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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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20 Running title: Safety of cat collars

## Abstract

25

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  
30 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  
35 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  
40 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  
45 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

## 50 **Introduction**

Interventions to conserve wildlife sometimes require adjustments to the husbandry of domestic animals (Vanak & Gompper 2009; Silva-Rodriguez & 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/km<sup>2</sup> (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

75 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  
80 ‘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  
85 (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  
90 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*  
95 *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

100 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  
105 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  
110 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  
115 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.

## 120 **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,

125 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  
130 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  
135 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  
140 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  
145 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

150 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,  
155 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  
160 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).

165

### *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  
170 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.



175 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.

### 180 *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  
185 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.

### 190 *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  
195 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.

## 200 **Results**

### *Interviews with veterinarians and practice records*

Eighty-five (79.4%) of the 107 veterinarians with a total of 1588 years of practice  
205 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.  
210 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  
215 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  
220 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

225 often active outside) included no collar injuries, nine fighting injuries (5.5%) and no  
motor vehicle accidents.

### *Interviews with the general public*

230 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  
235 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  
240 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

245 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

250 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  
255 veterinary treatment for fighting injuries and the proportion of owners who had lost a cat  
in a road accident (Table 6).

Table 4 here

Table 5 here

260 Table 6 here

### *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  
265 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.

270 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

275 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  
280 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  
285 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).

290 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  
295 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.

300

*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  
305 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).

310

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  
315 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).

320

**Discussion**

*Overall incidence of collar incidents, injuries and deaths relative to road accident trauma and fighting injuries*

325

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  
330 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.

335 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  
340 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  
345 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

350 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  
355 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  
360 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  
365 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,  
370 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



375 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.

380 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  
385 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*  
390 *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  
395 (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

400 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  
405 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’  
410 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  
415 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  
420 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.

425 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  
430 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  
435 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  
440 (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***

445 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

450 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  
455 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  
460 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  
465 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***

470 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

475 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).

480 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  
485 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;  
490 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  
495 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  
500 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  
505 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  
510 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),  
515 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  
520 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  
525 possible to enlist their support.

### *Strengths and limitations of the study*

Our study used a range of different protocols (interviews, online surveys), the samples  
530 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:

- 535 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  
540 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.
- 545 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*

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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.

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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.

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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

575 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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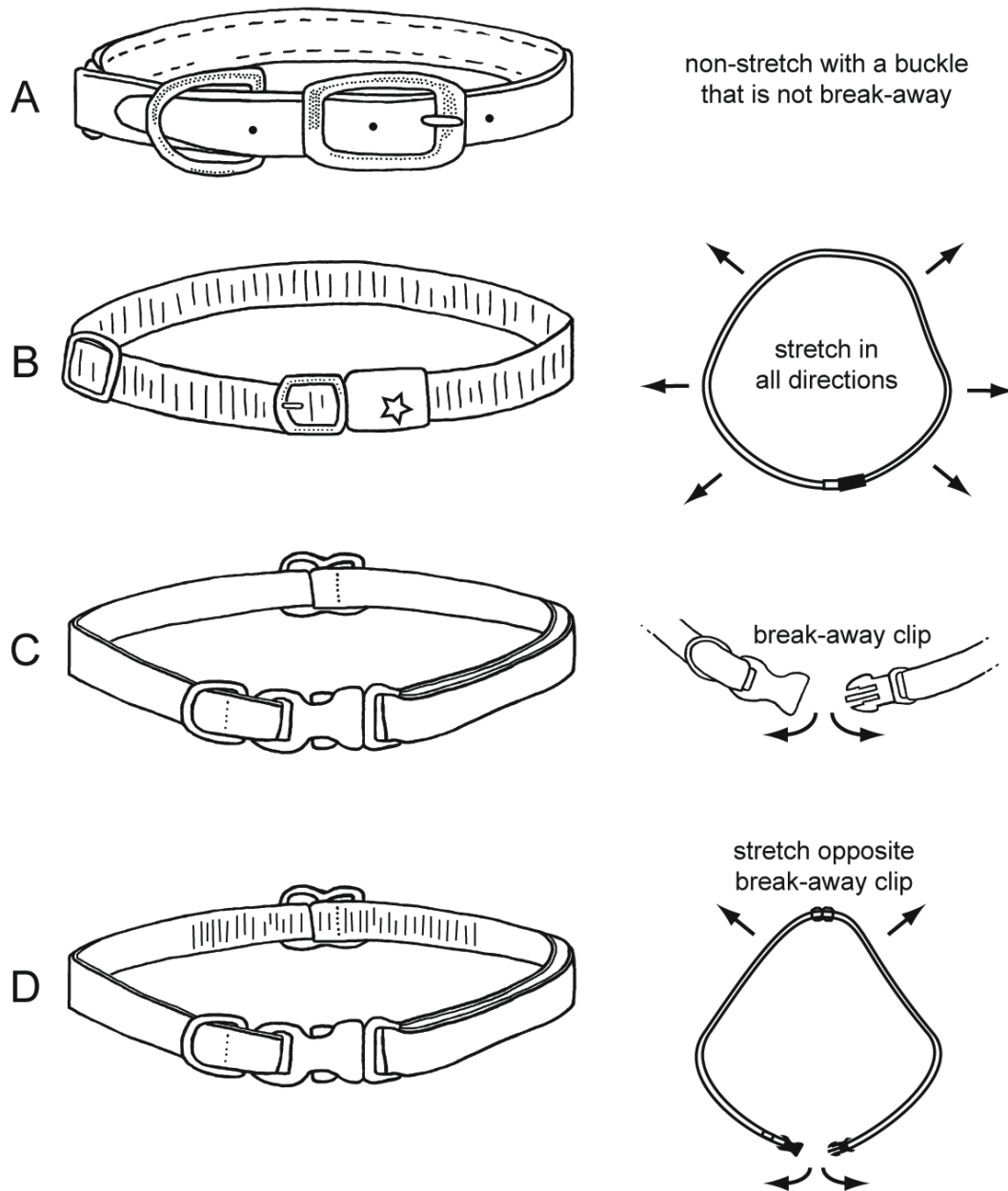
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785 **Figure 1:** Cat owners from the general public and from the Cat Welfare Society of Western Australia were asked to rate each of these collars as safe, unsafe or unsure.



