risks of wearing a collar are low, even if all cats were either confined or wearing predation deterrents wildlife biologists would still need to address other significant causes for wildlife decline in cities.

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Figure 1: Cat owners from the general public and from the Cat Welfare Society of Western Australia were asked to rate each of these collars as safe, unsafe or unsure.
Table 1: The types of collars worn by cats currently owned by people in the general community and members of the Cat Welfare Society of Western Australia. Respondents whose cats do not wear collars are excluded.

<table>
<thead>
<tr>
<th>Type of collar</th>
<th>General community</th>
<th>Cat Welfare Society</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard collar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buckle only (no break-away or elastic)</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Safety collar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stretch in all directions</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Break-away</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Break-away and stretch</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Other type of collar</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Can’t recall</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>26</td>
</tr>
</tbody>
</table>
Table 2: Reasons given by owners from the general community and members of the Cat Welfare Society of Western Australia who do not currently fit a collar to their cats. Each owner gave only one reason.

<table>
<thead>
<tr>
<th>Reason</th>
<th>General community</th>
<th>Cat Welfare Society</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think all collars are unsafe</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>My cat is microchipped and doesn’t need to wear a collar</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>I don’t think it’s necessary</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>My cat keeps losing its collar</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>
Table 3: Ratings of four different types of cat collar as safe, unsafe or unsure by cat owners from the general community and members of the Cat Welfare Society of Western Australia.

<table>
<thead>
<tr>
<th>Collar type</th>
<th>Survey group</th>
<th>Safe</th>
<th>Unsafe</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckle only (no break-away or elastic)</td>
<td>Community</td>
<td>21</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>Stretch in all directions</td>
<td>Community</td>
<td>24</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>Break-away</td>
<td>Community</td>
<td>31</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>Break-away and stretch</td>
<td>Community</td>
<td>35</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>Buckle only (no break-away or elastic)</td>
<td>CWS</td>
<td>3</td>
<td>39</td>
<td>7</td>
</tr>
<tr>
<td>Stretch in all directions</td>
<td>CWS</td>
<td>24</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Break-away</td>
<td>CWS</td>
<td>36</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Break-away and stretch</td>
<td>CWS</td>
<td>38</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>
Table 4: The proportions of cat owners from the general community and from the Cat Welfare Society of Western Australia who owned at least one cat that: experienced a collar incident, required veterinary treatment for a collar incident, died following a collar incident, required veterinary treatment for a road traffic accident, died following a road traffic accident, or required veterinary treatment for fighting injuries. Sample sizes (in parentheses), are unequal because not all respondents answered each category.

* Significant after sequential Bonferroni adjustment (Holm 1979).
+ Frequency of the incident was too low to compare the proportions validly.

<table>
<thead>
<tr>
<th>Problem</th>
<th>General community</th>
<th>Cat Welfare Society</th>
<th>Probability of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collar incident</td>
<td>0.27 (63)</td>
<td>0.62 (50)</td>
<td>z = -3.74, 0.0002*</td>
</tr>
<tr>
<td>Veterinary treatment for a collar incident</td>
<td>0.03 (63)</td>
<td>0.06 (50)</td>
<td>+</td>
</tr>
<tr>
<td>Died as a result of a collar incident</td>
<td>0.0 (63)</td>
<td>0.02 (50)</td>
<td>+</td>
</tr>
<tr>
<td>Veterinary treatment for a road traffic accident</td>
<td>0.22 (63)</td>
<td>0.31 (49)</td>
<td>z = -1.01, 0.3144</td>
</tr>
<tr>
<td>Died as a result of a road traffic accident</td>
<td>0.62 (63)</td>
<td>0.41 (49)</td>
<td>z = 2.22, 0.027</td>
</tr>
<tr>
<td>Veterinary treatment for a fighting injury</td>
<td>0.53 (63)</td>
<td>0.58 (50)</td>
<td>z = -0.60, 0.5512</td>
</tr>
</tbody>
</table>
Table 5: The frequency cat owners from the general community and from the Cat Welfare Society of Western Australia experienced the indicated welfare problems with their cats. The number of respondents is in parentheses. Numbers in the table may exceed the number of respondents because respondents may own multiple cats.

<table>
<thead>
<tr>
<th>Problem</th>
<th>General community (63)</th>
<th>Cat Welfare Society (55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor collar incident</td>
<td>18</td>
<td>80</td>
</tr>
<tr>
<td>Collar injury</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Collar death</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Veterinary treatment for a road traffic accident</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Died as a result of a road traffic accident</td>
<td>39</td>
<td>31</td>
</tr>
<tr>
<td>Veterinary treatment for a fighting injury</td>
<td>48</td>
<td>74</td>
</tr>
</tbody>
</table>
Table 6: Comparisons of the incidence (proportion of owners who had experienced the problem with at least one cat) of collar incidents, veterinary treatment for a road accident injury, death of a cat in a road accident and veterinary treatment for a fighting injury. Data are from Table 4. Probability values marked * are significant after sequential Bonferroni adjustment (Holm 1979).

<table>
<thead>
<tr>
<th>Owners</th>
<th>Collar incident vs veterinary treatment for road accident</th>
<th>Collar incident vs death from road accident</th>
<th>Collar incident vs veterinary treatment for fighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>General community</td>
<td>$z = 0.62$, $p = 0.53$</td>
<td>$z = -3.94$, $p &lt; 0.0002^*$</td>
<td>$z = -2.91$, $p = 0.0036^*$</td>
</tr>
<tr>
<td>Cat Welfare Society</td>
<td>$z = 3.13$, $p = 0.0017^*$</td>
<td>$z = 2.11$, $p = 0.0349$</td>
<td>$z = 0.41$, $p = 0.6883$</td>
</tr>
</tbody>
</table>