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795 **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.**

Type of collar	General community	Cat Welfare Society
<i>Standard collar</i>		
Buckle only (no break-away or elastic)	17	3
<i>Safety collar</i>		
Stretch in all directions	1	8
Break-away	3	9
Break-away and stretch	2	6
Other type of collar	2	0
Can't recall	8	0
<b>Total</b>	<b>33</b>	<b>26</b>

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**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.**

Reason	General community	Cat Welfare Society
I think all collars are unsafe	4	3
My cat is microchipped and doesn't need to wear a collar	13	3
I don't think it's necessary	3	2
My cat keeps losing its collar	0	4
Other	10	8
<b>Total</b>	<b>30</b>	<b>20</b>

**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.**

Collar type	Survey group	Safe	Unsafe	Unsure
Buckle only (no break-away or elastic)	Community	21	22	20
Stretch in all directions	Community	24	12	27
Break-away	Community	31	7	25
Break-away and stretch	Community	35	3	25
Buckle only (no break-away or elastic)	CWS	3	39	7
Stretch in all directions	CWS	24	13	12
Break-away	CWS	36	4	9
Break-away and stretch	CWS	38	2	9

815 **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**  
820 **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.**

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

Problem	General community	Cat Welfare Society	Probability of difference
Collar incident	0.27 (63)	0.62 (50)	$z = -3.74, 0.0002^*$
Veterinary treatment for a collar incident	0.03 (63)	0.06 (50)	+
Died as a result of a collar incident	0.0 (63)	0.02 (50)	+
Veterinary treatment for a road traffic accident	0.22 (63)	0.31 (49)	$z = -1.01, 0.3144$
Died as a result of a road traffic accident	0.62 (63)	0.41 (49)	$z = 2.22, 0.027$
Veterinary treatment for a fighting injury	0.53 (63)	0.58 (50)	$z = -0.60, 0.5512$

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**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.**

Problem	General community (63)	Cat Welfare Society (55)
Minor collar incident	18	80
Collar injury	2	4
Collar death	0	1
Veterinary treatment for a road traffic accident	14	19
Died as a result of a road traffic accident	39	31
Veterinary treatment for a fighting injury	48	74

840 **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  
 845 are from Table 4. Probability values marked \* are significant after  
 sequential Bonferroni adjustment (Holm 1979).

Owners	Collar incident vs veterinary treatment for road accident	Collar incident vs death from road accident	Collar incident vs veterinary treatment for fighting
General community	$z = 0.62, p = 0.53$	$z = -3.94, p < 0.0002^*$	$z = -2.91, p = 0.0036^*$
Cat Welfare Society	$z = 3.13, p = 0.0017^*$	$z = 2.11, p = 0.0349$	$z = 0.41, p = 0.6883$